NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N7419 **NAFO SCR Doc. 23/030**

SCIENTIFIC COUNCIL MEETING – JUNE 2023

Commercial data for the Greenland halibut fishery in the Upernavik area.

by

Rasmus Nygaard

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

Abstract

Although the commercial fishery in for Greenland halibut started around 1910, the first available catch statistics from the Upernavik area is from the 1960's. The fishery is traditionally performed with longline from small open boats, small vessels or from dog sledges through a hole in the sea ice. This document presents catch statistics and data from the commercial catches collected from various resources, from the landings of Greenland halibut in the fjords in the Upernavik district. The document includes statistics of commercial sampling effort done by the Greenland Institute of Natural Resources - GINR, calculations of mean size in the landings, a preliminary CAA. Also provided are three commercial CPUE indices. Two CPUE indices are based on log logbooks (one for longline logbooks and one for Gillnet logbooks) and one CPUE index based factory landings data (longline).

Introduction

The first available catch statistics from the Upernavik area is from 1964. The area consists deep branching fjords separeded from the Baffin Bay by a shallow archipelago with many settlements. The fishery is traditionally performed with longline from small open boats, small vessles or from dog sledges through a hole in the sea ice. 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. The inshore stock in division 1A is considered to be recruited from the stock in the Davis Strait, but the adults appear resident in the fjords and isolated by the banks from the offshore spawning stock.

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.

Materials and methods

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. Catch can practically be broken in any thinkable way.

Commercial sampling

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.

ALK

Age information is occasionally obtained from commercial landings, but the majority of otoliths collected in the area is through biological surveys with the GINR research vessel R/V Sanna during summer gillnet surveys. See SCR 22-009 for details on age readings of otoliths from surveys. No otoliths are available from 2002 to 2007.

Logbook CPUE calculation

A general linear model (GLM) with year, month and boat as factors is applied to the longline and gillnet fishery logbook data since 2010. Only longline setting with more than 200 hooks and gillnets with catches between 0 and 1000 kg/gillnet are included to omit obvious outlier values and limit the influence of data potential errors on the analysis. CPUE observations are log-transformed prior to the GLM analysis. Least-mean square estimates were used as standardized CPUE series. For more information about the standardized logbook CPUE see (SCR 18/023). A new CPUE based on factory landings data from longline fishery calculated in the same way as the logbook CPUE, but from a different source of statistics (see SCR 22-024 for details).

Results

Catches

The inshore fishery targeting Greenland halibut started in the beginning of the 1900 century with the introduction of the longline in Greenland. The fishery started in the Disko Bay and gradually spread to South Greenland and later the Uummannaq fjord and Upernavik districts. 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 1, table 1). A breakdown of catch by gear and month is provided in table 2.
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. Since then catches have decreased and in

Distribution of catch

The Upernavik area consists of several large ice fjords, but the main fishing grounds are the deep Ikeq fjord (Upernavik Icefjord) and Gulteqarffik (Gulteqarffik is the Inuit word for "where the gold is collected"). Since the large icefjords are often not accessible due to glacier ice, the fishery is sometimes restricted to the shallower fjords near Upernavik and the settlements in the area or less active icefjords like Tasiusaq Bay located between Gulteqarffik and Ikeq (fig 2).

Breakdown of catch

The catch by gear (longline or gillnet) and month is combined with the length frequencies from the commercial landings (table 3). The Catch by gear and month is used to calculate mean size in the landings and the CAA. Due to the logistical challenges in Greenland not all months or even years have commercial length information (table 3). In recent years the sampling has been challenged by Covid and other challenges leaving gaps in the sampling of the 3 different categories (Upernavik longline winter, Upernavik gillnet winter and Upernavik longline summer). Grader data from the area is available in 2020 and 2021 and can replace the lagging sampling in these years. In 2022 grader data was available from 3 different factories and therefore used for the CAA and length frequencies along with GINR sampling. Since the number of observations in the Grader data by far outnumber the GINR factory sampling, the GINR sampling now works as a backup in case Grader data is not received.

Mean size in the landings.

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 2012 the mean length in the longline fishery remained constant (fig 3). From 2013 a decrease in the size of the landed fish has been observed.

ALK – Age Length Key

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, the age readings have since then been reinitiated and an ALK is currently being constructed back in time. Until 2020 the CAA was created with an ALK was constructed using age readings from whole frozen otoliths from all 3 inshore areas collected from 2008, 2009 and 2010. However the 2021 CAA was constructed with individual years ALK from otolith readings of Upernavik Greenland from 2021. Only 32 Greenland halibut were aged in Upernavik in 2022 and the ALK used in 2022 is mainly Disko Bay fish. In spite of the ALK still being preliminary and unverified CAA reveal the dominance of the 2015 and 2016 year class in the CAA bubble plot (figure 4)

Factory landings CPUE (longline)

The new CPUE based on Factory landings data consists of more than 10 000 observations in all years and covers all longline fishery and therefore >90% of all the yearly catch (table 5). The CPUE shows a decrease from 2013 to 2017, but has fluctuated around the 2017 level (figure 5).

Logbook CPUE (longline)

Longline CPUE based on logbooks 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 6 and figure 6). The standardised longline logCPUE 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)

The gillnets the CPUE gradually decrease from 2009 to 2019 with a sudden drop in 2013 and 2014 and again in 2020-2022(table 7 and figure 7). 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 8). 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.

Discussion

CPUE indices are often heavily criticized for being untrustworthy. However, the CPUE's presented here are based on a very large number of observations. The CPUE index from the factory landings are based on all individual landings and typically constitute more than 10.000 observations per year. Furthermore, the longlines have been optimized for decades and are difficult to improve further. And finally the Greenland halibut is not a schooling species with a patchy distribution, improving the ability of the CPUE to track changes in the stock.

The Gillnet CPUE based on logbooks should be treated with 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" the CPUE has gradually decreased.

The CAA can still be improved with more agereadings from the area and unused length information is still available. Grader data is available from the most recent years but not incorporated in the CAA table yet.

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.

	Upernavik				Notes
Year	Longline	Gillnet	Unknown	Catch	
1964	9			9	
1965	33			33	
1966	20			20	
1967	2			2	
1968	1			1	
1969	1			1	
1970	6			6	
1971	3			3	
1972	3			3	
1973	3			3	Guess due to lack of data
1974	3			3	Guess due to lack of data
1975	5			5	
1976	7			7	Guess due to lack of data
1977	10			10	
1978	7			7	
1979	3			3	
1980	14			14	
1981				57	
1982				138	
1983				123	
1984				111	
1985				244	
1986				1000	Guess - due to lack of data
1988				777	
1989				1253	
1990				1245	
1991				1495	
1992				2156	
1993				3805	
1994				4844	
1995				3269	
1996				4846	
1997				4879	
1998				7012	
1999				5258	
2000	3764	0	0	3764	
2001	3239	0	0	3239	
2002				3019	
2003	2509	1378	0	3884	
2004	2476	2097	0	4573	
2005	3096	1743	0	4839	
2006	3535	1598	0	5132	
2007	4218	659	0	4877	
2008				5478	
2009				6497	
2010	5443	411	0	5941	
2011	6176	362	0	6471	
2012	6204	514	0	6718	
2013	5606	433	0	6039	
2014	6964	409	0	7374	

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

	Upernavik				Notes
Year	Longline	Gillnet	Unknown	Catch	
2015	5491	783	0	6274	
2016	6954	408	0	7362	
2017	6365	418	0	6783	
2018	7230	319	0	7549	
2019	8277	688	0	8966	Catch corrected in 2020
2020	6884	690	0	7574	
2021	7269	1211	0	8480	
2022	3939	799	0	7738	

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 2. Catch of Greenland halibut (t) by gear and month month and year.

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OKT	NOV	DEC	Total
Longline	2011	243	99	579	571	407	538	830	1292	942	323	352	0	6176
	2012	391	517	448	328	379	657	1026	987	597	547	217	111	6204
	2013	198	493	492	400	320	490	927	1018	821	313	71	61	5606
	2014	222	432	570	490	260	871	1369	853	870	665	314	48	6964
	2015	209	376	626	392	241	537	937	769	650	557	99	98	5491
	2016	502	590	424	343	555	801	1023	1026	740	427	270	255	6954
	2017	366	453	408	309	184	545	957	1053	1089	593	160	247	6365
	2018	460	532	472	534	327	763	918	1068	1021	514	290	331	7230
	2019	454	578	513	345	538	908	1120	1349	1364	636	277	195	8277
	2020	207	555	498	359	436	759	951	1234	1002	495	183	208	6884
	2021	281	446	552	256	338	913	1090	1398	1023	512	149	314	7269
	2022	180	502	645	534	393	594	841	1125	1090	656	200	179	6939

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OKT	NOV	DEC	Total
Gillnet	2011	48	129	60	66	13	40	0	0	0	0	6	0	362
	2012	1	70	87	131	2	0	0	0	31	55	45	92	514
	2013	21	14	37	84	19	0	0	0	0	0	172	85	433
	2014	22	64	61	72	9	0	0	0	0	0	50	131	409
	2015	12	12	2	56	32	0	51	289	167	0	108	53	783
	2016	10	87	89	99	4	0	0	0	1	0	97	22	408
	2017	16	33	43	88	105	13	1	0	14	0	51	55	418
	2018	7	24	30	70	9	0	0	0	0	0	136	43	319
	2019	3	20	72	116	11	0	0	0	7	11	181	268	688
	2020	31	33	41	158	34	0	0	0	0	0	215	177	690
	2021	144	39	74	82	214	39	3	1	0	275	309	31	1211
	2022	61	4	24	71	148	10	0	0	0	0	338	144	799

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OKT	NOV	DEC	Total
Total	2011													
	2012	392	587	535	459	380	657	1026	987	628	602	262	204	6718
	2013	220	507	530	484	339	490	927	1018	821	313	244	146	6039
	2014	244	495	632	562	269	871	1369	853	870	665	364	179	7374
	2015	221	388	628	448	273	537	988	1058	817	557	207	152	6274
	2016	512	677	513	442	559	801	1023	1026	740	427	366	277	7362
	2017	382	485	451	397	289	558	958	1053	1103	593	211	302	6783
	2018	467	556	502	603	336	763	919	1068	1021	514	426	374	7549
	2019	457	598	585	461	549	908	1120	1349	1371	647	458	463	8966
	2020	238	588	540	517	469	759	951	1234	1002	495	398	385	7574
	2021	424	485	626	337	552	952	1093	1399	1023	786	458	345	8480
	2022	241	506	669	605	541	604	841	1125	1090	656	537	323	7738

Table 3 Number of length measured Greenland halibut by gear, division and month from the inshore areas in 2019. Blocks indicates the use of length distributions in the CAA calculation.

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Longline	2010	736	669	1920				1939					
	2011		474	5721					6462	1250			
	2012			3551				3378	1743				
	2013			117	3892			1820		101			
	2014		3268	1250	86					4729	777		
	2015	108	5752	480	462	77	245	195	2823	516		158	
	2016			616	892			2101	2871				
	2017												
	2018		611						3385			1415	
	2019								2860				
	2020								3265				
	2021								1333				
	2022							977	2349				

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Gillnet	2010			517									
	2011		238	257									
	2012	-	1803	-	-	-	-	-	-	-	-	-	-
	2013		651	1464									553
	2014		475	338	2144								
	2015		1144									301	
	2016			632									
	2017												
	2018	76	1038									484	
	2019												
	2020												
	2021		958										
	2022												

Table 3 Number of Greenland halibut Individual weighed individuals on automated sorting mashines (Grader data) recalculated to individual lengths) by GINR.

Individual weighed individuals on automated sorting mashines (Grader data recalculated to individual lengths)												
2022	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
OBS	9379	72301	77329	4135		4128	35686	5561	4120		2747	
Mean weight												

Table 4. 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
2022	14	85	912	599	1563	1130	410	116	66	22	11	7	4	6	4945

T**able 5.** Upernavik Factory landings data and CPUE

Year	GLM LogCPUE	SE	df	lower.CL	upper.CL	Kg/100 hooks
2012	-0.52815	0.022671	142365	-0.57258	-0.48371	59
2013	-0.59467	0.021208	142365	-0.63624	-0.5531	55.2
2014	-0.59441	0.021185	142365	-0.63593	-0.55288	55.2
2015	-0.64946	0.021091	142365	-0.6908	-0.60812	52.2
2016	-0.68001	0.020943	142365	-0.72106	-0.63896	50.7
2017	-0.76443	0.021017	142365	-0.80562	-0.72323	46.6
2018	-0.64663	0.021008	142365	-0.68781	-0.60546	52.4
2019	-0.75787	0.020926	142365	-0.79888	-0.71685	46.9
2020	-0.88251	0.020978	142365	-0.92362	-0.84139	41.4
2021	-0.75113	0.020975	142365	-0.79224	-0.71002	47.2
2022	-0.74484	0.020963	142365	-0.78593	-0.70375	47.5

Table 6. Upernavik Longline logbooks data available for the CPUE calculation

Year	GLM LogCPUE	SE	df	lower.CL	upper.CL	Kg/100 hooks
2006	6.577697	0.048844	24118	6.48196	6.673434	71.88818
2007	6.361727	0.022098	24118	6.318414	6.40504	57.92459
2008	6.308415	0.022295	24118	6.264716	6.352115	54.91738
2009	6.335699	0.021832	24118	6.292906	6.378492	56.43638
2010	6.227139	0.019871	24118	6.188191	6.266087	50.63049
2011	6.11373	0.020411	24118	6.073723	6.153736	45.20216
2012	6.332862	0.021247	24118	6.291216	6.374508	56.27649
2013	6.212935	0.023032	24118	6.167791	6.258079	49.91642
2014	6.289934	0.021998	24118	6.246817	6.33305	53.91177
2015	6.116021	0.024775	24118	6.06746	6.164582	45.30584
2016	6.13016	0.025292	24118	6.080587	6.179734	45.95097
2017	6.103403	0.025283	24118	6.053846	6.152959	44.73776
2018	6.083343	0.025327	24118	6.033701	6.132986	43.84926
2019	6.170386	0.023468	24118	6.124388	6.216384	47.83707
2020	5.785573	0.024203	24118	5.738133	5.833013	32.55685
2021	6.126663	0.025407	24118	6.076863	6.176462	45.79056
2022	6.108854	0.027283	24118	6.055378	6.16233	44.98229

Table 7. CPUE Upernavik Gillnet logbooks available for the CPUE calculation

Year	GLM LogCPUE	SE	df	lower.CL	upper.CL	Kg/gillnet
2009	4.344637	0.029816	11389	4.286193	4.403081	77.06406
2010	4.420271	0.035674	11389	4.350343	4.490198	83.11881
2011	4.303501	0.036996	11389	4.230982	4.376019	73.95827
2012	4.42756	0.036039	11389	4.356918	4.498203	83.72687
2013	3.990627	0.0347	11389	3.922609	4.058646	54.08879
2014	4.060214	0.033967	11389	3.993632	4.126796	57.98672
2015	4.310595	0.040255	11389	4.231688	4.389503	74.48479
2016	4.319787	0.035109	11389	4.250968	4.388607	75.17261
2017	4.220687	0.034561	11389	4.152941	4.288433	68.08024
2018	4.287481	0.039647	11389	4.209765	4.365196	72.7829
2019	4.299022	0.035067	11389	4.230285	4.367759	73.62775
2020	3.806891	0.033076	11389	3.742056	3.871726	45.01028
2021	3.688002	0.029944	11389	3.629306	3.746697	39.96492
2022	3.87343	0.033567	11389	3.807633	3.939226	48.10711

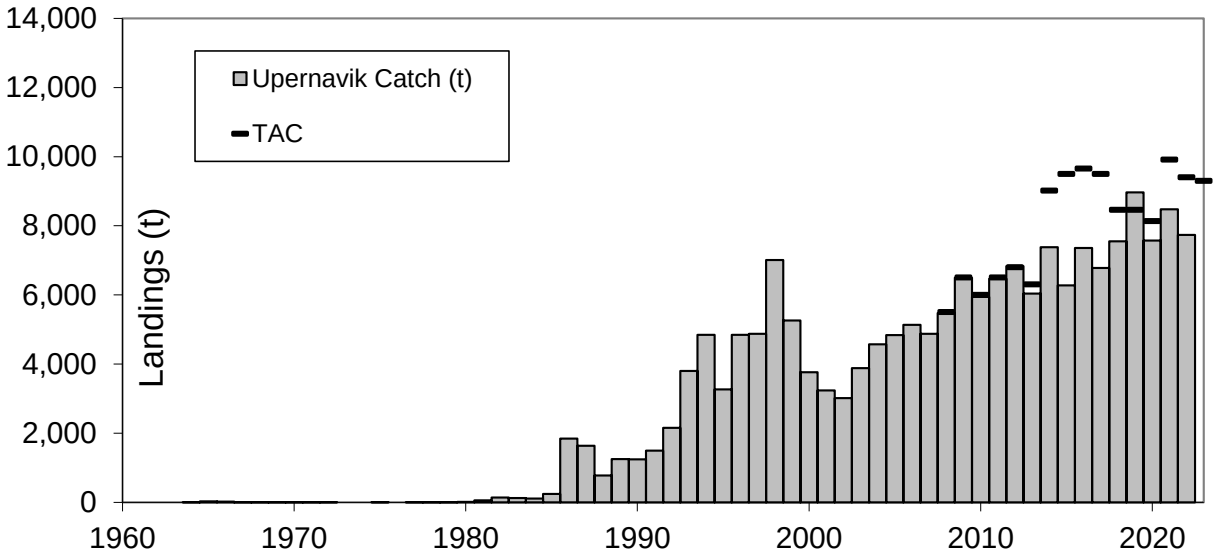

Figure 1. Catches of Greenland halibut in the Upernavik area.

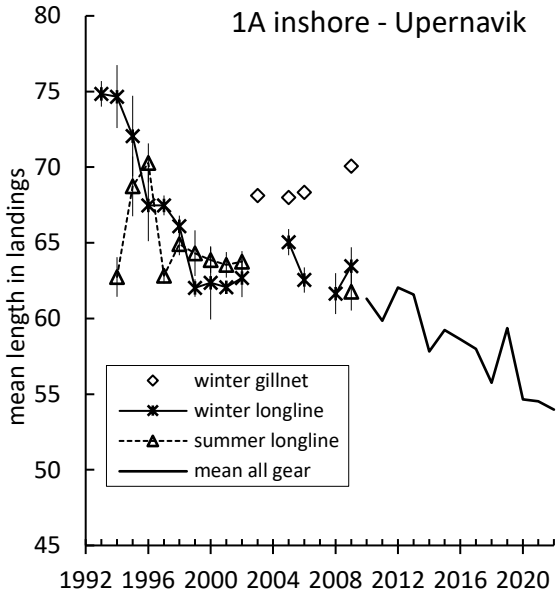

Figure 2. Upernavik mean length in the landings: longline summer and winter and overall mean weighted by season and gear (Mean all gear) (left) and in the gillnet fishery (right).

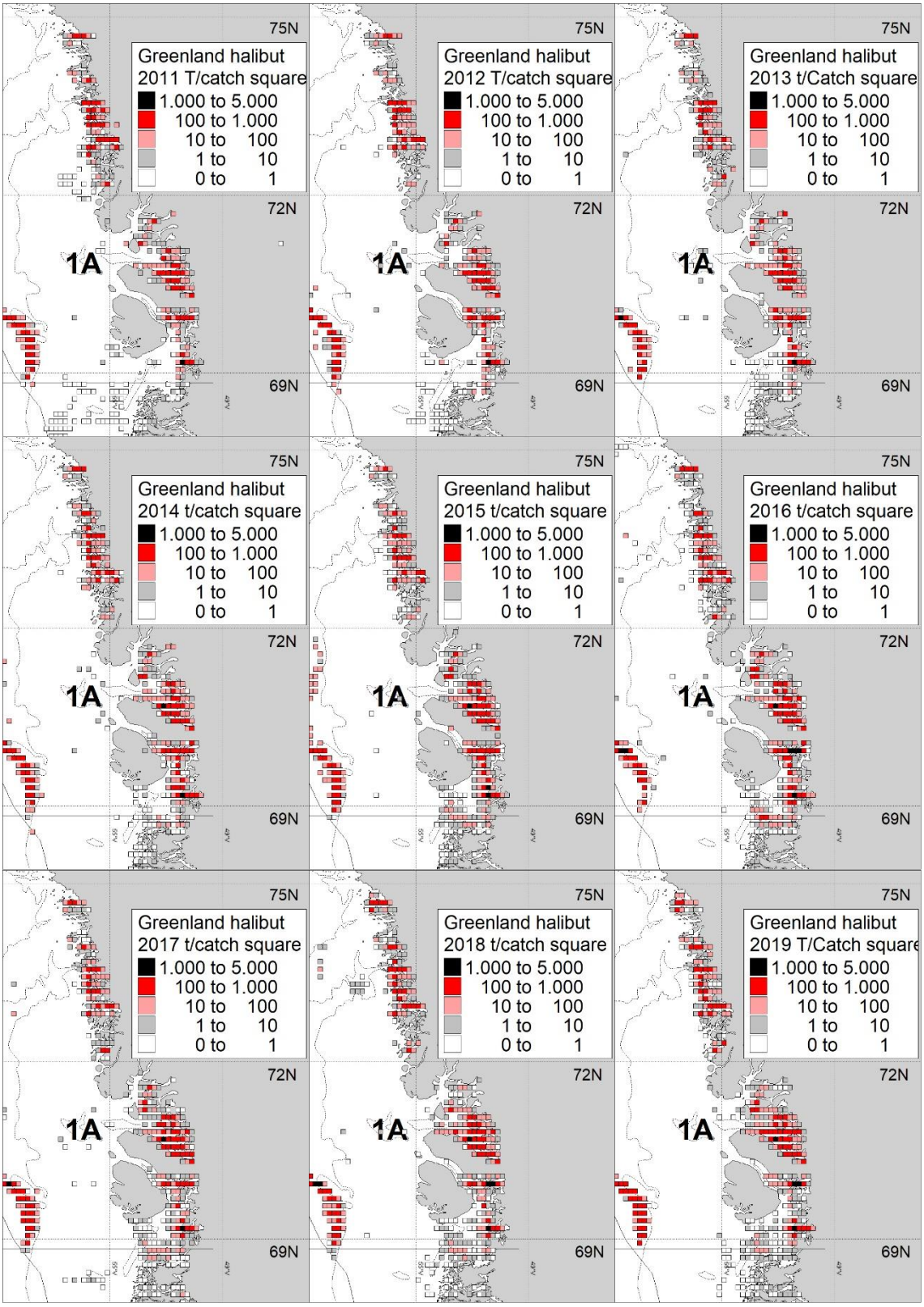

Figure 3. Greenland halibut catch by statistical square in the

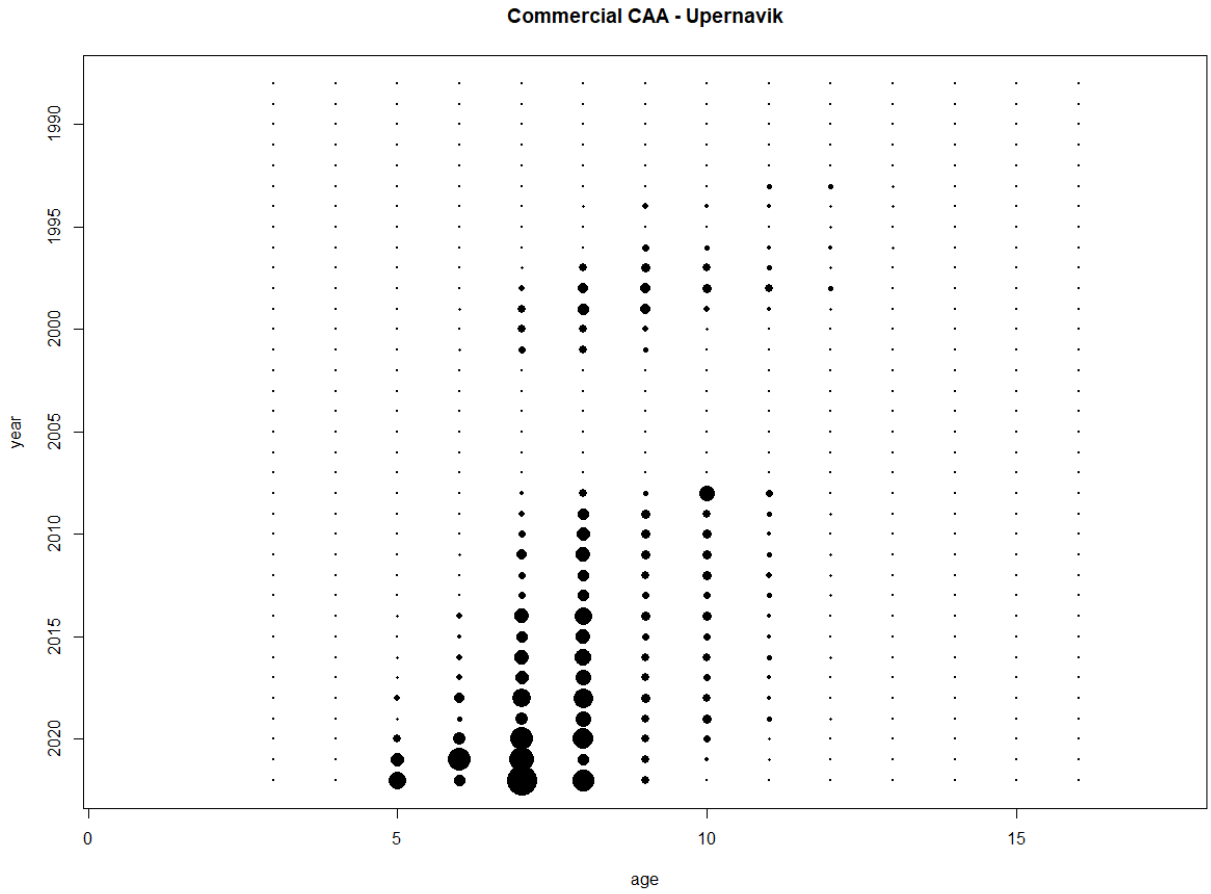

Figure 4. Catch At Age CAA bubble plot for the commercial landings in Upernavik. Sofar only 2021 have been recalculated with the new ALK from Upernavik 2021. Missing years (1991,1992,2002-2007)

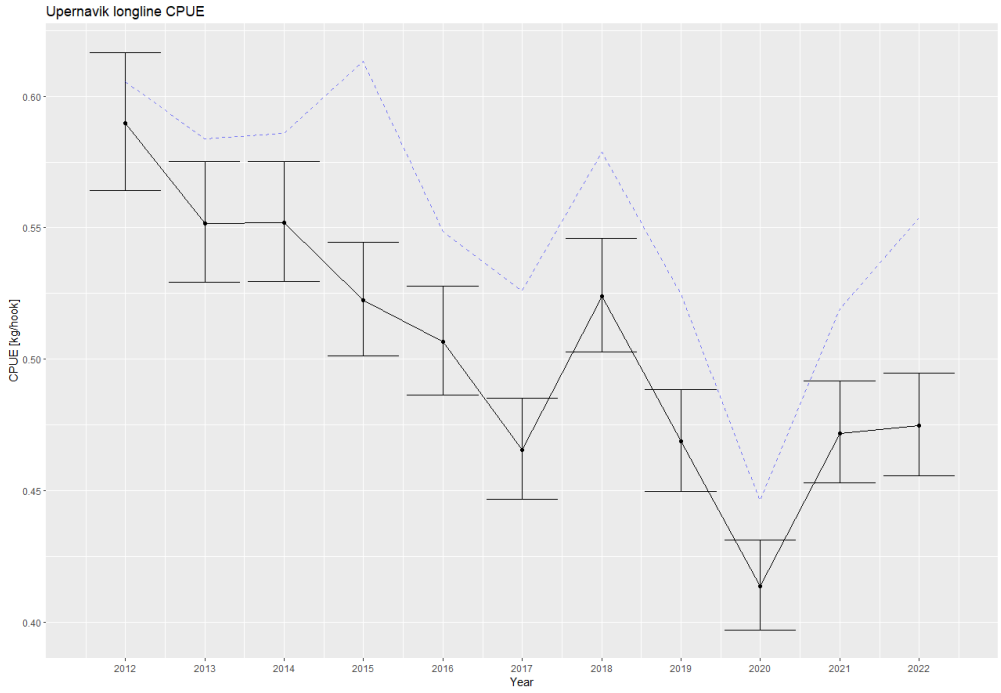

Figure 5. Commercial CPUE (Kg/hook) based on factory landing reports from all factories in Upernavik.

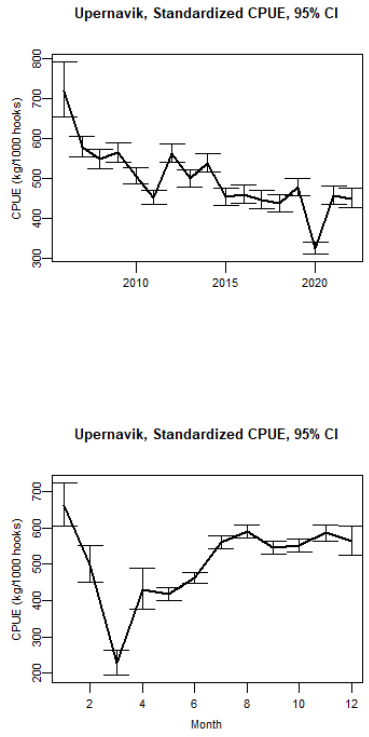

Figure 6. Upernavik Longline logbooks - Standardized mean and 95% CI CPUE based on logbooks from vessels larger than 30ft since 2006.

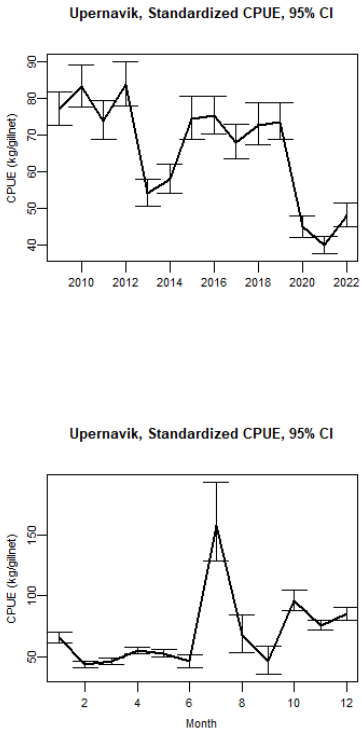

Figure 7. Gillnet logbooks - standardized mean and 95% CI CPUE based on logbooks from vessels larger than 30ft in Upernavik.

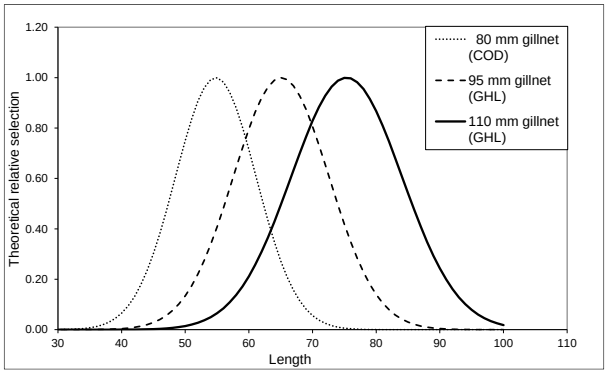

Figure 8. Relative selection curves for Greenland halibut with the most recently used gillnets. After a period with increasing use of illegal use of cod gillnets to target Greenland halibut the legal meshsize was changed from 110 mm halfmesh to 95mm halfmesh in 2017.

```
*********************************************
UPERNAVIK LONGLINE LOGBOOK CPUE
*********************************************
lm(formula = lcpue ~ Year + Month + Boat)

Residuals:
   Min     1Q  Median     3Q    Max
-7.7402 -0.2738  0.0424  0.3252  2.8383

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)     7.017187   0.094869  73.967  < 2e-16 ***
Year2007       -0.215970   0.045938  -4.701 2.60e-06 ***
Year2008       -0.269282   0.046149  -5.835 5.45e-09 ***
Year2009       -0.241998   0.047548  -5.090 3.61e-07 ***
Year2010       -0.350558   0.047217  -7.424 1.17e-13 ***
Year2011       -0.463967   0.047445  -9.779  < 2e-16 ***
Year2012       -0.244835   0.047624  -5.141 2.75e-07 ***
Year2013       -0.364762   0.048095  -7.584 3.46e-14 ***
Year2014       -0.287764   0.047807  -6.019 1.78e-09 ***
Year2015       -0.461676   0.049657  -9.297  < 2e-16 ***
Year2016       -0.447537   0.050030  -8.945  < 2e-16 ***
Year2017       -0.474294   0.049744  -9.535  < 2e-16 ***
Year2018       -0.494354   0.049931  -9.901  < 2e-16 ***
Year2019       -0.407311   0.049181  -8.282  < 2e-16 ***
Year2020       -0.792124   0.049616 -15.965  < 2e-16 ***
Year2021       -0.451035   0.050240  -8.978  < 2e-16 ***
Year2022       -0.468843   0.051547  -9.095  < 2e-16 ***
Month2         -0.283504   0.064927  -4.366 1.27e-05 ***
Month3         -1.070478   0.086026 -12.444  < 2e-16 ***
Month4         -0.436153   0.078380  -5.565 2.66e-08 ***
Month5         -0.461753   0.046394  -9.953  < 2e-16 ***
Month6         -0.362403   0.044117  -8.215 2.23e-16 ***
Month7         -0.168715   0.043781  -3.854 0.000117 ***
Month8         -0.117722   0.043683  -2.695 0.007046 **
Month9         -0.195719   0.043705  -4.478 7.56e-06 ***
Month10        -0.184720   0.043984  -4.200 2.68e-05 ***
Month11        -0.123519   0.044669  -2.765 0.005693 **
Month12        -0.162211   0.053411  -3.037 0.002392 **
BoatA-MADS     -0.318179   0.091226  -3.488 0.000488 ***
BoatAGGU S      0.062168   0.077871   0.798 0.424678
BoatAKAMALIK    0.196633   0.118552   1.659 0.097205 .
BoatAKKA AQQALU -0.625165   0.319604  -1.956 0.050469 .
BoatAKKA NUKA   -0.399668   0.080109  -4.989 6.11e-07 ***
BoatANE-ABEL    -0.263179   0.075460  -3.488 0.000488 ***
BoatANE-ANNA     0.090176   0.079818   1.130 0.258584
BoatANE KAREN   -0.105230   0.118574  -0.887 0.374837
BoatANGAJE-NUKA  0.134690   0.089013   1.513 0.130256
BoatANGAJOORA   -0.562431   0.162368  -3.464 0.000533 ***
BoatANGERLA S   -0.340328   0.185640  -1.833 0.066775 .
BoatANGAANNGU    0.098472   0.076643   1.285 0.198871
BoatANITSI       0.030952   0.097273   0.318 0.750338
BoatANNA-NUKA    0.042938   0.086094   0.499 0.617976
BoatAPUTSIAQ     0.249953   0.096345   2.594 0.009483 **
BoatAQQA         0.211996   0.075055   2.825 0.004739 **
BoatAQQALUULU    0.046425   0.077129   0.602 0.547242
```

BoatARNAQ 0.187875 0.077631 2.420 0.015524 *
BoatARNAQ ZEEB -0.532271 0.089726 -5.932 3.03e-09 ***
BoatARNARISSOQ 0.121772 0.078132 1.559 0.119117
BoatARNAALUK MALIK -0.280351 0.178913 -1.567 0.117135
BoatBJ. NUKARLEQ -0.353159 0.123935 -2.850 0.004382 **
BoatCECILIA -1.328294 0.103861 -12.789 < 2e-16 ***
BoatDORTINNGUAQ -0.119670 0.091913 -1.302 0.192929
BoatELIASSEN -0.011206 0.075724 -0.148 0.882360
BoatERNEERAQ L 0.015934 0.079837 0.200 0.841811
BoatFALIK L 0.039415 0.093243 0.423 0.672507
BoatHANS KUNUUT -0.033802 0.090858 -0.372 0.709872
BoatHANS PAALU 0.266115 0.073728 3.609 0.000308 ***
BoatHANS VILLAS 0.020557 0.075528 0.272 0.785484
BoatHILDA 0.257974 0.074088 3.482 0.000499 ***
BoatIINANNGUAQ 0.282808 0.092687 3.051 0.002282 **
BoatINUNNGUA 0.001384 0.085083 0.016 0.987021
BoatINUUNA -0.124601 0.252587 -0.493 0.621805
BoatIPIUTAQ -0.659588 0.097258 -6.782 1.21e-11 ***
BoatITATTAAQ -0.093338 0.124510 -0.750 0.453478
BoatJENS HENRIK 0.269400 0.100596 2.678 0.007410 **
BoatJESS -0.251181 0.252324 -0.995 0.319519
BoatJULIA NADUK -0.144882 0.102992 -1.407 0.159519
BoatJULIANE -0.097985 0.078464 -1.249 0.211753
BoatJUUKA 0.012654 0.079774 0.159 0.873968
BoatJUULUT -0.270236 0.161808 -1.670 0.094912 .
BoatJUUNTAAT -0.537000 0.080348 -6.683 2.38e-11 ***
BoatJAAKU-MALIK -0.221894 0.096454 -2.301 0.021428 *
BoatKABENA -0.306323 0.084569 -3.622 0.000293 ***
BoatKAMMA -0.007399 0.079648 -0.093 0.925987
BoatKATTANNGUAQ -0.736936 0.319486 -2.307 0.021084 *
BoatKLEEMANN 0.060664 0.074566 0.814 0.415903
BoatKUNUK -0.010664 0.107596 -0.099 0.921051
BoatKUUJUK -0.544880 0.136482 -3.992 6.56e-05 ***
BoatKAAKA-AQQALU 0.299297 0.217251 1.378 0.168323
BoatKAALEERAQ -0.175469 0.161360 -1.087 0.276856
BoatL. CHRISTINA -0.126734 0.130519 -0.971 0.331557
BoatL.CHRISTINA 0.240665 0.108756 2.213 0.026914 *
BoatLAILA S. 0.177564 0.089268 1.989 0.046699 *
BoatLENE BOHM 0.102639 0.146698 0.700 0.484148
BoatLYDIA -1.387195 0.157383 -8.814 < 2e-16 ***
BoatLAARSEERAQ LARSEN 0.154910 0.216566 0.715 0.474430
BoatM.A.FRENA -0.014311 0.130087 -0.110 0.912400
BoatMADS P. -0.135807 0.074282 -1.828 0.067522 .
BoatMALIGIAQ S -0.181771 0.096821 -1.877 0.060475 .
BoatMARY WEST -0.861566 0.157198 -5.481 4.28e-08 ***
BoatMASIK -0.019126 0.136352 -0.140 0.888451
BoatMASILIK -1.153610 0.543807 -2.121 0.033902 *
BoatMIILU 0.072327 0.076947 0.940 0.347248
BoatMILLE KUKA -1.202266 0.388404 -3.095 0.001968 **
BoatNANOQ 0.404550 0.079258 5.104 3.35e-07 ***
BoatNANUVIK -0.222924 0.093910 -2.374 0.017613 *
BoatNAPÁRTOQ 0.323054 0.123489 2.616 0.008901 **
BoatNAVARANA 0.116471 0.073991 1.574 0.115470
BoatNEQITAQ 0.567202 0.252205 2.249 0.024523 *
BoatNIELS -0.563082 0.088588 -6.356 2.11e-10 ***
BoatNIISE 0.062372 0.101727 0.613 0.539794

```
BoatNIISI            0.207730   0.075553   2.749 0.005974 **
BoatNIISIKA PAALU    -0.297372   0.073654  -4.037 5.42e-05 ***
BoatNILAK            -0.084428   0.251833  -0.335 0.737437
BoatNINO JAKOB        0.384601   0.079713   4.825 1.41e-06 ***
BoatNIVI K.          -0.191869   0.074382  -2.580 0.009900 **
BoatNONO             -0.400467   0.141058  -2.839 0.004529 **
BoatNORSAQ            0.055042   0.083330   0.661 0.508919
BoatNUKA              0.249568   0.319794   0.780 0.435162
BoatNUKANU S          0.395492   0.098656   4.009 6.12e-05 ***
BoatNUKARIIT III     -0.327526   0.074800  -4.379 1.20e-05 ***
BoatNUKARIIT IV      -0.012870   0.078089  -0.165 0.869094
BoatNUKARLEQ         -0.266285   0.125450  -2.123 0.033794 *
BoatNUUNU MALIK      -0.350171   0.122688  -2.854 0.004319 **
BoatOLE DAVID        -0.072027   0.104961  -0.686 0.492578
BoatOVE               0.145281   0.098372   1.477 0.139728
BoatPANITUAQ         -1.035178   0.112253  -9.222  < 2e-16 ***
BoatPAPEROQ          -0.077595   0.319527  -0.243 0.808128
BoatPIITAARAQ         0.172254   0.088809   1.940 0.052440 .
BoatPILO             -0.252998   0.129273  -1.957 0.050349 .
BoatPIPALUK          -0.533886   0.090634  -5.891 3.90e-09 ***
BoatPAARNAQ          -0.599725   0.089124  -6.729 1.75e-11 ***
BoatPAATAQ            0.183967   0.204813   0.898 0.369077
BoatQASIGIAQ         -0.143751   0.138563  -1.037 0.299542
BoatQILANNGAQ         0.057329   0.079114   0.725 0.468686
BoatQULLEQ            0.112348   0.157312   0.714 0.475127
BoatQAASIINA         -0.404263   0.153665  -2.631 0.008524 **
BoatRENA G.           0.045696   0.084027   0.544 0.586566
BoatRAASI            -0.544654   0.279325  -1.950 0.051200 .
BoatSAGDLEQ          -0.426950   0.100035  -4.268 1.98e-05 ***
BoatSAVIK            -0.048751   0.231834  -0.210 0.833448
BoatSOFIE            -0.208257   0.232138  -0.897 0.369661
BoatSUSSI LAILA       0.320519   0.387891   0.826 0.408635
BoatSVENDSEN         -0.816868   0.150053  -5.444 5.26e-08 ***
BoatTHOMASSEN II     -0.073317   0.157267  -0.466 0.641081
BoatTIA              -0.791702   0.387889  -2.041 0.041256 *
BoatTUPERNA          -0.258007   0.074264  -3.474 0.000513 ***
BoatTUPPI             0.407291   0.074794   5.446 5.22e-08 ***
BoatTUUKKAQ VII       0.459660   0.325824   1.411 0.158328
BoatULLORIAQ         -0.401556   0.143898  -2.791 0.005266 **
BoatULU               0.108943   0.113729   0.958 0.338113
BoatUUMAANNGUAQ      -0.083299   0.088646  -0.940 0.347391
BoatAAJU S.          -0.004239   0.128538  -0.033 0.973695
BoatAALIPAARAQ       -0.887121   0.543765  -1.631 0.102810
BoatAANNGUAQ P        0.041864   0.074439   0.562 0.573855
BoatAANAA RUTH       -0.174945   0.081754  -2.140 0.032373 *
BoatAAPIKANNA        -0.049873   0.543765  -0.092 0.926922
BoatAAQA AQQALU       0.309720   0.232317   1.333 0.182486
BoatAAQA JULIE       -1.624087   0.129810 -12.511  < 2e-16 ***
BoatAARSU            -0.041166   0.086647  -0.475 0.634718
BoatAAVU              0.290838   0.093027   3.126 0.001772 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5386 on 24118 degrees of freedom
Multiple R-squared:  0.2681,          Adjusted R-squared:  0.2636
F-statistic: 58.91 on 150 and 24118 DF,  p-value: < 2.2e-16
```

****
UPERNAVIK GILLNET LOGBOOK CPUE ALL MONTHS MAX CATCH 1001 KG/Gillnet
****

lm(formula = lcpue ~ Year + Month + Boat)

Residuals:

Min	1Q	Median	3Q	Max
-6.1923	-0.3366	0.0187	0.3516	2.9047

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	4.83235	0.40989	11.789	< 2e-16	***
Year2010	0.07563	0.03675	2.058	0.039590	*
Year2011	-0.04114	0.03932	-1.046	0.295503	
Year2012	0.08292	0.03908	2.122	0.033847	*
Year2013	-0.35401	0.03736	-9.476	< 2e-16	***
Year2014	-0.28442	0.03668	-7.754	9.68e-15	***
Year2015	-0.03404	0.04280	-0.795	0.426463	
Year2016	-0.02485	0.03743	-0.664	0.506741	
Year2017	-0.12395	0.03655	-3.391	0.000699	***
Year2018	-0.05716	0.04205	-1.359	0.174082	
Year2019	-0.04562	0.03803	-1.199	0.230422	
Year2020	-0.53775	0.03641	-14.771	< 2e-16	***
Year2021	-0.65664	0.03329	-19.724	< 2e-16	***
Year2022	-0.47121	0.03563	-13.224	< 2e-16	***
Month2	-0.41255	0.02935	-14.054	< 2e-16	***
Month3	-0.34769	0.02822	-12.319	< 2e-16	***
Month4	-0.17163	0.02768	-6.200	5.85e-10	***
Month5	-0.21780	0.03165	-6.882	6.22e-12	***
Month6	-0.34889	0.06043	-5.774	7.96e-09	***
Month7	0.88132	0.10930	8.063	8.19e-16	***
Month8	0.03184	0.12457	0.256	0.798288	
Month9	-0.35251	0.12991	-2.714	0.006666	**
Month10	0.38423	0.04767	8.061	8.35e-16	***
Month11	0.14849	0.02958	5.020	5.26e-07	***
Month12	0.26294	0.03385	7.769	8.59e-15	***
BoatAKAMALIK	0.11716	0.42874	0.273	0.784650	
BoatAKKA NUKA	-1.09216	0.41679	-2.620	0.008794	**
BoatANE-ABEL	-0.55868	0.41245	-1.355	0.175593	
BoatANE-ANNA	-0.33727	0.42419	-0.795	0.426572	
BoatANGAJE-NUKA	-0.11729	0.54024	-0.217	0.828124	
BoatANGAANNGU	-0.47001	0.41030	-1.146	0.252017	
BoatANNA-NUKA	0.45658	0.42624	1.071	0.284117	
BoatAQQA	-0.11148	0.41160	-0.271	0.786510	
BoatARNAQ	-0.26465	0.42152	-0.628	0.530115	
BoatARNAQ ZEEB	-0.62487	0.41841	-1.493	0.135352	
BoatARNARISSOQ	-0.58533	0.42001	-1.394	0.163463	
BoatELIASSEN	-0.87054	0.41220	-2.112	0.034715	*
BoatERNEERAQ L	-0.38515	0.41127	-0.936	0.349042	
BoatHANS PAALU	-0.55194	0.40928	-1.349	0.177506	
BoatHANS VILLAS	-0.24874	0.41939	-0.593	0.553128	
BoatHILDA	-0.29190	0.40855	-0.714	0.474953	
BoatJENS HENRIK	-0.76554	0.41726	-1.835	0.066579	.
BoatJULIA NADUK	-0.30721	0.42394	-0.725	0.468684	
BoatJULIANE	-0.57517	0.41366	-1.390	0.164421	

```
BoatJUUKA          -0.38914    0.46686  -0.834 0.404561
BoatJAAKU-MALIK    -0.12764    0.42962  -0.297 0.766389
BoatKABENA         -1.13939    0.41632  -2.737 0.006213 **
BoatKAMMA          -0.58203    0.44408  -1.311 0.190006
BoatKLEEMANN       -1.15474    0.40975  -2.818 0.004838 **
BoatLAILA S.       -0.29216    0.45159  -0.647 0.517674
BoatMADS P.        -0.27803    0.40889  -0.680 0.496537
BoatMALIGIAQ S     -0.84783    0.43344  -1.956 0.050487 .
BoatNANOQ          -1.21576    0.52747  -2.305 0.021191 *
BoatNANUVIK         0.03864    0.41572   0.093 0.925951
BoatNAVARANA       -0.46949    0.40915  -1.147 0.251213
BoatNIISE          -0.63385    0.47234  -1.342 0.179645
BoatNIISI          -1.06911    0.41091  -2.602 0.009285 **
BoatNIISIKA PAALU -0.79663    0.40840  -1.951 0.051124 .
BoatNINO JAKOB     -0.24059    0.41307  -0.582 0.560276
BoatNIVI K.        -0.74877    0.40862  -1.832 0.066916 .
BoatNUKANU S       -1.64532    0.44590  -3.690 0.000225 ***
BoatNUKARIIT III   -0.69134    0.40847  -1.693 0.090577 .
BoatNUKARIIT IV    -0.96386    0.40902  -2.357 0.018464 *
BoatPANITUAQ        0.05636    0.41929   0.134 0.893076
BoatPAARNAQ        -0.73433    0.41217  -1.782 0.074840 .
BoatQAASIINA       -0.18085    0.41829  -0.432 0.665490
BoatSAGDLEQ        -0.66409    0.41059  -1.617 0.105813
BoatSVENDSEN        0.01635    0.70801   0.023 0.981572
BoatTUPERNA        -1.37882    0.41162  -3.350 0.000812 ***
BoatTUPPI          -0.88646    0.44763  -1.980 0.047690 *
BoatULLORIAQ        0.12132    0.42194   0.288 0.773711
BoatAANNGUAQ P     -0.08958    0.40936  -0.219 0.826779
BoatAANAA RUTH      0.04898    0.41289   0.119 0.905577
BoatAARSU           0.08401    0.47188   0.178 0.858697
BoatAAVU            0.16981    0.44757   0.379 0.704401
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5763 on 11389 degrees of freedom
Multiple R-squared:  0.376,             Adjusted R-squared:  0.3719
F-statistic: 92.73 on 74 and 11389 DF,  p-value: < 2.2e-16
```