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Trawl, gillnet and longline survey results from surveys conducted by the Greenland Institute of Natural Resources in NAFO Division 1A Inshore

by

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Abstract

This paper presents the updated indices for the surveys performed by the Greenland Institute of Natural resources (GINR) in the Disko Bay, Uummannaq and Upernavik districts, all part of the inshore areas located in NAFO subarea 1. The Disko bay has been part of the Greenland Shrimp and Fish survey in West Greenland (SFW) since 1992. The Disko Bay has previously also been surveyed with a longline survey, but in 2001 this survey was changed to a gillnet survey. The Uummannaq and Upernavik districts have previously been surveyed longline, due to the bottom topography and ice conditions in the area, but since 2011 these surveys have gradually been changed to gillnet surveys,.

Introduction

Greenland halibut is a dominant fish species in the North-west Greenlandic fjords and of major importance to the people living in the area. In the Disko bay, targeted species include Greenland halibut, shrimp, cod and snow crab, whereas other species like wolffish and redfish are mainly bycatch and occasionally landed. In Uummannaq only Greenland halibut is directly targeted and bycatch species include cod, redfish, spotted wolffish and roughhead grenadier are occasionally landed. In Upernavik, only Greenland halibut is directly targeted and bycatches like spotted wolffish has rarely been landed, since the industry until recently (2014) was only interested in receiving Greenland halibut. Few other fish species of potential commercial interest are include American plaice, arctic skate, thorny skate, whereas species like capelin, Arctic cod and Greenland shark, are caught and used locally for bait and dogfood.

The **Disko Bay** is characterized by areas of smooth bottom and depths are mostly less than 600 meters. Glaciers are located in the North-eastern part of the bay (Torssukattak) and in the central eastern part (Kangia) where deeper waters are located (+900m). The **Uummannaq** fjord is by far the deepest of the three areas, and depths down to 1500 meters can be found in the South-eastern part of Uummannaq fjord with slightly shallower depths towards glacier fronts. Several large iceberg producing glaciers are present with the more dominant glaciers located in the south eastern part and north eastern parts (Rinks isbræ). The central parts of the Uummannaq fjord is shallower and with smooth bottom contours and depths of 500-700m, The **Upernavik** area is characterized by several iceberg producing glaciers which extend into deep fjords with depths of more than 900 m. Two of the more important fishing grounds are located in the Upernavik Icefjord and Gieskes Icefjord (Gulteqarffik). Surveys have been conducted in the area since the mid 1970's, using different types of longlines. Although the most important fishing areas are located in the icefjords, ice conditions often restricts surveys to open water parts. An overview of the most recent surveys and successful stations by year, vessel and gear is given in table 1.

Results

The **Disko Bay** trawl survey

The Greenland Shrimp and Fish survey in West Greenland has included the Disko Bay since 1991 and has throughout the time series been conducted with the 722 GRT stern trawler M/Tr 'Pâmiut'. In 2005 the gear was changed in this survey, but since then the area coverage and the trawl and its rigging has been unchanged. See SCR 16/010 for details. In 2005, a new gear was introduced making the tow time series less comparable, although calibration experiments indicated an almost 1:1 ratio in the catchability of age 1 (12-16 cm) individuals which constitute the majority of the survey catches (see discussion)
Trawl survey indicated increasing abundance during the 1990s and high abundances (mainly age 1) were found from 1998 to 2005 (fig 1). After 2006 the abundance indices returned to the lower levels with the exception of the high abundances identified in 2011 and 2013 (2010 and 2012 YC) (fig 2). The length distribution in the survey reveals that particularly the 2011 and 2014 YC seems small, whereas the 2013 is closer to average levels (fig 2).
The biomass indices in the trawl survey indicate a steady increase during the 1990's, with a substantial increase observed in 2003 and 2004 (fig 1). After the gear change in 2005 the biomass index has been in a decreasing trend with the two lowest values found in 2014-15 and 4 of the 5 lowest estimates found in the most recent 4 years (fig 1).

The **Disko bay** gillnet survey

The main objective for starting up the gillnet survey was a well-estimated selectivity compared to longlines and the possibility for targeting pre-fishery sized Greenland halibut (35-55cm TTL). The target is to fish 50-60 stations annually, but in the most recent 3 years only about half the stations have been fished (Table 2). The survey uses fixed positions of stations arranged in transects towards the important fishing grounds West of Ilulissat city and Torssukattak ice fjord in the northern part of the Disko Bay (table 2 and fig 3). The gillnets are composed of 60m long sections with mesh sizes 46, 55, 60 and 70 mm (knot to knot). The Gillnet sections are separated with a 2m open space between each section to prevent catchability interactions. Soak time is approximately 6-18 hours and fishing takes place both day and night. Stations are paired two and two, close to each other to allow for analysis of within station variability. Since the survey uses gillnets with narrow selection curves there is not a major difference between the trends of the CPUE and NPUE indices (fig 4). If comparing the gillnet NPUE (all sizes) to the trawlsurvey indices of Greenland halibut larger than 35 cm, the surveys seems to be correlated to some extent (fig 4, right), leading to increased credibility in the indices of both surveys (see discussion).
The gillnet survey CPUE and NPUE indicated low levels of pre-fishery recruits in 2006 and 2007, but returned to above average levels in 2008 and 2010. The increase in 2011 NPUEs was observed in the northern area of the Bay, while in the main fishing grounds at the Icefjord bank around Ilulissat the NPUEs remained low (fig 3). The high numbers of larger fish in 2011 did not seem to have any origin in the previous year estimated populations. This may either be due to migration/movements of the larger fish in the area or more likely reflecting the uncertainty of the estimates. The 2012 gillnet survey had defect 60 mm gillnet section and should be disregarded. Since 2013 indices have been below average levels indicating lower levels of pre fishery recruits.
Gillnet selection curves are well-known to be skew and not characterized by a normal distribution. In order to account for catch of larger fish a bi-modal (Wilemanns wings) with a fixed selectivity on larger fish approach was chosen. From the estimated underlying population (fig 9), there are no obvious cohort trend, which is likely due to already size overlapping year-classes. Length frequencies weighted by soak-time is given in figure 10. From 2013, significant numbers of cod have also been taken in the survey, mainly composed of the 2010 YC (fig 10).

The **Uummannaq** gillnet survey (experimental)

A few experimental gillnet stations were set in Uummannaq from 2011 to 2014 and in 2015 28 stations were set (table 1). Due to the bottom topography, currents and ice conditions the Uummannaq fjord is more difficult to operate in than the Disko bay. Nevertheless, the experimental stations have revealed the same levels of CPUE and NPUE as observed in the Disko Bay (fig 5). The size distribution in the survey also reveals

that pre-fishery recruits are present in the area and that there is an overweight of large individuals compared to the Disko bay (fig 9). In order to improve the survey new gillnets have been upgraded so the can be set down to 700m and an extra 90mm section has been added on the last part of the survey to include the fishable part of the stock and not only pre-fishery recruits. Catches from the 90mm section were not included in the CPUE and NPUE calculations (fig 5). Cod have also increasingly observed in the survey (fig 11 right).

The **Upernavik** gillnet survey (experimental)

Although the main fishing grounds in the Upernavik area are located in the deep ice fjords, the branching fjord systems between the ice fjords are more suitable for gillnets. The branching side fjords have more suitable depths, are more protected from icebergs and are possible to survey every year, whereas the deep ice fjords with icebergs are not always accessible. Since 2011, some experimental gillnet stations have been set every year and in 2015 gillnets have been fully implemented (Tab 1). The gillnet stations indicate CPUE and NPUE comparable to the level observed in the Disko Bay (fig 6). The length distributions indicates the presence of prefishery recruits at sizes rarely seen in landings from the Upernavik area (fig 9 right and fig 12). In 2015, a 90 mm section was added to all stations (fig 9 right and fig 12), although exclude in the CPUE and NPUE calculation (fig 6).

The longline surveys

Longline surveys have been conducted in the area for more than five decades, but the longline setup and equipment have changed several times throughout the time series. (for further details see Simonsen *et al*. 2000). The longline was changed from a 7mm thick mainline to a thinner type of longline also used by professional fishermen (5,5mm) in 2012. In general, professional fishermen prefers as thin a longline as possible and during the winter fishery they often use longlines as thin as 1 mm. Professional fishermen also have a far higher CPUE (50-100 kg/100 hooks) than observed in the survey (5-15kg/100hooks). The longline surveys are highly variable from year to year and not easily interpreted, but the longlines still has advantages compared to the trawl and gillnet surveys. The longline surveys are better at targeting large individuals (although this has been solved by adding a 90mm section to the gillnets) and provide independent observations of the size distribution in catches and gives an idea of the by-catch in the fishery. Longline CPUE from the surveys in Uummannaq and Upernavik are highly variable and gives little information on the status of the underlying populations (fig 7).

Discussion

Trawl calibration experiments indicated that the difference in catchability between the gears was length dependant for Greenland halibut and was at equilibrium at lengths around 12 cm, but twice as high at 40 cm. Since the abundance is highly driven by 1 year old recruits (15 cm) which normally constitute 80-90% of the abundance in the survey, there is little impact the abundance index whether calibrating or not. This is not true for the biomass where calibrating has a higher impact on the indices. However since the calibration experiments revealed an almost 1:1 relationship between the most abundant individuals, but a stronger difference individuals that must have been rare in the experiments, this could also imply that the catchability difference between the trawls are overestimated. Likewise the fact that indices prior to and non-calibrated indices after the gearchange are at the same level for Greenland halibut (but also other species) also indicate that the effect on the gearchange on the indices overestimated.
The correlation between the abundance of Greenland halibut larger than 35 cm in the trawl survey and the NPUE indices from the gillnet survey, provides an increased credibility in the survey indices of both surveys. The surveys generally occur separated by a month or less and in the same overall areas at the same depth intervals. The trawl survey covers most of the bay and relies on randomly distributed stations, whereas the gillnet survey relies on fixed stations. The correlation between the surveys could be caused by an evenly distributed stock with a high overlap in size selectivity of the two very different gears in relation to the present length distribution of the stock. Still both surveys show inter-annual variation which could be due to shifts in the distribution of the stock in and out of areas that are not covered by the surveys. It seems unlikely that the years with large changes in the indices, indicate a proportional change in the total biomass of the stock. Therefore the surveys should only be interpreted as indices and indicators of the overall development of the stock.

References

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Simonsen, C.S., Boje, J. and Kingsley, M.C.S., 2000. A Review Using Longlining to Survey Fish Populations with Special Emphasis on an Inshore Longline Survey for Greenland Halibut (*Reinhardtius hippoglossoides*) in West Greenland, NAFO Division 1A. NAFO Scr.Doc., 00/29

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

	Disko Bay		Disko Bay			Uummannaq			Upernavik		
Year	Trawl	vessel	Longline	Gillnet	Vessel	Longline	Gillnet	Vessel	Longline	Gillnet	Vessel
1990	*	Pa			AJ						
1991	41	Pa			AJ						
1992	39	Pa			AJ						
1993	31	Pa	11		AJ						
1994	27	Pa	8		AJ						
1995	33	Pa									
1996	33	Pa	17		AJ						
1997	34	Pa	24		AJ						
1998	33	Pa									
1999	34	Pa	12		AJ						
2000	23	Pa	10		AJ						
2001	23	Pa	1	8	AJ						
2002	22	Pa		55	AJ						
2003	19	Pa		56	AJ						
2004	14	Pa	8	50	AJ						
2005	16	Pa	1	47	AJ	20	0	AJ	-	-	-
2006	21	Pa	0	44	AJ	10	0	AJ	-	-	-
2007	18	Pa	0	30	AJ			AJ	-	-	-
2008	16	Pa	0	35	Ch	-	-	-	-	-	-
2009	24	Pa	-	-	-	-	-	-	-	-	-
2010	25	Pa	0	48	AJ	-	-	-	15	-	AJ
2011	26	Pa	0	50	AJ	16	4	AJ	13	7	AJ
2012	21	Pa	0	41	SA	28	3	SA	7	21	SA
2013	17	Pa	0	27	SA	28	7	SA	16	19	SA
2014	21	Pa	0	37	SA	23	4	SA	16	13	SA
2015	17	Pa	0	26	SA	18	28	SA	0	48	SA

NOTES:
Research vessels: (PA: RV Pâmiut, AJ: Adolf Jensen, Ch: Chartered commercial, SA: RV Sanna)
2001 – Longline survey in Disko bay changed to Gillnet survey (46,55,60,70 mm halfmesh).
2012 – Disko bay gillnet survey had defect 60 mm gillnet section.
2013 – Disko bay gillnet survey had stations with large catches of cod (fishing effect may have been affected)
2014 – Disko bay gillnet survey moved to May to reduce problems with glacier ice and icebergs.
2015 – Experimental 90mm mesh added in Uummannaq (partly) and Upernavik (all stations).
2016 – 90mm section fully implemented (46,55,60,70,90 mm halfmesh)

Table 2 . Number of gillnet settings by stat. square in gillnet survey in Disko Bay since 2001.

Square	Year														
	2001	2002	2003	2004	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015	Total
LD027			2	2					2	2	2	2	2	2	16
LE027			2	2					2	2	2	2	2	4	18
LF027			2	2		2	2						2	2	12
LF028			2	2		2		2	2	1	2	2	2		17
LG024			2	1									3		6
LG025				3		2				1	2	2	1		11
LG026		1		2		2				2	2	2	2	2	15
LG027	4	7	6	5	6	5	4	6	6	4	4	1	2		60
LG028	2	2	1	1	1	3	1		1	1					13
LH026		2	1		1	1		2	2	2	2	1	2	1	17
LH027		5	3	3	3	3		3	3	4	3		2		33
LH028	2	1	9	6	8	4	1	7	9	6	2		2		57
LJ026		3	2	2		4	2	3	2	3	3		3	3	31
LJ028		5	3	5	4	4	4	4	4	4	2	2	2		44
LK029		5	4	2	4	2	4		2	2	2	2			29
LL029		1	1		2		1								5
LM027								1							1
LM029		2	2		2										6
LM030		2	2		2										6
LM031		2	2		2										6
LN024		2	2	2	2	2			2	2	2	2	2	4	24
LN025		5	3	4	3	4	4	1	4	4	3	2	3	2	42
LN026		4	2	2	3	2	5	3	3	5	5	3	3	5	45
LN027		2	2	2	2	2		1	2	1	1	2	2		20
LN028		2	1	2	2			2		2	2	2			16
LP024		2					2		2	2					8
Total	8	55	56	50	47	44	30	35	48	50	41	27	37	25	558

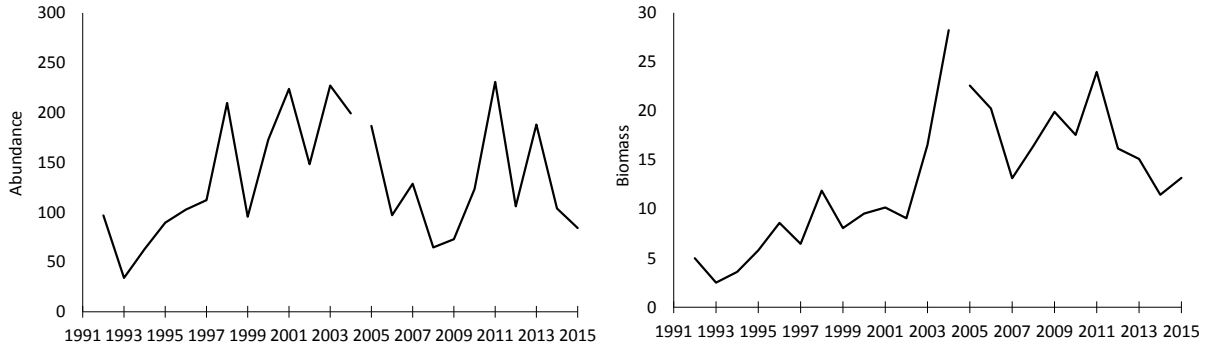

Fig. 1. Trawl survey (SFW) in Disko bay: Abundance (left) and biomass (right).

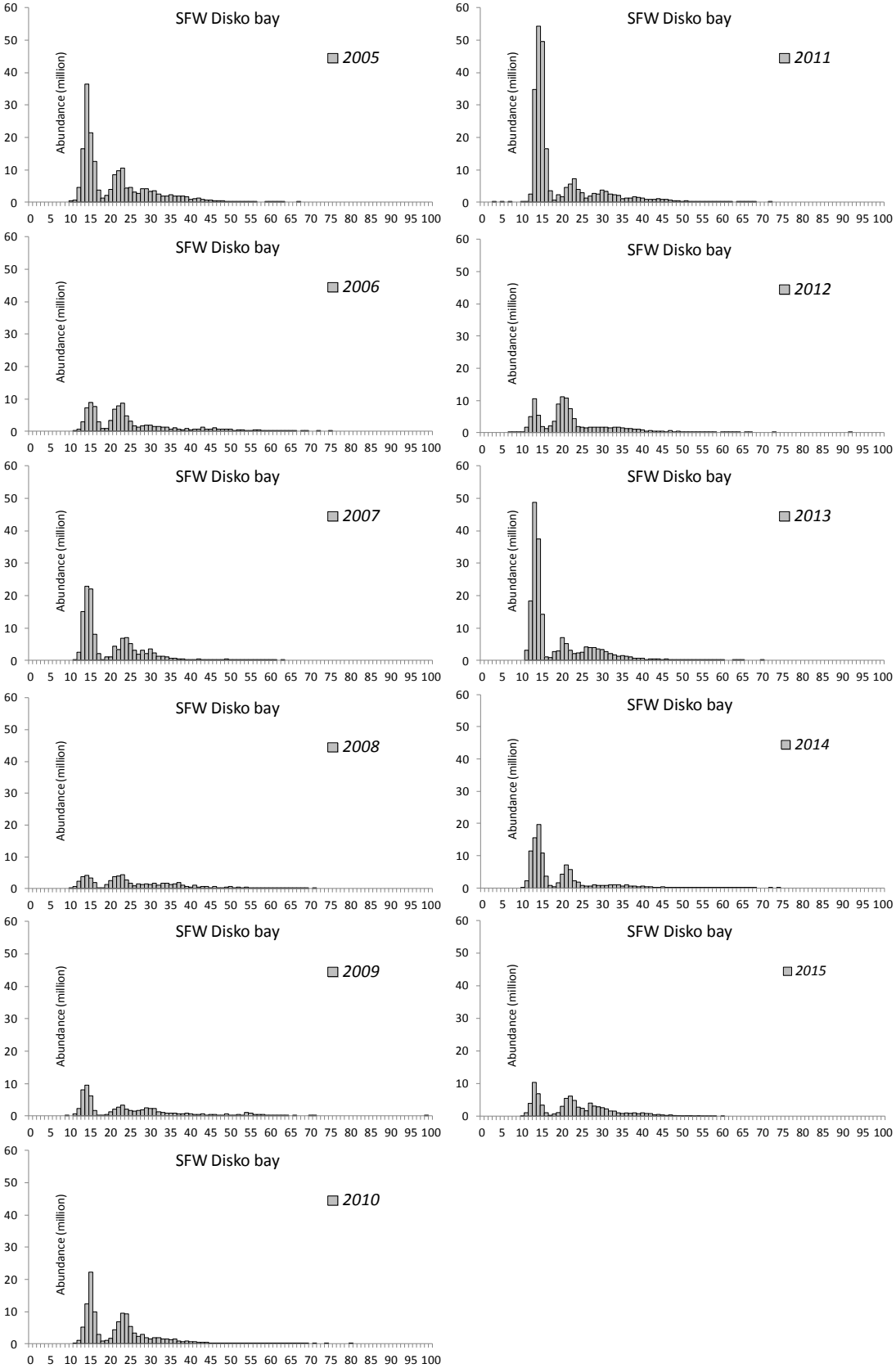

Fig. 2. Greenland halibut trawl survey length frequencies (SFW).

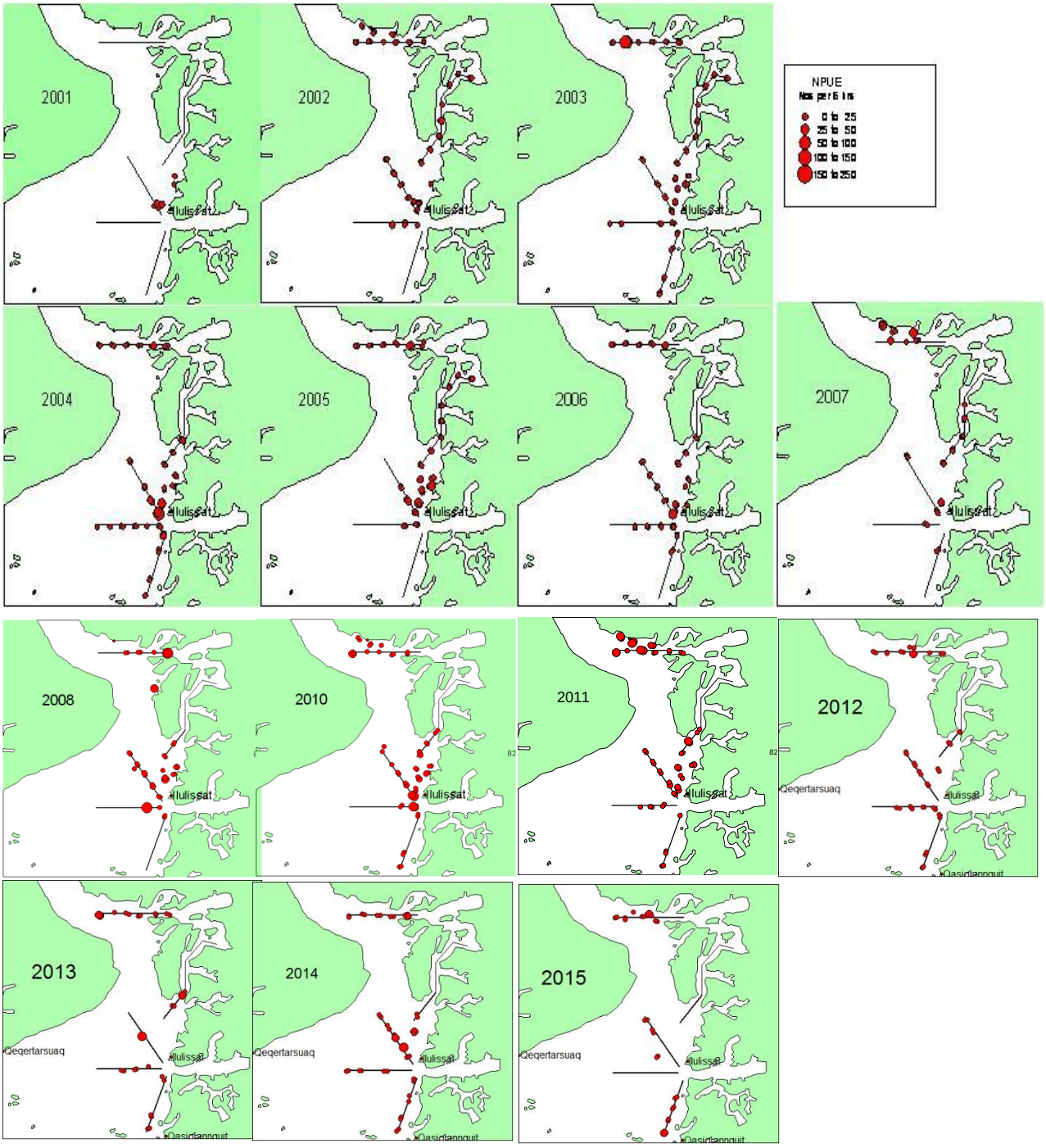

Fig. 3. Gillnet survey in Disko Bay by year. Lines indicate transects and dots the distribution of NPUE (Nos G.halibut per 6 hrs of setting).

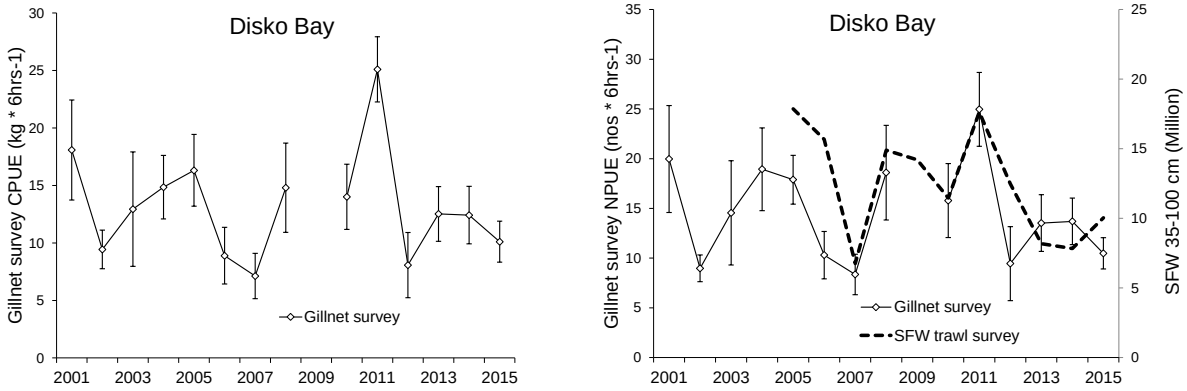

Fig. 4. Disko Bay gillnet survey CPUE (left) and NPUE (right) of Greenland halibut (all sizes) combined with SFW trawl survey abundance estimate of Greenland halibut sizes 35-100 cm.

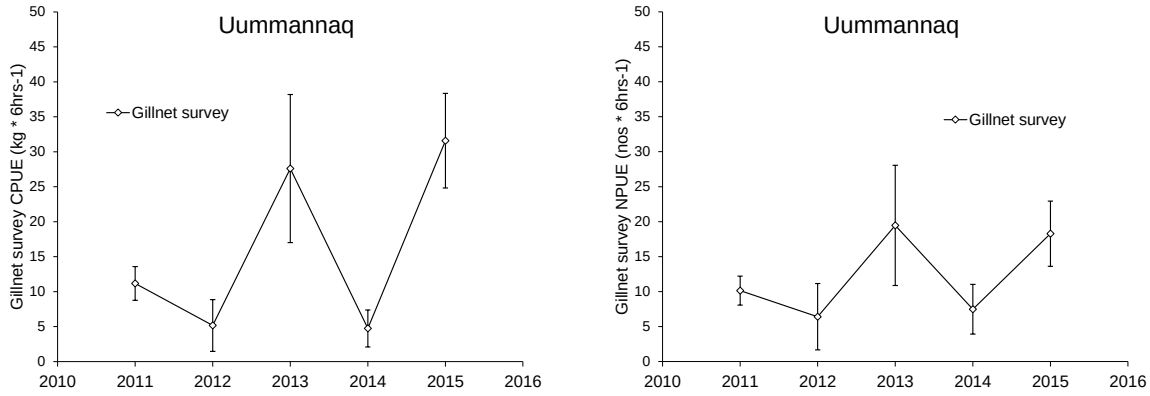

Fig. 5. Uummannaq gillnet survey CPUE (left) and NPUE (right) of Greenland halibut (all sizes).

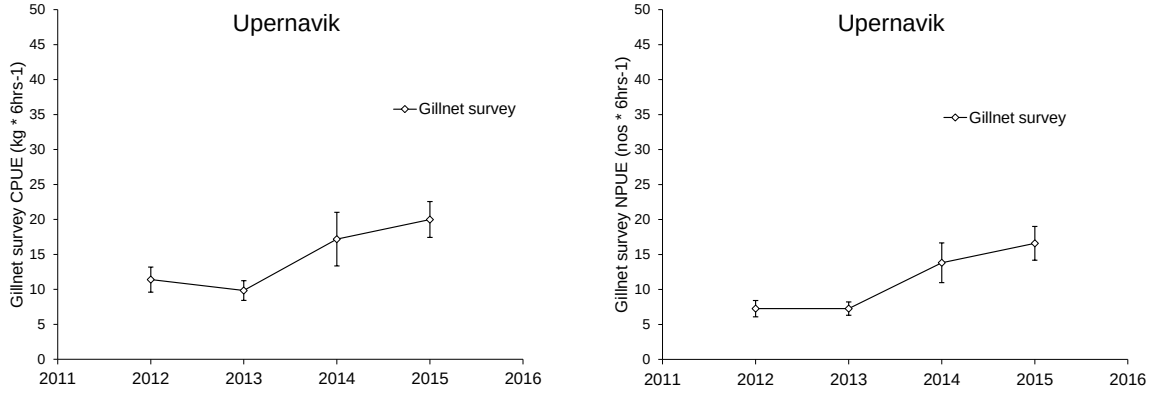

Fig. 6. Upernavik gillnet survey CPUE (left) and NPUE (right) of Greenland halibut (all sizes).

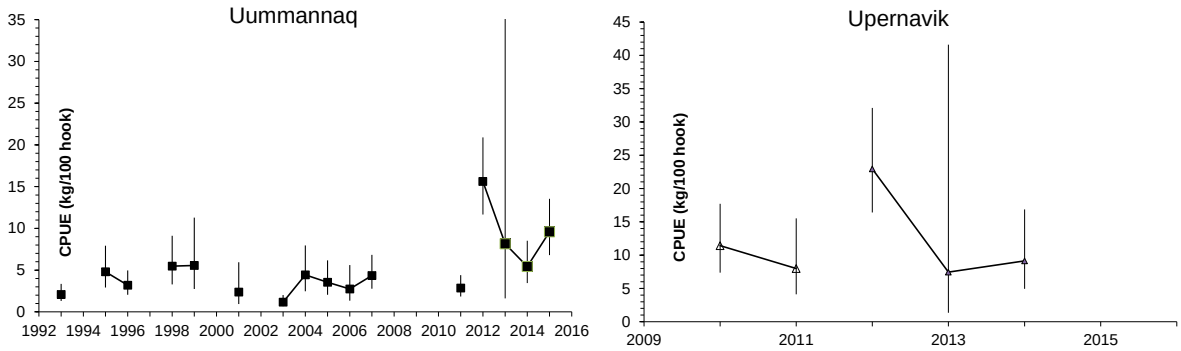

Fig.7. Longline survey indices with CI for Uummannaq (left) and Upernavik (right). New survey logline introduced in 2012. The survey was changed to Gillnet in Upernavik in 2015.

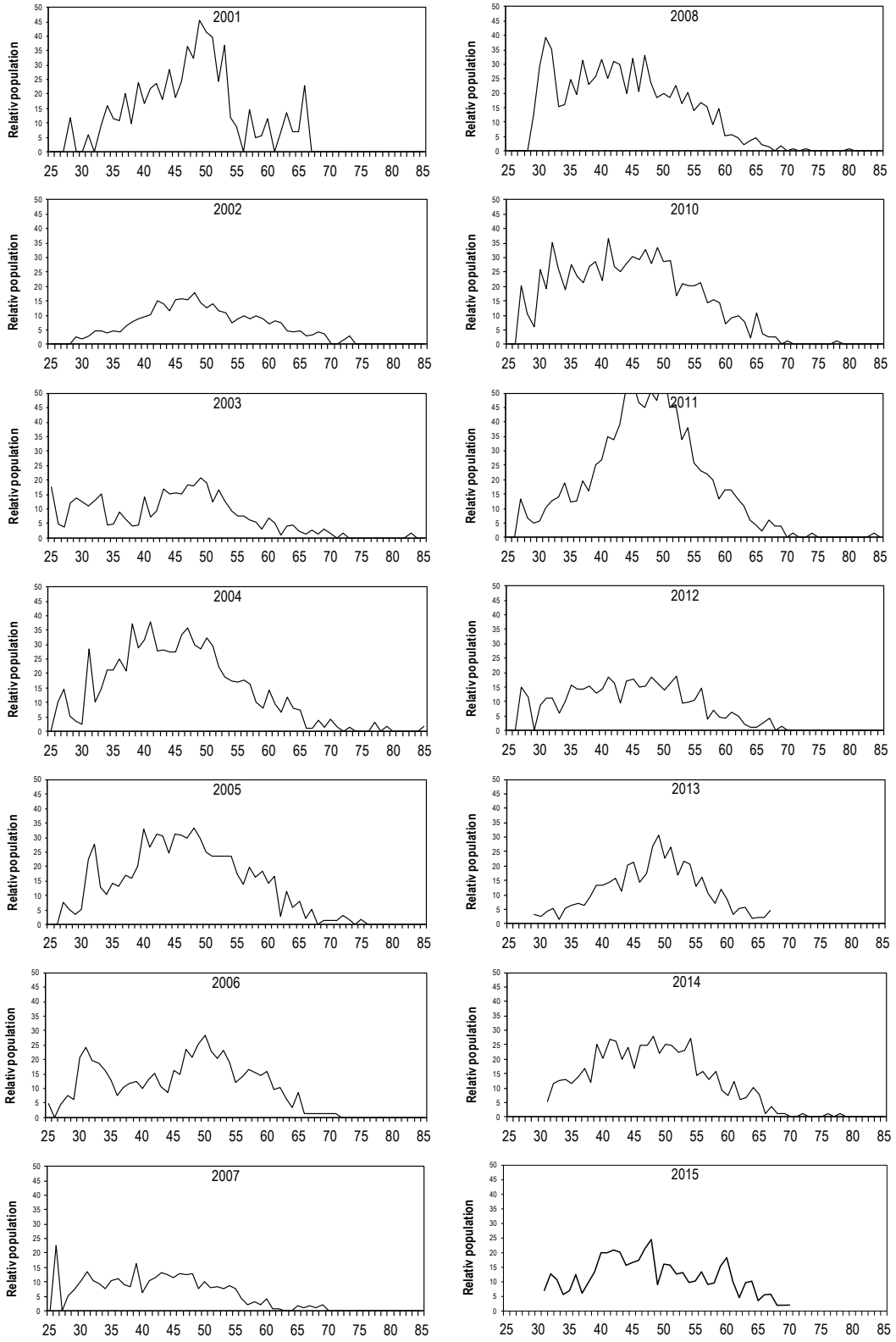

Fig. 8. Gillnet survey in Disko bay. Estimated relative population assuming a Wilemans Wings selectivity curve in 2001 to 2015.

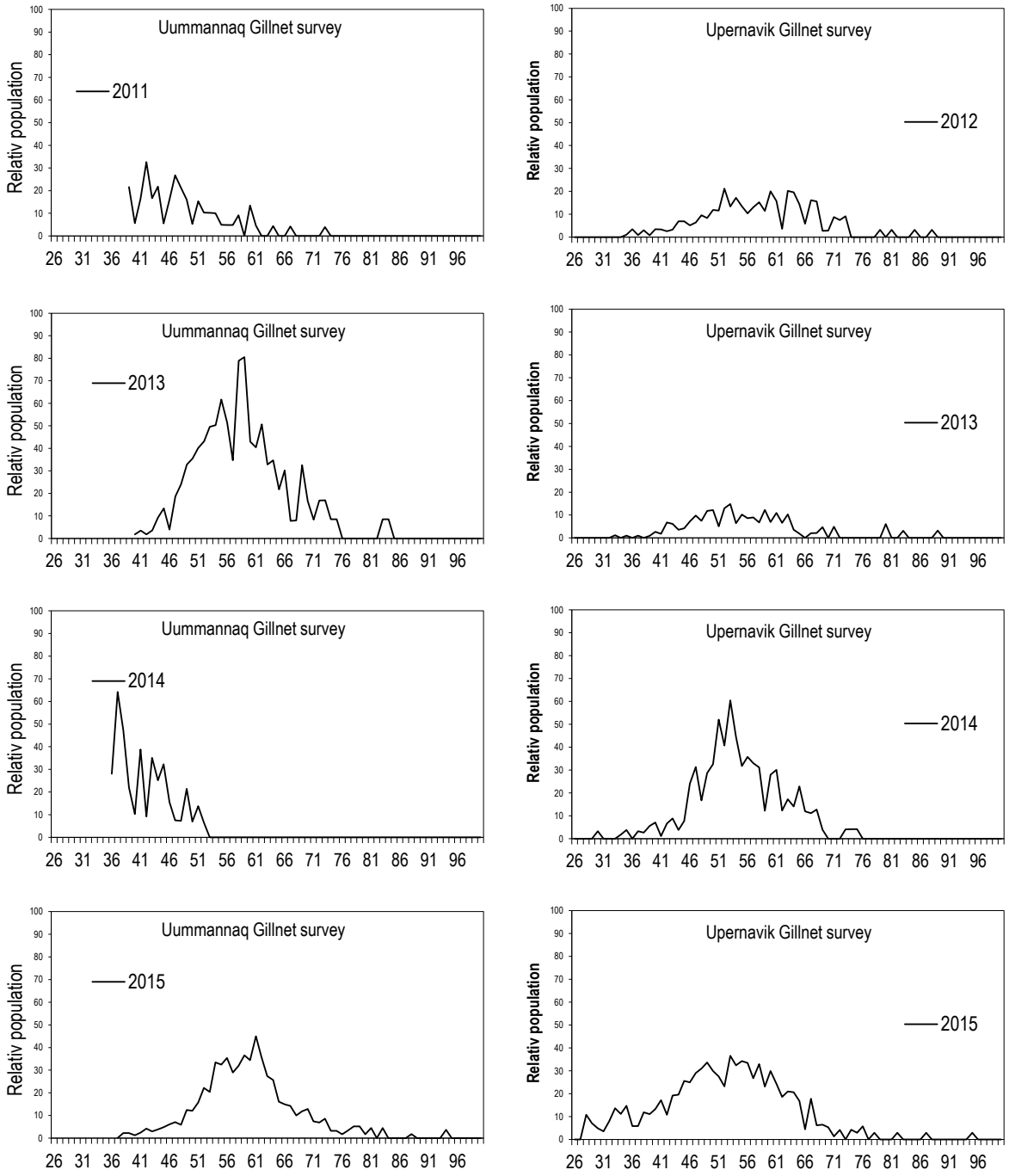

Fig. 9. Gillnet survey in Uummannaq (left) and Upernavik (right). Estimated relative population assuming a Wilemans Wings selectivity curve.

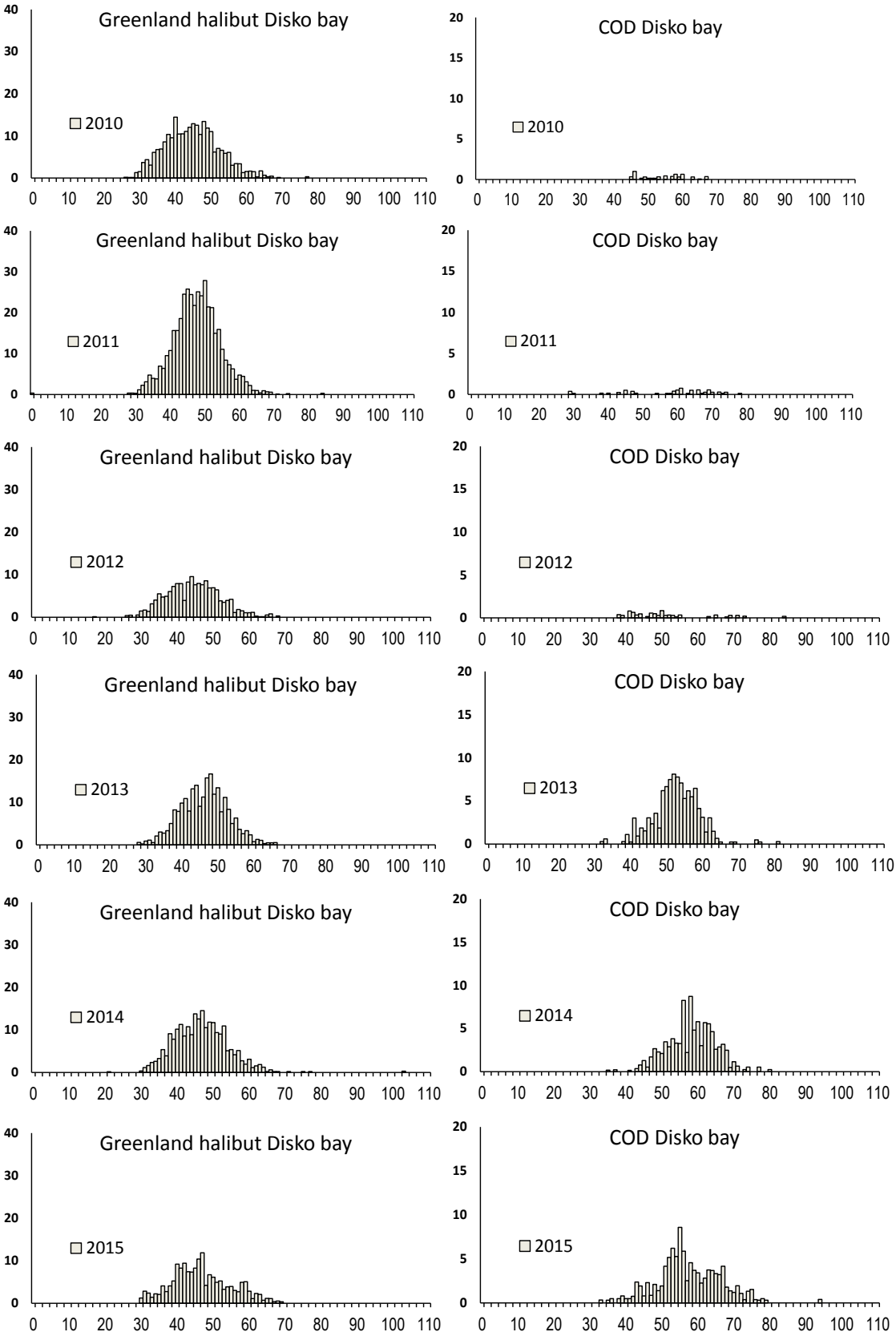

Fig. 10. Disko bay: Length distribution (N/100hr) for Greenland halibut (left) and cod (right).

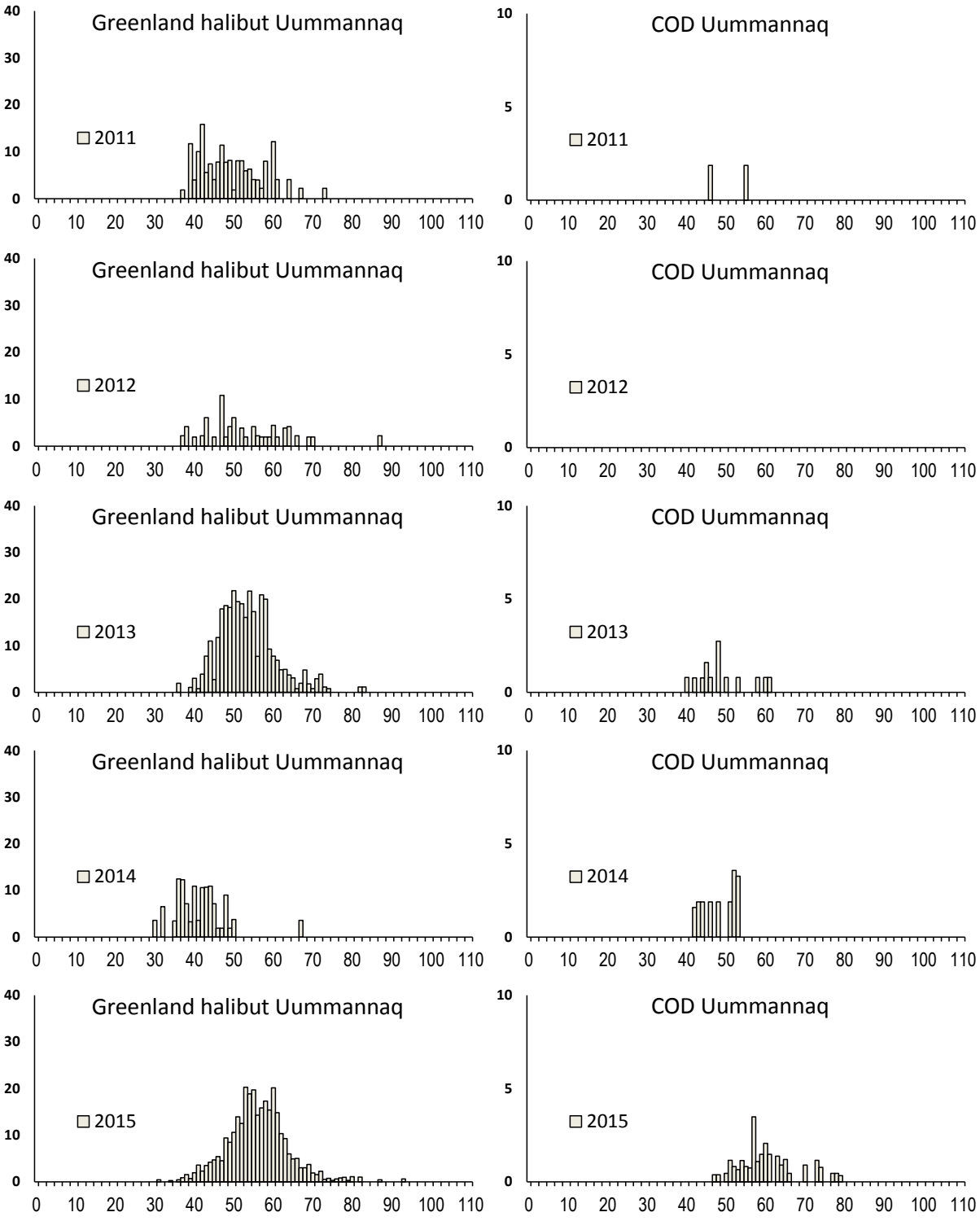

Fig. 11. Uummannaq: Length distribution (N/100hr) for Greenland halibut (left) and cod (right).

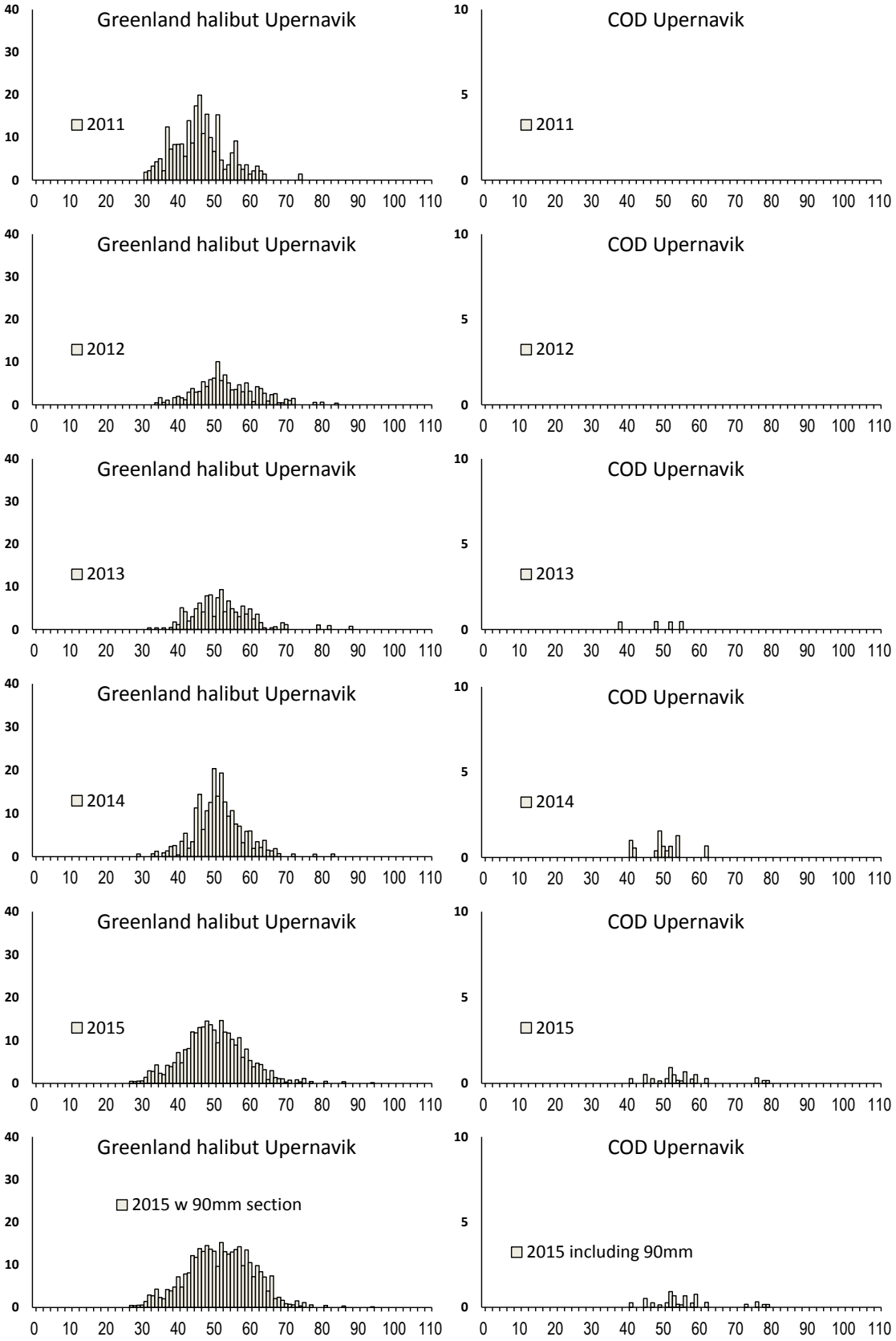

Fig. 12. Upernavik: Length distribution (N/100hr) for Greenland halibut (left) and cod (right).