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The Upernavik gillnet survey.

by

Rasmus Nygaard, Henrik Christiansen & Inuk Petersen.

Greenland Institute of Natural Resources, P.O. Box 570, 3900 Nuuk, Greenland

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Abstract

This paper presents the updated indices for the surveys performed by the Greenland Institute of Natural resources (GINR) in the fjords near Upernavik, part of the NAFO division 1A (inshore). The area was previously surveyed using longlines, but from 2011 to 2015 the surveys were gradually changed to gillnet surveys. Since 2016, gillnet surveys have been fully implemented in the area. The gillnet survey was originally designed to target pre-fishery recruits and commercial sized Greenland halibut from 30-55 cm. In order to survey commercially sized Greenland halibut a larger meshed section (90 mm half mesh) was added in 2016. Estimated NPUE and CPUE increased to an all-time high in 2020 and gradually decreased since.

Introduction

Greenland halibut is of major importance to the people living in North-West Greenland as the commercial fishery in the area is almost exclusively based on the Greenland halibut. Other sources of income is traditional hunting. The fjords near *Upernavik* where Greenland halibut are targeted are characterized by several large iceberg producing glaciers, which extend into deep narrow fjords with depths of more than 900 m (Fig. 1). The most important commercial fishing grounds are the Upernavik icefjord, Gieskes icefjord (Gulteqarffik), the fjords near Kullorsuaq, Tasiusaq bay, and areas close to the settlements in the area. Although the main fishing grounds in the Upernavik area are in the deep icefjords, the branching fjord systems between the icefjords are easier to access and survey. The branching side fjords have more suitable depths 0-700 m and have smaller icebergs and less summer glacier ice than the Upernavik icefjord and Gieskes icefjord, which are rarely accessible to the research vessels during the open water summer months. Therefore, the survey is limited to the fjord areas between the larger icefjords and only partly covering the commercial fishing grounds in the area. The management area extends to 75° North, and little to no fishery exists further north until the Qaanaaq fjord, although Greenland halibut are present in the entire Baffin bay area.

Materials and methods

Surveys have been conducted since the 1960's with longlines, but the results from the surveys were highly variable from year to year and difficult to interpret. From 2012 to 2015 the longline survey was gradually changed to a gillnet survey.

The survey is conducted with the GINR research vessel R/V Sanna. Stations are paired two and two, close to each other (0,5-1 NM) to allow for analysis of within- station variability. The gillnets are composed of 60 m long sections with mesh sizes 46, 55, 60 and 70 mm (knot to knot or half mesh). From 2016 and forward a 90 mm

section (half mesh) was added to the gillnet survey to increase the number of large Greenland halibut and also survey the commercial part of the stock. Theoretical selection curves indicates that the excluding the 60mm section provides a more flattened overall selection curve. Sections are separated with a 2 m open space to prevent catchability interactions. Soak time is approximately 6-18 hours and fishing occurs both day and night.

Length, weight, gutted weight, otoliths, and occasionally DNA samples are regularly collected during the surveys. Otoliths are collected from individual Greenland halibut and frozen in a plastic bag with a printed plastic label with individual information and an automatically created number. At the GINR, otoliths are read after a method developed in Norway. In the laboratory otoliths are photographed with translucent light with a Leica S9i stereomicroscope in a 5 MP TIF image. After imaging the otoliths are archived. Digitally archived images are then "read on screen" using ImageJ. In ImageJ both contrast and brightness can easily be adjusted, and a calibration beam allows for digital measurements of otoliths proportions. Images are standardized and attempts for automated digital reading are being tested.

Ageing of the otoliths was done by looking at the dried otolith through a stereomicroscope. However, from 2007 to 2009 the method changed to looking at fresh frozen otoliths through a stereomicroscope. Uncertainty about the method led, however, to a lack of reading until 2017.
An age length key (ALK) is produced from the aged otoliths for each cm group. If the ALK is incomplete for certain lengths, a backup ALK is used for the missing length combinations from the same year but combined inshore areas. The backup-ALK produced from all inshore areas in a given year, is screened for the missing length-age combinations. To produce a complete backup-ALK, missing ages for certain lengths are estimated from the von Bertalanffy growth equation. Temperature and depth loggers are attached to most gillnets, measuring the bottom temperature and revealing the sinking rate of the gillnets. The index is currently not corrected for sinking time which increases with depth. Sinking time varies from 20 min at shallow depth to almost 60 min in deep stations (+900m).

CTD stations are performed in the central part of the Upernavik isfjord and Tasiusaq bay. The data is analysed and stored by the Greenland Climate Research Centre GCRC, located in Nuuk.

Results

In the initial experimental years, the number of stations in the gillnet survey was low. Between 13 and 21 gillnet stations were made annually. The goal is to set more than 40 stations per year. An overview of the most recent surveys and stations by year, vessel, and gear is given in table 1.

From 2015 to 2019, survey NPUE remained at a stable level whereas the CPUE decreased slightly (Table 2 and Fig. 2). In 2020 a substantial increase in both NPUE and CPUE was observed across all stations (Fig. 3). After 2020 both CPUE and NPUE gradually decreased.

The increase from 2020 is mainly caused by higher numbers of Greenland halibut from 40 to 55 cm (Fig. 4). However, higher numbers of 30 cm Greenland halibut (around 3 years) were also observed in 2020 (Fig. 4). The slight decrease in CPUE from 2015 to 2019 is paralleled by a decrease in fish size (Fig. 4a). Whereas the number of prefishery recruits in the size range from 30-40 cm has been unchanged since 2017 the number of larger Greenland halibut has decreased (figure 4a and 4b).

The survey Catch-At-Age (Table 4 and Fig. 5) indicates a shift towards younger but more numerous fish in the survey. The strong 2015 cohort is clearly detectable in 2022 but is no longer detectable in 2023 (Fig. 5).

A length-weight relationship for the sampled Greenland halibut since 2010 is provided in table 5. Since graders (automated machines that weigh each fish in the factories and sort the landings in size groups) are now operational in several fish factories in the area, the individual weights from thousands of fish are combined with the annual survey length-weight relationship to estimate the length of the commercial landings.

Cod, redfish, Arctic skate, thorny skate, and spotted wolffish are also caught in the survey. CPUEs are not presented for these species currently.

Discussion

Only part of the commercial area is covered by the survey, the most important fishing grounds are inaccessible due to glacier ice. Therefore, the survey should be considered an index only. The increase in NPUE and CPUE in 2020 and 2021 (compared to previous years) corresponds well with observations of increased recruitment observed in Disko Bay and the Uummannaq fjord. The few otoliths read in 2022 may pose a problem leading to an underestimation of the age composition of the stock in 2022. A 2010 YC further seems visible in the bubbleplot which fits well with the larger than usual numbers of age 1 halibut observed in 2011 (2010 YC) in the Greenland shrimp and fish survey which includes the offshore recruitment area just west Upernavik. The 2015 year-class which was also observed as large in The Disko Bay and Uummannaq, is clearly visible in Upernavik.

References

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Table 1. Number of stations by gear (Table is incomplete).

Year	Longline	Gillnet	Vessel	Notes (mesh size)
1994	30	-	AJ	
1995	32	-	AJ	
1996	-	-	-	
1997	-	-	-	
1998	31	-	AJ	
1999	-	-	-	
2000	30	-	AJ	
2001				
2002				
2003				
2004				
2005	-	-	-	
2006	-	-	-	
2007	-	-	-	
2008	-	-	-	
2009	-	-	-	
2010	15	-	AJ	
2011	13	-	AJ	
2012	7	21	Sa	46,55,60,70
2013	16	19	Sa	46,55,60,70
2014	16	13	Sa	46,55,60,70
2015	0	48	Sa	46,55,60,70,90
2016	0	47	Sa	46,55,60,70,90
2017	0	41	Sa	46,55,60,70,90
2018	0	52	Sa	46,55,60,70,90
2019	0	31	Sa	46,55,60,70,90
2020	0	46	Sa	46,55,60,70,90
2021	0	49	Sa	46,55,60,70,90
2022	0	42	Sa	46,55,60,70,90
2023	0	38	Sa	46,55,60,70,90
2024	0	44	Sa	46,55,60,70,90

Research vessels: Adolf Jensen (AJ), R/V Sanna (Sa).

Table 2. CPUE and NPUE from the Gillnet survey in Upernavik.

Year	Number of stations	CPUE	SE	NPUE	SE	remark
2012	21	11.40	1.78	7.25	1.16	Initial years
2013	19	9.84	1.41	7.26	0.95	Initial years
2014	13	17.19	3.82	13.82	2.84	Initial years
2015	48	19.99	2.56	16.59	2.42	Full program
2016	49	15.95	1.92	13.02	1.58	Full program
2017	40	16.88	2.87	16.42	3.15	Full program
2018	50	16.55	3.04	16.94	3.23	Full program
2019	31	12.57	2.00	12.77	2.16	Full program
2020	45	26.61	4.09	26.47	3.79	Full program
2021	49	22.89	2.45	22.42	2.24	Full program
2022	42	17.19	2.42	17.24	2.02	Full program
2023	38	11.97	1.30	13.64	1.48	Full program
2024	44	11.91	1.47	14.60	1.59	Full program

Table 3. Number of otoliths collected and aged from the gillnet survey in Upernavik.

Year	Area	GHL Otoliths	Aged	Ageing method
2010	Upernavik	343	60	Frozen image
2011	Upernavik	491	0	Frozen image
2012	Upernavik	267	0	Frozen image
2013	Upernavik	296	0	Frozen image
2014	Upernavik	333	13	Frozen image
2015	Upernavik	407	8	Frozen image
2016	Upernavik	453	0	Frozen image
2017	Upernavik	361	0	Frozen image
2018	Upernavik	378	46	Frozen image
2019	Upernavik	326	293	Frozen image
2020	Upernavik	407	0	Frozen image
2021	Upernavik	529	516	Frozen image
2022	Upernavik	340	32	Frozen image
2023	Upernavik	324	308	Frozen image
2024	Upernavik	344	101	Frozen image

Table 4. Catch-At-Age table for the gillnet survey in Upernavik

Year	Index	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16
2012	119.6	0	0	4	9	16	23	32	14	10	7	3	0	1	0	0
2013	121.1	0	0	8	30	27	24	16	8	3	2	0	0	1	1	1
2014	213.9	0	0	7	7	23	60	68	40	7	0	1	0	1	0	0
2015	274.1	1	1	29	81	44	51	28	23	9	3	2	1	0	0	1
2016	238.3	0	1	19	52	68	45	31	11	6	2	1	1	0	0	0
2017	271.9	0	1	2	35	61	62	43	25	20	6	5	6	2	1	2
2018	271.5	1	5	23	40	48	51	34	18	16	20	4	2	8	2	2
2019	213.0	0	0	12	52	62	44	25	10	4	2	0	0	0	0	0
2020	432.2	0	11	89	180	91	43	13	4	1	1	0	0	0	0	0
2021	373.7	0	2	35	126	123	66	12	6	2	1	1	0	0	0	0
2022	287.4	0	4	21	115	38	80	24	5	1	1	0	0	0	0	0
2023	227.4	0	1	18	107	64	23	12	2	1	0	0	0	0	0	0
2024	239.3	0	3	74	93	51	13	5	1	0	0	0	0	0	0	0

Table 5. Modelled length-weight relationship for Greenland halibut in Upernavik.

Year	Area	Number of fish	Log a	b	R^2
2012	Upernavik	267	-13.326	3.431	0.985
2013	Upernavik	294	-12.853	3.299	0.988
2014	Upernavik	333	-12.978	3.33	0.984
2015	Upernavik	407	-12.696	3.267	0.991
2016	Upernavik	453	-12.607	3.255	0.984
2017	Upernavik	361	-12.445	3.216	0.985
2018	Upernavik	378	-12.722	3.283	0.989
2019	Upernavik	326	-12.421	3.205	0.986
2020	Upernavik	407	-12.454	3.227	0.99
2021	Upernavik	528	-12.862	3.323	0.988
2022	Upernavik	340	-12.951	3.336	0.99
2023	Upernavik	323	-12.926	3.325	0.989
2024	Upernavik	343	-13.015	3.354	0.986

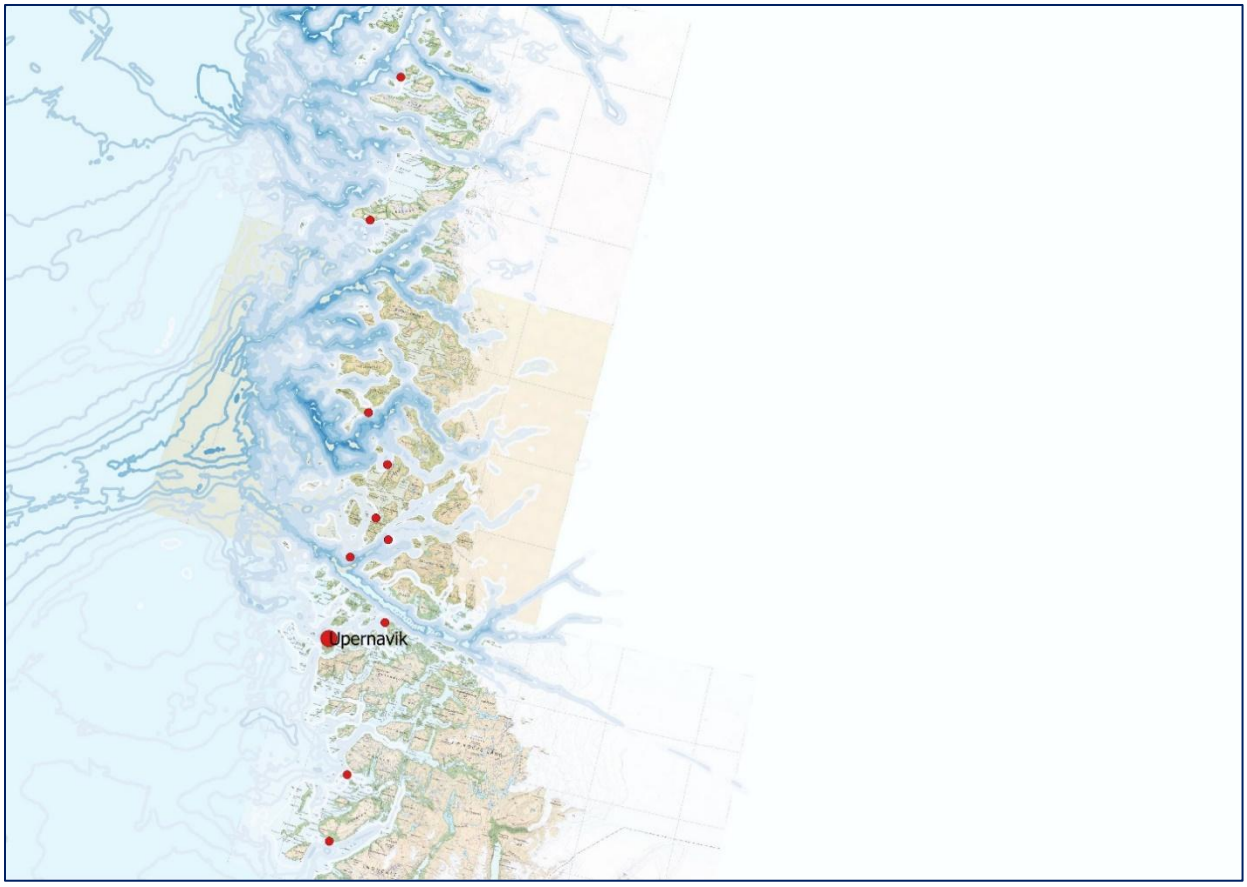

Figure 1. Map of the Upernavik area. Scale 1:2000000.

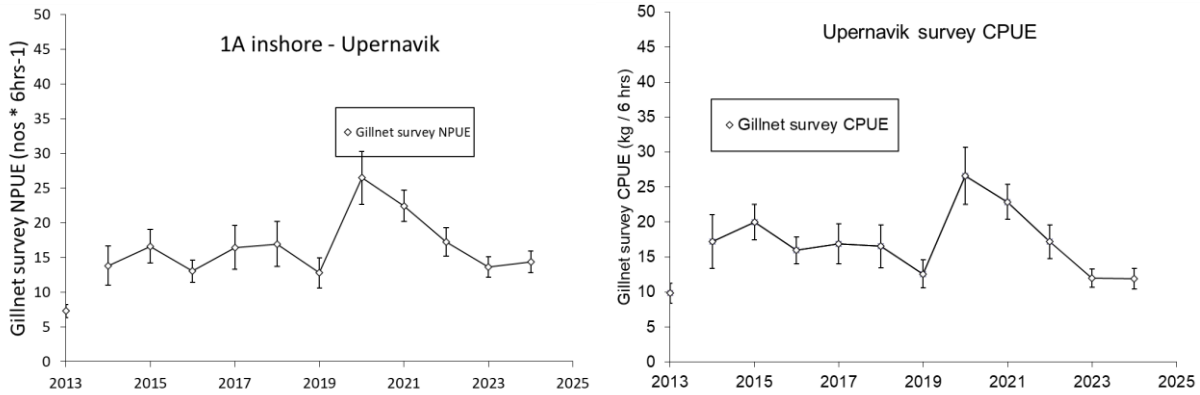

Figure 2. Upernavik gillnet survey NPUE (left) and CPUE (right) and of Greenland halibut (all sizes).

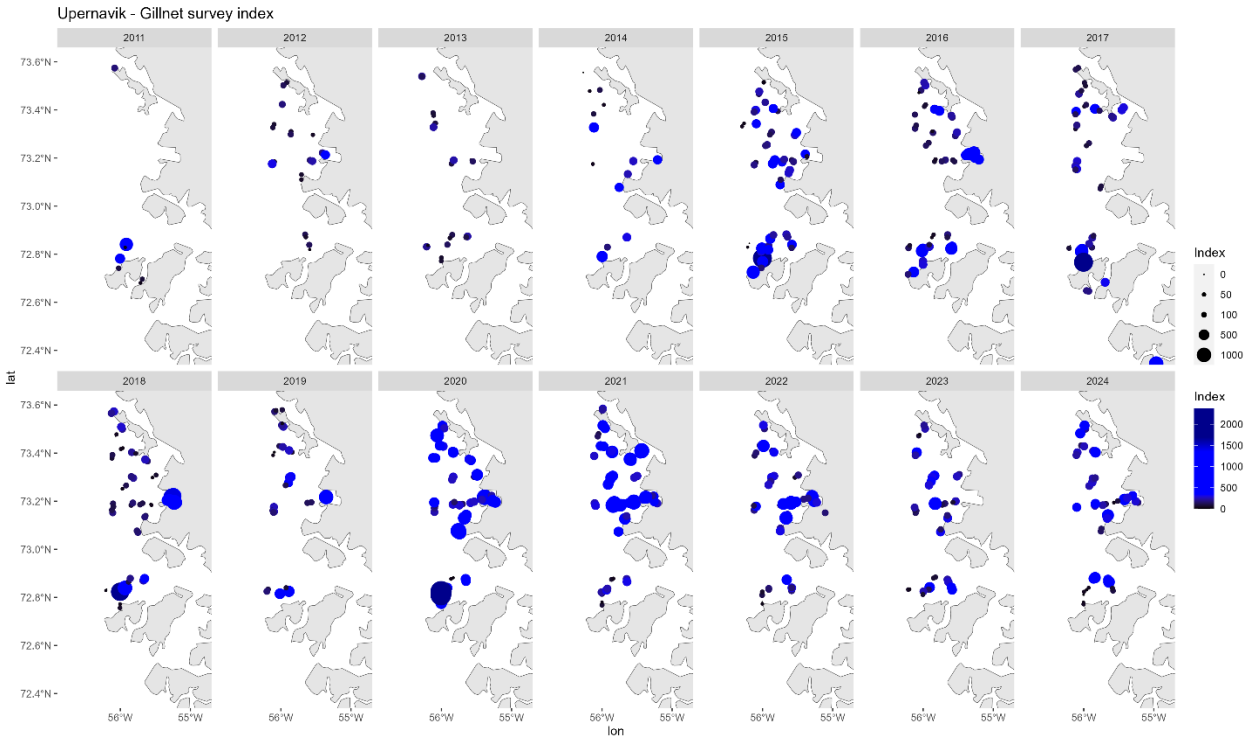

Figure 3. NPUE index by station (numbers per 100 hrs). Note map is missing smaller islands.

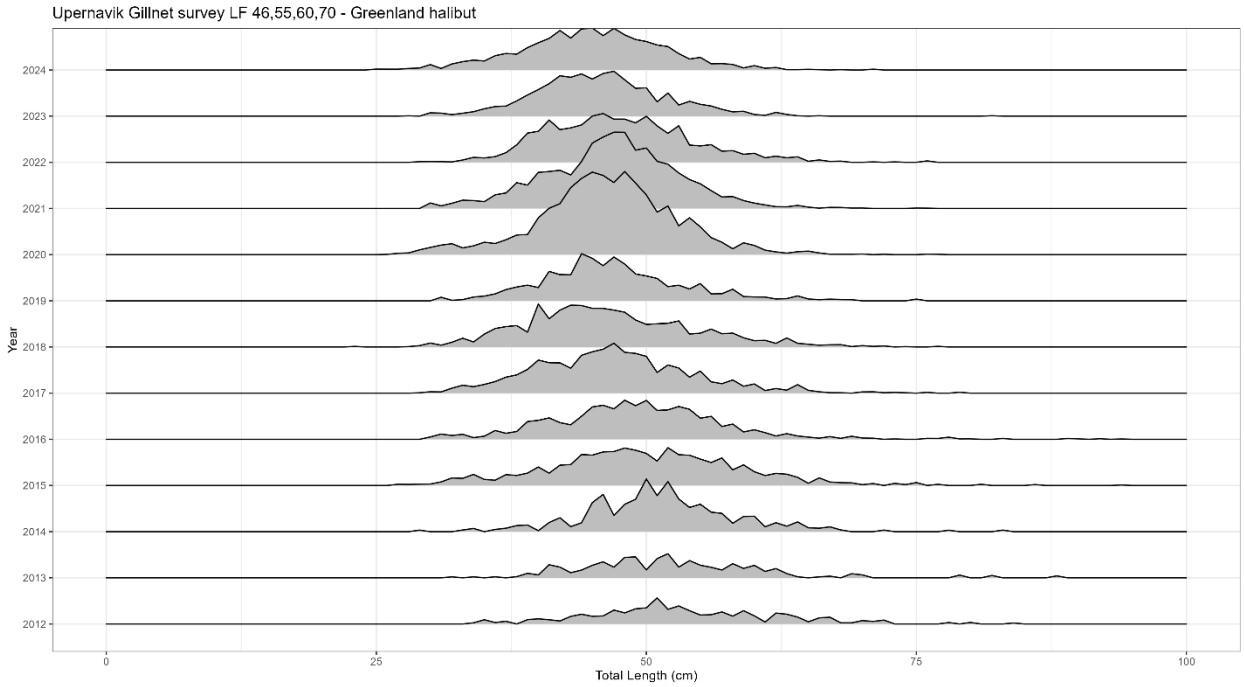

Figure 4a. Observed length frequency distribution (N/100hr) for Greenland halibut in Upernavik.

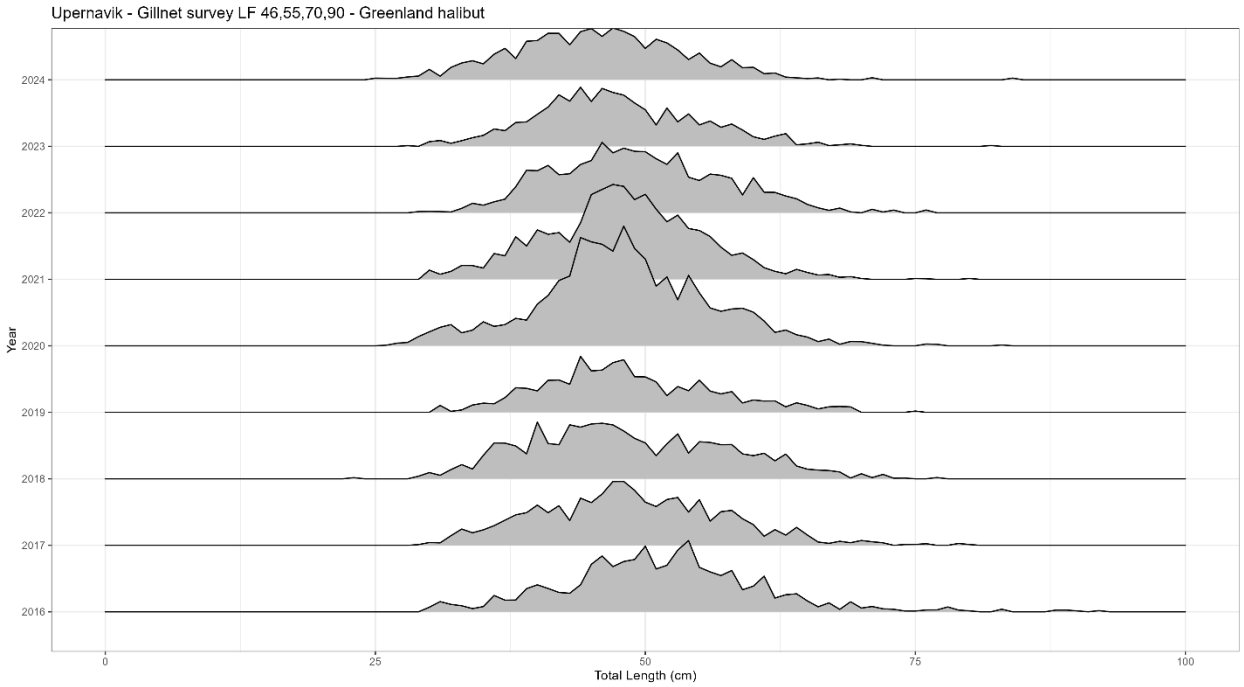

Figure 4b. Observed length frequency distribution (N/100hr) for Greenland halibut in Upernavik excluding the 60 mm and including the 90 mm mesh of the gillnet survey.

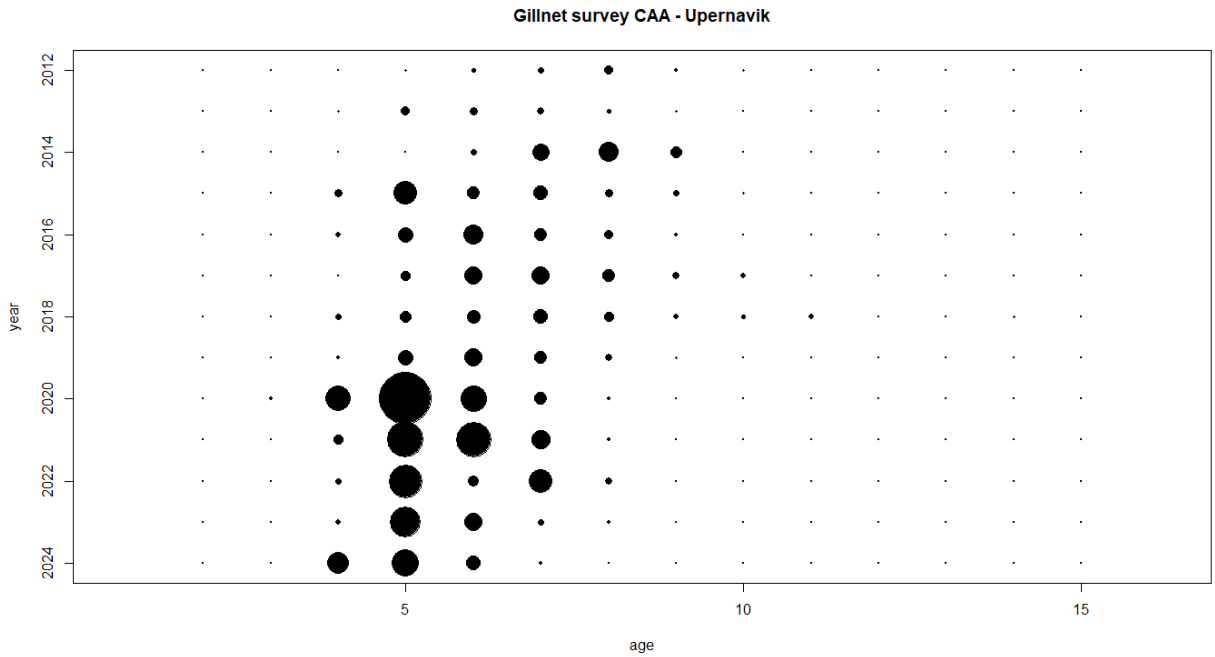

Figure 5. Catch-At-Age (CAA) bubble plot for Greenland halibut from the Upernavik gillnet survey.