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

by

Jesper Boje and Bjarne Lyberth

Greenland Institute of Natural Resources
P.O. Box 570, 3900 Nuuk, Greenland.

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 two of the three areas in rotation, approx. 30 fixed stations in each area and a newly initiated gillnet survey) were available for the assessment. The state of the stocks were as follows. **Disko Bay:** In the recent two decades annual landings increased from about 2 000 tons in 1987 to 10 500 tons in 1998 and 99. Since then landings increased again in 2002 to a record high of nearly 12 000 tons. Catches by season in 2003 showed that unusual high catches were taken in the 1st quarter of the year, probably affected by favourable ice and weather conditions. Recruitment indices from Disko Bay and offshore areas suggest high 1995 and onward year-classes, which the fishery might benefit in these years. In the winter fishery mean lengths has decreased for the past three years while the overall trend for the summer fishery is a slight increase over all years. A newly established gillnet survey (since 2001) shows stable catch rates from 2002 to 2003. The long line survey that started in 1993 has ceased in 2001. **Uummannaq:** Catches have been increasing from less than 2 000 tons before 1987 to a record high of 8 425 tons in 1999, but have since declined to 5 039 tons in 2003. Development in mean length in the summer fishery has showed an overall negative trend until 1999. Since then mean length in catches has increased slightly. In the winter fishery the mean length has been has been relatively stable except for the winter 2002. Survey results from 1993 to 1999 indicate an increase in abundance until 1998. In 2001 and further in 2003 survey abundance index decreased significantly to the lowest observed. Since the decrease in catch rates is for all lengths, the decline is most probably associated with availability to the gear. Catch composition in the commercial fishery has changed significantly since the 1980s towards a higher exploitation of younger age groups, but has stabilized in recent decade. **Upernavik:** Landings increased from about 1 000 tons prior to 1992 to highest on record, 7 012 tons in 1998. Since then landings have decreased continually by more than 50% to 3 000 tons in 2003. No recent information is available the commercial fishery and no surveys have been carried out. Apart from total catches there is thus no information to evaluate present stock status. New fishing grounds in the northern part of the district are being exploited, however, little information exists from these areas.

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 thus isolated from its origin spawning stock (Riget and Boje, 1989). Thus, the component does probably not contribute to the spawning stock in the Davis Strait (Boje, 1994). Only sporadic spawning is observed in the inshore area (Jørgensen and Boje, 1994) and the inshore component is not assumed to be self-sustainable, but dependent on recruits (immigration) from the nursery area at the offshore banks south 69°N latitude (Bech, 1995).

Description of the Fishery and Nominal Catches

The main inshore fishing grounds for Greenland halibut are in Div. 1A (Fig. 1), where the total landings amounted to 20 496 tons in 2003, and constitute far the majority (~99%) of inshore landings in Greenland. The inshore landings were around 7 000 tons in the late-1980s and increased until the late-1990s to a maximum of 25 000 tons.

The inshore fishery in Div. 1A is located in three main areas: Disko Bay, Uummannaq and Upernavik (Fig. 1). The fishery is not quota regulated, but in the latest years regulations have been have been made to restrict effort increase, thus from 1998 a special fishery licence is required to land catches of Greenland halibut. New license issues have since been limited. The total number of licenses is around 1100. There are no landing limitations on the fishery licenses. Therefore, in reality the fishery is unregulated.

The fishery is traditionally performed with longlines from small open boats or by means of dog sledges. In recent years bigger vessels (>25 feet) have increased in numbers. Typically the fishery is carried out in the inner parts of the ice fjords at depths between 500 to 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 area regulations on gillnets in order to limit effort. A total ban for gillnets has been in force since 2000. However, many exemptions have been given to this ban. Most recently a re-opening of a all year gillnet fishery in Ilulissat in front of the ice fjord. Exemption on the gillnet ban in Upernavik and Uummannaq in areas outside the Ice fjords have been given in the following periods: Upernavik 1. February- 30. April and again from 1. June to 30. September. In Uummannaq in the periods 1. February – 30. June and again from 1. October to 31. December. However 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 last century, and has traditionally taken the main part of the catches. The catches in Disko Bay have increased continually until the late-1990s at about 10 500 tons (Fig. 2). Since then catches declined to 7 052 tons in 2001, but has increased again in 2002 and further in 2003 to a historic high of 11 571 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 ice fjord north of Ilulissat, Torssukattak (Fig. 1). The winter fishery in Ilulissat Ice fjord, Kangia, is a traditional fishery from the ice by means of longlines. The fishery near Ilulissat is conducted within a relative small area and consist of a mixture of gillnet and longline fishery. However, the gillnet fishery is restricted to areas further from the ice fjord than the longline fishery. The majority of the landings in Disko Bay were caught within this area. The fishery in Ilulissat is carried out in all seasons but most often peak in summer. In 2003, probaby due to favorable ice condition, the winter fishery was unusually high and highest monthly catches in that year was taken in February (Fig. 3). This phenomenon has probably contributed to the record high catches of 2003. 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 ice in spring.

Uummannaq

The catches in Uummannaq were stable of about 3 000 tons prior to 1992, but has since increased with some fluctuations until 1999. Since then landings have declined to 5 039 tons in 2003 (Fig. 2 and Table 1).

The fishery in Uummannaq area is conducted in a large system of ice fjords. The main fishing grounds are in the southwest part of the fjord system. In previous times the southernmost ice fjord, Qarajaqs Ice fjord was the main fishing area but during the last decade the fishery has spread further north to include Sermilik and Itiviup Ice fjords (Fig. 1). 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. The main fishing grounds are Upernavik Ice fjord and Giesecke Ice fjord. New fishing grounds around Kullorsuaq in the northern part of the area are exploited these years (Fig. 1). Use of gillnets have up till now been prohibited in Upernavik but dispensations have been given for a fishery outside the ice fjords in 2002.

The catches in the Upernavik area have increased steadily from about 1 000 tons in the late-1980s to about 3 to 4 000 tons in 1993 to 1995 (Fig. 2 and Table 1). The total catch in 1998 was the highest on record 7 012 tons. Since then landings have declined and was 3 019 tons in 2002 followed by an increase to 3 884 tons in 2003.

Input Data

Research fishery

Longline survey

Prior to 1993 various longline exploratory fisheries 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 to use surveys results as anything 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 surveying gear have been performed since 2001. Parallel with the new gillnet survey the aim was to continue the longline survey. However in 2002 no longline survey was conducted and in 2003 the longline survey was only conducted in Uummannaq. In order to standardize the survey catch rates with respect to depth and area effects, a GLM was used to generate mean catch rates.

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. lesser than 40 cm. Experience with the gear so far, indicate that catch rates are sufficient to allow proper statistical analyses, and the strategy is therefore to continue this survey as a monitoring tool for the inshore Greenland halibut populations in Disko Bay.

The gillnet survey was initiated in 2001 and takes place only in Disko Bay with the research vessel '*Adolf Jensen*'. The location, Disko bay, is chosen due to the known presence of pre-fishery recruits in the entire area in combination with a bottom topography (approx. 3-400 m depth of even clay ground) that allows fishing with gillnets. The northern areas, Uummannaq and Upernavik, have both tough rock grounds not suitable for gillnet fishing. Only 8 stations were fished in the starting year 2001, while in 2002 and 2003 the number was increased to 55 and 58, respectively (see Table 2). The surveyed area cover the proposed young fish areas in Disko Bay, off Ilulissat and the Ice fjord and off the northern ice fjord Torssukattak (Fig. 4). Mesh sizes 45, 52, 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 analyse for within station variability. The survey uses fixed positions of stations.

The gillnets are selecting Greenland halibut in the length range 3 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 Ice fjords, Kangia (Ilulissat Ice fjord) and Torsukattak in the north. The gillnet survey do not cover those commercial fishing grounds. Greenland halibut smaller than 30 cm are occasional abundant in the area,

but are mostly recruited from offshore areas off Disko Bay and are supposed to perform a stepwise migration towards the commercial fishing grounds near the ice fjords.

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 Storr-Paulsen and Jørgensen (SCR Doc. 04/18 this meeting). For Greenland halibut ages 1 and older are selected by the gear. The CPUE for Greenland halibut (number per age per hour of ages 1-3) is estimated for the main offshore nursery area (Div. 1AS, 1BN and 1Bs) and for the Disko Bay. Both indices are 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 in 2002-03 was obtained from Greenland Fishery Licence Control (GFLK). Data from Upernavik was obtained from Upernavik Seafood. Only a part of the data from 2003 was allocated to gear and statistical square, and the remaining catches were allocated according to these available data. No information was provided on catches by gear in 2002, and for 2002 it was assumed that catches were distributed by gear as in 2003. Summer was defined as June-October (both included), remaining months was classified as winter.

Processed fish is normally converted to whole fish weight using conversion factor set by the authorities. In 1998 and 1999 a new set of conversion factors was introduced. The conversion factor for gutted fish with head and tail was multiplied by a factor 1.10 (previously 1.05). The conversion factor for gutted fish without tail and tail fin was 1.35 (previously 1.52).

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. Samples intensity from the commercial fishery in recent years is given in text table below.

Effort

In 1999 logbooks were introduced in the inshore fishery on a voluntary basis. The reporting has been very limited in both 1999 to 2001 (Simonsen, 2001), and no logbooks were available from the fishery in 2002 and 2003.

Catch at age

Catch at age data were compiled for the 2002 and 2003 fishery based on otolith sampling in summer, both from the surveys and from the commercial fishery (Table 5). For 2002 the ALK for Disko Bay and Uummannaq was compiled of otoliths from both areas due to incomplete sampling (Table 6). For 2003 the ALK for Disko Bay was based on otoliths from older fish in Uummannaq in addition to sampling from Disko Bay, due to incomplete coverage of the older age groups in Disko Bay. For Uummannaq in 2003 was used an ALK from Uummannaq (Table 7). Otoliths in the inshore part of 1A has been read by the same otolith reader from GINR in the entire period. No reliable maturity data were available.

For both 2002 and 2003 the gillnet fishery in summer was not sampled. Catch composition from this fishery was assumed equal to the winter gillnet fishery.

Sampling	2002	Uummannaq			
Nos length measurements					Nos otoliths
Gear \ Season	Summer	Winter	All	% sampled	
Longline	4150	1048	5,198		
Gillnet	1252	95	1,347		
All	5,402	1,143	6,545	0.354	419

Sampling	2003	Uummannaq			
Nos length measurements					Nos otoliths
Gear \ Season	Summer	Winter	All	% sampled	
Longline	2290	1048	3,338		
Gillnet		447	447		
All	2,290	1,495	3,785	0.350	236

Sampling	2002	Disko Bay			
Nos length measurements					Nos otoliths
Gear \ Season	Summer	Winter	All	% sampled	
Longline	7197	1700	8,897		
Gillnet		6469	6,469		
All	7,197	8,169	15,366	1.135	419

Sampling	2003	Disko Bay			
Nos length measurements					Nos otoliths
Gear \ Season	Summer	Winter	All	% sampled	
Longline	2081	1867	3,948		
Gillnet		797	797		
All	2,081	2,664	4,745	0.311	292

For 2002 catches were not available by gear type, so for the compilation of catch in numbers for Disko Bay and Uummannaq areas it was assumed that catches were distributed by gear as in 2003.

Biological Data

Data Storage Tags and behaviour of Greenland halibut

A programme on tagging with data storage tags, initiated between Nordic countries in 2002, to elucidate vertical migratory behaviour of Greenland halibut have been continued and ending in 2003. So far, 12 recaptures have been recorded from releases in Disko Bay, which represents a considerable amount of data (recordings every 15 minutes in periods up to 6 month). The recordings have not yet been analysed properly, but exploratory analyses tend to show that Greenland halibut is capable of performing extensive vertical excursions of up to 3-400 m within few hours. There is a general tendency that Greenland halibut move to deeper waters from November to February/March, probably inside the Kangia ice fjord.

Analytic Assessment

The possibilities of an analytic assessment have been explored in previous years by means of a separable VPA. However, Scientific Council have not approved the VPA as taken face value due to inaccurate determination of terminal F's and lack of effort data. However, it was felt that the VPA provided a likely scenario of stocks trends for the recent years. Difficulties in age determination of fish older than 10 years added considerably to uncertainty in input data.

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 Fig. 5. Gillnet selection curves are well-known being skew and not only 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 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 Ice fjord Torssukattak (Fig. 6). Fig. 7 summarizes the overall development in catch rates from survey from 2001 to 2003; from 2001 to 2002 both CPUE and NPUE decreased, and in 2003 the catch rates have been stable. The catches have been expressed as catch 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 dependant on this assumption. Partitioning the CPUE and NPUE in length groups, do only reveal a difference for smaller fish; these fish exhibit stable development from 2001 to 2003.

Assuming a bi-modal selection curve as given in Fig. 5 will result in relative underlying populations as provided in the right column of Fig. 8. The fit of the assumed selection curve is given at the left column (residual plots) and the catch by mesh sizes are given in middle column. Clearly, the figure illustrates the noisy data, where the 70 mm mesh size nearly always catch a smaller amount of fish than expected and the 60 mm mesh size mostly catch more than expected. The resultant relative population subsequently varies considerably between years, however, mostly outside the lengths selected by the gear, i.e. <30 cm and >60 cm. Also, the low number of observations in 2001 impedes any firm conclusions from the time series. In 2003 more abundant young fish < 35 cm seem coming into the survey, but the lengths are not fully selected.

Longline survey

Since 2001 when the gillnet survey was initiated, the longline survey has been restricted and the aim is to cover the areas Uummannaq and Upernavik only. In 2001 and 2003 a survey was carried out in Uummannaq only. In order to establish a calibration key for the two gears, gillnet and longline, longline settings will be conducted in Disko Bay in 2004 and 2005. This will allow an extension of the newly initiated gillnet survey index back in time.

Survey CPUE

Disko Bay

Since 2001 no longline survey has been carried out in Disko Bay.

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 and has since decreased to 58 cm in 2003 (Fig. 9, Table 4). Catch rates have, however, showed a considerable decrease since 1998/99. The “raw” catch rates (unstandardised) have been reduced by 86% since 1998, while the standardised catch rates are reduced by 90% since 1999 (Fig. 10). A length composition in the survey have varied considerably since 1993 and does not allow to track any strong year-classes (Fig. 11). Using the relation between total catches and the survey index as an approximation for exploitation level, reveal that exploitation of the populations in Uummannaq have increased since the late 1990’ies and especially in 2003 (Fig. 12).

Upernavik

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

Commercial Fishery

Size Distribution

Mean lengths from the longline landings in the period 1993 to winter 2004 in Disko Bay and Uummannaq are showed in Fig. 13. In Upernavik no sampling have been conducted from the commercial fishery since 2002. Fish caught in summer are generally smaller than fish caught during winter.

In Disko Bay mean length in the winter fisheries have fluctuated considerably in the time series with a slight increasing overall trend. The variation is most probably due to inadequate sampling. In recent 3 years mean length decreased from a high of about 80 cm to about 70 cm in 2003 and 2004. Fishing at the traditional winter fishing grounds in the ice fjord has been impeded in the recent years due to lack of land-fast sea-ice (the fishery is 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 increased somewhat from 1993 to 1996, but have thereafter been stable at about 60 cm.

In Uummannaq mean sizes in the winter fishery has been stable throughout the period at about 66 cm. Development in mean size in landings from the summer fishery decreased in the early period from 1993 to 1997, but have thereafter remained stable at about 64 cm.

Catch at Age

For all three areas there have been a shift in exploitation pattern through the time series (Fig. 14). While the younger age groups comprised between 25% and 50% of the catches in the late-1980s and early-1990s, they now constitutes about 60-80% of the catches. However, in Disko Bay and Uummannaq exploitation the younger age groups seem to decrease somewhat in recent years to about 50-60%. In Upernavik exploitation of the younger age groups have 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 provided in Fig. 15. The outliers in 1994 are considered 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 is a clear trend of a decline in mean weight at age in the entire period since 1993, while for ages 9 to 12 mean weights are stable.

Recruitment

Recruitment indices were available for the offshore area of Div. 1AB and for Disko Bay (inshore). In both areas recruitment index of age 1 fish was high in 2003, in the offshore areas above the average (702 nos/hr *vs* 528 nos/hr) for the time series, and in Disko Bay the index was the second highest in the time series (1989-03), 1705 nos/hour *vs* 800 nos/hour (Fig. 16). So far, no relation has been established between the recruitment strength in these surveys and strength of corresponding age groups in the fishery in Disko Bay.

Analytical Approaches

Exploratory runs were conducted using the production model ASPIC. ASPIC requires series of catch data and indices of stock biomass, either corresponding effort, CPUE, or survey catch rates. The advantage is that the model do not require age-disaggregated catch data, but requires starting guesses for *K*, carrying capacity, MSY and B1/K ratio (Initial biomass/K). Assuming effort equals catches and using the longline survey index from 1993 and onwards, resulted in conflicting signals between survey and catch/effort, which disables ASPIC to run.

State of the Stock Components

The abrupt decline in landings in the most recent years that raised concern by NAFO in 2002, have reversed for Disko Bay and Uummannaq since 2002, and for Upernavik catches have stabilised at a low level. 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. Since no surveys and sampling has been conducted in Upernavik area since 2001, there is no basis to evaluate the state of Greenland halibut stocks in that area in recent years.

Disko Bay

Since the beginning of the fishery for Greenland halibut in Greenland early in the 1900 in this area, landings have increased continuously. In the recent two decades annual landings increased from about 2 000 tons in 1987 to 10 500 tons in 1998 and 99. Since then landings declined to 7 000 tons in 2001, but increased again in 2002 to a record high of nearly 12 000 tons, and remained there in 2003. The reason for this high variation is unknown, and no effort measures are available. Ice and weather conditions are known to influence use of gear type in the fishery and can also limit the total fishery. Catches by season in 2003 showed that unusual high catches were taken in the 1st quarter of the year. Although the data are preliminary only, favourable weather conditions have obviously endorsed the fishery in this period and consequently resulted in the high catches of that year.

Recruitment indices from Disko Bay and offshore areas suggest high 1995 and onward year-classes, which the fishery might benefit in these years. This could explain the increase in catches in recent years. Age 9 in 2003 catches are estimated second highest in the time series.

In the commercial fishery mean length in catches are quite variable for the entire time series. In the winter fishery mean lengths has decreased for the past three years while the overall trend for the summer fishery is a slight increase over all years.

A newly established gillnet survey (since 2001) shows stable catch rates from 2002 to 2003. The long line survey that started in 1993 has ceased in 2001.

Uummannaq

Catches have been increasing from less than 2 000 tons before 1987 to a record high of 8 425 tons in 1999. Since then landings have declined to 5 039 tons in 2003. The seasonal distribution of catches has been constant for the recent years.

Development in mean length in the summer fishery has showed an overall negative trend until 1999. Since then mean length in catches has increased slightly. In the winter fishery the mean length has been relatively stable except for the winter 2002. Age composition in catches from the commercial fishery has changed significantly since the 1980s towards a higher exploitation of younger age groups, but has stabilized in recent decade.

Survey results from 1993 to 1999 indicate an increase in abundance until 1998. In 2001 and further in 2003 survey abundance index decreased significantly to the lowest observed. This dramatic reduction in biomass index is, however, in disagreement with data from the fishery. Mean lengths from the survey are relatively stable in the entire period, so the decrease in catch rates is for all lengths groups. Therefore the decline in catch rates is most likely associated with a shift in availability of the fish to the gear in the past three years.

Upernavik

Fishery in Upernavik developed in the mid-1980s and thus constitutes the youngest inshore fishery in West Greenland. Landings increased from about 1 000 tons prior to 1992 to about 5 000 tons in 1996 and 1997. In 1998 landings were the highest on record, 7 012 tons. Since then landings have decreased continually by more than 50% to 3 019 tons in 2002, though followed by a slight increase to 3 884 tons in 2003.

No sampling from the commercial fishery has been conducted since 2001 and neither any surveys. Apart from total catches there is thus no information to evaluate present stock status.

General Comments

The lack of reliable landing data for recent years and late delivery data 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. In 2002, no information had been provided on gear types in the fishery. For the past number of years the catch statistics is preliminary and frequent changes to the database creates confusion on the "true" version.

A voluntary logbook was introduced in 1999 for parts of the inshore Greenland halibut fishery. However, the return rate has been very low and shows no sign of improvement. Authorities should consider means to ensure a higher return rate of logbooks in the Greenland halibut commercial fishery in Div. 1A.

A 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, 26 mm sorting grids have since then been made mandatory in the shrimp fishery (since October 2000), but for the entire inshore shrimp fishery exemptions for the use of the sorting grids have been given until recently. No evaluations have been made on the effectiveness of the sorting grids.

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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.

Area/year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000[1]	2001[1]	2002[1]	2003
Disko Bay	2258	2670	2781	3821	5372	6577	5367	5201	7400	7837	8601	10671	10593	7574	7072	11718	11571
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234	4579	6294	6912	8425	7568	6558	5339	5039
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	2403	4846	4879	7012	5258	3764	3239	3019	3886
Unknown area	407	636	599	507	17	133							55	2239			
Total in 1A inshore:																	
STATLAN 21A	6696	6384	6927	7465	9243	11932	13204	14067	17046	17271	20835	19669	24333				21482
STACFIS	7196	7003	7492	8352	9929	11933	13088	14049	17037	17262	19774	24595	24332	21144	16869	20076	20496

[1] Unofficial data from the fishing industry (Royal Greenland, NUKA, Upernavik Seafood & Uummannaq Seafood.

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

	Year		
Statistical square	2001	2002	2003
LD027			2
LE027			2
LF027			2
LF028			2
LG024			2
LG026		1	
LG027	4	7	6
LG028	2	2	2
LH026		2	
LH027		5	4
LH028	2	1	7
LH038			1
LJ026		3	2
LJ028		5	4
LK029		5	4
LL029		1	1
LM029		2	2
LM030		2	2
LM031		2	2
LN024		2	2
LN025		5	3
LN026		4	2
LN027		2	2
LN028		2	2
LP024		2	
Total	8	55	58

Table 3. Landings of Greenland halibut allocated on area, season and gear. Allocation on gear was obtained from the distribution from the fishery in 1999 as no information was provided with the landings figures for 2001.

		summer		winter		Total
		longline	gillnet	longline	gillnet	
Disko	Ilulissat	7687	482	2295	482	
	Torssukataq	609	16	0		11571
Ummannaq		3384	801	540	313	5039
Upernavik		1764	539	745	838	3886

Table 4. Mean length (cm) from catches taken in inshore longline surveys. Standardized survey since 1993

Area/year	1962	1985	1986	1987	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Disko bay	-	62.4	53.5	62.2	55.9	56.5	-	53.6	57.0	-	56.7	54.3	56.1		
Uummannaq	67.8	70.5	-	61.8	57.5	-	57.8	59.5	-	61.2	61.5		59.7		58.0
Upernavik	-	-	-	-	-	64.6	60.8	-	-	57.1		58.4			

Table 5. 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**
4	0	0	0	5	34	7	0	0	0	0	0	1	0	1	0	0
5	0	0	0	5	92	15	3	0	8	0	0	4	9	15	2	2
6	1	0	0	11	122	62	15	0	1	21	74	41	98	33	54	64
7	9	0	1	279	332	280	112	45	47	132	397	360	535	224	283	425
8	59	14	24	806	476	479	281	459	323	646	775	619	729	390	561	722
9	182	106	141	535	390	339	539	639	941	1,113	944	836	780	521	771	1,187
10	173	121	185	333	451	280	396	798	651	1,168	1,248	1,028	636	450	421	610
11	132	94	188	238	532	240	190	463	454	607	754	786	478	485	575	847
12	73	49	126	76	309	122	91	185	273	185	346	426	223	280	393	422
13	63	33	80	45	140	91	50	127	145	69	132	136	52	78	398	158
14	65	39	59	67	92	112	45	27	75	19	68	72	28	33	175	146
15	38	31	42	57	18	75	41	36	44	10	27	29	12	31	112	135
16+	33	41	44	44	0	86	36	27	69	6	6	2	1	16	0	0
Total	828	528	890	2,501	2,988	2,188	1,799	2,806	3,031	3,976	4,770	4,340	3,583	2,557	3,745	4,718

B) Uummannaq

	Catch in numbers (thousands)															
age/year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
4	0	0	0	-	-	0	0	0	1	0	0	8	0	0	0	0
5	0	0	0	-	-	0	0	0	0	0	0	70	19	65	0	3
6	1	0	1	-	-	9	24	6	6	0	0	218	86	113	9	21
7	5	2	3	-	-	45	105	217	76	69	0	554	357	674	91	127
8	20	9	15	-	-	200	226	564	308	377	235	596	441	507	248	360
9	52	35	47	-	-	202	271	601	279	793	566	690	543	315	382	321
10	121	98	108	-	-	142	346	413	286	702	657	789	669	492	217	235
11	143	120	121	-	-	138	139	414	232	460	586	526	487	303	299	220
12	121	99	101	-	-	104	105	219	142	206	355	295	311	178	205	158
13	96	76	82	-	-	158	34	138	69	75	138	131	170	121	228	78
14	49	38	42	-	-	93	12	49	28	32	39	42	68	60	108	145
15	23	19	20	-	-	28	0	28	11	10	15	12	24	28	62	150
16+	17	20	21	-	-	20	3	22	15	6	5	4	8	12	87	94
Total	648	516	561	-	-	1,139	1,265	2,671	1,453	2,732	2,595	3,935	3,184	2,868	1,937	1,911

C) Upernavik

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

Table 6. Age-length keys used for 2002 catch in numbers.

	2002 age readings Ilulissat + Uummannaq																		
2002	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**Sum**
35-39	28	10	1															0	39
40-44		35	11	1														0	47
45-49		2	33	7														0	42
50-54			5	43	16	2												0	66
55-59				4	26	19	1											0	50
60-64					5	21	12	4										0	42
65-69						1	6	16	12	4								0	39
70-74								4	4	8	2							0	18
75-79										5	7	4		1	1			0	18
80-84											2	9	11	8	1			0	31
85-89											1	2	5	4	4	2		0	18
90-94													1	1	2	2	1	0	7
95-99																		0	0
100-104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110-115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sum	28	47	50	55	47	43	19	24	16	17	12	15	17	14	8	4	2	1	419

Table 7. Age-length keys used for 2003 catch in numbers.

2003 age readings Ilulissat + older fish (age 15+) from Uummannaq																			
2003	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**Sum**
35-39	19	20		1							0	0	0	0	0	0	0	0	40
40-44	1	28	22	1							0	0	0	0	0	0	0	0	52
45-49		2	24	16	4						0	0	0	0	0	0	0	0	46
50-54			4	25	13						0	0	0	0	0	0	0	0	42
55-59				4	14	11	2	1			0	0	0	0	0	0	0	0	32
60-64					2	17	8	7	1		0	0	0	0	0	0	0	0	35
65-69							2	6	3	1	0	0	0	0	0	0	0	0	12
70-74									4	2	4	2	0	0	0	0	0	0	12
75-79	0	0	0	0	0	0	0	0	1	1	1	1	2	1	0	0	0	0	7
80-84	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	0	6
85-89	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	4
90-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
95-99	0	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	0	0	0	1	0	1
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110-115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sum	20	50	50	47	33	28	12	14	9	4	6	10	3	2	1	1	1	1	292

2003 age readings Uummanaq																			
winter	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**Sum**
35-39	8	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
40-44	1	11	11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
45-49	0	1	21	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	34
50-54	0	0	0	19	16	0	0	0	0	0	0	0	0	0	0	0	0	0	35
55-59	0	0	0	1	21	7	3	0	1	0	0	0	0	0	0	0	0	0	33
60-64	0	0	0	0	2	16	8	5	2	0	0	0	0	0	0	0	0	0	33
65-69	0	0	0	0	0	3	7	9	5	2	0	0	0	0	0	0	0	0	26
70-74	0	0	0	0	0	0	0	1	1	1	4	2	0	0	0	0	0	0	9
75-79	0	0	0	0	0	0	0	0	1	1	1	1	2	1	0	0	0	0	7
80-84	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	0	6
85-89	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	4
90-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
95-99	0	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	0	0	0	1	0	1
105-109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110-115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sum	9	25	32	31	41	26	18	15	10	4	6	10	3	2	1	1	1	1	236

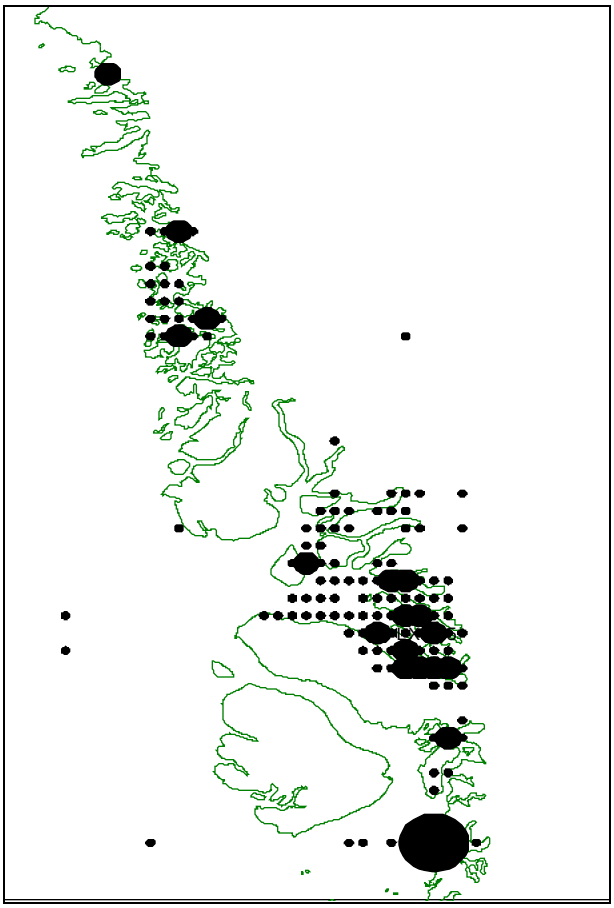

Fig. 1. Distribution of the inshore fishery for Greenland halibut in Div.1A in 2003. Landings is shown in tons per. Squarre (field-code). Catch statistics are provisional. For Disko Bay catch statistics was available for 93%; for Uummannaq 73%; for Upernavik 49% of the total landings.

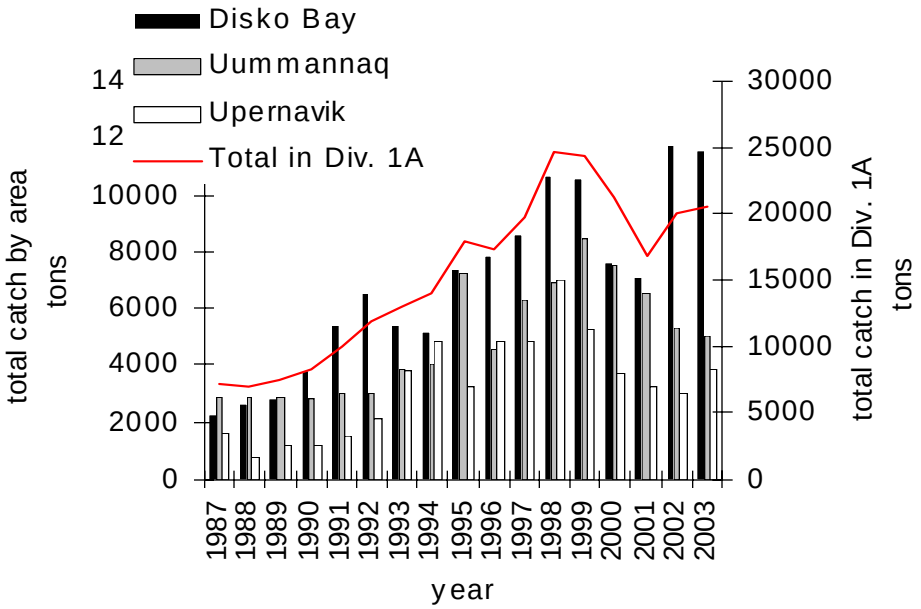

Fig. 2. Landings in NAFO Div. 1A since 1987 for the 3 main fishing areas. Landings from 2000-2001 are provisional. See also Table 1.

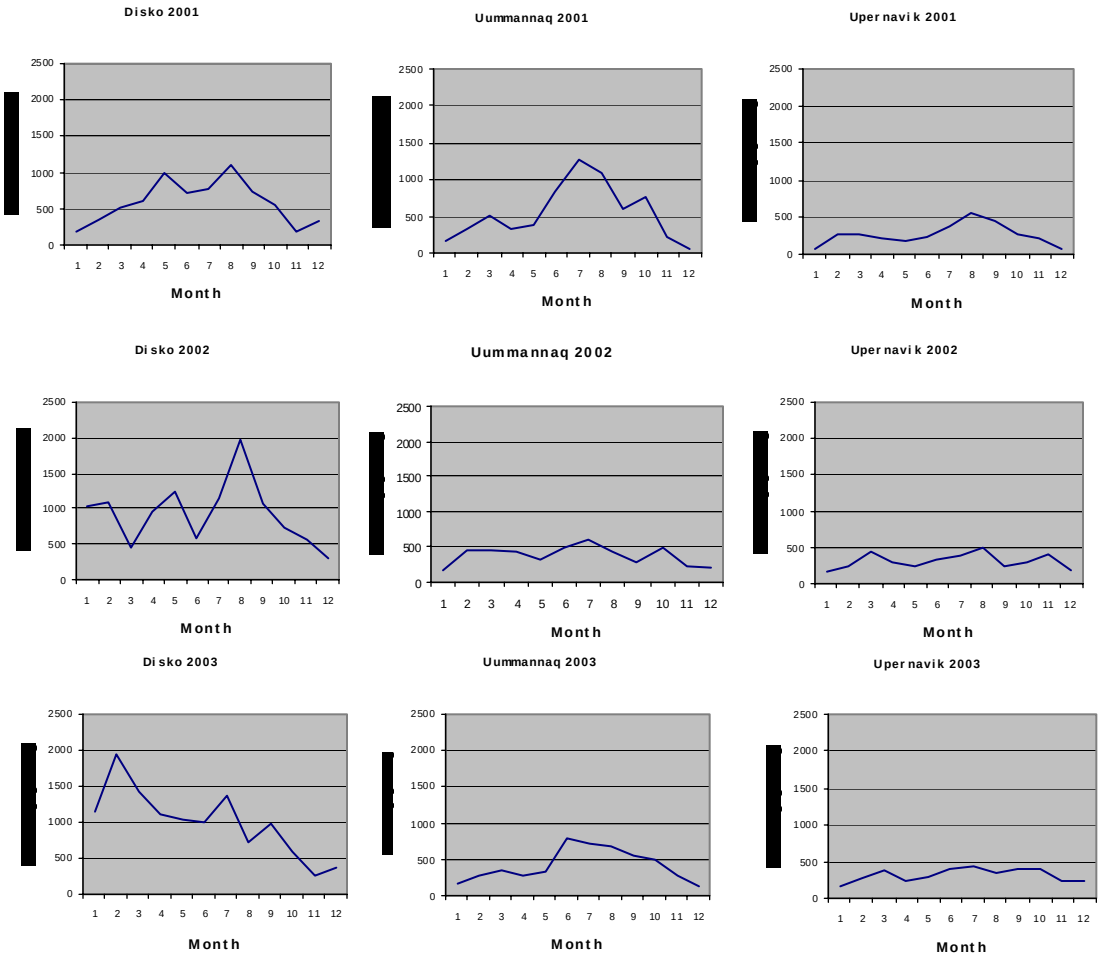

Fig. 3. Landings in NAFO Div.1A inshore by month and area for the years 2001-2003.

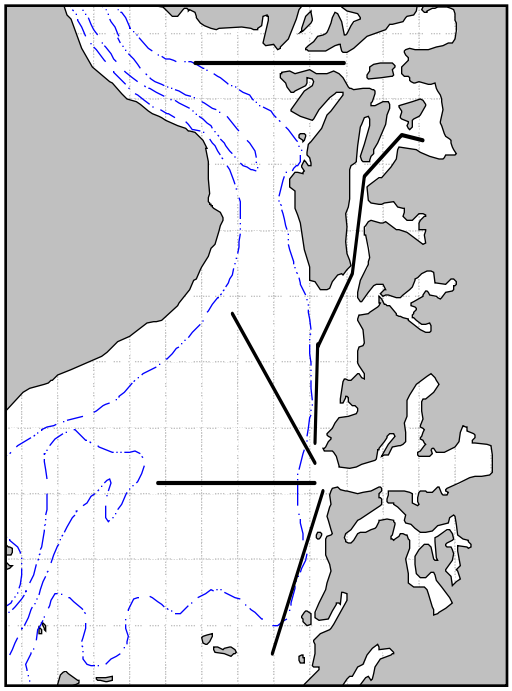

Fig. 4. Map of area in Disko Bay for gillnet survey. Lines are transects along which fixed stations are positioned.

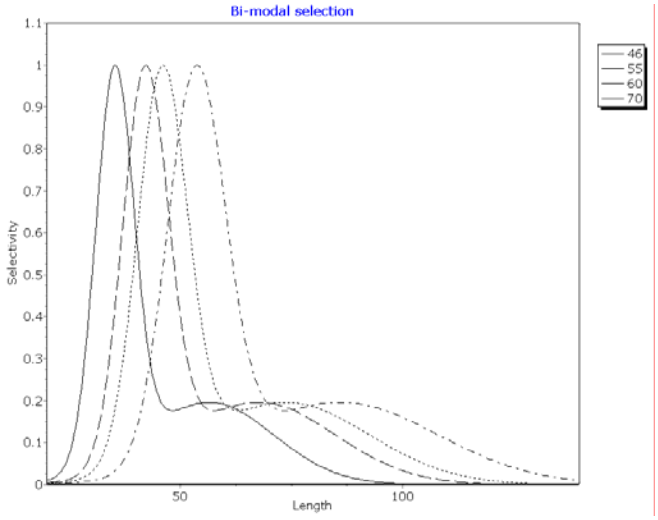

Fig. 5. Assumed bi-modal selection curves applied to the gillnet survey catches.

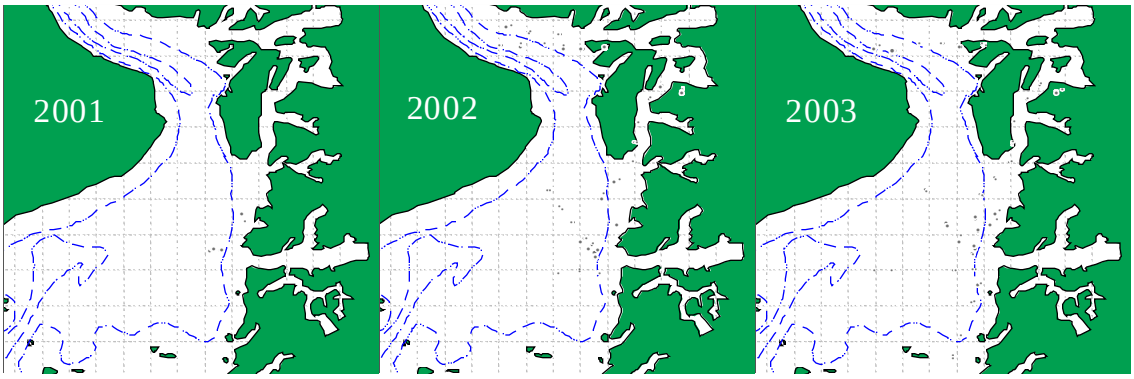

Fig. 6. Gillnet survey Disko Bay 2001-2003. NPUE distribution (Nos per 6 hrs of setting).

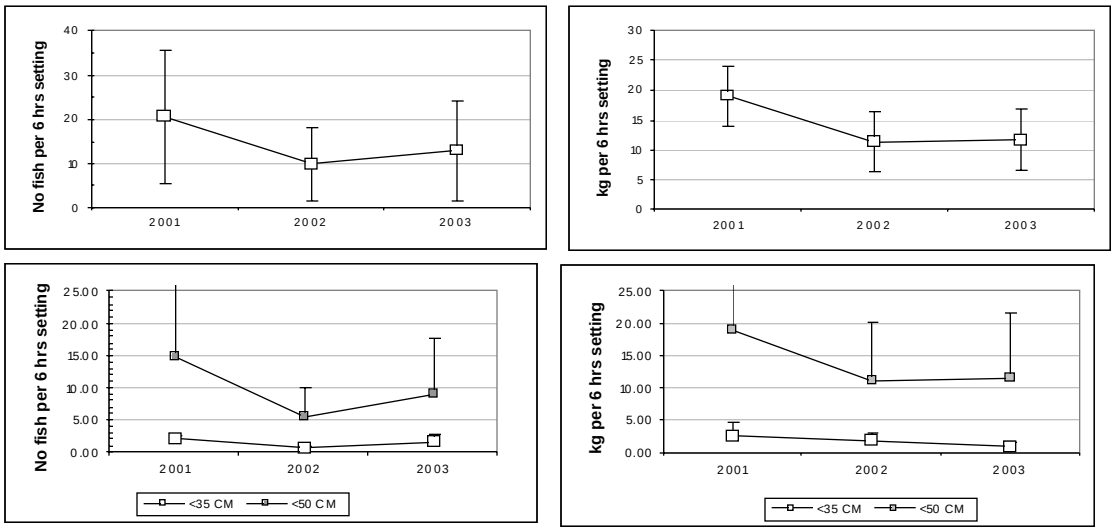

Fig. 7. Catchrates from gillnet survey 2001 – 2003 with 95% CI . Left: NPUE (nos of fish per 6 hrs of gillnet setting, Right: CPUE (kg's per 6 hrs of setting). Lower part is partitioned into length groups.

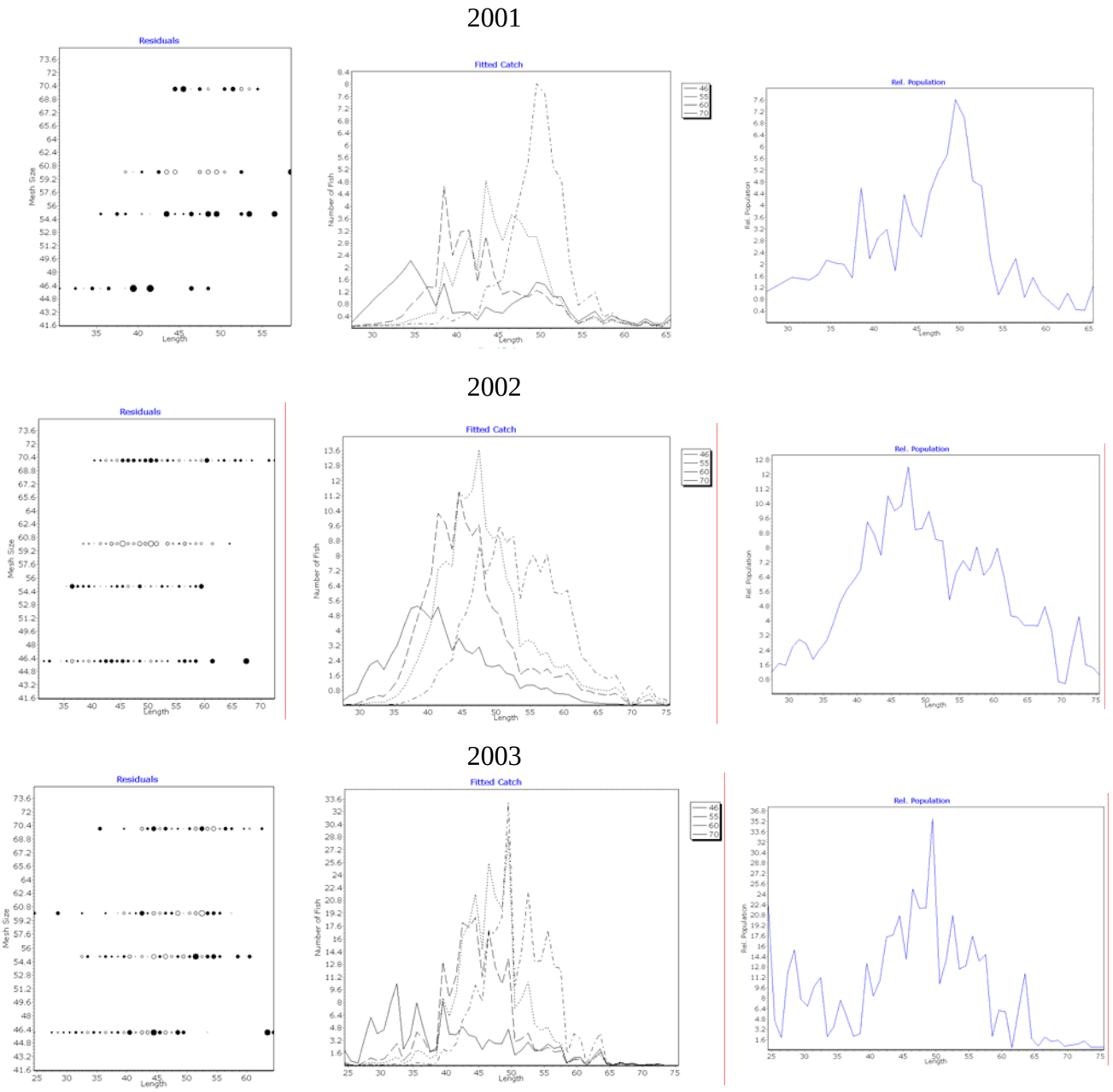

Fig. 8. Residual plots, catches by mesh sizes and resultant relative population when assuming a bi-modal selection curve as given in Fig. 5.

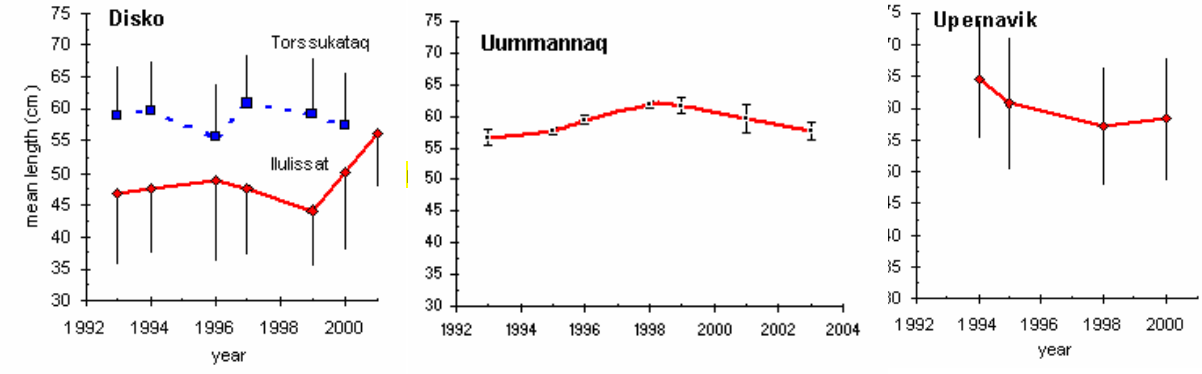

Fig. 9. Mean length for longline surveys conducted since 1993.

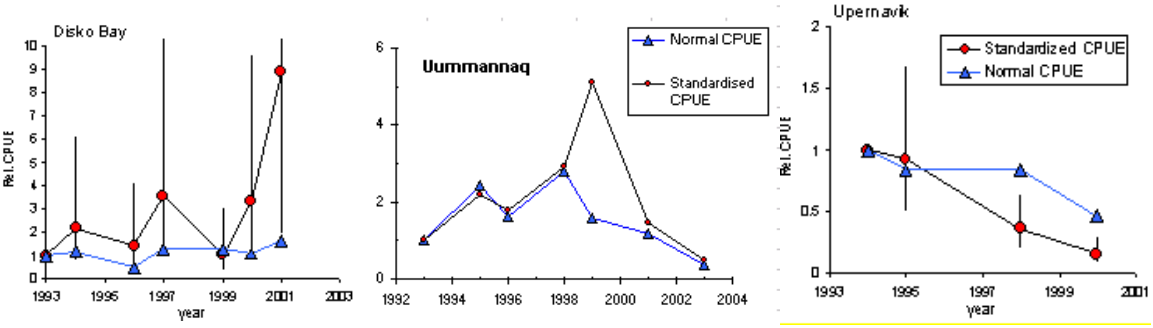

Fig. 10. CPUE index, both raw data index (normal CPUE) and standardized index (see text above). Indices are provided relative to the first year.

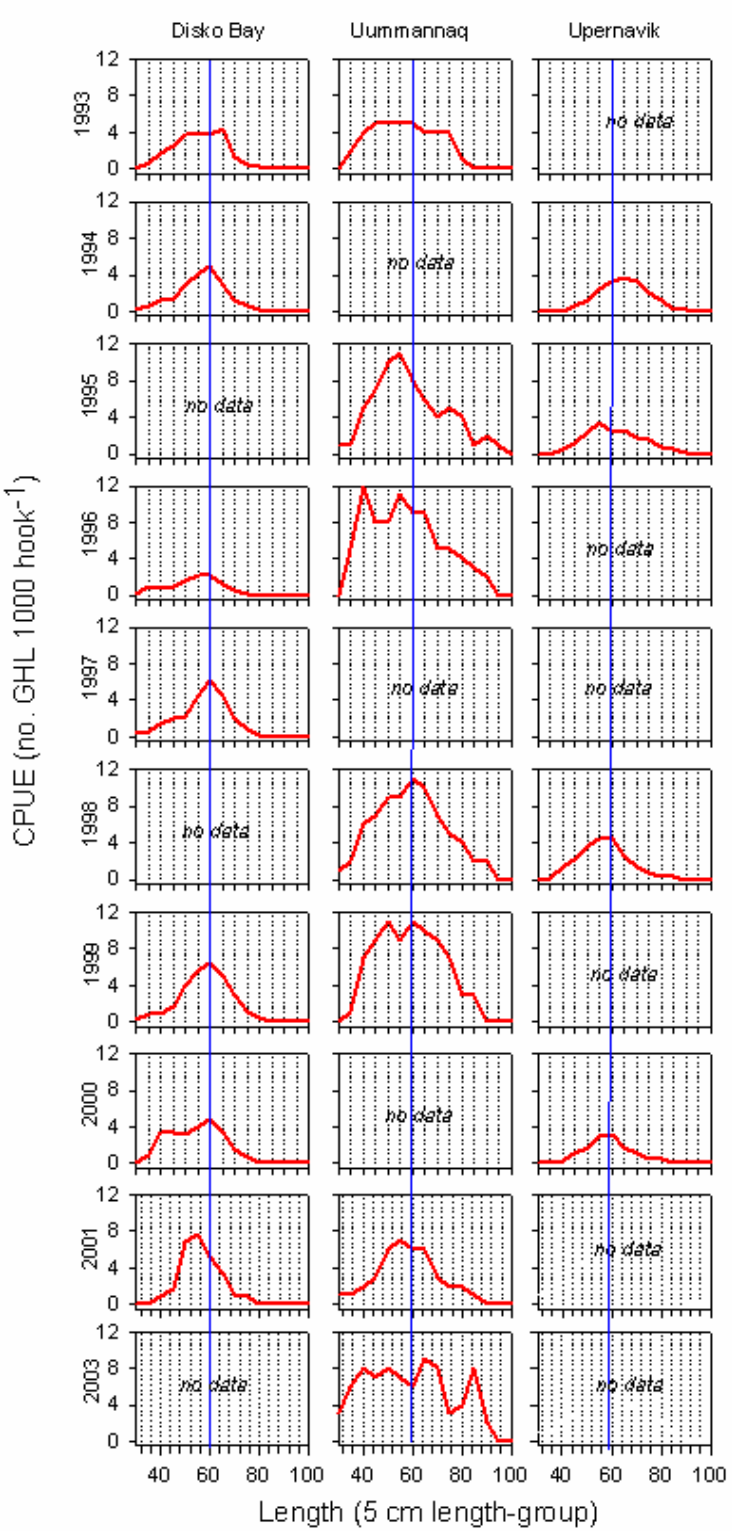

Fig. 11. CPUE (N/1000 hooks) of G. halibut from longlinesurvey stratified in 5 cm length interval. No data from 2002.

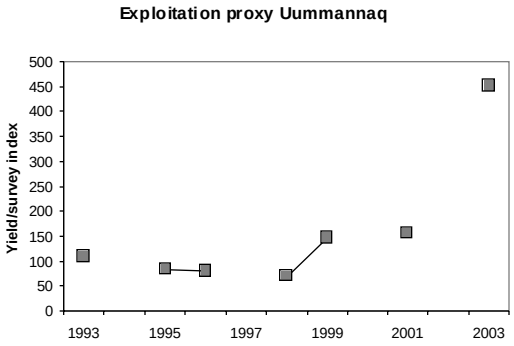

Fig 12. Plot of exploitation proxy (Yield/survey index) for Uummannaq area.

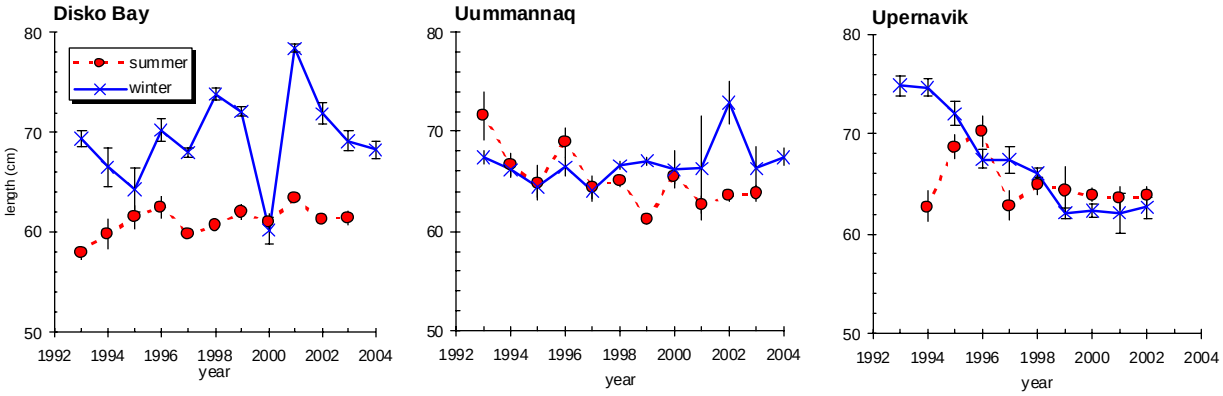

Fig. 13. Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik with 95% conf. Int.

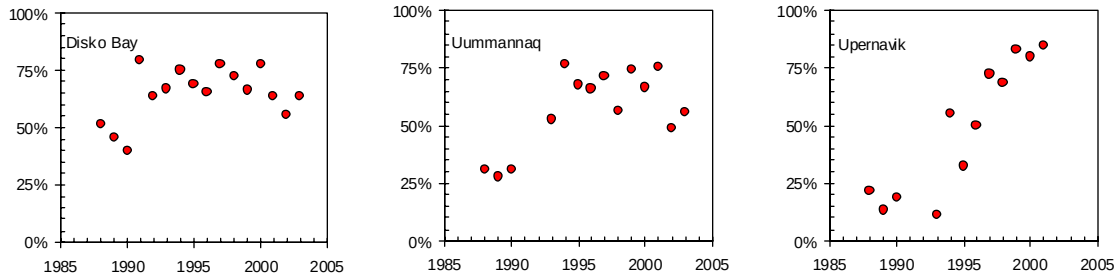

Fig. 14. The development in exploitation of the *age 10 and younger* expressed as percentages of those age groups in catches for each year.

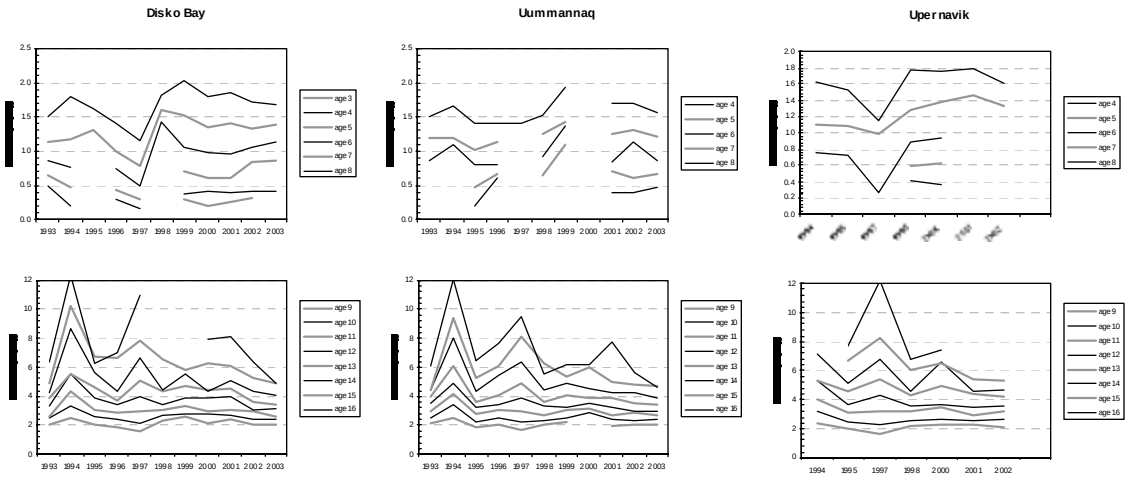

Fig. 15. Weight at age for the three areas Disko Bay, Uummannaq and Upernavik.

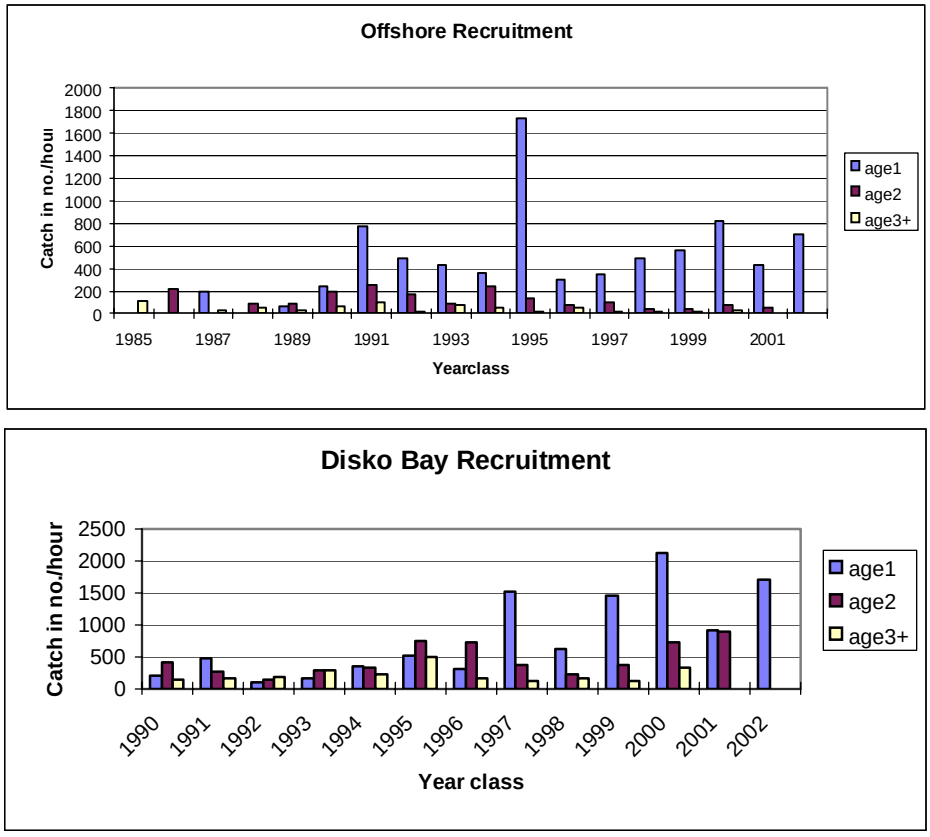

Fig. 16. **Upper**: Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the offshore nursery area (1AS-1B). **Lower**:Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the in the inshore Disko Bay (from SCR Doc. 04/18).