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An assessment of the Greenland halibut stock in the Upernavik area.

by

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Abstract

The stock of Greenland halibut in the Upernavik area is of major importance to the local community, supporting a substantial proportion of the population in the area and in Greenland in General. The fishery has increased gradually over 4 decades, with some signs of a decrease in the stock. During the recent decade, mean length in the landings has decrease as has commercial CPUEs based on longline logbooks and the commercial CPUE based on longline factory landings. However the decrease is gradual and at a slow rate. However, recent survey indices, indicate an increase in the number of pre fishery recruits. Particularly the 2015 year class, also seen in the Disko bay, seems dominant and appear also appear in the commercial catches in 2021 as smaller ~50 cm fish with a weight close to 1 kg.

This assessment document summarizes the data from received and collected from the commercial fishery (se SCR 18/023, SCR 22-024, SCR 22-029) and from a research gillnet survey research survey (SCR 21-010). For supporting tables and more information please see these original documents.

Introduction

The fishery is traditionally performed with longline from small open boats or dog sledges through a hole in the sea ice. The first available catch statistics from the Upernavik area is from 1964. In the 1980s, small vessels entered the fishery and the use of gillnets increased in the following years.

Catches and TAC

The first available catch statistics is from 1964. Although the fishery started around 1910 total landings remained at a low level until the beginning of the 1980s (fig 2, table 1).
In Upernavik, catches increased from the mid 1980's and peaked in 1998 at a level of 7 000 tons (tab.1, figure 1). Catches then decreased sharply, for unknown reasons, but during the past 15 years catches has gradually returned to and surpassed the former levels. Since 2014, factory vessels receiving catch from small boats have been used, in order to increase the factory capacity and increase competition and prices in the area. Total catch reached a record high 8955 t in 2019, and have remained high since then. A change in reporting procedure caused an underestimate of catch in the 2020 assessment.

Description of the fishery and the area.

The Upernavik area consists of several large ice fjords, but the main fishing grounds are the deep Ikeq fjord (Upernavik Ice fjord), Tasiusaq Bay and Gulteqarffik (Gulteqarffik is the Inuit word for "where the gold is collected"). Since the large ice fjords are often not accessible due to glacier ice, the fishery is sometimes restricted to the shallower fjords near Upernavik and the settlements (fig 1).

The archipelago is breached through deep channels connecting the fjords to the banks in Baffin Bay.

Fisheries and Management

Licences requirements were introduced in 1998 and in 2008 TAC and quota regulations were introduced for the inshore fishery. Logbooks have been mandatory for vessels larger than 30^{ft} since 2008. In 2012, the TAC was split in two components with ITQ's for vessels and a shared quota for open boats. The ITQ system currently does not specify catch to a certain district which causes a discrepancy between the ITQ and total quota set for each district. In 2014, it was decided by the Government og Greenland that only traditional fishing grounds should be taken from the Quota, whereas in other areas there should be free fishery. In 2021 the quota free areas were finally abandoned and the TAC now applies to the whole area.

In the 1980s, small vessels entered the fishery and the use of gillnets increased in the following years. In the late 1990s, the first regulations limiting areas open to gillnet fishery were introduced, limiting gillnet fishery to the winter season. Competence to regulate seasons and areas open to gillnet fishery, was transferred to municipalities in 2004, and areas open to gillnet fishery has expanded since then.
In 2017, the minimum mesh-size in the Greenland halibut fishery was reduced to 95 mm, which catches Greenland halibut as small as 50 cm and have a maximal selection in the interval 55-70 cm.

Data from commercial fisheries

Recent catch statistics (factory landing and logbooks) are available from a centralized database managed by the Greenland Fisheries License Control Authority (GFLK). Both logbook (haul by haul) and factory landings (daily individual landings) are reported as individual fishing events containing dates, field code or position, effort sorting categories and many more items.
Commercial samples are collected by the Greenland Institute of Natural Resources (GINR). During surveys or in sampling campaigns factories are visited and the size of the landed fish by species and gear is registered. However due to the logistic challenges in Greenland (size of Greenland and mainly transport by air or sea), sampling catch is challenging. In this regard, Upernavik poses a special challenge due to the many settlements with factories in the area. Factories are located in Upernavik (2) Aappilattoq (2) Inarsuit (1) Tasiusaq (1) Nuussuaq (1) Inarsuit (1) and Kullorsuaq (1). Fish landed to the different factories are however often taken in the same areas leading to the biased sampling location being a smaller problem. Only Kullorsuaq is rarely or never visited. To ensure sufficient length information from the commercial catches, GINR do commercial length measurements in factories during the winter months (jan-April). Factories are also visited during the gillnet survey conducted with the GINR research vessel R/V Sanna.

Due to low survey activity with the old and now sold research vessel R/V Adolf Jensen (Effort directed to Disko Bay and Uummannaq) a gab exists in the sampling around 2002 to 2007. Although no length frequencies exists from this period, it may be possible to reconstruct the missing data (data currently digitally archived)

In the recent years many of these factories have installed graders (a sorting machine weighing each individual fish), providing a valuable source of statistics for fish stock assessment. However, in Upernavik there is not the same great difference in the distribution of the fishery between summer and winter as seen in the Disko Bay, and sampling is less dependant on season. Commercial sampling is only separated by gear (longline or gillnet) and if possible also summer and winter.

Results

Commercial data

Length frequencies
In Upernavik there is little difference between summer and winter fishing grounds and only small differences in the summer and winter length distributions are observed. Mean individual length in the commercial landings decreased from 1993 to 1998 (fig 3). From 1999 to 2009 the mean length in the longline fishery remained constant, but then decreased gradually until 2021, where mean length in the landings reached 54.5 cm.

Age composition in the commercial catch

Age reading of Greenland halibut was suspended from 2011 to 2017 at GINR due to low quality of the age readings and lack of an internationally agreed method. However, in 2017 the ageing was reinitiated. An Age-Length-Key (ALK) is currently being constructed for every year back in time. For years prior to 2021, the ALK used to calculate CAA table, was created using age readings from whole frozen otoliths from all 3 inshore areas collected from 2008, 2009 and 2010. The 2021 CAA was constructed with individual years ALK from the Upernavik gillnet survey and based on the new method. In spite of the ALK still being preliminary, the CAA indicates the dominance of the strong 2015 year class, also observed in the surveys in in the Disko Bay in Uummannaq. In Upernavik a 2014 year class also appear dominating, but this seems could be due to overestimation by one year at the mean size in the landings are smaller in Upernavik than in Uummannaq.

Commercial CPUE

Three commercial CPUE indices are available for the stock. Two CPUE indices are based on longline logbooks (one for longline logbooks and one for Gillnet logbooks) and one CPUE index based factory landings data (longline). In the CPUE indices based on logbooks, a general linear model (GLM) with year, month and boat as factors is applied to the longline and gillnet fishery logbook data. For more information about the standardized logbook CPUE see SCR 18/023.
In the new CPUE based on factory landings, a general linear model (GLM) with year, month, vessel type and statistical catch square factors, is available from 2022 (SCR 22-024). The new CPUE covers almost all longline fishery,

Factory landings CPUE (longline)

A general linear model (GLM) with year, month and vessel type and catch area as factors was applied to the longline landings in the factory provided landing slips from 2013 to 2021 (See SCR 22-024). The new CPUE based on Factory landings data consists of more than 10 000 observations in all years and covers >90% all longline fishery (table 6). The CPUE shows a gradual decrease from 2013 to 2017. After this the CPUE first increase in 2018, then decrease two years 2019 and 2020 before returning to the 2017 level again in 2021. (figure 5).

Logbook CPUE (longline)

A general linear model (GLM) with year, month and boat as factors was applied to the commercial longline fishery from logbook mandatory vessels >30ft. commercial logbook CPUE show a gradual decrease from the beginning of the timeseries. Although the CPUE is based on only the larger vessels and a different source of statistics, the CPUE shows an almost identical trend as the Factory landings longline CPUE (table 5 and figure 8). The standardised longline log-CPUE series show a gradual but slow decreasing trend since 2007, when disregarding the outlier year 2020 (fig 6). The decrease is however very slow, if at all, since 2015.

Logbook CPUE (Gillnet)

A general linear model (GLM) with year, month and boat as factors was applied to the commercial gillnet fishery from logbook mandatory vessels >30ft. (table 5 and figure 9) The Gillnet CPUE based on logbooks should be analyzed with some caution, due to reduction of the allowed meshsize in 2017 from 110mm half mesh to 95mm halfmesh. In spite of these issues making the gillnets increasing the “effective ness” of the gillnets the CPUE gradually decrease from 2009 to 2019 with a sudden drop in 2013 and 2014 and again in 2020 and 2021. Both the previous old 110mm gillnets and new the 95mm gillnets mainly selects Greenland larger than the mean length in the landings (See figure 8). This implies a poor overlap with the selection curve and a gradual decrease in the number of older fish in the stock. The apparently large 2015 YC is currently too small (~50cm) to be fully selected by the commercial 95mm gillnets (figure 9). Since the gillnets mainly selects larger Greenland halibut the decrease in the gillnet CPUE could imply a decrease in the number of older and large individuals in the area.

Research survey data

The Greenland institute of Natural resources annually conducts a gillnet survey in the fjords near Upernavik. The survey gradually replaced a poorly performing longline survey in 2015. In the initial years fewer gillnet stations were set (table 6). From 2015 only Gillnet stations have been set and the survey has been completed in all years since then.

From 2014 to 2019, survey NPUE remained at a stable level whereas the CPUE decreased slightly (fig 4). In 2020 a substantial increase in both NPUE and CPUE was observed. The increase was observed across stations with particularly the last two stations in the survey having extremely high catches. The increase is mainly caused by higher numbers of Greenland halibut from 40 to 55cm (figure 10). Also higher than usual numbers of 30 cm Greenland halibut (around 3 years) was observed in 2020 (figure 10). The slow decrease in the CPUE from 2015 to 2019 is also seen as a small decrease in the size of the fish in the survey (figure 10). The recent increase in the NPUE and CPUE are caused by higher than usual numbers of small Greenland halibut.

Age distribution in the surveys

The survey Catch At Age (table 3 and figure 6) was created using the age length key (ALK) from Upernavik in 2019 and 2021 and partly in 2018 whereas the remaining years a backup ALK was used. The Backup ALK was made with the individual years Age readings from all inshore areas in division 1A inshore and therefore mainly the Disko bay individual years. In Upernavk the strong 2015 year class also appear.

Conclusion

Biomass and abundance

The fishery has increased gradually over 4 decades, from a low level to a level between 7 500 to 9 000 t in recent years. The gradually increasing catches have been followed by signs of changes in the composition of the stock. The overall decrease in the size distribution of the landed fish (although partly natural when utilizing a virgin stock), indicates a gradual change in the stock to be composed of younger individuals due to the gradual removal of old fish and slow growing individuals.

The Gillnet survey catch in Numbers-Per-Unit-Effort (NPUE) can be taken as an index for abundance and the gillnet Catch-Per-Unit-Effort can be taken as a proxy for Biomass. From 2014 to 2019 the Survey CPUE show a gradual but small and slow decrease. The decrease can also be observed in the shift in the survey length distribution during this period (loss of large Greenland halilbut in the 60-70 size range). The decrease is also observed in the commercial longline CPUE's as far back as 2007. The survey, the size composition back in time and the commercial CPUE's are therefore in agreement of a decreasing biomass over time from an unknown level to the present also unknown level. The recent increase in the survey CPUE is caused mainly by prefishery recruits (2015 YC and younger YC). The stock therefore at present show great growth potential in the coming years.

Recruitment

The survey NPUE increased a factor two in 2020 and remained at a higher level in 2021. Age composition in the survey and commercial catches indicate a higher number of Greenland halibut from the 2015 Year class. The length distribution in the gillnet survey further supports the observation of, a higher number of pre fishery recruits in the area than previously observed. The many small fish in the survey implies good recruitment in the area in the recent years which fits with the 2015 year class and potentially more recent year classes also observed in the Disko bay and Uummannaq.

Special comment

The slow but gradual decrease in the size of the landed fish during two decades, stabilizing at a level around 60 cm before starting to decrease again, may be a sign of the gradual removal of old fish that have reached Lmax. Greenland halibut show dimorphism where males are normally smaller than females. Male Greenland halibut are rarely seen larger than 80cm whereas females reach a size of up to 130 cm or more.

The survey indices of biomass show similar trends as the catches and the CPUE's , but seem to predict the catch to some level. This provides promise for modelling.

The new ALK based on new age readings show promising results, revealing small signs of being able to track cohords.

References

Riget, F. and J. Boje (1989). Fishery and some biological aspects of Greenland halibut (*Reinhardtius hippoglossoides*) in West Greenland waters. NAFO Sci.Council Studies(13): 41-52.

Riget and Nygaard (2017). An analyses of logbooks of Greenland Halibut Stock Component in NAFO Division 1A Inshore. NAFO SCR 18/023. Serial No N

Bjare and Nygaard (2022). A new longline based CPUE for Greenland halibut in NAFO division 1A inshore based on factory landing reports. NAFO SCR 12/024. Serial No N

Table 1. Catches (t) of Greenland halibut in the Upernavik area by gear.

Year	Catch	Year	Catch
1964	9	2000	3764
1965	33	2001	3239
1966	20	2002	3019
1967	2	2003	3884
1968	1	2004	4573
1969	1	2005	4839
1970	6	2006	5132
1971	3	2007	4877
1972	3	2008	5478
1973	3	2009	6497
1974	3	2010	5941
1975	5	2011	6471
1976	7	2012	6718
1977	10	2013	6039
1978	7	2014	7374
1979	3	2015	6274
1980	14	2016	7362
1981	57	2017	6783
1982	138	2018	7549
1983	123	2019	8966
1984	111	2020	7574
1985	244	2021	8480
1986	1000		
1988	777		
1989	1253		
1990	1245		
1991	1495		
1992	2156		
1993	3805		
1994	4844		
1995	3269		
1996	4846		
1997	4879		
1998	7012		
1999	5258		

Notes.
1998 License requirements introduced.
2002 Offshore shrimp trawlers equipped with grid separators.
2008 First Quota regulations introduced
2009 Logbooks mandatory for vessels larger than 30^{ft}.
2011 Inshore shrimp trawlers equipped with grid separators.
2012 Separate TAC set for vessels and small boats.
2014 Quota free areas outside TAC placed by the fisheries minister.
2017 Minimum mesh size in gillnets reduced from 110 halfmesh (220mm) to 95mm half mesh (190mm).
2019. Error in total catch due to change in reporting practice. Corrected in 2020.

Table 3. CAA – Catch at age for Greenland halibut in the Upernavik district. No ALK available for Upernavik in some years to calculate the CAA.

age/year	3	4	5	6	7	8	9	10	11	12	13	14	15+	16+	Total
1988	0	0	0	0	0	6	33	55	80	74	68	62	31	22	431
1989	0	0	0	0	0	2	16	34	59	66	69	73	40	31	390
1990	0	0	0	0	0	2	17	41	62	57	52	48	25	17	321
1991															
1992															
1993	0	0	0	0	0	2	16	86	252	268	143	95	40	46	948
1994	0	0	0	2	51	188	316	217	239	154	155	51	23	0	1396
1995	0	0	0	0	13	55	84	128	133	147	117	103	45	42	867
1996	0	0	3	0	16	114	359	275	238	206	151	90	48	39	1539
1997	0	0	4	25	142	428	500	430	278	175	67	37	19	8	2111
1998	0	0	0	116	343	538	535	505	410	275	112	84	39	10	2968
1999	0	14	55	172	449	619	566	343	229	138	51	36	16	5	2693
2000	0	0	2	108	420	446	302	160	133	116	48	38	17	9	1800
2001	0	0	28	144	404	422	258	103	104	87	36	14	9	3	1611
2002															
2003															
2004															
2005															
2006															
2007															
2008	0	0	4	65	197	429	274	788	372	135	10	6	0	6	2284
2009	0	0	5	51	333	579	465	421	262	187	112	65	94	7	2579
2010	0	0	3	47	376	707	471	484	242	126	70	27	15		2568
2011	0	5	51	175	555	772	468	484	260	141	80	31	18		3040
2012	0	2	28	111	375	620	445	504	312	188	117	50	27		2778
2013	0	12	42	107	387	581	368	401	259	161	113	55	34		2520
2014	3	31	177	349	773	919	483	475	243	131	88	45	27		3743
2015	5	25	98	205	574	752	405	388	200	117	92	52	43		2957
2016	2	17	138	308	736	867	460	452	251	142	103	52	34		3566
2017	2	30	188	325	679	799	423	406	214	122	97	51	32		3368
2018	4	58	332	546	990	1015	477	441	217	107	76	30	19		4310
2019	1	24	167	281	641	806	454	477	285	177	124	64	38		3539
2020	4	65	429	626	1177	1093	444	380	169	81	68	36	21		4593
2021	3	100	685	1218	1304	597	450	195	163	91	37	41	2	35	4923

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

Year	Index val	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16
2012	119.5947863	0	0	4	9	16	23	32	14	10	7	3	0	1	0	0
2013	121.0643464	0	0	8	30	27	24	16	8	3	2	0	0	1	1	1
2014	213.9250592	0	0	7	7	23	60	68	40	7	0	1	0	1	0	0
2015	274.1301119	1	1	29	81	44	51	28	23	9	3	2	1	0	0	1
2016	238.265859	0	1	19	52	68	45	31	11	6	2	1	1	0	0	0
2017	271.9163809	0	1	2	35	61	62	43	25	20	6	5	6	2	1	2
2018	271.4841734	1	5	23	40	48	51	34	18	16	20	4	2	8	2	2
2019	212.9902713	0	0	12	52	62	44	25	10	4	2	0	0	0	0	0
2020	432.2359051	0	11	89	180	91	43	13	4	1	1	0	0	0	0	0
2021	373.6783955	0	2	35	126	123	66	12	6	2	1	1	0	0	0	0

Table 5. Upernavik Longline logbooks data available for the CPUE calculation

Year	Logbook CPUE (longline)	Factory landings CPUE (longline)	Logbook CPUE (Gillnet)
UNIT	Kg/100 hooks	Kg/100 hooks	Kg/gillnet
2006	74.1		
2007	59.5		
2008	56.4		
2009	57.8		77.5
2010	51.8		86.4
2011	46.4		77.5
2012	57.7		86.7
2013	51.2	54.3	56.9
2014	55.3	54.3	60.6
2015	46.4	51.6	78.5
2016	47.2	49.9	77.6
2017	45.8	46	69.4
2018	45	51.7	75.8
2019	49.5	46.3	76.6
2020	34.2	40.8	47
2021	46.7	46.5	40.7

Table 6. CPUE and NPUE from the Gillnet survey in Upernavik.

Year	Number of stations	CPUE	NPUE	remark
2011				
2012	21	11.40071902	7.259341344	Initial years
2013	19	9.844795844	7.263899569	Initial years
2014	13	17.19401807	13.82307233	Initial years
2015	48	19.99247169	16.59781615	Sufficient coverage
2016	49	15.95998	13.02695915	Sufficient coverage
2017	40	16.88185439	16.42020525	Sufficient coverage
2018	50	16.55276735	16.94053371	Sufficient coverage
2019	31	12.5724346	12.77945974	Sufficient coverage
2020	45	26.61954734	26.47830739	Sufficient coverage
2021	49	22.89201134	22.42070373	Sufficient coverage

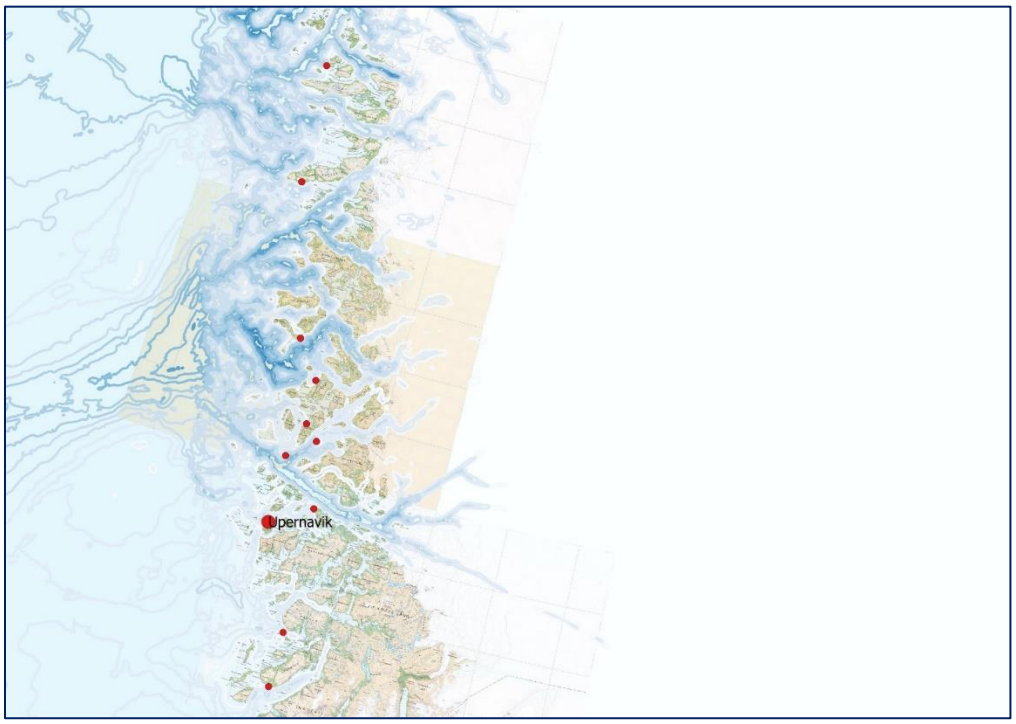

Figure 1. Map of the Upernavik area. Scale 1:2000000. Shown are Upernavik at the settlements of which have af fish factory and some have two. Deep channels branch through the archipelago separating the deep iceberg producing fjords.

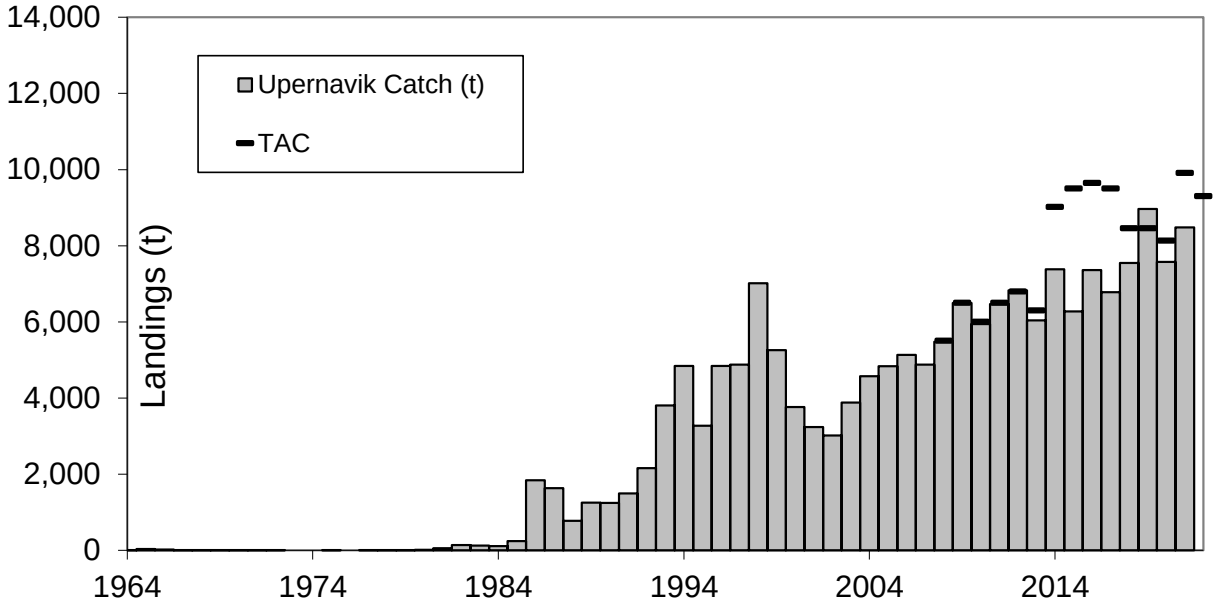

Figure 2. Catches of Greenland halibut in NAFO Subarea 1 Division 1Ainshore since 1904. 2013 LTQ for vessels >30ft imposed. Still shared quota for open boats, dogsledge and ice fishery.

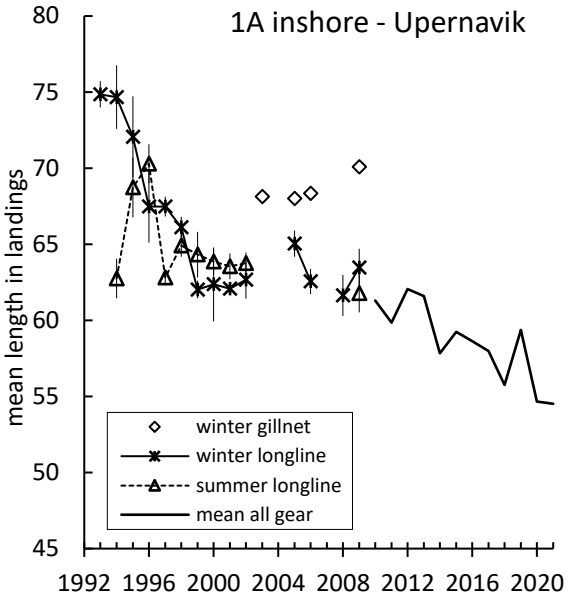

Figure 3. Upernavik mean length in the landings: longline summer and winter and overall mean weighted by season and gear (Mean all gear) (left) and in the gillnet fishery (right).

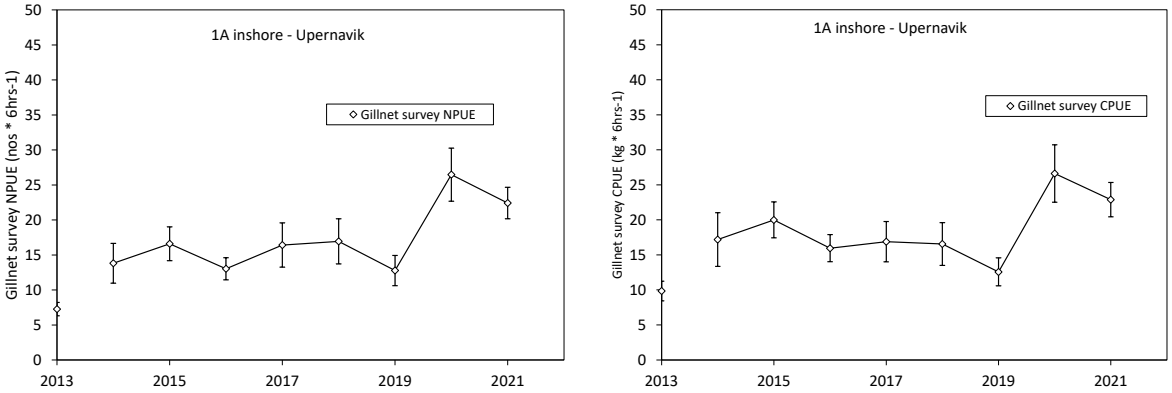

Figure 4 Upernavik gillnet survey NPUE (left) and CPUE (right) and of Greenland halibut (all sizes).

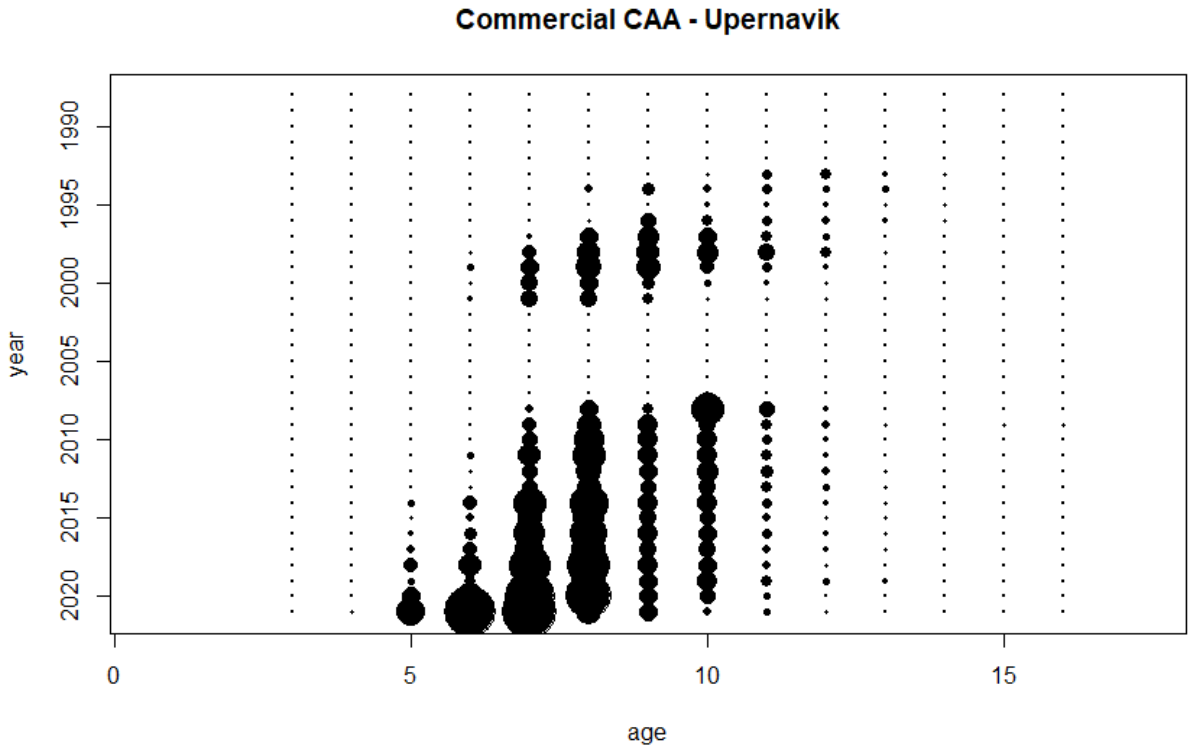

Figure 5. Catch At Age CAA bubble plot for the commercial landings in Upernavik. Only 2021 have been recalculated with the new ALK from Upernavik 2021. Missing years (1991,1992,2002-2007)

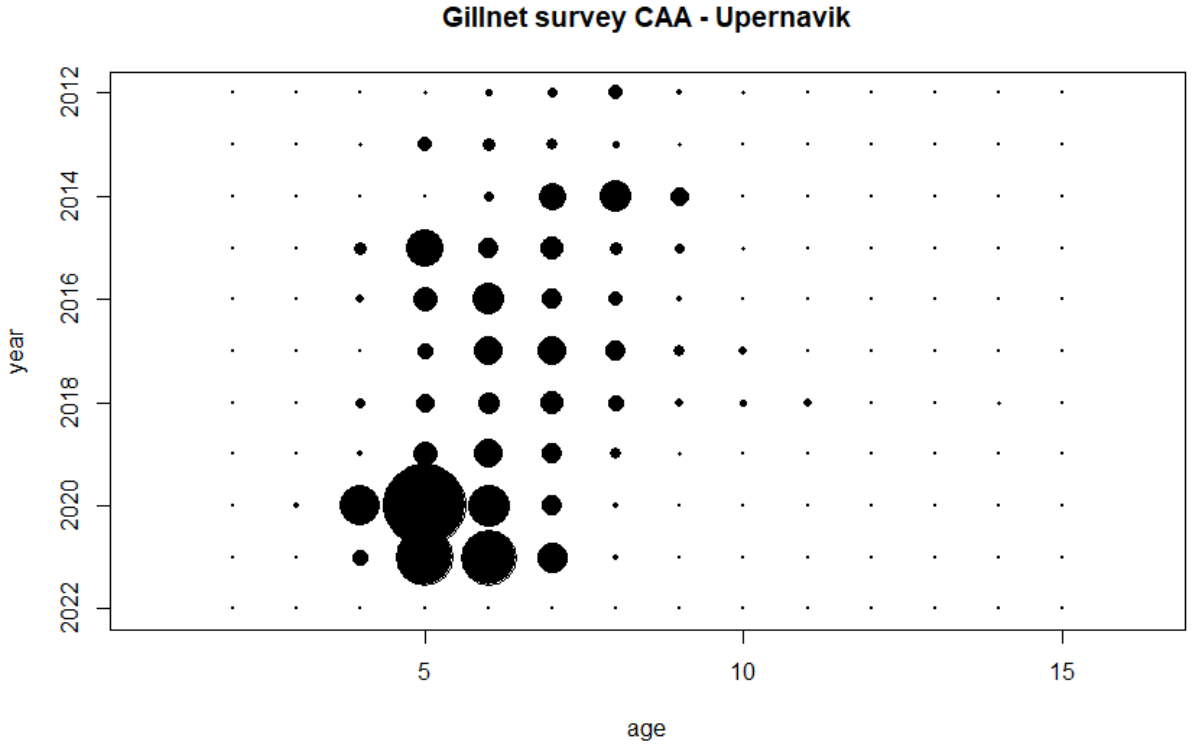

Figure 6. Upernavik survey Catch At Age CAA for the Upernavik gillnet survey.

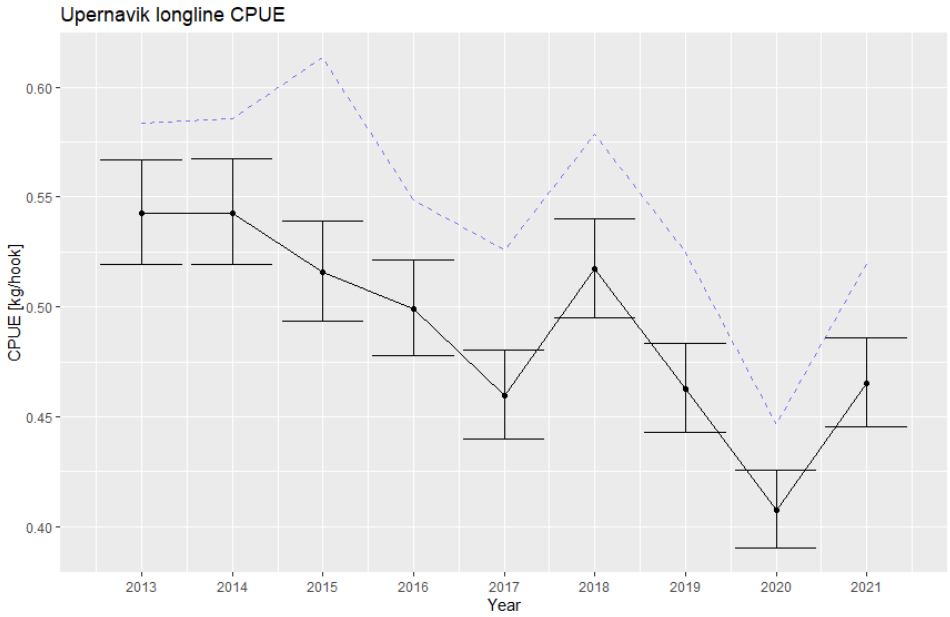

Figure7. Commercial CPUE (Kg/hook) based on factory landing reports from all factories in Upernavik.

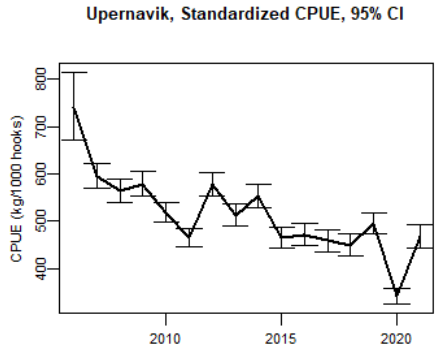

Figure 8. Upernavik Longline logbooks - Standardized mean and 95% CI CPUE based on logbooks from vessels larger than 30ft since 2006.

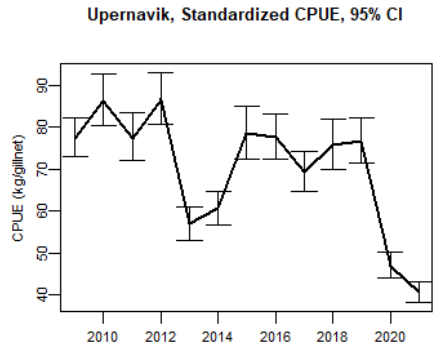

Figure 9. Gillnet logbooks - standardized mean and 95% CI CPUE based on logbooks from vessels larger than 30ft in Upernavik.

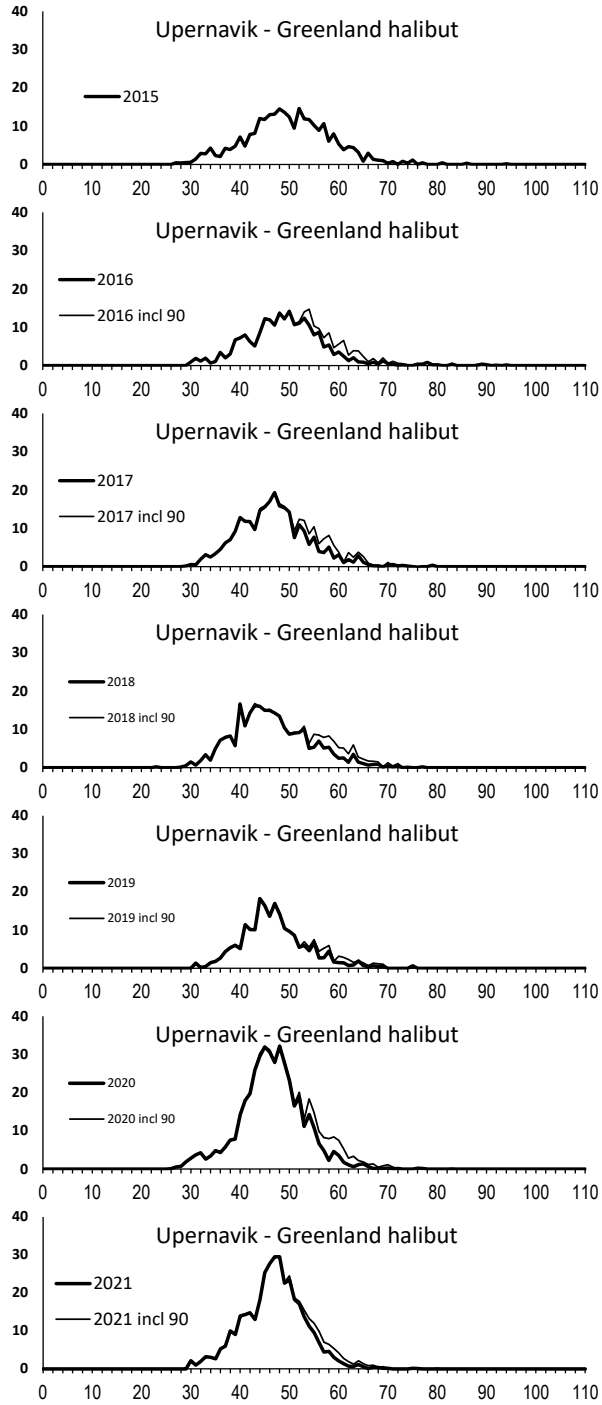

Figure 10. Gillnet survey observed LF (N/100hr) for Greenland halibut.