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

by

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Abstract

This paper present the assessment of Greenland halibut in the inshore part NAFO Div. 1A. The area covers the fjords in Disko Bay, Uummannaq and Upernavik. For the assessment information from the commercial fishery and research survey were available. Catch-at-age data for each of the three inshore areas were available from the fishery covering area, gear and season[1]. The research survey is conducted using longline, two of the three areas in rotation are surveyed with approximately 30 fixed stations in each area. The assessments were as follows: **Disko Bay;** Estimate of fishing mortality has shown a generally increasing trend from late-1980s to present. Survey results from 1993 onwards do not indicate any major changes in abundance. Mean length composition in the survey has been stable in recent decade. The survey in 2000 did, however, show a decline in mean length in Torssukataq. In the commercial fishery the mean length in the summer fishery has been relative stable while an increase has been observed in the winter fishery. **Uummannaq;** Survey results from 1993 onwards do not indicate any major changes in abundance. 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;** Survey results from 1993 to 99 have fluctuated without trend but the 2000 survey indicated reduction in abundance. Mean length compositions in both commercial and survey catches have decreased, most significantly in the winter fishery. In the traditional fishing grounds at Upernavik up to 73°45N 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 and the stock components are considered virgin.

1. Introduction

The Greenland halibut stock component in Div. 1A inshore is considered to be recruited from the Davis Strait stock, but the adults appear isolated from its origin spawning stock (Boje et al. 1994). Thus, the component do probably not contribute to the spawning stock in the Davis Strait (Boje, 1994 and 1999) and only sporadic spawning is observed in the inshore area (Jørgensen and Boje, 1994). Hence, the inshore component is not assumed to be a self-sustainable stock, but dependent on immigration from the nursery area south of Disko Island (Bech, 1995b).

2. Description of the fishery and nominal caches

The main inshore fishing grounds for Greenland halibut are in Div. 1A (Fig. 1), where the total landings amounted to

1 The catch data from the commercial fishery provided for the assessment was however very preliminary and are likely to have been underestimated by about 2000 tons.

18,905 tons in 2000, and constitute far the majority (~99%) of inshore landings in Greenland. The inshore landings in Div. 1A were around 7,000 tons in the late 1980's and have since increased until the late nineties to around 24 tons. In 2000 the landings decreased by more than 4,000 tons (please note paragraph 3.2.1 *Landing data*) compared to 1998 and 1999 (Fig. 2 and Table 1).

The inshore fishery in Div. 1A is located in three main areas: Disko Bay, Uummannaq and Upernavik (Fig. 1). The fishery is unquoted , but from 1998 a special fishery licence was required to land Greenland halibut catches. New license issues have since been limited. The total number of licenses is around 1200. There are no landing limitations on the fishery licenses.

The fishery is traditionally performed with longlines from small open boats below 20 GRT, or by means of dog sledges. In the latest years bigger boats (>25 foot) have however 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 more commonly in the following years. Authorities have in recent years tried to discourage the use of gillnets, which has lead to an increased proportion of longline catches. A total ban for gillnets has been in force from year 2000, however, many exemptions have been given to this ban. Gillnet fishery is regulated by a minimum mesh-size of 110 mm (half meshes), while there are no gear regulations on longline fishery. In recent years longline catches have comprised around 75 % of the catch.

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, Torsukattak (Fig. 1). The winter fishery in Ilulissat Icefjord, Kangia, is a typical traditional fishery from the ice with longlines (mainly field-code LG29, 30 & 31). The fishery near Ilulissat is conducted within a relative small area (field-code LG28) and consist a mixture of gillnet and longline fishery. The majority of the landings in Disko Bay is caught within this area (in 2000 5,400 tons). The fishery in LG28 is mainly carried out in winter, spring and summer. Often the fish disappear from the area in mid July where after the fishery move to Torssukataq north of Ilulissat (Simonsen and Roepstorff, 2000). The fishery in Torssukataq is almost exclusively carried out in the period July - August. Use of gillnets is prohibited in the innermost part of the ice fjords in the Disko Bay area. The catches in Disko Bay have increased continuously since 1990 (Fig. 2), but ceased in 1999 and decline in 2000 with almost 3,000 tons to a total of 7,574 tons. The drop is mainly believed to be due to limited landing capacity at the fishing industry.

Uummannaq

The fishery in Uummannaq area is conducted in a large system of icefjords . The main fishing ground is in the southwest part of the fjord system. Earlier times Qarajaq Icefjord was the main fishing area but in recent years the fishery has moved further north to 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. In 2000 landings was 7 568 tons (Fig. 2 and Table 1). The fluctuations in the fishery is to a certain degree explained by shift in effort. Fishermen from other areas, especially Upernavik, move to Uummannaq when the fishery is not optimal in their home area.

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 is prohibited in Upernavik.

The catches in the Upernavik area have increased steadily from about 1,000 tons in the late eighties to about 3 to 4,000 tons in 1993 to 1995 (Fig. 2 and Table 1). The total catch was in 1998 the highest on record 7,012 tons. In 1998 and 99 the catch declined to 5,258 and 3,764 tons respectively. The drop in 2000 was to a certain degree caused by temporarily closing of landing facilities (due to maintenance) and bad ice situation in the winter fishery.

3. Input data

3.1 Research Fishery

3.1.1 Longline 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 is conducted annually covering two of three areas alternately, with approximately 30 fixed stations in each area (for further details see (Simonsen et al., 2000)).

In July-August 2000 the research longline vessel 'Adolf Jensen' covered the fjord areas of Disko Bay and Upernavik. Development in CPUE and mean length for Greenland halibut in the different areas are respectively shown in Tables 3-4 and figure 4.

3.1.2 Trawl surveys

The Greenland Institute of Natural Resources annually conduct a stratified random trawl survey in the period July to September in the area between 59°N and 72°30'N, from the 3-mile limit to the 600-m depth contour line. The target species is shrimp, hence the trawl used is a shrimp trawl with 20 mm mesh size in codend. However, the survey also covers the offshore nursery grounds for Greenland halibut southwest of Disko Island, as well as the inshore nursery ground, Disko Bay. An index of abundance of yearclasses 1-3 is provided from the survey, for details see SCR Doc 01/35 Engelstoft and Jørgensen, 2001.

3.2 Commercial fishery data

3.2.1 Landings data

No official data was provided on the inshore landings of Greenland halibut in 2000. Instead catch data was obtained from direct from the fishing industry. These data was not allocated on gear why it was assumed that landing composition allocated on gear was the same as within season in 1999. Summer was defined at the month June-November (both included), other months was classified as winter.
It should be noted that after completion of the assessment information from the Greenland Fishery-licence Authority (GFLK) suggest that the catch numbers used in the assessment was likely to be underestimated by about 2000 for the whole inshore area.

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. Before gutted fish with head and tail was multiplied by a factor 1.05, this was changed to 1.10. The factor for gutted fish without tail and tail fin was before 1.52 and changed to 1.35. The conversion factors used in the 2000 landing data are not known but is likely to be the new factor.

3.2.2 Analysis of size distribution in landings

At landing, catches of Greenland halibut are separated in price-classes based on weight. In previous assessments the proportion of 'large fish' in longline landings has been used to analyse the relative proportion of big and small fish in landings. But as the definitions of size-classes have changed over time, these figures have not been used in latest years assessment.

Random samplings of commercial gillnet and longline landings were carried out in the three main areas in February/Marts and July/August in order to obtain length distributions in the catches (Fig. 6). Samples from the longline fishery were obtained from all areas and season. The gill net fishery was only covered in winter fishery in Disko Bay. The length distribution from the gillnet fishery in Disko Bay summer was thus used for Disko Bay winter and Uummannaq winter and summer.

3.2.3 Effort

In 1999 logbooks has been introduced in the inshore fishery on a voluntary basis. The available logbooks are at present limited and are presented in SCR working doc 01/26.

3.2.4 Estimation of fishing mortality

In order to estimate the level of fishing mortality, catch-curve analyses were performed. Total mortality (Z) was obtained from catch-curves based on catch composition in longlines catches in each of the three areas and for summer and winter respectively. Age groups 10-14 were used for the linear regressions in Disko Bay while age groups 11-15 was used for Uummannaq and Upernavik. Average values of Z for each of the three areas, Disko Bay, Uummannaq and Upernavik, were compiled as an average of the estimated Z values. The natural mortality, M, was set at 0.15. (Fig. 13)

3.2.5 Yield per recruit analysis

A Yield per recruit analysis was performed for each area. An average of mean weight-at-age and an assumed average exploitation pattern for the period 1988 to 2000 was used. Missing weight-at-age data were estimated by age-weight regressions. Input data to the Y/R is shown in table 13. Calculations were performed on single recruits in each area[2]. (Fig. 14)

3.2.6 Catch-at-age data

Calculations of catch-at-age data from 1988 to 1990 are described in Boje (1991), from 1991 to 1994 in Bech (1995), from 1995-97 in Simonsen and Boje (1997) and for 1998 in Simonsen (1998). As in latest years assessment a compiled age length/weight key for the recent 3 years was used for each area (Table 11 and 12). This was done due to frequent shift in age readers with only little or no inter-calibration. It was thus assumed that that the relative shift in growth was less than shift in interpretation of otolith structure. In 2000 there where no sampling of otoliths and thus also weight at age in Uummannaq area. The figures for 1999 where used instead.

3.3 Recruitment data

A recruitment index was provided from the Greenland trawl survey (Engelstoft and Jørgensen 2000).

Catches of age 1, age 2 and age 3+ were standardised to catch in number per hour as described in (Bech, 1995b). Data were plotted as year classes to visualise the relative year-class strength (Fig. 7).

3.4 Biological data

3.4.1 Migrations

A review of the tagging experiments in West Greenland in the period 1986-1998 has been conducted (Boje 1999). No fish tagged in the fjords have been caught in the offshore area in Div. 1A or in the more southern offshore spawning area. There is little to no fishing effort in Div. 1A offshore, but considerable fishing effort in the southern area. Therefore the former assumption that the stocks in the three main areas do not contribute to the offshore spawning stock in Davis Strait south of Div. 1A was confirmed. An insignificant intermingling between the fjords contributes further to the justification for assessing the three inshore areas separately. Tagging of inshore Greenland halibut in Div. 1A was continued in 2000.

3.4.2 Maturity

Observations of sexual maturity of Greenland halibut were carried out in Disko Bay and Upernavik in 2000 by visual assessment of the gonad according to table 6.

2 The software FishLab ver. 1.0 for Excel was used for calc. of reference points.

3.4.3 Condition

A 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

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

4. Assessment

4.1 Longline survey results.

The general trends in CPUE index from the standardized surveys (1993 to 2000) showed fairly stable values in Disko Bay and a somewhat fluctuating index in Upernavik and Uummannaq. The latest surveys in Uummannaq suggest a positive trend in abundance while a negative in Upernavik (Table 3). However, as demonstrated in Simonsen et al., 2000 variation in CPUE from the longline survey was very high why caution should be taken when analysing trends in CPUE.

In Disko Bay the survey indicate a stable mean length around 53.6 to 57.0 cm, Table 4. In all years the fish in Torssukataq icefjord has been bigger on average than fish from the area outside Ilulissat (Fig. 4). The survey in 2000 indicated an increase in mean length in Ilulissat while a decline in Torssukataq.

From CPUE on length-stratified samples we found that in all year, except 1993, the mode length has been just around 60 cm. The length classes 40 to 50 cm in 1999 and 2000 have been abundant and suggest incoming year classes above average (Fig. 8).

No survey was carried out in Uummannaq in 2000 but earlier results show steady incline in mean length throughout the survey series. The length disaggregated CPUE suggest that the increase is due to a shift in modal length from 50 cm in 1993 to 65 cm in 1998 and 99 (Fig. 8).

In Upernavik the survey have shown a general decline in mean length since 1993 (Table 4; Fig. 4). However the 2000 survey point to stabilization. From the length disaggregated CPUE it is shown that larger fish have become less abundant and that mode length has shifted from 65 cm to 55-60 cm (Fig. 8).

4.2 Estimation of fishing mortality

Total mortality was estimated by means of catch-curves, and estimates of F are given in table 5. F for Uummannaq and Upernavik was estimated to 0.40 and 0.21 respectively. This was as the same level at previous years. In Disko Bay F was estimated to 0.57 which is somewhat lower that the last estimated F (1997). Some earlier assessments have not been able or have had problems in estimating F. A reason could be that the fishery is exploiting different age-components in the different seasons and different localities. The general lower values obtained since 1996 compared to earlier disagree with information from the fishery, which indicate an increased effort (Simonsen and Boje, 1999). The shift in exploiting pattern throughout the year violates the input for a catch-curve analysis, especially as the shift it is intercepted with the present sampling strategy. The shift in exp loiting is probably caused by Gr. halibut's seasonal migrations in the fjords (Boje, 1999; pers. com. local fishermen). Problems with ageing Gr. halibut in a uniform way probably also cause problems in estimating F.

4.3 Effort

Logbooks are not mandatory in the fishery. However, in 1999 logbooks was introduced on a voluntary basis and information from these are at present very scarce and could not be used in the present assessment. Earlier attempts to estimate fishing effort has shown a significant correlation between effort (expresses as fishing days) and landings

(Simonsen and Boje, 1999). A presentation of the logbooks and preliminary analyses is presented in SCR working paper 01/26

4.4 Biological reference points

Y/R analyses performed for each area using long-term averages of mean weight-at-age and an assumed exploitation pattern (see table 13) gave the following estimates of $F_{0.1}$ and F_{max}.

At Disko Bay $F_{0.1}$ was estimated to 0.15 F_{max} to 0.27

As the F_{2000} was estimated to 0.57 the exploitation is beyond F_{max}.

At Uummannaq $F_{0.1}$ was estimated to 0.25 F_{max} to 0.49.

As the F_{2000} was estimated to 0.40 the exploitation of the inshore stock in Uummannaq is below F_{max}.

At Upernavik $F_{0.1}$ was estimated to 0.27 F_{max} was 0.48

As the F_{2000} was estimated to 0.21 the exploitation of the inshore stock in Upernavik is below $F_{0.1}$.

4.5 Analysis of size distribution in landings

Mean lengths from the longline landings in the period 1993 to 2001 in Disko Bay, Uummannaq and Upernavik are showed in Fig. 5. Fish caught in summer are general smaller than fish caught during winter season.

Disko Bay showed an overall positive trend in mean length except for winter 2000. Fishing at the traditional winter fishing grounds was impossible for most of the winter 2000 due to bad sea-ice conditions (the fishery is conducted from the ice). Instead an open-water fishery developed at alternative fishing grounds. The winter fishery in 2001 was conducted on the largest fish observed since 1993. Mean length in the summer fishery in 2000 was on average.

In Uummannaq, a negative trend in mean length in the summer fishery was observed from 1993 to 1999. In 2000 mean length increased somewhat. In the winter fishery the average size has only declined slightly since 1993.

In Upernavik a variable mean length without trend is seen for the summer, while for the winter fishery, mean length decreases significantly.

4.6 Catch at age

Age compositions in landings are shown in Table 8 to 10. In figure 12 exploitation pattern for fish younger than age 11 is shown. The exploitation in Disko Bay have since the early nineties been stable around 70 % of the landings being age 10 and below. In Uummannaq the same pattern have been observed since mid-1990s. The exploitation pattern in Upernavik have until 1996 been on relative old fish but have since increased to exploit still younger age groups.

For all areas the fishery have in the latest 10 years moved from a broad exploitation on many age groups to a narrow utilization where the majority of the fishery is conducted on around 4 age-groups.

4.7 Recruitment

Recruitment of ages 1, 2 and 3+ has fluctuated in the period investigated (Fig. 7). Offshore the numbers of one-year-old from the 1999 year-class were about average while it in Disko Bay it was the second highest on record. In Disko Bay the year-classes 1997 to 99 all seems to be strong. The 1997 year-class that was very strong inshore was still above average at age 2 but not at age 3. A linkage between the recruitment at age 1-3 and the subsequent recruitment to the inshore fishery at age 6-7 have however not yet been established due to the short time series.

4.8 Condition index

The condition was defined as: $K = \frac{W}{L^{3.3}} * 10^6$

The condition was applied on length-stratified samples (50 to 75 cm) from the summer fishery and allocated on sex (Figure 9 to 11). For the different area we did not find any significant difference (ANOVA P>0.1) between condition and sex.

In Disko Bay condition has varied through out the time series (Fig. 9). However, many of the same trends were observed for the different size groups. For the most groups the years 1993 and 1996 had the lowest condition while the highest was observed in 1998 and 99. The condition in 2000 declined for the smallest length groups (50 - 60 cm) and was stable to increasing for the bigger groups (65-75 cm).

The condition index in Uummannaq (Fig. 10) was more stable compared to Disko Bay. The negative trend observed in Disko Bay in 1993 and 96 was not evident in Uummannaq. For many of the length groups a decline in condition was found 1997 and onwards.

As for Uummannaq the Upernavik area (Fig. 11) did not show the variations observed in Disko Bay and was fairly stable. Especially for the smaller length groups (50 to 60 cm) 1993 was a year where condition was generally lowest. In recent years condition seems to be increasing for the smallest (50-55 cm) and to be stable for the largest length groups (65-75 cm).

4.8 Maturity

Estimation of sexual maturity of Greenland halibut continued in the summer 2000 and confirmed earlier studies. Maturity increased with fish size but maturity was, compared to other known spawning areas, considerably lower for fish of the same size and season (Gundersen *et al*., 2000). A study on Greenland halibut collected from the fishery on maturity covering the entire year was initiated in 1998 and may clarify the extent of the inshore spawning.

5. An analytical approach, separable VPA

A separable VPA was carried out for the Disko Bay area. This area was selected because of longer and more continuous data series compared to Uummannaq and Upernavik.

5.1 Determination of terminal F's

The limited number of years in survey CPUE series (1993-94 and 96-97 and 1999-2000) was considered inadequate for tuning to catch data. Instead the survey data was used to calibrate a separable VPA.

A number of combinations of F and S were used to estimate numbers at age from a separable VPA. Average q's were estimated for each combination using the survey data from the Greenland halibut longline survey (age 5-14) years 1993, 94, 96, 97 99 and 2000 and population estimates from the separable VPA. The average q's were used to estimate survey based population numbers. The ln-transformed sum of the residuals of the difference between the separable VPA estimated population number at age and the estimates from the survey was minimized in order to find the most appropriate combination of F and S to be used as input parameters in a separable VPA. A minimum was found in the interval 0.35 to 0.45. A F value of F=0.40 was thus found to be most appropriate. S was estimated to S=2.0 (Appendix, figure appendix 2).

The generated terminal F's were used to run a cohorte analysis (part of the Lowestoft VPA suite). Catch in numbers is given in Appendix A, Table 2 and weight at age in Table 3. Catch weights and stock weights at age were assumed similar, thus catch in numbers at age was adjusted in order to adjust the factor [calc. catch]/[norm. landings] around 1. As only few weight data are available prior to 1993, an average weight at age for the period was applied to the years 1985-1992. No maturity data is available maturity is assumed at age 10. Reference F is chosen for ages 10-14, which are the age-groups fully recruited to the fishery and contributing mostly to the catch in numbers.

A separable VPA was performed (Pope 1977, 1979) using 0.40 as terminal F. Input data is given in Appendix, Tables A. M was set to 0.15 for all ages. The chosen run of the separable analysis is given in Appendix Tables B and C. The matrix of residuals is shown figure *appendix 1*.

5.4 Output

Output from the VPA is given in Appendix tables B and C. Fishing mortality is low in the beginning of the time series (Fig. *appendix 3*), in the same level as M. VPA is known to perform very poor when this is the case. In later years F has fluctuated but a general increase is observed. Due to the low F's in the first part of the time series, biomass estimates as well as recruitment are not considered reliable in that period (Fig. *appendix 3*). For the recent years a increase in biomass is evident mainly caused by an increase in recruitment. The very high recruitment of age 5 1999 is partly driven by a unusual exploitation pattern in the winter fishery in 2000 where the fishery was conducted in other areas than normal due to bad ice conditions why the effort in areas with younger age groups was unusual high.

Comments on the analytical approach

The present assessment cannot be taken face value due to inaccurate determination of terminal F's and the scarcity of effort data from the commercial fishery, but provides a likely scenario of recent years development of the stock. The analyses suggest that a revision of catch in numbers is required, e.g. as inferred from the selection pattern in the separable VPA. The stock dynamics of the Disko Bay Greenland halibut component is rather unusual, as it is assumed that the component does not spawn and that recruitment originates from the offshore component. This implies that biological reference points should account for this non-existing link between biomass and recruitment,

6. State of the stock components

Disko Bay. Catches have been increasing in the past 10 years from about 2,000 to 10,500 t in 1998, In 2000 the landings dropped with 3 000 tons compared to 1999.

Long-line survey results since 1993 do not indicate any major changes in abundance. The survey in 2000 indicated incoming year-classes above average that at present are not fully recruited to the fishery. Yield per recruit analysis and estimation of fishing mortality suggests an F level above F_{max}. In commercial catches mean length has increased. In spite of the increasing fishery, age and length composition in both commercial and survey catches have not changed significant in recent years.

Uummannaq. Catches have been increasing from less than 2,000 t before 1987 to a record high in 1999 of 8,425 t. In 2000 the catches ceased to 7,568 tons.

Survey results since 1993 indicate some increase in both abundance and mean length. Yield per recruit analysis and estimation of present fishing mortality suggests F level a little below F_{max}. Catch 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. Catches in the winter season have been at a stable length composition while a decreasing trend in the summer fishery was observed until 1999. In spite of the increasing fishery the stock component does not appear to be significantly effected.

Upernavik. Catches have increased from about 1,000 t prior to 1992 to about 5,000 t. in 1996 and 1997. In 1998 catches was the highest on record 7,012 tons. In 2000 the catches dropped to 3,764 tons.

Survey results 1993 –99 do not indicate any major changes in abundance but the 2000 survey indicate a reduction. Yield per recruit analysis and estimation of present fishing mortality suggests an F level at or below $F_{0.1}$. Age and length compositions in commercial and survey catches have changed to smaller fish, which in the commercial winter fishery is a significant change. The new and increasing fishery has thus affected the stock component in Upernavik as expected for a fishery on a virgin population. New fishing grounds in the northern part of the district are recently exploited. Little information exists from these areas, but the stock components are here considered virgin.

6.1 General comments

Concern is expressed by the continuing increase in total landings of Greenland halibut in NAFO Div. 1A inshore, especially because lack of information from the commercial fishery impedes the assessment of the stocks.

The fishing mortalities estimated from catch curves should be interpreted carefully. The inshore fishery does contrary to offshore fishery, takes place on smaller sub-components and size composition in these vary within season and locality.

The output of the separable VPA in Disko Bay was considered to be indicative of trends in fishing mortality and stock size but was not considered to be sufficiently reliable to estimate current fishing mortality.

The inshore stocks depend on recruitment from the offshore nursery grounds and the spawning stock in Davis Strait. Available information suggests that spawning only occurs sporadic in the fjords, hence the stock is not self-sustainable. The fish remain in the fjords, and do not contribute back to the offshore spawning stock.

Provisional studies of the by-catch of Greenland halibut in the commercial shrimp fishery suggest that the by-catch is considerable and could have a negative effect on recruitment to the inshore stock component.

Direct measurement of effort in the fishery should be provided. This would make it possible to obtain estimates of Z from the commercial fishery. Furthermore, trends in effort could be compared to trends in F. There are strong indications that effort has increased in recent years. Logbooks have just been introduced for parts of the inshore Greenland halibut fishery and will hopefully provide support to the assessment in the future.

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Table 1. Landings and Greenland halibut (tons) in Div. 1A distributed on the main fishing grounds: Disko Bay, Uummannaq and Upernavik. Conversion faktor 1.05 for gutted fish with head, 1.50 for gutted fish without head, 1.52 for gutted fish without head and tail fin). 1) include 5768 tons unreported landings.. 2) Unofficial data from the fishing industry (Royal Greenland, Nuka, Polar Seafood. 3) after completion of the assessment information from the Greenland Fishery-licence Authority (GFLK) suggest that the catch numbers used in the assessment was likely to be underestimated by about 2000 for the whole inshore area.

Area/year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998[1)]	1999	2000[2+3)]
Disko Bay	2258	2670	2781	3821	5372	6577	5367	5201	7400	7837	8601	10671	10593	7574
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234	4579	6294	6912	8425	7568
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	2403	4846	4879	7012	5258	3764
Unknown or other areas in Div. 1A	407	636	599	507	17	133								15
Total in 1A	7196	7003	7492	8352	9929	11933	13088	14049	17037	17262	19774	24595	24277	18905

Table2. Landings of Greenland halibut allocated on area, season and gear in 2000. Allocation on gear was obtained from the distribution from the fishery in 1999 as no information was provided with the landings figures for 2000.

		summer		winter		Total
		longline	gillnet	longline	gillnet	
Disko	Ilulissat	1060	1,317	1,028	2,882	
	Torssukataq	685	475	47	77	7,574
Ummannaq		4,781	145	2,322	320	7,568
Upernavik		1,945		1,815		3,764

Table 3. CPUE values (kg/100 hooks) from longline surveys conducted in Div.1A inshore areas. Standardized survey since 1993

Area/year	1962	1985	1986	1987	1993	1994	1995	1996	1997	1998	1999	2000
Disko bay	-	-	8.3	16.5	3.1	3.1	-	3.9	4.4	-	3.6	3.9
Uummannaq	4.6	13.7	-	8.6	2.8	-	6.6	4.5	-	6.1	8.2	
Upernavik	-	-	-	-	-	5.2	3.9	-	-	4.2		2.5

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
Disko bay	-	62.4	53.5	62.2	55.9	56.5	-	53.6	57.0	-	56.7	54.3
Uummannaq	67.8	70.5	-	61.8	57.5	-	57.8	59.5	-	61.2	61.5	
Upernavik	-	-	-	-	-	64.6	60.8	-	-	57.1		58.4

Table 5. Estimates of fishing mortality (F) from catch curve analysis on commercial samples from 1987 to 1999.

Area/year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Disko Bay	0.42	0.16	0.24	0.51	0.4	0.45	0.51	0.8	0.54	0.44	0.73			0.57
Uummannaq	1.09	1.01	1.01	0.88			1.2	0.98	1.31	0.25	0.45	0.41	0.38	0.40
Upernavik		0.35	0.41	0.48			0.42	0.58	0.43		0.20	0.12	0.24	0.21

Table 6. Descriptive stage of maturity used for visual analyses of Greenland halibut gonads (from Riget and Boje 1989).

Maturity stage	Physiological stage of gonads	
	Female	**Male**
1	Juvenile or immature: overay very small . eggs not visible to the naked eye.	Juvenile or immature: Testes mostly clear and very small having a length of less than ¼ of the abdominal cavity
2	Mature A: Egges becoming visible to the naked eye	Mature A: Testes opaque having a length between ¼ and ½ of the abdominal cavity
3	Mature B: Eggs 1-2 mm in diameter. Less than 50% of the eggs are translucent	Mature B: Testes opaque having a length between ½ and ¾ of the abdominal cavity
4	Mature C: Eggs 2-4 mm in diameter. More than 50% of the eggs are translucent	Mature C: Testes big and white in appearance having a length between ¾ and 1/1 of the abdominal cavity
5	Running stage: Some eggs extruded but several thousands clear eggs remaning	Running stage: sperm is running
6	Spent stage: Overay appears reddish purple. wall is thick and though. some residual clear and opaque eggs are seen	

Table 7. Maturity for female Greenland halibut in Div. 1A inshore according to table 6.

			length								
			50	55	60	65	70	75	80	85	90
Disko Bay	**1994**	mean GI	-	-	-	1.9	1.9	1.9	2.0	2.5	2.0
		std Gi	-	-	-	0.3	0.3	0.3	-	0.7	-
	1996	mean GI	-	-	1.0	1.3	1.7	1.9	2.0	2.0	-
		std Gi	-	-	-	0.5	0.5	0.3	-	-	-
	1997	mean GI	1.0	1.0	1.1	1.5	1.6	1.8	2.1	2.2	2.1
		std Gi	-	0.2	0.3	0.5	0.5	0.4	0.2	0.4	0.4
	1999	mean GI	1.0	1.0	1.1	1.0	1.0	1.2	1.4	1.7	2.0
		std Gi	-	-	0.3	0.2	0.1	0.4	0.5	0.7	-
	2000	mean GI	1.0	1.0	1.0	1.2	1.8	1.9	2.3	2.7	2.0
		std Gi	-	-	0.2	0.4	0.4	0.4	0.5	0.6	-
	All years		1.0	1.0	1.1	1.4	1.6	1.7	1.9	2.2	2.0
Uummannaq	**1994**	mean GI	1.1	1.2	1.4	1.6	2.1	2.0	2.3	1.9	3.6
		std Gi	0.2	0.4	0.5	0.5	1.2	0.4	1.1	0.3	2.4
	1995	mean GI	1.0	1.1	1.2	1.4	2.0	2.5	2.0	-	3.0
		std Gi	0.2	0.3	0.4	0.5	-	0.7	-	-	-
	1996	mean GI	1.0	1.1	1.0	1.3	1.9	1.9	2.0	2.1	2.5
		std Gi	-	0.2	-	0.5	0.4	0.3	0.4	0.2	0.6
	1997	mean GI	1.0	1.0	1.0	1.1	1.7	2.0	2.0	2.0	2.1
		std Gi	0.2	-	0.2	0.3	0.5	0.3	0.3	-	0.3
	1999	mean GI	1.0	1.1	1.3	1.5	1.8	1.8	1.9	2.0	2.3
		std Gi	0.2	0.3	0.5	0.5	0.4	0.4	0.2	-	0.6
	All years		1.0	1.1	1.2	1.3	1.8	2.0	2.0	2.0	2.6
Upernavik	**1997**	mean GI	1.0	1.0	1.0	1.2	1.7	2.1	2.2	2.4	2.4
		std Gi	-	-	0.2	0.4	0.5	0.7	0.4	0.5	0.5
	1998	mean GI	1.0	1.0	1.1	1.3	1.6	1.8	2.0	2.0	2.0
		std Gi	0.2	-	0.3	0.5	0.5	0.4	-	-	-
	2000	mean GI	1.0	1.1	1.6	1.6	2.0	2.0	2.0	2.0	-
		std Gi	0.3	0.5	0.5	0.5	-	-	-	-	-
	All years		1.0	1.0	1.3	1.4	1.8	2.0	2.1	2.1	2.2

Table 8. Catch at age of Greenland halibut in 1988-2000 in Disko Bay.

	Catch in numbers (thousands)												
age/year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
4	0	0	0	5	34	7	0	0	0	0	0	1	0
5	0	0	0	5	92	15	3	0	8	0	0	4	9
6	1	0	0	11	122	62	15	0	1	21	74	41	98
7	9	0	1	279	332	280	112	45	47	132	397	360	535
8	59	14	24	806	476	479	281	459	323	646	775	619	729
9	182	106	141	535	390	339	539	639	941	1113	944	836	780
10	173	121	185	333	451	280	396	798	651	1168	1248	1028	636
11	132	94	188	238	532	240	190	463	454	607	754	786	478
12	73	49	126	76	309	122	91	185	273	185	346	426	223
13	63	33	80	45	140	91	50	127	145	69	132	136	52
14	65	39	59	67	92	112	45	27	75	19	68	72	28
15	38	31	42	57	18	75	41	36	44	10	27	29	12
16+	33	41	44	44	0	86	36	27	69	6	6	2	1
Total	828	528	890	2501	2988	2188	1799	2806	3031	3976	4770	4340	3583

Table 9. Catch at age of Greenland halibut in Uummannaq area in 1988-2000. -indicates insufficient sampling.

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

Table 10. Catch at age of Greenland halibut in Upernavik area 1988-1998. - indicates insufficient sampling.

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

Table 11. Age-length keys used for 1999. Keys were compiled on data for the last 3 years 1997-99.

Disko Bay age-length key 1998-2000

length \ age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total
30	6	11																	17
35	1	33	19																53
40		2	56	7															65
45			10	64	13														87
50				15	105	12													132
55					31	93	21	1											146
60					1	15	71	45	12	1									145
65							8	45	71	27			1						152
70								2	24	58	25	17							126
75							1		3	22	29	14	4						73
80											6	5	10	1					22
85										1	3	1	11						16
90											1		1	1	2				5
95											1	1	3		1				6
100																			0
total																			1045

Ummannaq age-length key 1997-99

length \ age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total
30		1																	1
35		4			1														5
40			17	11	1														29
45			6	35	12														53
50			3	13	54	34	11	2											117
55				1	29	47	66	13											156
60						12	30	74	24	4	1								145
65				1	1	2	1	35	73	29	8								150
70						1	3	4	22	75	32	13							150
75							1	3	2	23	68	22	8	3					130
80							1			3	29	41	16	2	1	1			94
85											4	15	17	3					39
90												2	8	3	1	1			15
95															1				1
100															2				2
total																			1087

Upernavik age-length age-length key 1998-00

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		4	2																6
40			28	10	1														39
45			1	51	18														70
50				9	82	26													117
55					29	83	25	3											140
60						23	88	38	10										159
65							2	34	58	33	2		1						130
70									14	56	26	16	4						116
75										7	33	30	8	3					81
80											3	17	19	3					42
85												1	4	8					13
90											1			2	3				5
95															2				2
100																1			1
total																			923

Table 12. Weight and weight at age for each component in Div. 1A inshore compiled on data for the last 3 years 1998-2000. Due to missing sampling in 2000 in Uummannaq (B) the 1997-99 values was used.

	Disko Bay			**Uummannaq**			**Upernavik**		
	mean			mean			mean		
age (year)	length (cm)	weight (kg)	N	length (cm)	weight (kg)	N	length (cm)	weight (kg)	N
3	31.44	0.26	9						
4	36.02	0.40	46	36.20	0.50	5	36.00	0.38	6
5	41.53	0.64	85	44.27	0.76	26	41.42	0.59	31
6	47.43	1.00	86	47.59	0.99	61	46.63	0.90	70
7	52.81	1.45	150	52.92	1.30	98	52.39	1.27	128
8	57.13	1.84	120	56.47	1.58	96	56.86	1.68	132
9	61.65	2.33	101	58.90	1.83	113	61.17	2.12	115
10	64.38	2.66	93	63.13	2.29	131	63.88	2.49	75
11	67.97	3.12	110	67.26	2.82	121	67.31	3.06	82
12	71.72	3.73	109	71.51	3.48	134	70.49	3.43	96
13	76.28	4.56	65	76.61	4.45	142	75.20	4.29	64
14	76.34	4.66	38	80.33	5.29	93	77.19	4.85	63
15	84.93	7.19	30	84.43	6.08	49	80.53	5.69	36
16	87.00	7.80	2	85.36	6.22	11	84.75	6.54	16
17	93.00	10.03	3	94.80	9.93	5	94.20	8.47	5
18				86.00	5.92	2	100.00	10.70	1

Table 13. Input data to Yield per Recruit

Disko Bay

Weight at age

age	1987-92	1993	1994	1995	1996	1997	1998	1999	2000	mean
5	0.59	0.76	0.97	0.81	0.61	0.44	0.47	0.58	0.76	0.64
6	0.75	0.93	1.21	1.00	0.77	0.59	0.62	0.75	0.95	0.81
7	0.95	1.14	1.52	1.22	0.98	0.78	0.82	0.98	1.18	1.02
8	1.20	1.40	1.89	1.50	1.24	1.04	1.08	1.26	1.48	1.29
9	1.52	1.71	2.36	1.84	1.58	1.37	1.42	1.63	1.85	1.63
10	1.92	2.10	2.94	2.26	2.00	1.82	1.88	2.11	2.31	2.07
11	2.43	2.57	3.67	2.78	2.53	2.41	2.47	2.74	2.89	2.62
12	3.08	3.15	4.59	3.41	3.21	3.20	3.26	3.54	3.61	3.32
13	3.90	3.86	5.72	4.18	4.07	4.24	4.30	4.58	4.51	4.21
14	4.94	4.73	7.14	5.13	5.16	5.62	5.66	5.93	5.64	5.33
15	6.26	5.79	8.91	6.29	6.54	7.45	7.46	7.67	7.04	6.77
16	7.93	7.09	11.13	7.72	8.29	9.88	9.84	9.93	8.80	8.59
17	10.04	8.69	13.88	9.47	10.50	13.10	12.97	12.85	11.00	10.91
18	12.72	10.65	17.33	11.62	13.32	17.36				13.33

Relative F pattern

age	1988-94	1995	1996	1997	1998	1999	2000	mean	relative	M
5	0.01		0.01					0.01	0.01	0.15
6	0.02		0.01		0.01	0.01		0.01	0.01	0.15
7	0.12	0.35	0.07	0.00	0.06	0.08	0.01	0.11	0.12	0.15
8	0.33	0.77	0.32	0.03	0.20	0.21	0.09	0.31	0.32	0.15
9	0.60	0.89	1.00	0.20	0.42	0.43	0.24	0.59	0.61	0.15
10	0.79	1.00	0.99	0.66	0.91	0.80	0.43	0.86	0.88	0.15
11	0.92	0.99	0.91	1.00	1.00	1.00	0.67	0.97	1.00	0.15
12	0.70	0.89	0.86	0.76	0.88	0.96	1.00	0.84	0.87	0.15
13	0.64	0.88	0.74	0.68	0.67	0.60	0.99	0.70	0.72	0.15
14	0.95	0.66	0.48	0.40	0.66	0.56	0.53	0.62	0.64	0.15
15	1.00	0.68	0.29	0.39	0.54	0.43	0.63	0.56	0.57	0.15
16	1.00	0.66	0.31	0.36	0.16	0.04	0.68	0.42	0.44	0.15
17	0.64	0.66	0.08	0.62	0.09	0.03	0.06	0.36	0.37	0.15
18	0.33	0.66	0.72	0.73			0.15	0.61	0.63	0.15

Uummannaq

Weight at age

age	1995	1996	1997	1998	1999	2000*	mean
5	0.56	0.76	0.71	0.70	0.82	0.82	0.73
6	0.82	0.95	0.88	0.88	0.99	0.99	0.92
7	1.14	1.18	1.09	1.11	1.20	1.20	1.15
8	1.48	1.46	1.35	1.39	1.46	1.46	1.43
9	2.01	1.81	1.68	1.75	1.77	1.77	1.80
10	2.58	2.25	2.08	2.20	2.14	2.14	2.23
11	3.02	2.80	2.57	2.76	2.60	2.60	2.72
12	3.64	3.47	3.19	3.46	3.15	3.15	3.34
13	4.22	4.31	3.95	4.34	3.82	3.82	4.08
14	4.95	5.35	4.90	5.45	4.63	4.63	4.98
15	5.64	6.65	6.07	6.84	5.61	5.61	6.07
16	6.33	8.25	7.52	8.58	6.80	6.80	7.38
17	7.93	10.25	9.32	10.78	8.24	8.24	9.13
18	9.59	12.72	11.54	13.52	9.99	9.99	11.23

Relative F pattern

age	1988-94	1995	1996	1997	1998	1999	2000	mean	relative
5	0.02							0.02	0.02
6	0.01							0.01	0.01
7	0.05	0.08	0.00	0.00	0.00	0.03	0.03	0.03	0.03
8	0.25	0.61	0.06	0.06	0.06	0.06	0.14	0.18	0.18
9	0.40	0.81	0.35	0.31	0.31	0.16	0.28	0.37	0.38
10	0.71	0.91	0.49	0.66	0.66	0.44	0.50	0.63	0.64
11	0.89	1.00	0.80	1.00	1.00	0.72	0.99	0.91	0.94
12	0.98	0.96	1.00	0.94	0.94	1.00	1.00	0.98	1.00
13	1.00	0.96	0.92	0.68	0.68	0.99	0.75	0.86	0.88
14	0.66	0.80	0.68	0.54	0.54	0.71	0.48	0.63	0.65
15	0.35	0.76	0.43	0.36	0.36	0.44	0.24	0.42	0.43
16	0.29	0.76	0.26	0.27	0.27	0.23	0.11	0.31	0.32
17	0.38	0.76	0.04	0.55	0.55	0.16	0.03	0.36	0.36
18	0.19	0.76	0.34	0.15	0.15	0.11	0.02	0.24	0.25

Upernavik

Weight at age

age	1988-94	1995	1996 *	1997	1998	1999	2000	mean
5	0.65	0.49	0.76	0.71	0.69	0.69	0.72	0.67
6	0.76	0.75	0.95	0.88	0.87	0.87	0.89	0.85
7	1.09	1.10	1.18	1.09	1.09	1.08	1.10	1.10
8	1.58	1.60	1.46	1.35	1.36	1.35	1.36	1.44
9	2.33	2.13	1.81	1.68	1.70	1.68	1.69	1.86
10	3.11	2.75	2.25	2.08	2.13	2.09	2.10	2.36
11	4.08	3.47	2.80	2.57	2.66	2.61	2.60	2.97
12	5.07	4.23	3.47	3.19	3.33	3.26	3.22	3.68
13	5.68	5.23	4.31	3.95	4.16	4.06	4.00	4.49
14	7.15	5.94	5.35	4.90	5.21	5.07	4.95	5.51
15		7.58	6.65	6.07	6.51	6.32	6.14	6.54
16		8.75	8.25	7.52	8.14	7.88	7.61	8.03
17		10.20	10.25	9.32	10.19	9.83	9.43	9.87
18		12.36	12.72	11.54	12.74	12.26	11.69	12.22

Relative F pattern

age	1988-94	1996	1997	1998	1999	2000	mean	relative
5	0.06				0.01		0.04	0.04
6	0.06			0.02	0.03		0.04	0.04
7	0.06	0.02	0.03	0.11	0.16		0.08	0.08
8	0.09	0.19	0.15	0.28	0.41	0.11	0.22	0.22
9	0.34	0.78	0.37	0.45	0.68	0.63	0.52	0.53
10	0.59	0.78	0.64	0.69	0.75	0.94	0.69	0.69
11	1.00	0.88	0.81	0.91	0.91	0.91	0.90	0.91
12	0.96	1.00	1.00	1.00	1.00	0.68	0.99	1.00
13	0.85	0.96	0.70	0.66	0.68	0.81	0.77	0.78
14	0.64	0.75	0.69	0.81	0.87	1.00	0.75	0.76
15	0.32	0.52	0.59	0.61	0.70	0.59	0.55	0.55
16	0.18	0.37	0.39	0.25	0.35	0.66	0.31	0.31
17	0.13	0.07	0.05			0.43	0.09	0.09
18	0.13	0.21	0.10			0.25	0.14	0.14

* 1999 used as no data was avaliable for 2000

** from Uummannaq as no data was avaliable for 1996

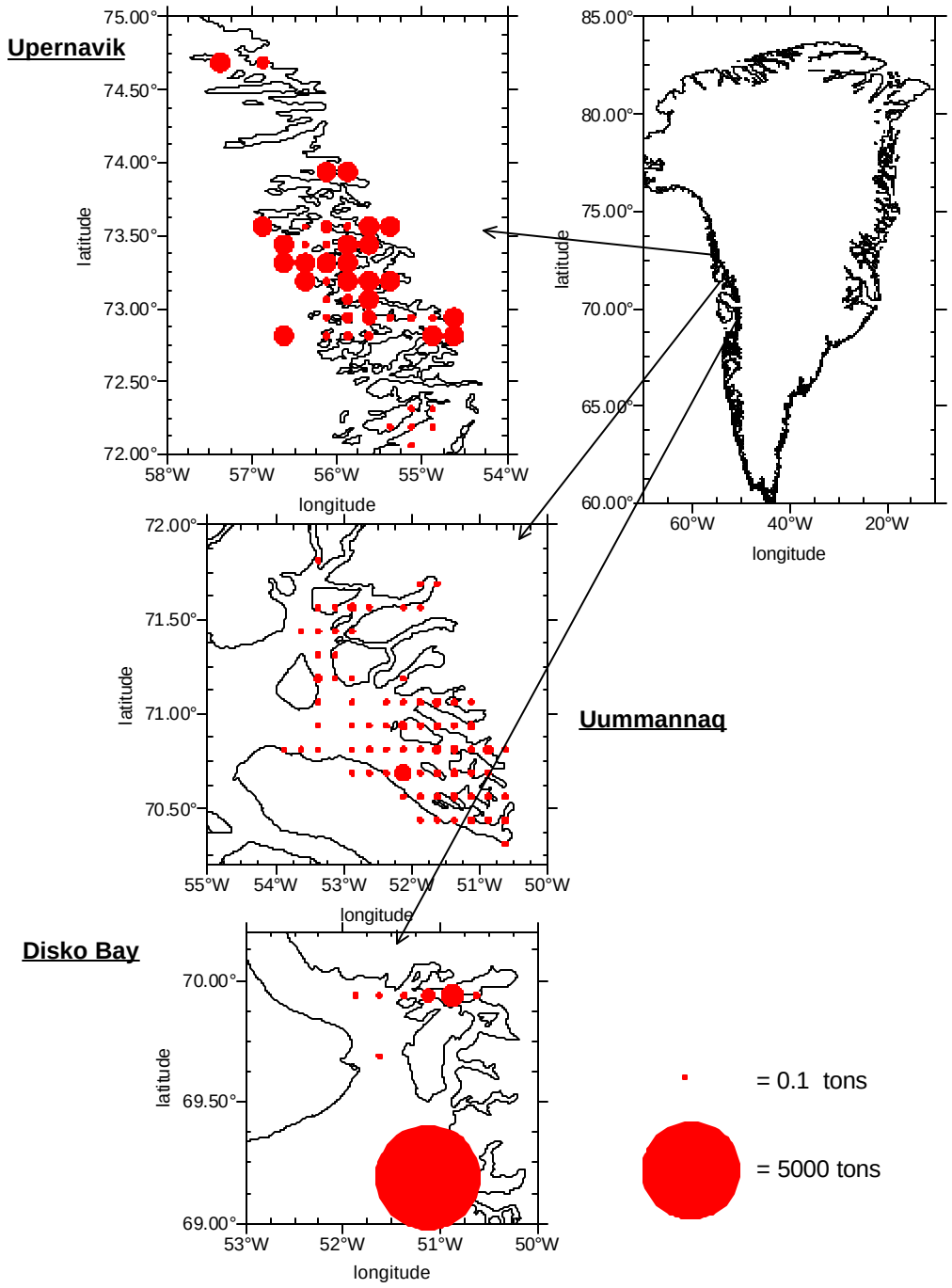

Figure 1. Location of main inshore fishing grounds for Greenland halibut in Div.1A. Landings is shown in tons per. Squarre (field-code). Catch statistics are provensial. For Disko Bay catch statistics was vaiable for 106%; for Uummannaq 40%; for Upernavik 90% of the total landings.

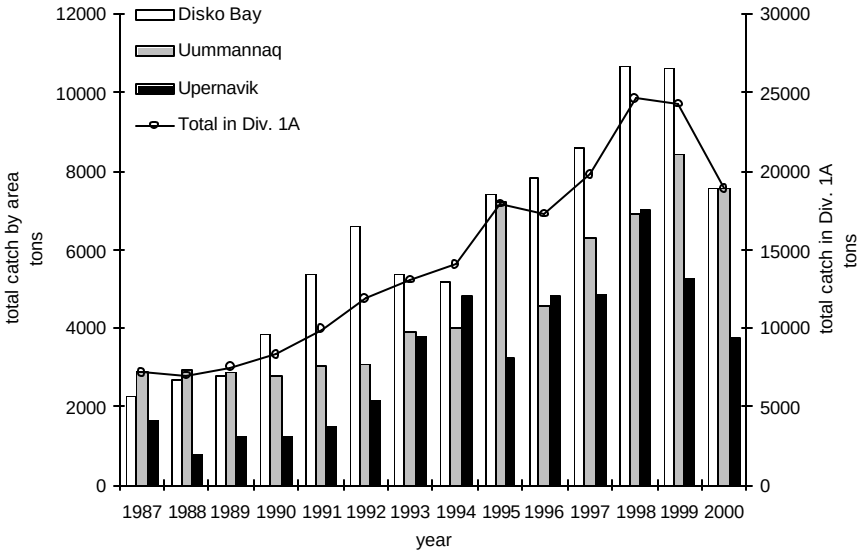

Figure 2. Landings in NAFO Div. 1A in the period 1987-2000 for the 3 main fishing areas. Landings for 1998 to 2000are provisional. It should be noted that after completion of the assessment information from the Greenland Fishery-licence Authority (GFLK) suggest that the catch numbers used in the assessment was likely to be underestimated by about 2000 for the whole inshore area. See also table 1.

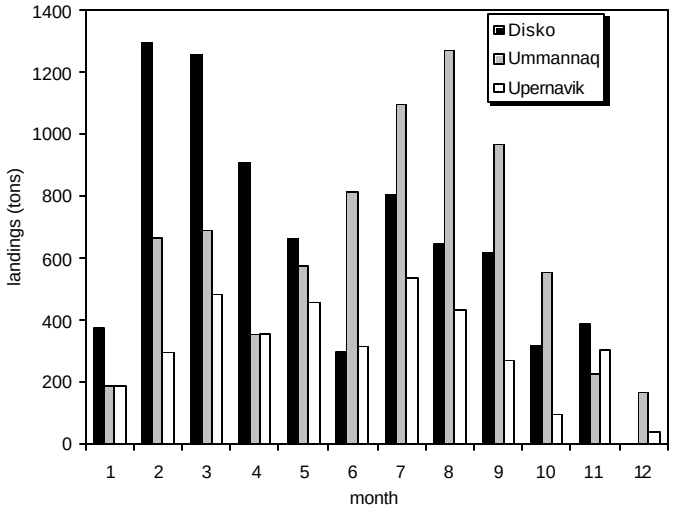

Figure 3. Landings in NAFO Div.1A in 2000 allocated on area and month. See also table xx

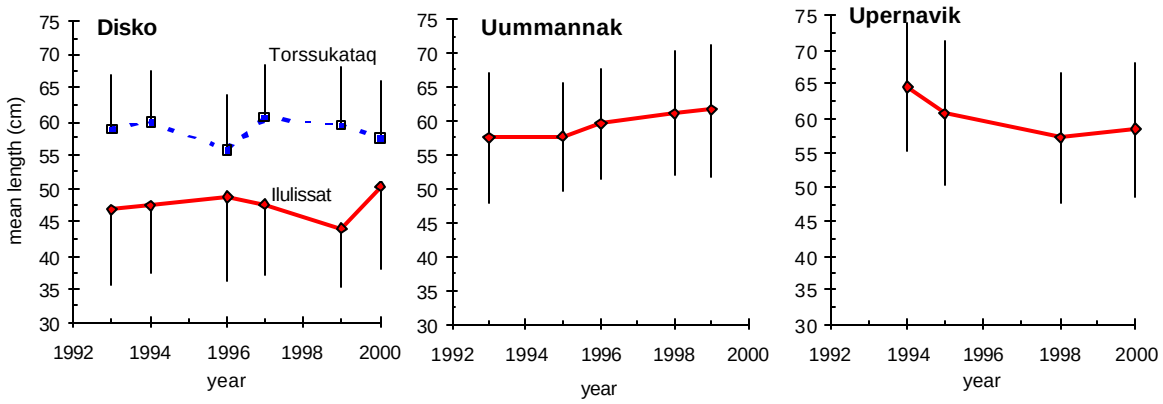

Figure 4. Mean length for research longline surveys 1993-99. +/- S.D

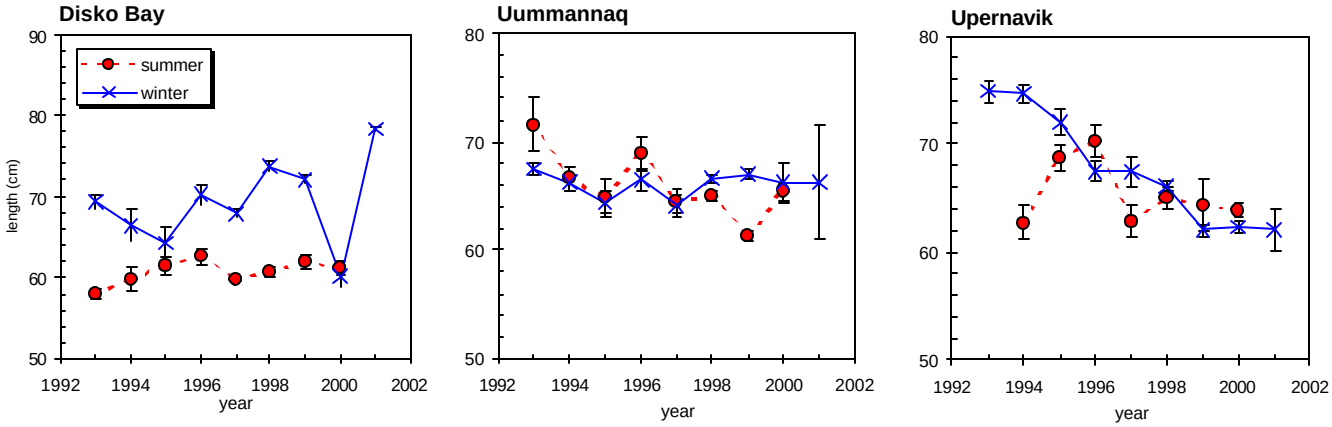

Figure 5. Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik +/- 95% conf.

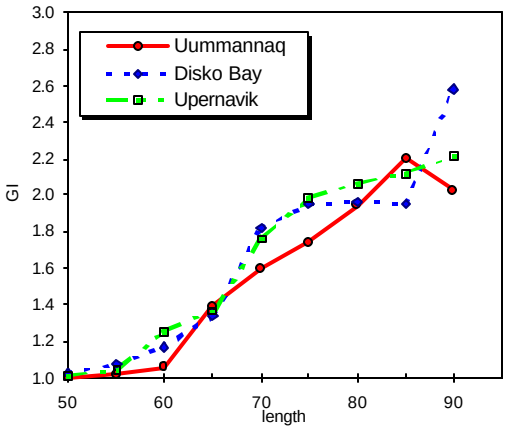

Figure 6. Maturity for females according to table 6 all years combined. See also table 7.

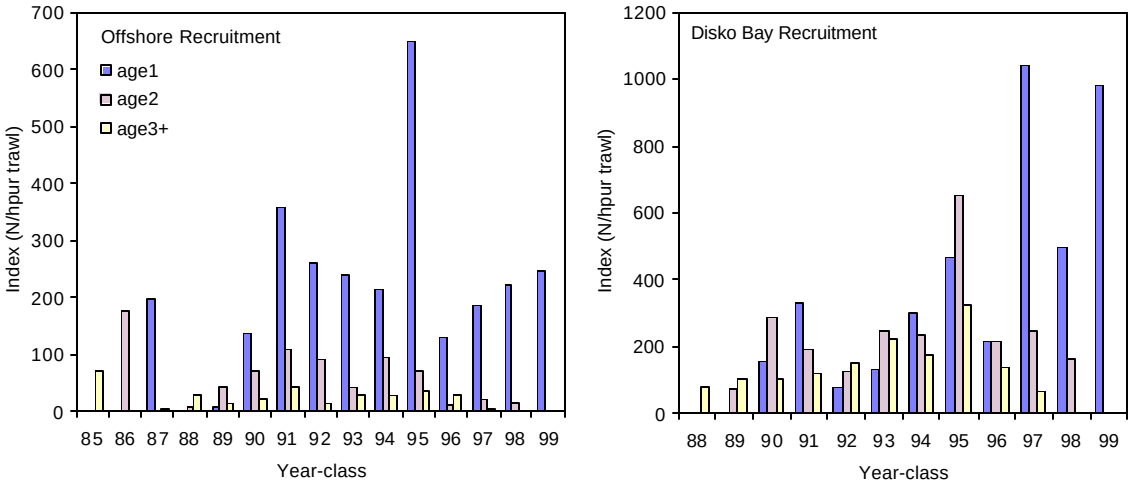

Figure 7. Year-class strength of recruits plotted as catch in numbers per hour, standardized index. The respective year-classes can be followed to age 3 in data from Greenland trawl survey. Missing values are due to missing observations. A) Offshore area, B) Disko Bay area

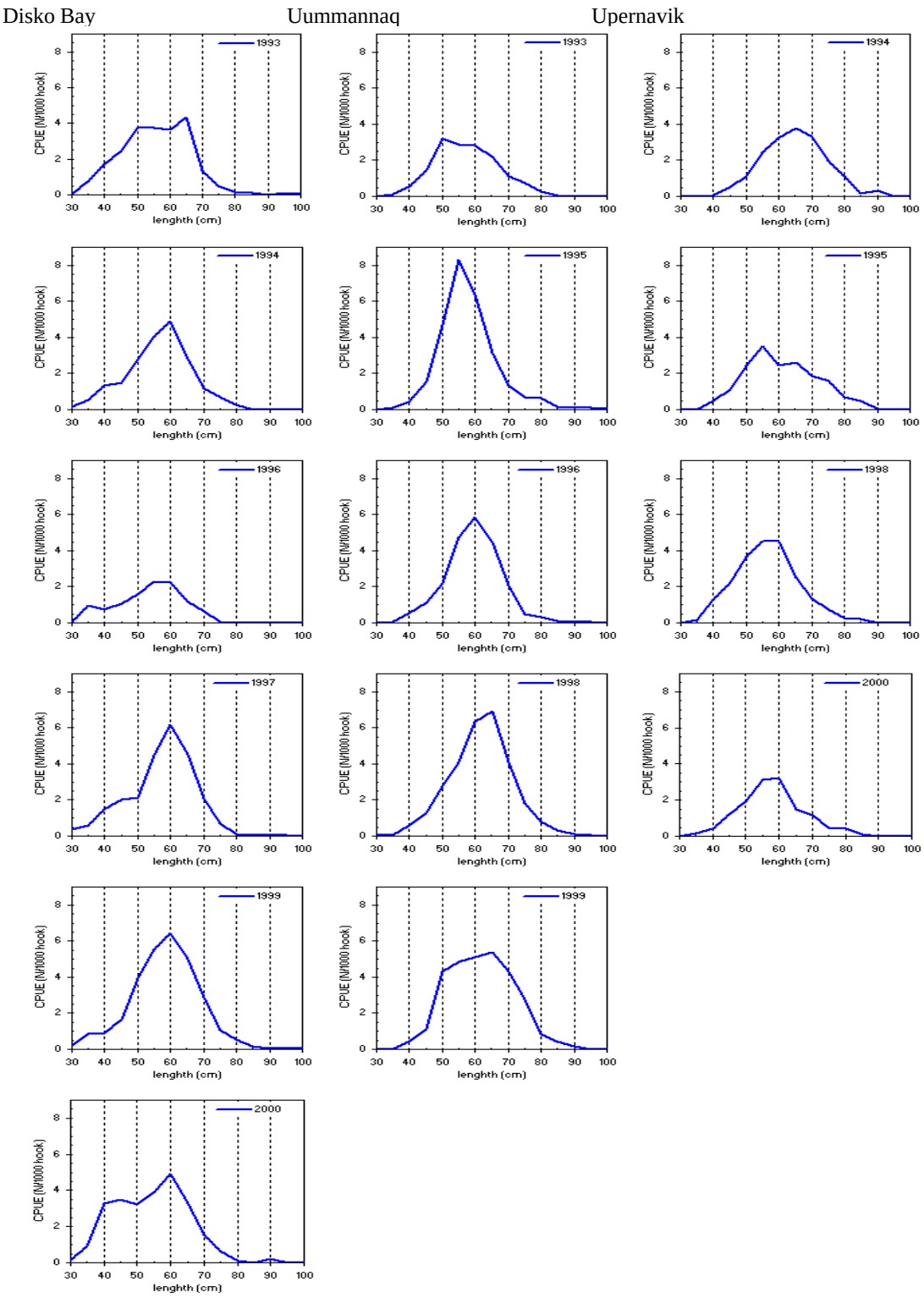

Figure 8. CPUE (N/1000 hooks) of G. halibut from longlinesurvey stratified in 5 cm length interval.

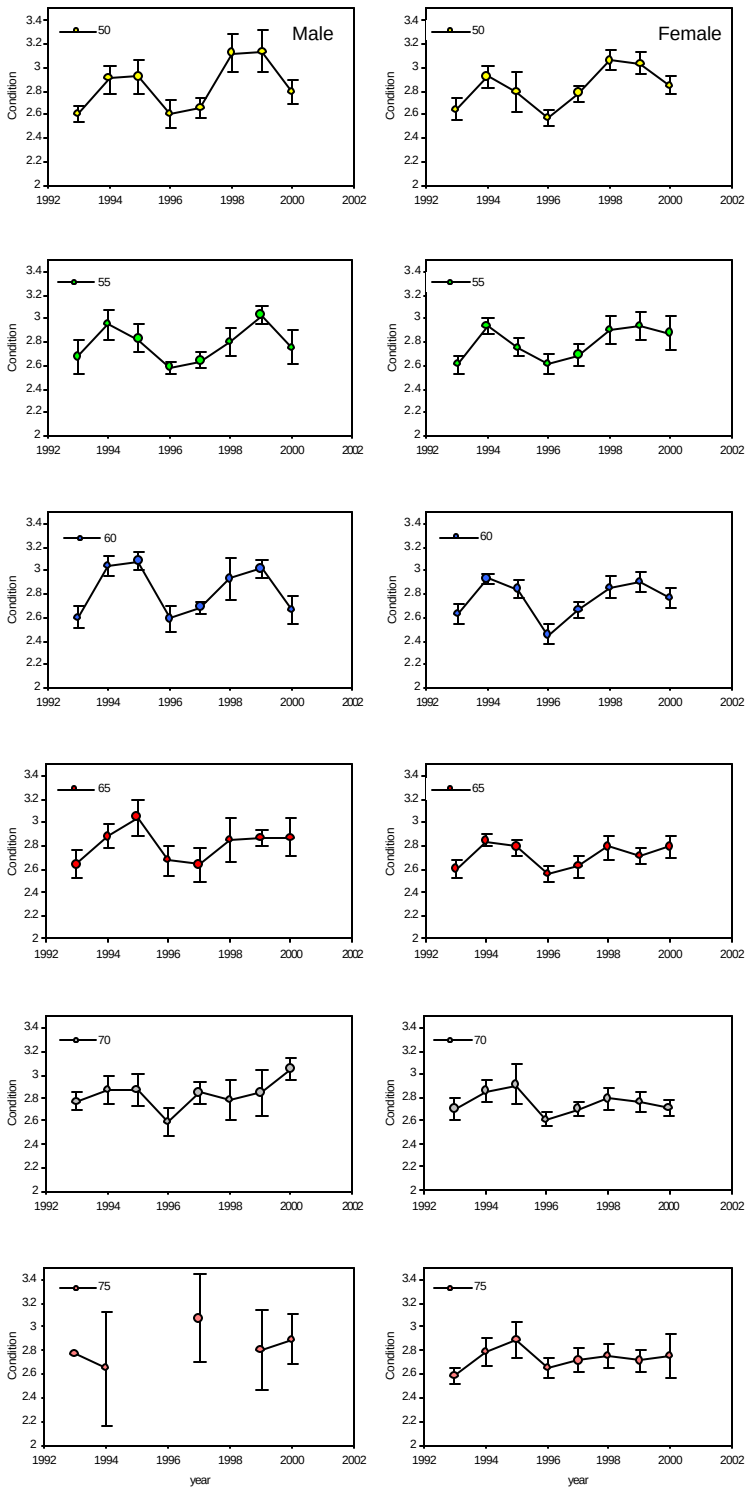

Figure 9. Length stratified condition factor for Gr. halibut (condition=weight/length3.3x 10^6) in Disko Bay. Errorbars 95 % conf. intervals

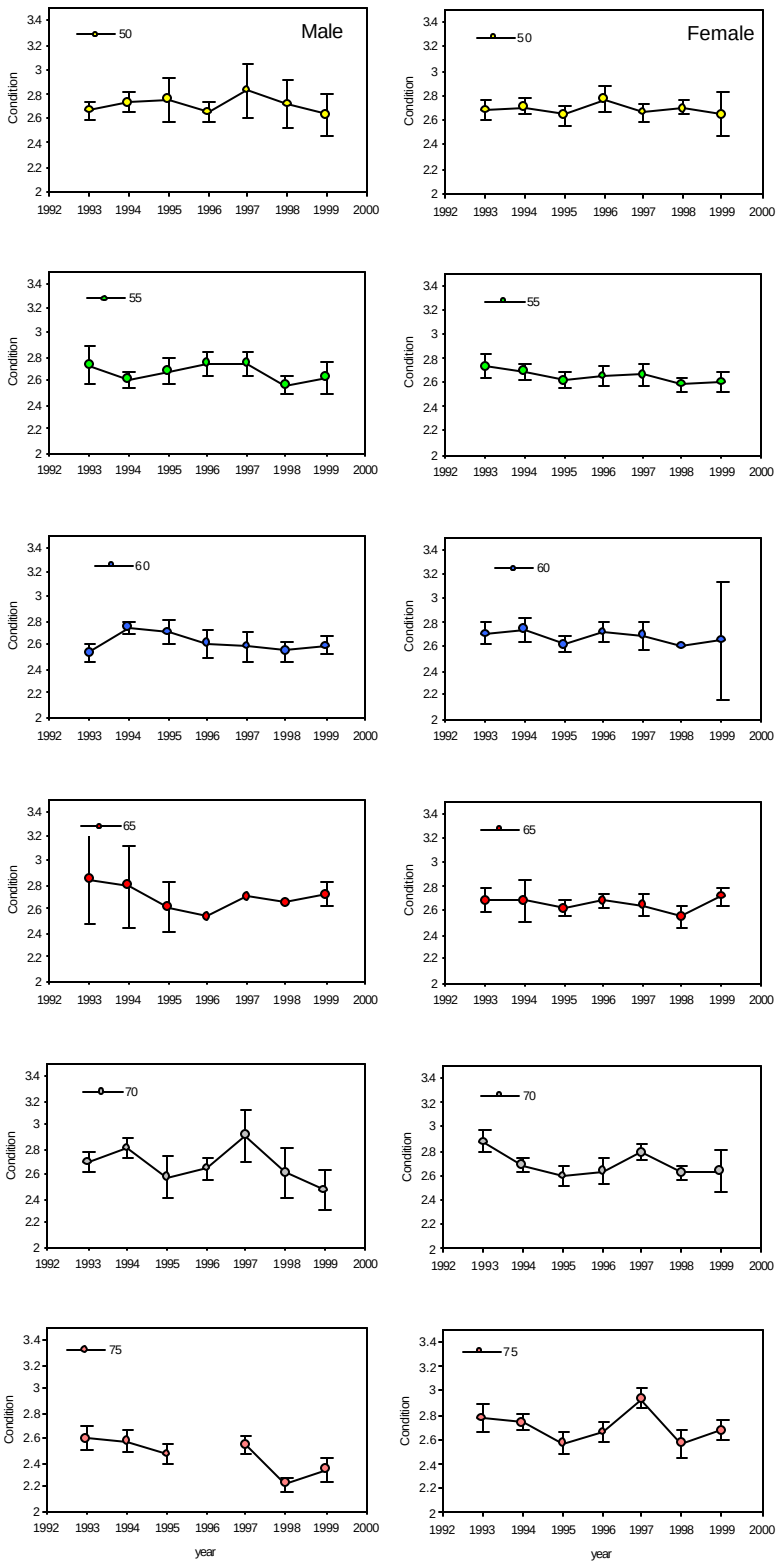

Figure 10. Length stratified condition factor for Gr. halibut (condition=weight/length3.3x 10^6) in Uummannaq. Error bars 95 % conf. intervals

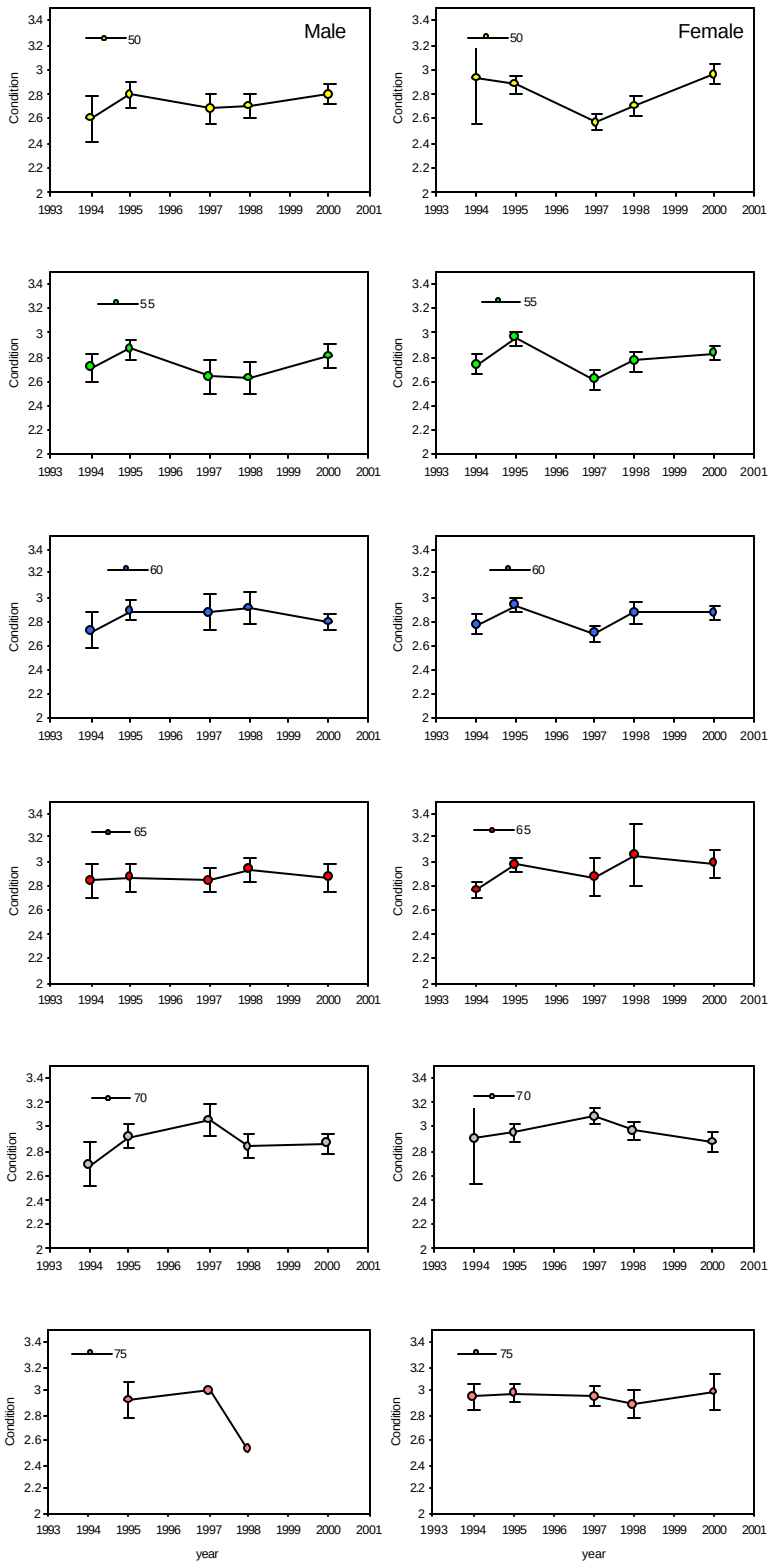

Figure 11. Length stratified condition factor for Gr. halibut (condition=weight/length3.3x 10^6) in Upernavik. Error bars 95 % conf. intervals

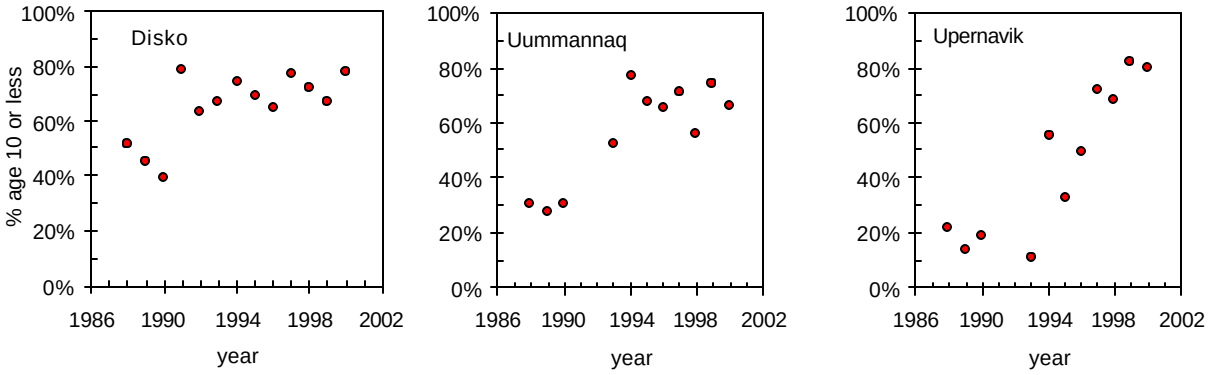

Figure 12. The development in explotation of the *age 10 and below* expressed as percentages for each year.

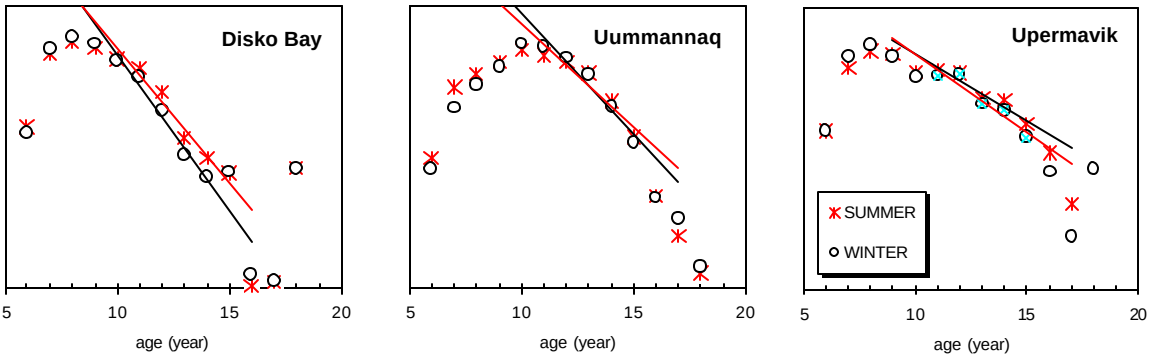

Figure 13. Catchcurves for the 3 main fishing areas bases on catch composiotion in the longline fishery for each season. Agegroup 10-14 in Disko Bay, agegruop 11-15 in Uummannaq and Upernavik was used for linear regression. Z was compiles as average of the estimated Z values. M was set to 0.15.

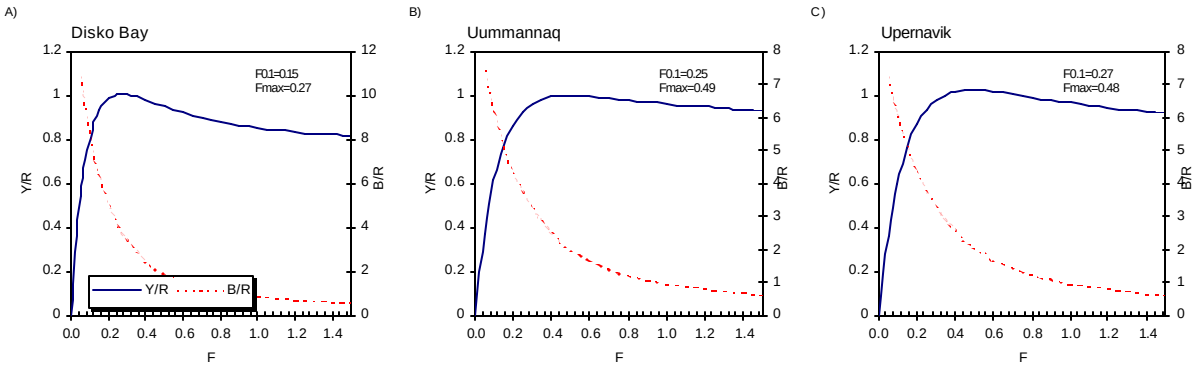

Figure 14. Yield per Recruit and Spawning Stock biomass per Recruit curve in A) Disko Bay, B) Uumannaq and C) Upernavik area.

Appendix analytical assessment

Tables A. Input data for VPA

Run title : GREENLAND HALIBUT DIV 1A - ILULISSAT

At 13/06/2001 18:58

Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
	AGE						
	5,	0,	0,	0,	0,	0,	0,
	6,	14,	14,	10,	1,	0,	0,
	7,	47,	44,	30,	9,	0,	1,
	8,	86,	81,	53,	59,	14,	24,
	9,	199,	189,	125,	182,	106,	141,
	10,	254,	235,	174,	173,	121,	185,
	11,	146,	123,	116,	132,	94,	188,
	12,	91,	67,	86,	73,	49,	126,
	13,	58,	41,	57,	63,	33,	80,
	14,	39,	26,	41,	65,	39,	59,
	15,	33,	22,	34,	38,	31,	42,
	16,	21,	13,	22,	18,	19,	23,
	+gp,	29,	17,	26,	15,	22,	21,
0	TOTALNUM,	1017,	872,	774,	828,	528,	890,
	TONSLAND,	2685,	2118,	2258,	2670,	2781,	3821,
	SOPCOF %,	100,	101,	100,	114,	164,	140,

Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
	AGE										
	5,	5,	92,	15,	3,	0,	8,	0,	0,	5,	7,
	6,	11,	122,	62,	15,	0,	1,	21,	74,	41,	98,
	7,	279,	332,	280,	112,	45,	47,	132,	397,	360,	535,
	8,	806,	476,	479,	281,	459,	323,	646,	775,	619,	729,
	9,	535,	390,	339,	539,	639,	941,	1113,	944,	836,	780,
	10,	333,	451,	280,	396,	798,	651,	1168,	1248,	1028,	636,
	11,	238,	532,	240,	190,	463,	454,	607,	754,	786,	478,
	12,	76,	309,	122,	91,	185,	273,	185,	346,	426,	223,
	13,	45,	140,	91,	50,	127,	145,	69,	132,	136,	52,
	14,	67,	92,	112,	45,	27,	75,	19,	68,	72,	28,
	15,	57,	0,	75,	41,	36,	44,	10,	27,	29,	12,
	16,	35,	0,	57,	21,	12,	31,	3,	4,	1,	0,
	+gp,	9,	0,	22,	11,	15,	38,	3,	1,	1,	1,
0	TOTALNUM,	2496,	2936,	2174,	1795,	2806,	3031,	3976,	4770,	4340,	3579,
	TONSLAND,	5372,	6577,	5367,	5201,	7400,	7800,	8601,	10671,	10593,	7574,
	SOPCOF %,	113,	115,	104,	92,	109,	107,	104,	117,	100,	89,
1											

Table 2 Catch weights at age (kg)

	YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
	AGE						
	5,	.5900,	.5900,	.5900,	.5900,	.5900,	.5900,
	6,	.7470,	.7470,	.7470,	.7470,	.7470,	.7470,
	7,	.9470,	.9470,	.9470,	.9470,	.9470,	.9470,
	8,	1.1990,	1.1990,	1.1990,	1.1990,	1.1990,	1.1990,
	9,	1.5180,	1.5180,	1.5180,	1.5180,	1.5180,	1.5180,
	10,	1.9230,	1.9230,	1.9230,	1.9230,	1.9230,	1.9230,
	11,	2.4350,	2.4350,	2.4350,	2.4350,	2.4350,	2.4350,
	12,	3.0830,	3.0830,	3.0830,	3.0830,	3.0830,	3.0830,
	13,	3.9050,	3.9050,	3.9050,	3.9050,	3.9050,	3.9050,
	14,	4.9450,	4.9450,	4.9450,	4.9450,	4.9450,	4.9450,
	15,	6.2620,	6.2620,	6.2620,	6.2620,	6.2620,	6.2620,
	16,	7.9310,	7.9310,	7.9310,	7.9310,	7.9310,	7.9310,
	+gp,	10.7812,	10.6726,	10.3518,	10.7566,	11.0161,	10.8076,
0	SOPCOFAC,	.9982,	1.0061,	1.0021,	1.1386,	1.6366,	1.4036,

Table 2 Catch weights at age (kg)

	YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
	AGE										
	5,	.5900,	.5900,	.7590,	.9730,	.8130,	.6100,	.2930,	.4990,	.4740,	.6390,
	6,	.7470,	.7470,	.9300,	1.2140,	.9980,	.7740,	.5080,	.6530,	.7690,	1.0000,
	7,	.9470,	.9470,	1.1400,	1.5150,	1.2240,	.9810,	.7730,	.8560,	1.1680,	1.4480,
	8,	1.1990,	1.1990,	1.3960,	1.8910,	1.5020,	1.2430,	1.1480,	1.1220,	1.5240,	1.8350,
	9,	1.5180,	1.5180,	1.7110,	2.3600,	1.8430,	1.5760,	1.5890,	1.4700,	1.9780,	2.3330,
	10,	1.9230,	1.9230,	2.0960,	2.9450,	2.2620,	1.9970,	2.1760,	1.9270,	2.3480,	2.6600,
	11,	2.4350,	2.4350,	2.5690,	3.6750,	2.7760,	2.5320,	2.9750,	2.2250,	3.0000,	3.1270,
	12,	3.0830,	3.0830,	3.1470,	4.5860,	3.4060,	3.2100,	3.6930,	3.3090,	3.5930,	3.7310,
	13,	3.9050,	3.9050,	3.8570,	5.7240,	4.1790,	4.0690,	4.7970,	4.3370,	4.5170,	4.5570,
	14,	4.9450,	4.9450,	4.7260,	7.1430,	5.1280,	5.1570,	5.9530,	5.6830,	5.1380,	4.6640,
	15,	6.2620,	6.2620,	5.7900,	8.9140,	6.2920,	6.5370,	7.3720,	7.4480,	7.1050,	7.1940,
	16,	7.9310,	7.9310,	7.0950,	11.1250,	7.7200,	8.2870,	10.0830,	9.7600,	10.0830,	7.8050,
	+gp,	10.6377,	.0000,	9.5835,	14.1970,	9.4730,	12.9451,	13.3757,	12.7900,	11.6830,	10.0300,
0	SOPCOFAC,	1.1320,	1.1459,	1.0413,	.9223,	1.0926,	1.0721,	1.0436,	1.1746,	1.0026,	.8893,
1											

Table 3 Stock weights at age (kg)

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	.5900,	.5900,	.5900,	.5900,	.5900,	.5900,
6,	.7470,	.7470,	.7470,	.7470,	.7470,	.7470,
7,	.9470,	.9470,	.9470,	.9470,	.9470,	.9470,
8,	1.1990,	1.1990,	1.1990,	1.1990,	1.1990,	1.1990,
9,	1.5180,	1.5180,	1.5180,	1.5180,	1.5180,	1.5180,
10,	1.9230,	1.9230,	1.9230,	1.9230,	1.9230,	1.9230,
11,	2.4350,	2.4350,	2.4350,	2.4350,	2.4350,	2.4350,
12,	3.0830,	3.0830,	3.0830,	3.0830,	3.0830,	3.0830,
13,	3.9050,	3.9050,	3.9050,	3.9050,	3.9050,	3.9050,
14,	4.9450,	4.9450,	4.9450,	4.9450,	4.9450,	4.9450,
15,	6.2620,	6.2620,	6.2620,	6.2620,	6.2620,	6.2620,
16,	7.9310,	7.9310,	7.9310,	7.9310,	7.9310,	7.9310,
+gp,	10.7812,	10.6726,	10.3518,	10.7566,	11.0161,	10.8076,

Table 3 Stock weights at age (kg)

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	.5900,	.5900,	.7590,	.9730,	.8130,	.6100,	.2930,	.4990,	.4740,	.6390,
6,	.7470,	.7470,	.9300,	1.2140,	.9980,	.7740,	.5080,	.6530,	.7690,	1.0000,
7,	.9470,	.9470,	1.1400,	1.5150,	1.2240,	.9810,	.7730,	.8560,	1.1680,	1.4480,
8,	1.1990,	1.1990,	1.3960,	1.8910,	1.5020,	1.2430,	1.1480,	1.1220,	1.5240,	1.8350,
9,	1.5180,	1.5180,	1.7110,	2.3600,	1.8430,	1.5760,	1.5890,	1.4700,	1.9780,	2.3330,
10,	1.9230,	1.9230,	2.0960,	2.9450,	2.2620,	1.9970,	2.1760,	1.9270,	2.3480,	2.6600,
11,	2.4350,	2.4350,	2.5690,	3.6750,	2.7760,	2.5320,	2.9750,	2.2250,	3.0000,	3.1270,
12,	3.0830,	3.0830,	3.1470,	4.5860,	3.4060,	3.2100,	3.6930,	3.3090,	3.5930,	3.7310,
13,	3.9050,	3.9050,	3.8570,	5.7240,	4.1790,	4.0690,	4.7970,	4.3370,	4.5170,	4.5570,
14,	4.9450,	4.9450,	4.7260,	7.1430,	5.1280,	5.1570,	5.9530,	5.6830,	5.1380,	4.6640,
15,	6.2620,	6.2620,	5.7900,	8.9140,	6.2920,	6.5370,	7.3720,	7.4480,	7.1050,	7.1940,
16,	7.9310,	7.9310,	7.0950,	11.1250,	7.7200,	8.2870,	10.0830,	9.7600,	10.0830,	7.8050,
+gp,	10.6377,	.0000,	9.5835,	14.1970,	9.4730,	12.9451,	13.3757,	12.7900,	11.6830,	10.0300,

1

Table 4 Natural Mortality (M) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
6,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
7,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
8,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
9,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
10,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
11,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
12,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
13,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
14,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
15,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
16,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
+gp,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,

Table 4 Natural Mortality (M) at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
6,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
7,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
8,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
9,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
10,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
11,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
12,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
13,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
14,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
15,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
16,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,
+gp,	.1500,	.0000,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,

1

Table 5 Proportion mature at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
7,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
8,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
9,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
16,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
7,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
8,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
9,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
16,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

1

Table 6 Proportion of M before Spawning

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
7,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
8,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
9,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
10,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
11,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
12,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
13,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
14,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
15,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
16,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
+gp,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,

Table 6 Proportion of M before Spawning

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
7,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
8,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
9,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
10,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
11,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
12,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
13,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
14,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
15,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
16,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
+gp,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,

1

Table 7 Proportion of F before Spawning

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
7,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
8,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
9,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
10,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
11,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
12,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
13,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
14,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
15,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
16,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
+gp,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,

Table 7 Proportion of F before Spawning

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
7,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
8,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
9,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
10,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
11,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
12,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
13,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
14,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
15,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
16,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
+gp,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,

1

Tables B.

Output tables, Separable f- and population matrices

```
Title :  GREENLAND HALIBUT DIV 1A - ILULISSAT

     At  5/06/2001  14:08

     Separable analysis
     from 1985 to 2000 on ages  5 to 16
     with Terminal F of  .400 on age 10 and Terminal S of 2.000

     Initial sum of squared residuals was   813.960 and
       final sum of squared residuals is    506.611 after 141 iterations

     Matrix of Residuals

      Years,    1985/86,1986/87,1987/88,1988/89,1989/90,
       Ages
       5/ 6,    -5.307, -4.891, -2.452,  -.840,   .486,
       6/ 7,     2.114,  2.578,  3.581,  5.090,  1.809,
       7/ 8,      .828,  1.271,   .917,   .472, -3.249,
       8/ 9,     -.331,   .117,  -.543,  -.559,  -.970,
       9/10,     -.119,   .240,  -.023,   .068,   .414,
      10/11,      .371,   .481,   .203,  -.088,   .181,
      11/12,      .189,  -.088,   .175,   .090,   .137,
      12/13,      .004,  -.480,  -.169,  -.299,  -.239,
      13/14,      .068,  -.581,  -.550,  -.547,  -.268,
      14/15,      .149,  -.519,  -.011,   .099,   .583,
      15/16,     -.518, -1.247,  -.425,  -.964,   .049,

       TOT ,      .000,   .000,   .000,   .000,   .000,
       WTS ,      .001,   .001,   .001,   .001,   .001,

      Years,    1990/91,1991/92,1992/93,1993/94,1994/95,1995/96,1996/97,1997/98,1998/99,1999/**,        TOT,         WTS,
       5/ 6,    -4.007, -3.205,   .003,  -.451,  3.413, -2.243, -1.195, -6.407, -6.022, -3.632,     -19.517,        .080,
       6/ 7,    -3.619,   .202,  2.399,  2.581,  2.535, -2.473, -1.491,   .879,  2.029,   .396,       -.640,        .094,
       7/ 8,    -4.281,  1.161,   .957,  1.274,   .326,  -.196, -1.133,   .131,  1.238,   .352,        .391,        .131,
       8/ 9,    -1.633,  1.447,   .700,   .222,  -.020,   .104,  -.705,   .544,   .600,  -.150,        .391,        .288,
       9/10,      .175,   .397,   .206,  -.259,  -.027,   .341,  -.154,   .311,   .046,  -.155,        .391,       1.000,
      10/11,      .371,  -.728,   .018,  -.158,  -.215,   .474,  -.334,   .382,   .056,  -.188,        .391,        .634,
      11/12,     1.292,  -.819,   .557,   .156,  -.282,   .169,   .210,   .214,  -.174,  -.029,        .391,        .490,
      12/13,     1.225, -1.397,   .068,  -.143,  -.848,  -.329,   .461,  -.232,  -.059,   .552,        .391,        .364,
      13/14,      .422, -1.455,  -.881,  -.275,   .155,   .003,  1.169,  -.511,  -.347,   .080,        .391,        .362,
      14/15,      .502,  5.945,  -.684,   .296,   .017,  -.795,  1.375,  -.714,   .020,   .499,        .391,        .134,
      15/16,     -.232,  4.722, -8.386,  -.530,   .030, -1.164,   .962,  -.455,  1.334,  3.095,       3.763,        .078,

       TOT ,      .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,     -17.535,
       WTS ,      .001,   .001,   .001,   .001,   .001,  1.000,  1.000,  1.000,  1.000,  1.000,

       Fishing Mortalities (F)

              ,    1985,   1986,   1987,   1988,   1989,   1990,
     F-values,   .2905,  .2342,  .2045,  .2047,  .1027,  .1940,

              ,    1991,   1992,   1993,   1994,   1995,   1996,   1997,   1998,   1999,   2000,
     F-values,   .4514,  .5195,  .4081,  .3020,  .3551,  .4379,  .4043,  .5740,  .6635,  .4000,

      Selection-at-age (S)

              ,       5,      6,
     S-values,   .0010,  .0010,

              ,       7,      8,      9,     10,     11,     12,     13,     14,     15,     16,
     S-values,   .0372,  .2180,  .5452, 1.0000, 1.3714, 1.6183, 1.6194, 1.7430, 2.9636, 2.0000,


                  Cohort analysis  Terminal populations from weighted Separable populations
       Fishing mortality residuals
       YEAR,       1985,    1986,    1987,    1988,    1989,    1990,
       AGE
         5,       -.0003,  -.0002,  -.0002,  -.0002,  -.0001,  -.0002,
         6,        .0059,   .0051,   .0035,   .0001,  -.0001,  -.0002,
         7,        .0165,   .0143,   .0057,  -.0038,  -.0038,  -.0069,
         8,        .0009,   .0059,  -.0115,  -.0135,  -.0154,  -.0318,
         9,        .0352,   .0580,  -.0006,   .0327,   .0124,  -.0199,
        10,        .0380,   .1127,   .0417,   .0044,   .0250,  -.0392,
        11,       -.1030,  -.0742,  -.0090,   .0017,   .0179,   .0161,
        12,       -.1478,  -.1766,  -.0729,  -.0724,  -.0145,  -.0020,
        13,       -.1034,  -.1572,  -.0807,  -.0429,   .0023,   .0579,
        14,       -.1030,  -.1455,  -.0158,   .1169,   .0962,   .1424,
        15,       -.1806,  -.3000,   .0032,  -.0319,   .1046,  -.0702,
        16,        .0008,   .1223,   .4139,   .3166,   .3945,   .1840,

Fishing mortality residuals
       YEAR,       1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,

       AGE
         5,        .0003,   .0100,   .0013,   .0001,  -.0004,   .0003,  -.0004,  -.0006,  -.0006,   .0000,
         6,        .0016,   .0210,   .0079,   .0017,  -.0004,  -.0003,   .0019,   .0064,   .0034,   .0019,
         7,        .0593,   .0543,   .0446,   .0065,  -.0061,  -.0078,   .0116,   .0302,   .0154,   .0495,
         8,        .2545,   .0572,   .0480,   .0087,   .0114,  -.0339,   .0579,   .0780,  -.0440,   .0140,
         9,        .0725,  -.0115,  -.0555,   .0485,   .0350,   .0113,   .0732,  -.0024,  -.0300,  -.0495,
        10,       -.1688,  -.0616,  -.1065,  -.0187,   .1702,  -.0755,   .1227,   .0141,  -.0458,   .0273,
        11,       -.3309,   .2194,  -.1149,  -.0890,   .1017,   .0096,   .0864,  -.0523,  -.0282,   .0708,
        12,       -.5642,  -.1400,  -.1327,  -.2053,  -.0041,   .0880,  -.1468,  -.0254,   .1727,  -.0192,
        13,       -.5662,  -.3518,  -.2343,  -.0871,   .1828,   .4961,  -.2121,  -.1352,   .0359,  -.2149,
        14,       -.2093,  -.3512,   .1728,  -.1616,  -.2473,   .7413,  -.2649,   .0145,   .3078,  -.0300,
        15,       -.1582, -1.5395,  -.0003,   .0322,  -.5260,   .6143,  -.4163,   .7303,   .0887,  -.1533,
        16,        .1075, -1.0390,  1.4605,   .8432,   .0226,   .3053,  -.1984,  -.3471,  -.7355,  -.8000,
```

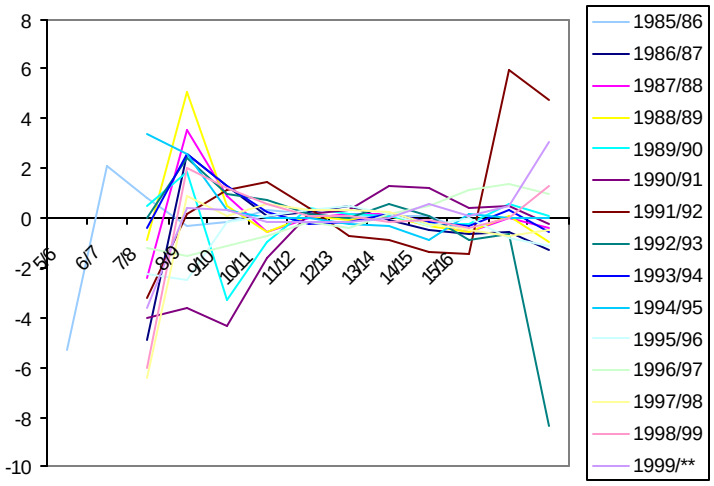

Figure appendix 1. Fishing mortality residuals

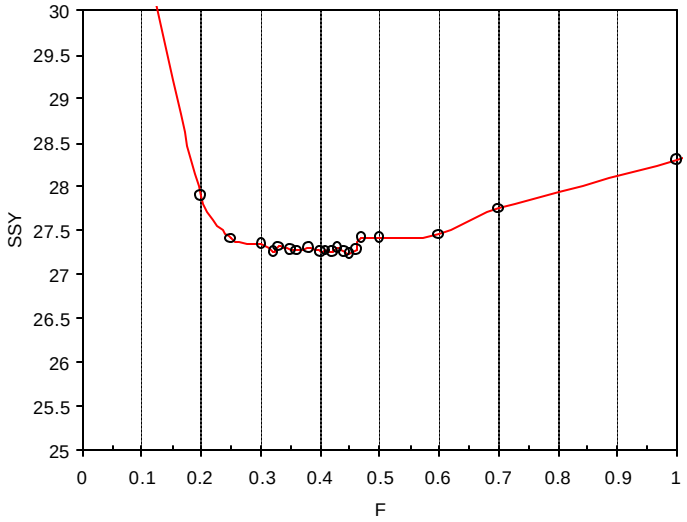

Figure appendix 2. Estimation of terminal F from ln-transformed sum of the residuals of the difference between the separable VPA estimated population number at age and the estimates from the survey to locate the most appropriate F.

Tables C.
Output tables from separable VPA

```
    Run title :  GREENLAND HALIBUT DIV 1A - ILULISSAT

    At  5/06/2001  17:22

                  Cohort analysis  Terminal populations from weighted Separable populations

       Table  8    Fishing mortality (F) at age
       YEAR,       1985,    1986,    1987,    1988,    1989,    1990,

       AGE
         5,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
         6,        .0062,   .0053,   .0037,   .0003,   .0000,   .0000,
         7,        .0273,   .0230,   .0133,   .0039,   .0000,   .0003,
         8,        .0643,   .0569,   .0331,   .0312,   .0070,   .0105,
         9,        .1936,   .1857,   .1110,   .1443,   .0684,   .0859,
        10,        .3285,   .3469,   .2462,   .2091,   .1277,   .1549,
        11,        .2953,   .2469,   .2715,   .2824,   .1588,   .2822,
        12,        .3223,   .2023,   .2581,   .2589,   .1517,   .3120,
        13,        .3670,   .2220,   .2506,   .2886,   .1686,   .3721,
        14,        .4033,   .2626,   .3407,   .4737,   .2752,   .4806,
        15,        .6803,   .3939,   .6093,   .5747,   .4091,   .5049,
        16,        .5817,   .5906,   .8230,   .7260,   .5999,   .5721,
       +gp,        .5782,   .5869,   .8169,   .7210,   .5962,   .5686,
0  FBAR 10-14,     .3433,   .2561,   .2734,   .3025,   .1764,   .3204,


       Table  8    Fishing mortality (F) at age
       YEAR,       1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,       FBAR 98-**

       AGE
         5,        .0008,   .0105,   .0018,   .0004,   .0000,   .0007,   .0000,   .0000,   .0001,   .0004,       .0002,
         6,        .0020,   .0215,   .0083,   .0020,   .0000,   .0002,   .0023,   .0069,   .0041,   .0023,       .0044,
         7,        .0761,   .0736,   .0598,   .0177,   .0071,   .0085,   .0266,   .0515,   .0401,   .0644,       .0520,
         8,        .3529,   .1705,   .1370,   .0745,   .0888,   .0616,   .1461,   .2032,   .1007,   .1013,       .1350,
         9,        .3185,   .2717,   .1670,   .2131,   .2286,   .2500,   .2937,   .3106,   .3317,   .1686,       .2703,
        10,        .2826,   .4579,   .3017,   .2833,   .5253,   .3624,   .5271,   .5882,   .6177,   .4273,       .5444,
        11,        .2881,   .9318,   .4449,   .3252,   .5887,   .6102,   .6409,   .7349,   .8817,   .6194,       .7453,
        12,        .1662,   .7006,   .5278,   .2834,   .5705,   .7967,   .5076,   .9035,  1.2463,   .6281,       .9260,
        13,        .1648,   .4895,   .4266,   .4020,   .7579,  1.2052,   .4427,   .7944,  1.1103,   .4329,       .7792,
        14,        .5774,   .5543,   .8842,   .3649,   .3716,  1.5045,   .4398,  1.0151,  1.4643,   .6672,      1.0489,
        15,       1.1795,   .0000,  1.2092,   .9272,   .5263,  1.9120,   .7820,  2.4315,  2.0550,  1.0321,      1.8395,
        16,       1.0103,   .0000,  2.2768,  1.4473,   .7328,  1.1811,   .6103,   .8010,   .5915,   .0000,       .4642,
       +gp,       1.0019,  1.1691,  2.2528,  1.4334,   .7276,  1.1706,   .6064,   .7951,   .5878,  2.0336,
0  FBAR 10-14,     .2958,   .6268,   .5170,   .3318,   .5628,   .8958,   .5116,   .8072,  1.0641,   .5550,
1


       Table  9    Relative F at age
       YEAR,       1985,    1986,    1987,    1988,    1989,    1990,

       AGE
         5,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
         6,        .0181,   .0207,   .0134,   .0011,   .0000,   .0000,
         7,        .0794,   .0898,   .0488,   .0128,   .0000,   .0010,
         8,        .1872,   .2223,   .1211,   .1030,   .0397,   .0327,
         9,        .5640,   .7249,   .4058,   .4769,   .3875,   .2682,
        10,        .9569,  1.3542,   .9004,   .6912,   .7239,   .4834,
        11,        .8603,   .9640,   .9930,   .9336,   .9001,   .8810,
        12,        .9388,   .7899,   .9441,   .8557,   .8599,   .9739,
        13,       1.0692,   .8666,   .9164,   .9538,   .9560,  1.1616,
        14,       1.1749,  1.0253,  1.2460,  1.5657,  1.5601,  1.5002,
        15,       1.9817,  1.5379,  2.2284,  1.8996,  2.3187,  1.5759,
        16,       1.6946,  2.3058,  3.0099,  2.3998,  3.4006,  1.7858,
       +gp,       1.6842,  2.2915,  2.9874,  2.3830,  3.3793,  1.7750,
0     REFMEAN,     .3433,   .2561,   .2734,   .3025,   .1764,   .3204,


       Table  9    Relative F at age
       YEAR,       1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,       MEAN 98-**

       AGE
         5,        .0025,   .0168,   .0034,   .0012,   .0000,   .0008,   .0000,   .0000,   .0001,   .0007,       .0003,
         6,        .0068,   .0343,   .0161,   .0061,   .0000,   .0002,   .0045,   .0086,   .0039,   .0041,       .0055,
         7,        .2573,   .1174,   .1156,   .0533,   .0127,   .0095,   .0520,   .0638,   .0377,   .1160,       .0725,
         8,       1.1930,   .2720,   .2650,   .2246,   .1578,   .0688,   .2855,   .2517,   .0947,   .1824,       .1763,
         9,       1.0768,   .4335,   .3231,   .6425,   .4062,   .2791,   .5740,   .3848,   .3118,   .3037,       .3334,
        10,        .9552,   .7305,   .5835,   .8541,   .9334,   .4046,  1.0302,   .7286,   .5805,   .7699,       .6930,
        11,        .9740,  1.4865,   .8604,   .9802,  1.0460,   .6811,  1.2528,   .9104,   .8286,  1.1161,       .9517,
        12,        .5619,  1.1177,  1.0208,   .8544,  1.0136,   .8893,   .9921,  1.1193,  1.1713,  1.1318,      1.1408,
        13,        .5570,   .7809,   .8252,  1.2116,  1.3466,  1.3454,   .8653,   .9841,  1.0435,   .7800,       .9359,
        14,       1.9518,   .8843,  1.7101,  1.0998,   .6603,  1.6796,   .8597,  1.2575,  1.3761,  1.2022,      1.2786,
        15,       3.9871,   .0000,  2.3389,  2.7950,   .9352,  2.1344,  1.5285,  3.0122,  1.9313,  1.8597,      2.2677,
        16,       3.4149,   .0000,  4.4037,  4.3624,  1.3020,  1.3185,  1.1929,   .9923,   .5559,   .0000,       .5160,
       +gp,       3.3866,  1.8650,  4.3573,  4.3206,  1.2929,  1.3068,  1.1853,   .9850,   .5524,  3.6642,
0     REFMEAN,     .2958,   .6268,   .5170,   .3318,   .5628,   .8958,   .5116,   .8072,  1.0641,   .5550,
1
```

Cohort analysis Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	3312,	3413,	3894,	4583,	5539,	6821,
6,	2437,	2850,	2938,	3351,	3945,	4767,
7,	1884,	2085,	2440,	2519,	2884,	3395,
8,	1489,	1578,	1754,	2073,	2160,	2482,
9,	1219,	1202,	1283,	1460,	1729,	1846,
10,	978,	864,	859,	988,	1088,	1390,
11,	615,	606,	526,	578,	690,	824,
12,	356,	394,	407,	345,	375,	507,
13,	203,	222,	277,	271,	229,	278,
14,	127,	121,	153,	186,	175,	167,
15,	72,	73,	80,	94,	100,	114,
16,	51,	31,	42,	38,	45,	57,
+gp,	71,	41,	50,	31,	52,	52,
0 TOTAL,	12814,	13481,	14703,	16517,	19011,	22700,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	GMST 85-98	AMST 85-98
AGE													
5,	7182,	9470,	9237,	8108,	7319,	11534,	13414,	12537,	54592,	19081,	0,	6897,	7597,
6,	5871,	6177,	8065,	7936,	6976,	6300,	9920,	11545,	10790,	46983,	16416,	5332,	5934,
7,	4103,	5043,	5203,	6884,	6817,	6004,	5421,	8519,	9869,	9249,	40348,	4060,	4514,
8,	2922,	3273,	4033,	4219,	5822,	5826,	5124,	4544,	6964,	8160,	7465,	3045,	3378,
9,	2114,	1767,	2375,	3027,	3370,	4585,	4714,	3811,	3192,	5420,	6347,	2208,	2464,
10,	1458,	1323,	1159,	1730,	2105,	2308,	3073,	3025,	2404,	1972,	3941,	1454,	1596,
11,	1025,	946,	720,	738,	1122,	1071,	1383,	1562,	1446,	1116,	1107,	839,	886,
12,	535,	661,	321,	397,	459,	536,	501,	627,	645,	515,	517,	448,	459,
13,	319,	390,	282,	163,	258,	223,	208,	260,	219,	160,	237,	251,	256,
14,	165,	233,	206,	159,	94,	104,	58,	115,	101,	62,	89,	139,	147,
15,	89,	80,	115,	73,	95,	56,	20,	32,	36,	20,	27,	71,	78,
16,	59,	23,	68,	30,	25,	48,	7,	8,	2,	4,	6,	32,	38,
+gp,	15,	0,	26,	15,	31,	58,	7,	2,	2,	1,	4,		
0 TOTAL,	25857,	29386,	31811,	33479,	34491,	38653,	43850,	46585,	90261,	92742,	76503,		
1													

Cohort analysis Terminal populations from weighted Separable populations

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	0,	0,	0,	0,	0,	0,
6,	0,	0,	0,	0,	0,	0,
7,	0,	0,	0,	0,	0,	0,
8,	0,	0,	0,	0,	0,	0,
9,	0,	0,	0,	0,	0,	0,
10,	978,	864,	859,	988,	1088,	1390,
11,	615,	606,	526,	578,	690,	824,
12,	356,	394,	407,	345,	375,	507,
13,	203,	222,	277,	271,	229,	278,
14,	127,	121,	153,	186,	175,	167,
15,	72,	73,	80,	94,	100,	114,
16,	51,	31,	42,	38,	45,	57,
+gp,	71,	41,	50,	31,	52,	52,

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
6,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
7,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
8,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
9,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
10,	1458,	1323,	1159,	1730,	2105,	2308,	3073,	3025,	2404,	1972,
11,	1025,	946,	720,	738,	1122,	1071,	1383,	1562,	1446,	1116,
12,	535,	661,	321,	397,	459,	536,	501,	627,	645,	515,
13,	319,	390,	282,	163,	258,	223,	208,	260,	219,	160,
14,	165,	233,	206,	159,	94,	104,	58,	115,	101,	62,
15,	89,	80,	115,	73,	95,	56,	20,	32,	36,	20,
16,	59,	23,	68,	30,	25,	48,	7,	8,	2,	4,
+gp,	15,	0,	26,	15,	31,	58,	7,	2,	2,	1,
1										

Cohort analysis Terminal populations from weighted Separable populations

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
	AGE						
	5,	1954,	2014,	2297,	2704,	3268,	4025,
	6,	1821,	2129,	2194,	2503,	2947,	3561,
	7,	1784,	1974,	2311,	2386,	2731,	3215,
	8,	1786,	1892,	2102,	2485,	2590,	2976,
	9,	1850,	1825,	1947,	2216,	2625,	2802,
	10,	1880,	1662,	1653,	1900,	2092,	2673,
	11,	1499,	1476,	1280,	1408,	1680,	2007,
	12,	1098,	1216,	1256,	1064,	1157,	1562,
	13,	795,	867,	1082,	1058,	895,	1084,
	14,	626,	600,	757,	918,	864,	824,
	15,	451,	456,	503,	587,	623,	715,
	16,	407,	249,	335,	298,	360,	451,
	+gp,	761,	437,	514,	335,	577,	560,
0	TOTALBIO,	16711,	16796,	18233,	19863,	22408,	26455,

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
	AGE										
	5,	4237,	5587,	7011,	7889,	5950,	7036,	3930,	6256,	25876,	12192,
	6,	4386,	4614,	7501,	9635,	6962,	4876,	5039,	7539,	8298,	46983,
	7,	3886,	4776,	5932,	10430,	8344,	5890,	4191,	7292,	11526,	13393,
	8,	3503,	3924,	5630,	7978,	8744,	7241,	5883,	5098,	10613,	14973,
	9,	3209,	2682,	4064,	7143,	6212,	7226,	7491,	5602,	6313,	12644,
	10,	2804,	2544,	2429,	5095,	4761,	4609,	6687,	5830,	5646,	5244,
	11,	2495,	2304,	1851,	2711,	3114,	2713,	4113,	3474,	4338,	3489,
	12,	1649,	2039,	1009,	1823,	1562,	1720,	1850,	2075,	2316,	1923,
	13,	1247,	1522,	1089,	932,	1077,	908,	997,	1126,	987,	727,
	14,	814,	1152,	972,	1133,	481,	536,	343,	653,	519,	289,
	15,	556,	498,	667,	652,	597,	364,	146,	238,	255,	145,
	16,	471,	186,	486,	329,	192,	400,	71,	76,	24,	31,
	+gp,	161,	0,	247,	217,	293,	757,	94,	25,	28,	12,
0	TOTALBIO,	29417,	31829,	38888,	55966,	48289,	44275,	40837,	45284,	76739,	112045,

1

Cohort analysis Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
	AGE						
	5,	0,	0,	0,	0,	0,	0,
	6,	0,	0,	0,	0,	0,	0,
	7,	0,	0,	0,	0,	0,	0,
	8,	0,	0,	0,	0,	0,	0,
	9,	0,	0,	0,	0,	0,	0,
	10,	1880,	1662,	1653,	1900,	2092,	2673,
	11,	1499,	1476,	1280,	1408,	1680,	2007,
	12,	1098,	1216,	1256,	1064,	1157,	1562,
	13,	795,	867,	1082,	1058,	895,	1084,
	14,	626,	600,	757,	918,	864,	824,
	15,	451,	456,	503,	587,	623,	715,
	16,	407,	249,	335,	298,	360,	451,
	+gp,	761,	437,	514,	335,	577,	560,
0	TOTSPBIO,	7517,	6962,	7381,	7568,	8248,	9876,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
	AGE										
	5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	6,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	7,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	8,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	9,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	10,	2804,	2544,	2429,	5095,	4761,	4609,	6687,	5830,	5646,	5244,
	11,	2495,	2304,	1851,	2711,	3114,	2713,	4113,	3474,	4338,	3489,
	12,	1649,	2039,	1009,	1823,	1562,	1720,	1850,	2075,	2316,	1923,
	13,	1247,	1522,	1089,	932,	1077,	908,	997,	1126,	987,	727,
	14,	814,	1152,	972,	1133,	481,	536,	343,	653,	519,	289,
	15,	556,	498,	667,	652,	597,	364,	146,	238,	255,	145,
	16,	471,	186,	486,	329,	192,	400,	71,	76,	24,	31,
	+gp,	161,	0,	247,	217,	293,	757,	94,	25,	28,	12,
0	TOTSPBIO,	10196,	10246,	8751,	12892,	12077,	12007,	14303,	13496,	14113,	11860,

Cohort analysis Terminal populations from weighted Separable populations

Table 14 Stock biomass at age with SOP (start of year) Tonnes

	YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
	AGE						
	5,	1950,	2026,	2302,	3079,	5348,	5649,
	6,	1817,	2142,	2199,	2850,	4823,	4998,
	7,	1781,	1986,	2316,	2716,	4469,	4513,
	8,	1783,	1903,	2107,	2830,	4238,	4177,
	9,	1847,	1836,	1952,	2524,	4296,	3933,
	10,	1877,	1672,	1656,	2164,	3424,	3752,
	11,	1496,	1485,	1283,	1603,	2750,	2817,
	12,	1096,	1223,	1259,	1211,	1893,	2193,
	13,	793,	872,	1085,	1205,	1465,	1521,
	14,	625,	604,	758,	1046,	1414,	1157,
	15,	451,	459,	504,	668,	1020,	1004,
	16,	406,	251,	336,	339,	589,	633,
	+gp,	760,	440,	515,	382,	944,	785,
0	TOTALBIO,	16681,	16899,	18272,	22616,	36674,	37132,

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	4797,	6402,	7300,	7276,	6501,	7543,	4102,	7348,	25943,	10843,
6,	4965,	5287,	7811,	8886,	7606,	5227,	5259,	8856,	8319,	41781,
7,	4399,	5473,	6177,	9620,	9116,	6315,	4373,	8565,	11556,	11910,
8,	3965,	4497,	5862,	7358,	9553,	7763,	6139,	5988,	10640,	13316,
9,	3633,	3073,	4232,	6588,	6787,	7747,	7818,	6581,	6329,	11244,
10,	3174,	2916,	2529,	4699,	5202,	4942,	6979,	6847,	5660,	4664,
11,	2825,	2640,	1927,	2501,	3402,	2908,	4293,	4081,	4349,	3103,
12,	1867,	2336,	1051,	1681,	1707,	1844,	1931,	2437,	2322,	1710,
13,	1411,	1745,	1134,	860,	1176,	974,	1041,	1322,	990,	646,
14,	922,	1321,	1012,	1045,	525,	575,	358,	767,	520,	257,
15,	629,	571,	695,	601,	652,	390,	153,	279,	255,	129,
16,	533,	213,	506,	304,	210,	428,	74,	90,	24,	27,
+gp,	182,	0,	257,	200,	321,	812,	98,	29,	28,	11,
0 TOTALBIO,	33301,	36473,	40494,	51620,	52758,	47468,	42618,	53191,	76937,	99640,
1										

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,
AGE						
5,	0,	0,	0,	0,	0,	0,
6,	0,	0,	0,	0,	0,	0,
7,	0,	0,	0,	0,	0,	0,
8,	0,	0,	0,	0,	0,	0,
9,	0,	0,	0,	0,	0,	0,
10,	1877,	1672,	1656,	2164,	3424,	3752,
11,	1496,	1485,	1283,	1603,	2750,	2817,
12,	1096,	1223,	1259,	1211,	1893,	2193,
13,	793,	872,	1085,	1205,	1465,	1521,
14,	625,	604,	758,	1046,	1414,	1157,
15,	451,	459,	504,	668,	1020,	1004,
16,	406,	251,	336,	339,	589,	633,
+gp,	760,	440,	515,	382,	944,	785,
0 TOTSPBIO,	7504,	7005,	7396,	8617,	13500,	13862,

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
6,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
7,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
8,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
9,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
10,	3174,	2916,	2529,	4699,	5202,	4942,	6979,	6847,	5660,	4664,
11,	2825,	2640,	1927,	2501,	3402,	2908,	4293,	4081,	4349,	3103,
12,	1867,	2336,	1051,	1681,	1707,	1844,	1931,	2437,	2322,	1710,
13,	1411,	1745,	1134,	860,	1176,	974,	1041,	1322,	990,	646,
14,	922,	1321,	1012,	1045,	525,	575,	358,	767,	520,	257,
15,	629,	571,	695,	601,	652,	390,	153,	279,	255,	129,
16,	533,	213,	506,	304,	210,	428,	74,	90,	24,	27,
+gp,	182,	0,	257,	200,	321,	812,	98,	29,	28,	11,
0 TOTSPBIO,	11542,	11740,	9112,	11891,	13195,	12872,	14927,	15853,	14149,	10547,
1										

Table 16 Summary (without SOP correction)

Cohort analysis Terminal populations from weighted Separable populations

,	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 10-14,
1985,	3312,	16711,	7517,	2685,	.3572,	.3433,
1986,	3413,	16796,	6962,	2118,	.3042,	.2561,
1987,	3894,	18233,	7381,	2258,	.3059,	.2734,
1988,	4583,	19863,	7568,	2670,	.3528,	.3025,
1989,	5539,	22408,	8248,	2781,	.3372,	.1764,
1990,	6821,	26455,	9876,	3821,	.3869,	.3204,
1991,	7182,	29417,	10196,	5372,	.5269,	.2958,
1992,	9470,	31829,	10246,	6577,	.6419,	.6268,
1993,	9237,	38888,	8751,	5367,	.6133,	.5170,
1994,	8108,	55966,	12892,	5201,	.4034,	.3318,
1995,	7319,	48289,	12077,	7400,	.6127,	.5628,
1996,	11534,	44275,	12007,	7800,	.6496,	.8958,
1997,	13414,	40837,	14303,	8601,	.6013,	.5116,
1998,	12537,	45284,	13496,	10671,	.7907,	.8072,
1999,	54592,	76739,	14113,	10593,	.7506,	1.0641,
2000,	19081,	112045,	11860,	7574,	.6386,	.5550,
Arith. Mean ,	11252,	40252,	10468,	5718,	.5171,	.4900,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1						

Table 17 Summary (with SOP correction)

Cohort analysis Terminal populations from weighted Separable populations

,	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 10-14,
1985,	3312,	16681,	7504,	2685,	.3578,	.9982,	.3433,
1986,	3413,	16899,	7005,	2118,	.3024,	1.0061,	.2561,
1987,	3894,	18272,	7396,	2258,	.3053,	1.0021,	.2734,
1988,	4583,	22616,	8617,	2670,	.3098,	1.1386,	.3025,
1989,	5539,	36674,	13500,	2781,	.2060,	1.6366,	.1764,
1990,	6821,	37132,	13862,	3821,	.2757,	1.4036,	.3204,
1991,	7182,	33301,	11542,	5372,	.4654,	1.1320,	.2958,
1992,	9470,	36473,	11740,	6577,	.5602,	1.1459,	.6268,
1993,	9237,	40494,	9112,	5367,	.5890,	1.0413,	.5170,
1994,	8108,	51620,	11891,	5201,	.4374,	.9223,	.3318,
1995,	7319,	52758,	13195,	7400,	.5608,	1.0926,	.5628,
1996,	11534,	47468,	12872,	7800,	.6059,	1.0721,	.8958,
1997,	13414,	42618,	14927,	8601,	.5762,	1.0436,	.5116,
1998,	12537,	53191,	15853,	10671,	.6731,	1.1746,	.8072,
1999,	54592,	76937,	14149,	10593,	.7487,	1.0026,	1.0641,
2000,	19081,	99640,	10547,	7574,	.7181,	.8893,	.5550,
Arith. Mean ,	11252,	42673,	11482,	5718,	.4807		.4900,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			
1							

Figure appendix 3. Summary plots of landings, fishing mortality, recruitment at age 5 and stock biomass derived from cohorte analysis (Table B, 17)