Northwest Atlantic Fisheries Organization

Serial No. N6203 **NAFO SCR Doc. 13/48**

SCIENTIFIC COUNCIL MEETING – JUNE 2013

Updated indices for the Greenland Halibut Stock Component in NAFO Division 1A Inshore

by

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Abstract

This paper presents updated indices used for the assessment of Greenland halibut in the inshore part of NAFO Div. 1A. The area covers the fjords in the three distinctive geographical areas, Disko Bay, Uummannaq and Upernavik.

Disko Bay: Catches increased during the 1980s and peaked in 2004 with catches of more than 12 000t. Since then catches decreased and stabilized around 8000 tons. Mean length in landings, decreased from 2001 in both the summer and the winter fishery, and have dropped to the lowest value observed in the 2012 summer fishery. The standardized logbook CPUE series reveals a decrease in CPUE in Disko bay of about 30 % from 2007 to 2011, but the index increased slightly in 2012. The gear was changed in the Greenland shrimp and fish trawl survey in 2005 and the indices from 2005 to 2012 have been recalculated according to the new gear, making the two time series less comparable. After record high abundance estimate in 2011 driven by a large number of age1 individuals, indices decreased to slightly below average for the 2005 to 2012 period. Likewise the biomass index decreased from a record high in 2011 to below average in 2012. The Gillnet survey CPUE and NPUE indices decreased from a record high level in 2011 to below average in 2012. However, in the 2012 gillnet survey the 60 mm section was defect and did not function properly, which could also be seen as highly negative residuals for that section.

Uummannaq: Catches increased during the 1980s and peaked in 1999 at more than 8000t. Since then, catches have stabilized around 6000 tons. Mean length in the landings increased in 2012 to almost the average of the past decade. The standardized CPUE series reveals an increasing trend from 2007 to 2011. The longline survey was continued in 2012. However the gear was updated to a thinner longline in 2012, resulting in a high increase in CPUE and making the indices non-comparable.

Upernavik: Catches increased during the 1980s and peaked in 1998 at 7000 tons, but decreased in the years after. In 2012, 6830 tons was caught. Mean length in the landings in 2012 were at the average level since 1999. The standardized CPUE series reveals a decreasing trend from 2007 to 2011 but an increase in 2012. The longline survey was continued in 2012, but the gear was updated to a thinner longline in 2012, resulting in a high increase in CPUE and making the indices non-comparable.

Introduction

The Greenland halibut stock component in Div. 1A inshore is considered to be recruited from the Davis Strait stock, but the adults appear resident in the fjords and are thus isolated from its spawning stock (Riget and Boje, 1989). As a result, the inshore component probably does not contribute to the spawning stock in the Davis Strait (Boje, 1994). In samples from Disko Bay <10% of females in the reproductive age, were mature during the assumed peak spawning period in spring (Simonsen and Gundersen 2005). Also in former times only sporadic spawning was observed in the inshore area (Jørgensen and Boje, 1994) and the inshore component is therefore not assumed to be self-sustainable, but dependent on recruits and immigration from the offshore area (Bech, 1995). Evidence that supported this stock structure in 1994 caused NAFO to separate the assessment and advice on the inshore stock components from the offshore component in the Davis Strait and Baffin Bay.

Description of the fishery and Catches

The inshore fishery for Greenland halibut started in the beginning of the 1900 century and the main areas are Disko Bay, Uummannaq and Upernavik, all located in NAFO division 1A (fig. 1). Catches were however less than 1000 tons prior to 1960 and during the 1970's catches increased gradually to around 3 000 tons. In the 1980's and 1990's catches increased further to above 20,000 and peaked at the end 1990s at about 25,000 tons. Since then catches have stabilized around 20,000 tons. The fishery is traditionally performed with longline from small open boats or from dog sledges on the sea ice. In recent decades larger vessels (>25 feet) have entered the fishery. In the middle of the 1980s gillnets were introduced to the inshore fishery, and were used more commonly in the following years. Longlines however still constitute the majority of the total landings. In the late 1990s authorities introduced regulations limiting areas of gillnet fishery in order to limit effort and particular season. Competence to lay down local rules have been given to the area municipalities in 2004, and areas where gillnet fishery is allowed has been expanded since then. The gillnet fishery is regulated by a minimum mesh-size of 110 mm (half meshes). Since 1998 regulations have restricted effort increase by means of licenses to land fish. TAC for inshore areas and stocks was introduced in 2008. From 2012 the TAC was split in two categories, an ITQ for vessels larger than 30' ft and a shared quota for small vessels and open boats.

The fishery for Greenland halibut in the Disko bay started in the beginning of the 19'th century, and the major part of the catches in Greenland have traditionally been taken here. The catches in Disko Bay have increased continually during the 1990 and reached a maximum in 2004 at more than 12000 tons (Table 1 and fig 1). However, since 2006 catches have decreased to just 6300 tons in 2009, but since then catches have stabilized at around 8000 tons. The main fishing ground for Greenland halibut in the Disko bay is the mouth of Kangia (Ilulissat icefjord) inside Kangia and Torssukattak, the northern part of the Disko bay (fig. I,4).

In Uummannaq , catches increased during the 1980s and peaked in 1999 at more than 8000 tons (table 1 and fig 1). Since then, catches have stabilized around 6000 tons. The fishery in Uummannaq is scattered all over the fjord near settlements and particular in the south eastern part of the fjord (fig I3).

In Upernavik, catches increased from the mid 1980's and peaked in 1998 at a level of 7 000 tons (table 1 and fig 1). This was followed by a period of decreasing catches. In 2012, 6800 tons were caught in the Upernavik area, but a part of these catches were landed in the Disko bay. The area consists of a large number of icefjords. The main fishing grounds are Ikeq (Upernavik Icefjord) and Gulteqarffik (Giesecke Icefjord) (fig I2). Use of gillnets have been prohibited in Upernavik but derogations have been given for a fishery outside the Icefjords since 2002.

Inshore fishery in division 1BCDEF

A significant fishery has previously taken place in both the fjords around Nuuk (division 1D) and the fjords in south west Greenland (division 1F). The fishery in Nuuk peaked in the end of the 1980's at more than 2000 tons but then completely collapsed. In the recent years, catches from the Nuuk area has increased and were at 300 tons in 2012. The fishery inshore in south Greenland seems to have peaked (800 tons) and collapsed twice since 1910, but is currently at a low level. Distribution of fisheries on other inshore stocks of Greenland halibut can be found in the appendix (fig I1 and I5).

Commercial Fishery data

Catch data

Data on the inshore catches of Greenland halibut for Disko Bay and Uummannaq were available from the Greenland Fishery Licence Control (GFLK). The summer season was defined as June-November (both included) and the remaining months were classified as winter. Processed fish is normally converted to whole fish weight using a conversion factor set by the authorities. The conversion factor for gutted fish with head and tail are multiplied by a factor 1.1. The conversion factor for gutted fish without head and tail are 1.35.

Mean length in landings

In the Disko bay mean length in the Greenland halibut landings caught in summer are generally smaller than fish caught during winter, and winter mean size in general shows higher inter annual variation (fig 2). The winter fishery in the Disko bay is highly dependent on ice coverage and access to the inner parts of the Kangia icefjord, where larger fish are accessible at greater depths. In the Disko Bay mean length in landings, have decreased since 2001 and the 2012 summer fishery mean was the lowest observed in the time series.
In Uummannaq there is not the same difference between summer and winter fishing grounds and only small differences are seen in the summer and winter length frequencies (fig 2). The mean length increased in both the 2012 summer and winter longline fishery and the 2013 winter fishery.

In Upernavik the summer and winter fishery also to a large degree takes place in the same areas and only minor differences are seen in the length frequencies from summer and winter fishery (fig 2). The mean length in the landings has been stable since 1999, except for a decrease in the 2010 and 2011 summer fishery. However, in 2012 the mean length increased in the summer and winter longline fishery.

Mean length in Gillnet landings.
Gillnets are highly size selective and the trends only imply recent incidents of landings from gillnets were a smaller mesh size was used (presumably 70mm cod gillnets), and no conclusions on stock trends should be made on this analysis (fig 3.). Mean length in the gillnet landings increased from the beginning of the time series and until the mid 2000's, presumably caused by an outfacing of older 90mm and 100mm gillnets. However particularly in the Disko bay there has been incidents of small gillnet landed Greenland halibut particularly in the Disko bay. These incidents seems caused by an increased use cod gillnets (70mm) to target Greenland halibut after the decrease of larger individuals in the Disko bay stock.

In Nuuk (division 1D inshore) mean length in the longline landings seems stable to decreasing since 2009 if accounting for the confidence intervals (fig 4).

Logbook CPUE

Logbooks have been mandatory for vessels greater than 30'ft (9,4m), but voluntary logbooks from 2007 were also available. Small boats, dog sledges and non factory vessels that land their catches are obligated to report data on area (field-code), gear and effort to the factory in which they land their catch, and this info is then reported to GFLK. A GLM model was applied to longline fishery logbook data since 2008 (fig 5). The model explained less than 25 % the variability in the data and only covers 5-30% percent of the total landings. The CPUE series does not account for fishing grounds within the area and shifts in the distribution could also cause changes in the trends. The CPUE series indicated slight increase in the Disko Bay, a decrease in Uummannaq and an increase in Upernavik.

Research Surveys

The Greenland shrimp and fish trawl survey

The Greenland shrimp and Fish trawl survey with the research vessel R/V Pâmiut, also covers the Disko bay. The trawl survey mainly catches individuals less than 50 cm. The gear was changed in 2005. From 2012 no correction

for this gear change has been made and the indices from 2005 to 2012 have been recalculated according to the new gear, making the two time series less comparable (fig 6). However, the calibration factors for Greenland halibut are length dependant, using non-calibrated values only has an effect on the biomass estimate, not on the abundance estimate (fig 6). Also using the original shrimp area stratification has a minor effect. After record high abundance estimate in 2011, driven by a large number of age1 individuals (fig 7), indices decreased to slightly below average for the 2005 to 2012 period. Likewise the biomass index decreased from a record high in 2011 to below average in 2012.

***The* Disko bay gillnet survey**

The main objective for using gillnets is a well-estimated selectivity and the possibility for targeting pre-fishery sized Greenland halibut, i.e. less than 50 cm. The location is chosen due to the known presence of pre-fishery recruits in combination with bottom topography (approx. 3-400 m depth of even clay bottom) that allows fishing with gillnets. Only 8 stations were fished in the first survey year in 2001, thereafter the number increased to about 50-60 (see Table 2). The surveyed area covers the proposed young fish areas in Disko Bay, off Ilulissat and the Icefjord and off the northern icefjord Torssukattak (table 2 and fig 11). Mesh sizes 46, 55, 60 and 70 mm (knot to knot) with twines 0.28, 0.40, 0.40 and 0.50 mm correspondingly, were used to target the fish size groups approximately 30 – 50 cm. Multi-gang gillnets being approx. 300 m were composed of 4 sections, one of each meshsize, with 2 m space between each section to prevent catchability interactions between sections. Soaktime is approx. 10 hours and fishing occurred both day and night. Stations were paired two and two, close to each other to allow for analysis of within station variability. The survey uses fixed positions of stations, but the stations often vary from year to year due to variable ice conditions. 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. The mesh sizes 46, 55, 60 and 70 mm was chosen in order to select fish in the length range 30 – 50 cm, i.e. pre-fishery recruits. The resulting selection curve is nearly 100% in that length interval, thus it is assumed that the catches in this length range will reflect the fished population. When estimating the underlying relative population this selectivity curve is assumed.
Greenland halibut larger than 50 cm seem to concentrate at the commercial fishing grounds within and off Kangia and Torsukattak in the north. The gillnet survey only covers the boundary of those commercial fishing grounds. Greenland halibut smaller than 30 cm are thought to perform a stepwise migration towards the main commercial fishing grounds near the icefjords.
The survey CPUE and NPUE decreased from a record high in 2011 to below average in 2012 (fig 8). The increase in 2011 NPUEs is seen to derive mainly from the northern area off Torssukateq, while in the main fishing grounds at Kangia the NPUEs have remained low. However, in 2011 and 2012 the innermost stations that usually provide high NPUEs were not covered due to ice.
From the estimated underlying population in figure 9, there is no obvious cohort trend. The high numbers of larger fish in 2011 seem not 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. However, in the 2012 survey the 60mm mesh section were defect and did not function properly, which could also be seen as highly negative residuals for that section (fig 10). But overall the 2011 increase in total NPUE and CPUE should be interpreted cautiously with the above considerations in mind.

Longline surveys

Prior to 1993 various longline exploratory surveys were conducted with research vessels. Due to variable survey design and gear, these surveys are not comparable. In 1993 a longline survey for Greenland halibut was initiated for the inshore areas of Disko Bay, Uummannaq and Upernavik. The survey was conducted annually covering two of three areas alternately, with approximately 30 fixed stations in each area (for further details see Simonsen *et al*. 2000). The longline survey was continued in 2012 in both Uummannaq (fig 12 left) and Upernavik (fig 12 right) in 2012. However the gear was updated to a thinner longline in 2012, resulting in a high increase in CPUE and making the indices non-comparable to the 1993-2011 survey.

Analytical assessments

CAA -Catch at age

Age readings has been suspended since 2010.

Exploratory analytical assessments

Exploratory analytical assessments were conducted in the 2006 assessment of the Disko Bay area, by separable VPA, XSA and Survey based assessment (SURBA). The output showed a continuous increase in fishing mortality, but none was accepted as providing an accurate assessment an accurate assessment, but suggested that the continuous increase in catches is due to *increased recruitment in combination with an increased fishing mortality However; the assessment is unable to estimate the relative size of these two elements* (SCR 06/35).

General Comments

An earlier study of the by-catch of Greenland halibut in the commercial shrimp fishery (Jørgensen and Carlsson, 1998) suggest that the by-catch is considerable and could have a negative effect on recruitment to the inshore stock component. However, sorting grids have since then been made mandatory in the shrimp fishery (since October 2000), but for the entire inshore shrimp fishery derogations have been given until recently. In 2012, sorting grids seems to be used on the inshore trawlers targeting shrimp.

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Table 1. Landings and Greenland halibut (‘000t) in Div. 1A inshore distributed on the main fishing areas: Disko Bay, Uummannaq and Upernavik.

	Disko Bay	Uummannaq	Upernavik	Unknown/other	Total in Div. 1A inshore:	STATLANT 21 SA1 Excl offsh. 1BCDEF	STACFIS SA1 Div 1A inshore
1987	2,3	2,9	1,6	0,4	7,2	6,7	7,2
1988	2,7	2,9	0,8	0,6	7,0	6,4	7,0
1989	2,8	2,9	1,3	0,6	7,5	6,9	7,5
1990	3,8	2,8	1,2	0,5	8,4	7,5	8,4
1991	5,4	3,0	1,5	0,0	9,9	9,2	9,9
1992	6,6	3,1	2,2	0,1	11,9	11,9	11,9
1993	5,4	3,9	3,8	0,0	13,1	13,2	13,1
1994	5,2	4,0	4,8	0,0	14,0	14,1	14,0
1995	7,4	7,2	3,3	0,0	17,9	17,0	17,0
1996	7,8	4,6	4,8	0,0	17,3	17,3	17,3
1997	8,6	6,3	4,9	0,0	19,8	20,8	19,8
1998	10,7	6,9	7,0	0,0	24,6	19,7	24,6
1999	10,6	8,4	5,3	0,1	24,3	24,3	24,3
2000	7,6	7,6	3,8	2,2	21,1	21,0	21,1
2001	7,1	6,6	3,2	0,0	16,9	16,5	16,9
2002	11,7	5,3	3,0	0,0	20,1	17,6	20,1
2003	11,6	5,0	3,9	0,0	20,5	21,5	20,5
2004	12,9	5,2	4,6	0,0	22,7	25,2	22,7
2005	12,5	4,9	4,8	0,8	22,9	21,6	22,9
2006	12,1	6,0	5,1	0,0	23,2	24,2	23,2
2007	10,0	5,3	4,9	0,0	20,6	0,0	20,6
2008	7,7	5,4	5,5	0,3	18,9	0,0	18,9
2009	6,3	5,5	6,5	0,0	18,3	0,0	18,3
2010	8,5	6,2	5,9	0,0	20,6	0,0	21,0
2011	8,0	6,4	6,5	0,0	20,9	0,0	20,9
2012	7.8	6,2	6,8	0,1	20,7	21,3	20,7

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	Total
LD027			2	2					2	2	2	10
LE027			2	2					2	2	2	10
LF027			2	2		2	2					8
LF028			2	2		2		2	2	1	2	13
LG024			2	1								3
LG025				3		2				1	2	8
LG026		1		2		2				2	2	9
LG027	4	7	6	5	6	5	4	6	6	4	4	57
LG028	2	2	1	1	1	3	1		1	1		13
LH026		2	1		1	1		2	2	2	2	13
LH027		5	3	3	3	3		3	3	4	3	30
LH028	2	1	9	6	8	4	1	7	9	6	2	55
LJ026		3	2	2		4	2	3	2	3	3	24
LJ028		5	3	5	4	4	4	4	4	4	2	39
LK029		5	4	2	4	2	4		2	2	2	27
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	16
LN025		5	3	4	3	4	4	1	4	4	3	35
LN026		4	2	2	3	2	5	3	3	5	5	34
LN027		2	2	2	2	2		1	2	1	1	15
LN028		2	1	2	2			2		2	2	13
LP024		2					2		2	2		8
Total	8	55	56	50	47	44	30	35	48	50	41	464

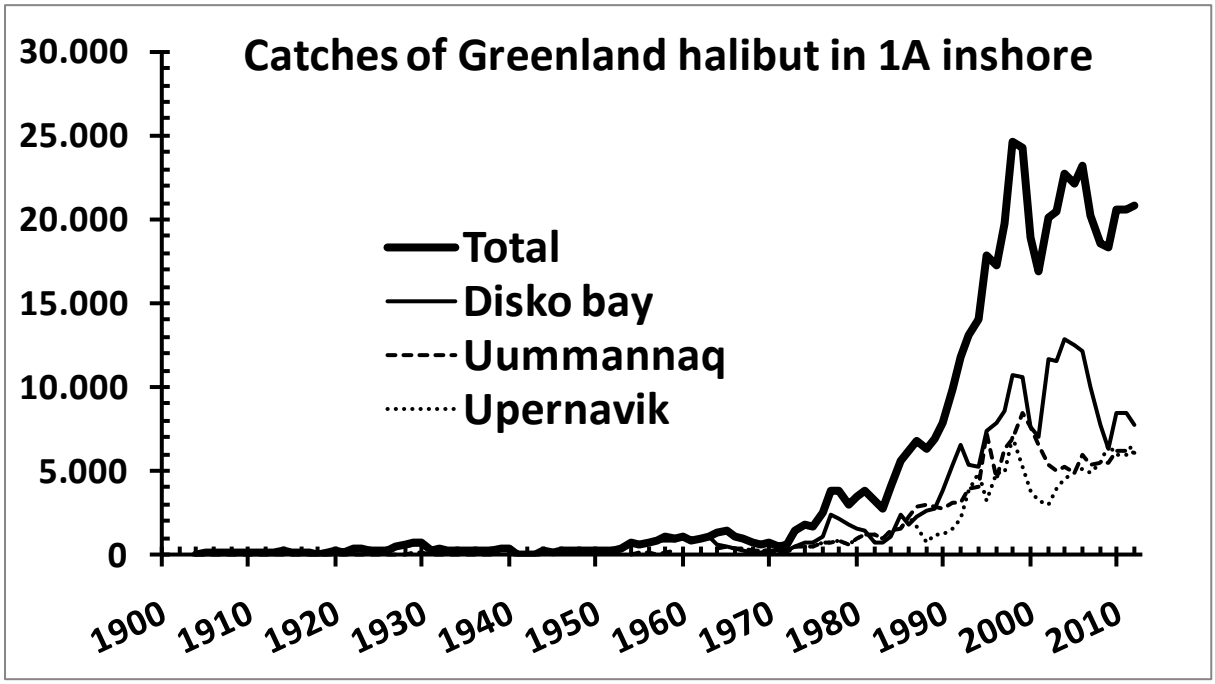

Fig. 1. Landings in NAFO Div. 1A since 1987 for the 3 main fishing areas. Data on landings from 2000-2007 are provisional. See also Table 1.

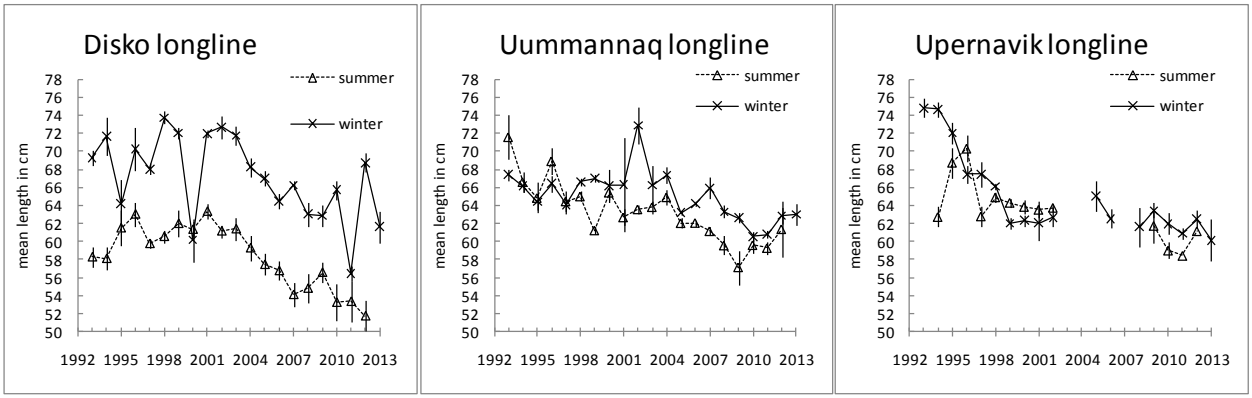

Fig. 2. Longline mean length in landings from Ilulissat, Uummannaq and Upernavik with 95% conf. Int.

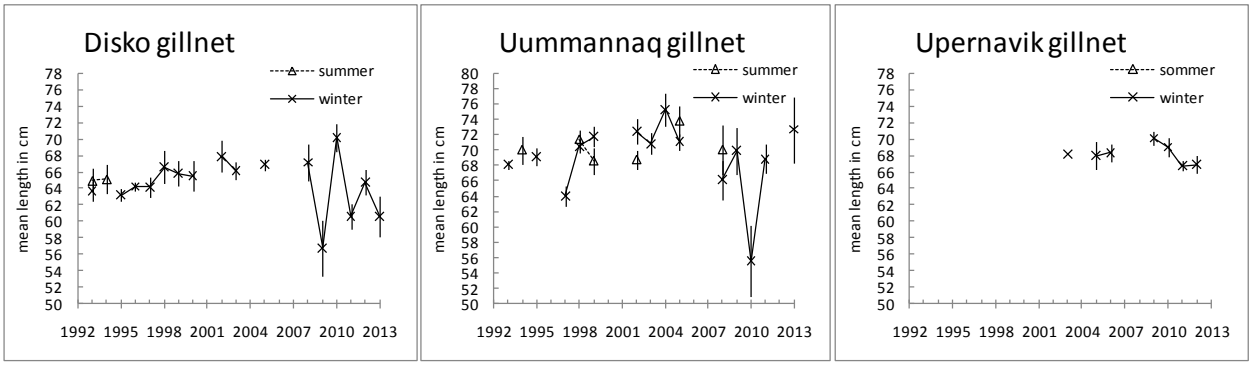

Fig. 3. Gillnet mean length in landings in Ilulissat, Uummannaq and Upernavik with 95% conf. Int.

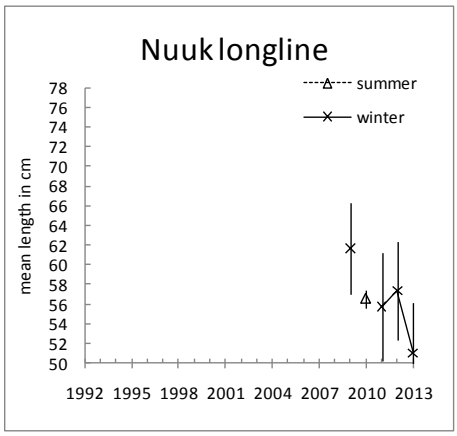

Fig. 4 Longline mean length in landings from Nuuk with 95% conf. Int.

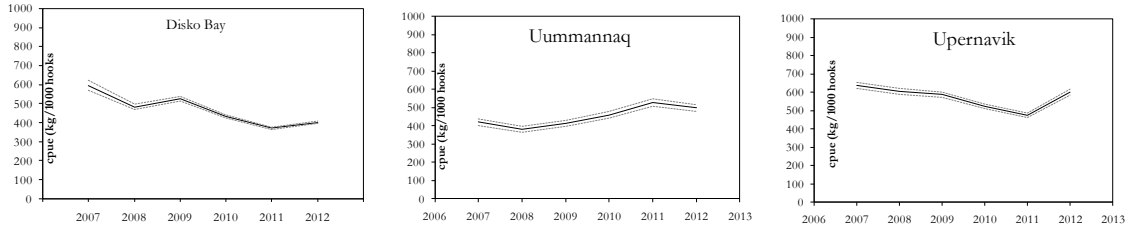

Fig 5. Standardized CPUE series for for commercial LongLine catches.

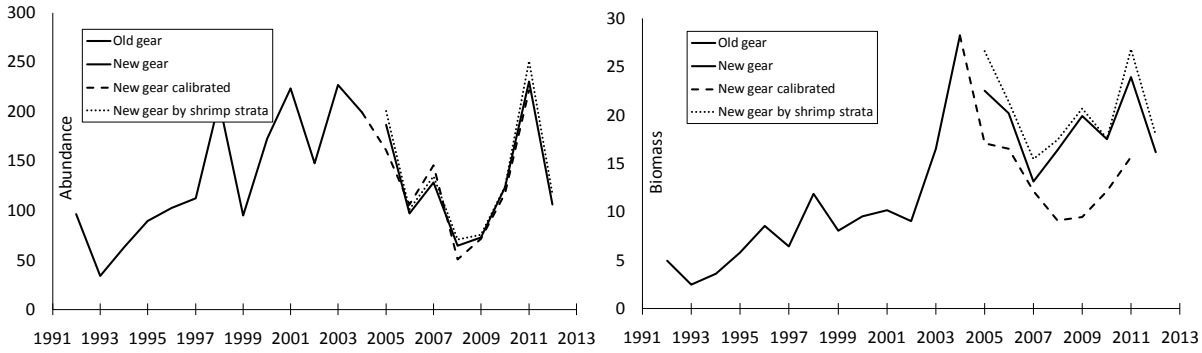

Fig. 6. Abundance in million and Biomass in kt (‘000 t) indices of Greenland halibut from the Paamiut trawl survey in Disko Bay. In 2005 a new survey trawl was introduced, but the 2005-2011 catch figures have been adjusted to the old gear according to (Rosing and Wieland, 2005).

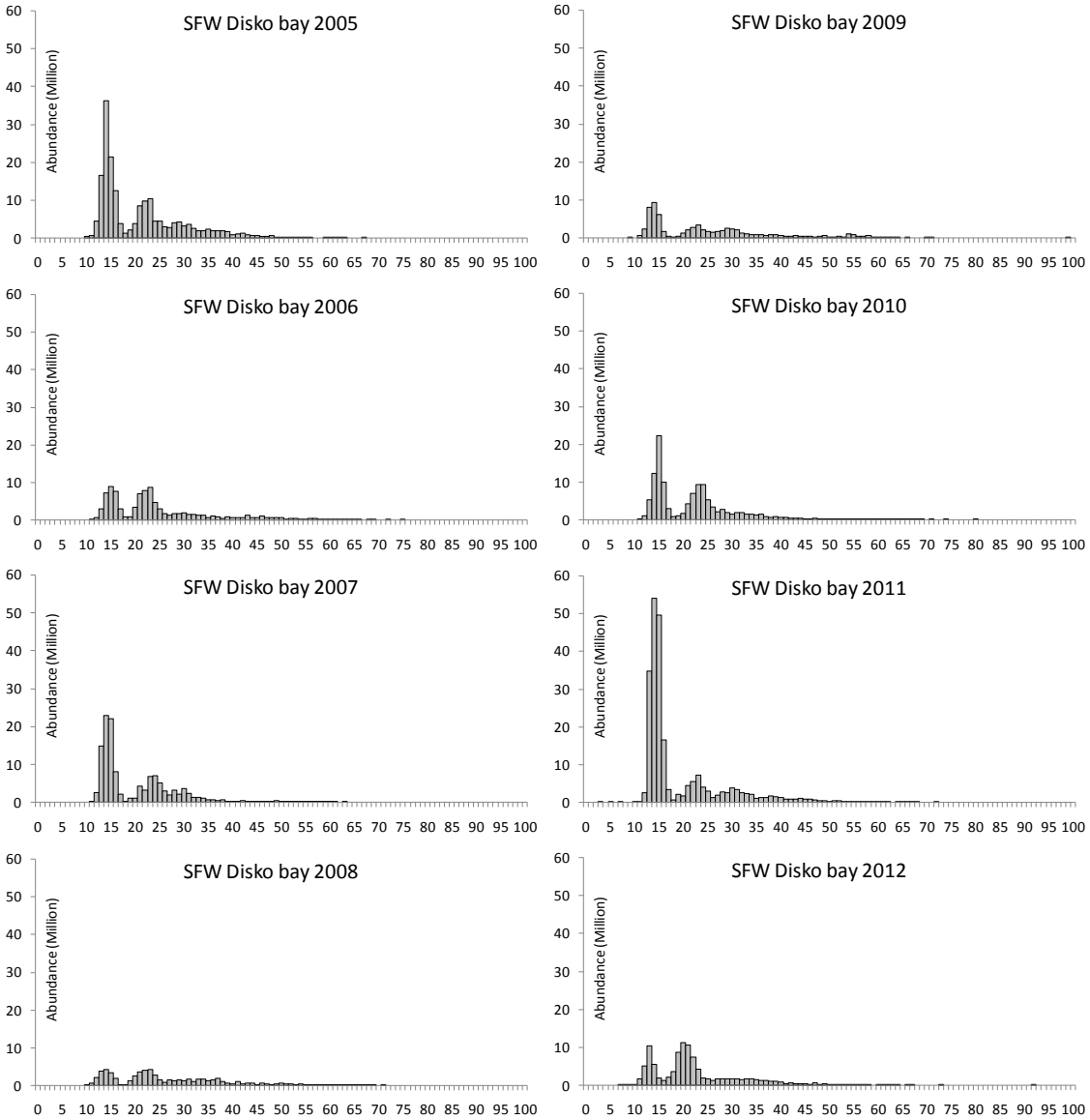

Fig . 7. Length distributions in Disko bay from the Greenland shrimp fish survey (GINR SFW) since 2005.

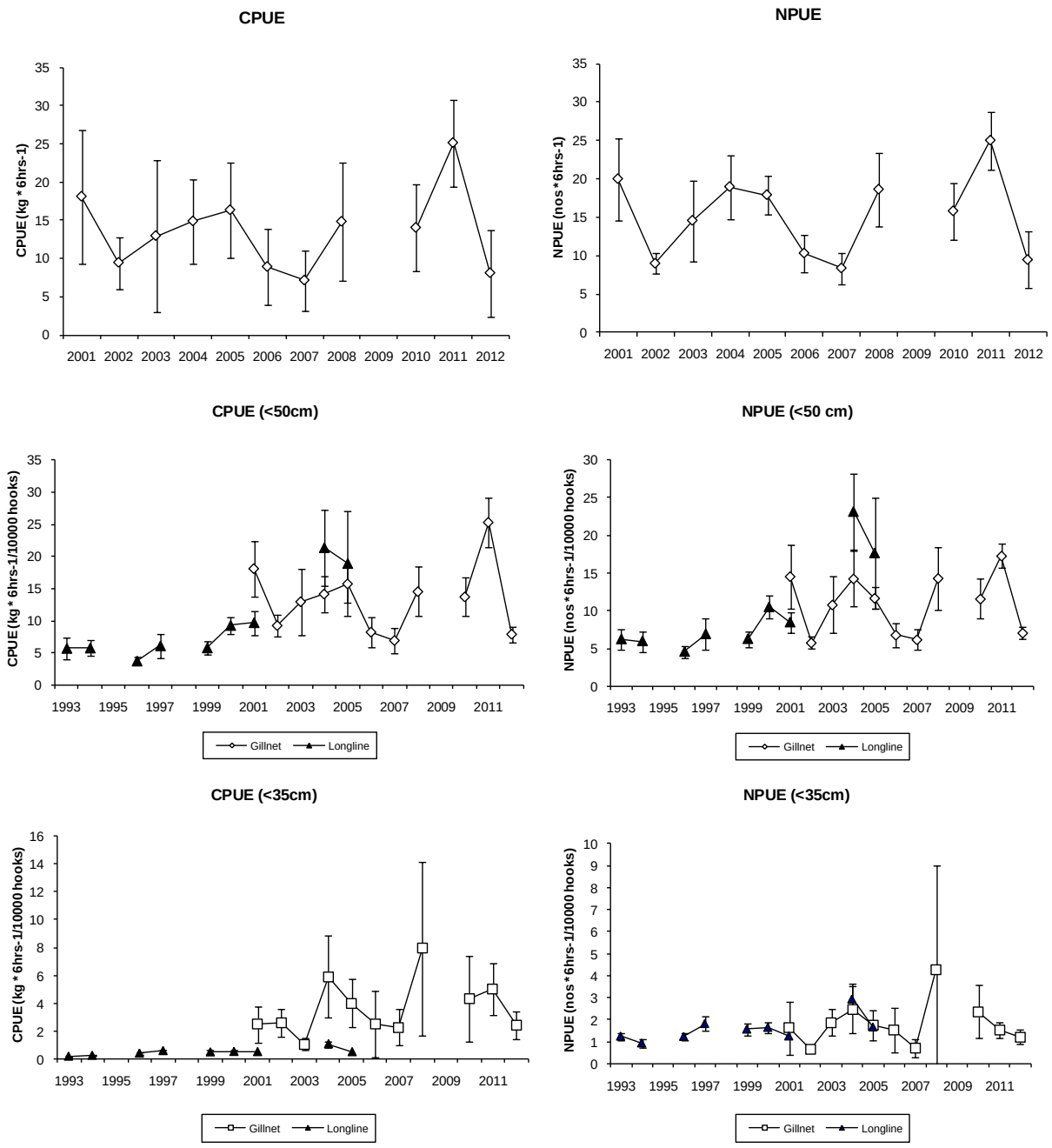

Fig. 8. Catch rates from the gillnet survey in Disko bay in weight (CPUE) and numbers (NPUE). Upper panel: CPUE and NPUE for catches including all lengths, Mid-panel: CPUE and NPUE for fish < 50 cm, incl. calibrated longlinesurvey catches prior to 2006. Lower panel: CPUE and NPUE for fish < 35 cm, incl. calibrated longlinesurvey catches prior to 2006.

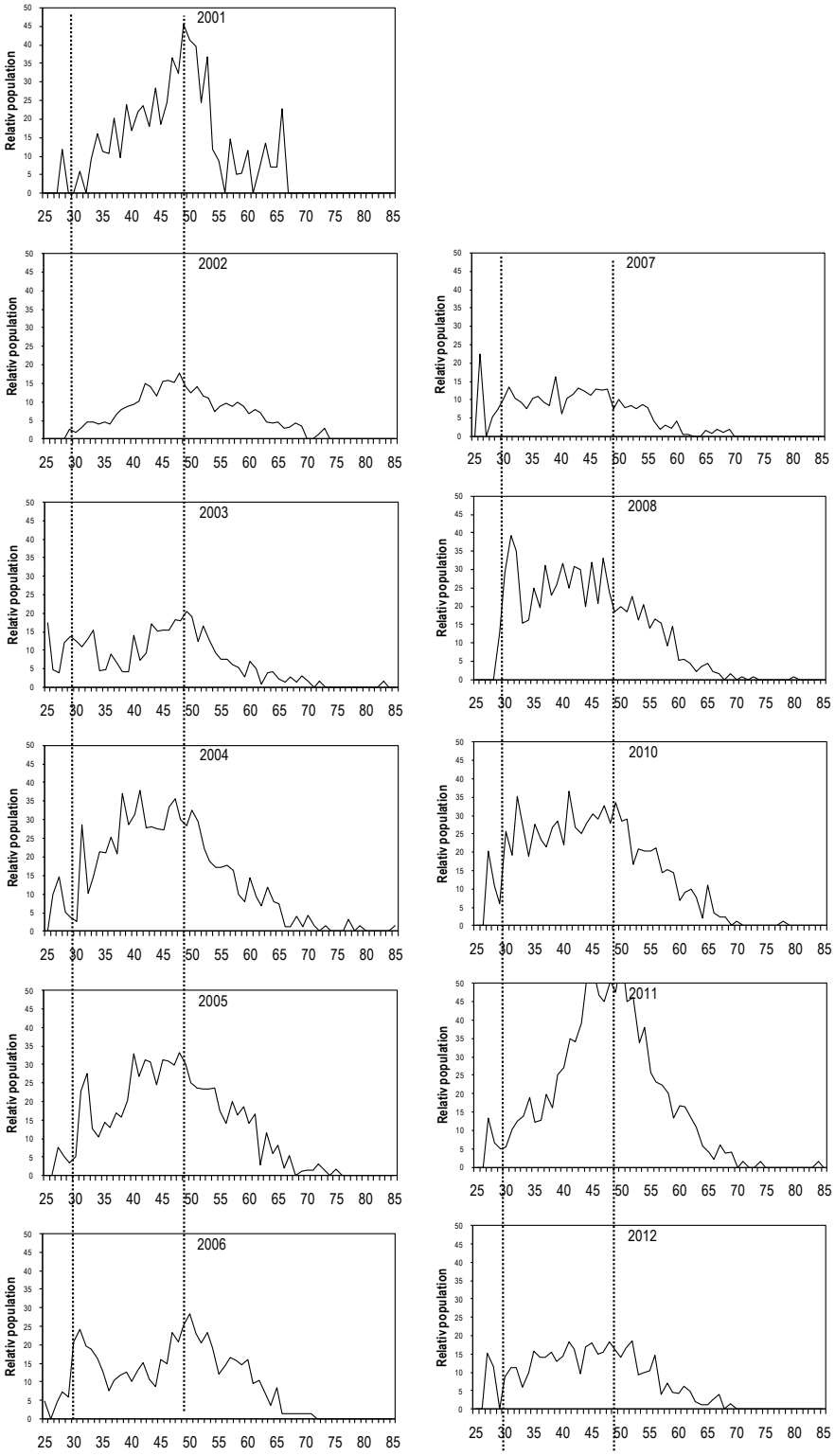

Fig 9 Gillnet survey in Disko bay. Estimated relative population assuming a Wilemans Wings selectivity curve in 2001 to 2011. The dashed lines indicate the length interval 30-50 cm where fully selection is assumed.

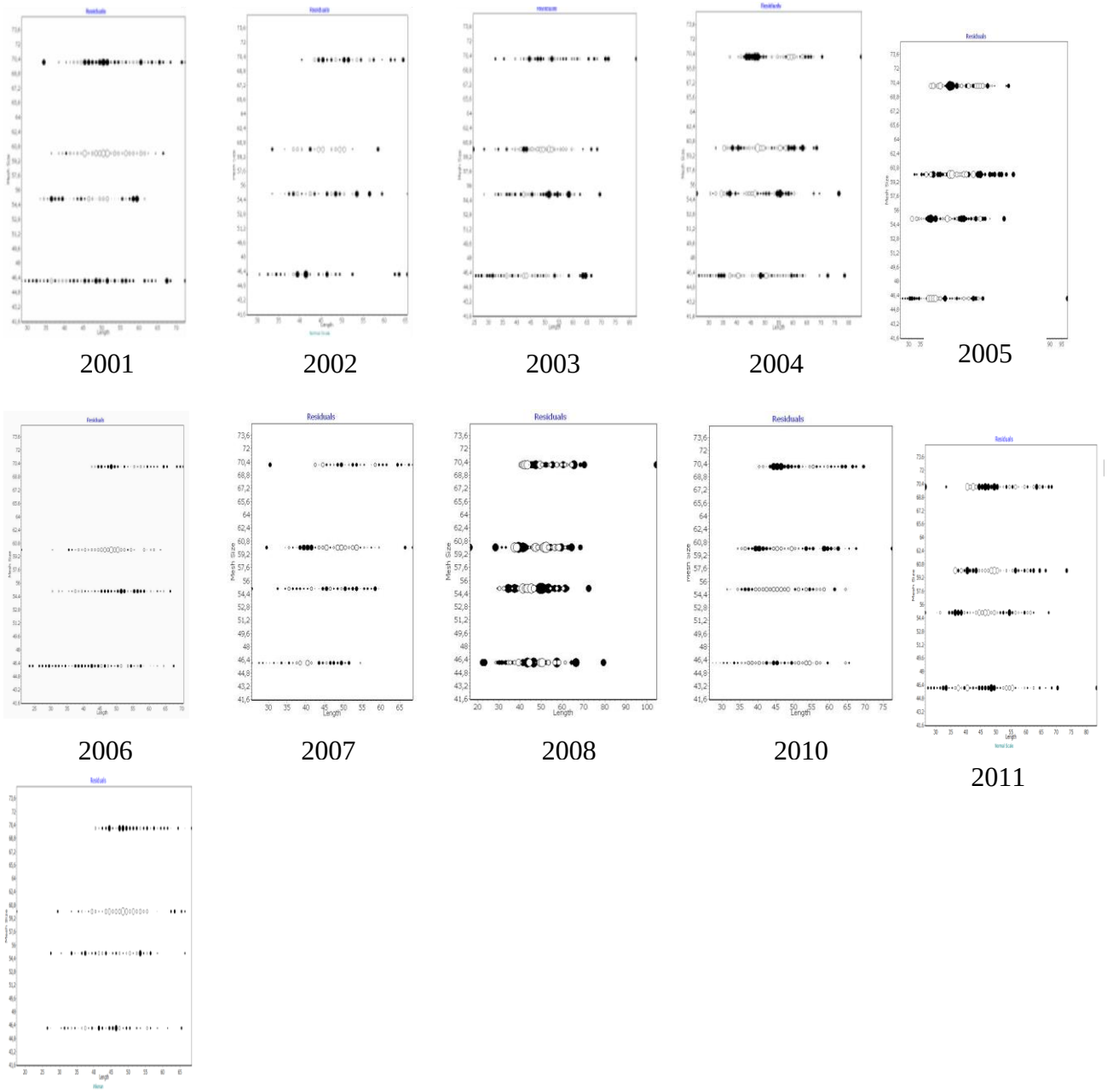

Fig. 10. Residuals for each meshsize (y-axis) by length (x-axis) from the selectivity model (Wilemans Wings) 2001-2012.

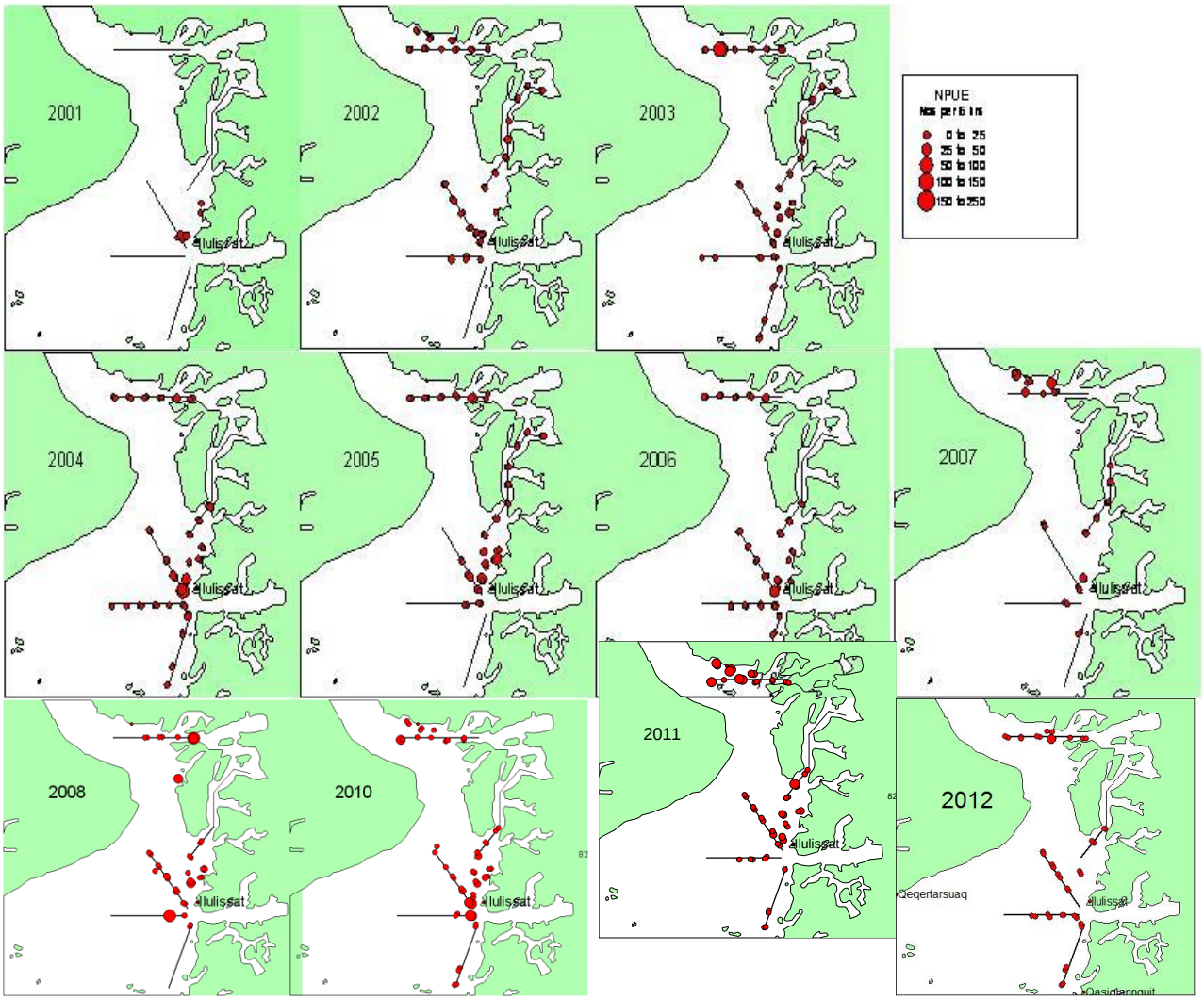

Fig. 11. Gillnet survey in Disko Bay 2001-2011. NPUE distribution (Nos G.halibut per 6 hrs of setting).

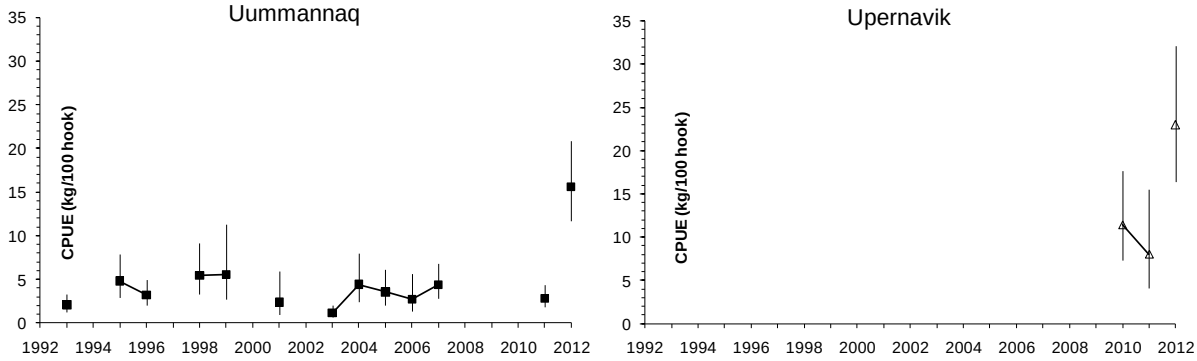

Fig. 12. Longline survey indices with CI for Uummannaq (left) and Upernavik (right). New survey logline introduced in 2012.

Appendix I

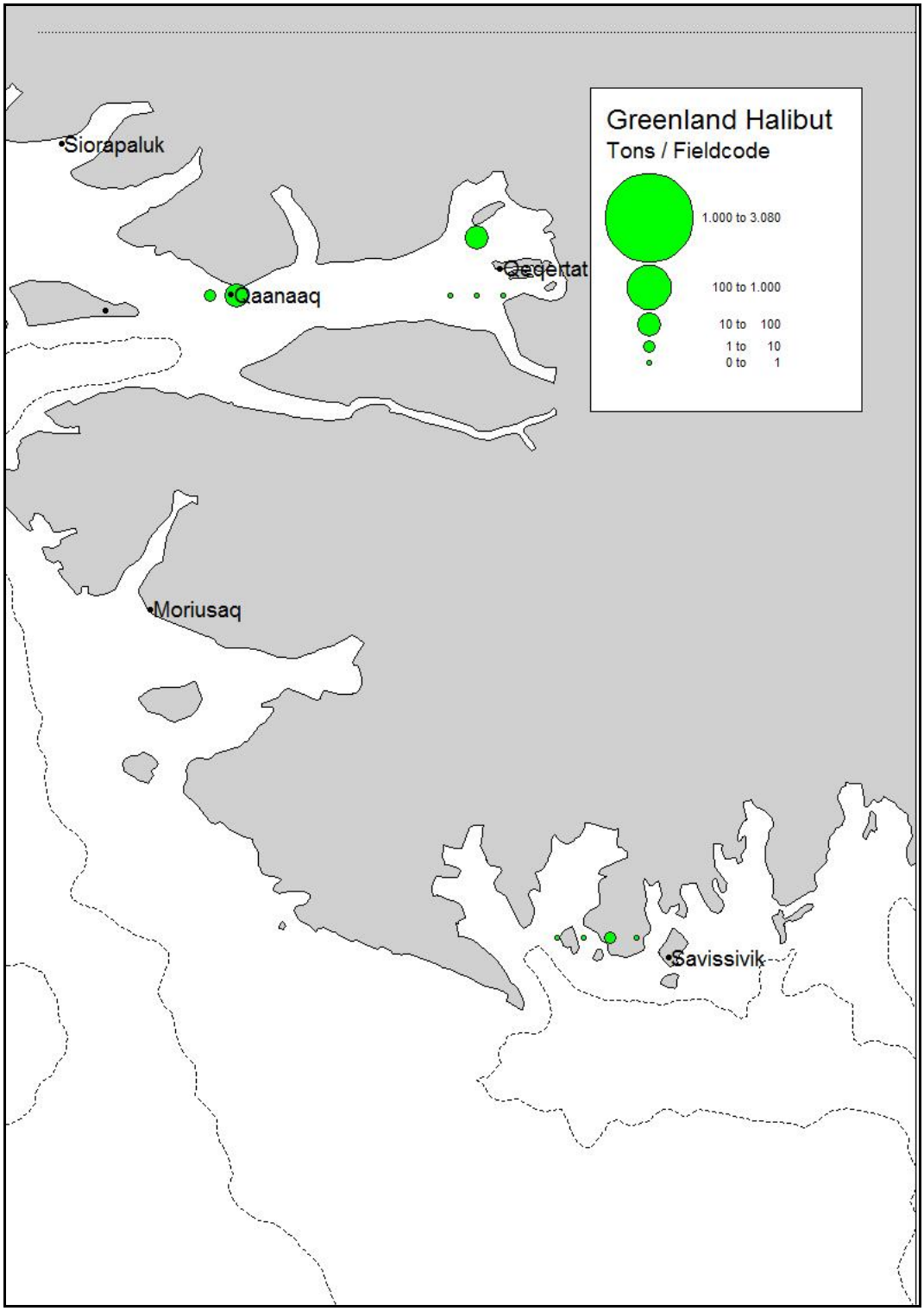

Figure I,1 Catch by fieldcode in the Qaanaq area.

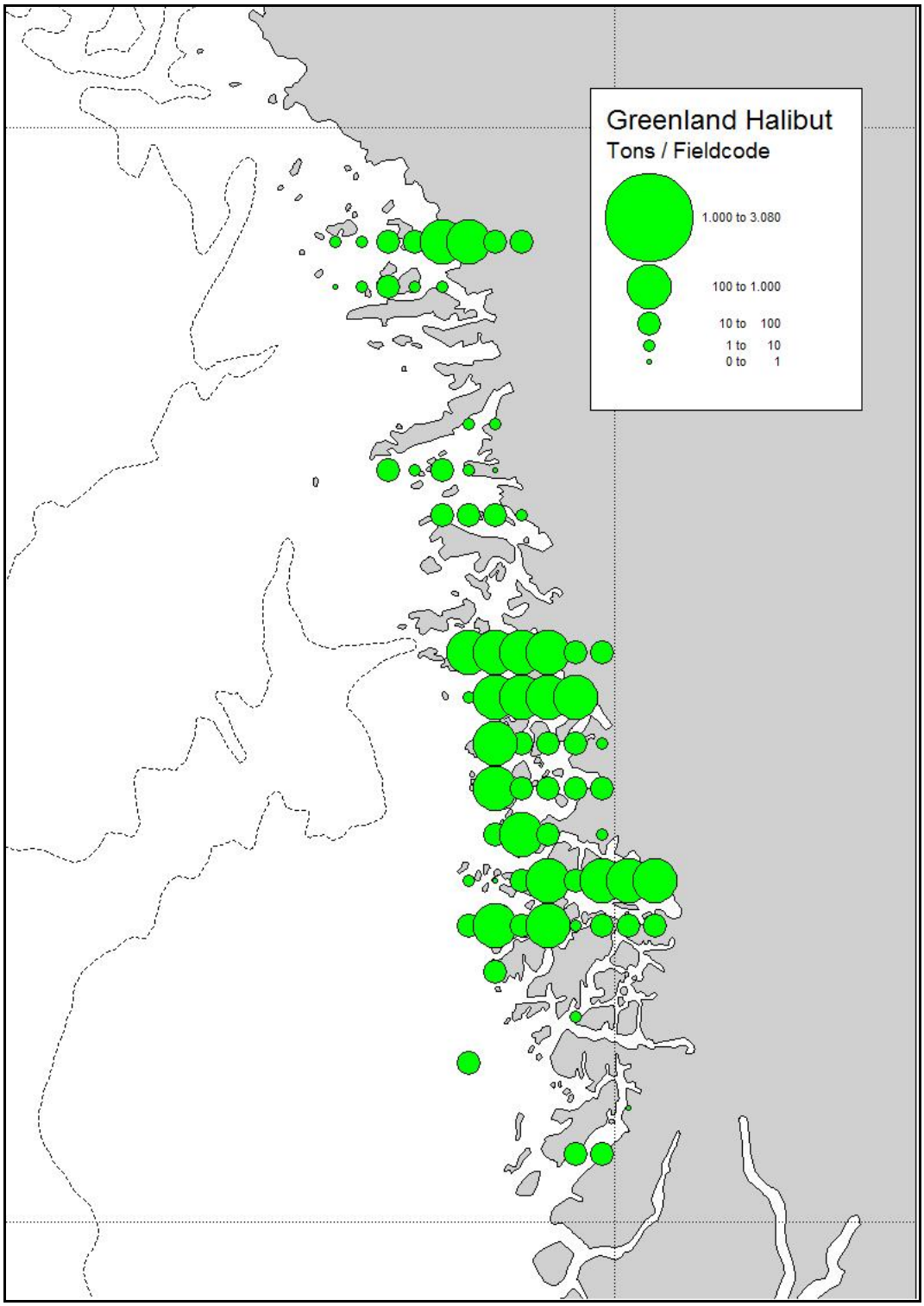

Figure I,2 Catch by fieldcode in the Upernatik area.

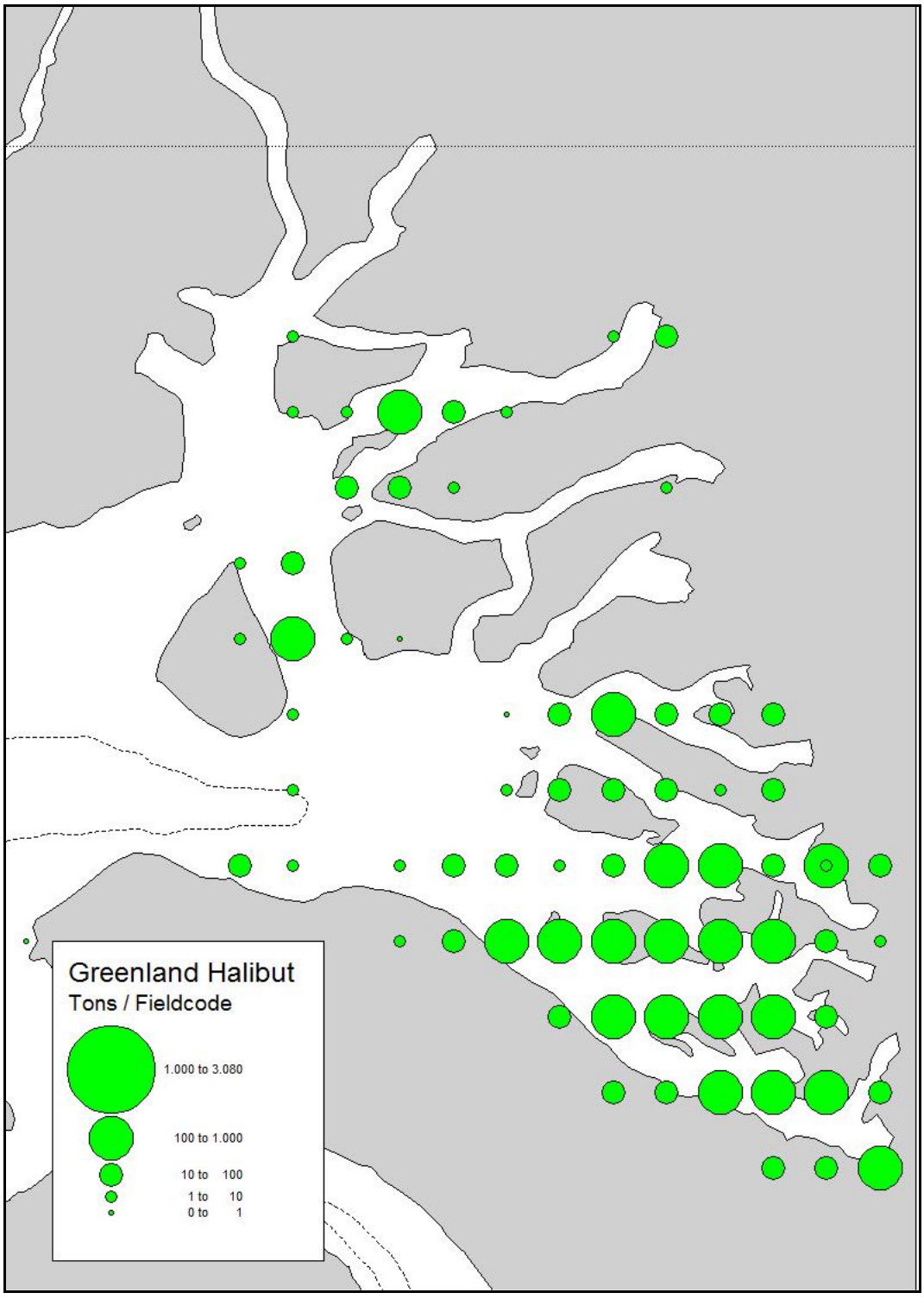

Figure I,3 Catch by fieldcode in the Uummannaq area.

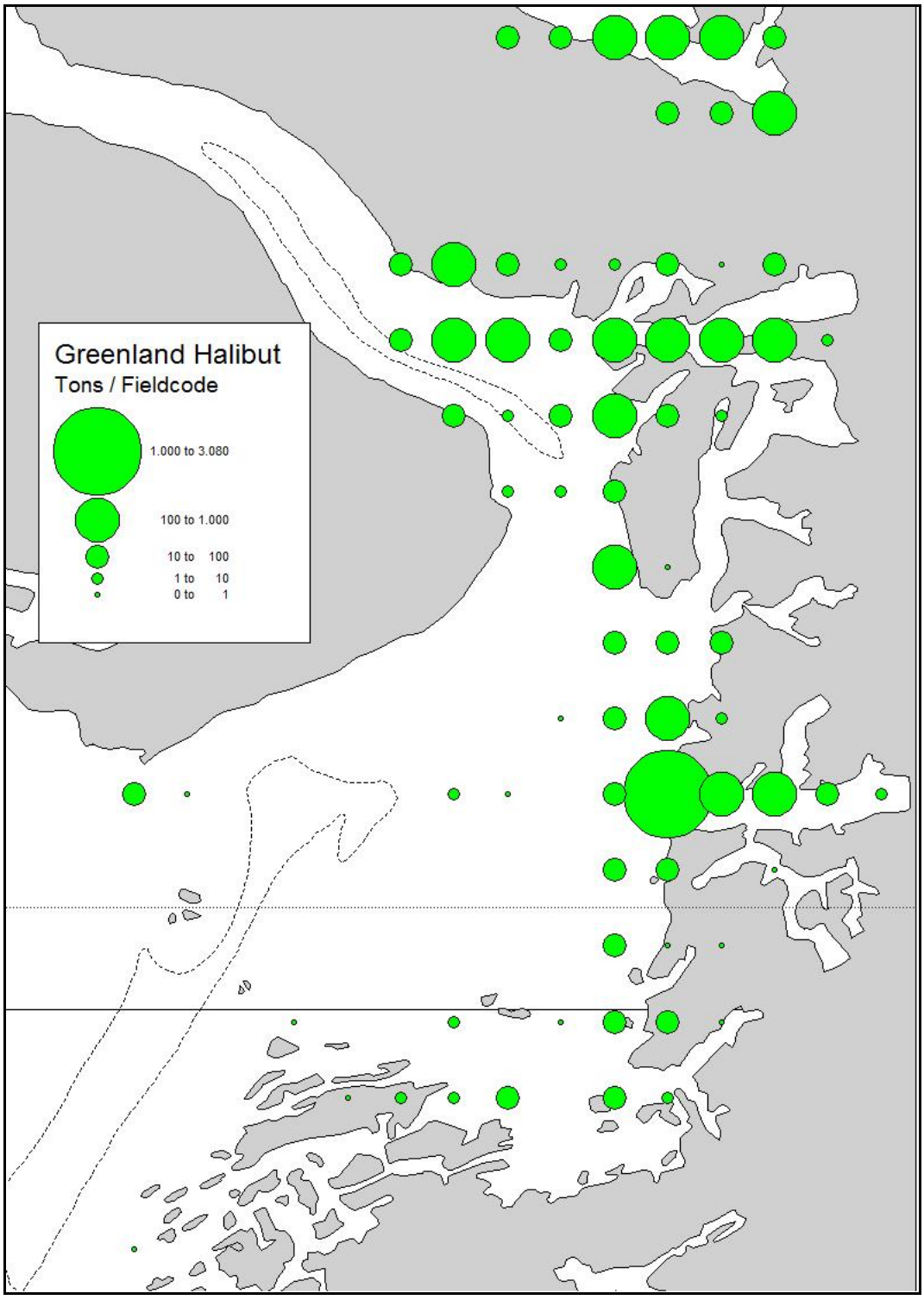

Figure I,4 Catch by fieldcode in the Disko bay area.

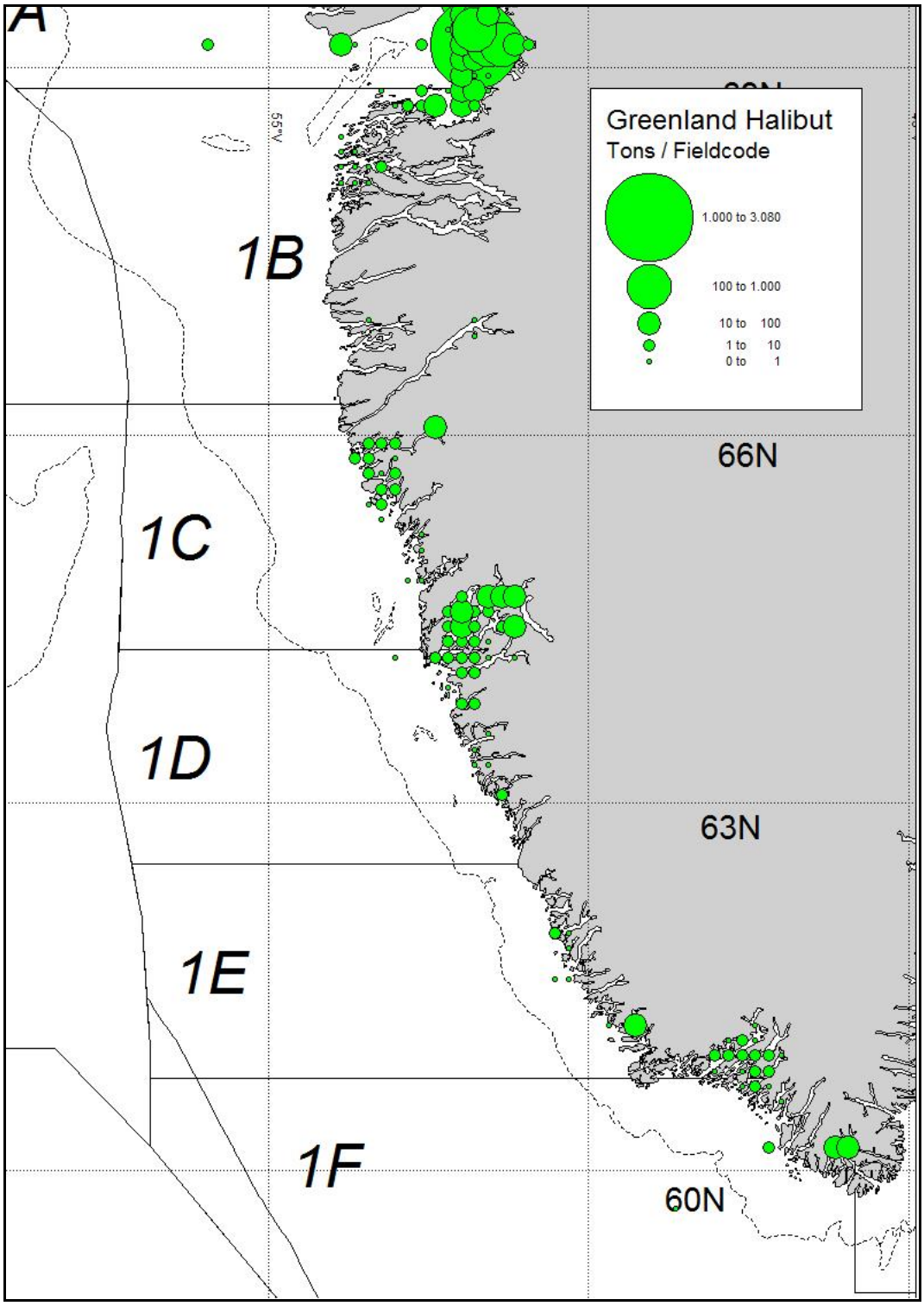

Figure I,5 Catch by fieldcode in the South-west Greenland fjords.

Appendix II

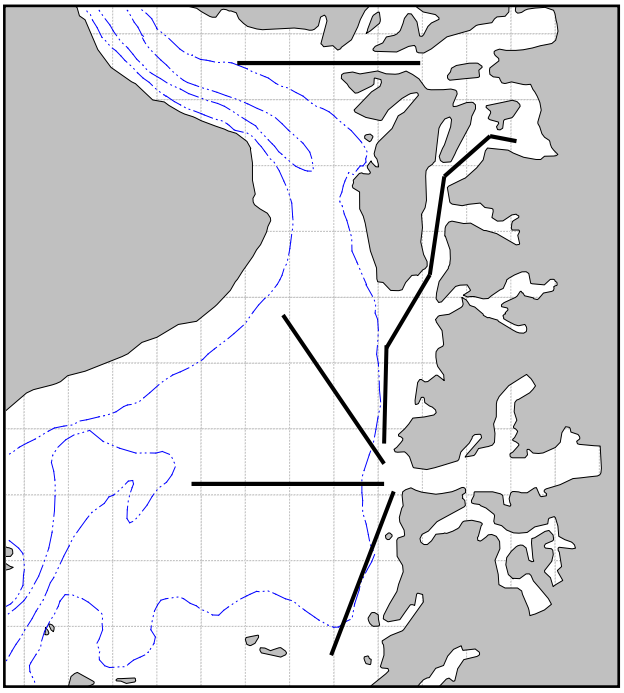

Fig. II,1. Map of area in Disko Bay for gillnet survey. Lines are transects along which fixed stations are positioned.

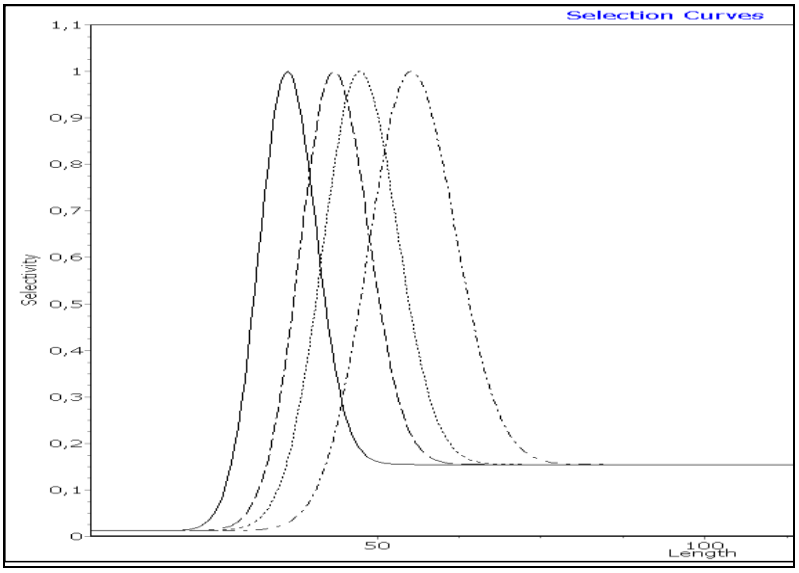

Fig II,2. Assumed selectivity curve applied to gillnet survey catches (Wilemans wings).