Greenland halibut in Subarea 0+1 (offshore) Advice June 2022 for 2023-2024

Recommendation for 2023 and 2024

The main index for this stock has not been updated since 2017, consequently stock status is increasingly uncertain. However, SC notes that the stock varied without trend between 2013-2017 while the fishery was increasing. Average catches during this period were 29,640 t, therefore, SC recommends catches not to exceed this value in 2023 and 2024.

Management objectives

Canada and Greenland adopted a total allowable catch (TAC) of 36 370 t for 2019 to 2022. Canada requests that stock status be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with the precautionary approach.

Convention General Principles	*Status*	*Comment/consideration*
Restore to or maintain at B_{MSY}	○	B_{MSY} Unknown
Eliminate overfishing	○	F_{MSY} Unknown
Apply Precautionary Approach	●	B_{lim} *valid to 2017*
Minimise harmful impacts on living marine resources and ecosystems	●	Fishing closures are in effect in SA0 and Div. 1A. No specific measures.
Preserve marine biodiversity	○	Cannot be evaluated

● OK
● Intermediate
● Not accomplished
○ Unknown

Management unit

The Greenland halibut stock in Subarea 0 + 1 (offshore) is part of a larger population complex distributed throughout the Northwest Atlantic. From 2020, separate assessments are made on the inshore management units in 1A-F and 0B.

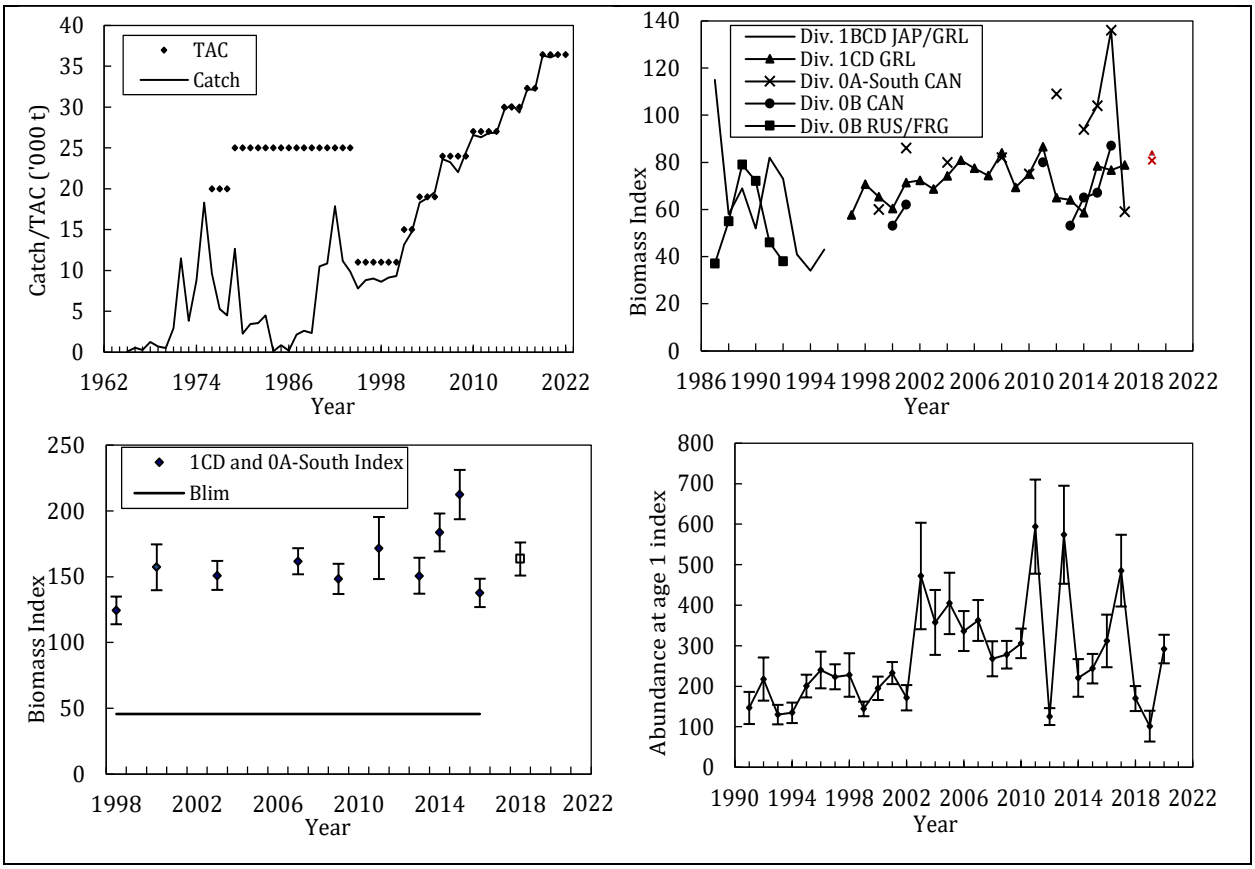
Stock status

The 0A-South and 1CD biomass index was above B_{lim} throughout the time series, 1999 to 2017. The 2019 value is similar in magnitude to previous surveys, however, it is not considered directly comparable. Despite a lack of index survey data in recent years the stock status is not expected to have changed drastically during 2018 to present.

Special Comment

The main index for this stock has not been updated since 2017, consequently stock status is increasingly uncertain: this increases the risks associated with management decisions. It is essential that surveys resume as soon as possible to update indices.

In assessing stock status SC considered the observed stability in length frequencies from surveys and the fishery, the age-1 index, that TACs have been consistently achieved, longevity of the species, and that status in 2017 was well above B_{lim}.



Reference points

B_{MSY} is not known for this stock. In 2015 a proxy for B_{lim} was developed based on 30% of a period of stability in the 0A-South and 1CD index (1999-2012). However, no surveys were conducted in 2018, 2020 or 2021 and the 2019 survey was not considered comparable to previous surveys. The previous B_{lim} was valid to 2017, but needs to be re-evaluated once a new time series is established.

Assessment

The assessment is qualitative with input from research surveys (total biomass and abundance indices to 2017, an index of age 1 fish to 2020, and length frequency distributions to 2017) and fishery length frequencies to 2021.

The next assessment is expected to be in 2024.

Human impact

Mainly fishery related mortality has been documented. Other sources (e.g. pollution, shipping, oil-industry) are undocumented.

Biology and Environmental interactions

No specific studies were reviewed during this assessment

Fishery

Catches were first reported in 1964. Catches increased from 1989 to 1992 due to a new trawl fishery in Div. 0B with participation by Canada, Norway, Russia and Faeroe Islands and an expansion of the Div. 1CD fishery with participation by Japan, Norway and Faeroe Islands. Catch declined from 1992 to 1995 primarily due to a reduction of effort by non-Canadian fleets in Div. 0B. Since 1995 catches have been near the TAC and increasing in step with increases in the TAC, with catches reaching a high of 36 436 t in 2021.

Recent catch and TACs ('000 t)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TAC	27	30	30	30	32.3	32.3	36.4	36.4	36.4	36.4
STACFIS SA 0	13.4	14.9	15.4	14.1	15.9	16.0	18.3	17.9	19.1[2]	
STACFIS SA 1	13.5	14.7	14.9	15.2	16.2	16.2	18.0	18.1	17.3	
Total STACFIS[1]	26.9	29.6	30.3	29.3	32.1	32.2	36.3	36.0	36.4	

[1] Based on STATLANT, with information from Canada and Greenland authorities to exclude inshore catches.

[2] STACFIS estimate using 1.5 conversion factor for J-cut, tailed product; 1 129 t increase over reported catch.

Effects of the fishery on the ecosystem

The impact of bottom fishing activities on VMEs in SA 0 was assessed in 2016. Three areas have been designated as marine refuges, that exclude bottom contact fisheries: Disko Fan, Davis Strait and Hatton Basin. Areas in SA 1 have also been closed to fishing to protect benthic habitats.

Greenland Shark is a bycatch species of concern in the SA 0+1 (offshore) fishery given its low reproductive rate, slow growth rate and limited ecological information. SC has examined Greenland Shark bycatch records and survey encounters in the NAFO Convention Area to determine the amount of, and spatial and temporal patterns in Greenland Shark bycatch.

Basis for Advice

A quantitative assessment of risk at various catch options is not possible for this stock, therefore, it is not possible to quantitatively evaluate the sustainability of the TAC. There was no biomass index available for 2018, 2020 or 2021, and there is uncertainty in the comparability of the 2019 estimate. TAC advice in 2022 is based on a qualitative review of available data.

Sources of information

SCR 22/022, 023, 21/014; SCS Doc. 22/009, 012, 017

III. STOCKS ASSESSMENTS

A. STOCKS OFF GREENLAND AND IN DAVIS STRAIT: SUBAREA 0 AND SUBAREA 1

Recent Conditions in Ocean Climate and Lower Trophic Levels

- The ocean climate index in Subarea 0-1 above normal in 2021.
- Mean initiation timing of the spring phytoplankton bloom in 2021 was the earliest of the time series.
- Spring bloom magnitude (total production) was slightly below normal in 2021

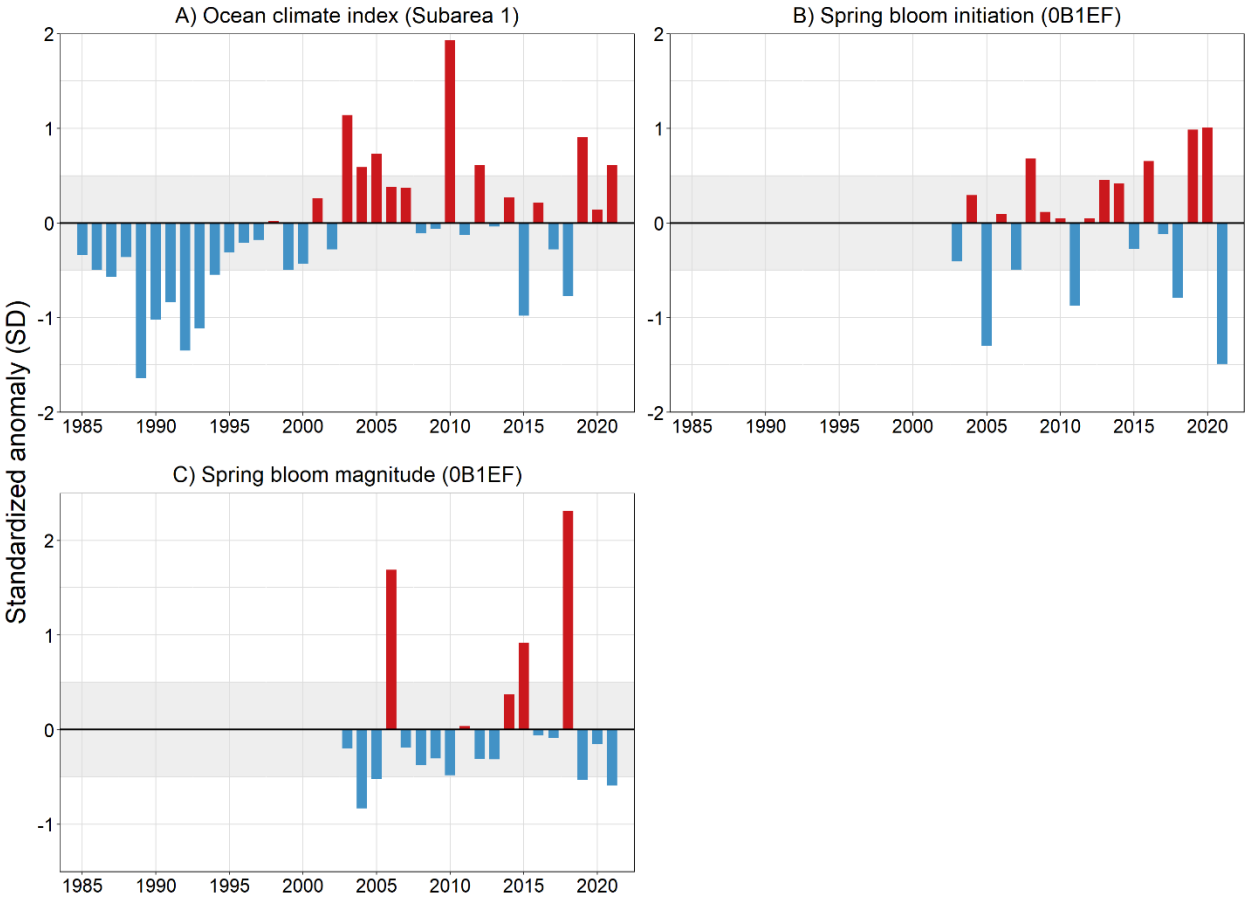


Figure A1. Annual anomalies of environmental indices for NAFO Subareas 0 and 1. The ocean climate index (A) for the period 1990-2020 is the average of 10 individual time series. These includes standardized anomalies of 4 SSTs time series, 4 temperature time series at 3 hydrographic stations and 2 air temperatures time series (see Cyr and Belanger 2022 for details). Spring bloom anomalies (B, C) for the 2003-2021 period are derived from four satellite boxes (HS, NLAB, CLAB, GS – see Cyr and Belanger 2022 for details). Positive (negative) anomalies indicate late (early) bloom timing or magnitude above (below) the mean for the reference period. Anomalies were calculated using the following reference periods: ocean climate index: 1981-2010, spring bloom indices: 2003-2020. Anomalies within ± 0.5 SD (shaded area) are considered near-normal conditions.

Environmental Overview

Hydrographic conditions in this region depend on a balance of ice melt, advection of polar and sub-polar waters and atmospheric forcing, including the major winter heat loss to the atmosphere that occurs in the central Labrador Sea. The cold and fresh polar waters carried south by the east Baffin Island Current are counter balanced by warmer waters are carried northward by the offshore branch of the West Greenland Current (WGC). The water masses constituting the WGC originate from the western Irminger Basin where the East Greenland Currents (EGC) meets the Irminger Current (IC). While the EGC transports ice and cold low-salinity Surface Polar Water to the south along the eastern coast of Greenland, the IC is a branch of the North Atlantic current and transports warm and salty Atlantic Waters northwards along the Reykjanes Ridge. After the currents converge, they turn around the southern tip of Greenland, forming a single jet (the WGC) that propagates northward along the western coast of Greenland. The WGC is important for Labrador Sea Water formation, which is an essential element of the Atlantic Meridional Overturning Circulation. At the northern edge of the Labrador Sea, after receiving freshwater input from Greenland and Davis Strait, part of the WGC bifurcates southward along the Canadian shelf edge as the Labrador Current.

Ocean Climate and Ecosystem Indicators

The ocean climate index in Subarea 0-1 has been predominantly above or near normal since the early 2000s, except for 2015 and 2018 that were below normal (1A). After being in 2019 at its highest value since the record high of 2010, the index was normal in 2020 and again above normal in 2021. Before the warm period of the last decade, cold conditions persisted in the early to mid-1990s.

Spring bloom initiation has been oscillating between early (negative anomalies) and late (positive anomalies) timing between 2003 and 2020. In 2021, the average timing of the spring bloom in Subarea 0B1EFT was the earliest of the time series and followed the two latest bloom onset on record for the region (Figure A1B). Spring bloom magnitude (total production) remained mostly below or near-normal between 2003 and 2020 with the exception of a few highly productive bloom in 2006, 2015 and 2018 (Figure A1C). In 2021, mean bloom magnitude in the region was slightly higher than normal (Figure A1C).

1. Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 0 and 1 (Offshore)

(SCR Doc. 22/022, 22/023, 21/014; SCS Doc. 22/009, 22/012)

a) Introduction

The Greenland halibut stock in Subarea 0 and 1 (offshore) is part of a larger population complex distributed throughout the Northwest Atlantic (Roy et al. 2014). The fishery distribution includes Canadian (SA0) and Greenland (SA1) offshore waters. Canada and Greenland manage the fisheries independently and request advice from NAFO SC. The fishery came under quota regulation in 1976 when a TAC of 20,000 t was established. TAC was increased to 25,000 t in 1979. In 1994 analysis of tagging and other biological information resulted in the creation of separate management areas for inshore Div. 1A. The portion of the TAC allocated to Subarea 0+1A (offshore) and 1B-F was set at 11 000 t and the TAC remained at this level from 1995-2001, during which time the TAC was fished almost exclusively in Div. 0B and Div. 1CD. A series of surveys took place during 1999-2004 in areas of Div. 0A and 1AB that had not been surveyed before resulting in an expansion of the fishery into these northern divisions between 2001 and 2006. In 2020 studies of parasites, analysis of historic taggings and fishery data resulted in the creation of separate management areas for inshore Div. 1B-F (SCR Doc. 20/034).

The assessment is qualitative, and since 2014 has been based on an index of survey biomass that combines Divisions 0A-South and 1CD surveys (ICES 2013). The surveys are conducted by the same vessel and gear during the fall which allows for a combination of the survey results. An index based harvest control rule was accepted as the basis for TAC advice in 2016 and 2018.

The vessel that conducted surveys from 1997 to 2017 was retired in 2018 and a new research vessel built by the Greenland Institute of Natural Resources will begin a new survey time series in 2022. No survey was conducted in 2018, 2020 and 2021. A commercial vessel was used for the 2019 survey. This change in vessel had an effect on gear performance such that the 2019 index is not directly comparable to previous years. Also, earlier timing for the 0A-South survey in 2019 introduced additional uncertainty to the comparability of this index. Assessment and advice in 2020 and 2022 were based on a qualitative review of available survey and fisheries data. The absence of a continuous survey series limits the assessment and STACFIS may be unable to evaluate the impact of the advised TAC.

Fishery and Catch: Bottom otter trawl gear is used by most fleets in the Subarea 1 fishery. There have been longline vessels occasionally in the offshore, however gillnet gear is not allowed. The Subarea 0 fishery is a mix of trawl and gillnet (between 30-40% of the catch in recent years) with the occasional use of longline. The trawlers in both Subareas have been using both single and double trawl configurations since about 2000. The gillnet fishery in Subarea 0 began in 2005 and has been using baited gillnets since about 2015. Baiting gillnets has been shown to increase catch rates (Bayse and Grant 2020).

Catches were first reported in 1964 and rose to 20,027 t in 1975 before declining to 2,031 t in 1986. Catches increased from 1989 to 1992 (reaching a level of 17,888 t) due to a new trawl fishery in Div. 0B with participation by Canada, Norway, Russia and Faeroe Islands and an expansion of the 1CD fishery with participation by Japan, Norway and Faeroe Islands. Catch declined from 1992 to 1995 primarily due to a reduction of effort by non-Canadian fleets in Div. 0B. Since 1995 catches have been near the TAC, increasing in step with increases in the TAC. Since 2019 the TAC has been 36,400 t. In 2021 catches were 36,436 t (Figure 1.1).

Fisheries and Oceans Canada does not include the J-cut and tail off product in its product list for Greenland halibut, however, the majority of the catch in this fishery (~90%) is processed as this product. An interim conversion factor (CF) of 1.49 was therefore provided in at-sea observer manuals and used by vessel operators and observers since 2007. In 2021, the CF for J-cut, tail off product was lowered by Canadian authorities from 1.49 to 1.4. Based on a review of at-sea observer experiments conducted in Subarea 0 the appropriate value to estimate round weight from J-cut, tail off, dressed weight is 1.5, which is comparable with J-cut, tail off CF values used by other countries that fish in the SA0+1 stock area (SCR Doc. 22/023). The catch in SA 0 for 2021 was adjusted accordingly.

Recent catch and TACs ('000 t):

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TAC	27	30	30	30	32.3	32.3	36.4	36.4	36.4	36.4
STACFIS SA 0	13.4	14.9	15.4	14.1	15.9	16.0	18.3	17.9	19.1[2]	
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[2] STACFIS estimate using 1.5 conversion factor for J-cut, tailed product; 1,129 t increase over reported catch.

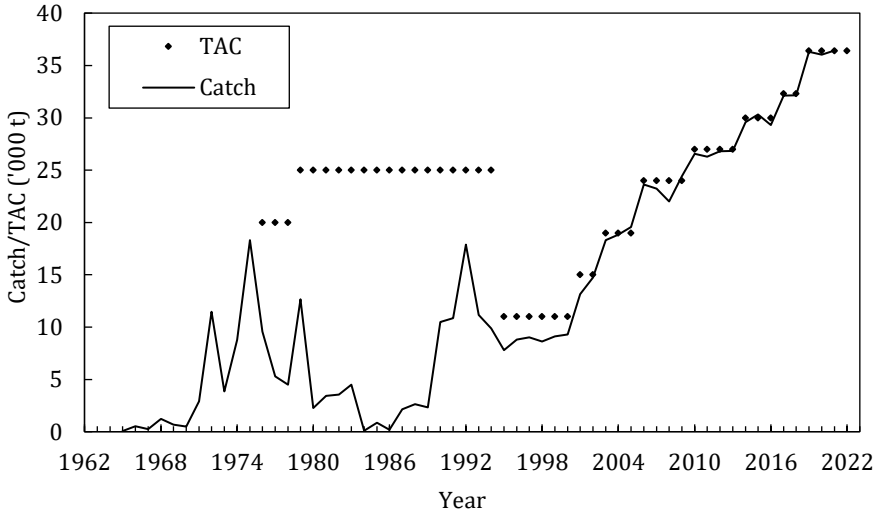

Figure 1.1. Greenland halibut in Subarea 0 and 1 (offshore): catches and TACs.

b) Data Overview

i) Commercial fishery

Length frequencies were available for 2021 from Greenland trawl fisheries in Div. 1AB, , Greenland, German, trawl fisheries in Div. 1CD, and from Canadian gillnet and trawl fisheries in Div. 0AB.

Length frequency data have been combined to produce an overview for the SA0+1 trawl fleets and the SA0 gillnet fleet. Modal length for the trawl fleets has varied from 49 to 51 cm and since 2014 the mode has remained above 50 cm. Modal length in the SA 0 gillnet fleet was approximately 61 cm prior to 2014 and since then has declined to about 56 cm observed in 2021.

ii) Research surveys

In the past, surveys were conducted by Russia and the Federal Republic of Germany in 0B (1987-1992) and by Greenland and Japan in 1BCD (1987-1995). Greenland and Canada began conducting surveys in 1997 and 1999, respectively (Figure 1.2).

Greenland Surveys (Div. 1CD)– Buffered stratified random bottom trawl surveys conducted during fall from 400 to 1500 m, from 1997-2017, and in 2019. Biomass in 1CD fluctuated with a slight positive trend through most of the time series (Figure 1.2). In 2017, biomass was similar to levels seen in 2015 and 2016. There were no surveys in years 2018, 2020 and 2021. The 2019 estimate is not comparable to previous values.

Canada Surveys (Div. 0A-South and occasionally in 0B and 0A-North**) –** Buffered stratified random bottom trawl surveys conducted during fall from 400 to 1500 m, in 1999, 2001, every second year between 2004 and 2014, annually to 2017 and in 2019. Biomass in Div. 0A-South varied with an increasing trend from 1999 to 2016 followed by a marked decline in 2017 (Figure 1.2). Biomass in Div. 0B in 2016 was similar to a previous high

observed in 2011. There were no surveys in years 2018, 2020, and 2021. The 2019 0A-South estimate is not comparable to previous values.

Combined 0A-South and 1CD Surveys - In 2014 STACFIS adopted a recommendation from the ICES Greenland halibut benchmark meeting (ICES 2013) to create a combined survey index with which to monitor the overall Subarea 0+1 (offshore) stock. The surveys are conducted with the same vessel and gear during the fall which allowed for simple addition of the survey estimates to create the index. The biomass index had remained stable at a relatively high level during 1999-2012 and therefore, based on Precautionary Approach Framework guidance from NAFO SC for stocks assessed using an index (SCS Doc. 04/12), the average over this period was accepted as a proxy for $B_{MSY,}$ and B_{lim} was set as 30% of the proxy $B_{MSY.}$ The index increased between 2014 and 2016 and while it declined in 2017 it remained well above B_{lim} (Figure 1.3). Abundance followed a similar trend. The decline observed in 2017 was a result of a decline in 0A-South. The 2019 value is similar in magnitude to previous surveys, however, it is not considered directly comparable for use in provision of advice.

The length distribution for 0A-South and 1CD surveys combined ranged from about 5 cm to 100 cm. Modal lengths have shifted from 42-43 cm at the beginning of the time series to a high of 51 cm in 2015. Secondary modes were clearly present in 2008 and 2012-2017.

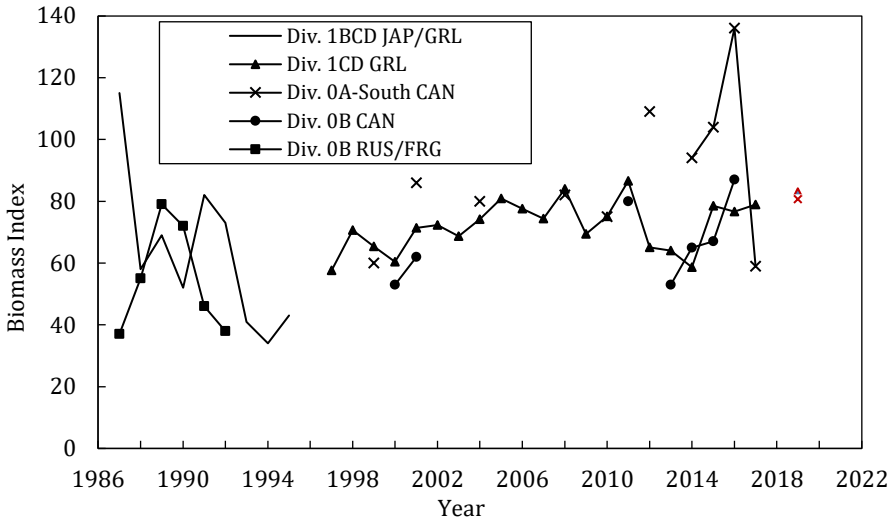

Figure 1.2 Greenland halibut in Subarea 0 and 1 (offshore): biomass indices from bottom trawl surveys. A survey in Div. 0A in 2006 is not included due to poor coverage.

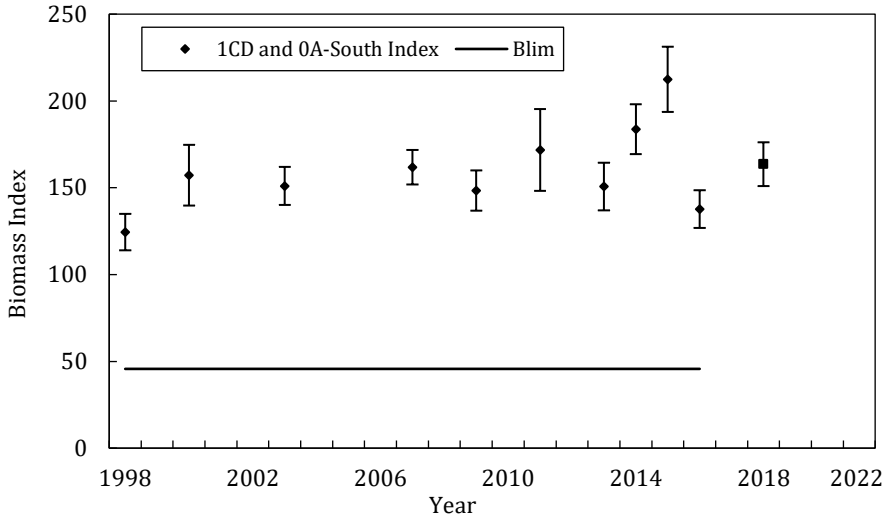

Figure 1.3 Greenland halibut in Subarea 0 and 1 (offshore): Biomass trends in Div. 0A-South + Div. 1CD survey and the proxy for B_{lim}.

Age-1 Abundance Index - The Petersen-method is used to assign Greenland halibut caught during the West Greenland shrimp survey to age 1, 2 and 3+ using length data. The survey takes place on the Greenland shelf in Div. 1A-F at depths 50 m to 600 m for fish sampling (SCR Doc. 21/014). The number of 1 year old fish in the survey area, including Disko Bay (also area within Division 0A when available), is used as an age-1 index. The index was generally increasing from 1988 to 2003, followed by a declining trend to 2010, and since then the index has been variable with series high values observed in 2011, 2013 and 2017 (Figure 1.4). Abundance in 2020 is near the series average. A change in survey vessel occurred in 2018, but gear performance analyses concluded the surveys were comparable (SCR 20/15).

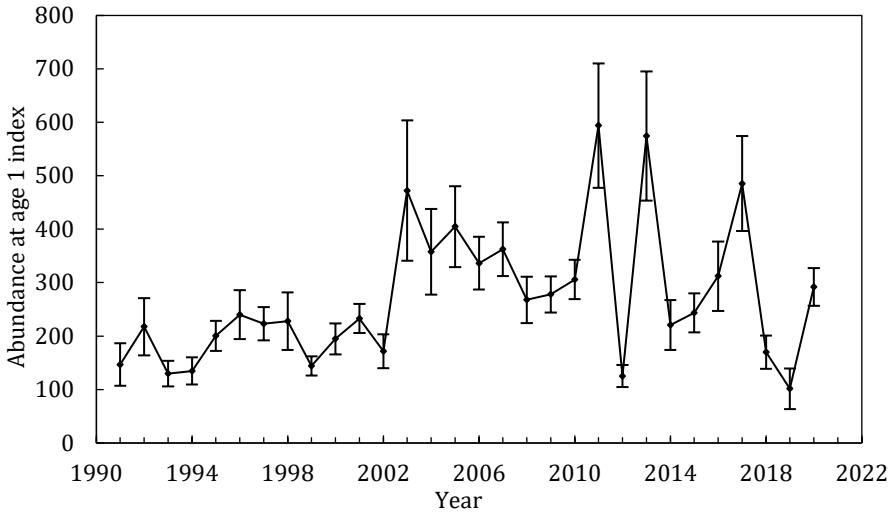

Figure 1.4 Greenland halibut in Subarea 0 and 1 (offshore): index at age 1 derived from the Greenland Shrimp and Fish Survey.

c) Assessment Results

There is no accepted analytical model. Several attempts to model the stock dynamics have been tried over the years using methods such as Yield per Recruit Analysis, XSA, ASPIC and Schaefer surplus production model.

i) Subarea 0 and 1 (offshore)

Biomass: The RV Pâmiut 0A-South+Div. 1CD combined survey biomass index, 1999 – 2017 had been relatively stable from 1999 to 2014 then more variable with a time series high in 2016 and a level near the series low in 2017, all values were above B_{lim}.

Recruitment: Recruitment is uncertain.

Fishing mortality: Fishing mortality is uncertain.

State of the Stock: The 0A-South and 1CD biomass index was above B_{lim} throughout the time series, 1999 to 2017. The 2019 value is similar in magnitude to previous surveys, however, it is not considered directly comparable. Despite a lack of index survey data in recent years the stock status is not expected to have changed drastically during 2018 to present.

d) Reference Points

B_{MSY} is not known for this stock. In 2015 a proxy for B_{lim} was developed based on 30% of a period of stability in the 0A-South and 1CD index (1999-2012). However, no surveys were conducted in 2018, 2020 or 2021 and the 2019 survey was not considered comparable to previous surveys. The previous B_{lim} was valid to 2017, but needs to be re-evaluated once a new time series is established.

The next full assessment of this stock is expected to be in 2024.

e) Recommendations:

In 2018 STACFIS **recommended** that *the CPUE data be explored and the General Linear Model examined to better understand the observed trends.*

In 2020 STACFIS **recommended** that *the overall 1A-F survey biomass be explored as an index of stock status instead of only the age 1 portion of this survey.*

STATUS: No progress has been made on these recommendations in 2022. However, effort is underway to explore spatial and length based models using all available survey indices as well as fishery catch and length frequencies, to identify the potential for their use in future assessments of this stock.

References

ICES 2013. Report of the benchmark on Greenland halibut stocks (WKBUT). ICES CM 2013/ACOM:44. 74pp.

Roy, D., D. C. Hardie, M. A. Treble, J. D. Reist and D. E. Ruzzante. 2014. Evidence of high gene flow in a locally adapted species: the paradox of Greenland Halibut (Reinhardtius hippoglossoides) panmixia in the Northwest Atlantic. Canadian Journal of Fisheries and Aquatic Science 71: 763-774.

2. Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 1 inshore

(SCR Doc. 18/023, 22/008, 009, 010, 024, 029, 031, 035, 036, 037, 038; SCS Doc. 22/11) Full assessment.

a) Introduction

The fishery targeting Greenland halibut developed in the Disko Bay and south Greenland in the beginning of the twentieth century. The fishery is conducted with longlines or gillnets from small vessels, open boats and through holes in the sea ice during the winter months. The fishery gradually spread from the Disko Bay to Uummannaq and Upernavik, but the catches remained low until the 1980s.

Quota regulations were introduced in 2008 as a shared quota for all vessels . In 2012, the TAC was split in two components with ITQ's for vessels and shared quota for small open boats. In 2014, the Government of Greenland set "quota free" areas within each subarea, and in these areas, catches were not drawn from the total quota, although still included in landing statistics. In 2022 the quota free areas were abolished.

To protect juvenile fish in the area, sorting grids have been mandatory since 2002 in the offshore shrimp fishery at West Greenland and since 2011 in the inshore shrimp fishery in the Disko Bay. Trawl fishery is not allowed