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An Assessment of the Greenland Halibut Stock Component in NAFO Division 1A Inshore

by

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Abstract

This paper presents 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. Information from the commercial fishery (only landings, no effort information) and research survey (longline survey in Uummannaq and a gillnet survey in Disko Bay) was available for the assessment. The state of the stocks was as follows. **Disko Bay:** Landings have been declining since 2004, especially between 2006 and 2007. Mean length in the landings have been gradually declining since 2001. CPUE (kg) in the gill net survey has been declining since 2005 and NPUE (number) has been declining since 2004. The decline in mean length in the commercial fishery is hence unlikely to be caused by incoming new young year-classes to the fishery. These trends are a cause of concern. Trawl survey biomass has been declining since 2004 but is still above the level in the 1990's. Recruitment has varied since the good 1997 year-class, but has been above the level in early and mid 1990's. The recruitment of the 2006 year-class was the third largest in the time series. **Uummannaq:** Landings have remained stable since 2002. Mean lengths from the commercial fishery have been relatively stable until 2007. Abundance indices in the longline survey indicate an increase until 1999, from 2001 to 2003 abundance indices decreased and in the same period landings declined, since 2004 abundance indices have remained stable. Both survey indices and mean lengths in the commercial fishery indicate a stable stock in the Uummannaq area. **Upernavik** Landings have remained relatively stable since 2004. It is difficult to evaluate the Greenland halibut stocks in that area since no surveys and sampling from landings has been conducted in Upernavik from 2002 until winter 2005 and 2006. However mean length in 2005 and 2006 is unchanged compared to 1999-2001.

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 caused in 1994 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 nominal catches

The lack of reliable landing data for recent years and incomplete data release from the Greenland authorities hampers the assessment of the inshore stock components in Div. 1 A. Official data on landings allocated on area (field-code), fishing gear and effort is a prerequisite for disaggregating catches and compiling catch in numbers, thereby allowing any analytical approaches to determine stock status. Improvement of the current assessment is entirely dependent upon this. For a number of years, the catch statistics are preliminary and frequent changes to the database questions its reliability.

The main inshore fishing grounds for Greenland halibut in Greenland are in Div. 1A (Fig. 1), where the total landings amounted to 20 576 tons in 2007, and constitute ~99% of inshore landings in Greenland. The inshore landings were around 7 000 tons in the late 1980's and increased until the late 1990's to a maximum of about 24 600 tons in 1998, since 2004 landings have been fluctuating around 22 000 tons.

The inshore fishery in Div. 1A is located in three main areas: Disko Bay, Uummannaq and Upernavik (Fig. 1). Quota regulations have been introduced from 2007 with quotas of 12 500 tons for Disko Bay and 5 000 tons for Uummannaq and Upernavik areas, since 1998 regulations have restricted effort increase by means of licenses to land fish. New license issues have since been limited after 1998 and the total number of licenses is now around 1300. There are no landing limitations on the fishery licenses. So fishery is free until the quota has been reached.

The fishery is traditionally performed with longlines from small open boats or by dog sledges. In recent 10-15 years bigger vessels (>25 feet) have entered the fishery. Typically the fishery is carried out in the inner parts of the ice-fjords at depths between 500 and 800 m. In the middle of the 1980s gillnets were introduced to the inshore fishery, and were used more commonly in the following years. In the late nineties authorities introduced regulations limiting areas of gillnet fishery in order to limit effort. A total ban for gillnets has been in force since 2000. However, derogations have been given to this ban. Competence to lay down local rules have been given to Uummannaq and Upernavik municipalities in 2004, and areas where gillnet fishery is allowed has been expanded in all three municipalities. The gillnet fishery is regulated by a minimum mesh-size of 110 mm (half meshes), while there are no gear regulations on the longline fishery.

Disko Bay

Disko Bay is the area where Greenland halibut fishery developed in Greenland in the beginning of the 1900, and the major part of the catches in Greenland have traditionally been taken here. The landings in Disko Bay have increased continually until the late 1990s to about 10 500 tons (Fig. 2 and Table 1). After a decline in 2001 to 7 052 tons, landings have increased again in 2002 and further in 2004 to a historic high of 12 857 tons, in 2007 landings amounted 10 381 tons. The Greenland halibut fishery is conducted in, and in front of an ice fjord (Kangia) in the immediate vicinity of Ilulissat town, and in an icefjord north of Ilulissat, Torssukattak (Fig. 1). The winter fishery in Ilulissat Icefjord, Kangia, is a traditional fishery from the ice using longlines. The fishery near Ilulissat is conducted within a small area (2 nm^2) and consist of a mixture of gillnet and longline fishery. However, the gillnet fishery is restricted to areas further from the icefjord than the longline fishery. The majority of the landings in Disko Bay are caught within this area. The fishery in Ilulissat and the other two areas is carried out in all seasons but most often peak in summer (Fig. 3). It has been observed that the fish disappear from the area in mid July, where after the fishery move to Torssukattak north of Ilulissat (Simonsen and Roepstorff, 2000). The fishery in Torssukattak is almost exclusively carried out in the period July - August. Fishery in this fjord is restricted by sea ice in spring.

Uummannaq

The landings in Uummannaq were stable around 3 000 tons prior to 1992, but has increased with some fluctuations until 1999 where 8 425 tons were landed. Since 2003 yearly landings have been stable around 5 000 tons, in 2007 landing were 5 318 tons (Fig. 2 and Table 1).

The fishery in Uummannaq area is conducted in a large system of icefjords. The main fishing grounds are in the southwest part of the fjord system. During late 1980s early 1990s the southernmost icefjord, Qarajaqs Icefjord was the main fishing area but during the last decade the fishery has spread further north to include Sermilik and Itiviup

Icefjords (Fig. 1). Use of gillnets is developing and in 2005 catches by gillnet exceeded that of longlines. Use of gillnets is prohibited in the inner parts of the fjords in Uummannaq.

Upernavik

The northernmost area consists of a large number of ice fjords. Fishery in this area started in the 1980's. The main fishing grounds are Upernavik Ice fjord and Giesecke Ice fjord. Use of gillnets have been prohibited in Upernavik but derogations have been given for a fishery outside the Icefjords since 2002.

The total landings in 1998 were the highest on record 7 012 tons. Landings declined to 3 019 tons in 2002 followed by a steady increase up until 2005 and since then landings were around around 5 000 tons per year, in 2007 total landings amounted 4 877 tons (Fig. 2 and Table 1).

3. Input data

3.1. Research Surveys

Longline survey

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). This survey has recently been evaluated and the main conclusions drawn are that the survey does not generate sufficient data for proper statistical analyses; this in combination with an almost unknown selectivity of the gear as well as catch efficiency, prevents use of survey results as anything other than indicative of overall stock trends, e.g. no information on year-class strength and population in absolute numbers. Therefore, a pilot study on using gillnet (multi-meshed) as survey gear have been performed since 2001. Parallel with the new gillnet survey the aim was to continue the longline survey. However in 2002, 2006 and 2007 no longline survey was conducted in Disko Bay, and in 2003 the longline survey was only conducted in Uummannaq. Due to varying coverage and number of longline settings between years, survey cpue's have been standardised with respect to depth and area effects by use of a GLM.

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 survey has been conducted since 2001 with the research vessel 'Adolf Jensen' in Disko Bay. The location is chosen due to the known presence of pre-fishery recruits in combination with a bottom topography (approx. 3-400 m depth of even clay bottom) that allows fishing with gillnets. In the northern areas, Uummannaq and Upernavik, gillnet surveys are not suitable in the proposed pre-fishery recruit areas. Only 8 stations were fished in the first survey year 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 (Fig. 4). 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.

The gillnets are selecting Greenland halibut in the length range 30 – 50 cm. Greenland halibut larger than 50 cm are abundant in the area, but seem mostly concentrated at the commercial fishing grounds in the immediate vicinity of Ilulissat and in the Icefjords, Kangia (Ilulissat Icefjord) and Torsukattak in the north. The gillnet survey do not cover those commercial fishing grounds. Greenland halibut smaller than 30 cm are occasionally abundant in the area, but are mostly recruited from offshore areas off Disko Bay and are thought to perform a stepwise migration towards the commercial fishing grounds near the icefjords.

Recruitment indices.

Greenland Institute of Natural Resources conducts annual surveys with R/V "Pamiut" in 3rd quarter for shrimp and demersal fish as described in Sünksen and Jørgensen (SCR 06/28). And since 1992 it has been extended to include the Disko Bay, fish have been routinely measured, and Greenland halibut are disaggregated to ages 1-3 by the Petersen method. In 2005 16 hauls were conducted in the Disko Bay. The CPUE for Greenland halibut (number per age per hour of ages 1-3) is estimated for the Disko Bay, using tows from depths >300m. The index is assumed indicative for recruitment to the Disko Bay fishable stocks only. Recruitment dynamics for the northern areas, Uummannaq and Upernavik are unknown.

3.2. Commercial fishery data

Landings data

Data on the inshore landings of Greenland halibut for Disko Bay and Uummannaq in 2006 and 2007 were obtained from Royal Greenland (RG) for the plants in Disko Bay and Uummannaq area, and Greenland Fishery Licence Control (GFLK). Data from Upernavik was obtained from Upernavik Seafood A/S and GFLK. Only a part of the data from 2006 and 2007 were allocated to gear, and the remaining catches were allocated according to these available data. Summer was defined as June-November (both included), 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 1.10. The conversion factor for gutted fish without head and tail are 1.35.

In order to obtain length distributions for the commercial catches/landings, random samplings from gillnet and longline fishery are carried out annually in the three main areas in February/March and July/August. Sampling intensity from the commercial fishery in the recent year is given in text table below.

Sampling	**2006**	**Disko Bay**			
Nos length measurements					**Nos otoliths**
Gear \ Season	Summer	Winter	All	% sampled	
Longline	**3497**	**1595**	5.092		
Gillnet		**1052**	1.052		
All	3.497	2.647	6.144	0,105	547

Sampling	**2006**	**Uummannaq**			
Nos length measurements					**Nos otoliths**
Gear \ Season	Summer	Winter	All	% sampled	
Longline	**2374**	**2310**	4.684		
Gillnet	**164**	**164**	328		
All	2.538	2.474	5.012	0,248	352

Sampling	2007	Disko Bay				
Nos length measurements						**Nos otoliths**
Gear \ Season	Summer	Winter	All	% sampled		
Longline	765	2702	3.467			
Gillnet		2434	2.434			
All	765	5.136	5.901	0,232	442	

Sampling	2007	Uummannaq				
Nos length measurements						**Nos otoliths**
Gear \ Season	Summer	Winter	All	% sampled		
Longline	760	3550	4.310			
Gillnet	625	625	1.250			
All	1.385	4.175	5.560	0,294	609	

Effort

A regulation has recently been put in force on mandatory logbooks for vessels longer than 30 feet, the total catch reported through logbooks in 2007 was around 2 500 tons representing about 10-15 % of total landings covering the entire fishing area (fig. 15). Efforts data are not yet available.

Catch at age

Catch at age data were compiled for the 2006 and 2007 fishery (Table 4), based on otolith sampling in summer, both from the surveys and from the commercial fishery, and on the distribution of catches by season and gear (Table 3). For 2006 the ALK for Disko Bay was based on otoliths from Disko Bay in 2003-2005. For Uummannaq in 2006 an ALK, supplemented with 2003 and 2004 readings, from Uummannaq was used (Table 5). No reliable maturity data were available. For 2006 and 2007 the gillnet fishery in summer was not sampled. Catch composition from this fishery was assumed equal to the winter gillnet fishery.

4. Assessment

4.1. Gillnet survey

The gillnet survey uses 4 different mesh sizes, 46, 55, 60 and 70 mm, for which is assumed a bi-modal selection curve as shown in Fig. 5. 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 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. From the selection curves in Fig 5, it is obvious that selection is nearly 100% in that length interval, thus it is assumed that the catches in this length range will reflect the fished population.

Most catches in the survey was obtained in the area just north of Ilulissat (stat. sq. LH028) and off the northern Icefjord Torssukattak (Fig. 6). Fig. 7 give standardised catch rates in survey from 2001 to 2007; from 2001 to 2002 both CPUE and numbers per unit effort (NPUE) decreased, and have since continuously increased to catch rates as obtained in 2001. The catches have been expressed as catch in kg or numbers per 6 hours of setting, assuming that catch rates are linear positive related to soak time. This has, however, not been proved, and since soak time is on average twice as high in 2002 as compared to 2001 and 2003, the trend in catch rates between years is dependent on this assumption. Disaggregating the CPUE and NPUE by length groups, show that the number of small fish increased in 2004 compared to previous years but decreased from 2005 to 2007.

Assuming a bi-modal selection curve (Wilemans wings) as given in Fig. 5 will result in relative underlying populations as provided in Fig. 8b. The fit of the assumed selection curve to the catch data is given in Fig 8a. The estimated relative population suggest an inflow of small fish since 2003, but cohorts are not easy to follow. Age distributions are rather uniform between years and only in 2003 high abundance of age 3 deviate from the mean.

Figures 13 and 14 show that the year to year consistency of cohorts is very poor in the gillnet survey, suggesting that the distribution is not totally covered.

4.2. Longline survey

Since 2001 when the gillnet survey was initiated, the longline survey has been restricted and the aim is to cover the Uummannaq area only by longline suvey. In order to establish a calibration key between the gillnet and longline surveys, longline settings were conducted in Disko Bay in 2004 and 2005. This allow an extension of the newly initiated gillnet survey index back in time (SCR 05/57).

Survey CPUE

Disko Bay

Apart from 2001 a longline survey was carried out in 2004-5 (Fig. 7). CPUE in 2004 and 2005 were similar high and above the average catch rate, at about same level as in 2001. Thus since 2001 catch rates are considerably higher than those obtained in the period 1993-2000 although not statistically significant. Length distributions of catches have since 2001 been narrower than prior to 2001 (Fig. 10). Using the relation between total catches and the survey index as an approximation for exploitation level, reveal that exploitation of the populations in 2006 and 2007 has doubled compared to 2005 (fig. 12).

Uummannaq

In Uummannaq mean size have been very stable in the time series of the longline survey. Mean length increased from 57 cm to 62 cm in 1998 decreased to 57 cm in 2003 and has been stable since then (Fig. 10). Catch rates have shown a considerable decrease from 1998/99 to 2003, but has since increased and stayed stable from 2004 to 2007 at about average of the time series. (Fig. 11). The length composition in the survey catches have varied considerably since 1993, in general being broad (Fig. 10). Distributions suggest that good year-classes are contributing to survey since 2003. Exploitation of the populations in Uummannaq have increased since the late 1990s and especially in 2003 and 2006 (Fig. 12).

Upernavik

Since 2000 no longline survey has been carried out in Upernavik.

4.3. 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, end 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).

4.4 Commercial Fishery

Size distribution

Mean lengths from the longline landings in the period 1993 to winter 2007 in Disko Bay and Uummannaq are showed in Fig. 16. In Upernavik no sampling have been conducted from the commercial fishery from 2002 until

winter 2005. Fish caught in summer are generally smaller than fish caught during winter.

Mean length in the winter fishery of Disko Bay decreased from a high of about 80 cm in 2001 to 66 cm in 2007. Fishing at the traditional winter fishing grounds in the icefjord has been impeded in the recent years due to lack of land-fast sea-ice (the fishery is traditionally conducted from the sea-ice) and an open-water fishery developed on alternative fishing grounds. This change in fishing grounds may have affected mean size in landings. Mean lengths in the summer fishery have fluctuated between 1993 and 2001 with a slightly increasing trend, but have thereafter been decreasing from 63 cm in 2001 to 54 cm in 2007, minimum individual weight for landing is 1 kg which corresponds to a length of about 48 cm.

In Uummannaq mean lengths in the winter fishery have been stable throughout the period at about 66 cm. Mean size in landings from the summer fishery decreased in the early period from 1993 to 1997, but have thereafter remained stable aroundout 64 cm but has since dropped to about 59 cm in 2007, mean size in landings from winter fishery have been relatively stable around 65 cm, since then.

Mean lengths in Upernavik winter fishery have been decreasing trough the 1990'ies, and have been stable around 62 cm since 1999 including the most recent samplings in 2005 and 2006. There have been no sampling from the summer fishery in the Upernavik area since 2002.

Catch at age

For all three areas there has been a shift in exploitation pattern through the time series (Fig. 17). While the younger age groups (under 10 years of age) composed between 25% and 50% of the catches in the late 1980'ies and early 1990'ies, they now constitute about 60-80% of the catches. In Disko Bay the proportion of younger fish has increased every year from 64% in 2002 to 81% in 2007. In Upernavik exploitation of the younger age groups has increased considerably in the period from less than 25% to more than 80% in 1999-2001. No catch-at-age is available for Upernavik since then.

Mean weight-at-age

Mean weight at age for Greenland halibut in the three fishing areas are shown in Figure 18. The outliers in 1994 are considered to be due to errors in age readings. For the younger fish mean weight at age have varied in the sampled time series, but recent values are overall at same level as those in the beginning of the period. For the older fish (> age 12) there was a clear trend of a decline in mean weight at age in the period since 1993, but have fluctuated since then.

Biomass and recruitment

Greenland shrimp-survey

Since 1988 annual trawl surveys with a shrimp trawl have been conducted off West Greenland in July-September. The survey covers the area between 59°N and 72°30'N (Div. 1A-1F), from the 3-mile limit to the 600-m depth contour line. The survey area was restratificated in 2004 based on better information about depths and all biomass and abundance indices have been recalculated. The recalculation did not change the trends in the development of the different stocks.

Estimated total trawlable biomass of Greenland halibut in the Disko Bay has fluctuated between 2,510 and 28,229 tons in 2004. Since then catches have decreased gradually to 12,166 tons in 2007. The 2007 estimate is, however, still above the average for the time series. The abundance increased from 106 mill. in 2006 to 146 mill in 2007 which is above the average for the time series (1991-2006). – 130 mill (fig. 19). The catches mainly consisted of one and two year fish (SCR (08/28).

Recruitment

A recruitment index was provided from the Disko Bay. Catches were standardized as catch in number per hour as described in Bech (1995). Data were plotted by year classes to visualize the relative year class strength and

development in relative abundance (Fig. 20). In recent years the allocation of stations in the shrimp trawl survey has been changed in order to minimize the variance in the estimation of biomass and abundance of shrimp. To minimize the effect of that the CPUE index has been recalculated using stations > 300 m only. This generally increases the mean number per tow but not the trend in the index.

The recruitment have been good in recent years although the recruitment of year classes 2002-2005 has been gradually decreasing. The recruitment increased again in 2007 and 2006 year class was the third largest on record.

Generally there is a steep decline between CPUE at age 1 and age 2 and 3+ .The 2005 year class is as age relatively high. It has been noted, that the year-classes estimated to be a very strong year-class at age 1 not have shown up in the fishery as a particularly strong year-classes.

State of the stock components

Exploitation of younger age groups has increased considerably for all areas in the past 10-15 years. The lack of information on fishing effort makes it difficult to evaluate trends in landings relative to stock biomass or fishing effort. As no surveys and only two samplings has been conducted in Upernavik area since 2001, there is no sufficient basis to evaluate the state of Greenland halibut stocks in that area in recent years.

Disko Bay

Landings have been declining since 2004, especially between 2006 and 2007. Mean length in the landings have been gradually declining since 2001. CPUE (kg) in the gill net survey has been declining since 2005 and NPUE (number) has been declining since 2004. The decline in mean length in the commercial fishery is hence unlikely to be caused by incoming new young year-classes to the fishery. These trends are a cause of concern. Trawl survey biomass has been declining since 2004 but is still above the level in the 1990's. Recruitment has varied since the good 1997 year-class, but has been above the level in early and mid 1990's. The recruitment of the 2006 year-class was the third largest in the time series.

Uummannaq

Landings have remained stable since 2002. Mean lengths from the commercial fishery have been relatively stable until 2007. Abundance indices in the longline survey indicate an increase until 1999, from 2001 to 2003 abundance indices decreased and in the same period landings declined, since 2004 abundance indices have remained stable.
Both survey indices and mean lengths in the commercial fishery indicate a stable stock in the Uummannaq area.

Upernavik

Landings have remained relatively stable since 2004. It is difficult to evaluate the Greenland halibut stocks in that area since no surveys and sampling from landings has been conducted in Upernavik from 2002 until winter 2005 and 2006. However mean length in 2005 and 2006 is unchanged compared to 1999-2001.

General Comments

Beginning from 2006 vessels larger than 30 feet are obligated to deliver logbooks from all inshore fisheries in Greenland however only about 10-15% of the fishery is reported in the logbook data from 2007.

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.

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Table 1. Landings and Greenland halibut (tons) in Div. 1A distributed on the main fishing areas: Disko Bay, Uummannaq and Upernavik. Conversion factor 1.1 for gutted fish with head, 1.50 for gutted fish without head, 1.52 for gutted fish without head and tail fin.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Disko Bay	2258	2670	2781	3821	5372	6577	5367	5201	7400	7837	8601	10671	10593	7574	7072	11718	11571	12857	12451	12114	10381
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234	4579	6293	6912	8425	7568	6558	5339	5039	5248	4856	5984	5318
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	3269	4846	4879	7012	5258	3764	3239	3019	3884	4573	4839	5132	4877
Unknown/other	407	636	599	507	17	133	0	0	0	0	0	0	55	2239				45	761	14	
Total in Div. 1A inshore:	7196	7003	7492	8352	9929	11933	13088	14049	17903	17262	19773	24595	24332	21144	16869	20076	20494	22723	22907	23245	20621
STATLAN 21A	6696	6384	6927	7465	9243	11932	13204	14067	17046	17271	20835	19669	24333				21482	22947			
STACFIS	7196	7003	7492	8352	9929	11933	13088	14049	17037	17262	19774	24595	24332	21144	16869	20076	20494	22723	22907	23245	20621

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

	year							
Square	2001	2002	2003	2004	2005	2006	2007	Total
LD027			2	2				4
LE027			2	2				4
LF027			2	2		2	2	8
LF028			2	2		2		6
LG024			2	1				3
LG025				3		2		5
LG026		1		2		2		5
LG027	4	7	6	5	6	5	4	37
LG028	2	2	1	1	1	3	1	11
LH026		2	1		1	1		5
LH027		5	3	4	3	3		18
LH028	2	1	9	6	8	4	1	31
LJ026		3	2	2		4	2	13
LJ028		5	4	5	4	4	4	26
LK029		5	4	2	4	2	4	21
LL029		1	1		2		1	5
LM029		2	2		2			6
LM030		2	2		2			6
LM031		2	2		2			6
LN024		2	2	2	2	2		10
LN025		5	3	4	3	4	4	23
LN026		4	2	2	3	2	5	18
LN027		2	2	2	2	2		10
LN028		2	2	2	2			8
LP024		2					2	4
Hovedtotal	8	55	58	51	47	44	30	293

Table 3. Landings of Greenland halibut allocated on area, season and gear.

2006	summer		winter		Total
	longline	Gillnet	longline	gillnet	
Disko	6177	1	3012	2227	11417
Ummannaq	2695	722	1650	205	5272
Upernavik	1865	767	1670	831	5132

2007	summer		winter		Total
	longline	Gillnet	longline	gillnet	
Disko	5944	47	2777	1613	10381
Ummannaq	2872	348	1588	510	5318
Upernavik	2733	130	1485	529	4877

Table 4. Catch at age of Greenland halibut. "–" indicates insufficient or missing sampling.

A) Disko Bay

Catch in numbers (thousands)

age/ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
4	0	0	0	5	34	7	0	0	0	0	0	1	0	1	0	0	0	1	0	0
5	0	0	0	5	92	15	3	0	8	0	0	4	9	15	2	2	2	48	10	2
6	1	0	0	11	122	62	15	0	1	21	74	41	98	33	54	64	56	287	211	56
7	9	0	1	279	332	280	112	45	47	132	397	360	535	224	283	425	409	516	882	459
8	59	14	24	806	476	479	281	459	323	646	775	619	729	390	561	722	691	703	1001	1073
9	182	106	141	535	390	339	539	639	941	1113	944	836	780	521	771	1.187	1083	868	1008	754
10	173	121	185	333	451	280	396	798	651	1168	1248	1028	636	450	421	610	634	423	522	749
11	132	94	188	238	532	240	190	463	454	607	754	786	478	485	575	847	730	481	582	151
12	73	49	126	76	309	122	91	185	273	185	346	426	223	280	393	422	311	213	231	94
13	63	33	80	45	140	91	50	127	145	69	132	136	52	78	398	158	144	100	105	4
14	65	39	59	67	92	112	45	27	75	19	68	72	28	33	175	146	130	97	89	166
15	38	31	42	57	18	75	41	36	44	10	27	29	12	31	112	135	152	122	125	126
16+	33	41	44	44	0	86	36	27	69	6	6	2	1	16	0	89	89	83	85	60
Total	828	528	890	2501	2988	2188	1799	2806	3031	3976	4770	4340	3583	2557	3745	4808	4431	5769	4852	3694

B) Uummannaq

Catch in numbers (thousands)

age/ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
4	0	0	0	-	-	0	0	0	1	0	0	8	0	0	-	0	0	1	1	3
5	0	0	0	-	-	0	0	0	0	0	0	70	19	65	-	3	1	17	32	40
6	1	0	1	-	-	9	24	6	6	0	0	218	86	113	-	21	10	101	12	181
7	5	2	3	-	-	45	105	217	76	69	0	554	357	674	-	127	105	108	47	221
8	20	9	15	-	-	200	226	564	308	377	235	596	441	507	-	360	197	192	243	340
9	52	35	47	-	-	202	271	601	279	793	566	690	543	315	-	321	249	142	70	273
10	121	98	108	-	-	142	346	413	286	702	657	789	669	492	-	235	198	115	284	192
11	143	120	121	-	-	138	139	414	232	460	586	526	487	303	-	220	163	109	127	149
12	121	99	101	-	-	104	105	219	142	206	355	295	311	178	-	158	118	74	324	94
13	96	76	82	-	-	158	34	138	69	75	138	131	170	121	-	78	82	58	49	64
14	49	38	42	-	-	93	12	49	28	32	39	42	68	60	-	145	103	80	108	82
15	23	19	20	-	-	28	0	28	11	10	15	12	24	28	-	150	78	67	9	71
16+	17	20	21	-	-	20	3	22	15	6	5	4	8	12	-	94	59	50	9	56
Total	648	516	561	-	-	1139	1265	2671	1453	2732	2595	3935	3184	2868	-	1911	1364	1115	866	617

Table 5a. Age-length keys used for 2006 catch in numbers.

	2003 +2004 + 2005 age readings Ilulissat + older fish (age 15+) from Uummannaq 2003																		
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
25-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35-39	0	77	52	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40-44	0	14	92	32	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49	0	0	12	84	32	8	0	0	0	0	0	0	0	0	0	0	0	0	0
50-54	0	0	1	20	75	29	1	0	0	0	0	0	0	0	0	0	0	0	0
55-59	0	0	1	7	26	55	21	3	1	0	0	0	0	0	0	0	0	0	0
60-64	0	0	1	5	10	17	45	23	9	1	0	0	0	0	0	0	0	0	0
65-69	0	0	1	4	1	1	6	5	13	4	2	0	0	0	0	0	0	0	0
70-74	0	0	0	1	0	1	1	0	3	5	2	4	2	0	0	0	0	0	0
75-79	0	0	0	0	0	0	0	0	0	1	1	1	2	2	1	0	0	0	0
80-84	0	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	0
85-89	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0
90-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
95-99	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
100-104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110-114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

2006 age readings Uummanaq age 4 from 2003+2004+2005																		
winter	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
30-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40-44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49	0	0	10	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50-54	0	0	2	9	11	0	0	0	0	0	0	0	0	0	0	0	0	0
55-59	0	1	0	1	14	0	1	0	0	0	0	0	0	0	0	0	0	0
60-64	0	2	0	0	4	7	17	1	1	0	0	0	0	0	0	0	0	0
65-69	0	0	0	0	0	0	11	7	16	1	0	0	0	0	0	0	0	0
70-74	0	0	0	0	0	0	0	10	24	3	3	0	0	0	0	0	0	0
75-79	0	0	0	0	0	0	1	1	15	8	16	0	0	0	0	0	0	0
80-84	0	0	0	0	0	0	0	0	3	2	28	3	0	0	0	0	0	0
85-89	0	0	0	0	0	0	0	0	1	0	4	2	3	0	0	0	0	0
90-94	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
95-99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100-104	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
110-114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Table 5b. Age-length keys used for 2007 catch in numbers.

2007 age readings Ilulissat +age 14 from Uummannaq 2007 and 15+ from Uummannaq 2003

	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
25-29	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-34	12	21	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35-39	0	20	24	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40-44	0	2	32	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49	0	0	5	43	17	7	0	0	0	0	0	0	0	0	0	0	0	0	0
50-54	0	0	0	13	52	30	5	0	0	0	0	0	0	0	0	0	0	0	0
55-59	0	0	0	0	14	44	6	5	0	0	0	0	0	0	0	0	0	0	0
60-64	0	0	0	0	4	10	12	13	0	0	0	0	0	0	0	0	0	0	0
65-69	0	0	0	0	0	4	5	6	4	2	0	0	0	0	0	0	0	0	0
70-74	0	0	0	0	0	0	2	1	0	0	0	3	2	0	0	0	0	0	0
75-79	0	0	0	0	0	0	1	0	0	1	0	2	2	2	1	0	0	0	0
80-84	0	0	0	0	0	0	0	1	0	1	0	5	4	1	0	0	0	0	0
85-89	0	0	0	0	0	0	0	0	0	0	2	1	3	0	1	0	0	0	0
90-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
95-99	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
100-104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110-114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

2007 age readings Uummanaq + older fish (age 17+) from 2006

winter	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
30-34	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35-39	4	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40-44	3	17	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-49	0	5	26	14	3	1	0	0	0	0	0	0	0	0	0	0	0	0
50-54	0	0	5	30	14	1	0	0	0	0	0	0	0	0	0	0	0	0
55-59	0	0	0	0	31	10	6	1	0	0	0	0	0	0	0	0	0	0
60-64	0	0	0	1	8	9	27	4	0	0	0	0	0	0	0	0	0	0
65-69	0	0	0	0	0	4	17	6	4	0	0	0	0	0	0	0	0	0
70-74	0	0	0	0	0	2	1	5	7	2	3	0	0	0	0	0	0	0
75-79	0	0	0	0	0	0	0	1	4	1	2	0	0	0	0	0	0	0
80-84	0	0	0	0	0	0	0	0	1	4	5	0	1	0	0	0	0	0
85-89	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0
90-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
95-99	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
100-104	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
105-109	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
110-114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

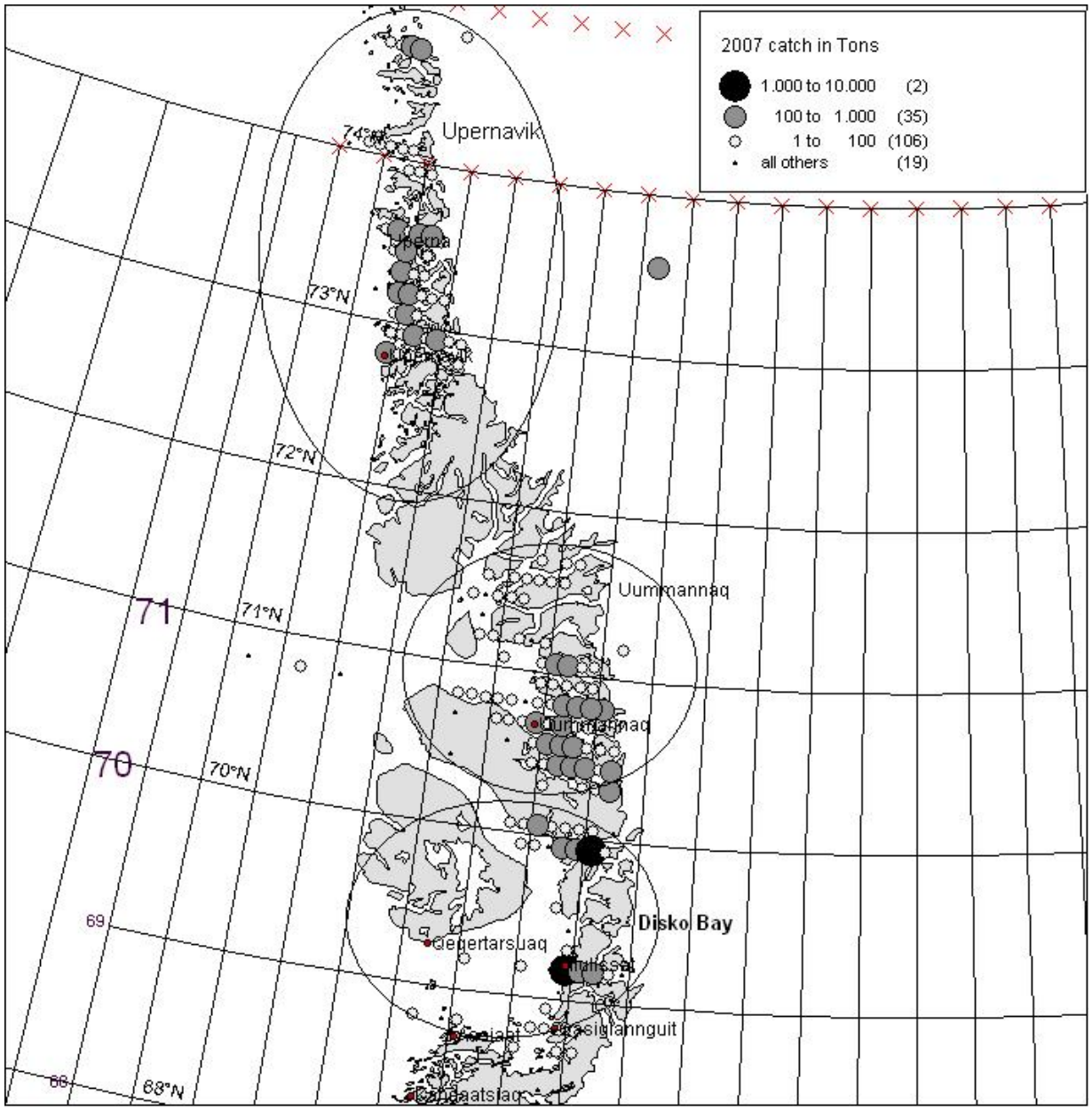

Fig. 1. Distribution of the inshore fishery for Greenland halibut in Div.1A Upernavik Area in 2007. Landings is shown in tonnes per statistical square (field-code defined as 1/32 x 3600 x cos(lat)). Catch statistics are provided by Upernavik Seafood, Royal Greenland and GFLK.

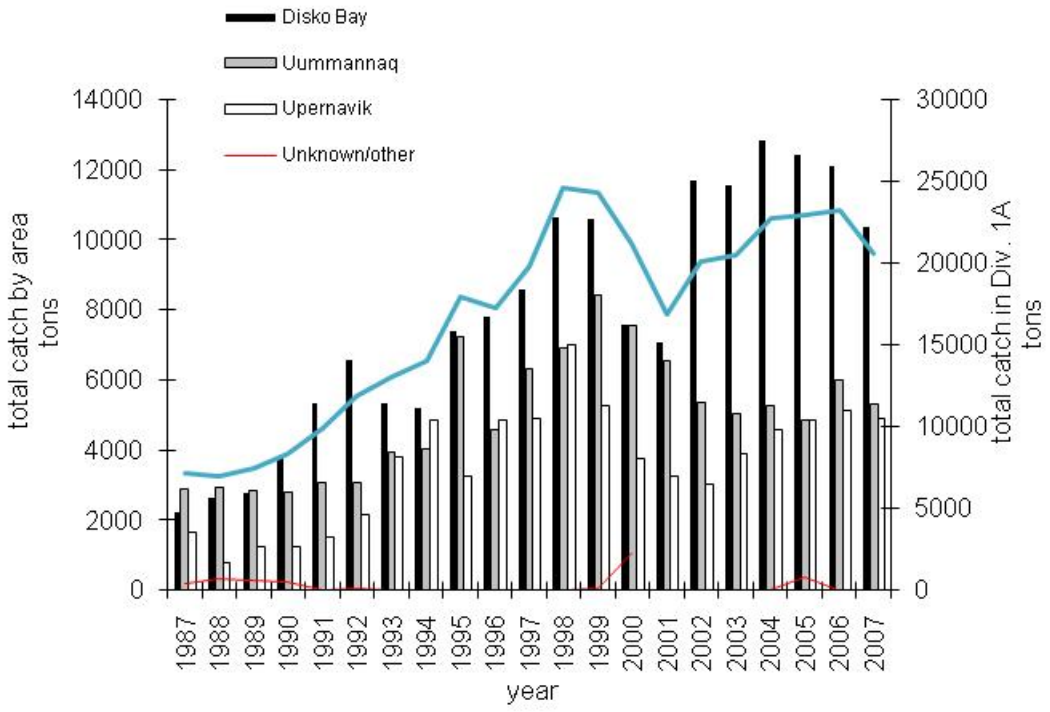

Fig. 2. Landings in NAFO Div. 1A since 1987 for the 3 main fishing areas. Data on landings from 2000-2007 are provisional. See also Table 1.

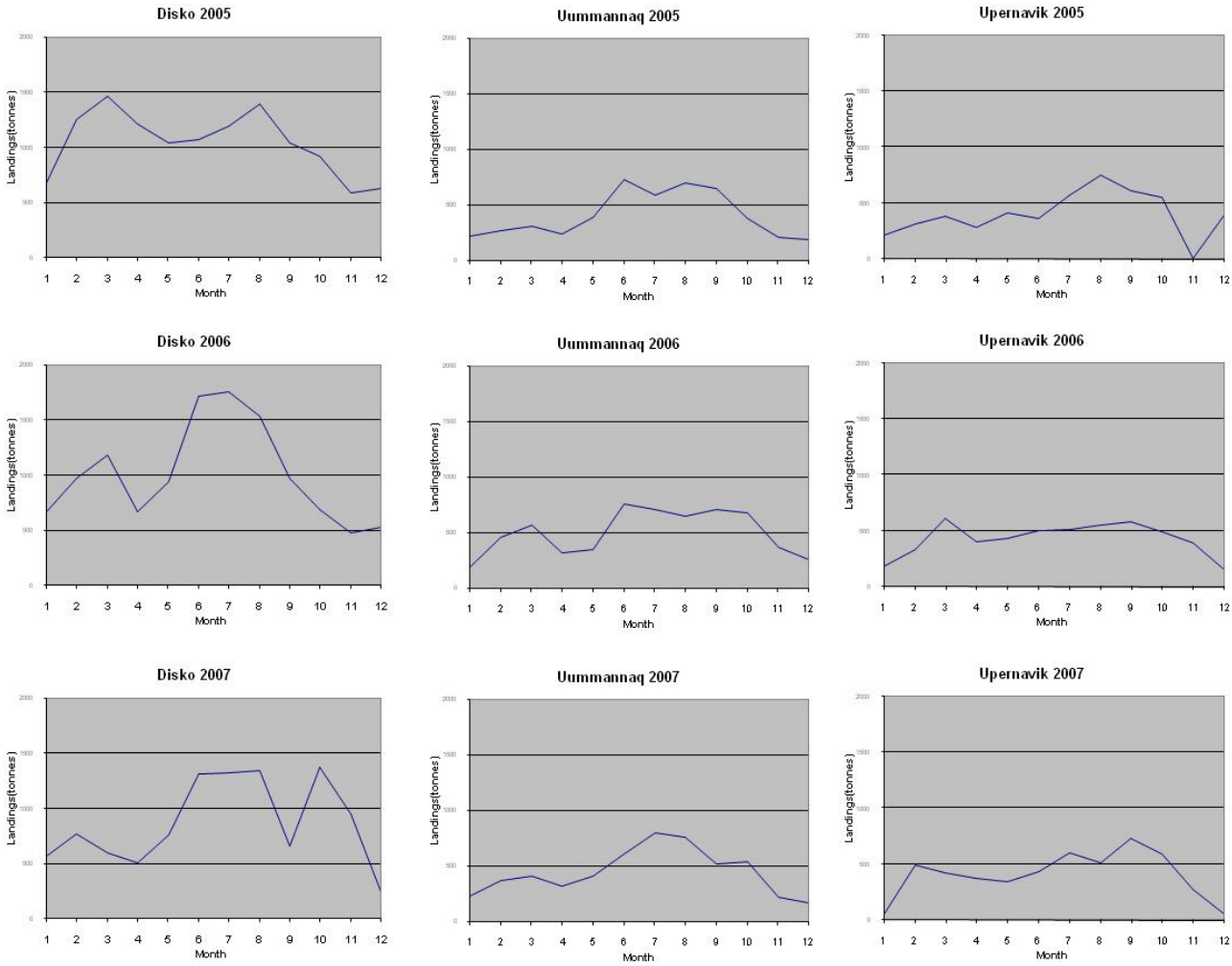

Fig. 3. Landings in NAFO Div.1A inshore by month and area for the years 2005-2007.

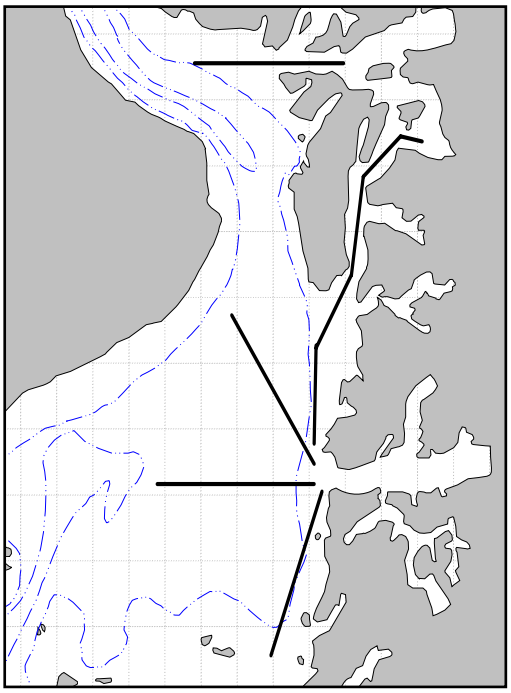

Fig. 4. Map of area in Disko Bay for gillnet survey. Lines are transects along which fixed stations are positioned.

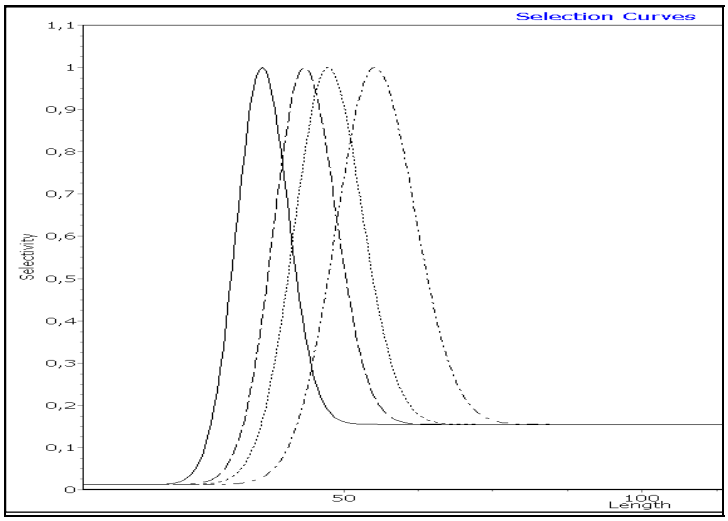

Fig. 5. Assumed selectivity curve applied to gillnet survey catches (Wileman's wings).

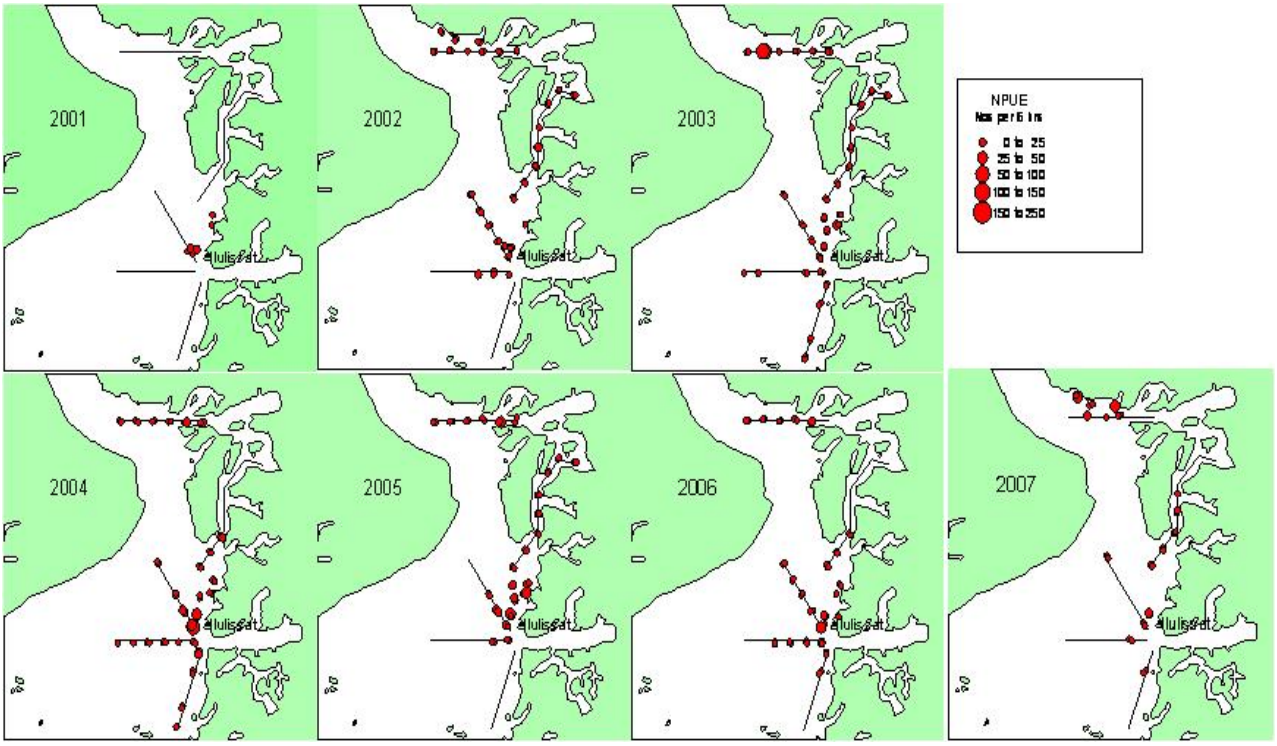

Fig. 6. Gillnet survey in Disko Bay 2001-2006. NPUE distribution (Nos G.halibut per 6 hrs of setting).

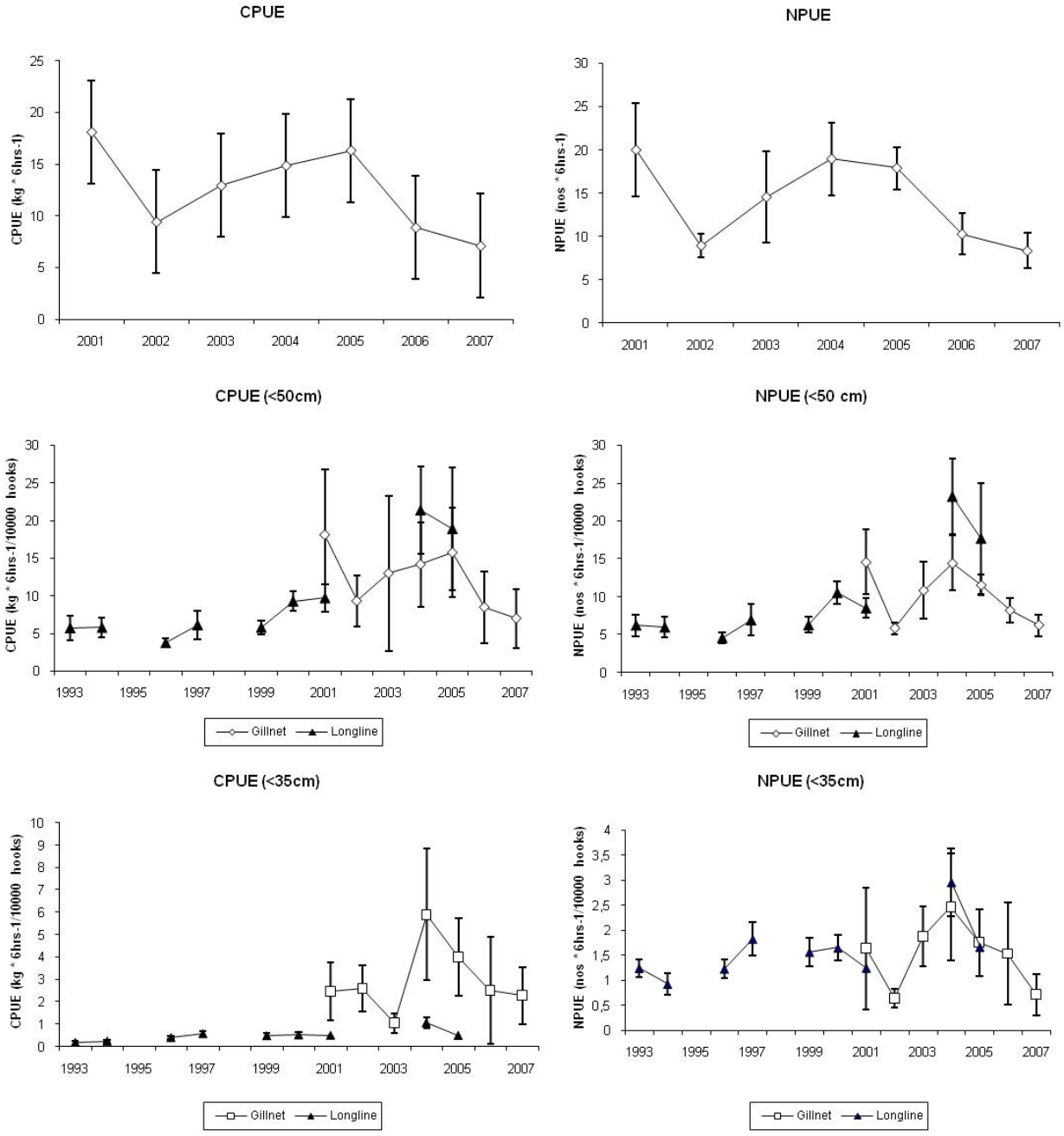

Fig. 7. Upper: Standardised catch rates from gillnet survey in Disko bay (1A) in weight (CPUE) and numbers (NPUE). Middle and lower: CPUE/NPUE by length < 50 cm and <35cm, respectively, for both gillnet and longline survey.

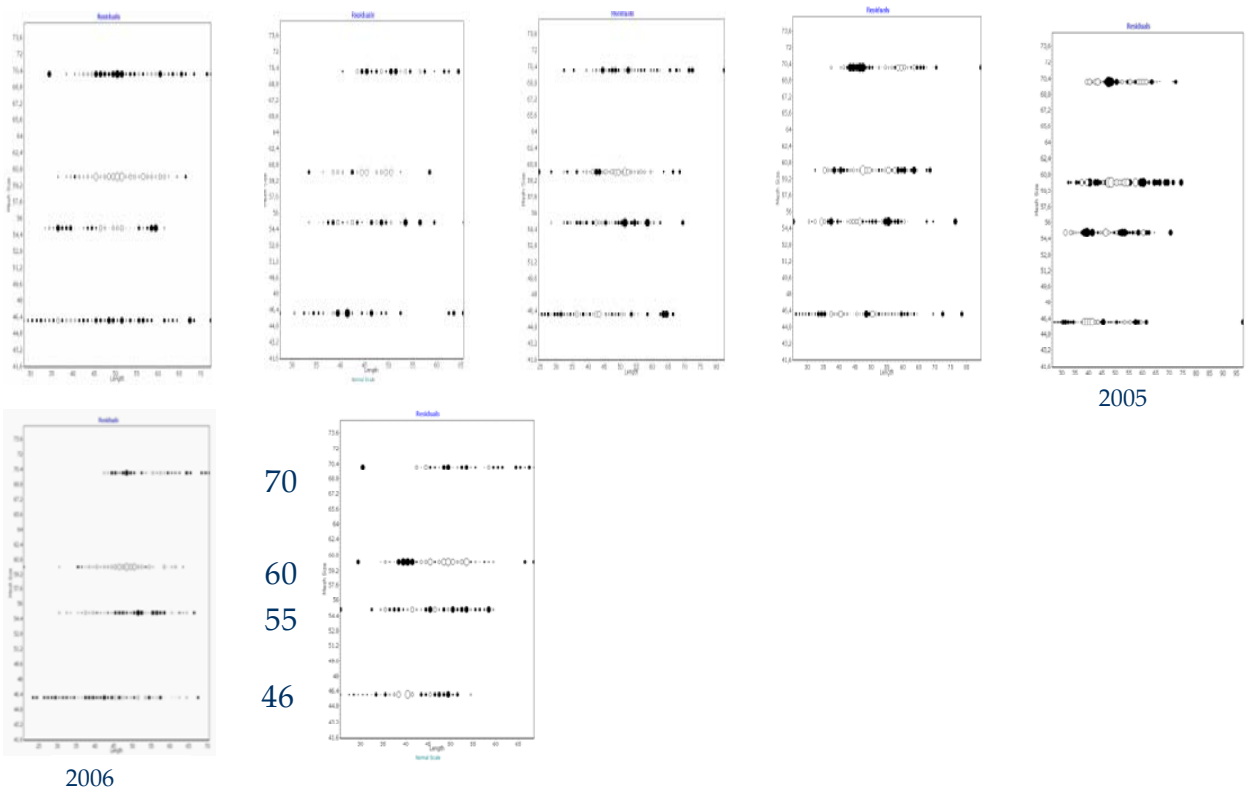

Fig. 8a. Gillnet survey in Disko Bay. Residuals for each meshsize (y-axis) by length (x-axis) from the selectivity model (Wilemans Wings) 2001-2006.

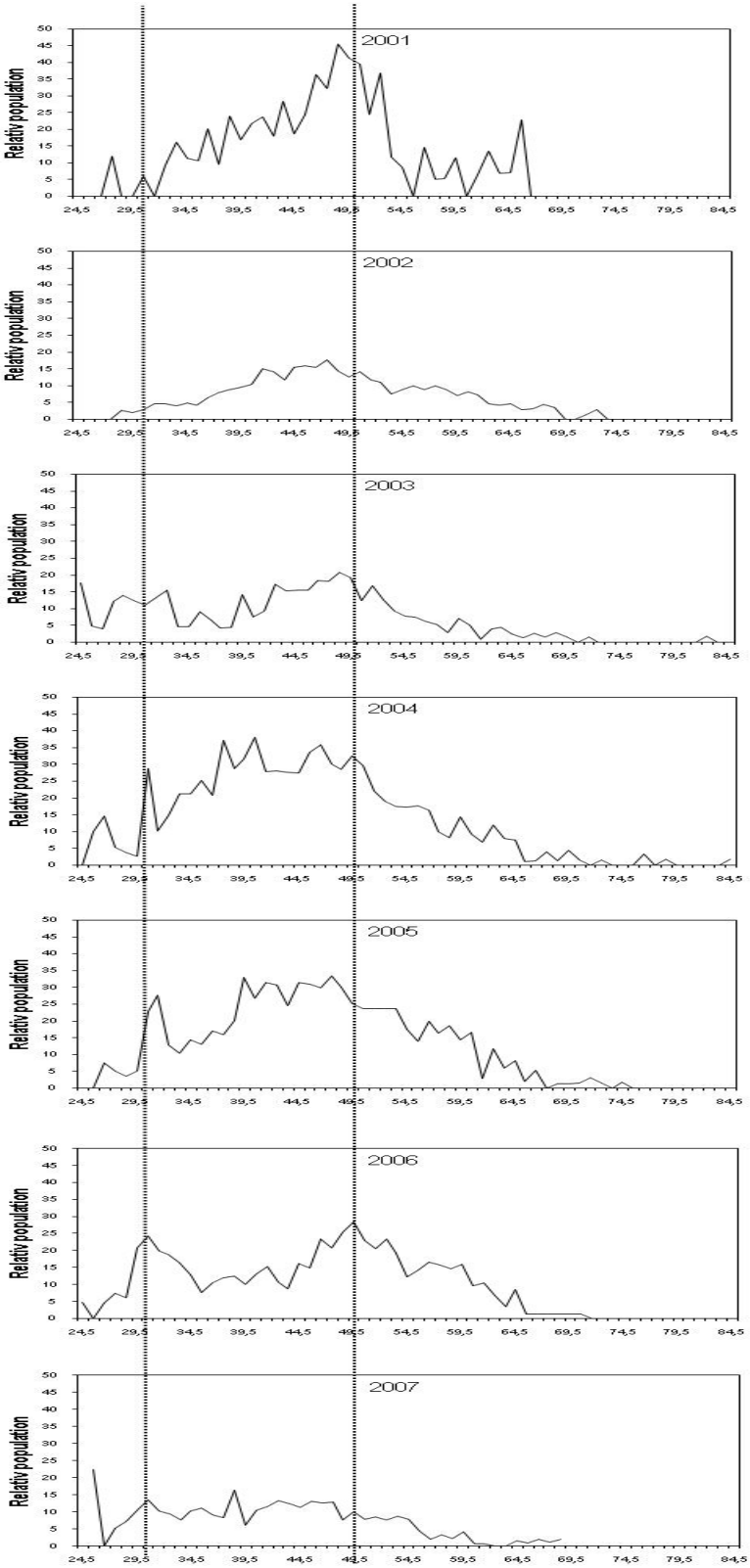

Fig. 8b. Gillnet survey in Disko Bay. Estimated relative population assuming a Wilemans Wings selectivity curve in 2001 to 2005 (from top to bottom): the dashed lines indicate the length interval 30 – 50 cm where fully selection is assumed.

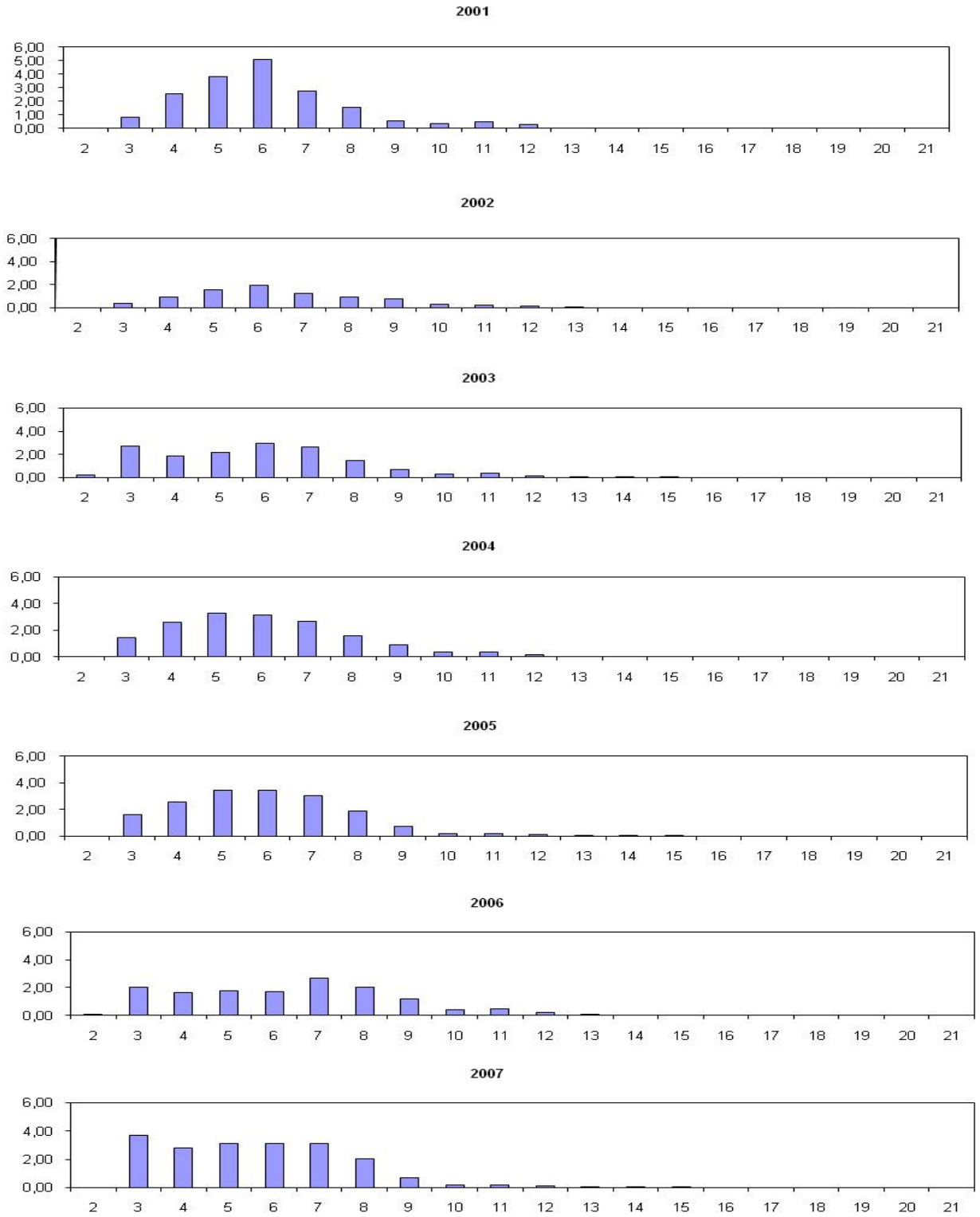

Fig. 9. Gillnet survey in Disko bay. Abundance (estimated relative population) by age.

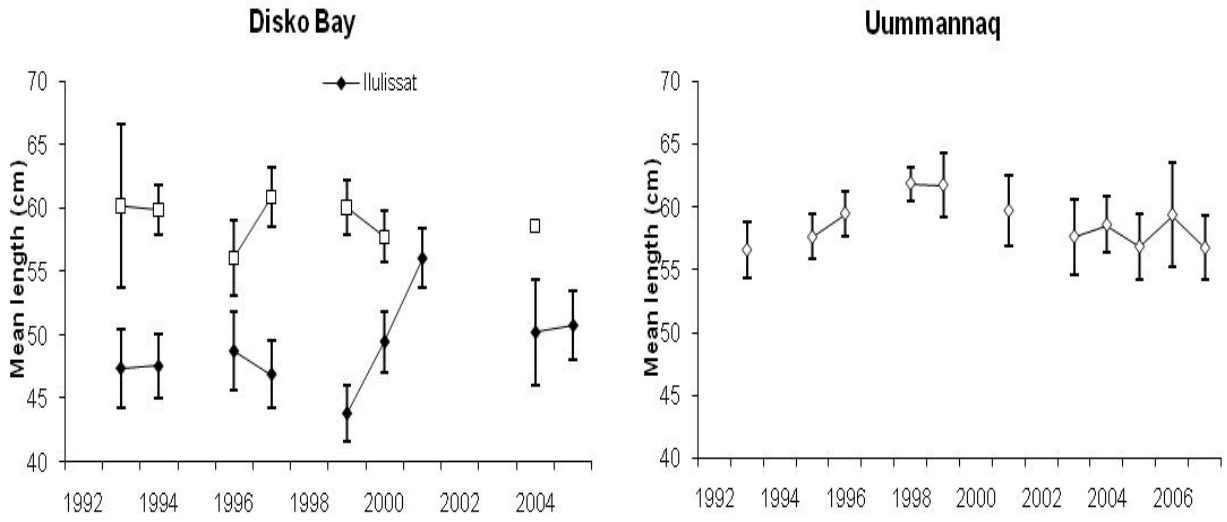

Fig. 10. Mean length for longline surveys conducted since 1993. 95% CI indicated.

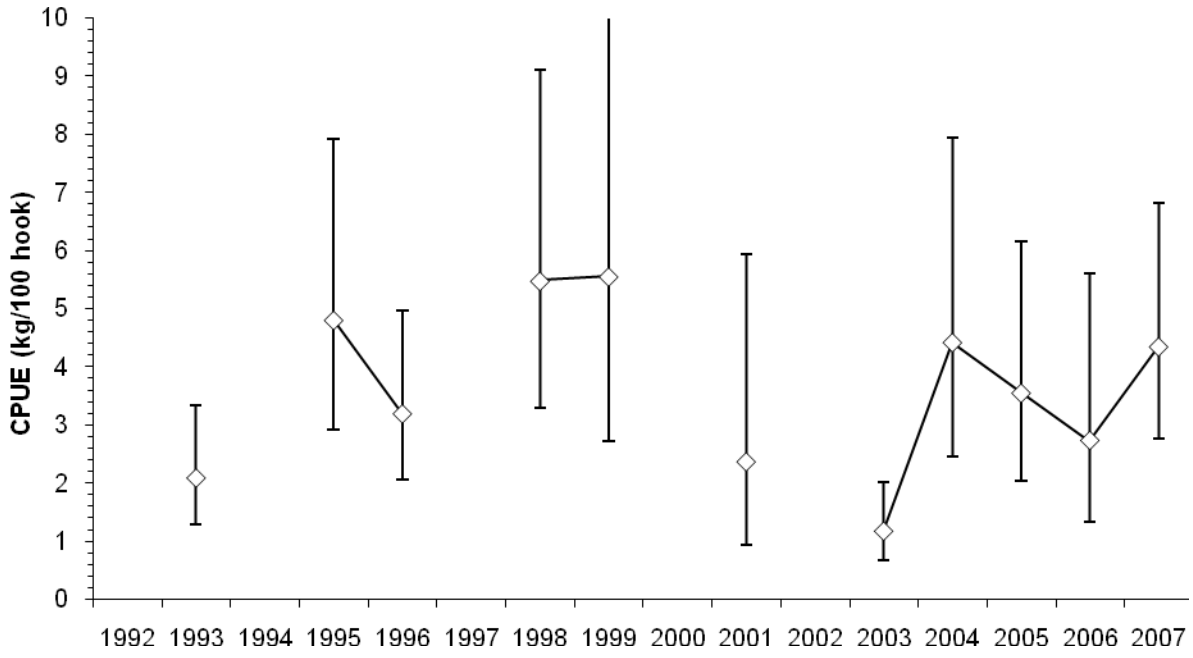

Fig. 11. Longline survey index for Uummannaq 1993-2007. 95% CI indicated.

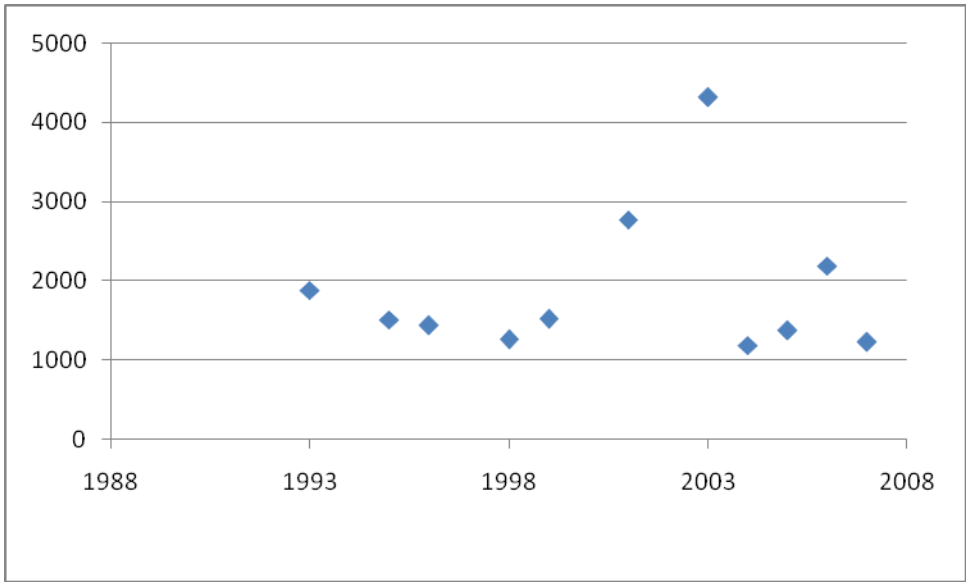

Fig. 12a. Exploitation proxies (Landings/standardized survey index) for Uummannaq.

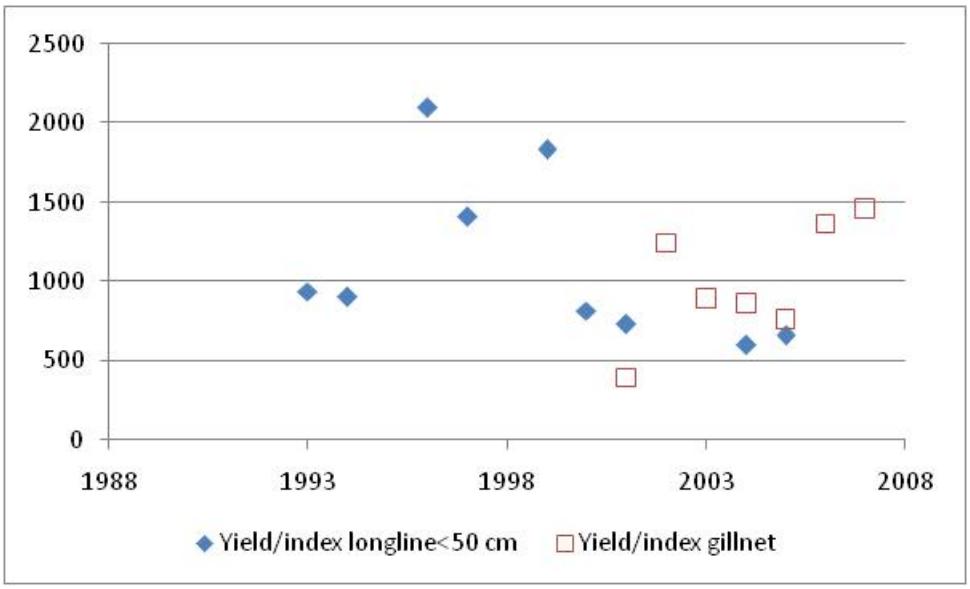

Fig. 12b. Exploitation proxy (Landings/standardized survey index) for Ilulissat for Gillnet survey catch rates and longline survey catch rates.

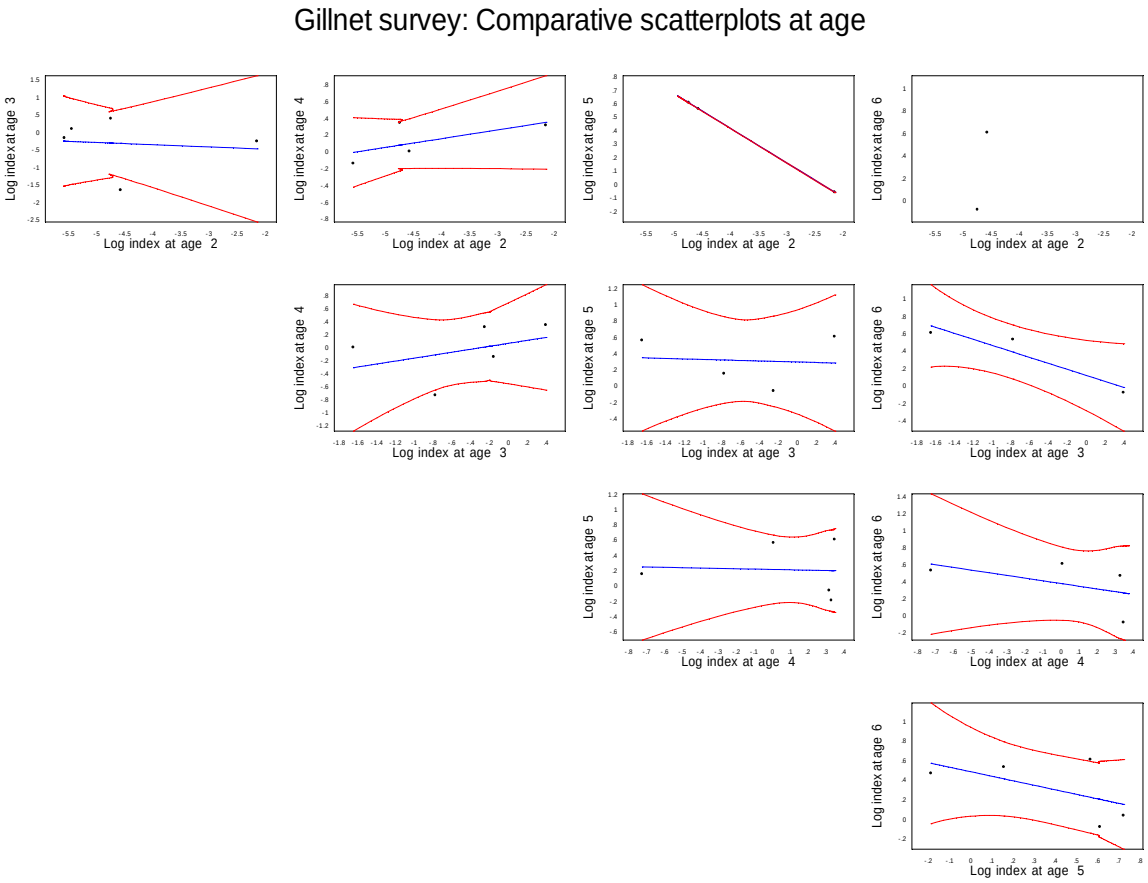

Fig. 13. Gillnet survey in Disko Bay. Plots of comparative cohorts

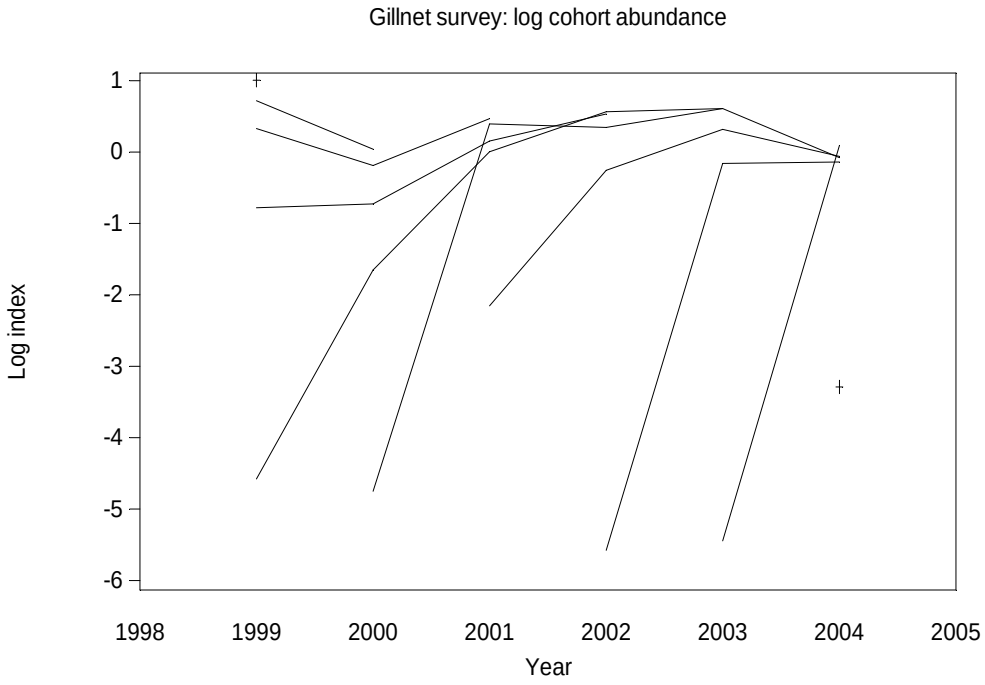

Fig. 14. Greenland halibut Disko Bay 1A; Catch curves of cohort's in the gillnet survey.

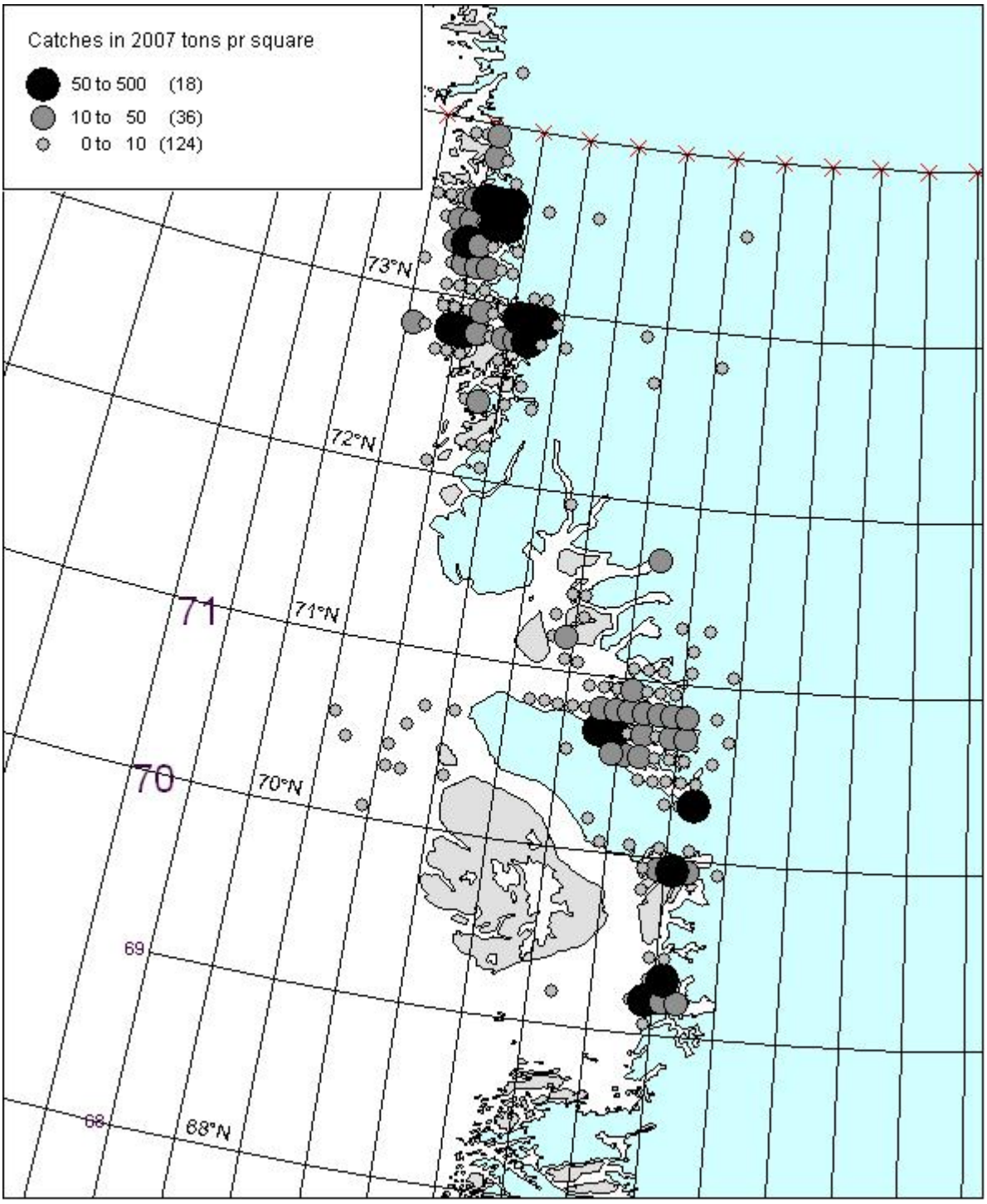

Fig. 15. Logbook reported catch distribution of the inshore fishery for Greenland halibut in Div.1A, catches shown in tonnes per statistical square (field-code defined as 1/32 x 3600 x cos(lat)).

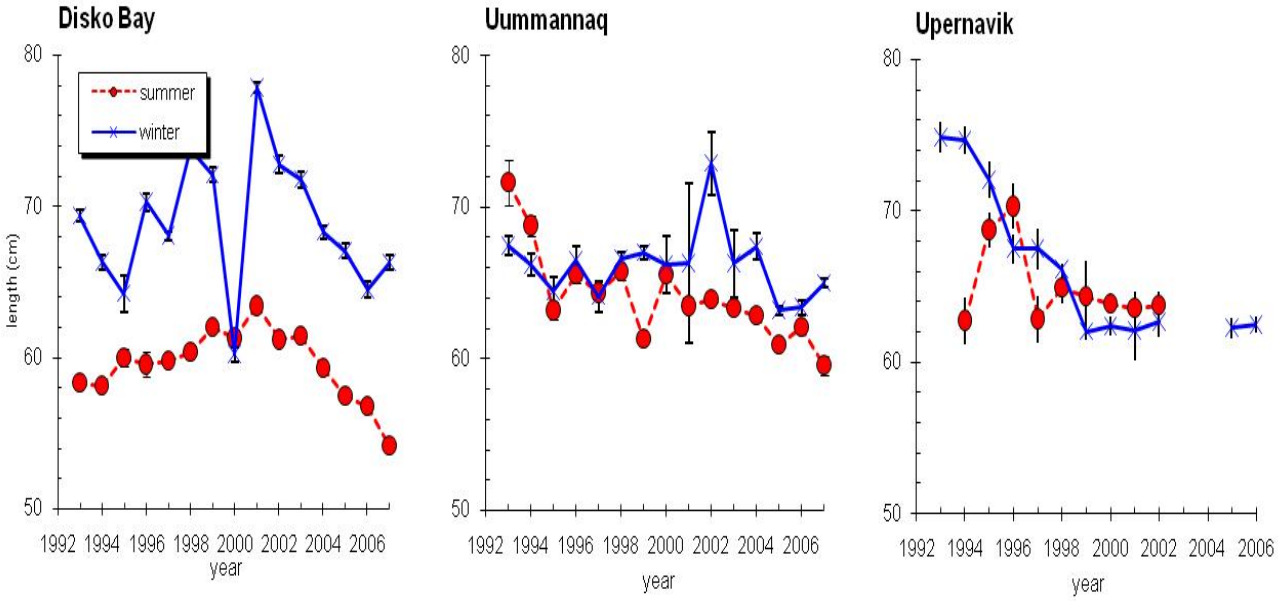

Fig. 16. Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik with 95% conf. Int.

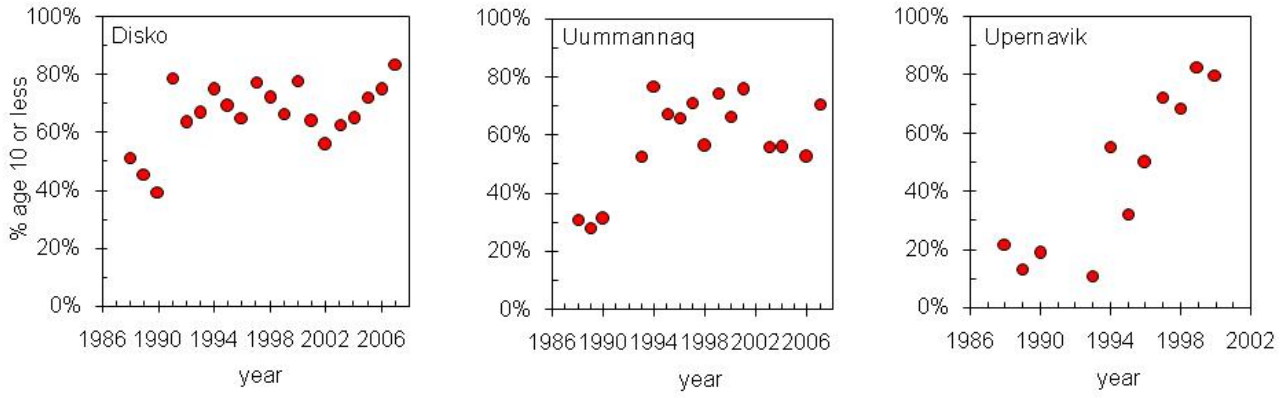

Fig. 17. The development in exploitation of the *age 10 and younger* expressed as percentages of those age groups in commercial landings by year.

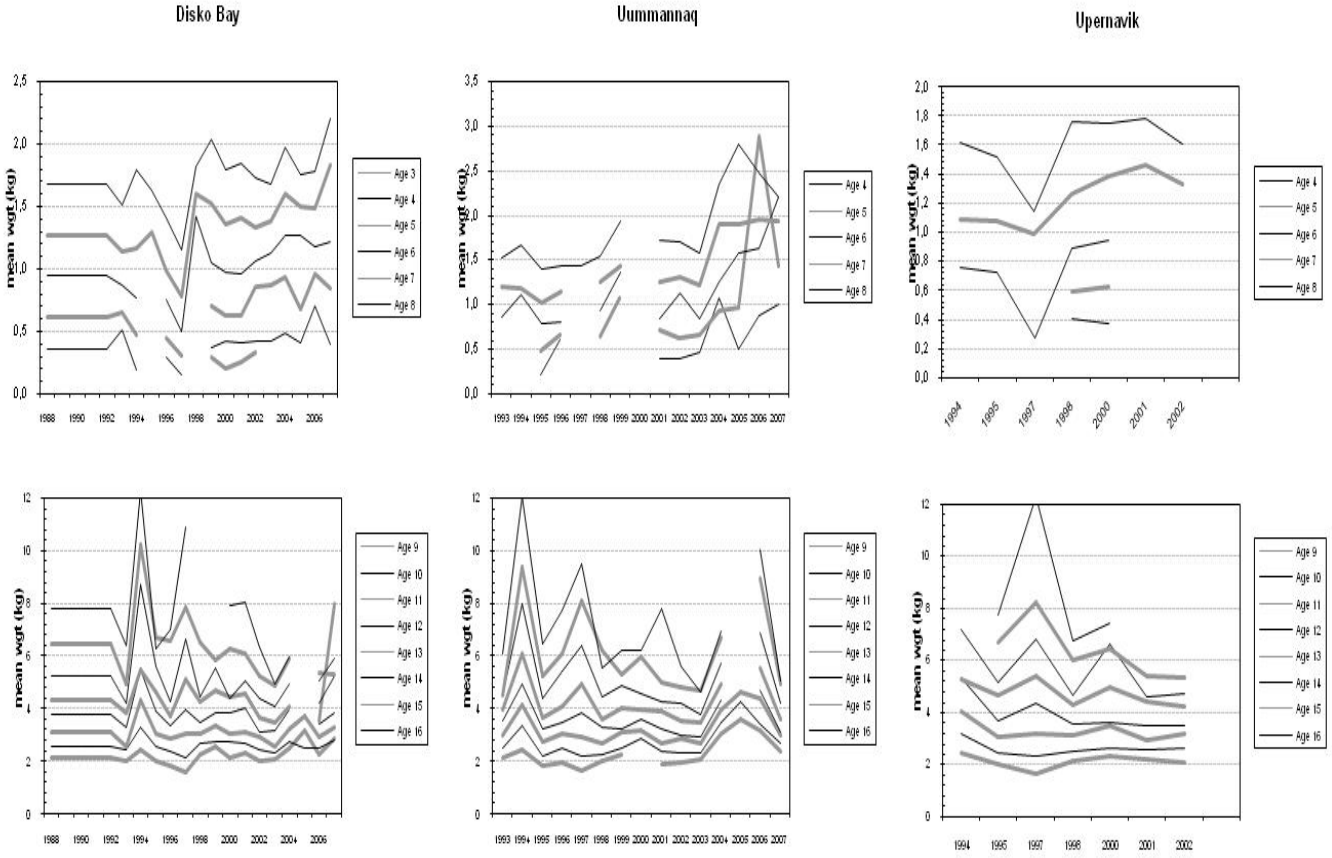

Fig. 18. Weight at age for the three areas Disko Bay, Uummannaq and Upernavik.

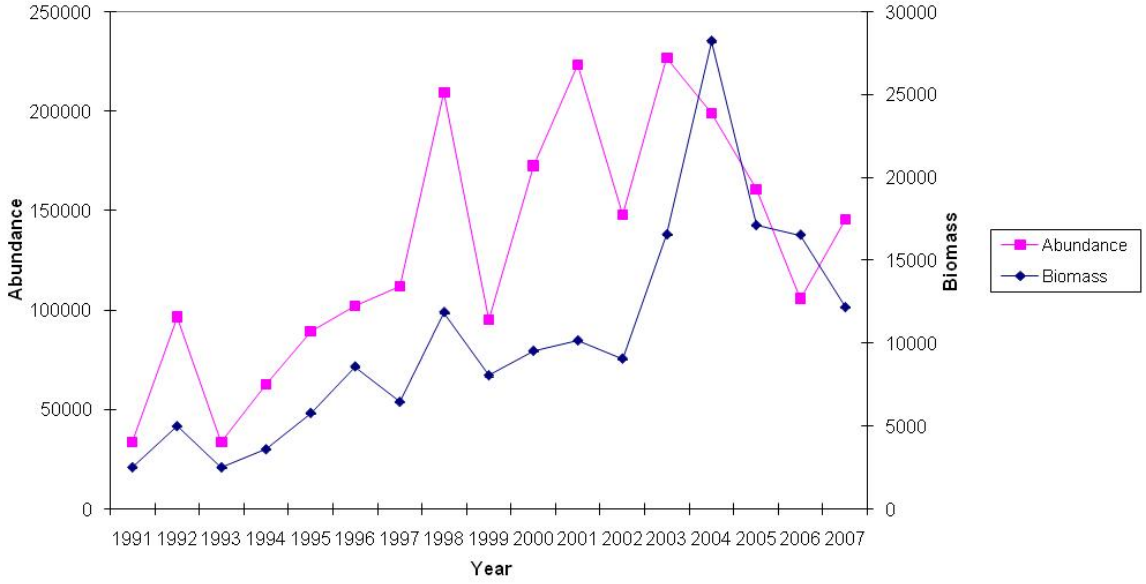

Fig. 19. Abundance ('1000) and Biomass (tonnes) indices of Greenland halibut from the Paamiut trawl survey in Disko Bay. In 2005 a new survey trawl was introduced, but the 2005-2007 catch figures have been adjusted to the old figures according to Nygaard et al. (SCR 08/28) .

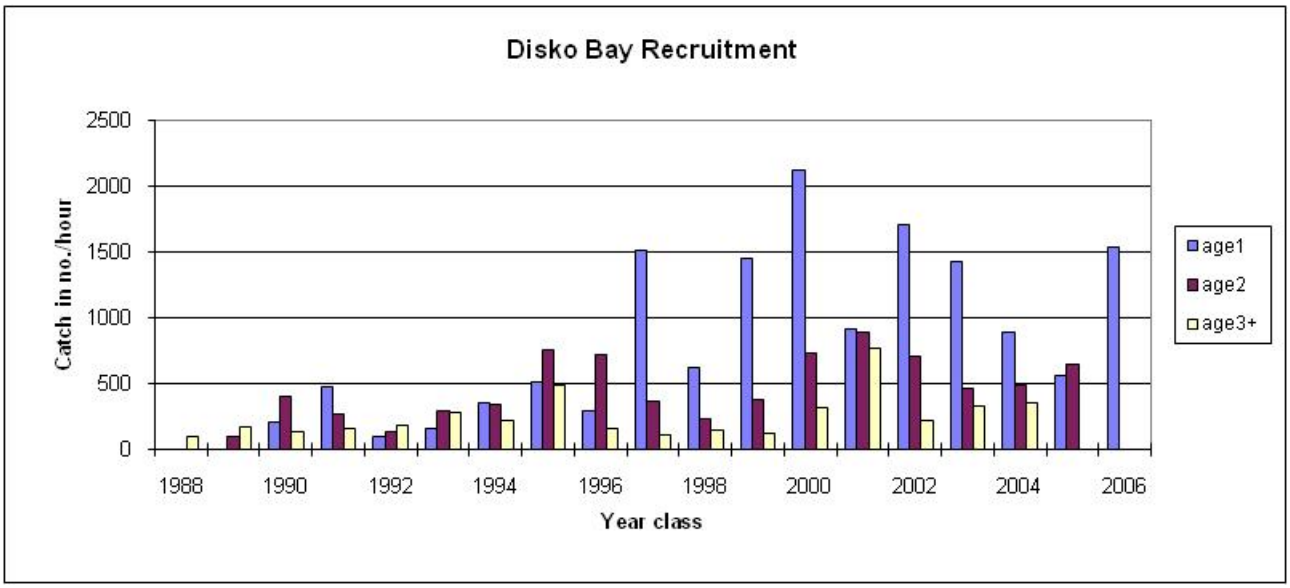

Fig. 20. Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the inshore Disko Bay. In 2005 a new survey trawl was introduced, but the 2005-2007 catch figures have been adjusted to the old figures according to Nygaard et al. (SCR 08/28) .