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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 previously also been surveyed with longlines, but in 2001 this survey was changed to a gillnet survey. The Disko bay has furthermore been part of the Greenland Shrimp and Fish survey (trawl) since 1992. The Uummannaq and Upernavik districts have previously been surveyed with longline, but from 2011 to 2015 the surveys were gradually changed to gillnet surveys. Since 2016, only gillnet stations have been set in all 3 areas and a large meshed section (90mm halfmesh) was added to better survey the adult part of the stocks.

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 and Upernavik, Greenland halibut is the only directly targeted species and other species like cod, redfish, spotted wolffish and roughhead grenadier are taken as bycatch only. About 1000 people have a license to fish commercially and the Greenland halibut is therefore of major social and economic importance to the local communities.

Survey area

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 the Icefjord (Kangia) where deeper waters are located (+900m). The Disko Bay is connected to the Baffin bay in the western side and in the North Western side (Vejgat). 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, 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 (store or large glacier) and North Eastern parts (Rinks isbræ). The central parts of the Uummannaq fjord is shallower and with smooth bottom contours at depths of 500-700m and connected to the Baffin Bay to the West. The **Upernavik** area is characterized by several large iceberg producing glaciers, which extend into deep narrow fjords and depths of more than 900 m. Two of the more important fishing grounds are located in the Upernavik ice fjord and Gieskes ice fjord (Gulteqarffik). Although the most important fishing areas are located in the ice fjords, ice conditions often restricts surveys to open water parts in the branching

fjords surrounding the settlements. An overview of the most recent surveys and successful stations by year, vessel and gear is given in table 1 and fig 1.

The surveys

Surveys have been conducted in the area since the mid 1970's, using different types of longlines as gillnets or trawls are harder to use due to bottom contours, very silty and soft bottoms and glacier ice.

In the Disko Bay it is possible to use trawls and the Disko bay has been part of the Greenland Shrimp and Fish survey (SFW) since 1991. The survey 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 18/032 for details. In this survey up to 90% of the Greenland halibut caught in the survey are juveniles at age 1 and 2.
In 2001, a gillnet survey was initiated in the Disko bay. The main objective for starting up the gillnet survey was a well-estimated selectivity and the possibility for targeting pre-fishery sized Greenland halibut (35-55cm TTL). The gillnets were composed of 60m long sections with mesh sizes 46, 55, 60 and 70 mm (knot to knot or half mesh). Sections are separated with a 2m open space 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. A similar survey was gradually implemented in Uummannaq and Upernavik in 2011-2014. The target is to fish 50 stations annually in each area. In 2016 a 90mm section was added to all stations in order to survey larger halibut.

Results

The **Disko Bay** trawl survey

The Disko bay part of SFW 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). However, only the 2010 YC can be followed as larger than average in the following years, whereas the 2012 YC seems at average levels already in 2014. The length distribution in the survey reveals that particularly the 2011 and perhaps the 2014 YC seems small (fig 2). The small 2011 YC also seems small as 3 year olds in the 2014 survey (fig 2b). However, in most years there seems to be a tendency for recruitment to be less varying at age 2-3.
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 lowest values found in the most recent 4 years (fig 1).

The **Disko bay** gillnet survey

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 (fig 3). 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 Ice fjord 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 just reflecting the uncertainty of the estimates. Since 2013, indices have been below average levels.
As 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 trawl survey 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).
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.

Raw LF can be found in fig 10-12. From 2013, significant numbers of cod have also been taken in the survey, composed of several YC's (fig 10). The 90mm section added in 2016, did not impact the overall length distribution in the Disko bay, indicating few larger individuals in the surveyed area (55-70 cm)(fig 10).

The **Uummannaq** gillnet survey

A few experimental gillnet stations were set in Uummannaq from 2011 to 2014 but are hardly representative of changes in the stock (table 1). However overall the experimental station revealed NPUE similar to the Disko bay and CPUE' higher than in the Disko Bay (Fig 5). From 2015 more gillnet stations have been taken. To allow for comparison with the Disko bay, catches from the 90mm section were not included in the CPUE and NPUE calculations (fig 5). The number of fish caught is higher and the individual sizes are much larger than the Disko Bay and therefore the CPUE is much larger (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 11). The 90mm section added in 2016 caught high numbers of Greenland halibut in the size range 55-65 cm in Uummannaq indicating higher numbers of larger individuals in the area (fig 11). Cod have also increasingly observed in the survey in Uummannaq (fig 11 right).

The **Upernavik** gillnet survey

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 easier to access and survey. The branching side fjords have more suitable depth and are more protected from icebergs and therefore possible to survey every year, whereas the deep ice fjords with icebergs and glacier ice 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 pre-fishery 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 were highly variable from year to year and not easily interpreted. The longline surveys were however finally stopped in 2016.

Climatic conditions in the Disko Bay

A well documented temperature increase occurred in 1997 along the west coast of Greenland and bottom temperatures has remained at a higher level since then (fig 13). The temperature increase has been related to both increased glacier retrieval (Holland et al, 2008, Motyka et al. 2011) and increased growth of one year old Greenland halibut (Sünksen et al 2009).

Discussion

In the beginning of the Disko Bay gillnet survey time series commercial landed Greenland halibut were larger in the area and fish smaller than 55 cm were regarded pre-fishery recruits. However, in the recent decade smaller and smaller Greenland halibut have been landed and nowadays the fishery targets Greenland halibut as small as 40 cm with smaller hooks and illegal use of finer meshed gillnets (80mm). Therefore the gillnet survey is increasingly surveying both recruits and the fished stock. The fishery may therefore directly be impacting the gillnet survey indices.

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 gear change are at the same level for Greenland halibut (but also other species) indicate that the effect of the gear change on the indices may be 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 only and indicators of the overall development of the stock.

Recruitment
Although recruitment seems to vary from year to year, this does not seem to be the case at age 2 or 3. Often estimates strong or weak YC at age one seems close to average levels a year or two later. It has been suggested that this may be related to density dependant mortality at in years of extra high recruitment (Sünksen et al. 2009).

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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	31	-	AJ	21	-	AJ			
1994	27	Pa	32	-	AJ	-	-	AJ	30	-	AJ
1995	33	Pa	-	-	--	19	-	AJ	32	-	AJ
1996	33	Pa	29	-	AJ	24	-	AJ	-	-	-
1997	34	Pa	24	-	AJ	-	-	-	-	-	-
1998	33	Pa	-	-	-	23	-	AJ	31	-	AJ
1999	34	Pa	26	-	AJ	10	-	AJ	-	-	-
2000	23	Pa	35	-	AJ	-	-	-	30	-	AJ
2001	23	Pa	15	8	AJ						
2002	22	Pa		55	AJ						
2003	19	Pa		56	AJ						
2004	14	Pa	8	50	AJ						
2005	16	Pa	9	47	AJ	21	0	AJ	-	-	-
2006	21	Pa	3	44	AJ	16	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	-	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
2016	12	Pa	0	54 (76)	Sa	0	49	Sa	0	47	Sa
2017	30	Pa	0	36	Sa	0	48	Sa	0	41	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 in all areas (46,55,60,70,90 mm halfmesh) on all stations. 54 normal GHL stations and 22 ekstra stations to survey cod.

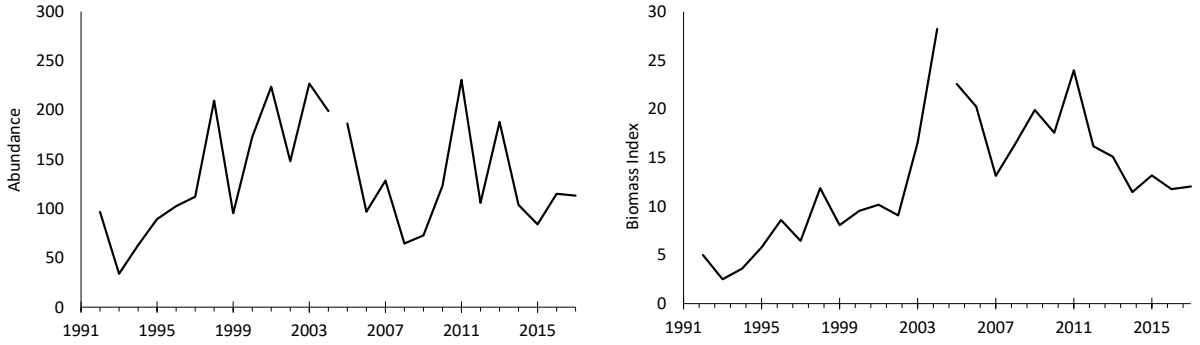

Fig. 1. Trawl survey (SFW) in Disko bay: Abundance (left) and biomass (right).

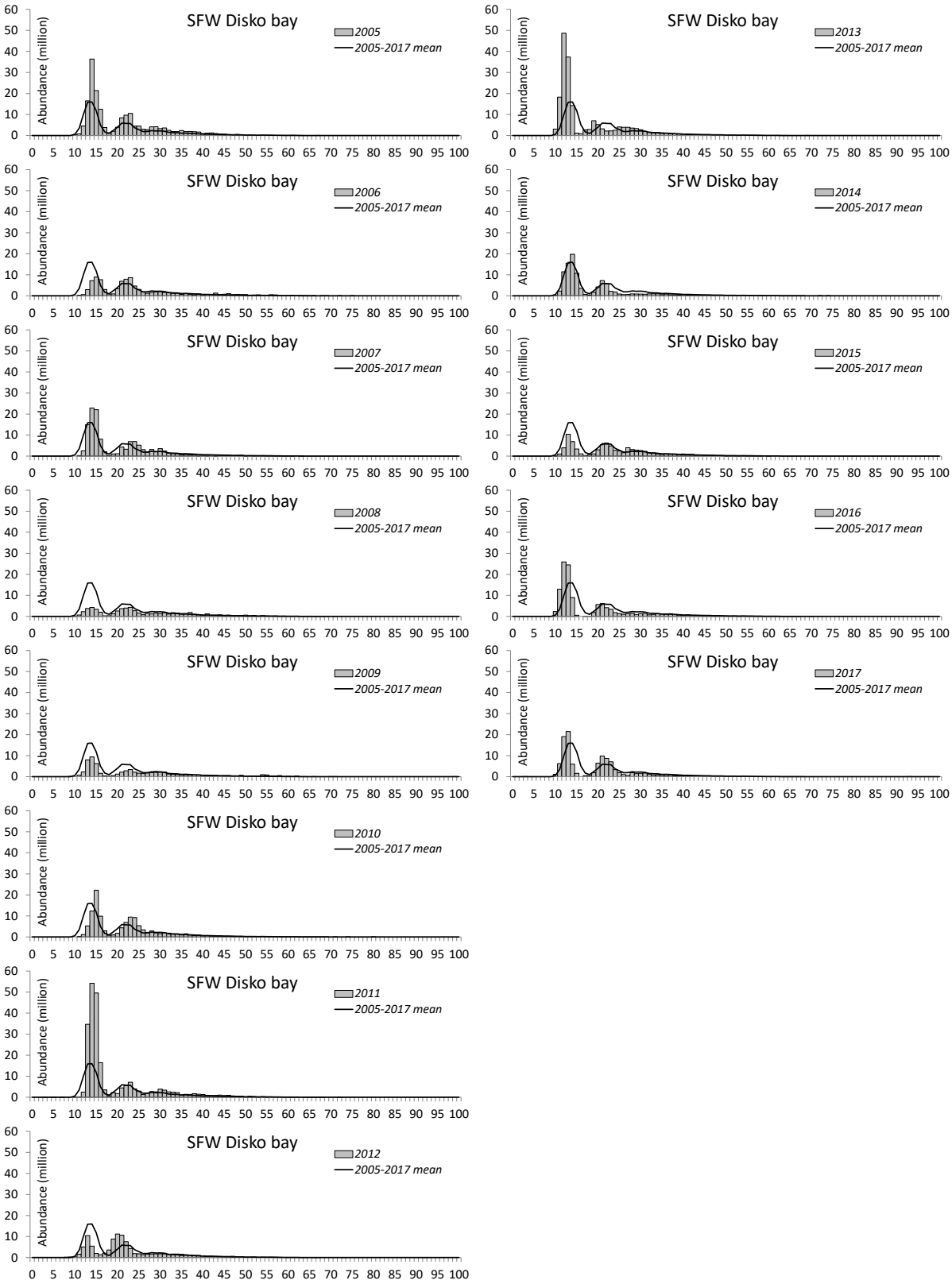

Fig. 2.a Greenland halibut trawl survey length frequencies (SFW).

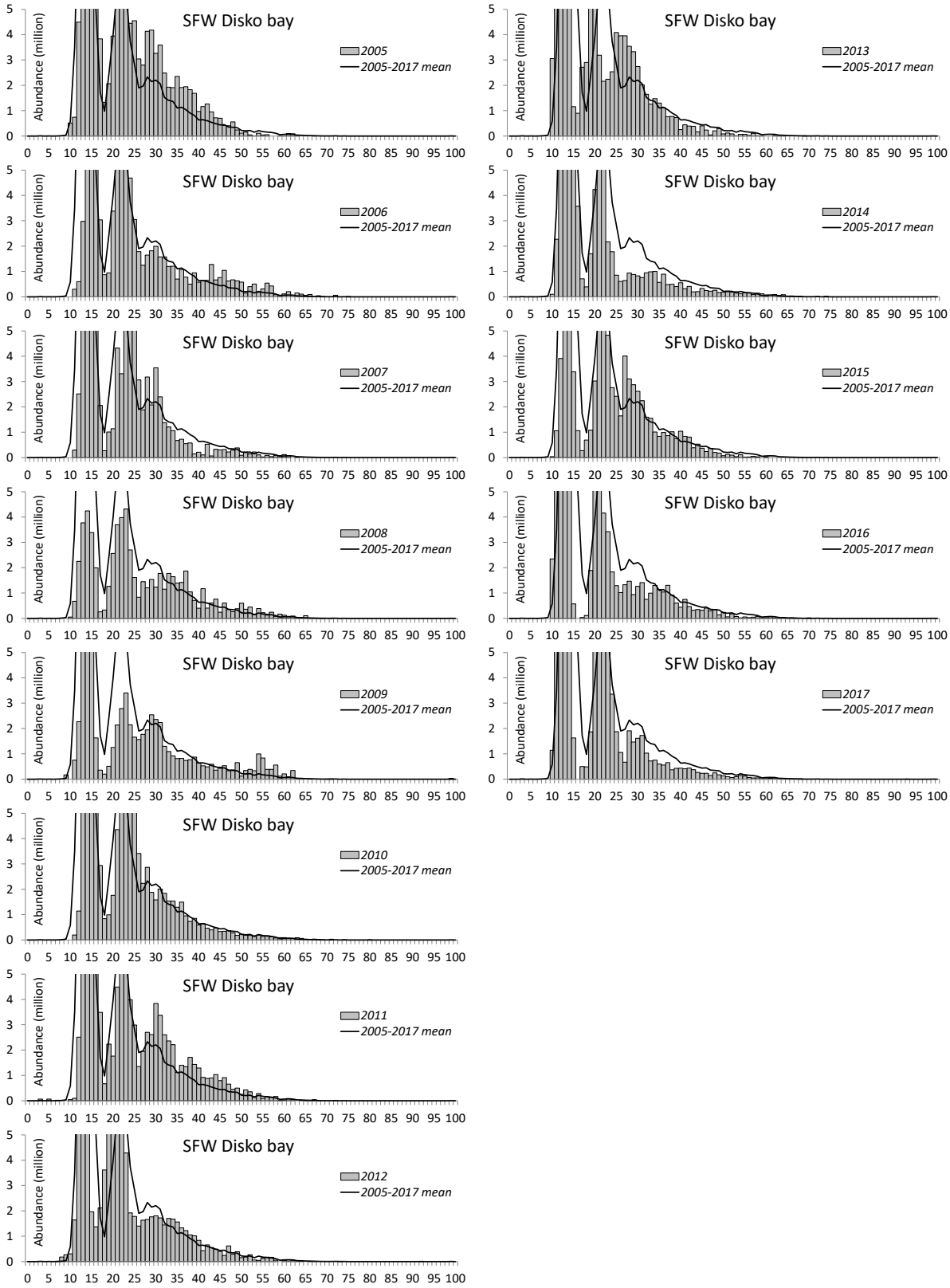

Fig. 2.b Greenland halibut trawl survey length frequencies (SFW).

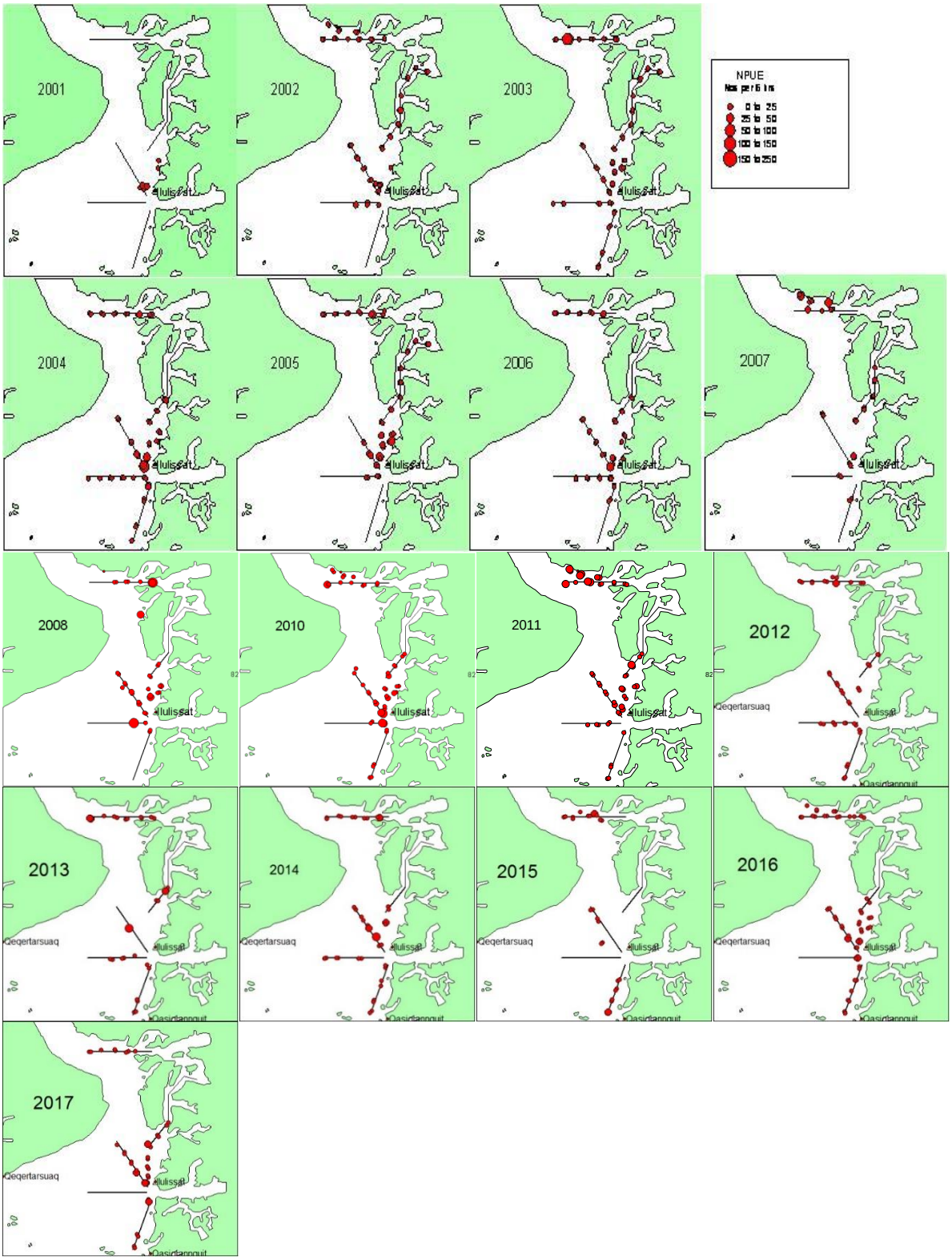

Fig. 3. Gillnet survey in Disko Bay by year. Lines indicate transects and dots the distribution of NPUE (Nos G.halibut per 6 hrs of setting).

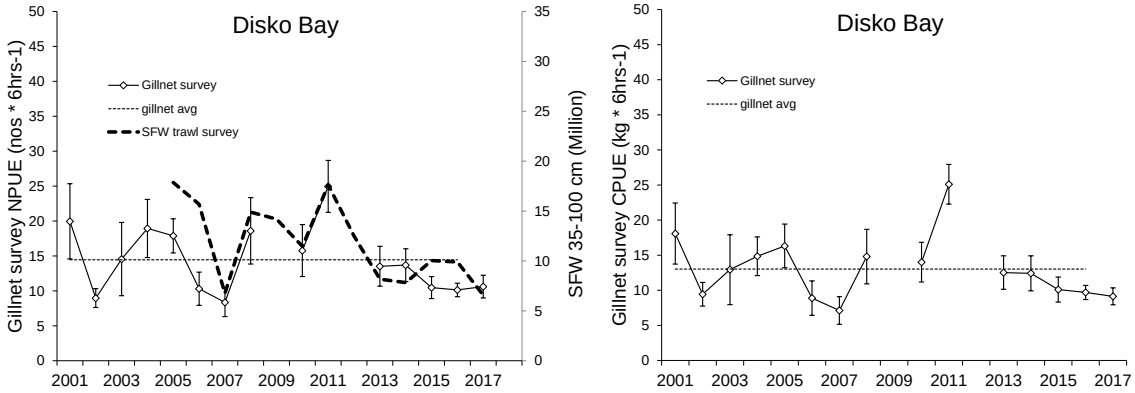

Fig. 4. Disko Bay gillnet survey NPUE (right) of Greenland halibut (all sizes) combined with SFW trawl survey abundance estimate of Greenland halibut sizes 35-100 cm and gillnet survey CPUE (left).

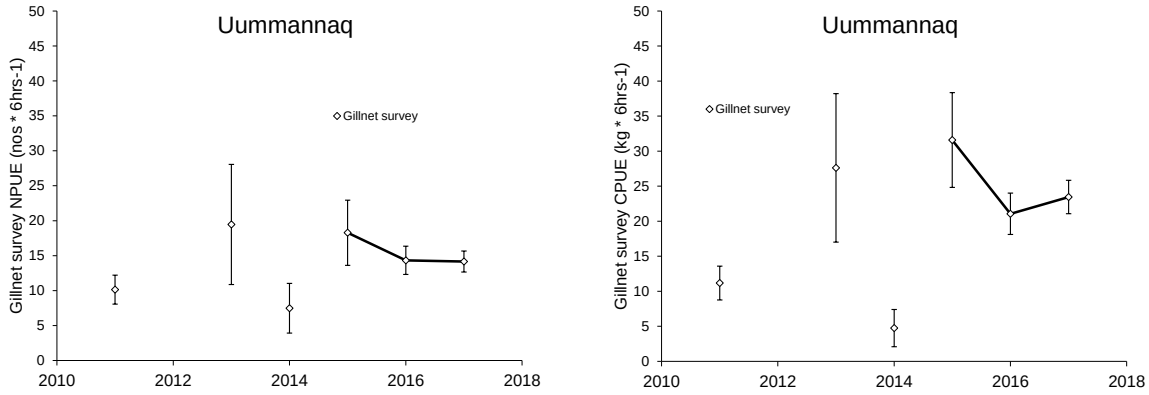

Fig. 5. Uummannaq gillnet survey NPUE (left) and CPUE (right) and of Greenland halibut (all sizes).

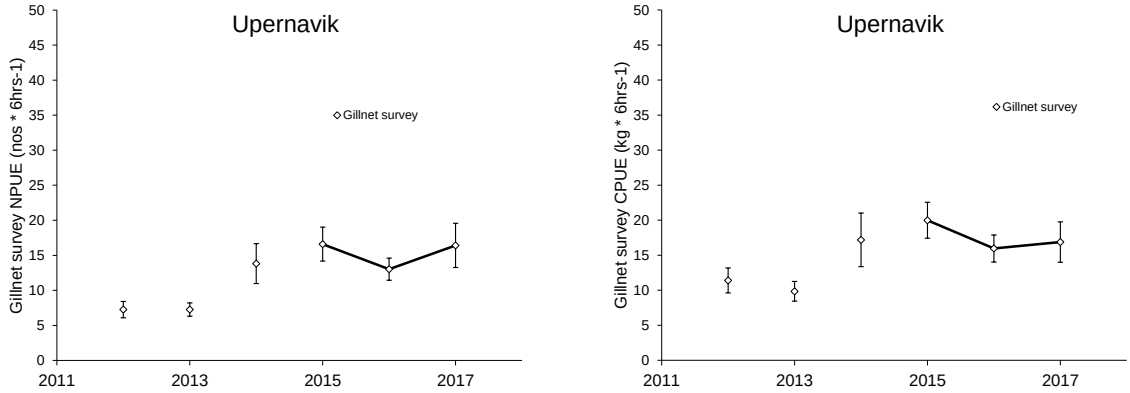

Fig. 6. Upernavik gillnet survey NPUE (left) and CPUE (right) and of Greenland halibut (all sizes).

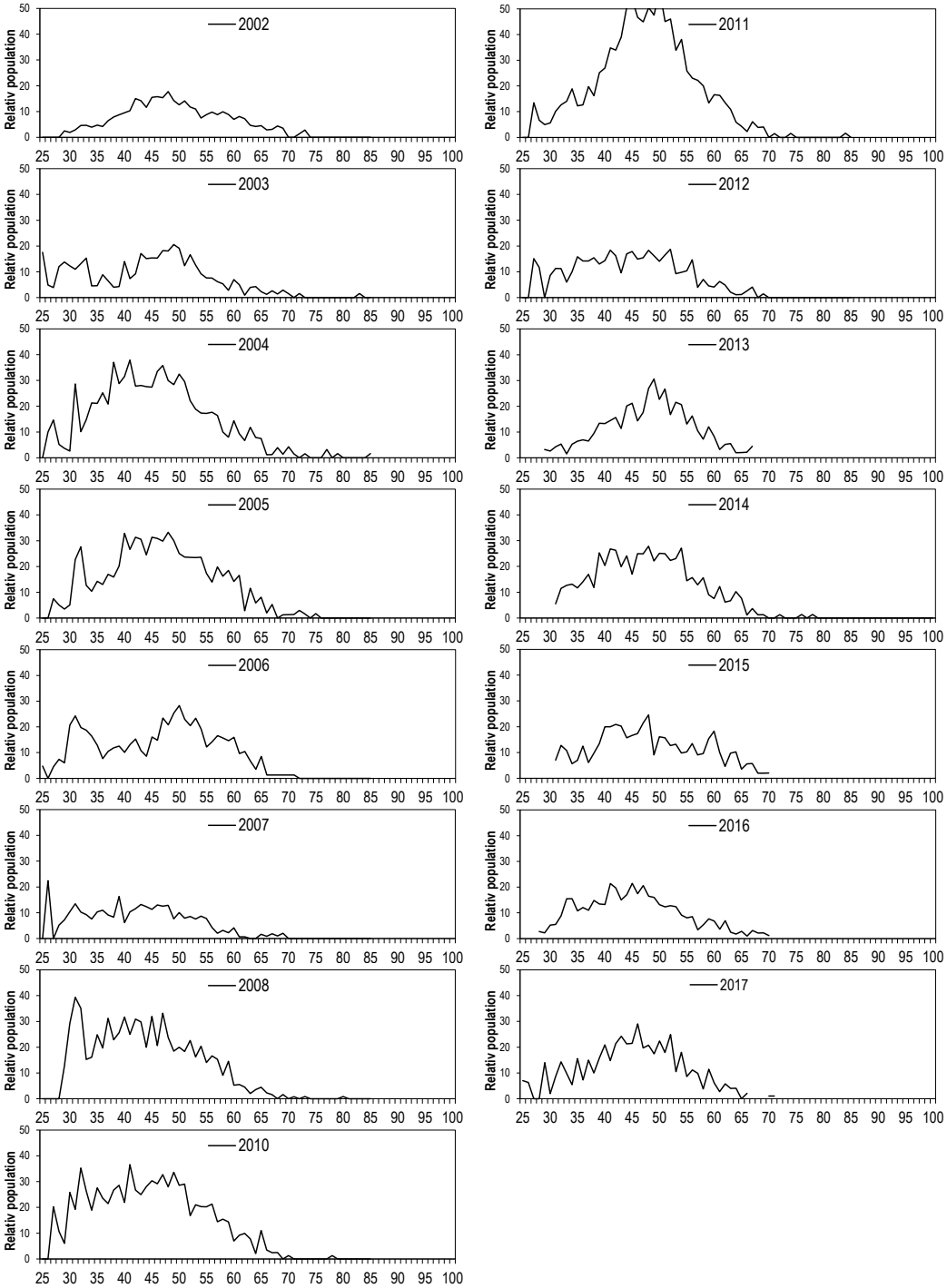

Fig. 7. Gillnet survey in Disko bay. Estimated relative population assuming a Wilemans Wings selectivity.

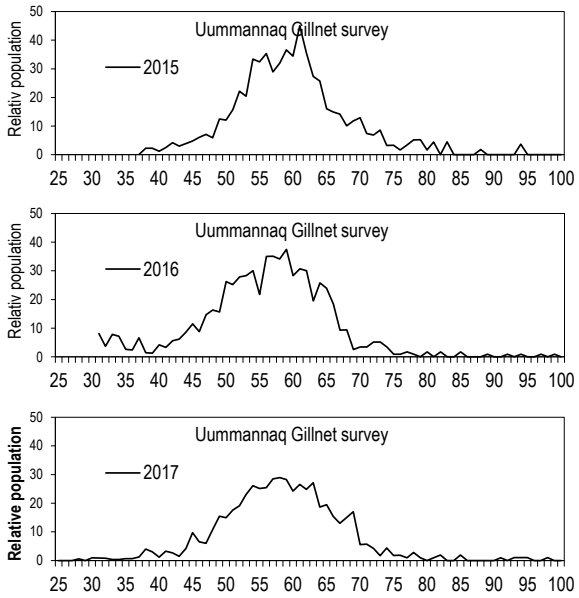

Fig. 8. Gillnet survey in Uummannaq (left) and Upernavik (right). Estimated relative population assuming a Wilemans Wings selectivity curve.

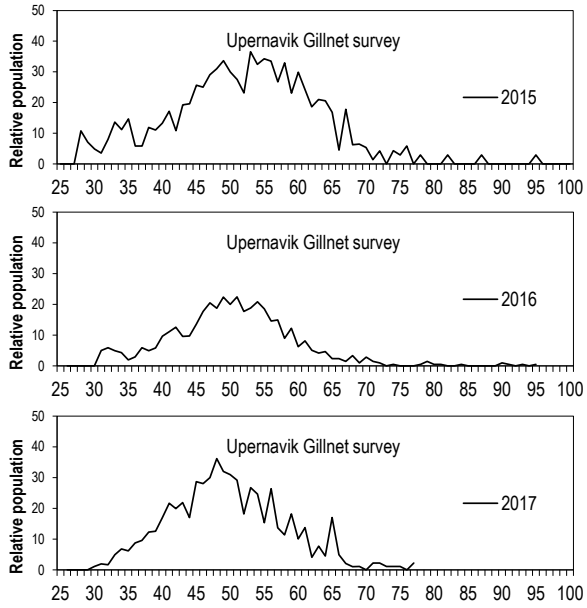

Fig. 9. Gillnet survey in Uummannaq (left) and Upernavik (right). Estimated relative population assuming a Wilemans Wings selection curve.

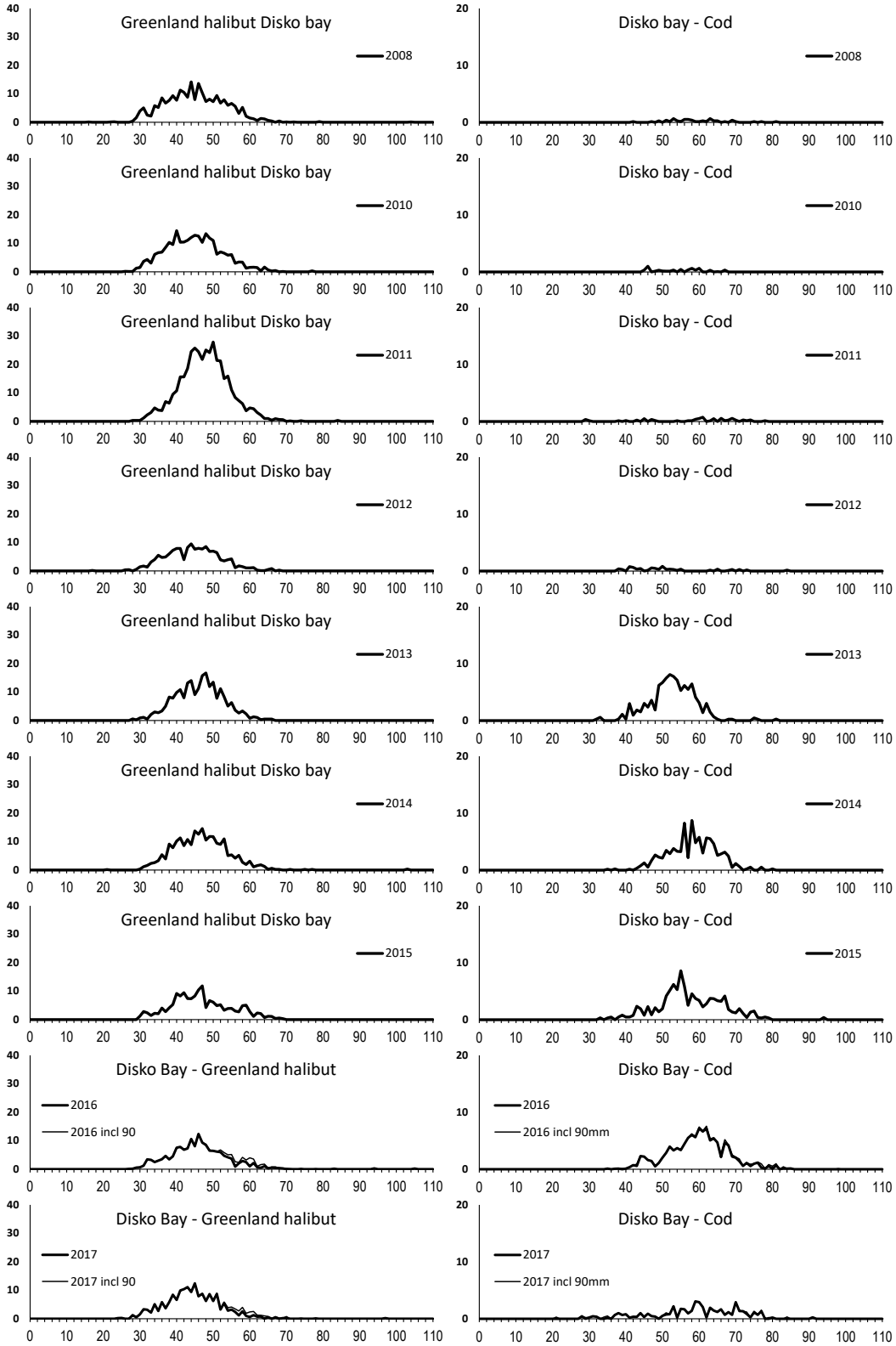

Fig. 10. Disko bay: Observed LF (N/100hr) for Greenland halibut (left) and cod (right).

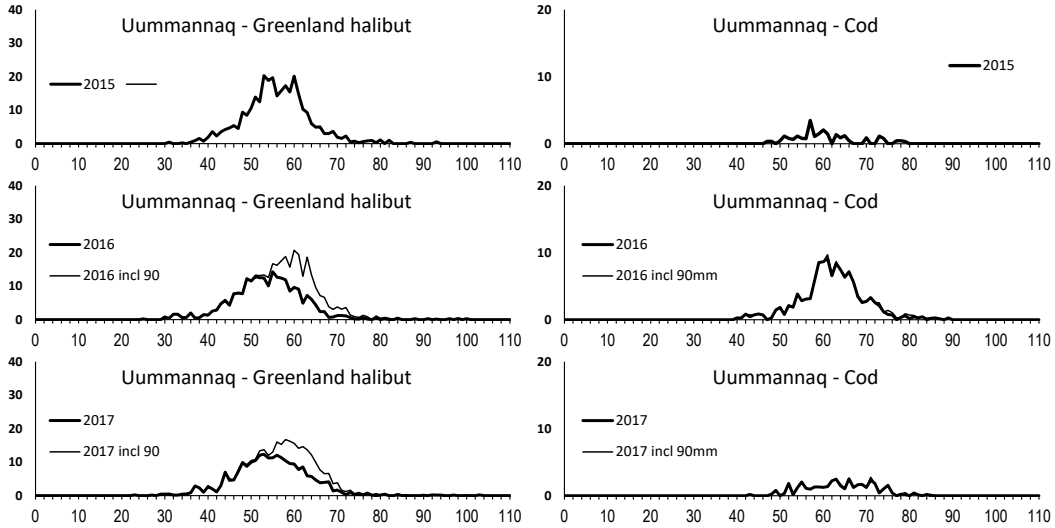

Fig. 11. Uummannaq. Observed LF (N/100hr) for Greenland halibut (left) and cod (right).

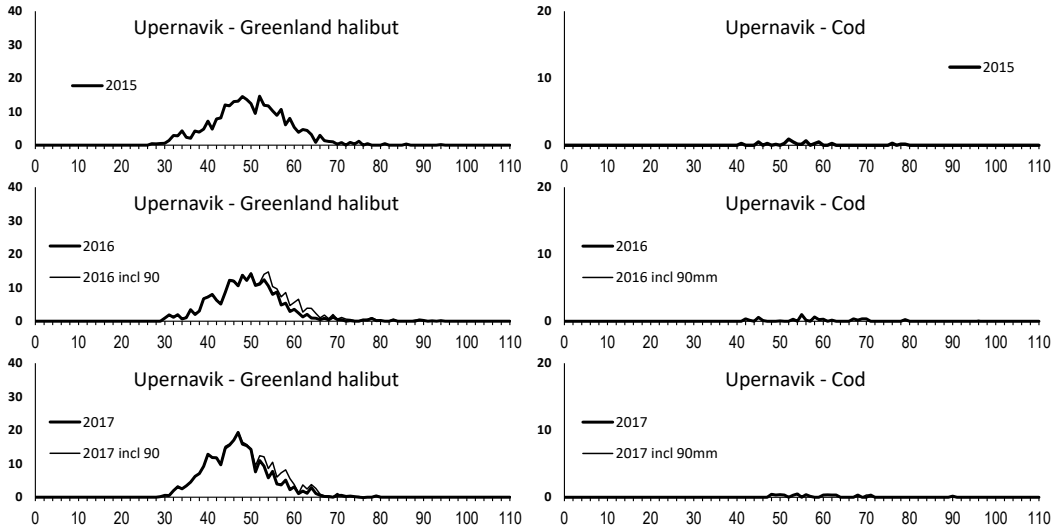

Fig. 12. Upernavik: Observed LF (N/100hr) for Greenland halibut (left) and cod (right).

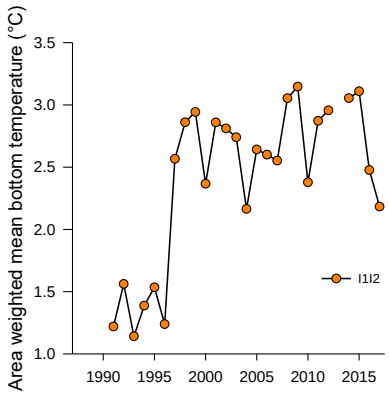

Fig. 13. Area weighted mean bottom temperature in the Disko Bay from the Greenland shrimp and fish survey.