Northwest Atlantic Fisheries Organization

Serial No. N4867 **NAFO SCR Doc. 03/49**

SCIENTIFIC COUNCIL MEETING – JUNE 2003

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

by

Claus S. Simonsen and Jesper Boje
Greenland Institute of Natural Resources
P.O. Box 570, 3900 Nuuk, Greenland.

Abstract

This paper present 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. Compared to previous years only limited information was available for 2002. Preliminary landing statistics was not provided for gear and statistical squares, and there was insufficient sampling from the commercial fishery. This prevented a compilation of catch in numbers and associated analytical assessment as well as a general description of the development of the fishery. A change in survey design from longline to gillnet further prevent any new stock indices to be presented. The preliminary assessments were as follows. Disko Bay: For a period for more than 10 years landings more or less increased annually from about 2 000 tons in 1987 to 10 500 tons in 1998 and 99. In 2000 and 2001 landings declined to about 7 000 tons but increases abruptly to a record high of 12 000 tons in 2002. Long-line survey results since 1993 do indicate stable abundance until 2000. CPUE in 2001 is remarkably higher although uncertain. Length composition in both commercial catches and survey indicates strong recruiting year-classes coming into the survey in 2000. Estimates on fishing mortality (F) indicate that F has increased in the entire period. Uummannaq: Catches have been increasing from less than 2 000 tons before 1987 to a record high in 1999 of 8 425 tons. Since then landings have declined to 5 339 tons in 2002. Mean lengths in survey have been stable in the entire period. Survey abundance peaked in 1999 and has since decreased to the same level as in 1996. Catch at age composition in the commercial fishery has changed significant since the 1980's towards a higher exploitation of younger age-groups, but have been stable in recent years up to 2001. Length distribution in the winter fishery has been increasing in 2002, but dropped again in 2003, while the length distribution in the summer fishery has been stable. Estimates on F indicate that F has been relative stable. Upernavik: Landings have 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 by more than 50% to 3 019 tons in 2002. Survey results indicate a decline in abundance since 1994 but a stabilization in recent years. Size and age distribution have changed to smaller fish but also stabilized in recent years. Estimates on fishing mortality F indicate that continuing increase in F until 2001. New fishing grounds in the northern part of the district are being exploited; however, little information exists from these areas.

1. Stock Perception

The Greenland halibut adult stock components in Div. 1A inshore is resident populations that do not mix with the offshore adult populations as inferred from tagging studies (Boje, 2002). Only few specimens from the inshore areas have been observed in ripe condition, suggesting that only sporadic spawning takes place (Riget and Boje, 1989). Only once in Uummannaq and in Disko Bay ichtyoplankton surveys on larvae and egg have been carried out and very few or no eggs and larvae were observed in the upper water masses, supporting the suggested sporadic spawning in these fjord areas (Smidt, 1969). From frequent offshore ichtyoplankton surveys in the past it is known that eggs and larvae are dispersed along the western shore of Greenland by the West Greenland Current and along the Eastern shore of Canada by the Canadian Polar Current (Templeman, 1973). At a length of about 6-7 cm the larvae metamorphose to the bottom-stage upon settling on the banks at depth of about 200 m. (Jensen, 1935; Riget

and Boje, 1988). Riget and Boje (1988) evaluated the occurrence of young Greenland halibut in West Greenland and location of possible nursery grounds. They concluded that high abundance of young fish at Lille- and Store Hellefisk Bank north of 68°N probably originated from the Canadian-Greenland stock, while smaller concentrations in southwest Greenland coastal areas may have derived from the spawning stock west of Iceland, i.e. the West Nordic stock. Investigations covering Store Hellefiske bank and into Disko Bay, shows that the young fish when growing up, migrate continuously into the deeper areas, both towards the fjords and towards the outer slopes of the continental shelf (Riget and Boje, 1989). Therefore, Greenland halibut in Div. 1A inshore part 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). Conclusively, the component does probably not contribute to the spawning stock in the Davis Strait and the inshore component is not assumed to be a self-sustaining, but dependent on recruits (immigration) from the nursery area at the banks south of Disko.

2. Description of the Fishery, Management Measures and Nominal Catches

Total landings in 2002 in Div. 1A inshore increased by 20% from about 17 000 tons in 2001 to about 20 000 tons in 2002 due to a 66% increase for the Disko Bay area. Catches in Upernavik was slightly decreasing (8%) from 2001 to 2002, while catches in Uummannaq decreased by 20% (Fig. 2). Landings in 1A constitute far the majority (~99%) of inshore landings in Greenland. Historically, the inshore landings were around 7 000 tons in the late-980s and increased until 1998 and 1999 with a high of 25 000 tons. Since then landings have fluctuated between 17 000 tons and 20 000 tons (Fig. 2 and Table 1).

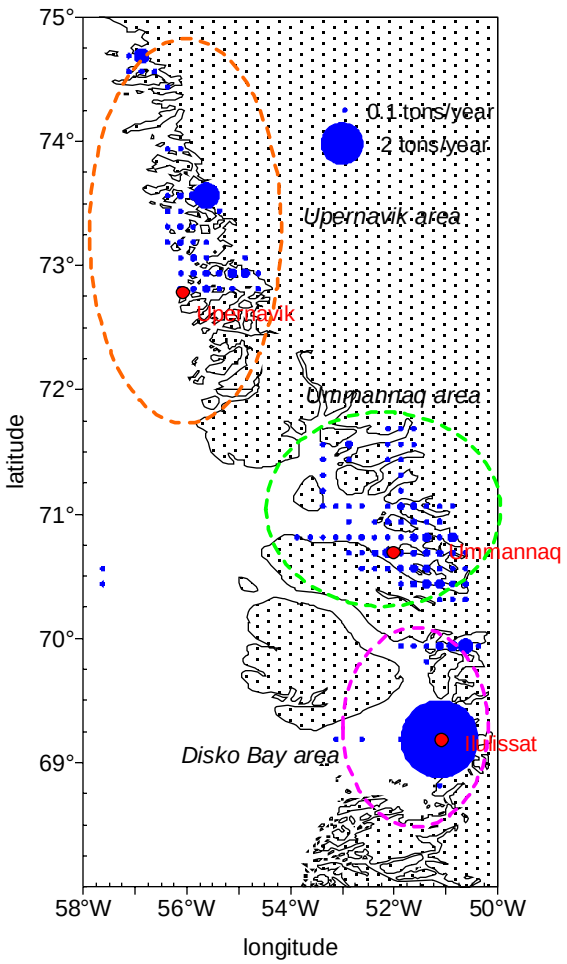

Figure 1. Location of main inshore fishing grounds for Greenland halibut in Div.1A. Distribution of landings is shown for 2001 as no information is available on the 2002 distribution.

The inshore fishery in Div. 1A is located in three well separated areas: Disko Bay, Uummannaq and Upernavik (Fig. 1). The fishery is not quota restricted, but in the latest years restrictions have been made on introduction of new vessels in fishery and from 1998 a special fishery licence to land catches is required. New license issues have since been limited. The total number of licenses is presently around 1200. There are no landing limitations on the fishery licenses.

The fishery is traditionally performed with longlines from small open boats or by means of dog sledges. Since the 1980s bigger vessels (>25 foot) have increased in numbers. Typically the fishery is carried out in the inner parts of the ice fjords at depth between 500 to 800 m. In the middle of the 1980s gillnets were introduced to the inshore fishery, and were used commonly in the following years. In the late-1990s authorities introduced regulation on gillnets in order to limit effort. A total ban for gillnets has been in force since 2000, but exemptions have been given until the beginning of 2003. In 2002 the policy was changed and gillnet fishing are now allowed in Disko Bay, Uummannaq and Upernavik. However there are time and area restrictions to the fishery. It is only allowed in certain areas outside the Icefjords. In Disko Bay: the Ilulissat area 1 January-15 May, Torsukattaq area 1 January-15 May, and 1 September-31 October. In Upernavik: 1 February-30 September. In Uummannaq: 1 February-30 June and 1 October to 31 December. 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

The Greenland halibut fishery is conducted in, and in front of an ice fjord in the immediate vicinity of Ilulissat town, and in an icefjord north of Ilulissat, Torssukataq (Fig. 1). The winter fishery in Ilulissat Icefjord, Kangia, is a traditional fishery from the ice with longlines (mainly field-code LG029, 30 and 31). The fishery near Ilulissat is conducted within a relative small area, approx. 1*2 nm (field-code LG028) and consist of a mixture of gillnet and longline fishery. The majority of the landings in Disko Bay were caught within this area. The fishery infront of the Ice Fjord (LG028) is carried out year-round. Often the fishery moves to Torssukataq north of Ilulissat in July (Simonsen and Roepstorff, 2000). The fishery in Torssukataq is almost exclusively carried out in the period July – August due to limitations by ice conditions (glacier fjord). The catches in Disko Bay have increased in 1990s (Fig. 2), and peaked in 1998-99 at around 10 000 tons, but has since increased to nearly 12 000 tons.

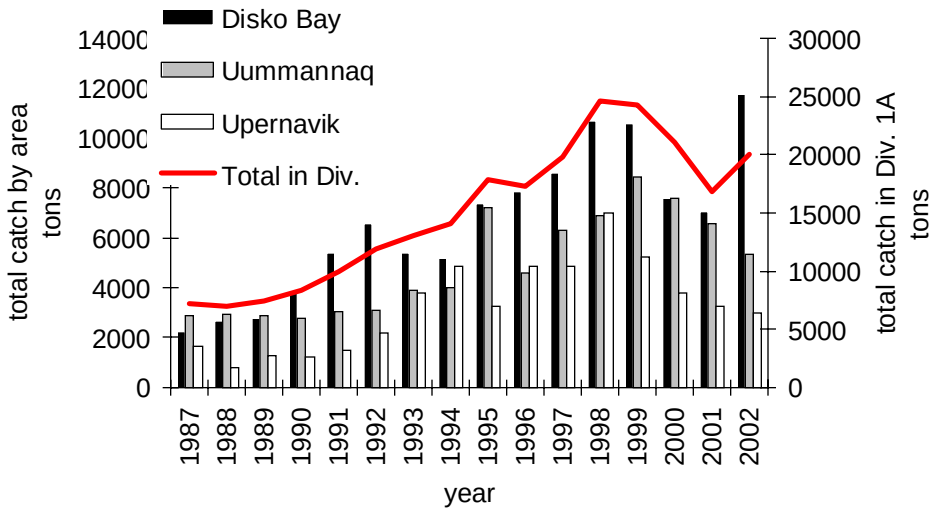

Fig. 2. Landings in NAFO Div. 1A since 1987 for the 3 main fishing areas. Landings after 1999 are provisional. See also Table 1.

Uummannaq

The fishery in Uummannaq area is conducted in a large system of icefjords (glaciers). The main fishing ground is in the southwest part of the fjord system. Earlier times Qarajaqs Icefjord was the main fishing area but during the recent decade the fishery has expanded further north to include Sermilik and Itividup Ice fjords (Fig. 1). Use of gillnets is prohibited in the inner parts of the fjords in 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 1999 landings have decreased from 8 400 tons to 5 300 tons in 2002 (Fig. 2 and Table 1).

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 recently exploited (Fig. 1). Use of gillnets have up till now been prohibited in Upernavik but dispensations have been given for a fishery outside the Icefjords in 2002.

The catches in the Upernavik area have increased steadily from about 1 000 tons in the late-1980s to about 3-4 000 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.

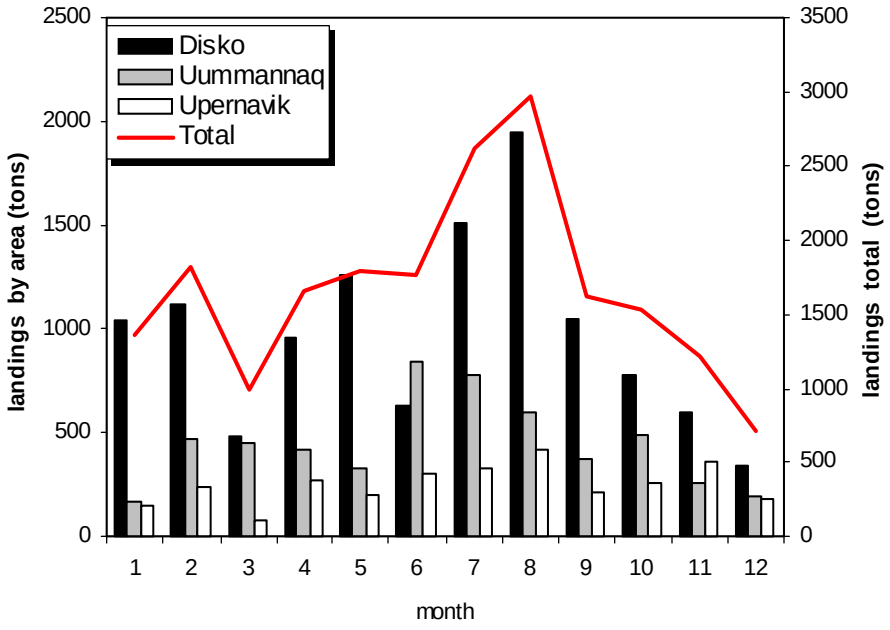

Fig. 3. Landings in NAFO Div.1A, inshore in 2002 by area and month.

3. Input data

3.1 Research Fishery

Change from longline to gillnet surveys

Prior to 1993 various longline exploratory fisheries with research vessels were conducted. 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 by the Greenland Institute of Natural Resources. 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. The main objective for using that gear is a well-estimated selectivity and 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 further develop this survey as a monitoring tool for the entire inshore Greenland halibut populations.

In July 2002 the research vessel 'Adolf Jensen' fished 33 stations along 4 transects covering the proposed young fish areas in Disko Bay (Fig. 4).

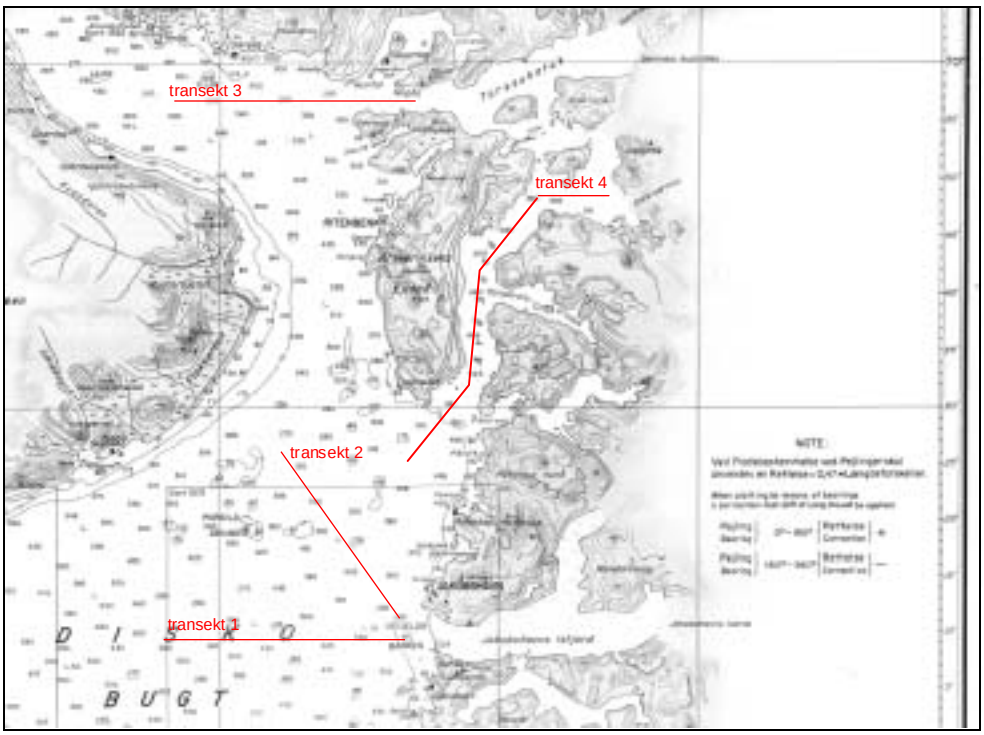

Fig. 4. The 4 tracks covered in Disko Bay by the newly developed gillnet survey in 2002 by GINR.

As the survey design and concept is still in development and that results only is available for 2 years, the results are not used in the assessment.

Greenland Institute of Natural Resources conducts annual survers for shrimp and demersal fish (Storr-Paulsen and Jørgensen 2003 (SCR Doc. 03/29). The CPUE (number per age per hour of age 1 (2001 year-class) was estimated as 431.0 specimens in the offshore nursery area (Div. 1AS, 1BN and 1BS), which is about average for the time series. In the Disko Bay the CPUE of age one was estimated at 912.5 specimens per hour, which is a little above average for time series . The abundance of 2-year olds is generally lower in the offshore area in comparison to the Disko Bay. But there is generally a steep decline in the CPUE of fish age one and fish age two the following year in both areas. The very god 2000 year-class in Disko Bay, was however also relatively god as age 2.

3.2 Commercial fishery data

Landings data

Data on the inshore landings of Greenland halibut for Disko Bay and Uummannaq in 2002 was obtained from Greenland Fishery Licence Control (GFLK). Data from Upernavik was obtained from Upernavik Seafood. Data from GFLK was not allocated on gear. 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 were carried out in the three main areas in February/March and July/August. Samples from the longline fishery were obtained from all areas and both seasons while the gill net fishery was covered in Disko Bay

winter and Uummannaq winter and summer. Gillnet samples was not achieved either summer or winter in Upernavik.

Effort

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

Earlier attempts to estimate fishing effort has shown a significant correlation between effort (expresses as fishing days) and landings (Simonsen and Boje, 1999).

Estimation of fishing mortality

In this years assessment no new attempts was made to estimate present fishing mortality.

Catch-at-age data

It was not possible to calculate catch in number for 2002 as there was no information on landings broken down on gear in Disko Bay and Uummannaq. For Upernavik these data were available, but here we did not have size distributions from gillnet fishery either summer or winter. Thus CN could not be compiled for any of the 3 areas (Table 4).

3.3 Recruitment data

Recruitment index

A recruitment index was provided from the Greenland shrimp trawl survey (SCR Doc. 03/29).

3.4 Biological data

Data Storage Tags and behaviour of Greenland halibut.

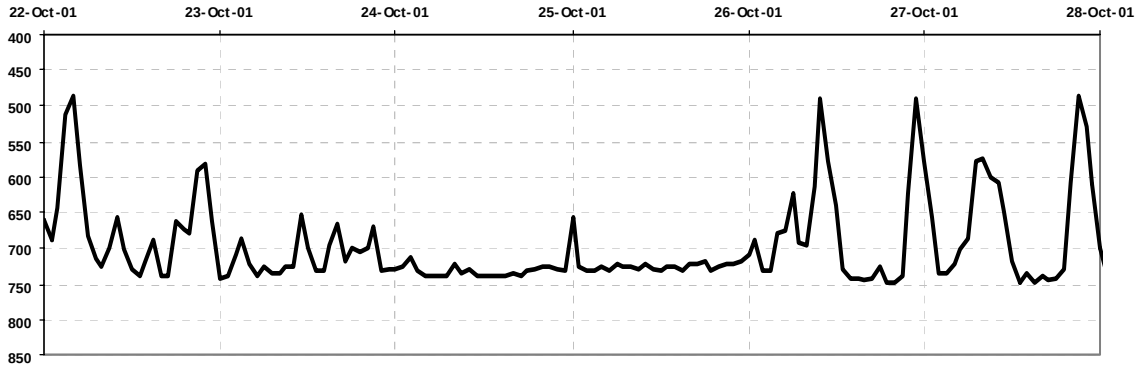

Fig.5. An example of the most common type of excursions as derived from DST tagging: X-axis: date, y-axis : depth in meter.

A study have been initiated between Nordic countries to elucidate vertical migratory behaviour of Greenland halibut by means of electronic tags, DST. In Greenland the area, Ilulissat, at West Greenland, were chosen because of the well-known residency of the fish and because of a suggested high fishing mortality ensuring a high recovery rate. In 2001/2002, 181 fish were tagged with DST's delivered from Star-Oddi in Iceland. DST's were set to record depth and temperature at intervals in the range 10-60 min. So far, 8 recaptures have been recorded, corresponding to recepture rates as seen for conventional tags. The recordings show that Greenland halibut is capable of performing extensive vertical excursions of up to 3-400 m within few hours. Preliminary analyses suggest that the excursions

are not related to a diurnal pattern, but occurred randomly in time. However, most vertical movements had duration of less an hour and amplitude of less than 50 m. An example of vertical movement is given in Fig. 4.

The tagging is planned to continue in 2003 in the same area.

Maturity

Observations of sexual maturity of Greenland halibut were carried out in all areas in 2002. The majority of all female fish were in GI stage 2. For further details see paper SCR Doc. 02/38 (Simonsen and Gundersen, 2002)

Condition and Weight at age

An age independent condition index was set up for Greenland halibut. The length – weight relationship was found to fit a power function:

$$W = K * L^B$$

where W = weight; L is total length, b is a constant and K is the condition factor. b was found to be 3.3 (N = 3240, $r^2 = 0.98$).

Thus the condition factor was defined as

$$K = \frac{W}{L^{3.3}} * 10^6$$

For weight at age information 10 fish in each cm-group was sampled, length and weight measured and the otolith age estimated. Mean weight at each age group was calculated as simple arithmetic mean.

3.5 Analytic assessment

The possibilities of an analytic assessment have been explored in previous assessment 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. The separable VPA was not run for this assessment as no catch at age data could be complied for 2002.

4. Assessment

4.1 Longline/gillnet surveys

Due to the newly initiated gillnet surveys and the concurrent ending of the longline surveys, results from the previous longline surveys are provided as in 2002 assessment paper.

Mean length

In Disko Bay the survey showed some discrepancy between Ilulissat and Torssukataq area (Fig. 6). In Torssukataq the mean size has been stable over time with in average larger fish compared to Ilulissat. In Ilulissat mean lengths until 1998 has been stable, but in the last two years mean size have increased and reached the level of Torssukataq.

In Uummannaq mean size have increased until 2000 (Fig. 6) followed by a slight decline in 2001 data (even though sparse) indicate a minor fall in mean length.

In Upernavik there have been a decreasing trend from 1994 to 1998 while the 2000 survey indicate a stabilization in mean length (Fig. 6).

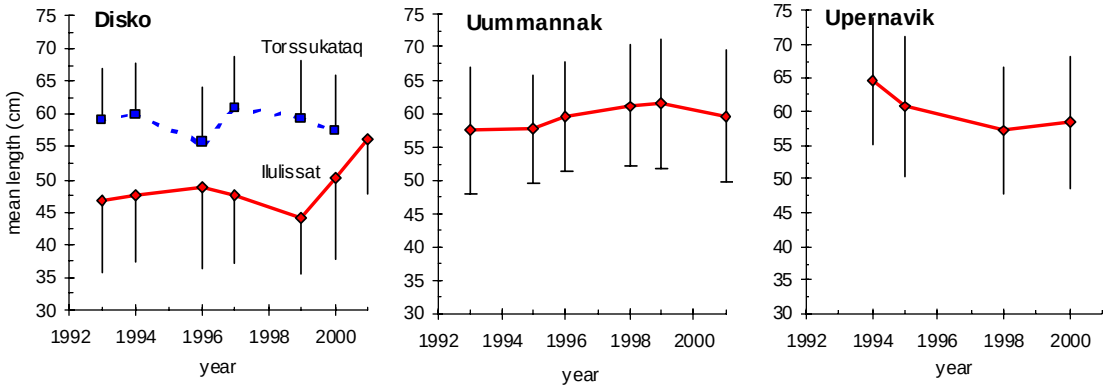

Figure 6. Mean length for research longline surveys since 1993 +/- S.D. No data available for 2002.

Survey CPUE

In order to standardise the survey with respect to dependent effects the CPUE indices was estimated by means of a GLM analysis (multiplicative model) using information on area (field-code), depth and year. First a full model was applied, then a reduced model sub-categorizing the variables (in order no to over-parameterize). Output from GLM is shown in Table 7. As no survey was carried out in 2002 new data have not been added to this index.

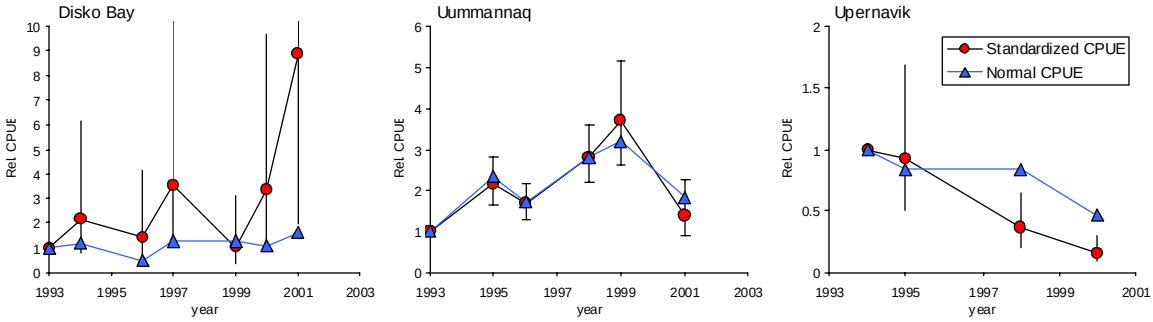

Fig. 7. CPUE index, both raw data index and standardized index (see text above). No data from 2002.

In Disko Bay the CPUE index have been fluctuating without any trend until 2001 which is about four times the average for the period 1993 to 2000. However, the year effect is no significant. According to local fishers the distribution of Greenland halibut in 2001 was somewhat unusual as high concentrations of fish where to be found in the Ilulissat area throughout summer. Usually catch rate drop in mid-July, which has been interpreted as a migration of fish out of the area (Simonsen and Roepstorff, 2000).

In Uummannaq CPUE has been increasing until 1999 but decreased significantly in 2001.

In Upernavik the CPUE index has decreased significantly throughout the time series.

CPUE length-stratified

From CPUE on length-stratified samples it was found:

In Disko Bay in all years, except 1993 and 2001, the modal length has been around 60 cm. In 1993 it was above, and in 2001, below 60 cm. Especially in 2000 length classes 40 to 50 cm where abundant suggest incoming year classes above average (Fig. 8).

In Uummannaq there is a shift in modal length from 50 cm in 1993 to 65 cm in 1998 and 99 (Fig. 8).

In Upernavik larger fish have become less abundant and the modal has shifted from 65 cm in 1994 to 55-60 cm in 2000 (Fig. 8).

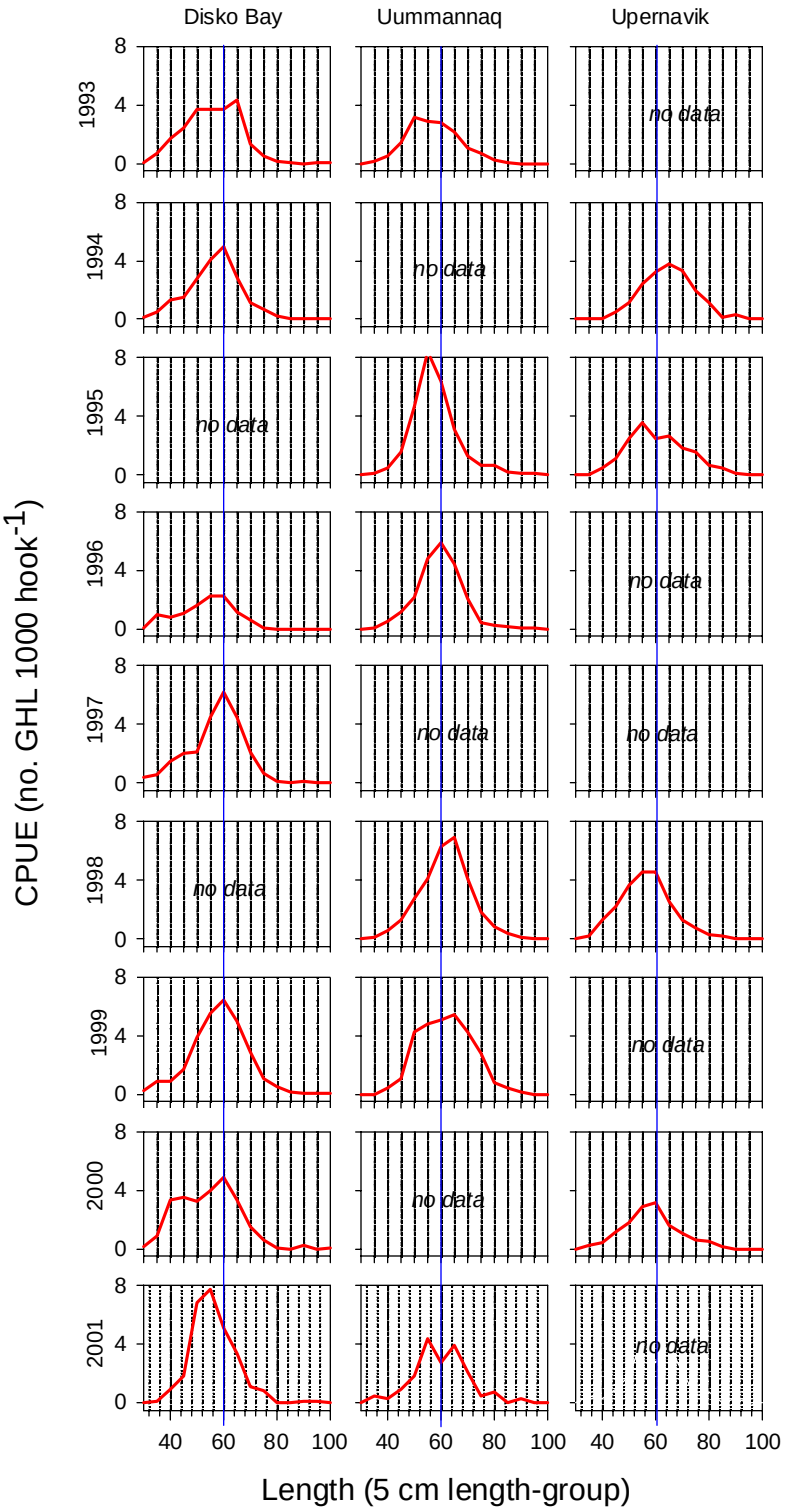

Fig. 8. CPUE (N/1000 hooks) of G. halibut from longlinesurvey stratified in 5 cm length interval. No data from 2002.

4.2. Commercial fishery

Size distribution

Mean lengths from the longline landings in the period 1993 to winter 2003 in Disko Bay, Uummannaq and Upernavik are showed in Fig. 9. Fish caught in summer are general smaller than fish caught during winter season.

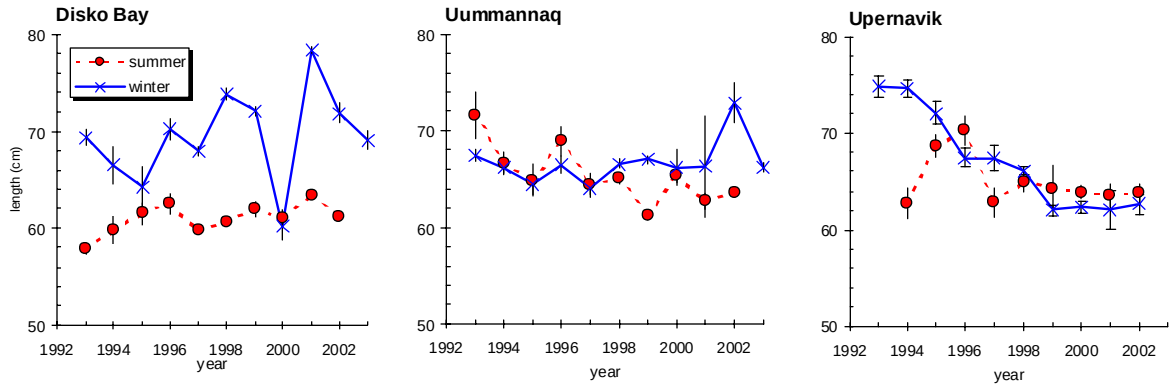

Fig. 9. Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik +/- 95% conf.

In Disko Bay mean length in the time series have fluctuated around 70 cm in the winter fishery and 61 cm in the summer fishery. There has been a tendency to an increase in fish size until 2001 but in latest years mean length has decreased, especially in the winter fishery. This could be because fishing at the traditional winter fishing grounds has been hampered due to lack of land-fast sea-ice (the fishery is conducted from the sea-ice). Instead an open-water fishery has developed on alternative fishing grounds.

In Uummannaq the development in mean length in the summer fishery has showed an overall negative trend through out the time series. In the winter fishery the mean length has been has been relatively stable except for the winter 2002.

In Upernavik mean length increased up to 1996 where after it stabilized at around 64 cm. In the winter fishery, mean length decreases significantly in the period 1993 to 1999, but have since been stable around 62 cm.

Fishing mortality

As catch at age data was not available F could not be estimated for 2002. Earlier calculations have indicated that F for age 10-14 is about 4 times higher in 2001 compared to the beginning of the time series. In Uummannaq F has increased about a two-fold. F was estimated to on the level same level in Upernavik and Disko Bay while somewhat lower in Uummannaq (about 25%).

Catch at age

Exploitation patterns for fish age 10 and below have increased for all tree areas (Fig. 10). In Disko Bay exploitation have been around 70 % since the early-1990s. In Uummannaq the same trend have been observed since mid-1990s. The exploitation pattern in Upernavik have until 1996 been on relative old fish (20% age 10 and below) but have since developed to exploit still younger age groups. Catch at age was not on hand for 2002 but it is likely that the latest years exploitation on relatively few age-groups continued. In 2001 over 80% of the fishery is conducted on 4 age-groups.

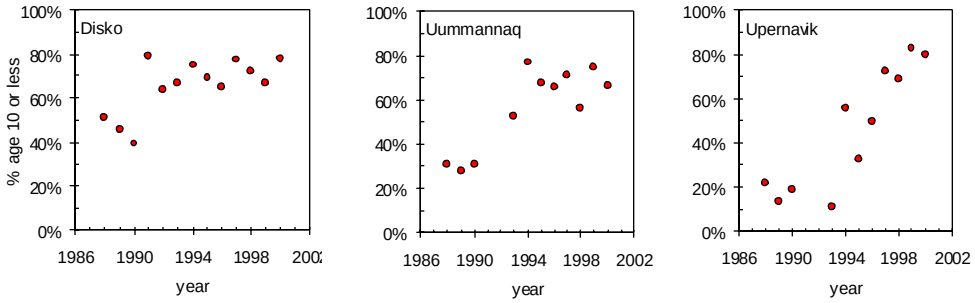

Fig. 10. The development in exploitation of the *age 10 and below* expressed as percentages for each year. No data for 2002

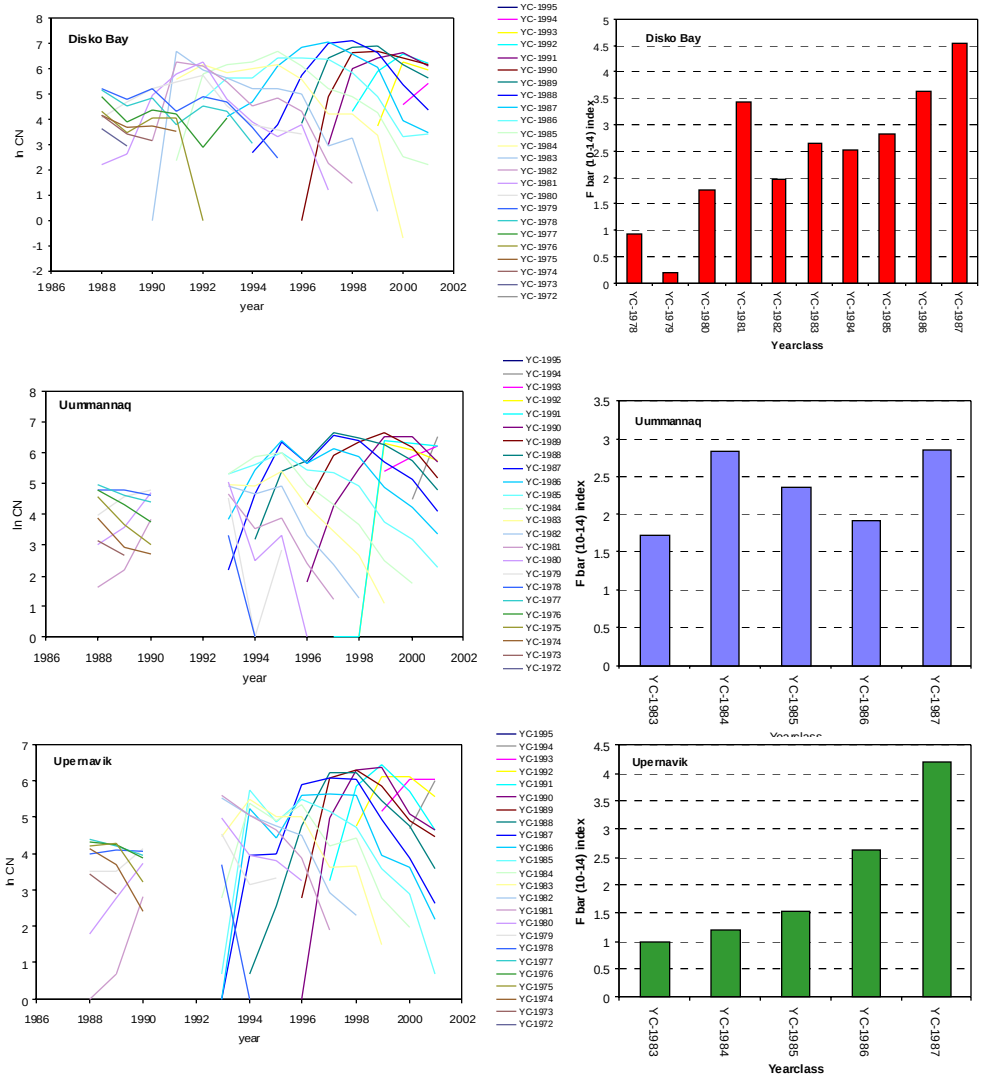

Fig. 11. Left panel: LN to catch in numbers in each area. The fate of the different year-classes can be followed. Right panel: time. For the ages 10-14 Z was estimated by linear regression. An F bar index was set up by using the Upernavik year-class 1983 as reference (this YC was considered to have been exposed to the lowest fishery exploitation rate).

Recruitment

Recruitment of ages 1, 2 and 3+ from the offshore and Disko Bay area are presented in SCR Doc. 03/29.

As mentioned in section 3.1 results from the recently initiated gillnet survey are to premature to include in an assessment, as both effort and location differed from 2001 to 2002.

Condition index and weight-at-age

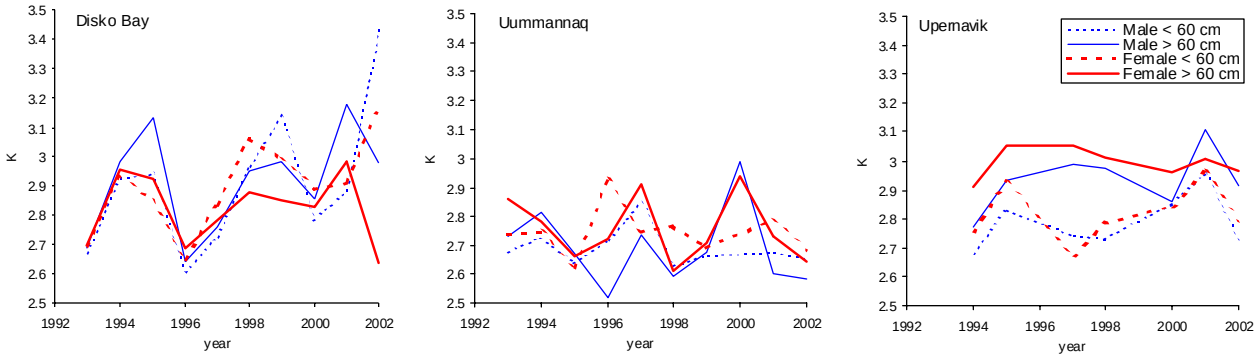

Fig. 12. Conditions index (K) on area, size and sex.

The condition index (K) was applied on length-stratified samples (larger or smaller than 60 cm) and on sex in each area (Fig.12). In Disko Bay the lowest K was found in 1996, but otherwise seemed to fluctuate with no clear trend throughout the time series neither between size and/or sex. Compared to the other areas the Uummannaq area had the lowest K. Neither here, any clear trend was observed in time. In Upernavik the larger fish had a high K. Also here the index fluctuated with no clear trend.

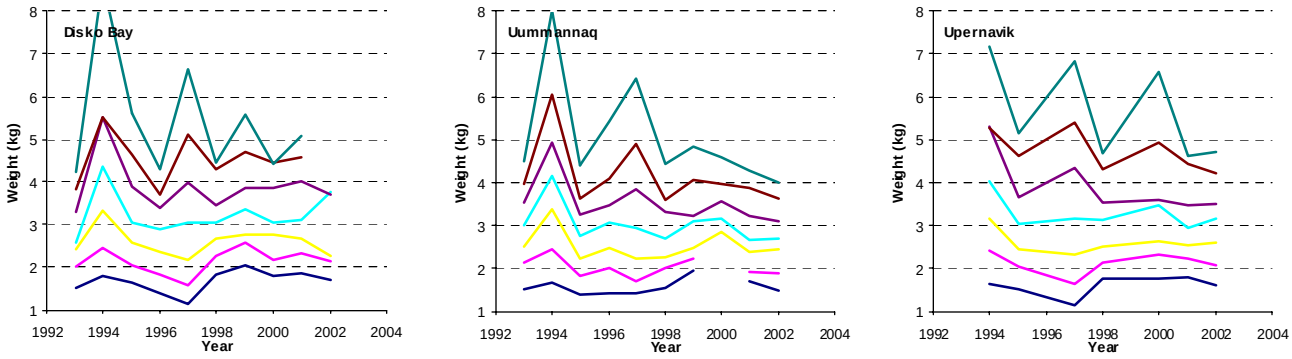

Fig. 13. Weight-at-age for ages 8-14

Some peculiarities were observed in the weight at age data (Fig. 13). In 1994 weights for all ages were higher than adjacent years. In 1997 only the older ages (>12 y) have higher mean weight at age while it was lower for ages 8-11. This is likely to reflect errors in age estimations. Ignoring the years 1994 and 1997 no dramatic change in weight at age was observed in the time series.

5. State of the Stock Components

Data deficiency for 2002, both for commercial and survey data, in combination with preliminary landing statistics, impedes an updated assessment of the populations. The abrupt decline in landings in the most recent years that raised concern by NAFO in 2002, have changed to an increase for Disko bay in 2002. The lack of information on fishing effort makes it difficult to evaluate trends in landings relative to stock biomass or fishing effort.

"Soft" information from fishermen and the industry about the fishery in 2002 suggest that: The increase in landings in Disko Bay in 2002 is a result of a rise in effort. Gillnet boats from Uummannaq were participating in a fishery in Torssukattaq in Disko Bay and thus re-allocated effort from Uummannaq to Disko Bay. In Upernavik several 25-35" boats were lost in a fire and 4 of the bigger vessels was involved in a new fishery for snow-crab. Thus effort was reduced in Upernavik in 2002.

Disko Bay

Since the beginning of the fishery for Greenland halibut in Greenland, which started in this area early in the 1900, 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 abruptly to a record high of nearly 12 000 tons in 2002. The reason for this variation is unknown, as no effort measures is available.

In the commercial fishery mean length are quite variable for the entire time series without any trend.

Survey results from 1993 onwards do not indicate any major changes in abundance, except for the year 2001, when the abundance-index was remarkably higher, although estimated with uncertainty. Length composition in the survey data indicate above average recruiting year-classes entering the fishery in 2000 and 2001. No data is available for 2002

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 5 339 tons in 2002.

Development in mean length in the summer fishery has showed an overall negative trend through out the time series. 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 1999. In 2001 survey abundance index decreased significantly to a level observed in the mid 1990's. No data is available for 2002. Catch composition in the commercial fishery has changed significantly since the 1980s towards a higher exploitation of younger age groups, but has recently stabilized.

Upernavik

Fishery in the area is relatively new and started in the mid-1980s. Landings have 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 by more than 50% to 2 993 tons in 2002. A standardized effort index for the area showed a falling trend since 1998 even though the year effect was not statistical significant.

Mean length increased up to 1996 where after it stabilized at around 64 cm. In the winter fishery, mean length decreases significantly in the period 1993 to 1999, but have since been stable around 62 cm.

Survey results from 1993 onwards indicate a steady and significant decline in abundance. Mean length compositions in both commercial and survey catches have decreased, most significantly in the winter fishery, but have stabilized since 1999. In the traditional fishing grounds at Upernavik up to 73°45'N younger and fewer age groups are caught. New fishing grounds in the northern part of the district have been exploited only recently. Little information exists from these areas.

6. General Comments

The lack of confident landing data for recent years hampers the assessment of the inshore stock components in Div. 1A. 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.

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, 22 mm sorting grids have since then been made mandatory in the shrimp fishery (since October 2000). 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.

7. References

Bech, G., 1995a. An assessment of the inshore Greenland halibut stock component in NAFO Divisions 1A. NAFO SCR Doc. 95/67

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

Boje, J. (1991). An assessment of the Greenland halibut stock component in NAFO Subareas 0+1. NAFO SCR Doc. 91/38

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. (2002). Intermingling and seasonal migrations of Greenland halibut (*Reinhardtius hippoglossoides*) populations determined from tagging studies. Fishery Bulletin, 100: 414-422.

Engelstoft, J. J. and O. A. Jørgensen (2002). Biomass and abundance of dermersal fish stocks off West-Greenland estimated from the Greenland trawl survey 1988-2001. NAFO SCR Doc. 02/48.

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 J. Boje (1994). Sexual maturity of Greenland halibut in NAFO Subarea 1. NAFO SCR Doc., No. 94/42, (N2412).

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

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

Simonsen, C. S. (1998). An assessment of the inshore Greenland halibut stock component in NAFO Division 1A inshore. NAFO SCR Doc. 98/44 (N3035).

Simonsen, C. S. and J. Boje (1997). An assessment of the inshore Greenland halibut stock component in NAFO Division 1A. NAFO SCR Doc. 97/78 (N2915).

Simonsen, C. S. and J. Boje (1999). An assessment of the inshore Greenland halibut stock component in NAFO Division 1A. NAFO SCR Doc. 99/48.

Simonsen, C.S. and Roepstorff, A., 2000. Udvikling og adfærd af fisk and 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. 2001. Logbook in the inshore fishery for Greenland halibut in NAFO Div. 1A. NAFO SC Working Paper, No. 01/26.

Simonsen, C.S. and Gundersen A. C. (2002). Maturity of Greenland Halibut (*Reinhardtius hippoglossoides*) in the Fjords of Northwest Greenland. NAFO SCR Doc. 02/38

Smidt, E. L. B. (1969). The Greenland halibut, *Reinhardtius hippoglossoides*, biology and exploitation in Greenland waters. Meddelelser fra Danmarks Fiskeri- og Havunders¢gelser 6(4): 79-148.

Storr-Paulsen, M. And O.A. Jørgensen (2003). Biomass and Abundance of Demersal Fish Stocks off West Greenland Estimated from the Greenland Shrimp survey, 1988-2002. NAFO SCR. Doc. 03/29.

Table 1. Landings and Greenland halibut (tons) in Div. 1A distributed on the main fishing grounds: Disko Bay, Uummannaq and Upernavik. Conversion faktor 1.1 for gutted fish with head, 1.50 for gutted fish without head, 1.52 for gutted fish without head and tail fin). 1) Unofficial data from the fishing industry (Royal Greenland, NUKA, Upernavik Seafood and Uummannaq Seafood.

Area/year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000[1]**	**2001[1]**	**2002[1]**
Disko Bay	2258	2670	2781	3821	5372	6577	5367	5201	7400	7837	8601	10671	10593	7574	7072	11718
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234	4579	6294	6912	8425	7568	6558	5339
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	2403	4846	4879	7012	5258	3764	3239	3019
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			
STACFIS	7196	7003	7492	8352	9929	11933	13088	14049	17037	17262	19774	24595	24332	21144	16869	20076

Table 2. 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	no information	no information	no information	no information	
	Torssukataq	no information	no information	no information	no information	11718
Ummannaq		no information	no information	no information	no information	5339
Upernavik		1267	109	1545	99	3019

Table 3. 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**
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
Upernavik	-	-	-	-	-	64.6	60.8	-	-	57.1		58.4	

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**
4	0	0	0	5	34	7	0	0	0	0	0	1	0	1	-
5	0	0	0	5	92	15	3	0	8	0	0	4	9	15	-
6	1	0	0	11	122	62	15	0	1	21	74	41	98	33	-
7	9	0	1	279	332	280	112	45	47	132	397	360	535	224	-
8	59	14	24	806	476	479	281	459	323	646	775	619	729	390	-
9	182	106	141	535	390	339	539	639	941	1113	944	836	780	521	-
10	173	121	185	333	451	280	396	798	651	1168	1248	1028	636	450	-
11	132	94	188	238	532	240	190	463	454	607	754	786	478	485	-
12	73	49	126	76	309	122	91	185	273	185	346	426	223	280	-
13	63	33	80	45	140	91	50	127	145	69	132	136	52	78	-
14	65	39	59	67	92	112	45	27	75	19	68	72	28	33	-
15	38	31	42	57	18	75	41	36	44	10	27	29	12	31	-
16+	33	41	44	44	0	86	36	27	69	6	6	2	1	16	-
Total	828	528	890	2501	2988	2188	1799	2806	3031	3976	4770	4340	3583	2557	

B) Uummannaq

												Catch in numbers (thousands)			
age/year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
4	0	0	0	-	-	0	0	0	1	0	0	8	0	0	-
5	0	0	0	-	-	0	0	0	0	0	0	70	19	65	-
6	1	0	1	-	-	9	24	6	6	0	0	218	86	113	-
7	5	2	3	-	-	45	105	217	76	69	0	554	357	674	-
8	20	9	15	-	-	200	226	564	308	377	235	596	441	507	-
9	52	35	47	-	-	202	271	601	279	793	566	690	543	315	-
10	121	98	108	-	-	142	346	413	286	702	657	789	669	492	-
11	143	120	121	-	-	138	139	414	232	460	586	526	487	303	-
12	121	99	101	-	-	104	105	219	142	206	355	295	311	178	-
13	96	76	82	-	-	158	34	138	69	75	138	131	170	121	-
14	49	38	42	-	-	93	12	49	28	32	39	42	68	60	-
15	23	19	20	-	-	28	0	28	11	10	15	12	24	28	-
16+	17	20	21	-	-	20	3	22	15	6	5	4	8	12	-
Total	648	516	561	-	-	1139	1265	2671	1453	2732	2595	3935	3184	2868	

Table 4. Catch-at-age of Greenland halibut (continued).

C) Upernavik

	Catch in numbers (thousands)														
age/year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
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 5. Age-length keys used in 2002 assessment.

Disko Bay age-length key, data combined from 2000+2001+2002

length \ age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total
30	16	19																	35
35		67	29	1															97
40		4	108	16	1														129
45			11	105	11														127
50				16	95	15													126
55					13	76	18												107
60					1	10	51	30	12										104
65								15	49	23									87
70									5	38	12	3							58
75										8	10	4	2						24
80												2	5						7
85													4	2					6
90														4	5				9
95														1	1				2
100																			0
total	16	90	148	138	121	101	69	45	66	69	22	9	11	7	6	0	0	0	918

Ummannaq age-length key, data combined from 2000+2001+2002

length \ age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total
30	6	9																	15
35		39	19																58
40		4	73	5															82
45			9	72	4														85
50				11	86	23	2												122
55					11	76	31	1											119
60					1	9	60	38	16										124
65							1	21	61	35	4								122
70									7	40	20	5							72
75										8	15	11	6		1	1			42
80												4	14	10	6	1			35
85													6	7	4	3	2		22
90														5	6	2	2	1	16
95														1	1				2
100																			0
total	6	52	101	88	102	108	94	60	84	83	39	20	26	23	18	7	4	1	916

Upernavik age-length age-length key, data combined from 2000+2001+2002

length \ age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total
30		2																	2
35																			0
40			9	1															10
45			1	19	5														25
50				1	54	23	1												79
55					15	76	40	1	1										133
60						13	61	40	23	1									138
65							4	15	49	38	5								111
70									12	40	27	3							82
75										2	20	16	10	2					50
80											1	1	7	6	2		1		18
85											1	1	1	4	2	1			10
90														1	5	2	1		9
95															1				1
100																			0
total		2	10	21	74	112	106	56	85	81	54	21	18	13	10	3	2	0	668

Table 6. Weight and weight at age for each component in Div. 1A inshore compiled on data for the last 3 years 2000-2002.

	Disko Bay			Uummannaq			Upernavik		
AGE	**length**	**weight**	**N**	**length**	**weight**	**N**	**length**	**weight**	**N**
3	30.64	0.31	22	30.88	0.24	8			
4	36.19	0.47	90	36.62	0.41	52	33.50	0.31	2
5	41.47	0.65	148	41.57	0.63	101	42.30	0.61	10
6	46.75	0.93	138	47.14	0.96	88	46.86	0.93	21
7	52.07	1.34	121	52.41	1.36	102	52.64	1.39	73
8	56.79	1.79	101	56.53	1.73	108	56.44	1.72	112
9	60.64	2.23	69	60.21	2.10	94	60.25	2.19	106
10	63.53	2.62	45	63.67	2.59	60	63.30	2.60	56
11	66.62	3.11	66	66.49	2.98	84	66.16	3.05	85
12	70.75	3.89	69	70.28	3.73	83	69.72	3.57	81
13	74.09	4.31	22	73.67	4.02	39	74.04	4.42	54
14	76.44	4.73	9	76.05	4.51	20	77.05	4.86	20
15	83.64	6.82	11	82.35	5.90	26	80.06	5.69	18
16	91.14	8.20	7	86.22	6.77	23	83.31	6.84	13
17	93.33	10.23	6	87.50	7.44	18	89.30	8.63	10
18				86.14	6.51	7	89.67	8.33	3
19				88.75	6.91	4	87.50	8.08	2
20				90.00	6.34	1	93.00	9.29	1

Table 7. Output from standardization of CPUE by GLM analysis.

```
 CPUE LONGLINE SURVEY DISKO BAY    08:20 Monday, May 20, 2002 773

                                    The GLM Procedure

                                 Class Level Information

                  Class         Levels    Values

                  AR                 7    1994 1996 1997 1999 2000 2001 19930

                  FELT               3    H L M

                  DYB                3    DEEP MEDIUM SHALLOW

                                 Number of observations    179

                                    The GLM Procedure

Dependent Variable: LNCPUE

       Source                       DF         Sum of Squares     Mean Square    F Value    Pr > F

       Model                        10     2731.300735      273.130073      17.43    <.0001

       Error                       168     2632.209495       15.667914

       Corrected Total             178     5363.510230

                      R-Square     Coeff Var      Root MSE    LNCPUE Mean

                      0.509238     -232.5623      3.958272      -1.702026

       Source                       DF       Type I SS     Mean Square    F Value    Pr > F

       AR                            6      158.846380       26.474397       1.69    0.1263
       FELT                          2     1786.326172      893.163086      57.01    <.0001
       DYB                           2      786.128182      393.064091      25.09    <.0001

       Source                       DF     Type III SS     Mean Square    F Value    Pr > F

       AR                            6       63.666311       10.611052       0.68    0.6682
       FELT                          2     1256.617229      628.308615      40.10    <.0001
       DYB                           2      786.128182      393.064091      25.09    <.0001

                                                        Standard
           Parameter                 Estimate              Error    t Value    Pr > |t|

           Intercept             -5.208091905 B      0.95296734      -5.47      <.0001
           AR         1994        0.777328723 B      1.03637752       0.75      0.4543
           AR         1996        0.358089778 B      1.06138764       0.34      0.7363
           AR         1997        1.271508671 B      1.09070862       1.17      0.2454
           AR         1999        0.052474695 B      1.07979793       0.05      0.9613
           AR         2000        1.215905759 B      1.05078077       1.16      0.2489
           AR         2001        2.181017088 B      1.49276842       1.46      0.1459
           AR         19930       0.000000000 B       .                .          .
           FELT       H           2.662029407 B      0.85789096       3.10      0.0022
           FELT       L          -5.896692764 B      0.79900623      -7.38      <.0001
           FELT       M           0.000000000 B       .                .          .
           DYB        DEEP        4.698995014 B      1.26651244       3.71      0.0003
           DYB        MEDIUM      4.806731699 B      0.68388415       7.03      <.0001
           DYB        SHALLOW     0.000000000 B       .                .          .

NOTE: The X'X matrix has been found to be singular, and a generalized inverse was used to solve
      the normal equations.  Terms whose estimates are followed by the letter 'B' are not
      uniquely estimable.
```

CPUE LONGLINE SURVEY UUMMANNAQ 08:20 Monday, May 20,
The GLM Procedure

Class Level Information

Class	Levels	Values
AR	6	1995 1996 1998 1999 2001 19930
FELT	3	H L M
DYB	3	DEEP MEDIUM SHALLOW

Number of observations 100

The GLM Procedure

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	35.53987027	3.94887447	5.83	<.0001
Error	90	60.96742175	0.67741580		
Corrected Total	99	96.50729202			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.368261	59.59154	0.823053	1.381157

Source	DF	Type I SS	Mean Square	F Value	Pr > F
AR	5	15.47246125	3.09449225	4.57	0.0009
FELT	2	14.61989345	7.30994672	10.79	<.0001
DYB	2	5.44751557	2.72375779	4.02	0.0213

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AR	5	16.45626853	3.29125371	4.86	0.0006
FELT	2	17.74563415	8.87281708	13.10	<.0001
DYB	2	5.44751557	2.72375779	4.02	0.0213

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		0.140653629	B	0.32783467	0.43	0.6689
AR	1995	0.770869077	B	0.26584230	2.90	0.0047
AR	1996	0.517822525	B	0.25134450	2.06	0.0423
AR	1998	1.030709255	B	0.25225867	4.09	<.0001
AR	1999	1.303789843	B	0.33490320	3.89	0.0002
AR	2001	0.338781156	B	0.46392599	0.73	0.4671
AR	19930	0.000000000	B	.	.	.
FELT	H	0.729233035	B	0.36076669	2.02	0.0462
FELT	L	-1.219633980	B	0.26920069	-4.53	<.0001
FELT	M	0.000000000	B	.	.	.
DYB	DEEP	0.894205065	B	0.31837588	2.81	0.0061
DYB	MEDIUM	0.709015862	B	0.28944591	2.45	0.0162
DYB	SHALLOW	0.000000000	B	.	.	.

NOTE: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

CPUE LONGLINE SURVEY upernavik 08:20 Monday, May 20, 2002 921

The GLM Procedure

Class Level Information

Class	Levels	Values
AR	4	1995 1998 2000 19940
FELT	3	H L M
DYB	3	DEEP MEDIUM SHALLOW

Number of observations 121

The GLM Procedure

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	194.1096055	27.7299436	5.38	<.0001
Error	113	582.3493998	5.1535345		
Corrected Total	120	776.4590052			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.249993	363.3386	2.270140	0.624800

Source	DF	Type I SS	Mean Square	F Value	Pr > F
AR	3	52.1240600	17.3746867	3.37	0.0210
FELT	2	30.6241810	15.3120905	2.97	0.0553
DYB	2	111.3613645	55.6806822	10.80	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AR	3	62.4760171	20.8253390	4.04	0.0090
FELT	2	20.5475480	10.2737740	1.99	0.1410
DYB	2	111.3613645	55.6806822	10.80	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		-1.014850184	B	0.73108029	-1.39	0.1678
AR	1995	-0.078654510	B	0.60061750	-0.13	0.8960
AR	1998	-1.002663201	B	0.57883716	-1.73	0.0860
AR	2000	-1.819458952	B	0.60951424	-2.99	0.0035
AR	19940	0.000000000	B	.	.	.
FELT	H	0.015044259	B	0.70370372	0.02	0.9830
FELT	L	-0.958449143	B	0.49142213	-1.95	0.0536
FELT	M	0.000000000	B	.	.	.
DYB	DEEP	2.813238408	B	0.74059299	3.80	0.0002
DYB	MEDIUM	3.041620888	B	0.66553316	4.57	<.0001
DYB	SHALLOW	0.000000000	B	.	.	.

NOTE: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.