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Knowledge about the dynamics of the Greenland halibut in the fjords in NAFO subarea 1B to 1F inshore.

by

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Abstract

The Greenland halibut inshore stocks in West Greenland (NAFO Subarea 1) are considered mainly to be recruited from the stock in the Davis Strait and the southern fjords in West Greenland from the Denmark strait between Greenland and Iceland. Only sporadic spawning has been observed in the inshore areas in Greenland. Tagging studies have indicated that migration from the fjords to the offshore areas (Davis strait) in North West Greenland is limited and that the adults appear resident in the fjords. In 1994, NAFO decided to separate the assessment and advice on the inshore stock components in Division 1A from the offshore component in the Davis Strait and Baffin Bay. However, since the fishery in the remaining inshore areas from 1B to 1F, was insignificant at that time, these areas are still assessed with the offshore stocks in Subareas 0 and 1. This document summarizes most of the available literature, catches and knowledge on the inshore stocks in division 1B-1F. Catch history from 1960 to present indicate a level of isolation between the inshore fjords in NAFO Division 1B,1C,1D,1E and 1F, from the nearby important fishing grounds in the Davis strait in Divisions 1C, 1D and 0B. This is further supported by studies of parasites used as biological tags and tagging studies from 1935 to present from the Godthåb fjord (inshore 1D) and fjords in South Greenland (1E and 1F). The apparent separation could be related to the shallower banks along West Greenland creating a barrier to migration of adult Greenland halibut. Maps of the bottom contours are further presented to show how fjords in West Greenland are mostly connected to the Davis Strait through narrow and in some cases shallow channels.

Introduction

The Greenland halibut fishery started in the fjords in West Greenland with the introduction of longlines in the beginning of the 19th century. The fishery has always been most pronounced in the inshore areas in Division 1A (Disko Bay, Uummannaq and Upernavik), but the fishery in the other fjord areas further south in West Greenland has just as long a history, with catch statistics going back to the 1960's in all areas and even to 1910 in the fjords around Qaqortoq in south Greenland (1F). The areas from 1B to 1F are characterized by the most developed fishing industry (factories) and infrastructure (harbors) located in some of the larger cities in Greenland (Sisimiut, Maniitsoq, the capital Nuuk, Paamiut, Narsaq and Qaqortoq) and several larger settlements. Although the fishery inshore in Division 1B to 1F has a long history, it has so far never been quota regulated. Since 2012, the fishery in the inshore fjords in divisions

1B to 1F have gradually increased to about 2 000 t per year for the combined areas. However, recent signs of decreasing stocks have been observed (decreasing size in the landings) in the Godthåb fjord (1D) where typically half of the inshore landings are taken. Greenland halibut in the area are mainly targeted with longlines from small open boats and small vessels. Gillnets from small boats and small vessels were also used inshore in the previous intense fishing period from 1960-1990. The offshore fishery in the Davis Strait and Baffin Bay has gradually increased since the mid 1960's and is mainly conducted with trawl in Subarea 1 and a combination of Trawlers and large gillnetters in Subarea 0.

Currently, scientific advice is provided for several North Atlantic Greenland halibut stocks. The North East Arctic stocks in East Greenland, Iceland and Faroe Islands are assessed as one unit in ICES. In West Greenland, NAFO provides advice for the inshore areas in 1A (advise is given separately for the Upernavik area, Uummannaq fjord and Disko Bay). The remaining inshore areas in West Greenland (1B-1F inshore) have never been assessed as separate stocks and remain part of the offshore assessment of areas in Davis Strait (0B and 1CD) and Baffin Bay (0A and 1AB).

However, the validity of these delineations is challenged by several genetic and studies (Knudsen et al 2007, Roy et al 2014, Westgaard et al. 2016). A recent genetic study using SNP's concluded that Greenland halibut found in East Greenland/South Iceland are genetically indistinguishable from those in West Greenland (Westgaard et al. 2016), but no samples from the Grandbanks and Flemish cap (Divisions 2J3KLMNO) were included in this study. Further tagging studies have shown a high degree of connectivity between the Barents Sea area and the area north of Iceland (Albert and Vollen 2015). These recent studies indicate that the current management areas may be in conflict with the biological entities.

Materials and Methods

For practical reasons, individual fjords have been assigned to a NAFO division based on their connection to the offshore areas. This is particularly important for the Godthåbs fjord and the fjords in South Greenland that would otherwise be cut in half by the officially defined NAFO divisions. This means that although the northern part of the Godthåbs fjord is strictly located in division 1C, the whole fjord is assigned to division 1D. Hence the NAFO Subdivisions are only used to define the borders at the basis line along the coast, but from there the inshore NAFO area flows the contour of the fjord.

In the spatial analysis of bottom topography and the definition of troughs separating offshore waters and inshore fjord areas, we have utilized the 3-dimensional model International Bathymetric Chart of the Arctic Oceans, IBCAO, version 4 of 2020. The IBCAO model is a pan-arctic model of the sub-sea terrain morphology based on bathymetric data measurements from primarily scientific multi beam mapping cruises and single beam navigational echo sounders from commercial vessels now covering 19.8 % of the Arctic Ocean and related oceans and waters. The IBCAO version 4 model is of 200m x 200m spatial resolution compared to the previous version 3 of 500m x 500m spatial resolution and involves a higher density of inshore high-resolution data to describe the fjords systems and their entrances more accurately than previous.

Catch statistics from 1910 to present were assembled from various sources of published statistics and archived digitized raw data or data compiled by month and area. In statistics from 1910-1960 the NAFO division were occasionally inferred from location of the cities and Settlements located within that division. From 1964 to 1966 landing statistics from different sources were in good agreement. The highest disagreement in the landing statistics was in Nuuk in 1985, but in this case the discrepancy is likely due to one source only including publicly owned factories from the Royal Greenland Trading Department (Den Kongelige Grønlandske Handel, KGH), but excluding private companies. In this case and in cases with minor differences in landing statistics, the higher value was used.

The historic tagging experiments (1952–1979 and 1986-1988) conducted by the Greenland Fisheries Research Institute (Grønlands Fiskeri Undersøgelser - GFU) has recently been digitalized and combined with more recent experiments (2005-2019) conducted by the Greenland Institute of Natural Resources (GINR). All data were made available at the Nordic Greenland halibut Tagging Workshop held in Reykjavik (Iceland), in August 2019. Tags and recaptures have been mapped.

Catches by statistical square, from 2009 to 2019 were calculated from vessel haul by haul logbooks operating offshore and from factory landing reports from the inshore areas. All data was extracted from the Greenland fisheries License control authority (GFLK) database (LULI). Commercial length frequencies are collected and stored at the GINR.

Results

Subsea morphology and bathymetry of the shelf, fjords and offshore areas around Greenland are shown in Figure 1. Particularly data from the fjords systems of Godthåb Fjord and Qeqertarsuup Tunua (Disko Bay), as well as all fjords in South East Greenland have been highly improved in the new model, being based on nearly full coverage, high resolution scientific multi beam data sources. This leads to a more precise definition of potential bathymetric barriers and potential pathways for migrating Greenland Halibut between offshore and inshore waters than previously. Many fjords, although not all, are bathymetrically isolated from the offshore waters in the Davis strait. In some fjords deeper but narrow channels extend partly into the shelf or bank areas off West Greenland. This can be observed in Bredefjord in south Greenland. However, in other fjords from 1B to 1F the banks off West Greenland may provide a barrier to migration for adult Greenland halibut.

Catches of Greenland halibut in divisions 1B to 1F have varied a lot since the 1960's with decades of intense fishery and long periods with very limited fishery (Table 1 and Figure 2). In the fjords from Kangaatisaq to Sisimiut (1B inshore, Nordre strømfjord), annual catches gradually increased from 355 t in 1963 and peaked in 1979 at 1275 t, but thereafter gradually decreased and has in most years remained below 100 t since 1986. In 2019, landings reached 80 t in division 1B inshore, far below the historical level.

In the fjords near Maniitsoq (Division 1C, Hamburger sound and Evighedsfjord) catches varied from 28 t to 179 t from the 1960's to the end of the 1980's, peaking in 1980 with 327 t. Catches gradually decreased thereafter, and were almost non-existent from 1986 to 2004. Since 2005 catches have gradually been increasing and reached 221 t in 2019.

In the fjords near the Capitol Nuuk (1D inshore, Godthåbsfjord, Ameralik fjord, Buksefjord and Grædefjord) annual landings fluctuated around 500 t annually from 1966 to 1980. Catches then increased and reached 2,136 t by 1985. After this period, the fishery gradually decreased and from 1989 to 2002 the fishery was virtually non-existent. From 2003 catches started to increase again, reaching 1,369 t in 2016. In 2019, the total catch decreased to 834 t from 1,117 t in 2018.

In the fjords around Paamiut and the settlements Arsuk and Ivittuut (1E inshore) annual catch statistics are available from 1919 to 1939, but the landings were at a low level. No statistics have been found from WWII to the end of the 1950's. From 1960, catches were, with a few exceptions, below 100 t until the end of the 1970's. Catches increased from 1981 and peaked in 1985 with 507 t and 497 t in 1989. From 1995 to 2003 the fishery was virtually non-existentand remained below 100 t until 2013. From 2014 the fishery has increased to round 300 t with a peak of 409 t in 2017.

In the fjords around Narsaq, Qaqortoq and Nanortalik (Bredefjord to lichtenau fjord) the catches gradually increased from 1911, peaking in 1923 with 397 t landed and gradually decreasing to nothing by 1931. No statistics has been found between WWII to the end of the 1950's. From 1960, catches have a similar trend to Division 1E, with catches varying between 50 and 150 t in most years. From 1981 catches increased, reaching 847 t in 1985 and gradually decreased thereafter and remained below 100 t in most years from 1989 to 2013. In the period 2015 to 2018 catches gradually increased reaching 376 t in 2017. In 2019, the total catch was more than halved as only 139 t of Greenland halibut was landed to factories in Division 1F inshore.

In the offshore fishing areas in the Davis Strait in Divisions 0B and 1CD the fishery has gradually increased since the 1990's. According to Statlant21 data a significant fishery also took place from 1960 to 1987 conducted mainly by other nations. After 2001, the offshore fishery in Subarea 1 expanded northwards and now includes the Baffin Bay stocks in Divisions 0A, 1A and 1B. (Figure 3)

Maps of the catches by statistical catch square show a separation of the fishing grounds between the inshore and the offshore areas (Figure 4). Small catches reported on the banks are presumably juvenile Greenland halibut moving through sorting grids and reported as bycatch in the shrimp fishery. The gradual increase in the landings in the fjords can be observed from 2009 to 2019.

Catches over the year from 2016-2020 is presented in figure 11. In division 1B the fishery has in the most recent 4 years been concentrated during the summer. In Division 1B there is hardly any fishery in the winter months, probably related to sea ice forming in the fjords. Due to the irminger current supplying warmer waters from the south, sea ice rarely forms in the fjords further south. A bit further south in the 1 C area the fishery is mainly conducted during the winter months with lower landings occurring in the summer. In the 1D inshore fjords the fishery is very stable throughout the year. Lowest landings occur in the valuable lumpfish season (April and May). Highest landings occur in June when spawning capelin provide access to high quality and free bait for longlines. In the fjords in Division 1E and 1F, landings also occur in all months with no apparent seasonality (Figure 11).

Commercial data from fisheries in the fjords around Nuuk (Godthåb fjord and Ameralik) shows a gradual decrease in the mean size in the landings during the intense fishing periods from the 1960's to the mid 1980's and again from 2012 to present day (Figure 5).

Longline length distributions from commercial samples from the Greenland fishery in 1CD offshore is shown in Figure 6. Since most of the Greenland halibut offshore are targeted with trawl, commercial samples from longlines are rarely available from the offshore area.

Length distributions from the inshore longline fishery in Nuuk has been regularly sampled (Figure 6). Longlines are known to have wide selection curves in contrast to gillnets and trawls therefore providing good insight into the size composition of the stock. Unfortunately, the sample size is low in the years 2009 and 2013 with commercial length samples from both the offshore area in 1CD (Figure 5) and inshore area in 1D (figure 7), therefore providing little insight in the comparable size composition inshore versus offshore.

Tagging studies on Greenland halibut in West Greenland have been conducted since 1935 (Smidt E., 1969). The historic tagging experiments conducted by GFU has recently been digitized and combined with more recent experiments conducted by GINR and are presented in Figures 8-10. Unfortunately, the release and recapture data following the tagging experiments from 1935 to 1952 has not been found in the paper archives, but these experiments are reported in Riget and Boje (1989). In the tagging experiments from 1935-1981 there were 440 recaptures and all but 2 were recaptured within the fjords where they had been released between 0-15 after tagging. The maps in Figure 8-10 include tagging data from 1952 to 2019. The data was prepared and shared with the ICES working group currently analyzing combined tagging data from several nations within the North Atlantic. In the overall map numerous long-distance migrants are observed moving (Figure 8). In the Godthåbs fjord (1D inshore) few long-distance migrants are observed and none of the long distance migrants were recaptured on the offshore fishing grounds in the Davis Strait (Division 1C and 1D) (Figure 9). Since, many of the recapture locations inshore are reported by catch square, there are many overlapping recaptures within fjords that can not be distinguished from each other in the maps. In south Greenland there are relatively more long-distance migrants than in the Godthåbs fjord (Figure 10). Greenland halibut have been documented to be able to migrate over long distances (Albert O.T. and Vollen T., 2015, Boje J., 1999). Based on 308 recaptures out of 1,798 tagged in 1969-1970, Riget and Boje (1987) concluded that Greenland halibut in the Godthåb fjord and Ameralik fjord were very stationary. Riget and Boje reached this conclusion, since 303 of the recaptures was from the Godthåb fjord/Ameralik fjord and the remaining 5 recaptures had missing location information. Therefore, none of the tagged Greenland halibut in this study were documented to have moved out of the tagging fjord.

In a 1987 study based on 839 Greenland halibut tagged in the Godthåb fjord, 6 were recaptured offshore (5 in the Denmark strait, 1 off Newfoundland) and the remaining 39 were recaptured in the Godthåb fjord (Boje J. 1994). Boje also reported results for South Greenland fjords (Cape Farewell area) and East Greenland fjords Ammassalik (Tasilaq) and the fjords inshore in Division 1A. From 120 Greenland halibut tagged in 1988 in South Greenland (1F inshore), there were 8 recaptures including one long distance migrant recaptured in 1990 in the Denmark strait. The remaining 7 recaptures were recorded within the same fjords, as where they were released. From 183 Greenland halibut tagged fjords in East Greenland in 1990, there was 13 recaptures during 1990-1994. Two recaptures were recorded in 1992 in ICES division XIVb and one was recapture was recorded in 1993 in ICES Division Va. The remaining 10 recaptures were all recorded at or near the tagging site. Based on these findings Boje (1994) concluded that there were indications of a connection between the fjord populations in Southwest Greenland/ East Greenland fjords and the stock component west of Iceland.

In a further analysis of the tagging experiments from 1986 to 1998, it was concluded that Greenland halibut in the fjords of northwestern Greenland (1A) appear to be resident and do not intermingle with other offshore or more southerly inshore populations (Boje 1999). Boje also found that among Greenland halibut released in the Davis Strait, Baffin Bay, and the fjords of southwestern and eastern Greenland, a substantial portion migrated distances up to 2,500 kilometers, primarily to the Denmark Strait between Greenland and Iceland, but also from the fjords of western Greenland to the Newfoundland coast (N=1). However, since the Greenland halibut fishery in many of the inshore areas (1B-1F) had almost ceased to exist shortly after the tagging studies were initiated, it is likely that the recapture rates in some areas would be underestimated in the tagging experiments conducted after 1986. In a re-analysis of the tagging data from 1986 to 1998, it was found that if accounting for fishing effort (1993-1997 catch per area), recaptured Greenland halibut were found at their release locality (especially at Tasiilaq in East Greenland, in the fjords of Cape Farewell (South Greenland) in Godthåb Fjord, Uummannaq, and Upernavik in West Greenland), and that 99% of the recaptured halibut remained within the release areas (Boje 2002).

Parasites used as biological tags (Boje et al. 1997) have further showed that the adult stock components of Greenland halibut in the Godthåbsfjord (1D inshore) and south Greenland fjords (1F inshore) appear isolated from offshore components in the western Atlantic, as well as from inshore components in the Uummannaq fjord (1A inshore). The parasite study further indicated that Greenland halibut stock components off Newfoundland and in the Davis Strait seem to have a common origin from the spawning stock complex in the Davis Strait and therefore mix while performing spawning migrations to this area (Boje et al. 1997).

Discussion

Greenland halibut spawning grounds are presumed to be located in the Davis Strait (Gundersen A.C et al. 2004) and in East Greenland and Southwest Iceland (Stenberg 2007). Due to the dominating ocean currents, larvae presumably reach the nursery areas in West Greenland from different spawning areas. The recruits in the northern areas (mainly NAFO 1A) derives from the Davis Strait spawning component (Riget and Boje, 1989), and very high juvenile densities are found just north of the spawning grounds on the banks in Divisions 1B and 1A (store hellefiskebanke) both inshore and offshore (Nygaard and Nogueira 2020). But juvenile Greenland halibut are also found in the Nuuk fjord (Nygaard et al 2020) and in the other southern fjords in West Greenland (GINR unpublished survey data).

Since the prevailing ocean current moves northwards along the coast of West Greenland, eggs and larvae from the Davis Strait spawning component should have difficulty reaching the southern parts of inshore areas in NAFO 1B-1F through passive drift. Therefore, it seems more reasonable to suggest that these areas are supplied with eggs and larvae from the East Greenland/Iceland area (Boje 1999). Such a drift and recruitment pattern is well established for other species such as Atlantic cod (Therkildsen et al. 2013), haddock (Stein 2007) and redfish (Cadrin et al. 2010), occasionally recruiting to West Greenland from East Greenland and Iceland. Support of this 'East to West' recruitment pattern for Greenland halibut is provided by Smidt (1969), who used larvae growth patterns to distinguish between larvae from Iceland and Davis Strait spawning grounds, respectively.

The catch history in the fjords suggests that during certain periods the stocks are gradually depleted to a level where the fishery is no longer profitable. As the inshore fjords are gradually supplied with recruits from the spawning stocks, the growth of the remaining fish in the fjord and recruits leads to a rebuilding of the biomass over a decade or more, whereby the fishery can be reinitiated. In the inshore areas, the process of depletion and rebuilding, seems to have taken place several times. During the low fishery period inshore in division 1B to 1F from the mid 1980's to 2010, the offshore fishery in 1CD has grown and is today about one order of magnitude greater than the inshore fishery in 1B to 1F. It seems unlikely that the fishery would be virtually non-existing over two decades although being so close to a much large stock if there were free movement of adult Greenland between the inshore and the offshore area. In South Greenland it seems the process of depletion and rebuilding has occurred 3 times.

Although commercial samples of size distributions in the landings are not directly comparable between the inshore and offshore area due to gear differences, the gradually decreasing mean size in the landings in 1D inshore and the decreasing landings, indicates a partial depletion of the inshore stock in the Nuuk area (1D). Such a gradual depletion of the inshore stocks in Division 1D seems unlikely in combination with the much larger fishery and gradually increasing catches over decades, the high commercial CPUE and stable survey indices observed offshore in division 1CD by Treble and Nogueira, (2020).

Several tagging studies from 1935-2019 from the Godthåbs fjord and Ameralik (division 1D), Arsuk fjord (Division 1E), Tunugdliarfik Fjord and Lichtenau fjord (Division 1F), have shown that almost all (98-99%) recaptures are found within the same fjord as they were released up to 15 years later (Riget and Boje 1989). Although tagging experiments from 1986-1998 had a higher proportion of Greenland halibut recaptured offshore, these recaptures occurred in a period of low fishing intensity in the fjords. If accounting for effort, these results fit well with the overall resident behavior of fjord populations in West Greenland in general (Boje 2002). Furthermore, In spite thousands of releases and hundreds of recaptures the fjords in Division 1D-1F, not a single Greenland halibut has so far been recaptured in Division 1CD offshore.

Although, genetic studies (Westgaard et al. 2016, Roy et al. 2014, Knudsen et al. 2007) and tagging studies have shown a high degree of connectivity between stocks of Greenland halibut over long distances, it should be noted that inshore stocks isolated from the offshore stocks in the adult phase, would be genetically identical to the offshore stocks. This is obvious, as they recruit from the offshore spawning stocks in either the Davis Strait between Greenland and Canada or from the Denmark Strait between Iceland and Greenland. The lack of migration between the inshore and the offshore stocks in the adult phase, would therefore not be in conflict with lack of genetic differentiation over long distances.

There are several possible explanations for the apparent isolation of the adult phase of the fjord stocks. One possible explanation is that the shallower banks on the shelf constitutes a barrier to adult migration. Whereas the shallow water would not constitute a barrier to the newly settled larvae Greenland halibut or even to 1 or 2 year old recruits that are found in high numbers at depths from 150-200m, it is well known that Greenland halibut gradually migrate to deeper water as they grow. Furthermore, the fjords in West Greenland are highly productive with both classical spring blooms but also secondary bloom periods most likely related to glacier activity and runoff form the Greenland ice sheet (Juul-Petersen T. et al 2015). It has been suggested that coastal regions influenced by large marine-terminating glaciers support a substantially higher marine productivity, also at higher trophic levels (Meire L. et al 2017).

Conclusion

All available literature suggests that the recruitment to Southwest Greenland fjords (Divisions 1B-1F) to a large extent comes from spawning grounds in East Greenland-Iceland. Catch history from 1960 to present, provide evidence of a dis-jointed stock dynamics and a separation between the inshore fjords in Divisions 1B,1C,1D,1E and 1F from the nearby important fishing grounds in the Davis strait in Division 1C and 1D. The lack of seasonality in the fishery also indicates that adult Greenland halibut remain within the fjords throughout the year. This is further supported by studies of parasites used as biological tags and tagging studies from 1935 to present from the Godthåb fjord (inshore 1D) and fjords in South Greenland (1F). These studies indicate that if larvae settle in the fjords, the majority of the Greenland halibut will remain in the fjords as they grow. The apparent separation could be related to the shallower banks along West Greenland creating a barrier to adult migration of Greenland halibut, perhaps combined with the high productivity due to upwelling around glacier fronts and icebergs in many of the fjords providing good feeding conditions for Greenland halibut. Since larvae and recruits are found at shallower water on the banks and in the archipelago between the fjords and the banks, the banks would not create a barrier to juvenile Greenland halibut. Therefore, given the lack of connectivity between the inshore stocks in Division 1B-1F and the offshore stocks in Divisions 0AB+1CD+1AB, it would be appropriate to provide advice for the areas separately.

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Table 1. Catches of Greenland halibut in NAFO subarea 1 in Metric tonnes (inshore fjords and bays only)

	1A-Qaanaaq	1A-Upenavik	1A-Uummannaq	1A-Disko	1B-Sisimiut	1C-Maniitsoq	1D-Nuuk	1E-Paamiut	1F-Qaqortoq
1904			16	10				0	0
1905			16	89				0	0
1906			15	93				0	0
1907			15	99				0	0
1908			0	76				0	0
1909			17	106				0	0
1910			20	105				0	52
1911			5	94				0	171
1912			3	87				0	99
1913			3	106				0	85
1914			8	176				0	208
1915			10	147				0	199
1916			0	156				0	289
1917			4	136				0	152
1918			0	57				1	122
1919			14	135				0	138
1920			11	233				0	199
1921			23	146				0	219
1922			9	297				0	266
1923			14	301				0	397
1924			12	239				0	286
1925			14	223				1	224
1926			28	268				1	141
1927			55	455				0	118
1928			43	500				0	96
1929			86	616				8	86
1930			68	596				1	68
1931			0	242				0	8
1932			12	294				0	0
1933			4	280				0	15
1934			0	231				0	0
1935			0	237				0	0
1936			0	205				4	0
1937			0	210				7	1
1938			0	251				14	0
1939				357					
1940				350					
1941				38					
1942				49					
1943				61					
1944				298					
1945				70					
1946				202					
1947				224					

Table 1. Continued

	1A-Qaanaaq	1A-Upenavik	1A-Uummannaq	1A-Disko	1B-Sisimiut	1C-Maniitsoq	1D-Nuuk	1E-Paamiut	1F-Qaqortoq
1948				229					
1949				265					
1950				250					
1951				257					
1952				201					
1953				323					
1954			16	673					
1955			76	541					
1956			84	670					
1957			31	853					
1958			177	870					
1959			206	796					
1960				1045		143	121	62	25
1961				887	13	55	107	30	34
1962				906					
1963				1124	355	61	494	48	42
1964		9	403	789	172	82	1006	66	103
1965		33	688	630	893	136	413	54	133
1966		20	675	377	598	145	458	79	175
1967		2	593	257	512	148	134	55	86
1968		1	407	227	432	80	206	34	69
1969		1	584	264	344	28	329	128	22
1970		6	326	257	195	41	185	65	18
1971		3	149	261	236	29	288	35	34
1972		3	271	267	492	92	614	57	79
1973					797	26	742	212	145
1974					797	114	660	172	83
1975		5	309	1093	1048	176	360	80	60
1976					596	43	184	63	38
1977		10	754	2876	1189	163	573	113	217
1978		7	1144	2486	1182	179	600	113	102
1979		3	835	2116	1275	290	537	31	95
1980		14	1422	1849	620	327	713	129	105
1981		57	1662	1720	375	196	711	389	254
1982		138	1210	1064	330	60	810	377	638
1983		123	966	953	82	52	563	394	280
1984		111	1259	1656	422	108	962	507	458
1985		244	1833	2970	194	77	2136	286	847
1986				1736	89	23	1180	191	361
1987		1634	2897	2258	39	15	555	48	111
1988	3	777	2920	2670	42	1	419	45	108
1989	1	1253	2859	2781	21	0	66	497	33
1990	8	1245	2779	3821	13	0	36	178	14
1991	17	1495	3045	5372	28	0	16	24	55
1992	0	2156	3067	6577	9	0	58	47	34
1993	8	3805	3916	5367	15	0	34	117	56

Table 1. Continued

	1A-Qaanaaq	1A-Upenavik	1A-Uummannaq	1A-Disko	1B-Sisimiut	1C-Maniitsoq	1D-Nuuk	1E-Paamiut	1F-Qaqortoq
1994	5	4844	4004	5201	45	15	110	74	59
1995	8	3269	7234	7400	1	0	26	8	45
1996	8	4846	4579	7837	1	0	91	2	11
1997	26	4879	6293	8601	0	0	1	2	4
1998	16	7012	6912	10671	0	0	1	2	5
1999	25	5258	8425	10593	1	0	1	3	1
2000	1	3764	7568	7574	1	1	1	0	4
2001	17	3239	6558	7072	2	1	0	0	30
2002	19	3019	5339	11718	10	0	3	1	28
2003	6	3884	5039	11571	20	4	29	3	85
2004	13	4573	5248	12857	40	1	47	21	41
2005	6	4839	4856	12451	23	10	39	34	26
2006	14	5132	5984	12114	18	32	238	34	140
2007		4877	5318	10381	1	1	76	16	51
2008	1	5478	5426	7700	2	76	55	15	25
2009		6497	5451	6321	1	56	104	26	59
2010	1	5941	6226	8458	1	93	226	31	12
2011	21	6471	6146	8487	14	81	104	28	26
2012	50	6830	6130	7755	3	55	277	11	61
2013	11	6039	7007	9073	13	94	1024	44	95
2014	129	7381	8199	9177	18	224	1211	295	73
2015	138	6274	8244	8674	71	112	864	251	228
2016	139	7362	10304	10760	41	108	1369	232	278
2017	210	6783	9049	6409	85	112	1100	409	376
2018	252	7549	8839	8399	70	208	1117	314	343
2019	221	7668	10143	8759	80	221	834	311	139

Notes. Blanks indicates, no catch or no data available.

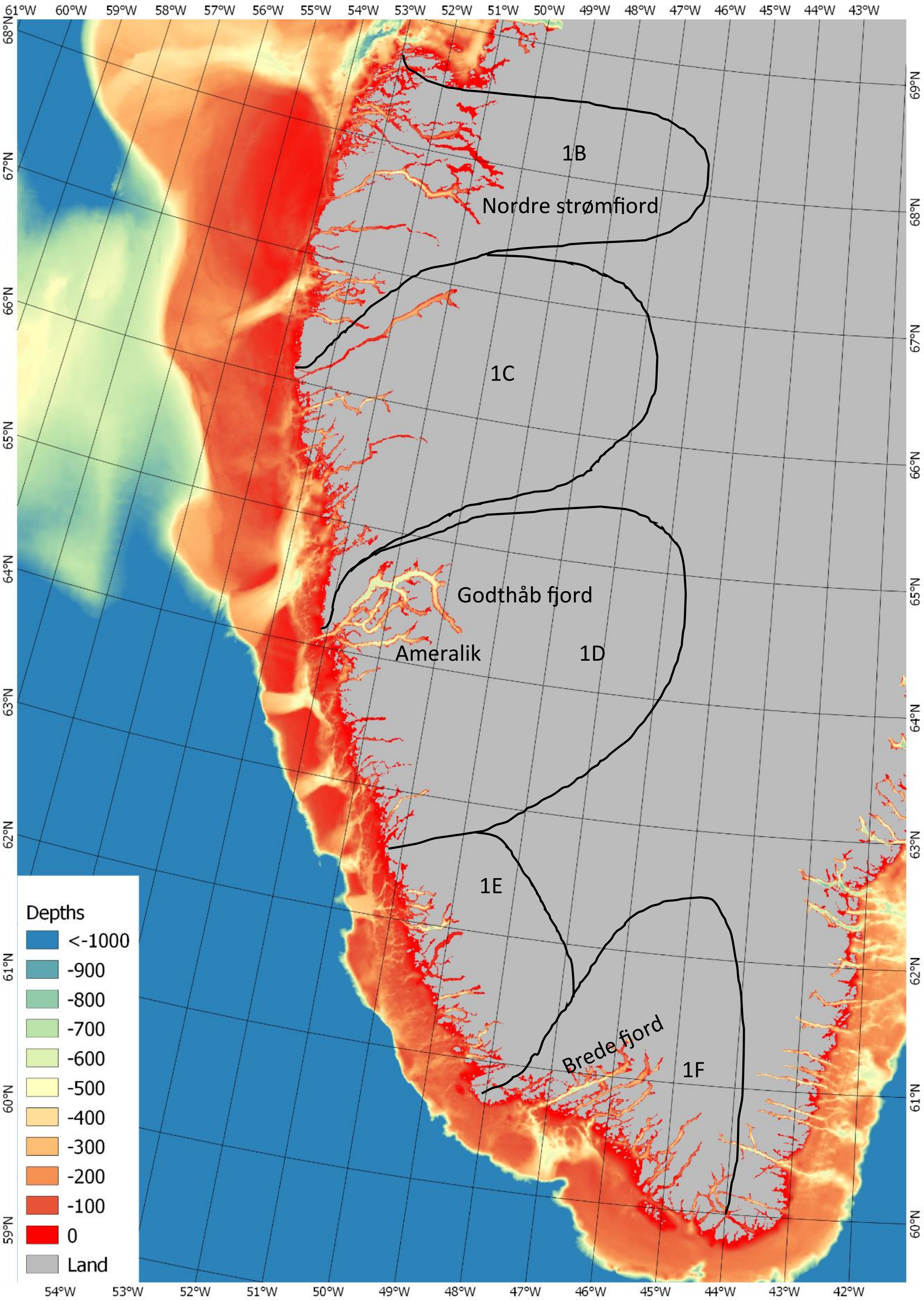

Figure 1. Depth map of the Southwest Greenland shelf area.

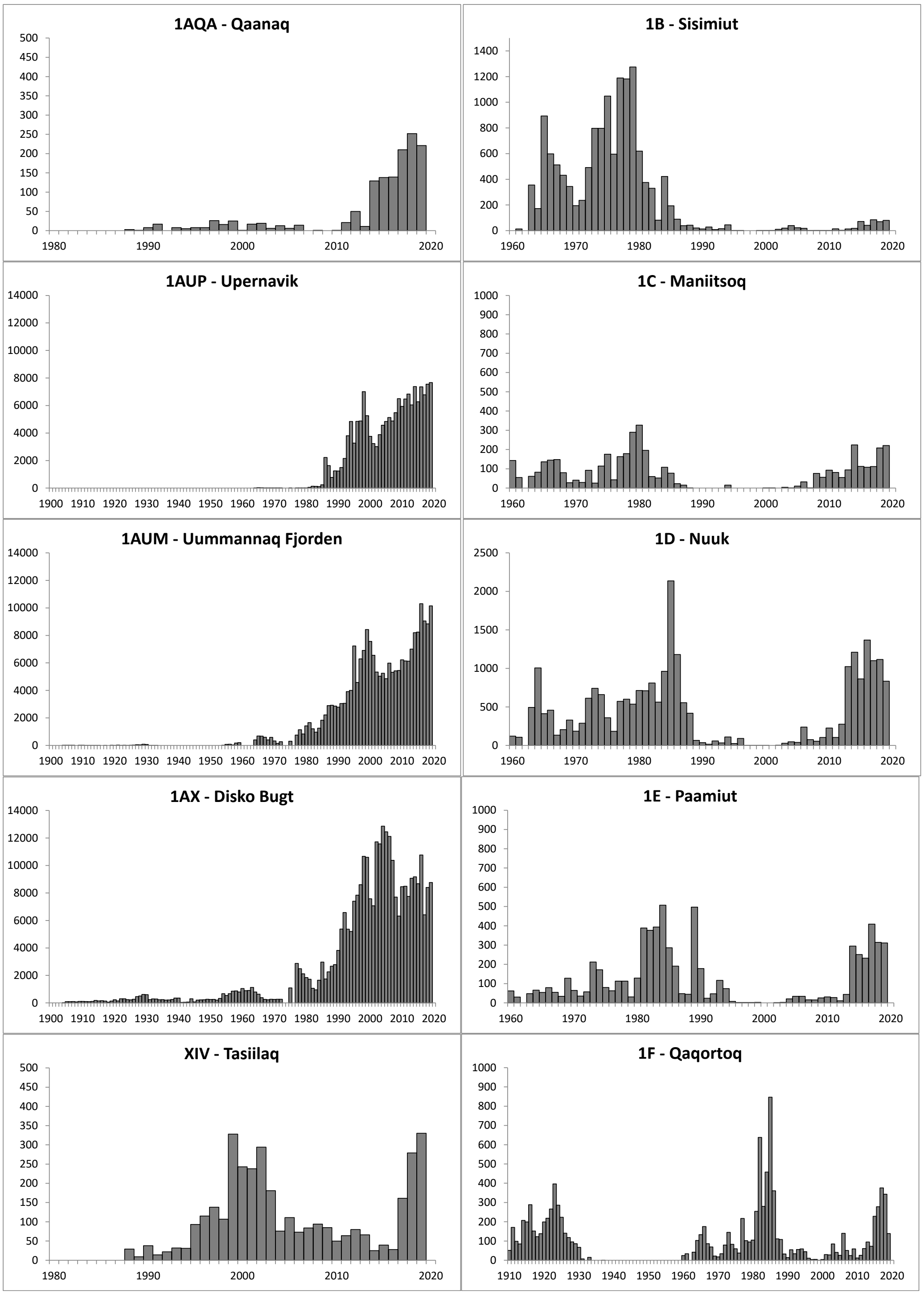

Figure 2. Catches in t/year of Greenland halibut by NAFO from the Qaanaaq fjord in North Greenland to Tasiilaq in East Greenland (inshore).

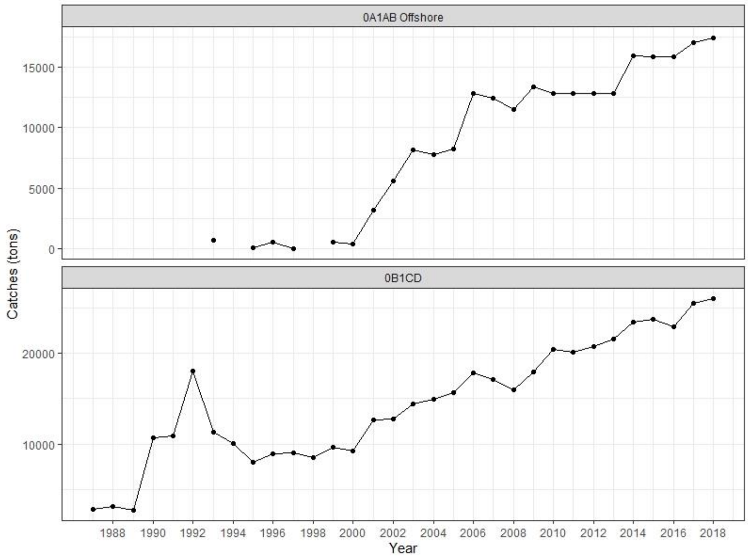

Figure 3. Catches of Greenland halibut in NAFO Divisions 0A and 1AB offshore (Baffin Bay), and Divisions 0B and 1CD offshore (Davis Strait), from 1987 to 2018. Note according to Statland data a fishery also took place from 1968 to 1983 conducted by other nations than Greenland and therefore offshore.

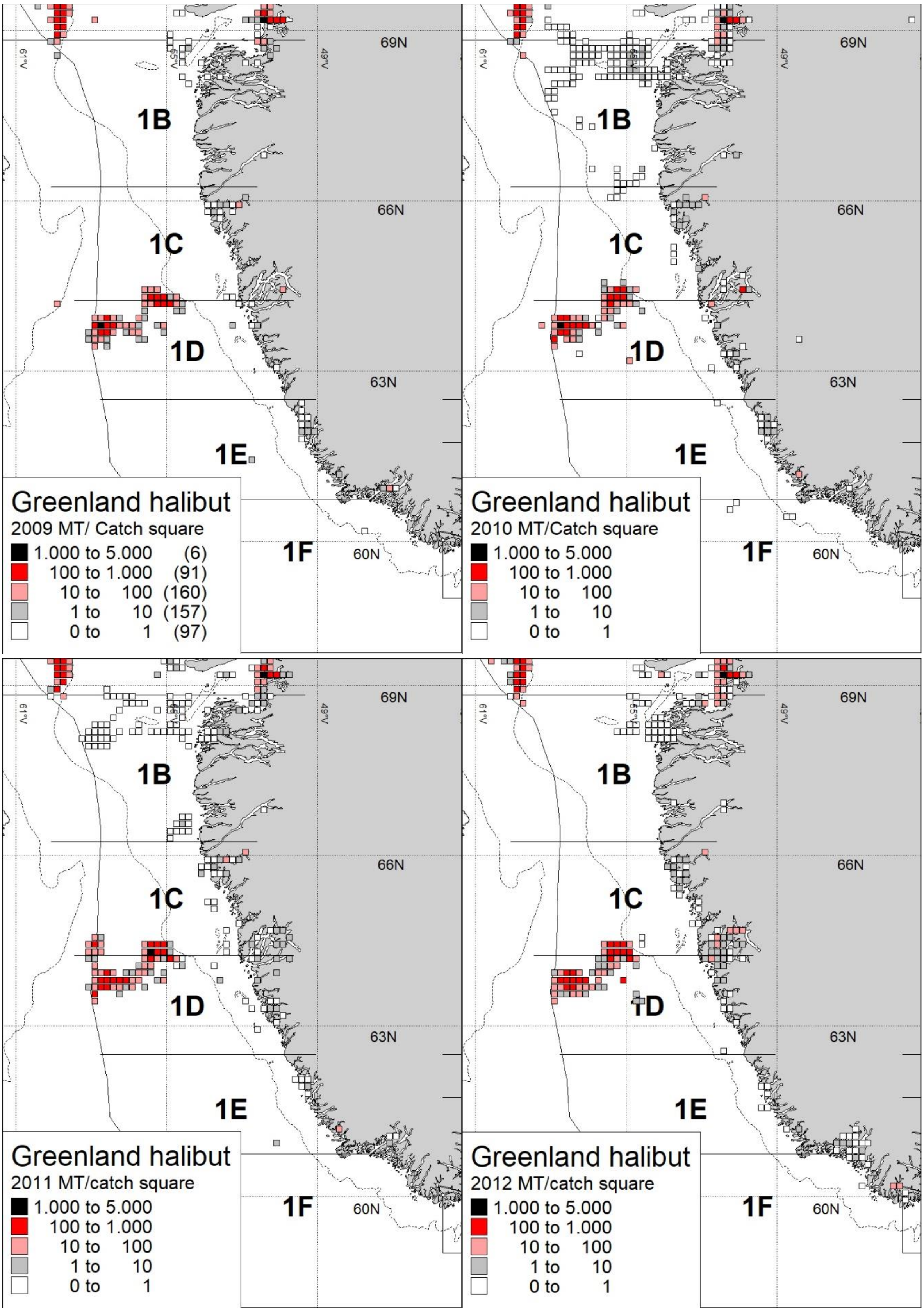

Figure 4. Distribution of catches of Greenland halibut by statistical catch square 2009-2019. Catches include directed trawl, longline and gillnet fisheries and bycatches in shrimp fisheries reported in logbooks from the offshore area and factory landings reported by small boat and sea ice fisheries from the inshore areas.

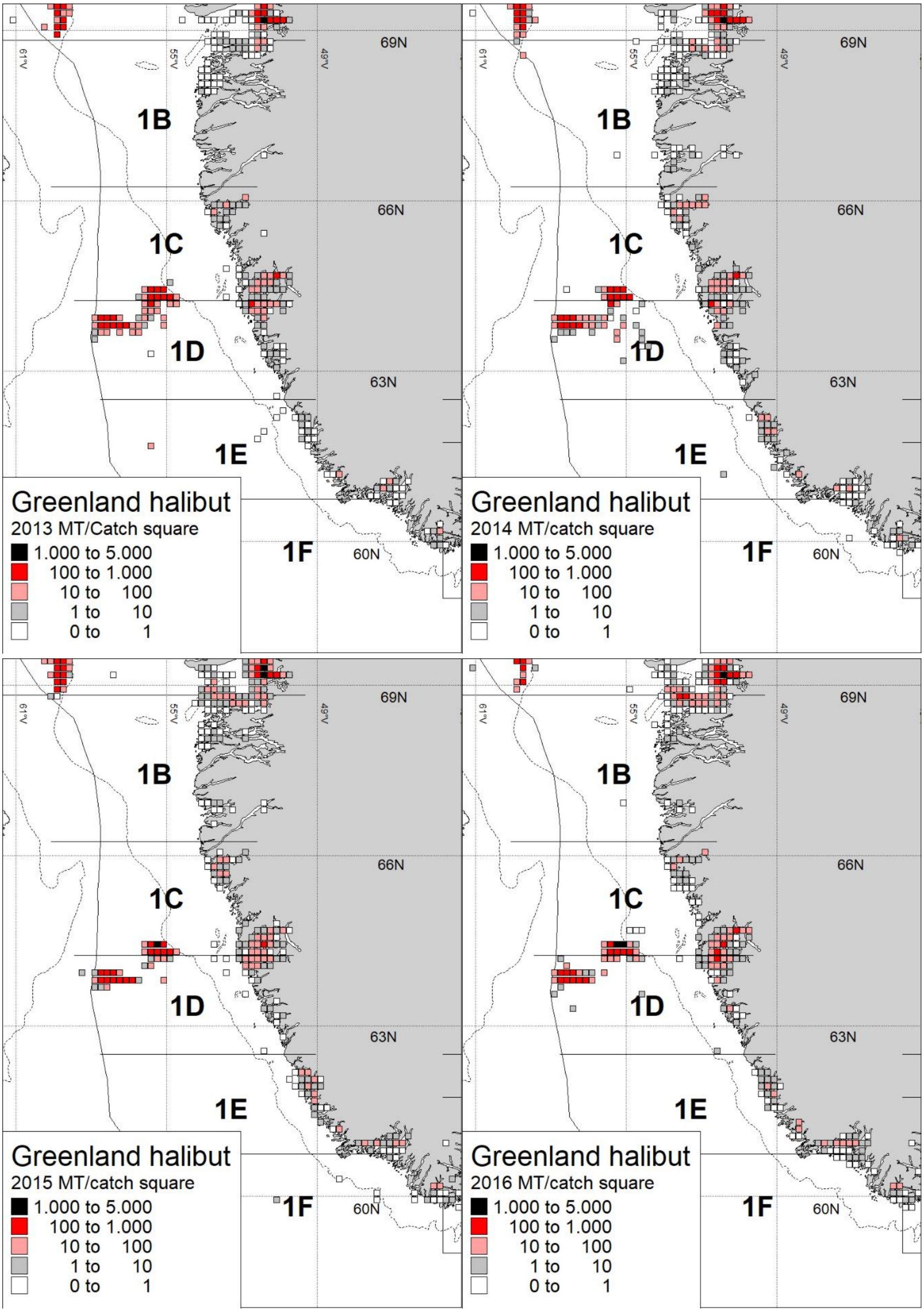

Figure 4. continued

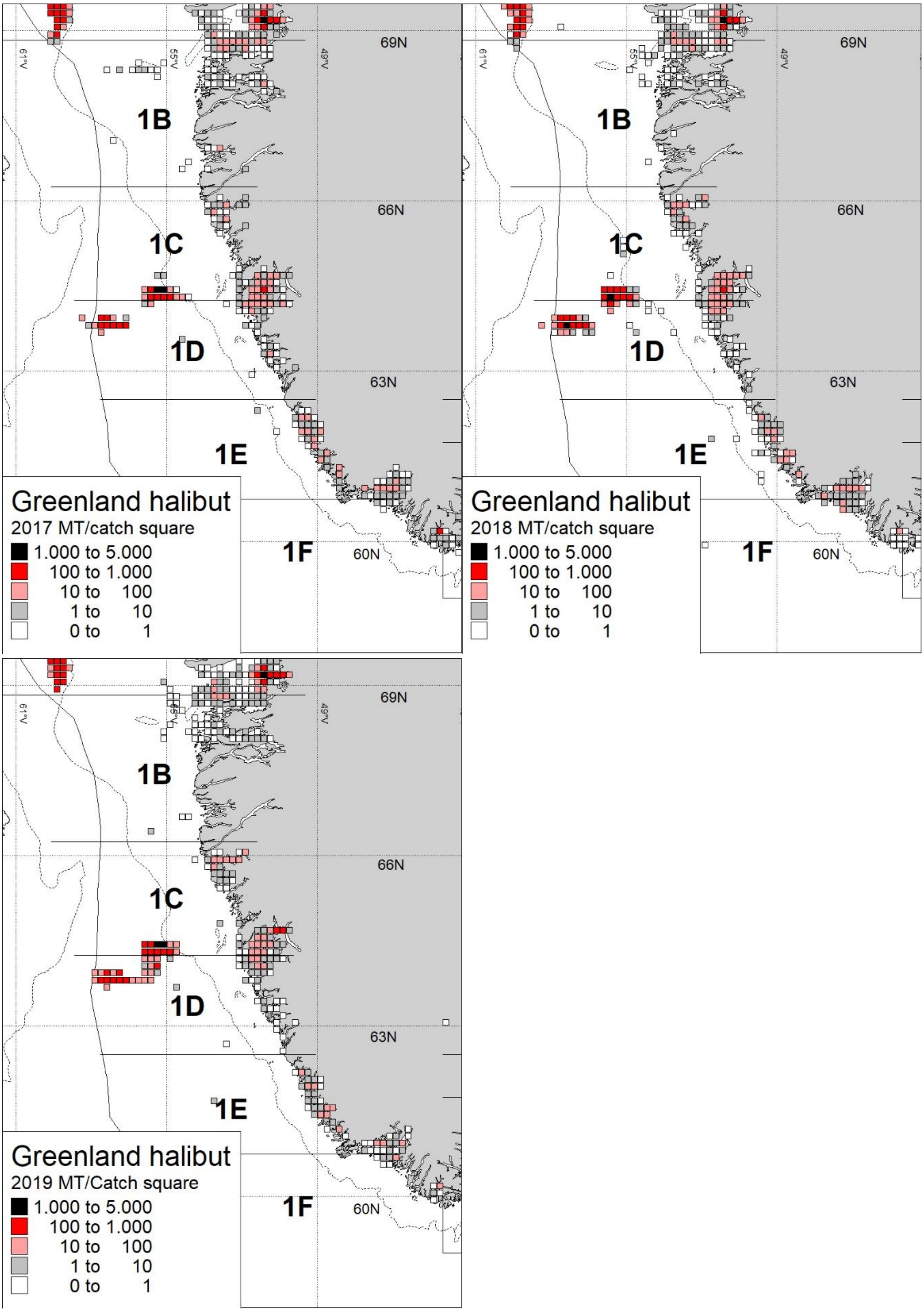

Figure 4. continued

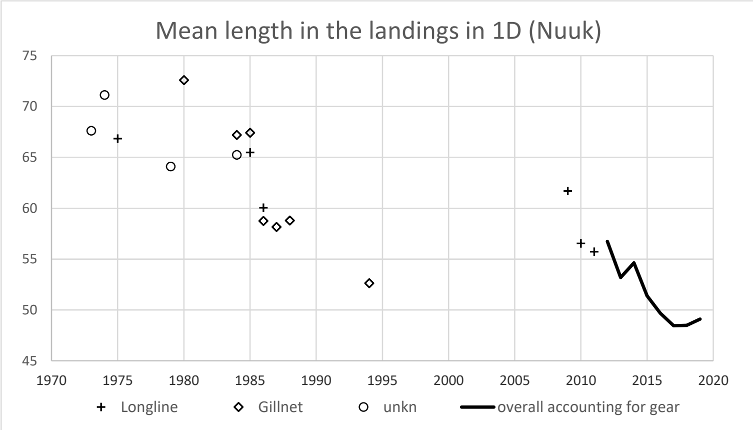

Figure 5. Mean length in commercial factory landings. Data from 2012 to 2019 have been recalculated to an overall mean size in the landings

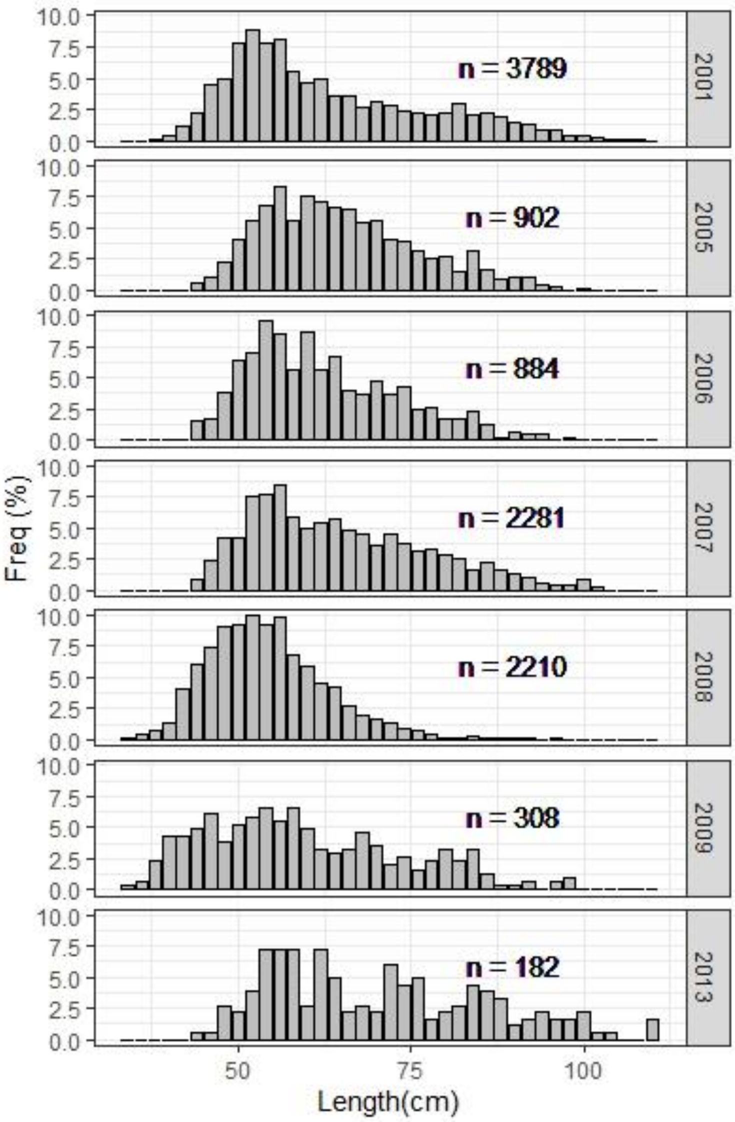

Figure 6. Length distribution for Greenland halibut from offshore operating longline vessels fishing in 1CD offshore.

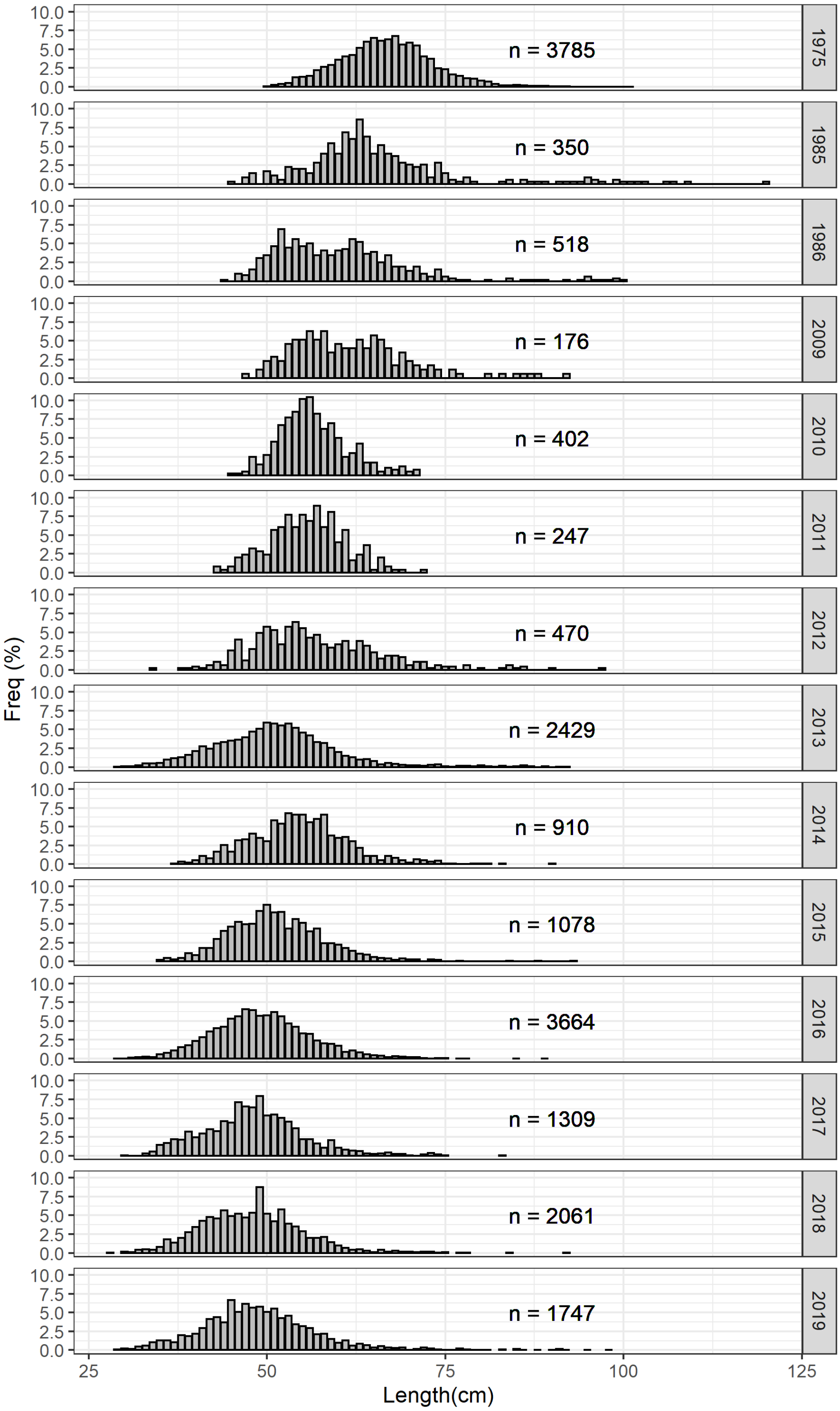

Figure 7. Length distribution for Greenland halibut landed to factories in Nuuk division 1D inshore.

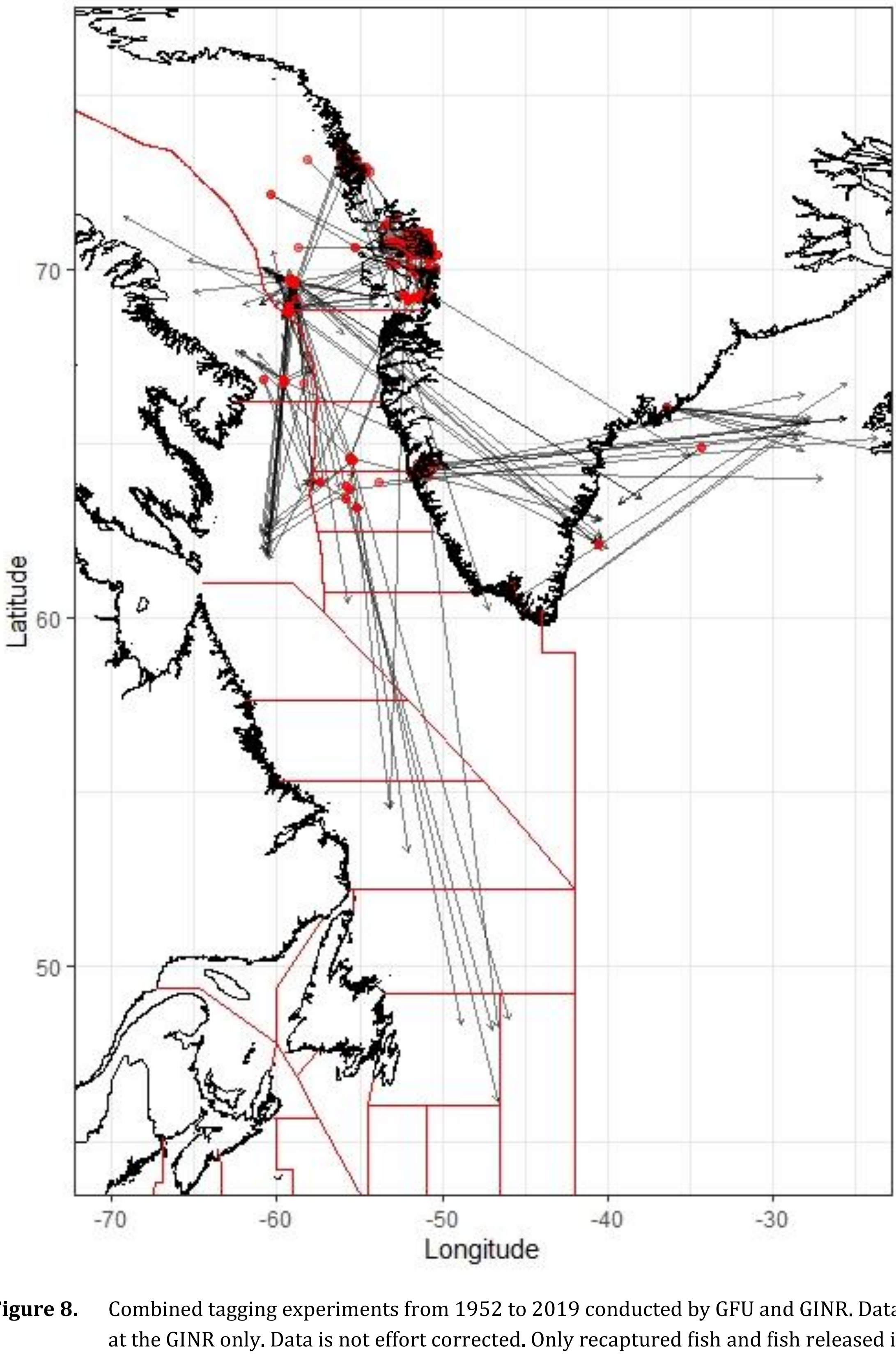

Figure 8. Combined tagging experiments from 1952 to 2019 conducted by GFU and GINR. Data stored at the GINR only. Data is not effort corrected. Only recaptured fish and fish released in Greenland NAFO Subareas 1 and 0 and ICES XIV, are included in the maps.

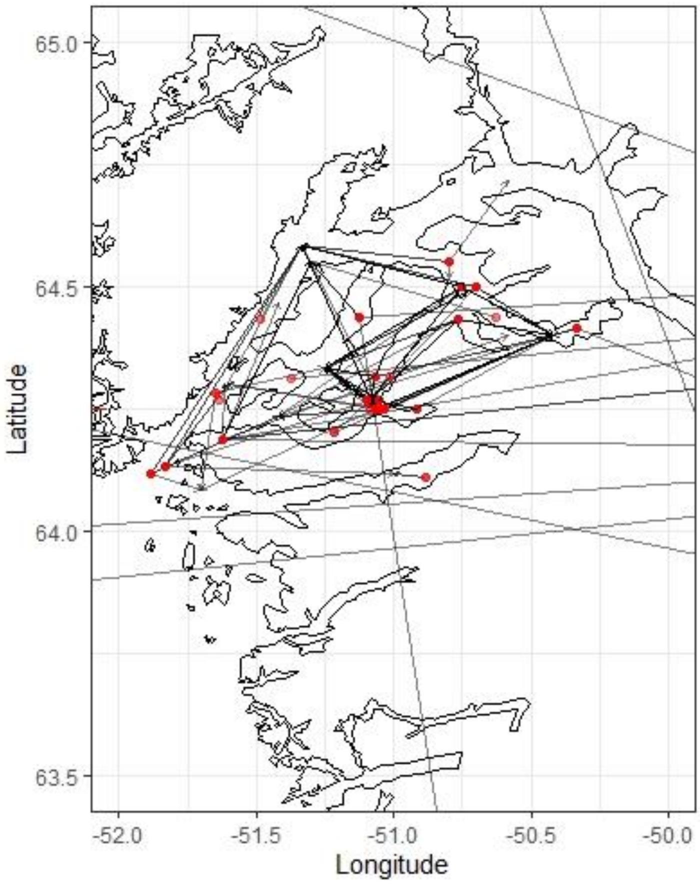

Figure 9. Godthåb Fjord (Division 1D inshore) tagging experiments conducted from 1952-2019 by GFU and GINR. Note that recaptures are reported by Statistical catch square leading to several recaptures at the same reported location.

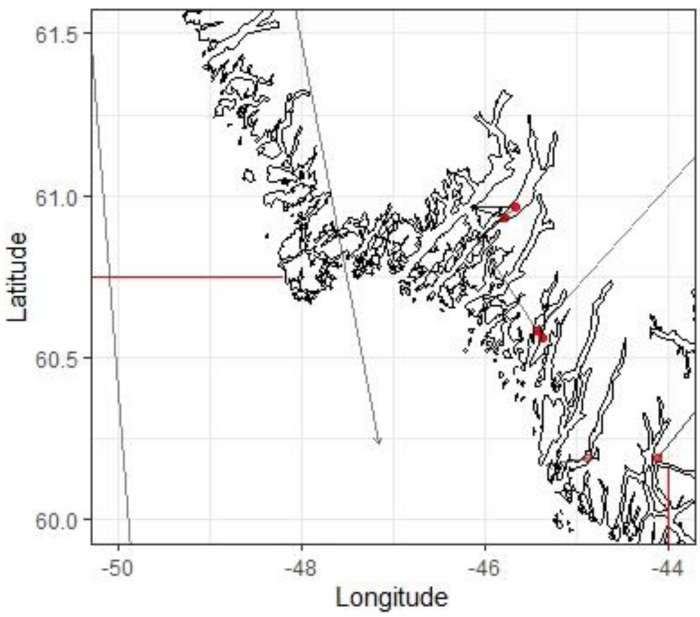

Figure 10. South Greenland (Division 1F inshore) tagging experiments conducted from 1952-2019 by GFU. Note that recaptures are reported by Statistical catch square leading to several recaptures at the same reported location.

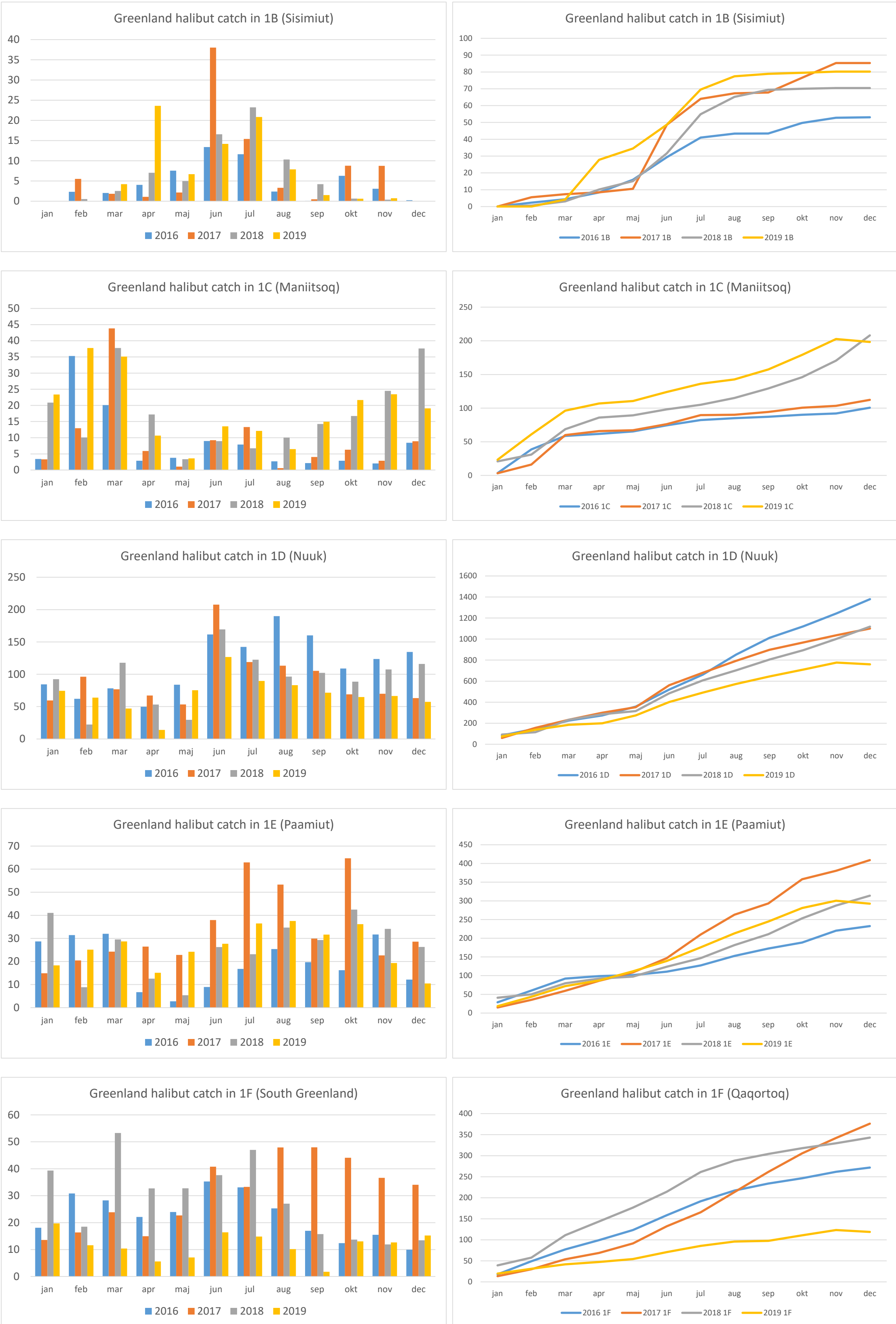

Figure 11. Landings (t) of Greenland halibut by month (left) and accumulated (right) from 2016-2020.