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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. No survey was conducted in 2009 due to technical problems. Quality of the data provided from the commercial fishery has improved in recent years and a CPUE index is now included for the northernmost Upernavik area.

Disko Bay: catches increased from about 2 000t in the mid 1980s and peaked in 2004 with catches of more than 12 000t. However, since 2006 catches have decreased sharply and in 2009 only 6 300t was landed. 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 1990s. The recruitment index reveals low recruitment in 2007 and 2008. However, abundance at age one may be a poor indicator of recruitment, since strong cohorts' often reveal average strength at year 3.

Uummannaq: catches increased from a stable level of 3 000t in the mid 1980s and peaked in 1999 at a level of more than 8 000t. Catches then decreased and have since 2002 fluctuated between 5 000 and 6 000t. 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: catches increased from the mid 1980s and peaked in 1998 at a level of 7 000t. This was followed by a period of decreasing catches, but since 2002 catches have increased substantially and in 2009 catches have reached 6500t. No survey has been conducted in this area since 2002. Data quality provided by Upernavik seafood has however improved to an unusually high standard since 2007. A CPUE index is now presented for the area, indicating a ~10 % decrease in catch rates since 2008. Mean length in landings have remained stable since 1999 at around 62 cm in both the summer and winter fishery.

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 inshore fishery in SA1 is located in three main areas: Disko Bay, Uummannaq and Upernavik (Fig. 1).
Total landings in SA1 inshore peaked at the end 1990s at about 25 000t. This was followed by two years in a row of decreasing catches to below 17 000t, upon which catches increased again to a level of 23 000t in 2005. Since 2006 however, catches have decreased substantially to a level of 18 000t. Unlike the decrease seen in the end 1990s, the recent decrease in SA1 inshore is driven exclusively by the Disko bay area where catches have been halved in just 3 years.

TAC for inshore areas and stocks been introduced in 2008 with quotas of 12 500tons for Disko Bay and 5 000tons for Uummannaq and Upernavik areas. Since 1998 regulations have restricted effort increase by means of licenses to land fish. There are no landing limitations on the fishery licenses and fishery is free until the quota has been reached which has led to pressure on authorities for "extra quota" when the quota have been reached. The fleet has some peculiar constraints. Fishermen are allowed to move and fish in an area north of their home area, but are not allowed to fish in an area south of their home fjord area. This means that effort can move north, but not south.

The fishery is traditionally performed with longline 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. Longlines however still constitute 90-99 % of the total landings. In the late 1990s 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 500tons (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. However, since 2006 catches have decreased sharply and in 2009 only 6 300t was landed. 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. 4). 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 increased from a stable level of 3 000t in the mid 1980s and peaked in 1999 at a level of more than 8 000t. Catches then decreased and have since 2002 fluctuated between 5 000 and 6 000t. (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 landings in the Upernavik area increased from the mid 1980s and peaked in 1998 at a level of 7 000t. This was followed by a period of decreasing catches, but since 2002 catches have increased substantially and in 2009 catches have reached 6500t. (Fig. 2 and Table 1). The northernmost area consists of a large number of ice fjords. Fishery in this area started in the 1980s. 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.

Input data

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 CPUEs 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 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 4). The surveyed area covers the proposed young fish areas in Disko Bay, off Ilulissat and the Icefjord and off the northern icefjord Torssukattak (Fig. 5). 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 trawl surveys with R/V "Pamiut" in June/July for shrimp and demersal fish. 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. 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.

Commercial fishery data

Landings data

Data on the inshore landings of Greenland halibut for Disko Bay and Uummannaq were obtained from Royal Greenland 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 minor fraction of the data received from RG was allocated to gear, and the remaining catches were allocated according to these available data. 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 1.10. The conversion factor for gutted fish without head and tail are 1.35.

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 500tons representing about 10-15 % of total landings covering the entire fishing area. Efforts data are not yet 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. However, data quality provided to GFLK by different companies along the coastline is improving, and especially Upernavik seafood now provides high quality data. Figure 3 gives a CPUE index for Upernavik since 2007.

CAA -Catch at age

For 2009 the CAA data was based on otoliths from the Disko Bay 2009 otoliths only (Table 2). Catch at age data is presented in Table 3a-b. The CAA is based on length frequencies collected from the commercial fishery during summer and winter season (Table 3b). No maturity data were available. In 2008 no length frequencies was available from the Uummannaq area and the CAA is based on winter length frequencies. Total catch in numbers is therefore an underestimate as winter mean length is normally higher than summer mean length.

Assessment

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 figure 6. 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 figure 6, 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.

In 2007 most catches in the survey was obtained in the area just north of Ilulissat (stat. sq. LH028) and off the northern Icefjord Torssukattak (Fig. 7). The standardized catch rates in the survey from 2001 to 2008 reveal a decline from 2004 to 2007 (Fig. 8). However, the 2008 CPUE and NPUE are at the same level or slightly increasing.

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 (Fig. 9).

Assuming a bi-modal selection curve (Wilemans wings) as given in figure 6 will result in relative underlying populations as provided in figure 10b. The fit of the assumed selection curve to the catch data is given in figure 10a. The estimated relative population suggest an inflow of small fish since 2003, but cohorts are not easy to follow (fig 11). Age distributions are rather uniform between years and only in 2003 high abundance of age 3 deviate from the mean. Figure 15 show that the year to year consistency of cohorts is very poor in the gillnet survey, suggesting that the distribution is not totally covered.

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 survey. In order to establish a calibration key between the gillnet and the longline surveys, both longline and gillnet 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. 9). 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. 12). 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. 12b).

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. 12). Catch rates have shown a considerable decrease from 1998/99 to 2003, but have since increased and stayed stable from 2004 to 2007 at about average of the time series (Fig. 13). The length composition in the survey catches have varied considerably since 1993, in general being broad (Fig. 12). Distributions suggest that good year-classes are contributing to survey since 2003. Exploitation of the populations in Uummannaq has increased since the late 1990s and especially in 2003 and 2006 (Fig. 12a). No survey has been conducted since 2007.

Upernavik

Since 2000 no longline survey has been carried out in Upernavik, but a survey is scheduled in 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).

Commercial Fishery

Size distribution

Mean lengths from the longline landings in the period 1993 to spring 2010 in Disko Bay and Uummannaq are showed in figure 16. Fish caught in summer are generally smaller than fish caught during winter, and winter average size in general shows higher inter annual variation.
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 which is below the proposed minimum size. However average size has since increased to about 56 cm in 2009.

In Uummannaq mean lengths in the winter fishery and the summer fishery have shown a decreasing trend since 2007.

Mean lengths in Upernavik winter fishery have been decreasing trough the 1990'ies, and have been stable around 62 cm since 1999.

Catch at age

For all three areas there has been a shift in exploitation pattern through the time series (Fig. 17). In the Disko Bay, exploitation of age-class 10 and younger has increased since 2002 to 90%. In the Uummannaq fjord exploitation of age 10 and younger has increased since 2006 to 80% and is at the same high level as in the 1990s. In Upernavik the exploitation of age-class 10 and younger is at a lower level than the end 1990s.

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 (SCR 10/30). 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 re-stratified 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 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 slightly above 9 000t. The abundance has decreased in recent years and in 2009 the estimate is 71 mill. (Fig. 19).

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. However, age 1 Greenland halibut is abundant at depths of 200-300 meters and the recruitment index may not fully cover ages 1 and 2.

Estimated length distributions (Fig. 21) from the Greenland shrimp/fish survey indicates that abundance at age one may be a poor indicator of recruitment in the inshore areas, since strong cohorts often reveal average strength at year 3. It is possible that if recruitment is above a certain threshold, it will meet its carrying capacity. An indicator of this is the fairly strong 2004 year-class that at age 3 was at about the same level as the weaker 2005 cohort at age 3 (~30cm).

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 in Uummannaq and Disko bay makes it difficult to evaluate trends in landings relative to stock biomass or fishing effort.

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 1990s. Recruitment has varied since the good 1997 year-class, but has been above the level in early and mid 1990s. The recruitment of the 2006 year-class was the third largest in the time series, but recruitment in 2008 is below average.

Uummannaq

Landings have remained stable since 2002. Mean lengths from the commercial fishery have been relatively stable until 2007 but has decreased since then. 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 or decreasing 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. The CPUE index from the commercial fishery reveals decreasing catches and that the current catch level of 6 500t may not me sustainable. 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.

References

Bech, G., 1995. Recruitment of Greenland halibut at West Greenland. NAFO Scr.Doc. 95/19.

Boje, J. (1994). Migrations of Greenland halibut in Northwest Atlantic based on tagging experiments in Greenland waters 1986-92. NAFO Scr.Doc. 94/18

Boje, J. And Lyberth, B. (2005) Survey Calibration for Greenland Halibut in Division 1A Inshore. NAFO Scr. Doc.05/57 (N5143)

Jørgensen, O. A. and D. M. Carlsson (1998). An estimate of by-catch of fish in the West Greenland shrimp fishery based on survey data. NAFO Scr.Doc. 98/41(N3030)

Jørgensen, O.A. and Boje, J., 1994. Sexual maturity of Greenland halibut in NAFO Subarea 1. NAFO Scr.Doc., 94/42(No. N2412).

Lyberth, B. And Boje, J. 2006 An Assessment of the Greenland Halibut Stock Component in NAFO Division 1A Inshore. NAFO Scr. Doc. 06/35 (N5258)

Nygaard, R. and Jørgensen O. A., 2010. Biomass and Abundance of Demersal Fish Stocks off West Greenland Estimated from the Greenland Shrimp Survey, 1988-2009. NAFO Scr. doc.10/30.

Riget, F. and J. Boje (1989). Fishery and some biological aspects of Greenland halibut (*Reinhardtius hippoglossoides*) in West Greenland waters. NAFO Sci.Council Studies(13): 41-52.

Simonsen, C.S. and Roepstorff, A., 2000. Udvikling og adfærd af fisk & fiskere i Diskobugt området. In: H. M. and O.R. Rasmussen (Editors), Innusuk -Arktisk Forsknings Journal. Direktoratet for Kultur, Uddannelse og Forskning, Nuuk, Grønland, pp. 29-43. *In danish*

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

Simonsen C.S. and Gundersen A.C. (2005) Ovary development in Greenland halibut *Reinhardtius hippoglossoides* in west Greenland waters J. Fish Biol. 67 1299-1317

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 21A	STACFIS
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	0,0	0,0	18,9
2009	6,3	5,5	6,5	0,0	0,0	0,0	18,3

Table 2. Summary of the Age-length keys used for 2009. Age readings are from Disko bay area only.

	Age													
Length	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16+
5-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-24	20	0	0	0	0	0	0	0	0	0	0	0	0	0
25-29	41	19	2	0	0	0	0	0	0	0	0	0	0	0
30-34	17	37	9	0	0	0	0	0	0	0	0	0	0	0
35-39	0	20	23	1	1	0	0	0	0	0	0	0	0	0
40-44	2	6	39	10	3	0	0	1	0	0	0	0	0	0
45-49	0	0	10	43	30	2	0	0	0	0	0	0	0	0
50-54	0	0	0	5	52	25	3	0	0	0	0	0	0	0
55-59	0	0	0	0	11	36	12	7	0	0	0	0	0	0
60-64	0	0	0	0	3	12	23	17	6	1	0	0	0	0
65-69	0	0	0	0	0	4	12	17	10	7	1	0	0	0
70-74	0	0	0	0	0	1	0	7	21	22	14	4	2	0
75-79	0	0	0	0	0	0	0	0	10	7	14	6	4	1
80-84	0	0	0	0	0	0	0	0	2	4	7	12	4	0
85-89	0	0	0	0	0	0	0	0	0	1	5	4	2	1
90-94	0	0	0	0	0	0	0	0	0	2	2	1	0	2
95-99	0	0	0	0	0	0	0	0	0	0	1	1	1	2
100-104	0	0	0	0	0	0	0	0	0	0	0	0	1	4
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	5
110-114	0	0	0	0	0	0	0	0	0	0	0	0	0	5

Table 3a. Disko bay Catch at age of Greenland halibut. "–" indicates insufficient or missing sampling.

age/year	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1988	0	0	1	9	59	182	173	132	73	63	65	38	33	828
1989	0	0	0	0	14	106	121	94	49	33	39	31	41	528
1990	0	0	0	1	24	141	185	188	126	80	59	42	44	890
1991	5	5	11	279	806	535	333	238	76	45	67	57	44	2501
1992	34	92	122	332	476	390	451	532	309	140	92	18	0	2988
1993	7	15	62	280	479	339	280	240	122	91	112	75	86	2188
1994	0	3	15	112	281	539	396	190	91	50	45	41	36	1799
1995	0	0	0	45	459	639	798	463	185	127	27	36	27	2806
1996	0	8	1	47	323	941	651	454	273	145	75	44	69	3031
1997	0	0	21	132	646	1113	1168	607	185	69	19	10	6	3976
1998	0	0	74	397	775	944	1248	754	346	132	68	27	6	4770
1999	1	4	41	360	619	836	1028	786	426	136	72	29	2	4340
2000	0	9	98	535	729	780	636	478	223	52	28	12	1	3583
2001	1	15	33	224	390	521	450	485	280	78	33	31	16	2557
2002	0	2	54	283	561	771	421	575	393	398	175	112	0	3745
2003	0	2	64	425	722	1.187	610	847	422	158	146	135	89	4808
2004	0	2	56	409	691	1083	634	730	311	144	130	152	89	4431
2005	1	48	287	516	703	868	423	481	213	100	97	122	83	3943
2006	0	10	211	882	1001	1008	522	582	231	105	89	125	85	4852
2007	0	2	56	459	1073	754	749	151	94	4	166	126	60	3694
2008	0	2	46	363	825	552	548	105	66	2	114	86	40	2751
2009	0	1	26	199	904	962	515	337	147	79	55	40	26	13	3303

Table b. Uummannaq CAA. (– = insufficient sampling, [1] = winter length freq only).

age/year	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1988	0	0	1	5	20	52	121	143	121	96	49	23	17	648
1989	0	0	0	2	9	35	98	120	99	76	38	19	20	516
1990	0	0	1	3	15	47	108	121	101	82	42	20	21	561
1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	0	0	9	45	200	202	142	138	104	158	93	28	20	1139
1994	0	0	24	105	226	271	346	139	105	34	12	0	3	1265
1995	0	0	6	217	564	601	413	414	219	138	49	28	22	2671
1996	1	0	6	76	308	279	286	232	142	69	28	11	15	1453
1997	0	0	0	69	377	793	702	460	206	75	32	10	6	2732
1998	0	0	0	0	235	566	657	586	355	138	39	15	5	2595
1999	8	70	218	554	596	690	789	526	295	131	42	12	4	3935
2000	0	19	86	357	441	543	669	487	311	170	68	24	8	3184
2001	0	65	113	674	507	315	492	303	178	121	60	28	12	2868
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	0	3	21	127	360	321	235	220	158	78	145	150	94	1911
2004	0	1	10	105	197	249	198	163	118	82	103	78	59	1364
2005	1	17	101	108	192	142	115	109	74	58	80	67	50	1115
2006	1	32	12	47	243	70	284	127	324	49	108	9	9	1315
2007	3	40	181	221	340	273	192	149	94	64	82	71	56	1767
2008	4	46	203	249	381	304	213	166	104	71	91	79	63	1974
2009*	0	3	9	25	238	525	470	415	243	157	90	42	20	11	2248

Table 3c. Upernavik Catch at age of Greenland halibut. "–" indicates insufficient or missing sampling.

age/year	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1988	0	0	0	0	0	6	33	55	80	74	68	62	31	22	431
1989	0	0	0	0	0	2	16	34	59	66	69	73	40	31	390
1990	0	0	0	0	0	2	17	41	62	57	52	48	25	17	321
1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	0	0	0	0	0	2	16	86	252	268	143	95	40	46	948
1994	0	0	0	2	51	188	316	217	239	154	155	51	23	0	1396
1995	0	0	0	0	13	55	84	128	133	147	117	103	45	42	867
1996	0	0	3	0	16	114	359	275	238	206	151	90	48	39	1539
1997	0	0	4	25	142	428	500	430	278	175	67	37	19	8	2111
1998	0	0	0	116	343	538	535	505	410	275	112	84	39	10	2968
1999	0	14	55	172	449	619	566	343	229	138	51	36	16	5	2679
2000	0	0	2	108	420	446	302	160	133	116	48	38	17	9	1800
2001	0	0	28	144	404	422	258	103	104	87	36	14	9	3	1611
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	0	0	4	65	197	429	274	788	372	135	10	6	0	6	2284
2009	0	0	11	48	275	513	497	472	315	220	121	60	42	5	2580

Table 4. Number of gillnet settings by stat. square in gillnet survey in Disko Bay since 2001.

	year								
FELT	2001	2002	2003	2004	2005	2006	2007	2008	Grand 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		1	6
LG027	4	7	6	5	6	5	4	3	40
LG028	2	2	1	1	1	3	1	1	12
LH026		2	1		1	1		2	7
LH027		5	3	4	3	3		4	22
LH028	2	1	9	6	8	4	1	1	32
LJ026		3	2	2		4	2	3	16
LJ028		5	4	5	4	4	4	4	30
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	2	20
LN027		2	2	2	2	2		1	11
LN028		2	2	2	2				8
LP024		2					2		4
LJ025								2	2
LJ027								3	3
LK026								1	1
LK028								3	3
LP025								2	2
LP027								2	2
LP028								1	1
Grand Total	8	55	58	51	47	44	30	36	329

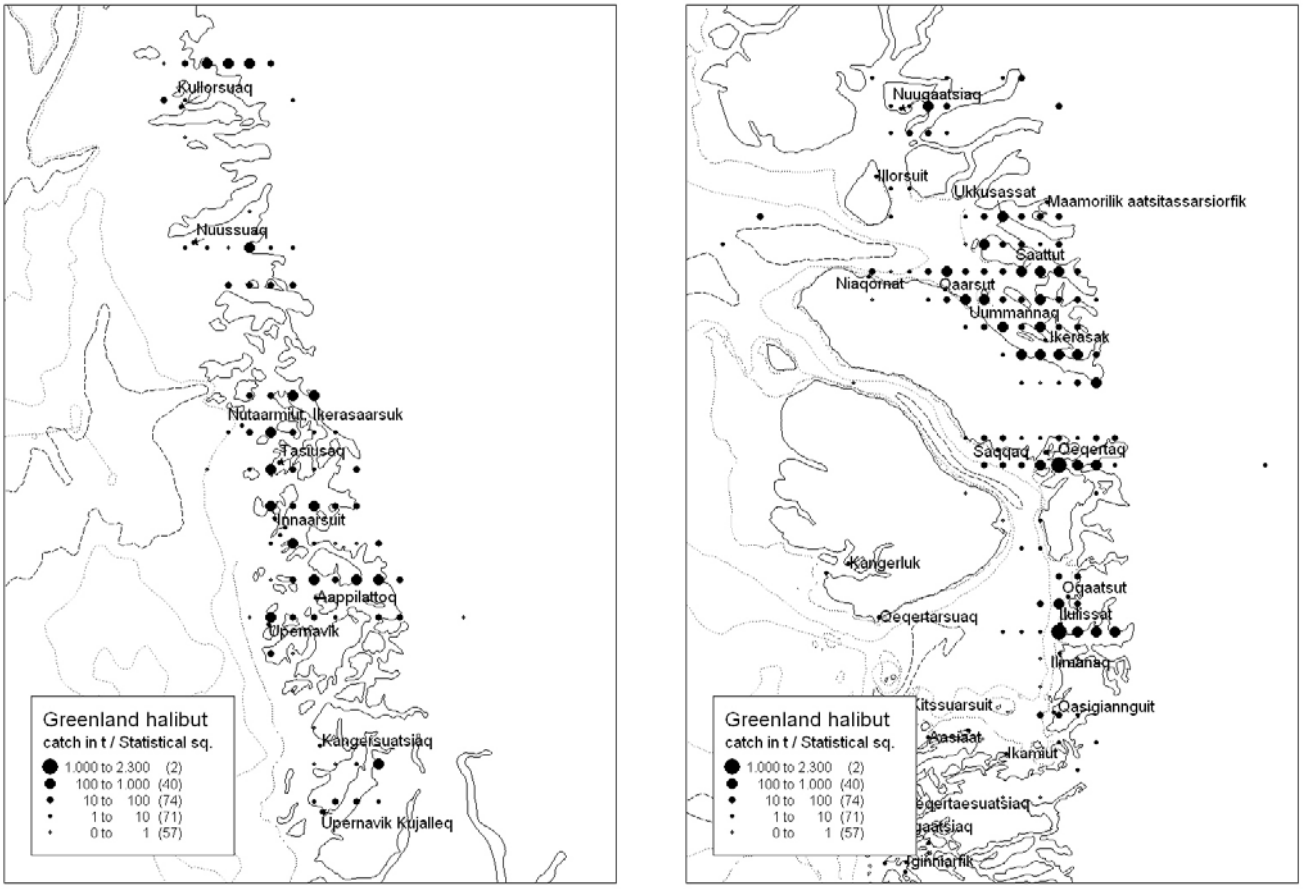

Fig. 1. Distribution of the inshore fishery for Greenland halibut in Div.1A Upernavik Area in 2007. Landings is shown in tonnes per statistical square (field-code defined as 1/32 x 3600 x cos(lat)). Catch statistics are provided by Upernavik Seafood, Royal Greenland and GFLK.

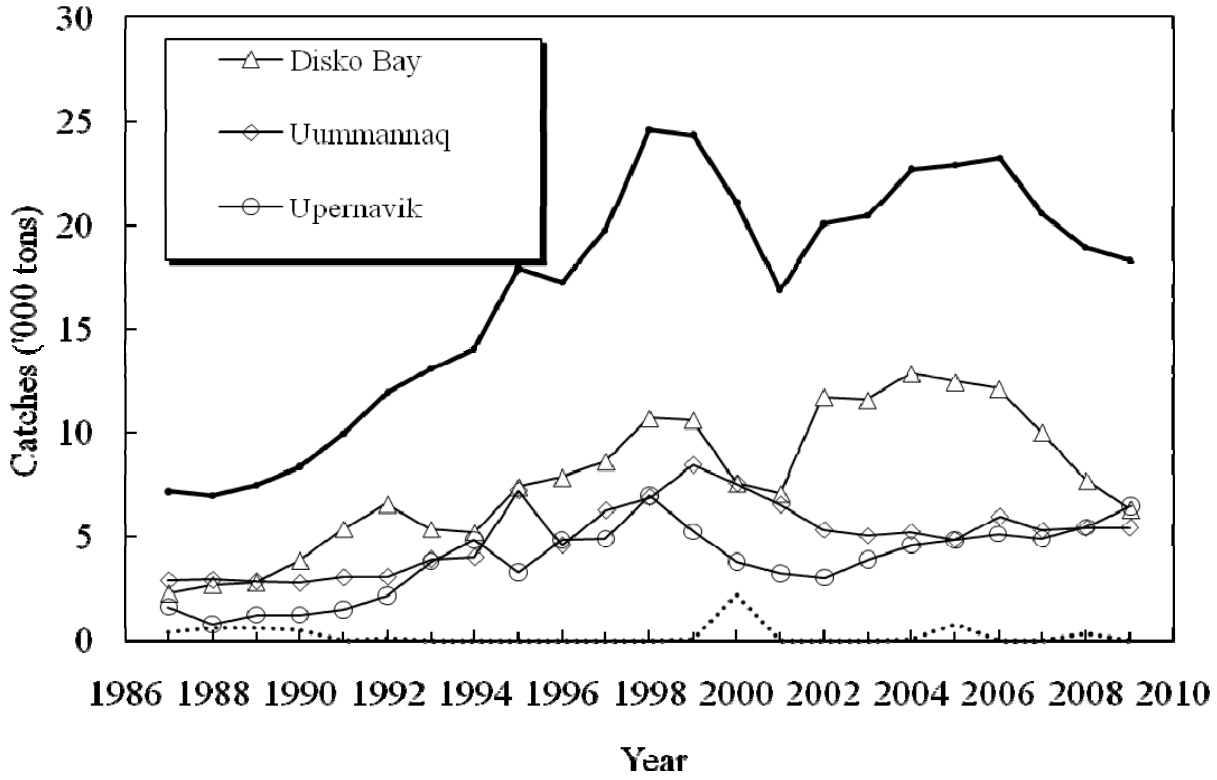

Fig. 2. Landings in NAFO Div. 1A since 1987 for the 3 main fishing areas. Data on landings from 2000-2007 are provisional. See also Table 1.

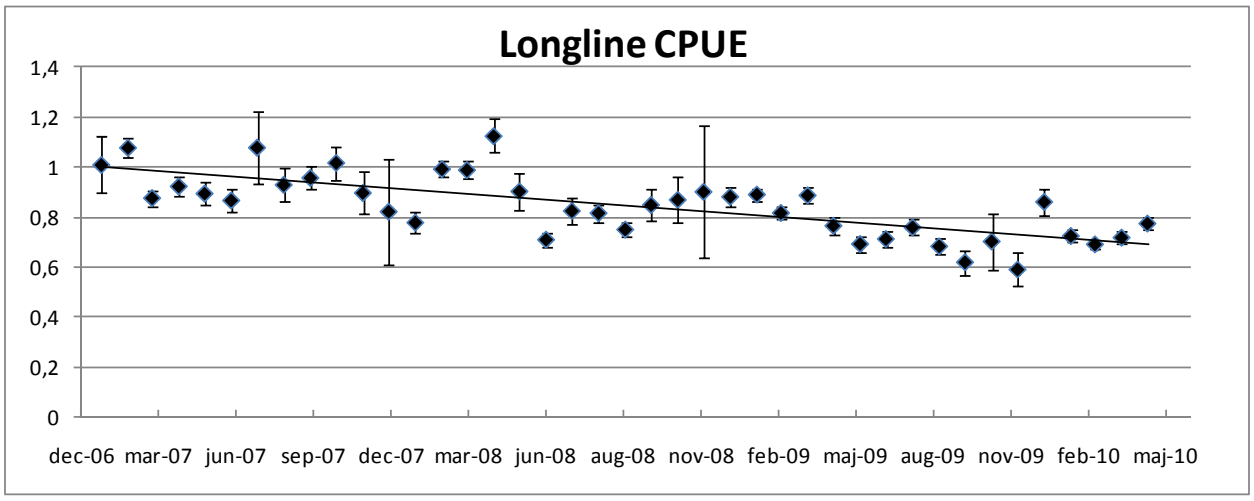

Fig 3 . CPUE for commercial LongLine catches (kg/hook). Data provided by Upernavik Seafood.

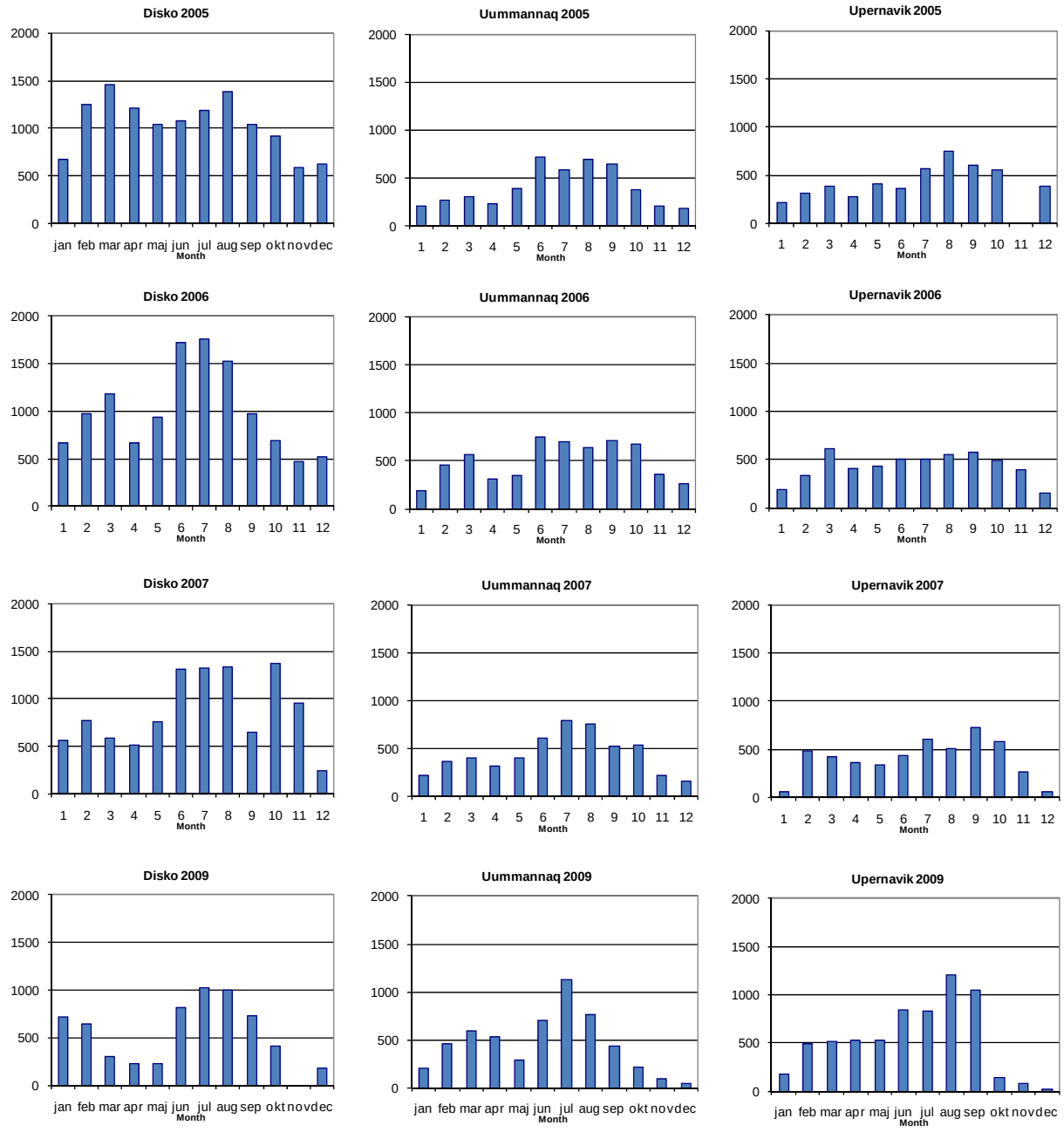

Fig. 4. Landings (t) in NAFO Div.1A inshore by month and area since 2005 (2008 missing).

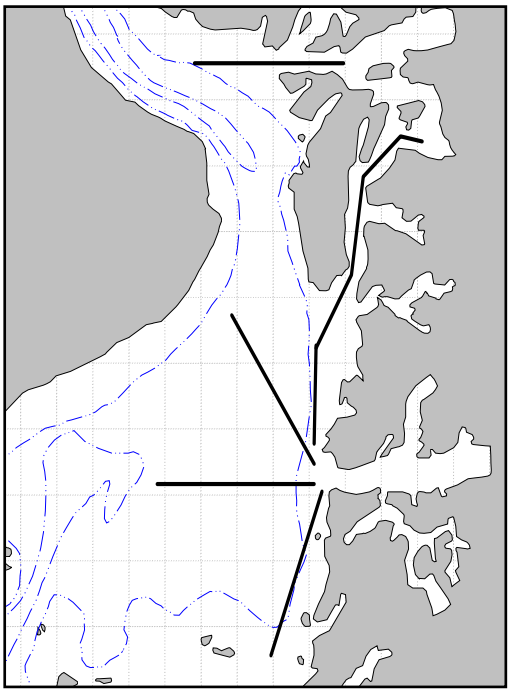

Fig. 5. Map of area in Disko Bay for gillnet survey. Lines are transects along which fixed stations are positioned.

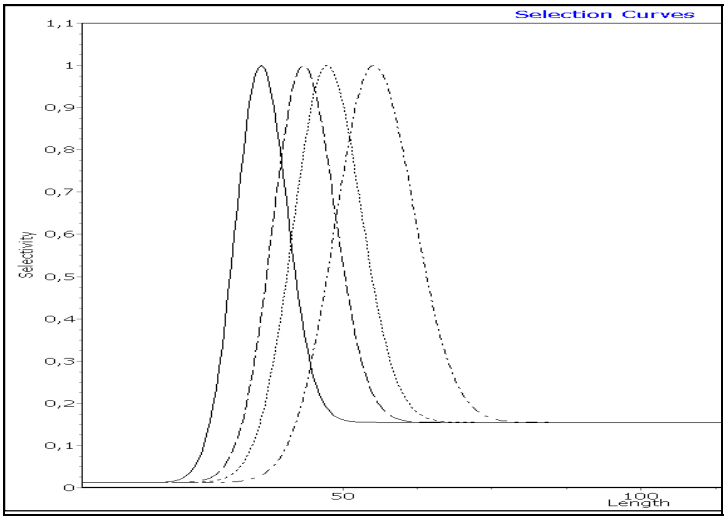

Fig. 6. Assumed selectivity curve applied to gillnet survey catches (Wilemans wings).

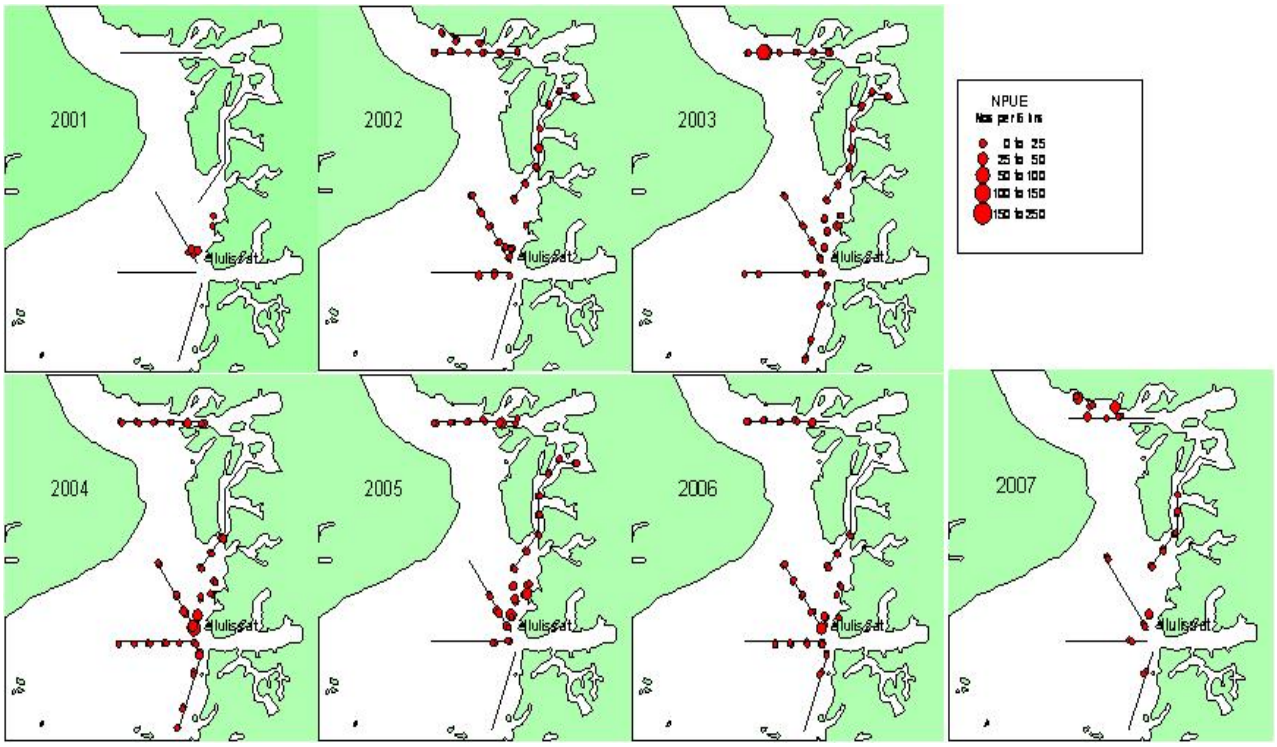

Fig. 7. Gillnet survey in Disko Bay 2001-2007. NPUE distribution (Nos G.halibut per 6 hrs of setting).

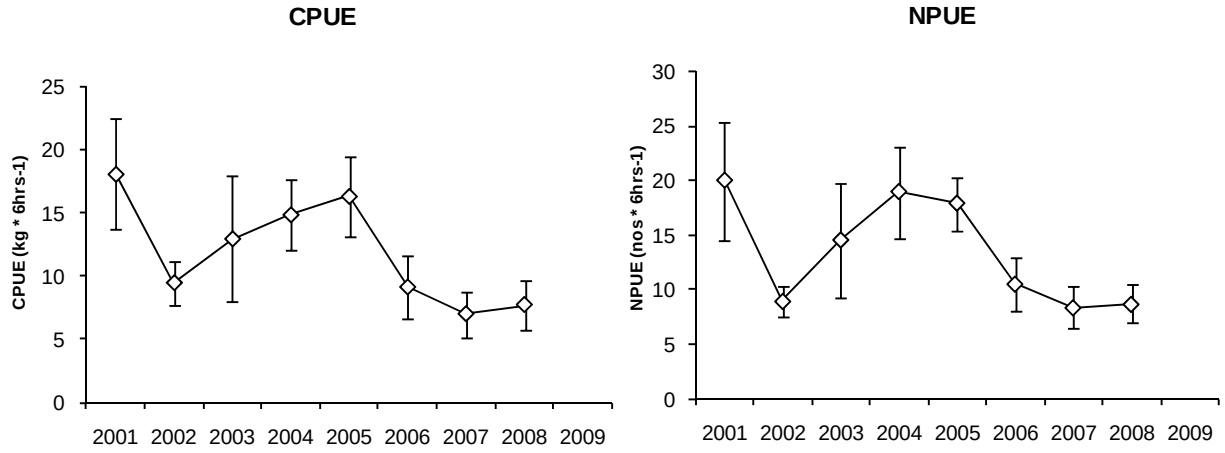

Fig. 8. Standardised catch rates from gillnet survey in Disko bay (1A) in weight (CPUE) and numbers (NPUE).

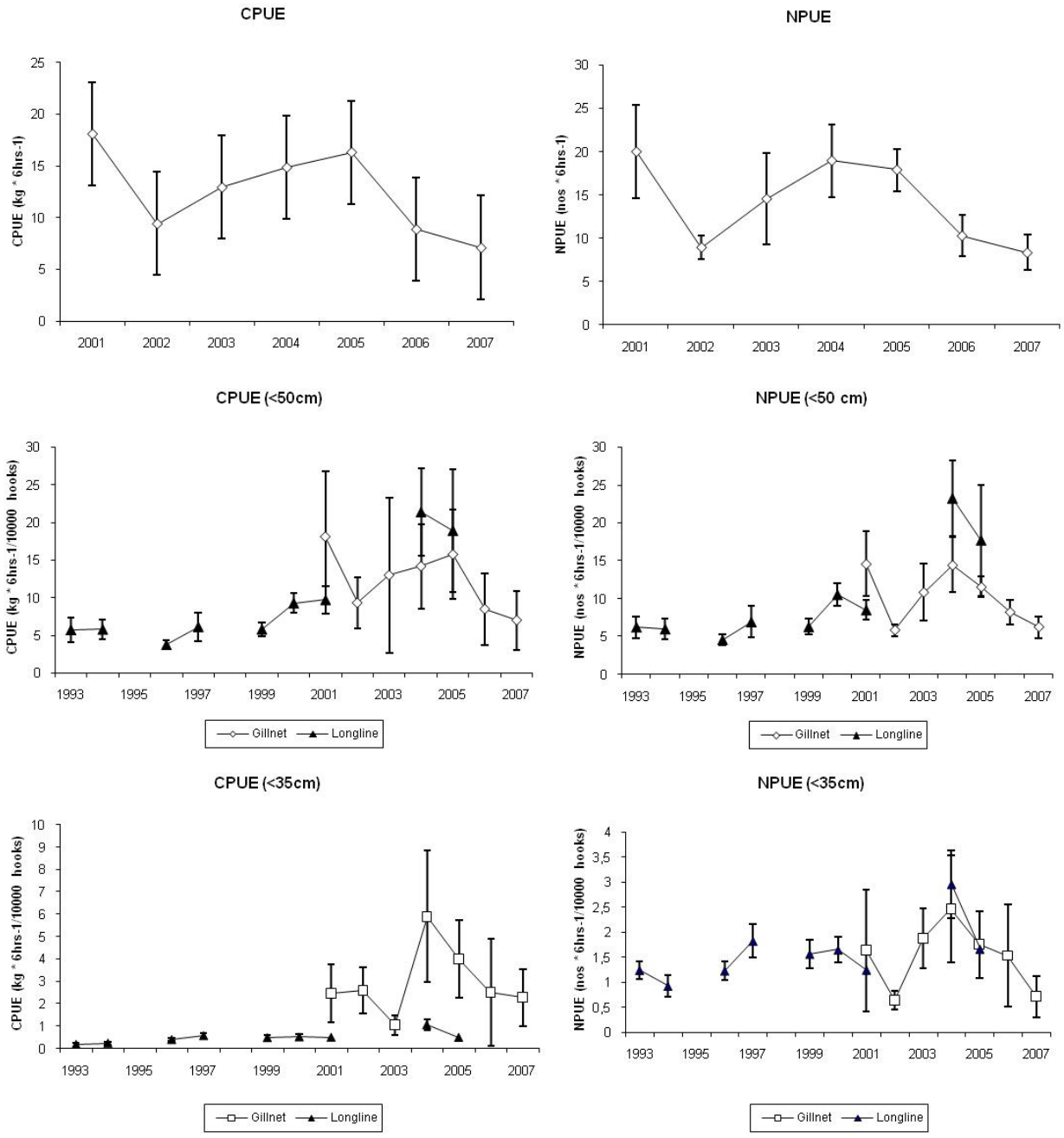

Fig. 9. Upper: Standardised catch rates from gillnet survey in Disko bay (1A) in weight (CPUE) and numbers (NPUE). Middle and lower: CPUE/NPUE by length < 50 cm and <35cm, respectively, for both gillnet and longline survey.

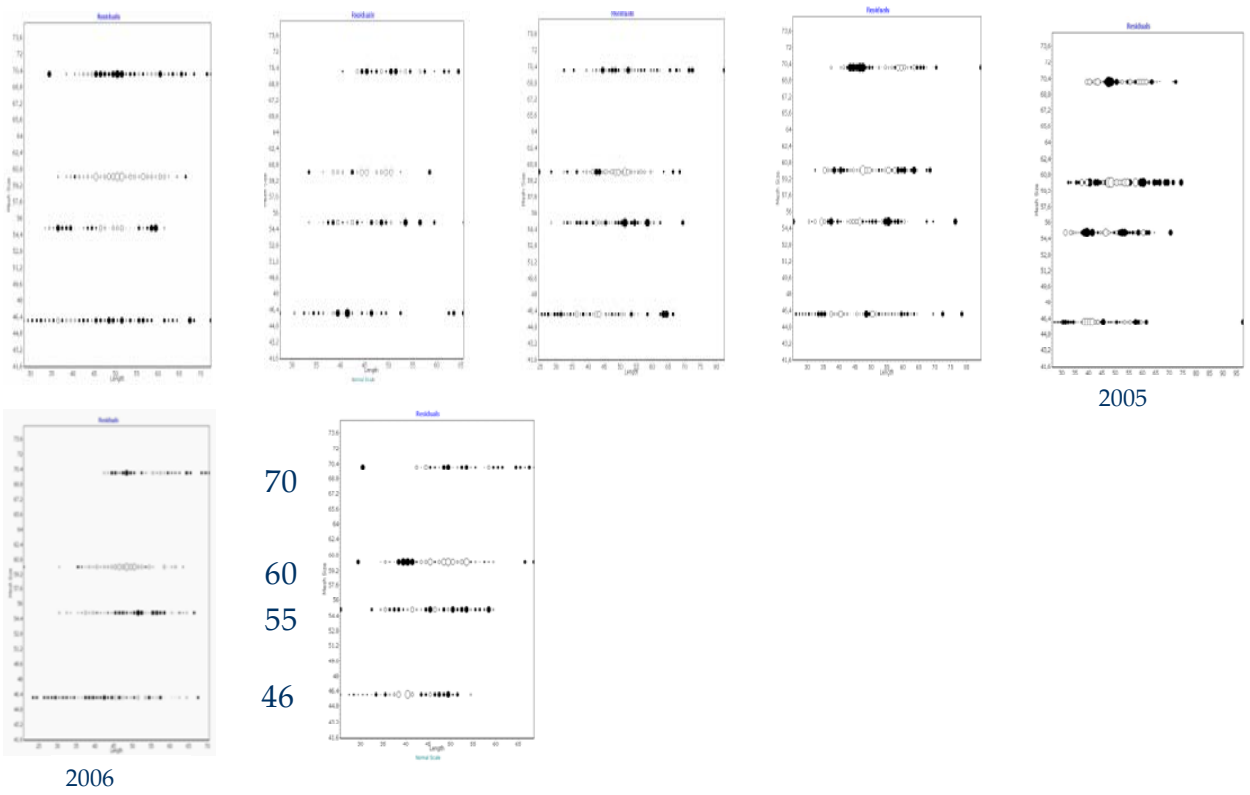

Fig. 10. Gillnet survey in Disko Bay. Residuals for each meshsize (y-axis) by length (x-axis) from the selectivity model (Wilemans Wings) 2001-2007.

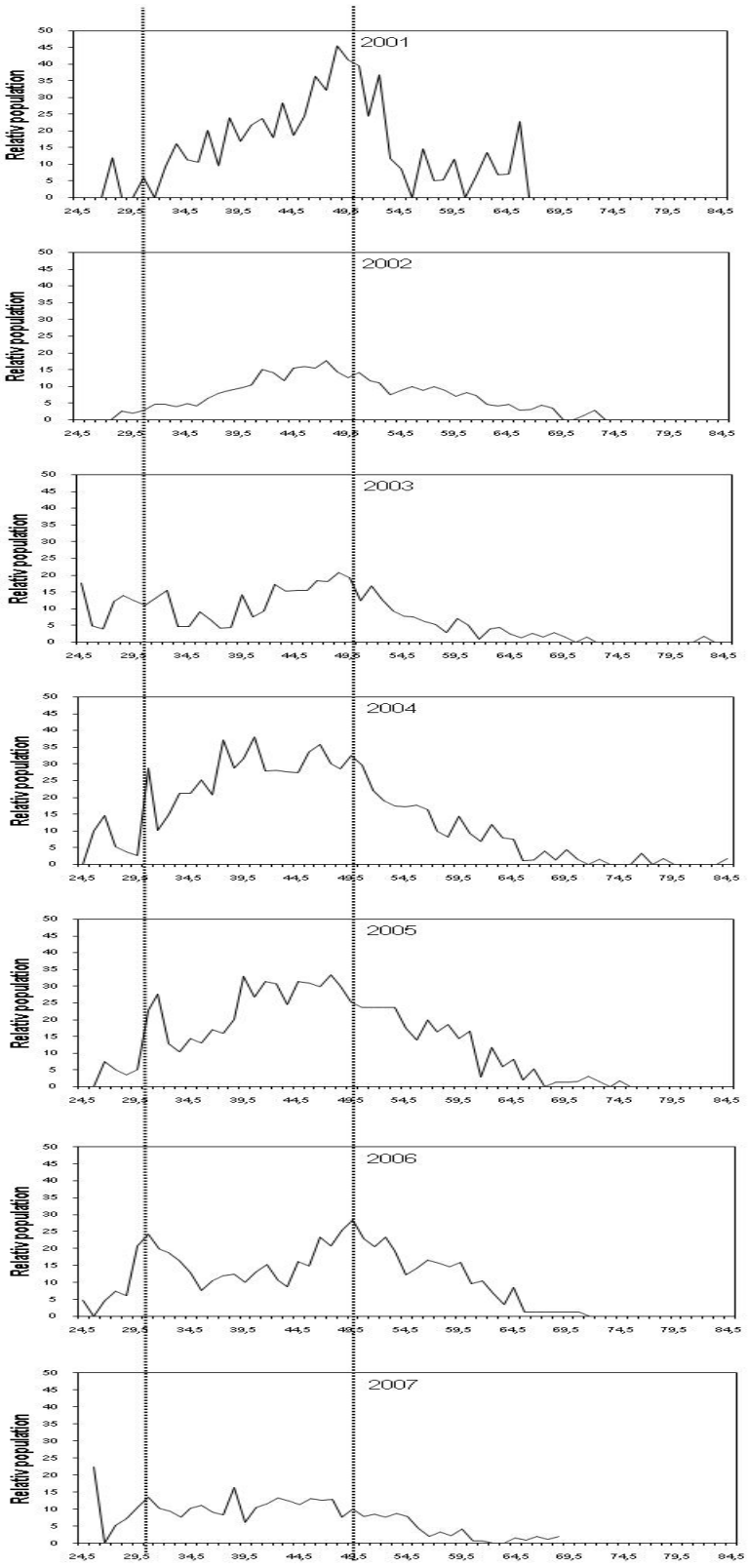

Fig 10b Gillnet survey in Disko bay. Estimated relative population assuming a Wilemans Wings selectivity curve in 2001 to 2007. The dashed lines indicate the length interval 30-50 cm where fully selection is assumed.

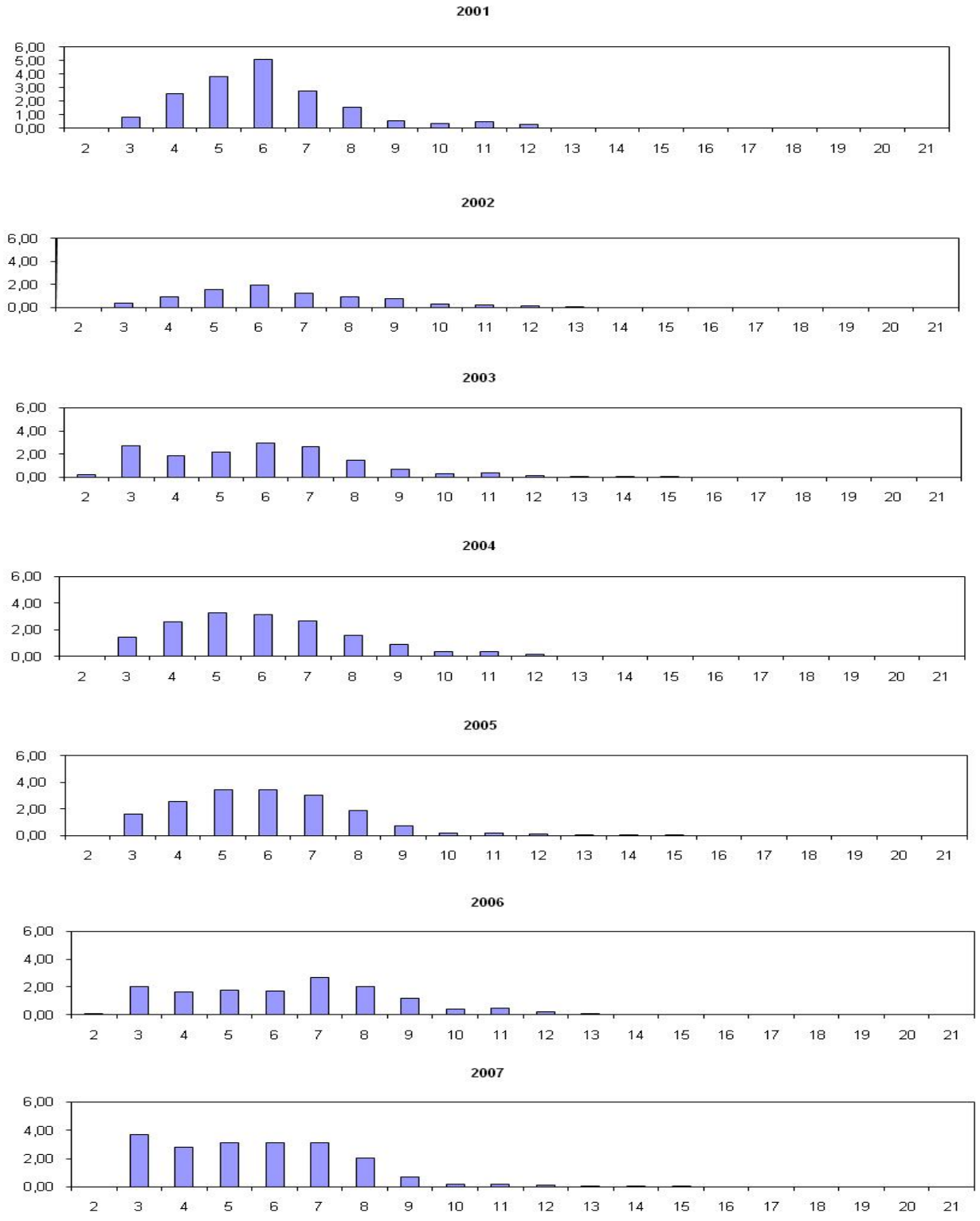

Fig. 11. Gillnet survey in Disko bay. Abundance (estimated relative population) by age.

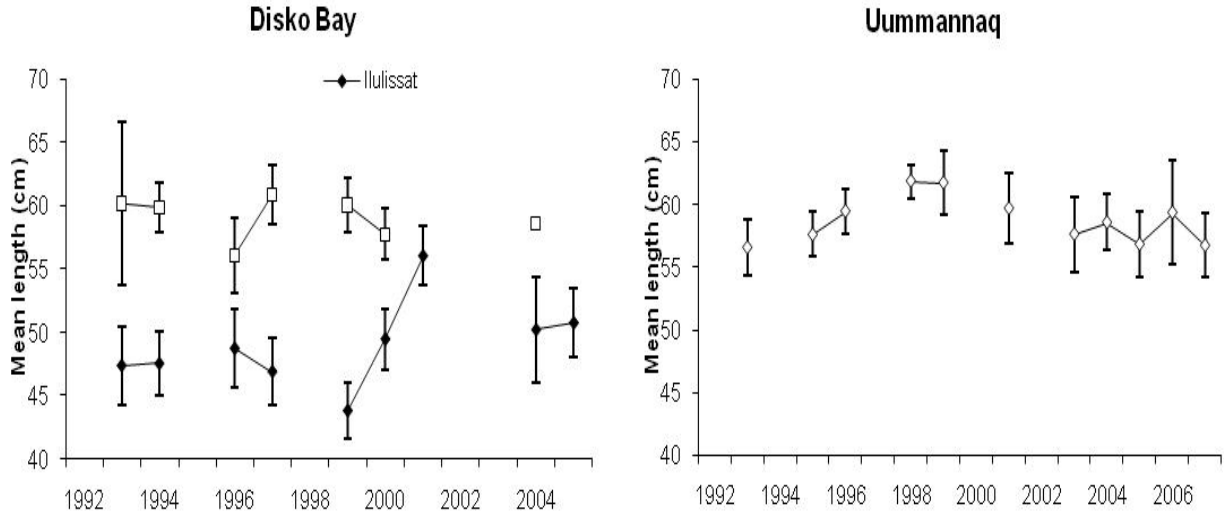

Fig. 12. Mean length for longline surveys conducted since 1993. 95% CI indicated. (No survey since 2007)

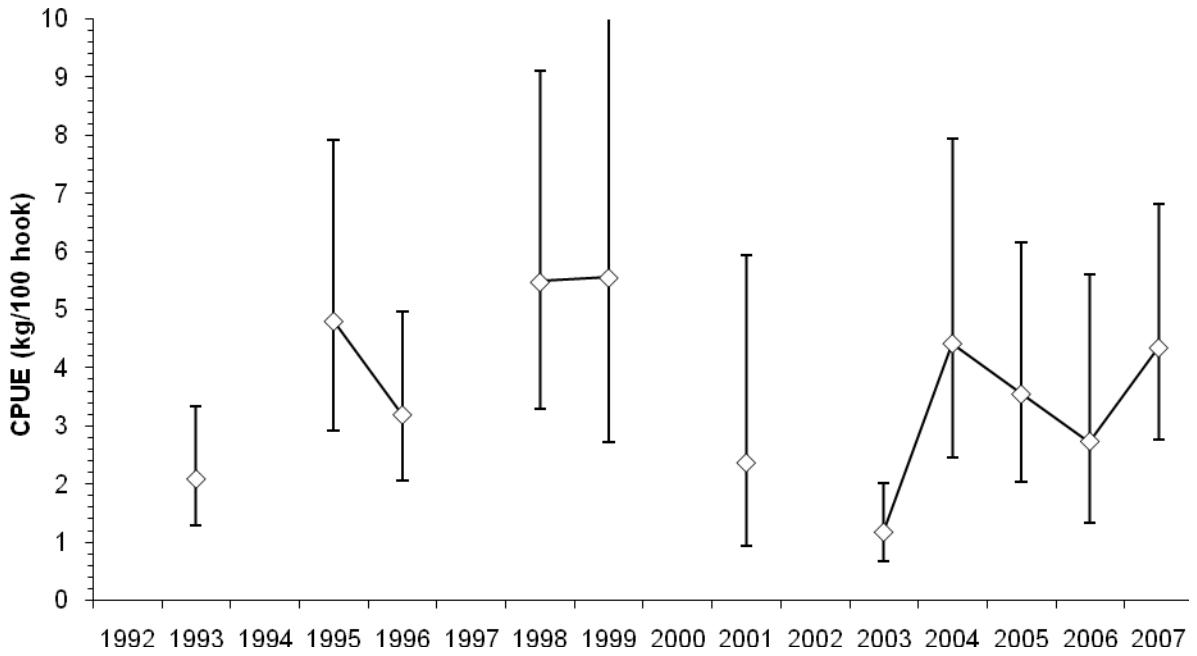

Fig. 13. Longline survey index for Uummannaq 1993-2007. 95% CI indicated. (No Survey since 2007)

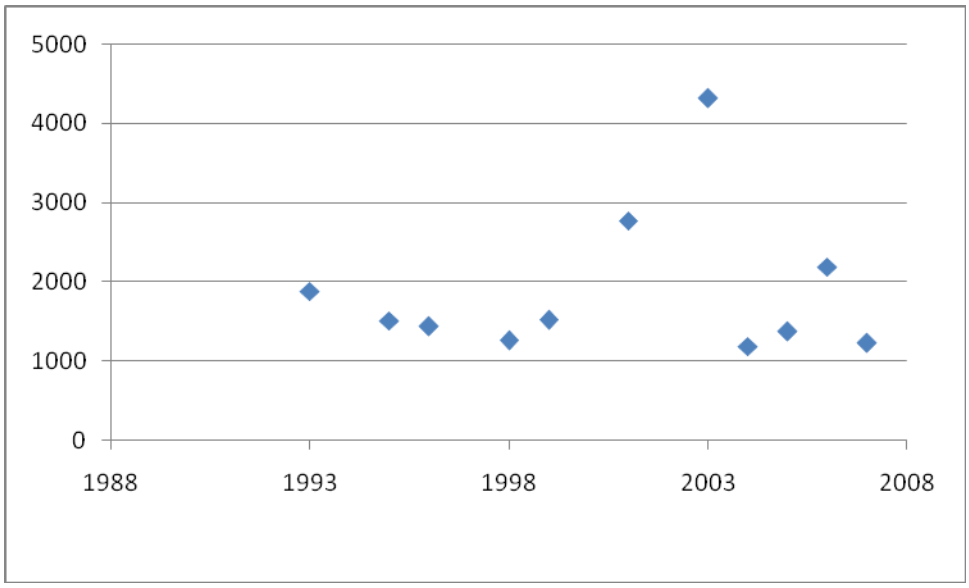

Fig. 14a. Exploitation proxies (Landings/standardized survey index) for Uummannaq.

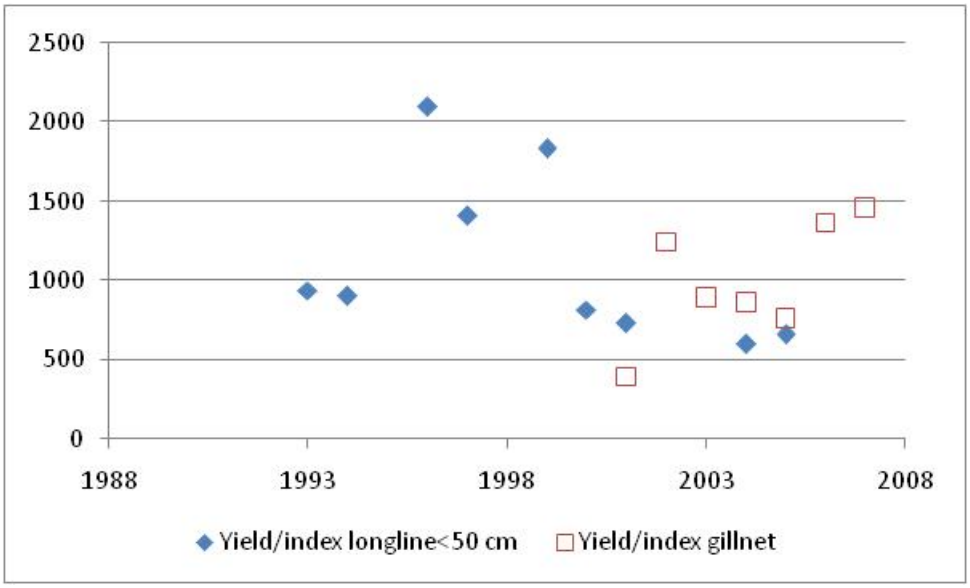

Fig. 14b.Exploitation proxy (Landings/standardized survey index) for Ilulissat for Gillnet survey catch rates and longline survey catch rates.

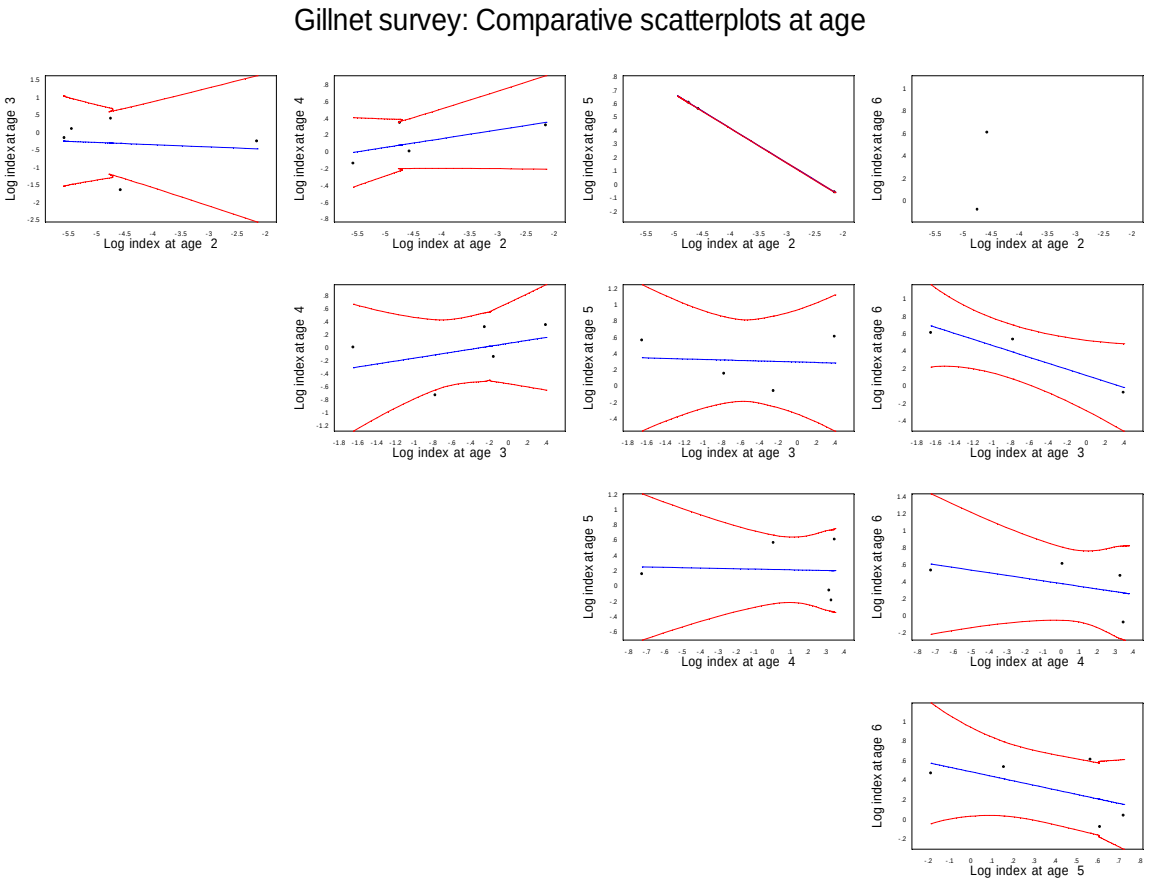

Fig. 15. Gillnet survey in Disko Bay. Plots of comparative cohorts

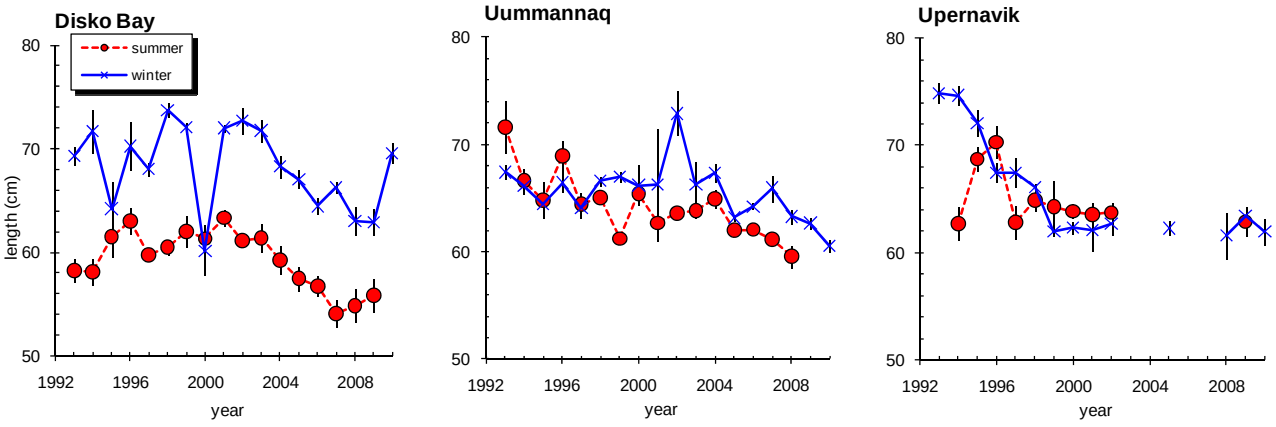

Fig. 16. Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik with 95% conf. Int.

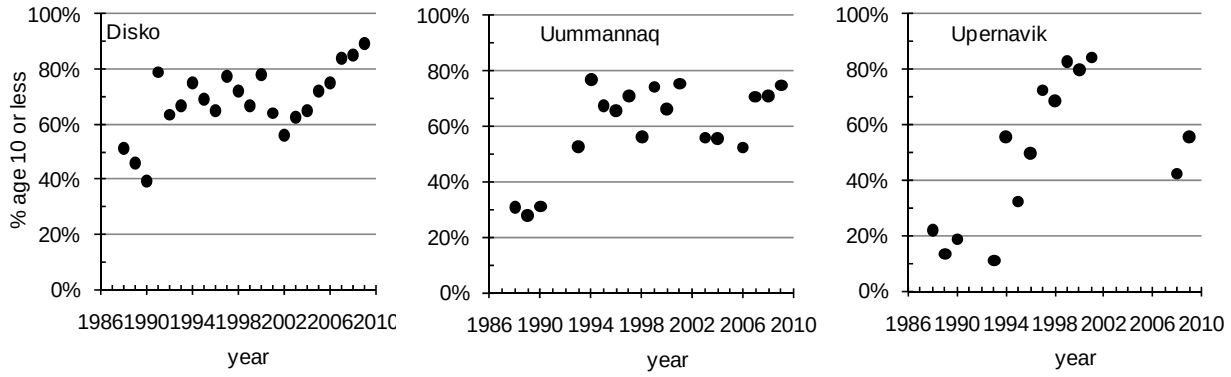

Fig. 17. The development in exploitation of the *age 10 and younger* expressed as percentages of those age groups in commercial landings by year.

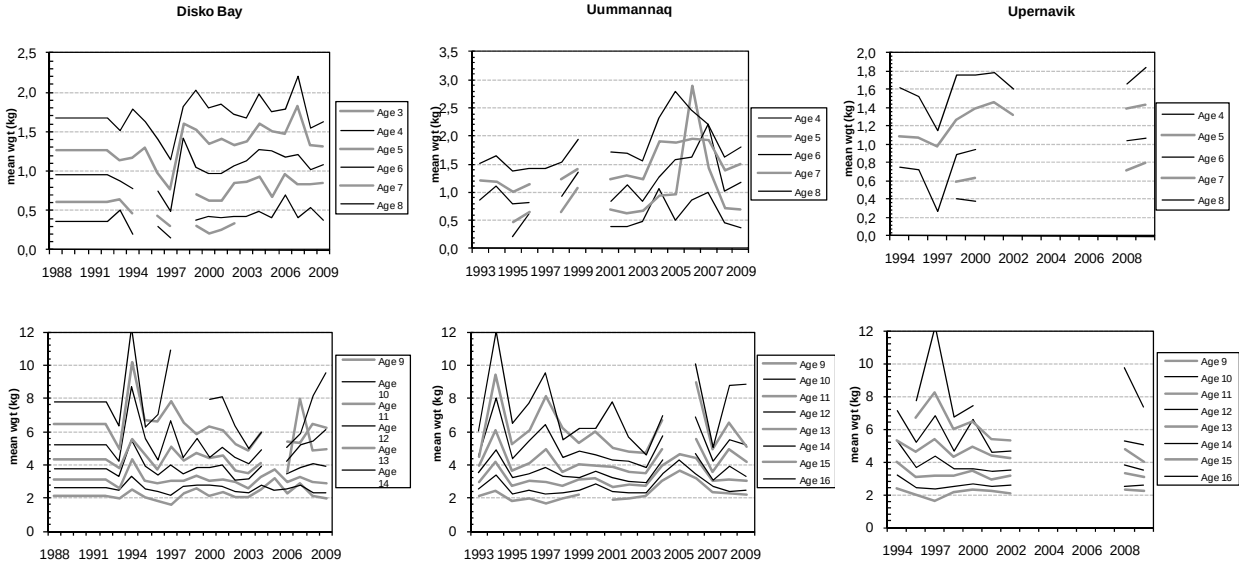

Fig. 18. Weight at age for the three areas Disko Bay, Uummannaq and Upernavik.

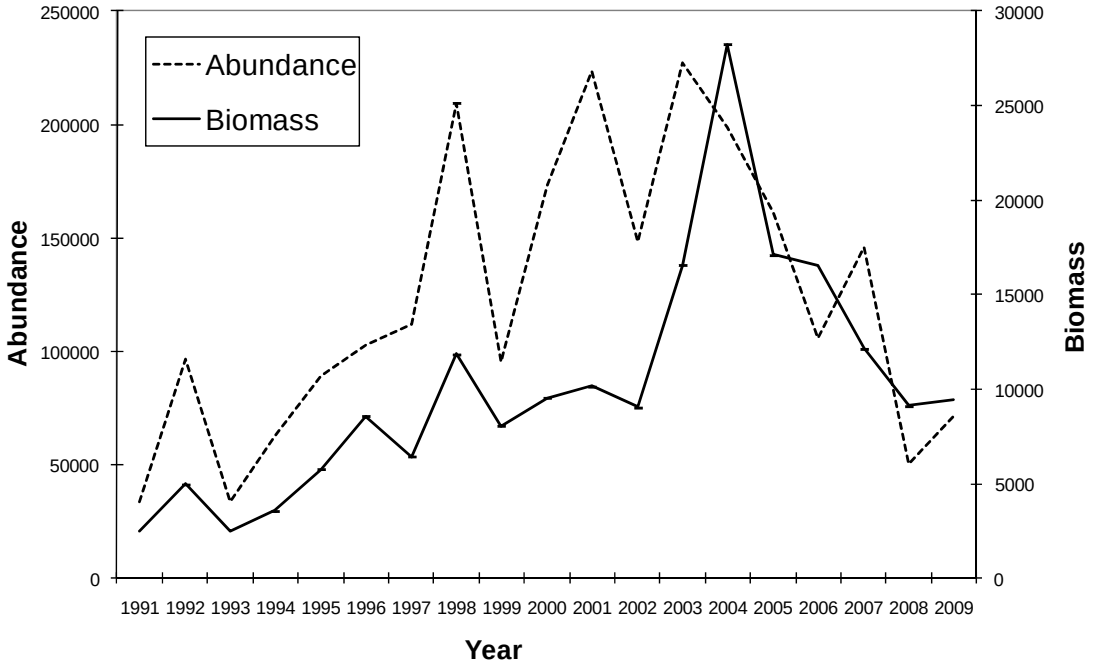

Fig. 19. Abundance ('1000) and Biomass (tonnes) indices of Greenland halibut from the Paamiut trawl survey in Disko Bay. In 2005 a new survey trawl was introduced, but the 2005-2007 catch figures have been adjusted to the old figures according to Nygaard et al. (SCR 10/30) .

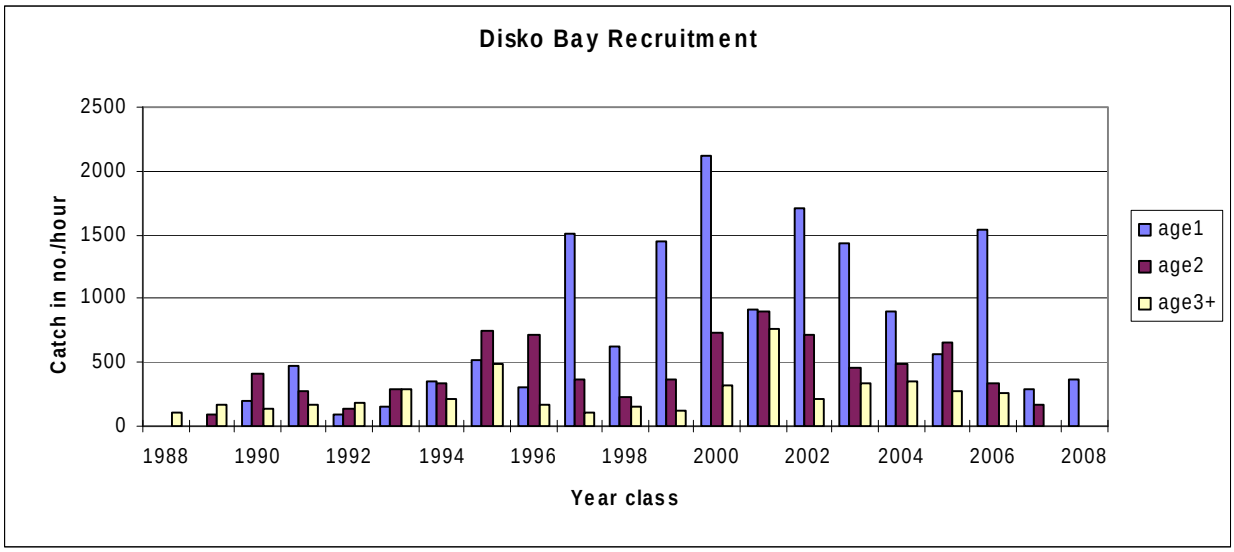

Fig. 20. Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the inshore Disko Bay. In 2005 a new survey trawl was introduced, but the 2005-2007 catch figures have been adjusted to the old figures according to Nygaard et al. (SCR 08/28) .

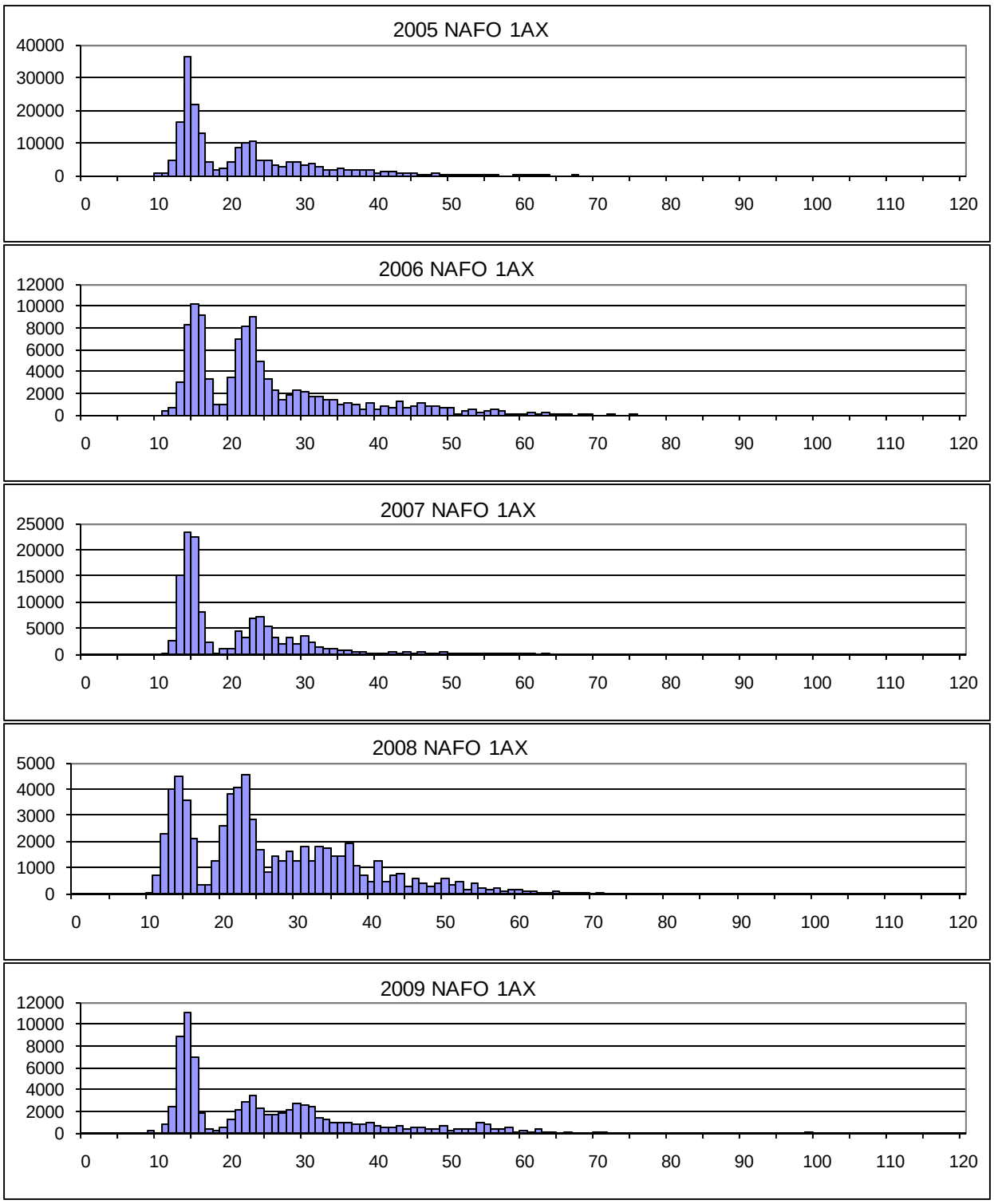

Fig. 21. Length distributions in Disko bay from the Greenland shrimp/fish survey since 2005.