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Commercial data for the Greenland halibut fishery in Uummannaq

by

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Abstract

Although the commercial fishery in for Greenland halibut started around 1910 the first available catch statistics from the Uummannaq area, is from the 1950's. The fishery is traditionally performed with longline from small open boats or dog sledges through a hole in the sea ice. This document presents catch statistics combined from various resources from the Uummannaq fjord. The document includes statistics of commercial sampling effort done by the GINR and calculations of mean size in the landings and a preliminary CAA. Also provided are 3 indices of CPUE. Two based on logbooks (one longline fishery and one gillnets fishery) and one on factory landings data (longline).

Introduction

The first available catch statistics from the Uummannaq fjord is from 1954. The fishery is traditionally performed with longline from small open boats or dog sledges through a hole in the sea ice. 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 restricting the 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. The minimum mesh-size in the gillnets was 110 mm (half meshes or knot to knot) until 2017 when the meshsize was reduced to 95 mm halfmesh. In general, gillnets have narrow selection curves and targeting fish at certain size intervals. Theoretical selection curves and factory landings show that 110 mm gillnets catche Greenland halibut from 55 cm and has maximal selectivity in the size interval 65-85 cm. 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.
Licence requirements were introduced in 1998 and in 2008 TAC and quota regulations were introduced for the inshore fishery. A separate TAC is set for each area. 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.

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 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. To ensure sufficient length information from the commercial catches, GINR do commercial length measurements in factories during the winter months (jan-April). However, in Uummannaq 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.
An alternative source of length information in the catch are Grader data. Graders are automated sorting mashines that weigh each fish individually and sort them according to size categories. If extracted, the millions of individual weights can be transformed into length information. Graders typically do not register information on gear. This is however not a problem since all fish in the landings provide information, and gear therefore is randomly incorporated into in the length distribution.

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 22-010 for details).

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 2008. Only longline setting with more than 200 hooks and gillnets with catches between 0 and 1001 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. In 2022, 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 (SCR 22-024) Another difference is that due to the high number of small boat fishermen and diverse types of fishery all using the same standard gear (longlines from either logbook vessels, small open boats or directly from the sea ice) the model use year, vessel type (vessel, boat, dog sledge or snowmobile) and statistical catch square

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 1954. The fishery is traditionally performed with longline from small open boats or dog sledges through a hole in the sea ice.

In **Uummannaq**, catches increased during the 1980s and peaked in 1999, at more than 8.000 tons (tab 1 and figure 1). Catch then decreased to around 6 000 t, whereafter the gradual increase started again. Since 2016, annual catches have been around 10 000 per year. The tragic Karrat fjord tsunami disaster leading to the closure of the settlements Nuugaatsiaq and Illorsuit, likely affected the fishery negatively in 2017 and 2018. In 2022, 9007 t (estimated round weight) were caught in the area.

Distribution of catch

The fishery in Uummannaq is scattered all over the fjord near settlements (fig.2). Particular in the deep South-eastern part of the fjord from Uummannaq and towards East where depths of more than 1500 meters are common. Greenland halibut can however be found in all areas in the fjord. The area is highly productive with 10 large iceberg producing glaciers where rinks Isbræ (karrat Fjord and "Store" ("Large" or "great") are located are among the more remarkable.

Breakdown of catch

The catch by gear (longline or gillnet) and month is combined with the length frequencies from the commercial landings (table 3) to calculate mean size in the landings and the CAA. Due to the logistical challenges in Greenland not all months have commercial length information (table 3). Nevertheless, in most years the sampling covers the 3 different categories (Uummannaq longline winter, Uummannaq gillnet winter and Uummannaq longline summer). Grader information has not been received from the 2022 and due to logistics no sampling was done in the summer of 2022.

Size of the landed fish.

In **Uummannaq** there is not any major difference between summer and winter fishing grounds and only small differences in the summer and winter length distributions are observed. Only Gear is accounted for in the length sampling. Mean individual length in the commercial landings have gradually decreased since 1993 (Figure 3). In 2021 the Mean length in the landings decrease by 4 cm in just one year, from 57 cm in 2020 to 53 cm in 2021. Grader data from 2021 provided by the industry from the Grader placed in Uummannaq estimate a mean length in the landings of 55,1 cm (recalculated from individual mean weights registered by the grader). However, this is without data from the last two months of longline fishery 2021 therefore biasing the estimate slightly upwards. Although length information of less than 1000 fish is currently available from the area, the estimated overall mean is close to the previous estimate of around 54 cm.

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, 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.

CAA – Catch At Age

The 2021 CAA was constructed with individual years ALK from the GINR Uummannaq 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 partly in Upernavik (figure 4). However, due to the low number aged Greenland halibut from Uummannaq in 2022 and the lag of sufficient length information from the catches, the CAA from Uummannaq in 2022 is unreliable.

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 2012 to 2022 (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 substantial decrease from 2013 to 2017 and a slow but sustained decrease after 2017. (figure 5).

Logbook CPUE (longline)

A general linear model (GLM) with year, month and boat as factors was applied to the longline fishery logbook data since 2006. The longline logbook catch in the first year was low and the initial value is uncertain (table 7). The CPUE initially increases from 2007 to 2011 but then gradually decrease until 2022. The increase observed in the 2021 CPUE index from the logbooks seems to be a year effect and is not confirmed in 2022 (fig 6).

Logbook CPUE (Gillnet)

A general linear model (GLM) with year, month and boat as factors was applied to the longline fishery logbook data since 2008. Fewer observations is available in the first year 2008, and the initial value is uncertain. From 2009, the CPUE gradually increases and peaks in 2013 and again in 2018, whereafter it decreases until 2020. Some caution should be given when interpreting the CPUE after 2017 due to the allowed reduction from 110 mm gillnets to 95mm gillnets leading to a gradual transition to these gillnets selecting fish on average about 10 cm smaller (figure 8) (change from about 60 to 50 cm at first selection). The Increase prior to the regulation change should however not be affected by the reduction in mesh size. The increase in 2021, may partly be due to the 2015 year class starting to be selected by the 95 mm gillnets used in the fishery.

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.

More work on the CAA table is needed. 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

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Table 1. Catches (t) of Greenland halibut in Uummannaq by gear and year.

	Uummannaq		Notes
Year	Longline Gillnet	Catch	
1954		16	
1955		76	
1956		84	
1957		31	
1958		177	
1959		206	
1960			No catch statistics ?
1961			No catch statistics ?
1962			No catch statistics ?
1963			No catch statistics ?
1964		403	
1965		688	
1966		675	
1967		593	
1968		407	
1969		584	
1970		326	
1971		149	
1972		271	
1973			No catch statistics ?
1974			No catch statistics ?
1975		309	
1976			No catch statistics ?
1977		754	
1978		1144	
1979		835	
1980		1422	
1981		1662	
1982		1210	
1983		966	
1984		1259	
1985		1833	
1986			No catch statistics ?
1987		2897	
1988		2920	
1989		2859	
1990		2779	
1991		3045	
1992		3067	

1993			3916	
1994			4004	
1995			7234	
1996	3176	1437	4579	
1997			6293	
1998			6912	
1999			8425	
2000	7103	465	7568	
2001	6185	375	6558	
2002			5339	
2003	3924	1115	5039	
2004	4140	1101	5248	
2005	1947	2908	4856	
2006			5984	
2007	4460	858	5318	
2008			5426	
2009			5451	
2010	5617	610	6226	
2011	5046	1179	6397	
2012	5847	357	6204	
2013	6639	369	7008	
2014	7800	407	8207	
2015	7279	962	8244	
2016	9512	792	10305	
2017	8261	788	9049	
2018	7505	1334	8839	
2019	8142	2021	10162	
2020	8880	1797	10677	
2021	8479	1130	9609	
2022	7977	1030	9007	Poor commercial sampling. No grader data available.

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 halfmesh (190mm).

Table 2. Uummannaq Landings of Greenland halibut (t) by gear and month.

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OKT	NOV	DEC	Total
Longline	2011	169	156	306	560	357	772	1298	736	98	585	9	0	5046
	2012	387	614	625	158	217	1023	1140	957	301	184	207	35	5847
	2013	197	354	482	357	547	1128	1352	934	609	424	216	38	6639
	2014	172	351	667	572	347	965	1420	1201	1032	532	415	126	7800
	2015	173	462	701	598	211	494	1428	1068	1060	657	314	113	7281
	2016	598	731	585	469	871	1405	1540	1324	1129	519	217	127	9512
	2017	432	563	732	521	311	900	1340	1167	921	885	291	197	8261
	2018	157	370	508	564	427	1173	1455	1017	876	708	134	118	7505
	2019	443	409	440	466	666	1321	1398	1036	663	865	234	200	8142
	2020	193	470	455	440	537	1692	1597	1210	1102	760	183	241	8880
	2021	161	297	350	176	814	1632	1364	1208	1160	945	208	164	8479
	2022	146	219	671	735	376	1051	1569	1078	701	773	349	310	7977

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OKT	NOV	DEC	Total
Gillnet	2011	158	293	8	0	140	531	50	0	0	0	0	0	1179
	2012	90	37	60	14	0	3	0	0	0	9	57	85	357
	2013	66	56	54	77	28	0	0	1	0	0	57	30	369
	2014	83	76	42	62	0	1	0	0	0	0	40	104	407
	2015	74	38	59	43	1	0	617	95	2	0	23	10	963
	2016	20	40	44	115	38	0	0	67	180	120	86	82	792
	2017	46	18	27	33	24	37	46	3	32	131	158	233	788
	2018	163	76	270	316	3	14	3	0	0	0	320	169	1334
	2019	207	509	362	263	8	1	1	3	1	1	250	414	2021
	2020	229	324	380	284	3	4	4	2	3	13	261	288	1797
	2021	241	55	104	207	59	6	0	0	0	0	85	373	1130
	2022	248	10	105	127	141	16	0	0	0	0	163	219	1030

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OKT	NOV	DEC	Total
Total	2011													
	2012	477	651	685	172	217	1026	1140	957	301	193	265	120	6204
	2013	263	410	537	434	575	1128	1352	935	609	424	273	68	7008
	2014	256	427	710	633	347	965	1420	1201	1032	532	455	230	8207
	2015	247	500	761	640	212	494	2045	1163	1063	657	337	124	8244
	2016	618	772	629	584	908	1405	1540	1391	1309	638	303	208	10305
	2017	478	581	760	554	335	938	1386	1169	953	1016	449	430	9049
	2018	320	445	778	880	430	1187	1458	1017	876	708	454	287	8839
	2019	650	918	802	730	674	1322	1400	1039	664	866	484	614	10162
	2020	423	794	835	725	540	1696	1601	1212	1105	773	444	528	10677
	2021	402	352	454	383	873	1638	1364	1208	1160	946	293	536	9609
	2022	394	229	776	862	517	1068	1569	1078	701	773	512	529	9007

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	-	3047	1583	-	-	-	-	-	854	2673	-	-
	2011	-	287	3265	1853		2973	2328	988	-	5124	-	-
	2012	-	-	2416	-	-	-	-	1469	-	-	-	-
	2013	-	484	3068	-	-	-	-	287	1485	-	-	-
	2014	-	4390	-	-	-	-	-	1690	-	-	-	-
	2015	-	5972	-	-	-	-	864	821	-	-	-	-
	2016	-		5940	-	-	-	777		-	-	-	-
	2017	-	5126	3858	-	-	-		4208	-	-	-	-
	2018	-	732	4770	-	-	-	3239	-	-	-	-	-
	2019	-	3653	-	-	-	-	204	3250	-	-	-	-
	2020	-	3955	-	-	-	453	-	2031	1334	-	-	-
	2021	-	821	2259	-	-	-	-	3232		-	-	-
	2022	-	-	495	-	-	-	-	-	-	-	-	-

	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Gillnet	2010	-	127		-	-	-	-	-	-	-	-	-
	2011	-	632	1454	-	-	-	-	-	-	-	-	-
	2012	-	-	-	-	-	-	-	-	-	-	-	-
	2013	-	45	-	-	-	-	-	-	-	-	-	-
	2014	-	-	-	-	-	-	-	-	-	-	-	-
	2015	-	185	-	-	-	-	-	-	-	-	-	-
	2016	-	-	487	-	-	-	-	-	-	-	-	-
	2017	-	102	-	-	-	-	-	-	-	-	-	-
	2018	-	331	91	-	-	-	-	-	-	-	-	-
	2019	-	1902	-	-	-	-	-	-	-	-	-	-
	2020	1744	2753	-	-	-	-	-	-	-	-	-	-
	2021	-	163	-	-	-	-	-	-	-	-	-	-
	2022	-	-	237	-	-	-	-	-	-	-	-	-

Table 4 2021 Uummannaq grader data: W is the mean weight (g) of the individual weights registered by the grader. # obs is the number of Greenland halibut passing the grader in Uummannaq in 2021. ML is the Mean of the lengths estimated from a LW relationship and the individual W (g). Raw data kindly provided by the Greenland fishing industry. (data not received in 2022)

2021	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
W (g)	1764	1822	1690	2037	1530	1598	1620	1643	1641	1459	NA	NA
# obs	20899	13761	48620	55551	146335	177245	155751	153469	115541	79663	NA	NA
ML	56.54	57.29	55.93	59.42	54.11	54.74	54.98	55.2	55.24	53.45	NA	NA

Table 5. CAA – Catch at age for Greenland halibut in the Uummannaq district.

age/year	3	4	5	6	7	8	9	10	11	12	13	14	15+	16+	Total
1988	0	0	0	1	5	20	52	121	143	121	96	49	23	17	648
1989	0	0	0	0	2	9	35	98	120	99	76	38	19	20	516
1990	0	0	0	1	3	15	47	108	121	101	82	42	20	21	561
1991															
1992															
1993	0	0	0	9	45	200	202	142	138	104	158	93	28	20	1139
1994	0	0	0	24	105	226	271	346	139	105	34	12	0	3	1265
1995	0	0	0	6	217	564	601	413	414	219	138	49	28	22	2671
1996	0	1	0	6	76	308	279	286	232	142	69	28	11	15	1453
1997	0	0	0	0	69	377	793	702	460	206	75	32	10	6	2732
1998	0	0	0	0	0	235	566	657	586	355	138	39	15	5	2595
1999	0	8	70	218	554	596	690	789	526	295	131	42	12	4	3935
2000	0	0	19	86	357	441	543	669	487	311	170	68	24	8	3184
2001	0	0	65	113	674	507	315	492	303	178	121	60	28	12	2868
2002															
2003	0	0	3	21	127	360	321	235	220	158	78	145	150	94	1911
2004	0	0	1	10	105	197	249	198	163	118	82	103	78	59	1364
2005	0	1	17	101	108	192	142	115	109	74	58	80	67	50	1115
2006	0	1	32	12	47	243	70	284	127	324	49	108	9	9	1315
2007	0	3	40	181	221	340	273	192	149	94	64	82	71	56	1767
2008	0	4	46	203	249	381	304	213	166	104	71	91	79	63	1974
2009	0	3	9	25	238	525	470	415	243	157	90	42	20	11	2248
2010	0	1	8	77	484	822	459	458	235	128	79	32	21		2804
2011	0	0	11	94	465	743	432	441	242	141	91	43	26		2730
2012	0	0	6	61	347	627	393	422	260	168	114	57	37		2492
2013	0	1	9	72	397	730	494	531	302	173	108	49	31		2896
2014	0	1	20	120	622	1026	613	608	308	163	107	46	32		3667
2015	0	2	26	112	489	828	545	582	354	211	144	68	41		3403
2016	0	4	49	203	840	1290	736	727	386	211	132	58	40		4679
2017	2	28	204	424	924	1079	564	553	299	174	121	62	38		4473
2018	2	36	265	499	1036	1150	586	550	261	137	93	43	29		4687
2019	5	67	311	528	1171	1307	691	644	306	158	102	47	35		5372
2020	5	61	356	576	1225	1404	694	652	319	162	120	57	38		5668
2021	0	148	673	1408	1435	1088	719	405	175	129	27	33	5	18	6263
2022	7	164	1946	1683	525	549	359	174	57	26	5	1	0	14	11020

Note: The CAA is based on age-readings from 2008,2009 and 2014 from 2009-2020.
2021, 2022 CAA based on readings from individual years.
2022 poor length freq sampling.

Table 6 **CPUE** Factory landings (longline only) used to calculate longline CPUE for all longline fishery.

Year	GLM LogCPUE	SE	df	lower.CL	upper.CL	Kg/100 hooks
2012	-0.26861	0.027692	163500	-0.32289	-0.21434	76.4
2013	-0.31899	0.027661	163500	-0.37321	-0.26478	72.7
2014	-0.29296	0.027673	163500	-0.34719	-0.23872	74.6
2015	-0.38362	0.027604	163500	-0.43772	-0.32951	68.1
2016	-0.31322	0.02754	163500	-0.3672	-0.25924	73.1
2017	-0.57109	0.027472	163500	-0.62494	-0.51725	56.5
2018	-0.63624	0.027489	163500	-0.69012	-0.58236	52.9
2019	-0.66781	0.027477	163500	-0.72166	-0.61395	51.3
2020	-0.70164	0.027515	163500	-0.75557	-0.64771	49.6
2021	-0.68676	0.027549	163500	-0.74075	-0.63276	50.3
2022	-0.75108	0.02754	163500	-0.80506	-0.69711	47.2

Table 7. CPUE **L**ogbook (**longline**) for vessels >30ft. Uumannaq

Year	GLM LogCPUE	SE	df	lower.CL	upper.CL	Kg/100 hooks
2006	6.069351	0.080408	14182	5.911741	6.226962	43.24
2007	5.916828	0.033834	14182	5.850509	5.983147	37.12323
2008	5.912818	0.034064	14182	5.846047	5.979588	36.97466
2009	5.947472	0.033589	14182	5.881632	6.013311	38.27844
2010	6.104182	0.029413	14182	6.046529	6.161835	44.77263
2011	6.221199	0.026507	14182	6.169241	6.273156	50.33063
2012	6.149778	0.02633	14182	6.098168	6.201388	46.86133
2013	6.060816	0.024751	14182	6.012301	6.10933	42.87251
2014	6.202949	0.024645	14182	6.154641	6.251256	49.42043
2015	6.033019	0.024565	14182	5.984869	6.081169	41.6972
2016	6.025286	0.023736	14182	5.97876	6.071812	41.376
2017	5.847541	0.024546	14182	5.799428	5.895653	34.63816
2018	5.914378	0.025718	14182	5.863967	5.96479	37.03239
2019	5.868763	0.02439	14182	5.820957	5.91657	35.3811
2020	5.803131	0.025539	14182	5.753071	5.853191	33.13353
2021	5.948923	0.026972	14182	5.896054	6.001792	38.33403
2022	5.746608	0.028631	14182	5.690488	5.802728	31.31267

Table 8. CPUE logbook (**gilllnet**) for vessels >30ft. Uumannaq

Year	GLM LogCPUE	SE	df	lower.CL	upper.CL	Kg/gillnet
2008	3.184801	0.255732	5060	2.683456	3.686145	24.16248
2009	3.998082	0.071204	5060	3.858491	4.137672	54.49353
2010	4.088609	0.065777	5060	3.959658	4.217561	59.65685
2011	4.1949	0.062239	5060	4.072885	4.316915	66.3471
2012	4.098318	0.072418	5060	3.956349	4.240288	60.23888
2013	4.442363	0.070333	5060	4.304481	4.580246	84.9755
2014	4.366415	0.069226	5060	4.230702	4.502128	78.76077
2015	4.264958	0.08224	5060	4.103732	4.426183	71.16193
2016	4.286786	0.072661	5060	4.144339	4.429233	72.73233
2017	4.360966	0.072118	5060	4.219584	4.502349	78.33277
2018	4.382446	0.065892	5060	4.253269	4.511623	80.03356
2019	4.299359	0.064589	5060	4.172737	4.425981	73.65257
2020	4.099904	0.062201	5060	3.977964	4.221844	60.3345
2021	4.230436	0.062833	5060	4.107255	4.353616	68.7472
2022	4.142892	0.063424	5060	4.018553	4.26723	62.98471

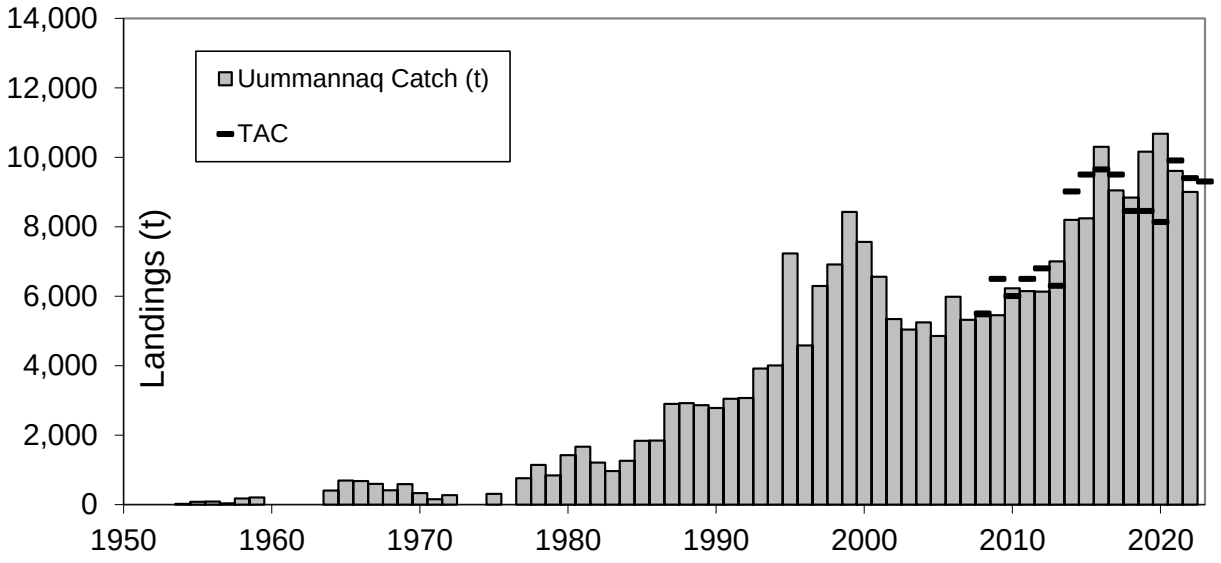

Figure 1. Catches of Greenland halibut in NAFO Subarea 1 Division 1Ainshore since 1954.

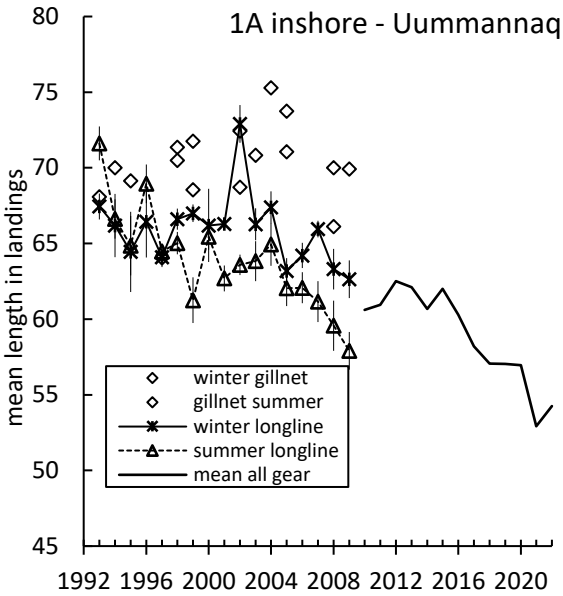

Figure 2. Uummannaq mean length in the landings: longline summer, longline winter, gillnet and overall mean weighted by area, season gear and amounts (after 2010).

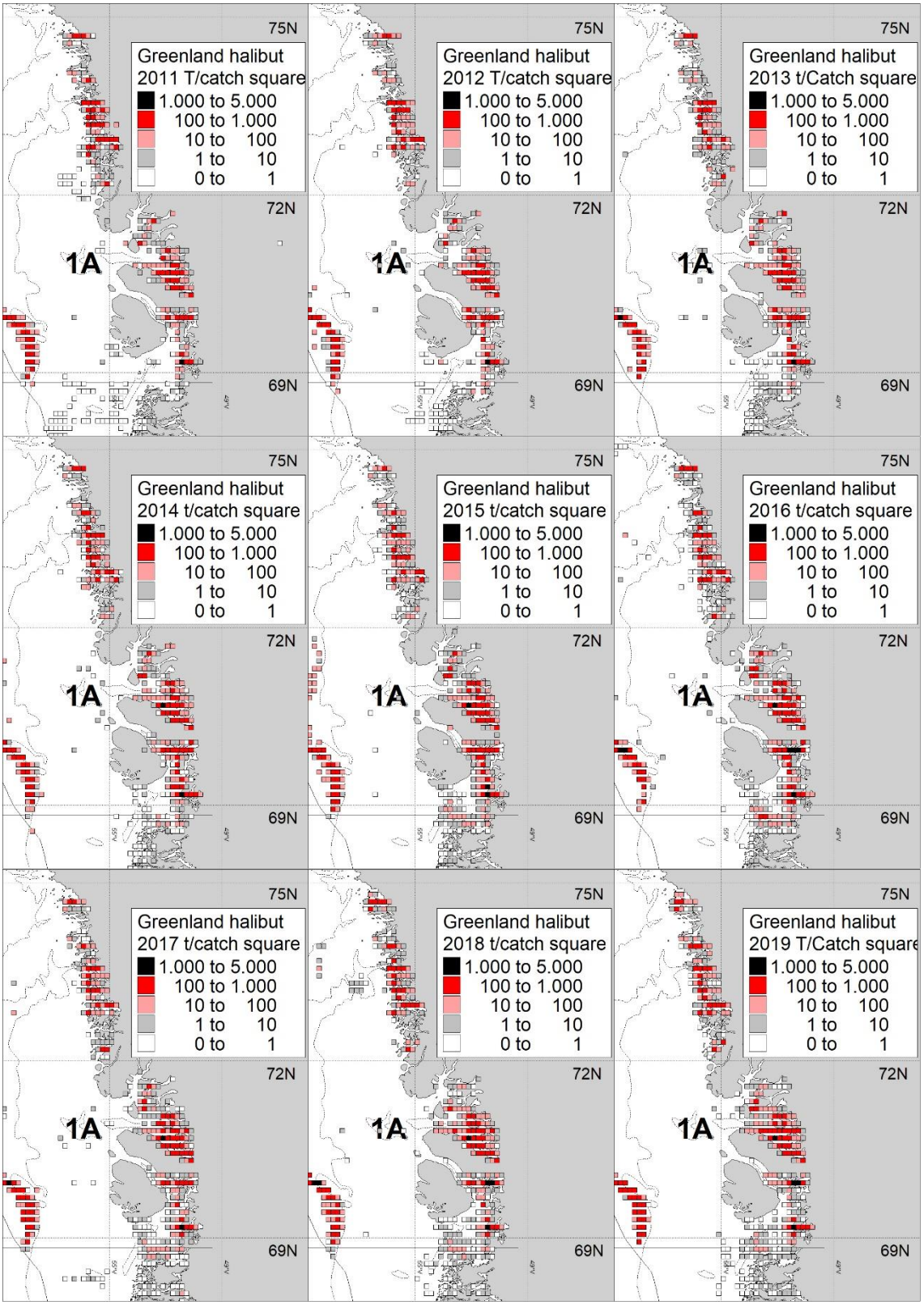

Figure 3. Greenland halibut catch by statistical square in the Disko Bay.

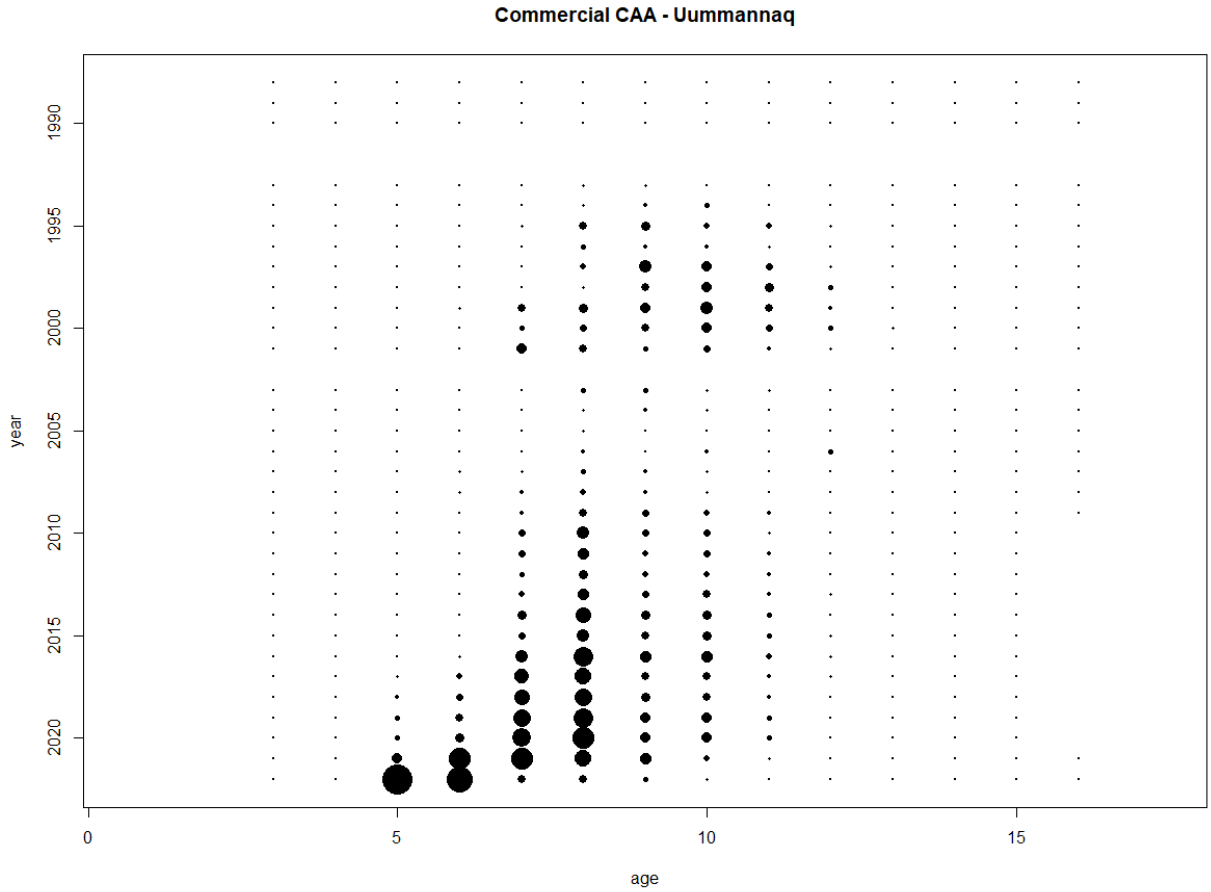

Figure 4. Catch At Age CAA bubble plot for the commercial landings in Uummannaq. Year 2021 have been recalculated by the new ALK from Uummannaq 2021.

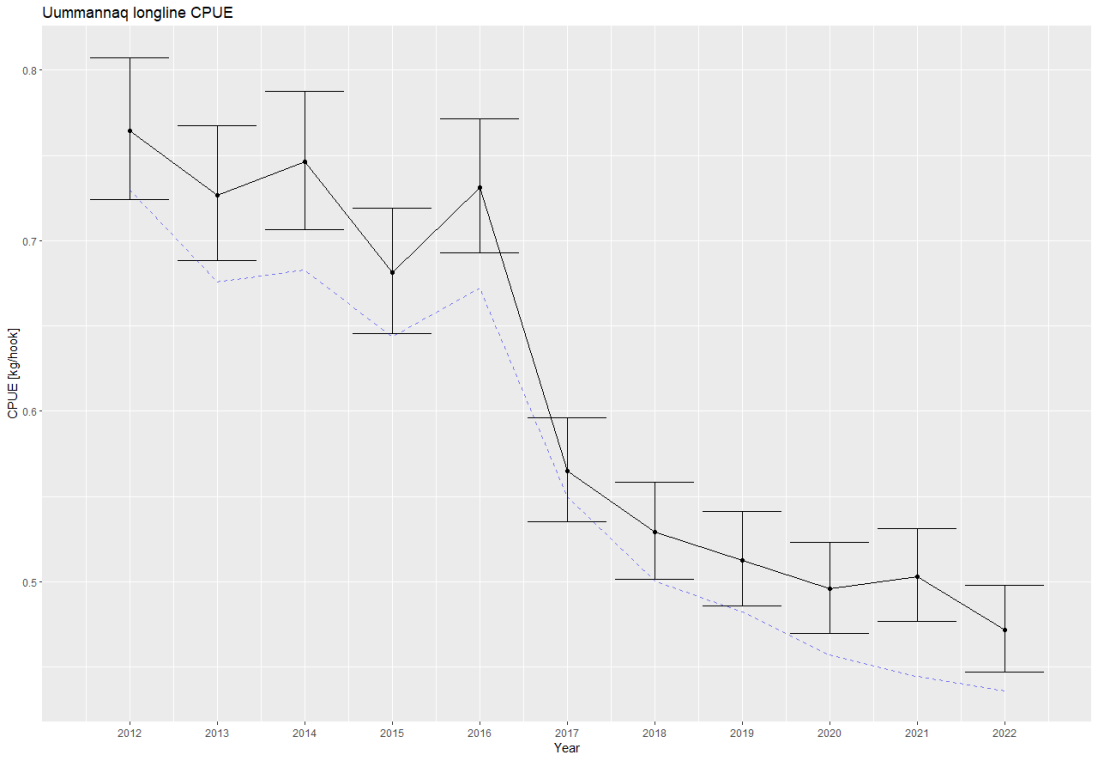

Figure 5. Commercial CPUE (Kg/hook) based on factory landing reports from all factories in Uummannaq.

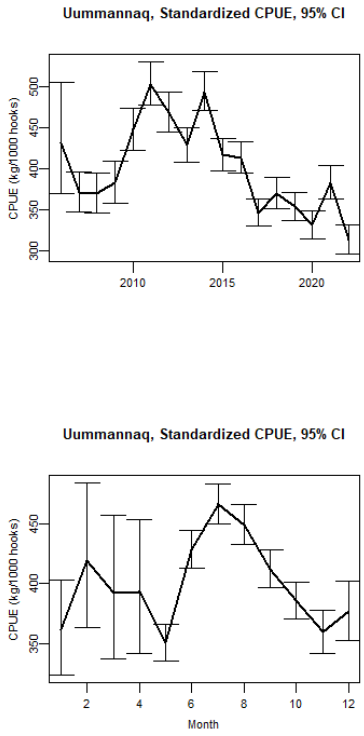

Figure 6. Standardized longline mean and 95% CI CPUE based on logbooks from vessels larger than 30ft in Uummannaq.

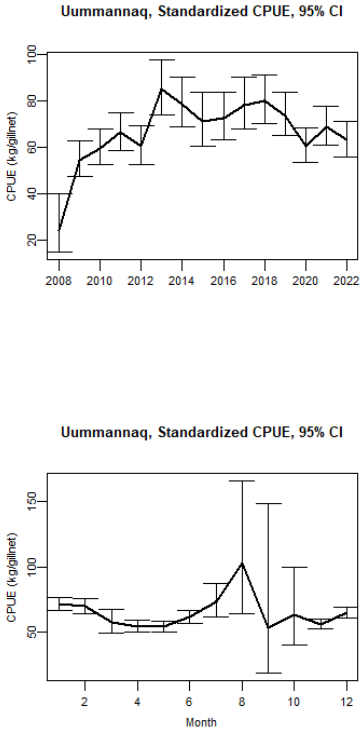

Figure 7. Gillnet Standardized mean and 95% CI CPUE based on logbooks from vessels larger than 30ft in Uummannaq.

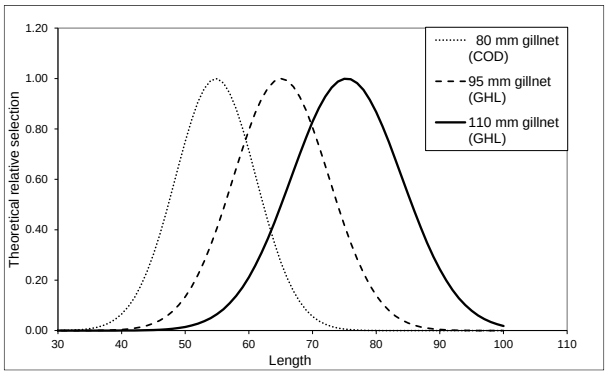

Figure 8. Relative selection curves for Greenland halibut with the most recently used gillnets. After a period with increasing use of illegal use of cod gillnets in the Disko bay used to target Greenland halibut, the legal meshsize was changed from 110 mm halfmesh to 95mm halfmesh in 2017.

```
*****************************************
UUMMANNAQ LONGLINE LOGBOOK CPUE
*****************************************

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

Residuals:
   Min     1Q  Median     3Q    Max
-4.6714 -0.2541  0.0214  0.2810  2.8580

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)         6.335239   0.108736  58.262  < 2e-16 ***
Year2007           -0.152523   0.077429  -1.970 0.048877 *
Year2008           -0.156534   0.082353  -1.901 0.057353 .
Year2009           -0.121880   0.082789  -1.472 0.140997
Year2010            0.034831   0.082153   0.424 0.671593
Year2011            0.151847   0.080580   1.884 0.059528 .
Year2012            0.080427   0.080138   1.004 0.315583
Year2013           -0.008535   0.079469  -0.107 0.914469
Year2014            0.133597   0.079653   1.677 0.093518 .
Year2015           -0.036333   0.079686  -0.456 0.648433
Year2016           -0.044065   0.079485  -0.554 0.579323
Year2017           -0.221811   0.079679  -2.784 0.005379 **
Year2018           -0.154973   0.080033  -1.936 0.052842 .
Year2019           -0.200588   0.080074  -2.505 0.012255 *
Year2020           -0.266221   0.080349  -3.313 0.000924 ***
Year2021           -0.120428   0.080880  -1.489 0.136514
Year2022           -0.322743   0.081690  -3.951 7.83e-05 ***
Month2              0.148339   0.088446   1.677 0.093531 .
Month3              0.082470   0.092266   0.894 0.371431
Month4              0.084638   0.087274   0.970 0.332169
Month5             -0.031052   0.055569  -0.559 0.576302
Month6              0.169560   0.054212   3.128 0.001765 **
Month7              0.254702   0.054000   4.717 2.42e-06 ***
Month8              0.217095   0.054150   4.009 6.13e-05 ***
Month9              0.131811   0.054546   2.417 0.015682 *
Month10             0.064936   0.054549   1.190 0.233903
Month11            -0.005390   0.056884  -0.095 0.924517
Month12             0.040915   0.060929   0.672 0.501901
BoatAGGU S          0.109256   0.059081   1.849 0.064443 .
BoatAJO            -0.229454   0.279486  -0.821 0.411669
BoatAKA            -1.613590   0.476472  -3.387 0.000710 ***
BoatAKKA AQQALU    -0.518113   0.076415  -6.780 1.25e-11 ***
BoatAKKAANNGUAQ ZEEB -0.370631   0.061315  -6.045 1.53e-09 ***
BoatANE-ANNA       -0.310927   0.062279  -4.993 6.03e-07 ***
BoatANGAJE-NUKA    -0.347833   0.077668  -4.478 7.58e-06 ***
BoatANGAJOORA      -0.747397   0.077709  -9.618  < 2e-16 ***
BoatANGAJOORAQ     -0.353496   0.063567  -5.561 2.73e-08 ***
BoatANGAANNGU      -0.219241   0.059443  -3.688 0.000227 ***
BoatANITSI          0.017796   0.059179   0.301 0.763641
BoatAPUTSIAQ       -0.247494   0.093597  -2.644 0.008196 **
BoatARNARISSOQ     -0.505575   0.122713  -4.120 3.81e-05 ***
BoatARNAALUK MALIK -0.459316   0.176624  -2.601 0.009318 **
BoatAVALERAQ       -0.235967   0.061852  -3.815 0.000137 ***
```

BoatAVATAQ -0.608894 0.082855 -7.349 2.11e-13 ***
BoatBASSI -0.209335 0.160352 -1.305 0.191752
BoatBETA 0.042986 0.243152 0.177 0.859679
BoatBJ. NUKARLEQ -0.146576 0.059206 -2.476 0.013309 *
BoatDORTINNGUAQ -0.075786 0.059547 -1.273 0.203138
BoatFALIK L -0.264157 0.067398 -3.919 8.92e-05 ***
BoatGAABA -1.044496 0.244910 -4.265 2.01e-05 ***
BoatIINANNGUAQ 0.609812 0.095289 6.400 1.61e-10 ***
BoatILULIAQ -0.347659 0.244129 -1.424 0.154446
BoatINUNNGUA -0.162202 0.057645 -2.814 0.004903 **
BoatINUUNA 0.251888 0.107704 2.339 0.019364 *
BoatIPIUTAQ -1.649169 0.154578 -10.669 < 2e-16 ***
BoatITATTAAQ -0.056374 0.083131 -0.678 0.497694
BoatIVALU -0.456071 0.243230 -1.875 0.060805 .
BoatJENS HENRIK -0.042375 0.073440 -0.577 0.563947
BoatJESS -0.670177 0.131175 -5.109 3.28e-07 ***
BoatJOHANSEN -0.924711 0.219213 -4.218 2.48e-05 ***
BoatJOLLE-000017589 0.192672 0.278815 0.691 0.489553
BoatJULIA NADUK -0.291456 0.074264 -3.925 8.73e-05 ***
BoatJULIANE -0.327062 0.066307 -4.933 8.21e-07 ***
BoatJUUKA -0.007266 0.058582 -0.124 0.901286
BoatJUULUNNGUAQ -0.049225 0.278598 -0.177 0.859757
BoatJAAKU-MALIK -0.503731 0.476126 -1.058 0.290083
BoatKABENA -0.333483 0.117013 -2.850 0.004379 **
BoatKAMMA -0.358462 0.064872 -5.526 3.34e-08 ***
BoatKARO -0.197885 0.081999 -2.413 0.015823 *
BoatKATRI -0.239518 0.082377 -2.908 0.003648 **
BoatKATTANNGUAQ -0.725873 0.475897 -1.525 0.127213
BoatKOORUARSUMMIU -0.249580 0.095383 -2.617 0.008890 **
BoatKRISTINA -0.144139 0.067243 -2.144 0.032086 *
BoatKUNUK -0.330281 0.090966 -3.631 0.000284 ***
BoatKUTUK -0.327638 0.278977 -1.174 0.240244
BoatKUUJUK -0.665175 0.098777 -6.734 1.71e-11 ***
BoatKAAKA-AQQALU -0.080287 0.075254 -1.067 0.286045
BoatKAALEERAQ -0.224364 0.075946 -2.954 0.003139 **
BoatL. CHRISTINA -0.394641 0.082550 -4.781 1.77e-06 ***
BoatL.CHRISTINA -0.217261 0.097392 -2.231 0.025710 *
BoatLAILA S. -0.249843 0.062604 -3.991 6.62e-05 ***
BoatLENE BOHM -0.362217 0.076653 -4.725 2.32e-06 ***
BoatLINDENHANN -0.002030 0.243998 -0.008 0.993363
BoatLINE -3.099746 0.475837 -6.514 7.55e-11 ***
BoatLAARSEERAQ LARSEN -0.192433 0.127617 -1.508 0.131603
BoatM.A.FRENA -0.499218 0.116259 -4.294 1.77e-05 ***
BoatMALAMUK -0.298835 0.083438 -3.582 0.000343 ***
BoatMALIGIAQ S -0.696273 0.079831 -8.722 < 2e-16 ***
BoatMASIK -0.346464 0.057728 -6.002 2.00e-09 ***
BoatMIILU 0.155194 0.147942 1.049 0.294189
BoatMIILU-PALU -0.410274 0.131255 -3.126 0.001777 **
BoatMILLE KUKA -1.938908 0.476022 -4.073 4.66e-05 ***
BoatMINA -0.541359 0.107199 -5.050 4.47e-07 ***
BoatMINOU II -0.478748 0.338868 -1.413 0.157741
BoatNAJANNGUAQ -0.333954 0.118408 -2.820 0.004804 **
BoatNAJATTAAQ -1.000606 0.142689 -7.013 2.45e-12 ***
BoatNAJATUAQ 0.167971 0.339310 0.495 0.620582
BoatNÂLO -1.361350 0.143130 -9.511 < 2e-16 ***

```
BoatNANOQ           0.038730   0.092173   0.420 0.674357
BoatNANUVIK         -0.377540   0.106382  -3.549 0.000388 ***
BoatNEQITAQ         -0.343940   0.059784  -5.753 8.95e-09 ***
BoatNIELS           -0.518710   0.068736  -7.546 4.75e-14 ***
BoatNIISE           -0.651391   0.176545  -3.690 0.000225 ***
BoatNIISIKA PAALU    -0.471444   0.176670  -2.669 0.007628 **
BoatNIKULIINA        -0.120040   0.279014  -0.430 0.667035
BoatNILAK            0.130384   0.095174   1.370 0.170727
BoatNIVI K.          -0.403575   0.077752  -5.191 2.13e-07 ***
BoatNONO             -0.752229   0.130721  -5.754 8.87e-09 ***
BoatNORSAQ           -0.323247   0.063518  -5.089 3.64e-07 ***
BoatNUKA             0.486133   0.338903   1.434 0.151472
BoatNUKA AQQALUK      0.120576   0.154673   0.780 0.435665
BoatNUKANU S          0.027831   0.074830   0.372 0.709958
BoatNUKARIIT III     -0.221731   0.105753  -2.097 0.036039 *
BoatNUKARIIT IV      -0.300392   0.089207  -3.367 0.000761 ***
BoatNUKARLEQ         -0.349624   0.086692  -4.033 5.54e-05 ***
BoatNUUNI           -0.238996   0.090526  -2.640 0.008298 **
BoatNUUNU            -0.326779   0.243183  -1.344 0.179048
BoatOVE             -0.530661   0.072588  -7.311 2.80e-13 ***
BoatPANITUAQ         -1.032984   0.076104 -13.573  < 2e-16 ***
BoatPAPEROQ          -0.308936   0.187517  -1.648 0.099476 .
BoatPINIARTOQ        -0.074840   0.088503  -0.846 0.397778
BoatPIPALUK          -0.677265   0.071063  -9.530  < 2e-16 ***
BoatQAJAQ            0.158351   0.475837   0.333 0.739303
BoatQASIGIAQ         -0.280336   0.057894  -4.842 1.30e-06 ***
BoatQILANNGAQ        -0.116743   0.059054  -1.977 0.048074 *
BoatQAASIINA         -0.619536   0.142853  -4.337 1.46e-05 ***
BoatRENA G.          -0.204108   0.082367  -2.478 0.013222 *
BoatRIKKE           -0.470407   0.101522  -4.634 3.63e-06 ***
BoatSAGDLEQ          -0.282721   0.116821  -2.420 0.015528 *
BoatSARFARFIK        -0.318547   0.063652  -5.005 5.67e-07 ***
BoatSAVIK           -0.162855   0.078644  -2.071 0.038396 *
BoatSOFIE           -0.459019   0.068624  -6.689 2.33e-11 ***
BoatSUSSI LAILA      -0.766198   0.338952  -2.260 0.023806 *
BoatTUPPI           -0.210513   0.475726  -0.443 0.658127
BoatTUPPIA           -0.184102   0.476629  -0.386 0.699311
BoatUILOQ            0.037231   0.074775   0.498 0.618562
BoatULU             -0.071517   0.059273  -1.207 0.227617
BoatAAJU S.          -0.065389   0.058240  -1.123 0.261566
BoatAAJUUA           -0.207850   0.061166  -3.398 0.000680 ***
BoatAALIPAARAQ       -0.484613   0.070144  -6.909 5.09e-12 ***
BoatAANAA RUTH       -0.556842   0.088337  -6.304 2.99e-10 ***
BoatAAPIKANNA        -0.310895   0.102210  -3.042 0.002357 **
BoatAAQA AQQALU      -0.141766   0.063463  -2.234 0.025508 *
BoatAAQA JULIE       -0.945947   0.103828  -9.111  < 2e-16 ***
BoatAARSU           -0.483515   0.072749  -6.646 3.11e-11 ***
BoatAAVU            -0.006869   0.064845  -0.106 0.915644
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4722 on 14182 degrees of freedom
Multiple R-squared:  0.2299,         Adjusted R-squared:  0.2221
F-statistic:  29.2 on 145 and 14182 DF,  p-value: < 2.2e-16
```

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

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

Residuals:
   Min     1Q  Median     3Q    Max
-4.1857 -0.2801  0.0237  0.3056  2.4567

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)     3.562526   0.252344  14.118  < 2e-16 ***
Year2009        0.813281   0.247862   3.281 0.001041 **
Year2010        0.903809   0.247154   3.657 0.000258 ***
Year2011        1.010099   0.246890   4.091 4.36e-05 ***
Year2012        0.913518   0.253385   3.605 0.000315 ***
Year2013        1.257563   0.252392   4.983 6.48e-07 ***
Year2014        1.181614   0.251984   4.689 2.81e-06 ***
Year2015        1.080157   0.255818   4.222 2.46e-05 ***
Year2016        1.101985   0.254792   4.325 1.55e-05 ***
Year2017        1.176166   0.253698   4.636 3.64e-06 ***
Year2018        1.197645   0.252473   4.744 2.16e-06 ***
Year2019        1.114558   0.252751   4.410 1.06e-05 ***
Year2020        0.915103   0.252280   3.627 0.000289 ***
Year2021        1.045635   0.252420   4.142 3.49e-05 ***
Year2022        0.958091   0.252114   3.800 0.000146 ***
Month2         -0.022635   0.037829  -0.598 0.549630
Month3         -0.215800   0.074947  -2.879 0.004002 **
Month4         -0.271511   0.039184  -6.929 4.76e-12 ***
Month5         -0.280605   0.038049  -7.375 1.91e-13 ***
Month6         -0.151457   0.038399  -3.944 8.11e-05 ***
Month7          0.026407   0.088932   0.297 0.766530
Month8          0.363122   0.242091   1.500 0.133692
Month9         -0.295605   0.523380  -0.565 0.572235
Month10         -0.123917   0.233955  -0.530 0.596371
Month11         -0.243966   0.028120  -8.676  < 2e-16 ***
Month12         -0.101345   0.027043  -3.748 0.000181 ***
BoatANE-ANNA    -0.189929   0.071410  -2.660 0.007845 **
BoatANGAJE-NUKA  -0.346203   0.077881  -4.445 8.97e-06 ***
BoatANGAJOORA    -0.413697   0.303046  -1.365 0.172273
BoatANGAJOORAQ   -0.382299   0.105784  -3.614 0.000304 ***
BoatANGUTEERAQ    0.177494   0.521329   0.340 0.733521
BoatANGAANNGU    -0.115360   0.044495  -2.593 0.009550 **
BoatANITSI      -0.389662   0.055556  -7.014 2.62e-12 ***
BoatAPUTSIAQ     -0.176665   0.130153  -1.357 0.174726
BoatARNARISSOQ    0.075094   0.368376   0.204 0.838478
BoatASSA MARIE   -0.527223   0.187231  -2.816 0.004883 **
BoatAVALERAQ     -0.085204   0.057559  -1.480 0.138861
BoatBJ. NUKARLEQ  -0.486938   0.097633  -4.987 6.32e-07 ***
BoatDORTINNGUAQ   -0.203066   0.048568  -4.181 2.95e-05 ***
BoatENOKSEN II    0.309954   0.187357   1.654 0.098117 .
BoatFALIK L      -0.221177   0.050725  -4.360 1.32e-05 ***
BoatIINANNGUAQ   -0.165705   0.069249  -2.393 0.016752 *
```

```
BoatINUNNGUA     -0.256594   0.073046  -3.513 0.000447 ***
BoatINUUNA       -0.178421   0.108042  -1.651 0.098718 .
BoatITATTAAQ     -0.305130   0.069803  -4.371 1.26e-05 ***
BoatJENS HENRIK   1.737506   0.202998   8.559  < 2e-16 ***
BoatJULIA NADUK  -0.046761   0.047246  -0.990 0.322351
BoatJULIANE       0.042202   0.140467   0.300 0.763854
BoatJUUKA        -0.305311   0.040547  -7.530 5.99e-14 ***
BoatJAAKU-MALIK  -0.066154   0.062183  -1.064 0.287440
BoatKABENA       -0.662845   0.217399  -3.049 0.002308 **
BoatKAMMA        -0.307411   0.064465  -4.769 1.91e-06 ***
BoatKATRI        -2.582446   0.520340  -4.963 7.17e-07 ***
BoatKRISTINA     -0.604145   0.070151  -8.612  < 2e-16 ***
BoatKAAKA-AQQALU -0.542043   0.148737  -3.644 0.000271 ***
BoatKAALEERAQ    -0.578623   0.201352  -2.874 0.004074 **
BoatL. CHRISTINA -1.077782   0.368281  -2.927 0.003443 **
BoatLAILA S.     -0.001017   0.086763  -0.012 0.990646
BoatLENE BOHM    -1.361476   0.190176  -7.159 9.29e-13 ***
BoatM.A.FRENA    -0.747724   0.094263  -7.932 2.63e-15 ***
BoatMAKI         -0.503523   0.151184  -3.331 0.000873 ***
BoatMALAMUK       0.363545   0.303126   1.199 0.230460
BoatMALIGIAQ S   -0.644928   0.086195  -7.482 8.57e-14 ***
BoatMALIK         0.924048   0.520521   1.775 0.075919 .
BoatMASIK        -0.193778   0.056549  -3.427 0.000616 ***
BoatNAJA-NUKA    -0.789541   0.368049  -2.145 0.031984 *
BoatNANOQ        -0.036000   0.080514  -0.447 0.654799
BoatNANUVIK       0.058364   0.098018   0.595 0.551572
BoatNEQITAQ      -0.017527   0.087563  -0.200 0.841360
BoatNIELS        -0.875877   0.090823  -9.644  < 2e-16 ***
BoatNIISIKA PAALU -0.274841   0.117335  -2.342 0.019201 *
BoatNORSAQ       -0.078427   0.051168  -1.533 0.125408
BoatNUKANU S     -0.122950   0.130185  -0.944 0.344998
BoatNUKARIIT III -0.814562   0.101295  -8.041 1.10e-15 ***
BoatNUKARIIT IV  -0.976116   0.237119  -4.117 3.91e-05 ***
BoatNUKARLEQ     -0.222360   0.125003  -1.779 0.075325 .
BoatNUUNI        -0.200572   0.148663  -1.349 0.177343
BoatOVE           0.021297   0.204160   0.104 0.916922
BoatPANITUAQ     -0.019244   0.109509  -0.176 0.860511
BoatPAPEROQ       0.298418   0.263795   1.131 0.258005
BoatQASIGIAQ     -0.016150   0.069395  -0.233 0.815979
BoatQILANNGAQ     0.040002   0.043557   0.918 0.358461
BoatQAASIINA     -0.129094   0.054547  -2.367 0.017986 *
BoatRENA G.      -0.192092   0.061327  -3.132 0.001744 **
BoatRIKKE         0.087729   0.178314   0.492 0.622748
BoatSARFARFIK    -0.506646   0.088802  -5.705 1.23e-08 ***
BoatSAVIK        -0.447341   0.239303  -1.869 0.061632 .
BoatSOFIE        -0.065149   0.105140  -0.620 0.535521
BoatUILOQ         0.184234   0.235983   0.781 0.435011
BoatULU          -0.281351   0.063492  -4.431 9.57e-06 ***
BoatAAJU S.      -0.345835   0.062497  -5.534 3.29e-08 ***
BoatAAJUUA       -0.074056   0.072064  -1.028 0.304172
BoatAALIPAARAQ   -0.535837   0.221734  -2.417 0.015703 *
BoatAANAA RUTH   -0.206034   0.110240  -1.869 0.061686 .
BoatAAQA AQQALU  -0.803541   0.081714  -9.834  < 2e-16 ***
BoatAAQA JULIE   -0.321604   0.096552  -3.331 0.000872 ***
BoatAARSU        -0.656535   0.082629  -7.946 2.36e-15 ***
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BoatAAVU         -0.201656   0.047010  -4.290 1.82e-05 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5172 on 5060 degrees of freedom
Multiple R-squared:  0.2309,         Adjusted R-squared:  0.2161
F-statistic: 15.66 on 97 and 5060 DF,  p-value: < 2.2e-16
```