Northwest Atlantic Fisheries Organization

Serial No. N3035 **NAFO SCR Doc. 98/44**

SCIENTIFIC COUNCIL MEETING - JUNE 1998

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

by

C. S. Simonsen

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

1. Introduction

The Greenland halibut stock component in Div. 1A inshore is considered as a separate part of the Davis Strait stock (Boje et al. 1994). The component do probably not contribute to the spawning stock in Davis Strait (Boje, 1994) and only sporadical 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 recruitment from the nursery area south of Disko Island (Bech 1995).

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 19,799 tons in 1997, and comprising 99.31 % of the total inshore landings in Greenland. The inshore landings in Div.1A were around 7,000 tons in the late 1980's, but have since then increased steadily (Fig. 2 and Table 1). In 1997 catches were rather even distributed over the year but with a tendency toward higher catches around July and August (Fig. 3).

The fishery is traditionally performed with longlines from small open boats below 20 GRT, or by means of dog sledges. Typically the fishery is carried out the inner parts of the ice fjords at depth between 500 to 800 m (Fig. 1). In the middle of the 1980s gillnets were introduced to the inshore fishery, and were used more commonly in the following years. However, 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 is in force from year 2000. Gillnet fishery in 1997 was regulated by a minimum mesh-size of 110 mm (half meshes) while there are no regulations on longline fisheries. Mostly 3 mm. lines are used, but larger 20-30 foot vessels are using 5 mm. lines. Longline catches have the lastest years comprised of around 75 % of the catch. The catches allocated on area and gear throughout the year are shown in figure 3

At landing the fish are sorted by gear and weight classes. The weight classes are 1.0 to 1.5 kg, 1.5 to 3.3 kg and above 3.3 kg. The category of "large fish" (>3.3 kg) as longline catches gives almost twice the price compared to "small fish" and gillnet landings.

The inshore fishery in Div.1A is located in three main areas: Disko Bay, Uummannaq and Upernavik (Fig. 1) and there are no quotas on the fishery, but from 1998 a licence is required to land commercial catches.

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, Torssukattâk (Fig. 1). The winter fishery in Ilulissat Icefjord, Kangia, is a typical fishery from the ice with longlines (field-code LG29, 30 & 31). In 1997 a fishery in the Southerly inlet has started (field-code LF29-30). The fishery near Ilulissat (field-code LG28) is mixtures of gillnet and longline carried out all year around. From

this small fishing ground (140 km^2) over 4,000 tons was landed in 1997. The fishery in Torssukattâk 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 increased from about 2,300 tons in 1987 to about 6,600 tons in 1992. In 1993 and 1994 the catches decreased to 5,200 ton, however, in 1998 catches once again reached a historic high levels of 8,601 tons. Fig. 2 and Table 1). Longline catches comprised 66% in 1996 and 61% 1997.

Uummannaq

Uummannaq area is a large system of icefjords where fishery is conducted. The main fishing ground is in the southwestern part of the fjord system. Beforehand Qaraq Icefjord was the main fishing area but in recent years the fishery have moved further north to Sermilik (field-code LZ29) and Itividup Ice fjords (field-code MA28-MB25) (Fig. 1). Use of gillnets is prohibited in the inner parts of the fjords in Uummannaq.

The catches at Uummannaq were stable at about 3,000 tons in the period 1987 to 1992. In 1993 and 1994 the catches increased to 4,000 tons and peaked in 1995 with 7,200 tons (Fig. 2 and Table 1). In 1997 the catch was 6,293 tons. The longline catches comprised 70% in 1996 and 76% in 1997.

Upernavik

The northernmost area consists of a large number of ice fjords. The main fishing grounds are Upernavik Ice fjord (field-code MT & V 8-13) -and Giesecke Ice fjord (field-code ND8). 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). In 1996 and 1997 the total catch was almost 5,000 tons.

3. Input data

3.1 Research Fishery

3.1.1 Longline surveys

Before 1993 various longline exploratory fisheries with research vessels were conducted. Due to different 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.

In July 1997 the research longline vessel 'Adolf Jensen' covered the fjord areas of Disko Bay. Upernavik was also to be covered but due to technical problems this area was cancelled. In Disko Bay a total of 25 longline settings, with a total of 37025 hooks were performed. Eleven longline were set in the Torssukatak and 14 in the Ilulissat area. Mean CPUE values and length for Greenland halibut in the different areas are shown in Table 2 and 3.

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 (Engelstoft and Jørgensen 1998).

3.2 Commercial fishery data.

3.2.1 Analysis of size distribution in landings.

When sold commercial landings of Greenland halibut are separated in price-classes based on weight. Fish between 0.8 and 3.3 kg are here referred to as 'small fish', while fish above 3.3 kg are referred to as 'large fish'. In order to examine changes in commercial catch compositions, the proportion of 'large fish' in longline landings was analysed for the years 1991 to 1997 (Fig. 5). It should be noted that change in size-class was made in 1996 as fish above 3.5 kg formerly was classified as large. Competition between the fishing industry in Upernavik in 1997 have resulted in different definitions of large fish as one company is settings the limit at 3.0 kg and the other at the official 3.3 kg. The figures shown are not corrected for these errors why data should be interpreted carefully.

Random sampling of commercial gillnet and longline landings was carried out in the three main areas in February/Marts and July/August in order to obtain length distributions in the catches (Fig. 6). Bias in sampling from commercial landings especially in wintertime is likely. Fish in the category "small" are often discarded in the longline winter-fishery where transportation take place by dog sledges (because of their limited carrying capacity). The discard seems to be largest in the winter-fishery in Disko Bay. A investigation of the extent of the discard is planned for the winter 1999.

3.2.2 Estimation of fishing mortality.

In order to estimate the level of fishing mortality, catch-curve analyses were performed. Total mortailty, Z-values were obtained from catch-curves based on catch composition in longlines catches in each of the three areas and for summer / winter. Age groups 10-14 were used for the linear regressions for all samples. 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 to 0.15.

3.2.3 Yield per recruit analysis.

A Yield per recruit analysis was performed for each area. An average of mean weight-at-age and exploitation pattern for the period 1993 to 1997 was used in Ilulissat and Uummannaq. In Upernavik data was only available for the period 1994 to 1997. Missing weight-at-age data were estimated by age-weight regressions. Calculations were performed on single recruits in each area.

3.2.4 Catch-at-age data.

Catch-at-age for the three inshore areas were based on sampling from the commercial fishery covering area, gear and season (Tables 6, 7 & 8). Calculations of catch-at-age data for 1988 to 1990 are described in Boje (1991), for 1991 to 1994 in (Bech 1995) and for 1995-97 in (Simonsen and Boje 1997)

Ageing has not been consistent this year due to shift in personal analysing the otoliths Age data from 1997 was compared to 1996 (Fig. 7). In 1997 the smaller fish were aged younger and the bigger fish aged older. This has had serious effect on the length at age and weight at age data and thus, the conversion of length distribution to age distribution in the Greenland halibut stock. Therefore, using the assumption that growth have not changed significant in the last 3 years and that variation from year to year more is caused by the age reader than by growth difference, data were combined for the last 3 years by area. Thereby the "age-reader effect" has been smoothed out. Catch at age using the 1997 age-length key is shown in appendix 1.

3.3 Recruitment data.

A recruitment index was provided from the Greenland trawl survey (Engelstoft and Jørgensen 1998).

By use of the Petersen-method ages 1, 2 and 3 were separated from catches taken during the period 1988 to 1997. Catches of age 1, age 2 and age 3+ were standardised as catch in number per hour as described in (Bech 1995). Data were plotted as year classes to visualise the relative year-class strength (Fig. 9).

Spawning stock biomass (SSB) was calculated for the years 1988 to 1995 by assuming knife-edge maturity ogive, using catch in numbers in Div. 1C and D of ages 10 to 18 in the joint Japan/Greenland survey as an index for spawning biomass. SSB for 1996 is not available due to lack of survey this year. A stock-recruitment plot based on the standardised CPUE-values for the year class one for the privous years is shown in figure 10

3.4 Biological data.

Inshore tagging of Greenland halibut was continued in 1997. No recaptures have so far been recorded of fish tagged in the fjords in Div. 1A outside the tagging area (unpublished data).

Observation of sexual maturity of Greenland halibut was done by visual assessment of the gonad. Definition of sexual maturity was done according to table 5, from (Riget and Boje 1989). In August up to 10 fish in each cm group were examined (Fig. 8). The results showed that: MALE STAGE 1 was dominating (>90%) and hardly any mature males was observed in any of the three areas. FEMALE STAGE 1 was most pronounced in Disko Bay (67%) while the ratio between STAGE 1 and 2 in Uummannaq and Upernavik was almost identical. Although only accounting a small part of the population a tendency of increasing STAGE 3 fish going north was observed. In Upernavik 2 female fish in the post-spawning stage were observed. A study on the maturity covering the entire year was iniated in Marts 1998. This study will hopefully clearfy the extend of the inshore spawning.

4. Assessment

4.1 Long line survey results.

When comparing the mean length recorded in the surveys since the 1960 's a decline in length with time is evident (Table 3). However, looking at the surveys in the period 1993 to 1997 a statistical significant decline is not evident (Fig. 4) -for Ilulissat mean-length is stable; in Torssukatak the mean-length is fluctuating but seems stable; in Uummannaq a weak increase in mean length is observed while a decline is seen in Upernavik.

As for mean length the values obtained in the surveys since the 1960's is considerable higher that the CPUE found at the surveys in the nineties (Table 3). A comparison of CPUE in the specific areas (by ANOVA) was done in 1997 (Simonsen and Boje 1997). The CPUE figure obtained in last year's survey do not change the outcome of this statistical test. Thus, the only area that has shown a significant decrease in CPUE is Upernavik (only two surveys have been carried out in this area).

4.2 Estimation of fishing mortality

Fishing mortality was estimated by means of catch-curves (Table 5). F values at Disko Bay were found to be F_{1997} of 0.73; at Uummannaq F_{1997} of 0.45 and at Upernavik F_{1997} of 0.20.

The F values estimates in 1997 are higher than 1996 but general lower than in the values obtained in the beginning of the nineties. This disagrees with information from the fishery, which indicate an increased effort. The reason for the "noisy F" values may bee that the fishery is exploiting different age-components in the different seasons and different localities, why the basis for a catch-curve analysis may be violated. Ageing problems may also causes problems in estimating F (see section 3.2.4). An attempt to describe the trend in fishing mortality is shown in figure 9. Here the relative F for the total catch in numbers (gillnet and longline) is shown for each area. A significant ($P<0.05$) increase in F was found for all tree areas.

4.3 Biological reference points.

Y/R analyses performed for each area using long-term averages of mean weight-at-age and exploitation pattern 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 0.252
As the F_{1997} was estimated to 0.73. The exploitation of the inshore stock in Disko Bay is beyond F_{max}.

At Uummannaq $F_{0.1}$ was estimated to 0.22 F_{max} to 0.42.
As the F_{1997} was estimated to 0,45. The exploitation of the inshore stock in Uummananq is beyond F_{max}.

At Upernavik $F_{0.1}$ was estimated to 0.26 F_{max} was 0.49
As the F_{1997} was estimated to 0.20. The exploitation of the inshore stock in Upernavik is around $F_{0.1}$.

4.4 Analysis of size distribution in landings.

Generally there was a trend toward a decline in the category 'large fish' in the landings for the different fishing grounds (Fig. 5). However, the decline was only significant significant for the Uummannaq area. For the period 1995 to 97 an increase was observed. Whether this reflects the change in the weight-class categories (se section 3.21), a increase in discard of small fish or an actual increase in number of large fish is unknown.

Samples from the commercial longline landings in the period 1993 to Marts 1998 in Disko Bay, Uummannaq and Upernavik showed (Fig. 6): *Disko Bay*, a difference between summer and winter catches, an overall positive trend (b=1.21) in mean length with time (not significant); *Ummannaq*, a difference between summer and winter catches, an overall *negative trend* (b=-0,64) in mean length with time (not significant); *Upernavik*, a difference between summer and winter catches, an overall negative trend (b=-1,51) in mean length with time (not significant).

4.5 Age compositions in landings.

The age compositions in the landings in a given year are shown in figure 12. A still greater percentage of the catches constitute of younger fish indicating that the stock composition is changing towards fewer and younger age groups.

4.5 Recruitment.

Recruitment has fluctuated in the period investigated (Fig. 10). Offshore the numbers of one year old from the 1996 yearclass was below average (130.9 spec./hour). The 1995 year-class that appeared very strong as one year old had declined in strength as the the numbers of two years old were not above average (72.5 spec./hour) Inshore recruitment in 1996 also seemed to be below average (215 spec./ hour). Inshore the numbers of 2 years from 1995 year-class was still the highest in the times series (Fig. 10).

Estimates of by-catch in the shrimp fishery suggest that up to 2.449 specimens of small Greenland halibut is caught pr kg shrimp in Disko Bay (Jørgensen and Carlsson 1998).This area is also known to be a nursery ground for Gr. Halibut (Bech 1995). Length frequencies of the by-catch have modes around 13 and 17 cm corresponding to 1 and 2 years old fish respectively (Smidt 1969). Thus, indicating that the shrimp fishery introduce a higher mortality on small Gr. halibut and thus probably have an negative effect on the recruitment to the inshore stock component.

The standardised CPUE-values for age 1 from the Greenland trawl survey is plotted against SSB at spawning time (Fig.11).

5. State of the stock components.

Disko Bay (Ilulissat).

Catches have been increasing continuously in the past 10 years from about 2,000 t to 8,601 t. in 1997 The catch was thus not kept at a stable level as recommended in 1997.

Catch composition has not undergone dramatic changes in recent years. Survey results since 1993 do not indicate any major changes in total abundance or catch composition. Yield per recruit analysis and estimation of present fishing mortality suggests a F level above F_{max}. The stock component in Disko Bay is composed of younger and smaller individuals compared to the two other areas but do not appear to be by the increasing fishery affected in latest years. Whether this is

due to influx of strong year-classes or due to redistribution of the stock/fishery is unknown.

The lack of information of effort from commercial fishery and the high exploitation level (which is limited to very small areas), may lead to adoption of a cautious harvest strategy for the stock component in order to prevent the stock from being further growth overfished.

Uummannaq

Catches have been increasing from a level of 2,000 t before 1987 to about 3,000 t in the period 1987-1992 and further to a record high in 1995 of 7,000 t The catch in 1997 was 6294 t, an increase of 37% compared to 1996. Thus, it was not kept at a stable level as recommended in 1997.

Catch composition has changed significant since the 1980's towards a higher exploitation of younger age-groups, thus Indicating growth overfishing. Survey results since 1993 suggest a minor increase in total abundance. Yield per recruit analysis and estimation of present fishing mortality suggests a F level above F_{max}. Catch composition in the commercial fishery shows a significant downward trend in size. The stock component in Uunmannaq is thus affected by the increasing fishery and still younger age groups are exploited.

The lack of information of effort from commercial fishery may lead to adoption of a cautious harvest strategy for the stock component in order to prevent the stock from being further growth overfished.

Upernavik

The fishery for Greenland halibut in Upernavik began in 1986 and the stock component are therefore assumed a virgin stock before 1986.Catches have been increasing from a level of 1,000 t before 1992 to about 5,000 t. in recent years. Catch composition has changed continuously in the period exploiting still younger age-groups. Survey results in 1994 and 1995 suggest a decrease in total abundance and a decrease in mean length in catch composition. Yield per recruit analysis and estimation of present fishing mortality suggests a exploitation level around $F_{0.1}$ The stock component in Upernavik however, seems to be affected by the increasing fishery as the stock composition is going go towards still younger age groups.

The lack of information of effort from commercial fishery may lead to adoption of a cautious harvest strategy for the stock component in order to prevent the stock from being growth.

5.1 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 moralities estimated from catch curves should be interpreted very carefully. The inshore fishery does, contrary to offshore fishery, takes place on smaller sub-components dependent on season and locality within each of the 3 assessed areas. This may be an explanation for the high variation in calculated Z values from single samples. Secondly, change in the age-reading personnel is assumed to have lead to a change in perception of the otoliths.

The inshore stock is exclusively dependent on recruitment from the offshore nursery grounds and the spawning stock in Davis Strait. Only sporadic spawning occurs 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 the inshore stock component.

Measurments of effort in the fishery should be provided. This would make it possible to obtain other estimates of Z from the commercial fishery, such as catch-rate-at-age. Furthermore, trends in effort could be compared to trends in F. At the moment the Greenland Institute of Natural Resources and Greenland Fisheries Licence Authority has commenced work to introduce logbooks for parts of the inshore Greenland halibut fishery. Therefore effort-values hopefully will be available in the future.

6. References.

Bech, G. (1995). "An assessment of the inshore Greenland halibut stock component in NAFO Divisions 1A." NAFO Scr.Doc. N2582.

Bech, G. (1995). "Recruitment of Greenland halibut at West Greenalnd." NAFO Scr.Doc. N2526.

Boje, J. (1991). "An assessment of the Greenland halibut stock component in NAFO Subareas 0+1." NAFO Scr.Doc. 94/59(No. N2430).

Boje, J. (1994). "Migrations of Greenland halibut in Nirthwest Atlantic based on tagging experiments in Greenland waters 1986-92." NAFO Scr.Doc. 94/18(N2383).

Engelstoft, J. J. and O. A. Jørgensen (1998). "Biomass and abundance of dermersal fish stocks off West-Greenland estimated from the Greenland trawl survey 1988-1997." NAFO Scr.Doc. 98/40(N3028).

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 Sc.Working Paper 94/42(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. and J. Boje (1997). "An assessment of the inshore Greenland halibut stock component in NAFO Division 1A." NAFO Scr.Doc. 97/78 (N2915).

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

Table 1. Landings and Greenland halibut (tons) in Div. 1A distributed on the main fishing grounds: Disko Bay. Uummannaq and Upernavik. (A faktor of 1.05 is used to convert gutted fish weight to whole fish weight).

Area/year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Disko Bay	2258	2670	2781	3821	5372	6577	5367	5201	7400	7837	8601
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234	4579	6294
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	2403	4846	4879
Unknown	407	636	599	507	17	133					
Total in 1A	7196	7003	7492	8352	9929	11933	13088	14049	17037	17262	19774

Table 2. CPUE values (kg/100 hooks) from longline surveys conducted in Div.1A inshore areas.

Area/year	1962	1985	1986	1987	1993	1994	1995	1996	1997
Disko bay	-	-	8.3	16.5	3.1	3.1	-	3.9	4.4
Uummannaq	4.6	13.7	-	8.6	2.8	-	6.6	4.5	-
Upernavik	-	-	-	-	-	5.2	3.9	-	-

Table 3. Mean length (cm) from catches taken in inshore longline surveys.

Area/year	1962	1985	1986	1987	1993	1994	1995	1996	1997
Disko bay	-	62.4	53.5	62.2	55.9	56.5	-	53.6	57.0
Uummannaq	67.8	70.5	-	61.8	57.5	-	57.8	59.5	-
Upernavik	-	-	-	-	-	64.6	60.8	-	-

Table 4. Estimates of fishing mortality (F) from catch curve analysis on commercial samples from 1987 to 1996.

Area/year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Disko Bay	0.42	0.16	0.24	0.51	0.4	0.45	0.51	0.8	0.54	0.44	0.73
Uummannaq	1.09	1.01	1.01	0.88			1.2	0.98	1.31	0.25	0.45
Upernavik		0.35	0.41	0.48			0.42	0.58	0.43	0	0.20

Table 5. Descriptive stage of maturity used for visual analyses of Greenland halibut gonads.

Maturity stage	Physiologiacl stage of gonads	
	Fenale	**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 6. Catch at age of Greenland halibut in 1988-1996 in Disko Bay area.

	Catch in numbers (thousands)									
age/year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
4	0	0	0	5	34	7	0	0	0	0
5	0	0	0	5	92	15	3	0	8	0
6	1	0	0	11	122	62	15	0	1	21
7	9	0	1	279	332	280	112	45	47	132
8	59	14	24	806	476	479	281	459	323	646
9	182	106	141	535	390	339	539	639	941	1113
10	173	121	185	333	451	280	396	798	651	1168
11	132	94	188	238	532	240	190	463	454	607
12	73	49	126	76	309	122	91	185	273	185
13	63	33	80	45	140	91	50	127	145	69
14	65	39	59	67	92	112	45	27	75	19
15	38	31	42	57	18	75	41	36	44	10
16	18	19	23	35	0	57	21	12	31	3
17	11	14	15	7	0	12	10	15	5	2
18	4	8	6	2	0	10	1	0	33	1
19	0	0	0	0	0	7	3	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	1	0	0	0
Total	828	528	890	2501	2988	2188	1799	2806	3031	3976

Table 7. Catch at age of Greenland halibut in Uummannaq area in 1988-1996.
-indicates insufficient sampling.

	Catch in numbers (thousands)									
Age/year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
4	0	0	0	-	-	0	0	0	1	0
5	0	0	0	-	-	0	0	0	0	0
6	1	0	1	-	-	9	24	6	6	0
7	5	2	3	-	-	45	105	217	76	69
8	20	9	15	-	-	200	226	564	308	377
9	52	35	47	-	-	202	271	601	279	793
10	121	98	108	-	-	142	346	413	286	702
11	143	120	121	-	-	138	139	414	232	460
12	121	99	101	-	-	104	105	219	142	206
13	96	76	82	-	-	158	34	138	69	75
14	49	38	42	-	-	93	12	49	28	32
15	23	19	20	-	-	28	0	28	11	10
16	13	14	15	-	-	19	0	17	1	3
17	4	6	6	-	-	0	2	4	14	3
18	0	0	0	-	-	0	0	0	0	0
19	0	0	0	-	-	0	0	1	0	0
20	0	0	0	-	-	1	0	0	0	0
21	0	0	0	-	-	0	0	0	0	0
22	0	0	0	-	-	0	1	0	0	0
Total	**648**	**516**	**561**	**-**	**-**	**1139**	**1265**	**2671**	**1453**	**2732**

Table 8. Catch at age of Greenland halibut in Upernavik area 1988-1996.
- indicates insufficient sampling.

	Catch in numbers (thousands)									
age/year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
5	0	0	0	-	-	0	0	0	3	4
6	0	0	0	-	-	0	2	0	0	25
7	0	0	0	-	-	0	51	13	16	142
8	6	2	2	-	-	2	188	55	114	428
9	33	16	17	-	-	16	316	84	359	500
10	55	34	41	-	-	86	217	128	275	430
11	80	59	62	-	-	252	239	133	238	278
12	74	66	57	-	-	268	154	147	206	175
13	68	69	52	-	-	143	155	117	151	67
14	62	73	48	-	-	95	51	103	90	37
15	31	40	25	-	-	40	23	45	48	19
16	13	18	11	-	-	29	0	28	26	7
17	7	10	5	-	-	10	0	8	4	1
18	2	3	1	-	-	5	0	3	9	0
19	0	0	0	-	-	1	0	1	0	0
20	0	0	0	-	-	1	0	2	0	0
21	0	0	0	-	-	0	0	0	0	0
Total	431	390	321	-	-	948	1396	867	1539	2111

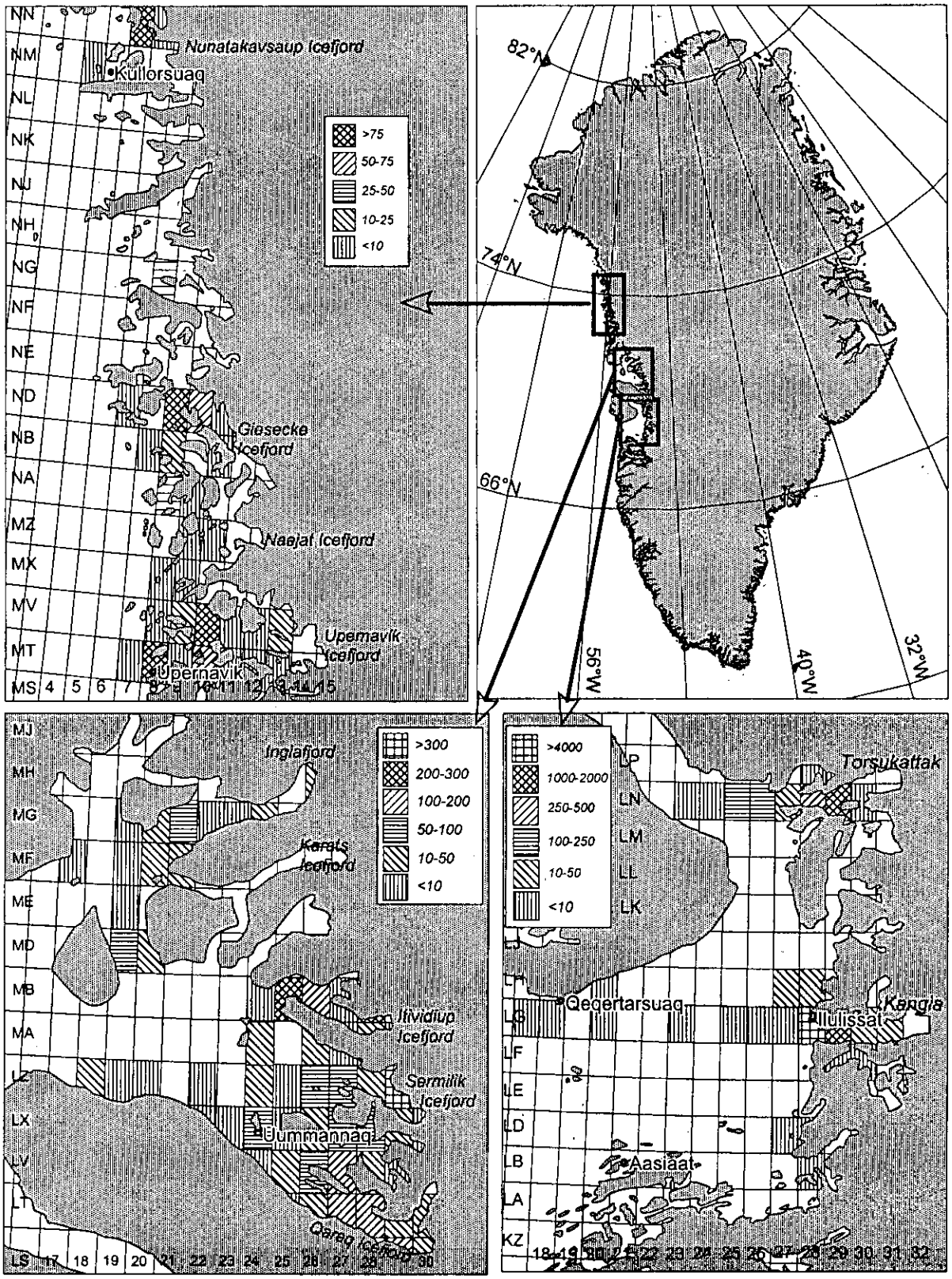


Figure 1.
Location of main inshore fishing grounds for Greenland halibut in Div.1A. Catch in tons per field-code is shown as hatching.
Please note that field-code information is only avaible for about 20 % of the fishery in Upernavik.

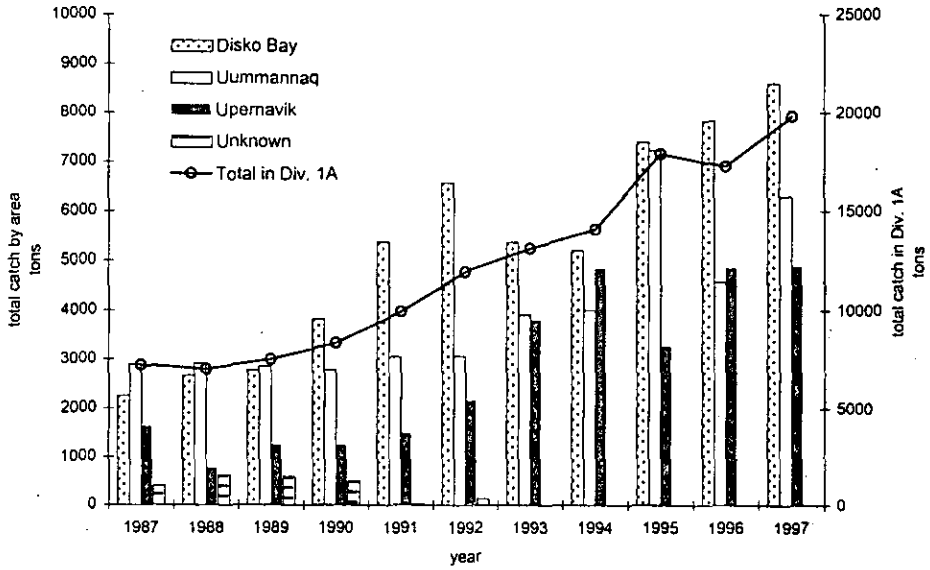


Figure 2.
Landings in NAFO Div. 1A in the period 1987-1996 for the tre main fishing areas.

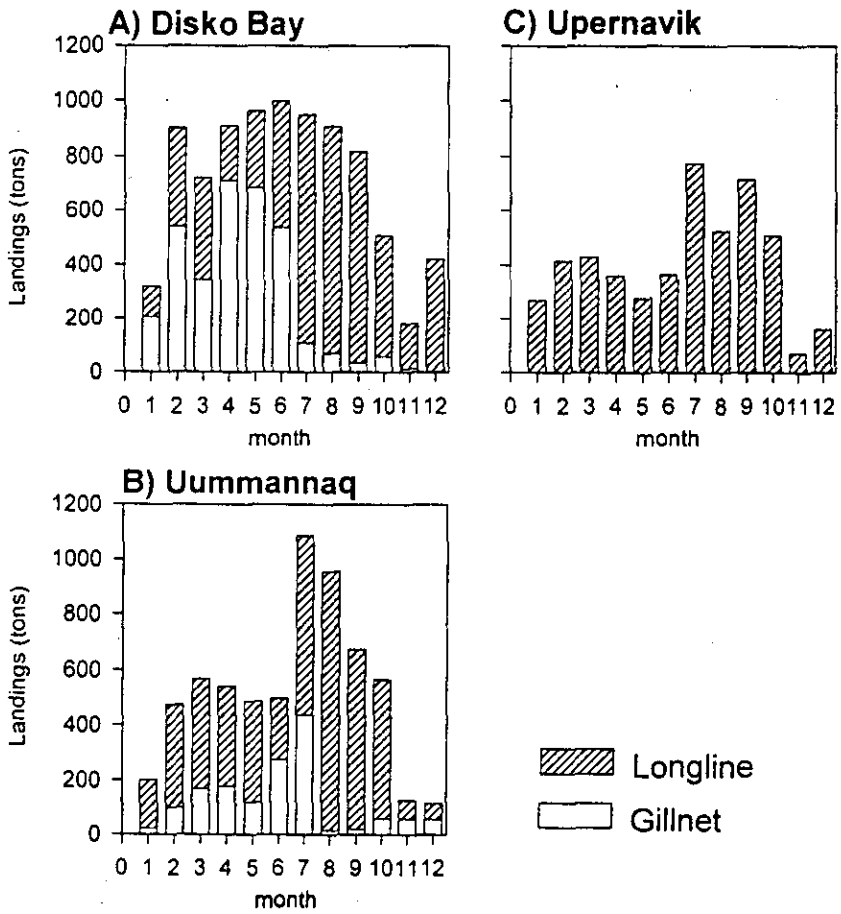


Figure 3
Landings in NAFO Div.1A in 1996 allocated on area, gear and month.

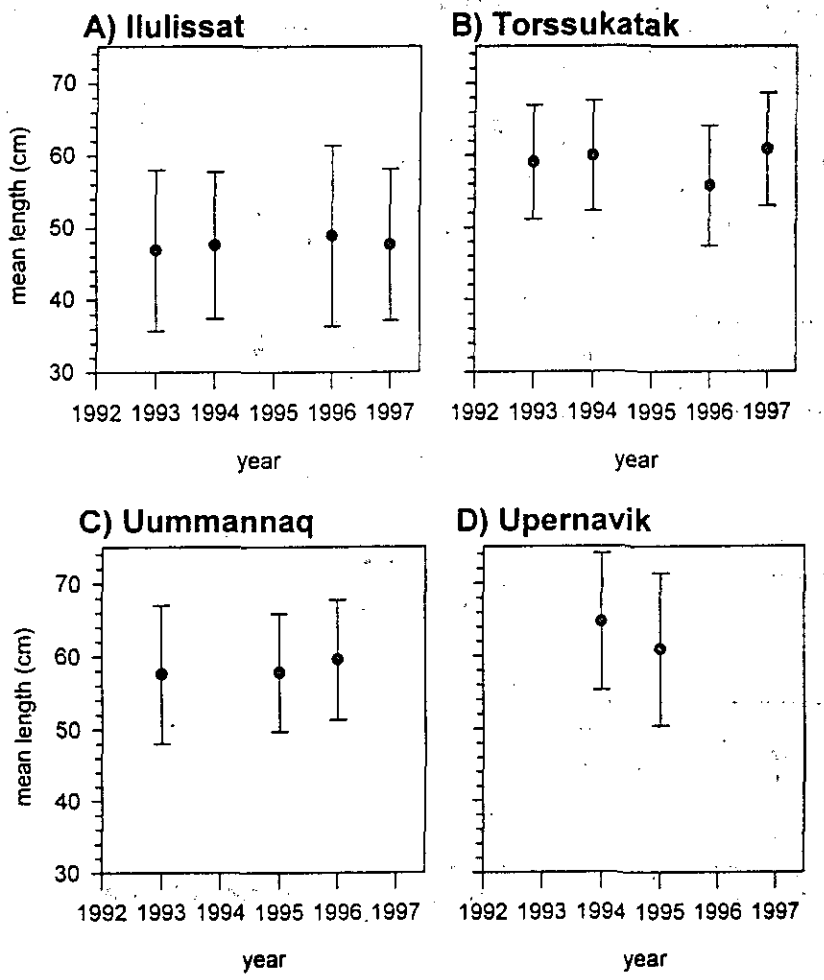


Figure 4
Mean length for research longline surveys 1993-97. +/- S.D

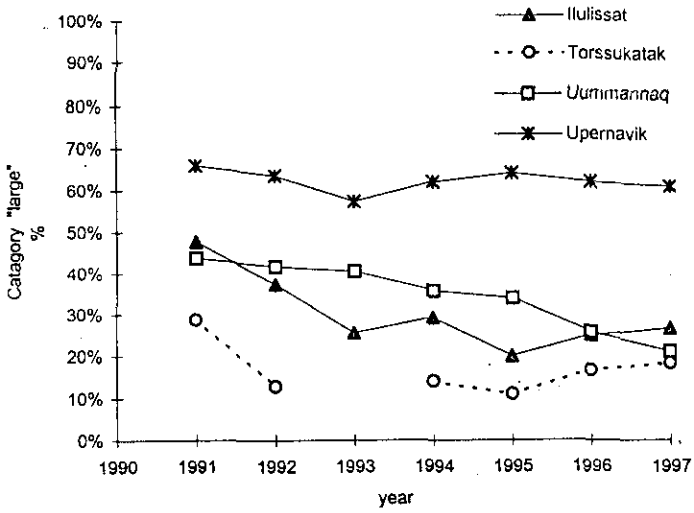


Figure 5
Respective proportion of catagory 'large fish' (see text for complete describtion) in the Disko Bay (div. in Ilulissat and Torssukatak), Uummannaq and Upernavik. Note that the *definition* of "large fish" was change in 1996 to 3.0 kg (formely 3.3 kg)

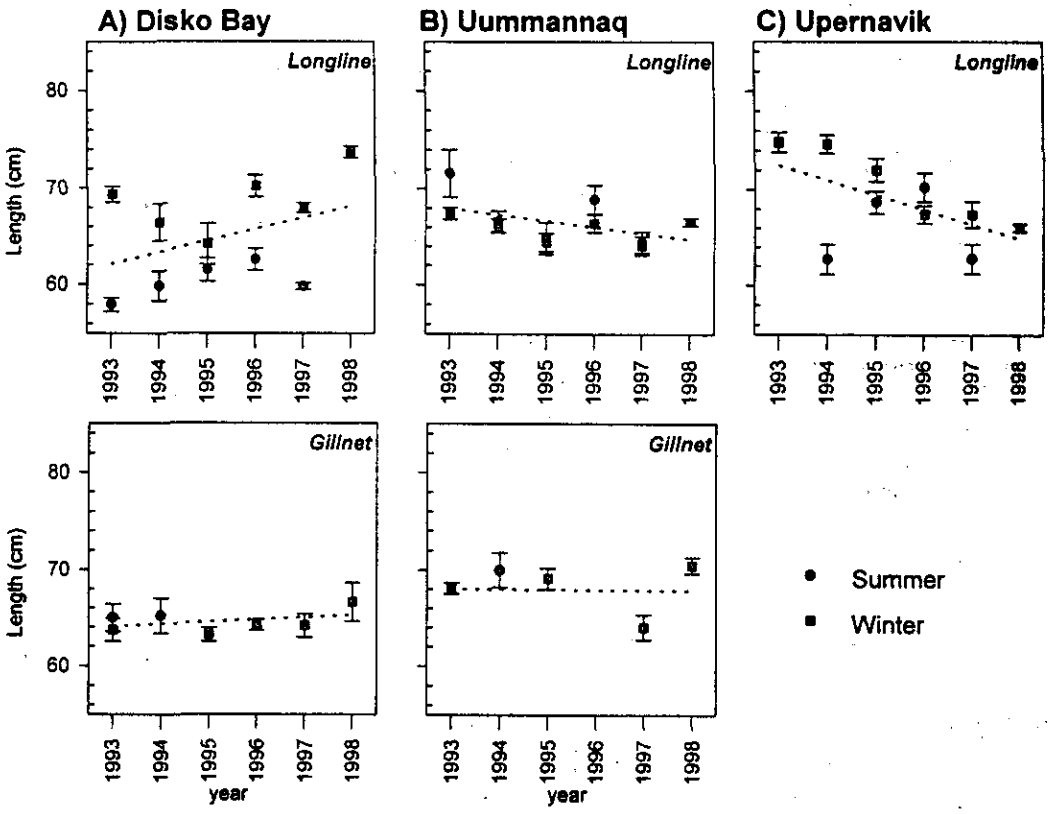


Figure 6
Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik +/- 95% conf.
Please note that some of the figure presented in 1997 (Simonsen and Boje 1997) where not weighted, this mistake has been corrected in this figure.

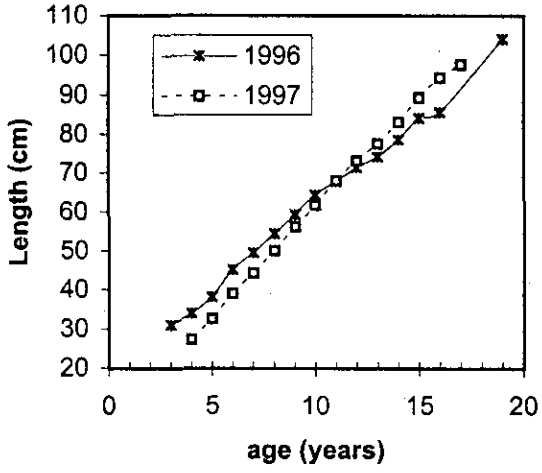


Figure 7
Mean length at age for Greenland halibut in Disko Bay. The age–length is comparede for 1996 and 1997.

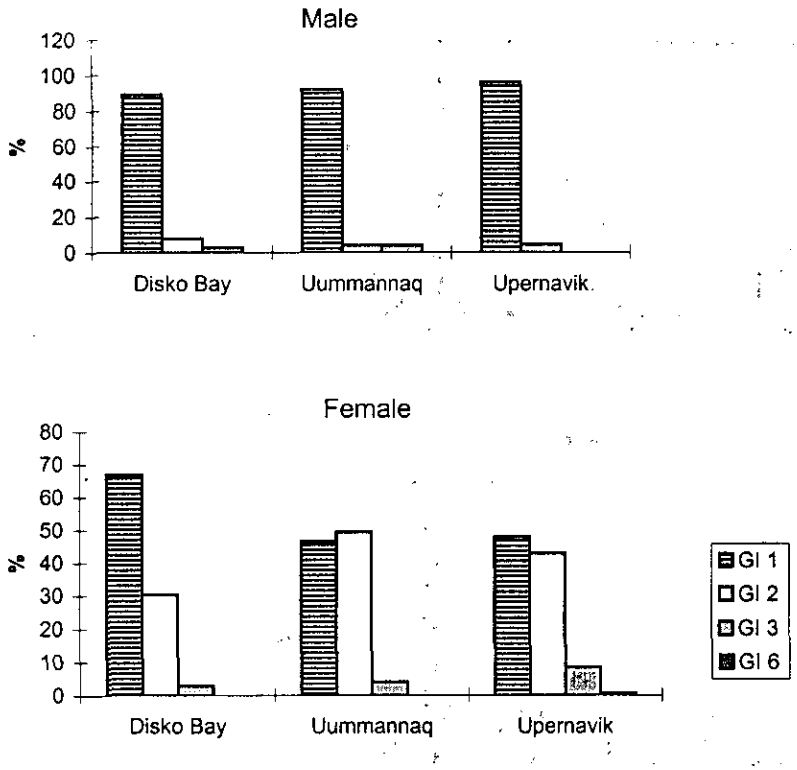


Figure 8
Sexual maturity of Greenland halibut by visual assessment of the gonad (see table 5).

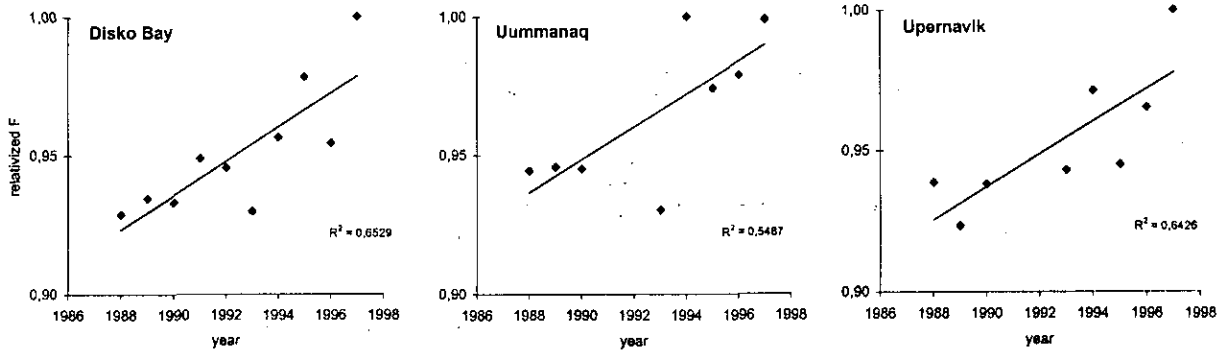
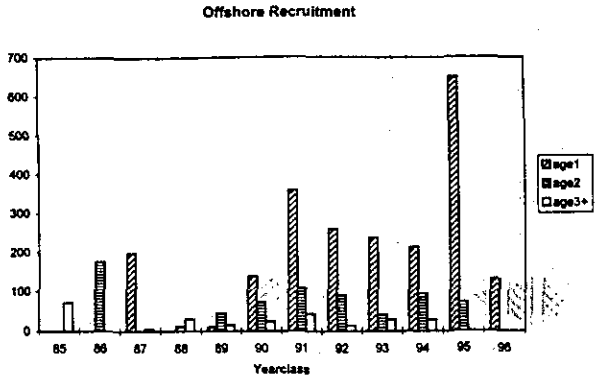


Figure 9
The relative F for the total catch in numbers (gillnet and longline) is shown for each area (age 10-14). Figure 10

A)



B)

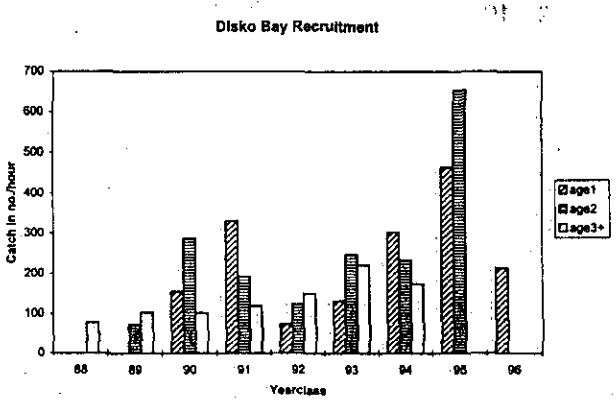
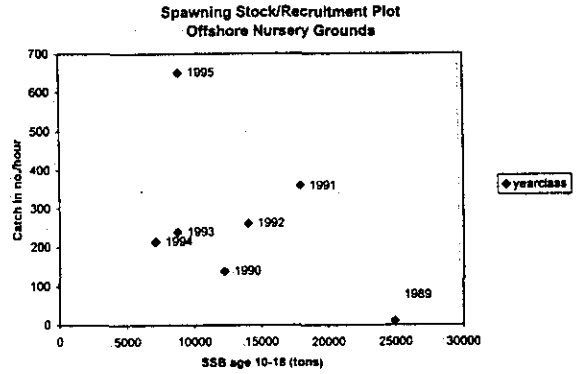


Figure 10
Year-class strength of recruits plotted as catch in numbers per hour, standardized index. The respective year-classes can be followed to age 3 in data from Greenland trawl survey. Mising values are due to missing observations.
A) Offshore area
B Disko Bay area

A)



B)

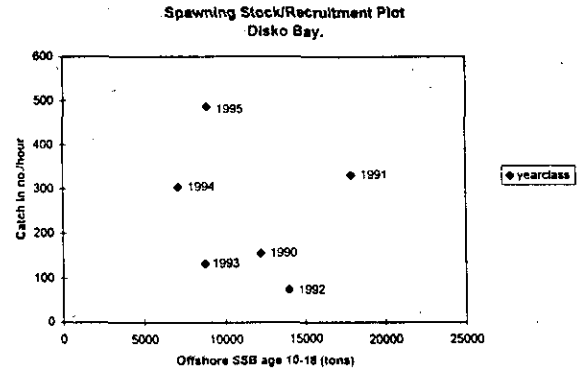


Figure 11
Stock-recruitment plot from the inshore nursery grounds. Yearclasses are plotted as standardized indices to the offshore spawning stock biomass, estimated for their respective year of spawning.
A) Offshore area
B Disko Bay area

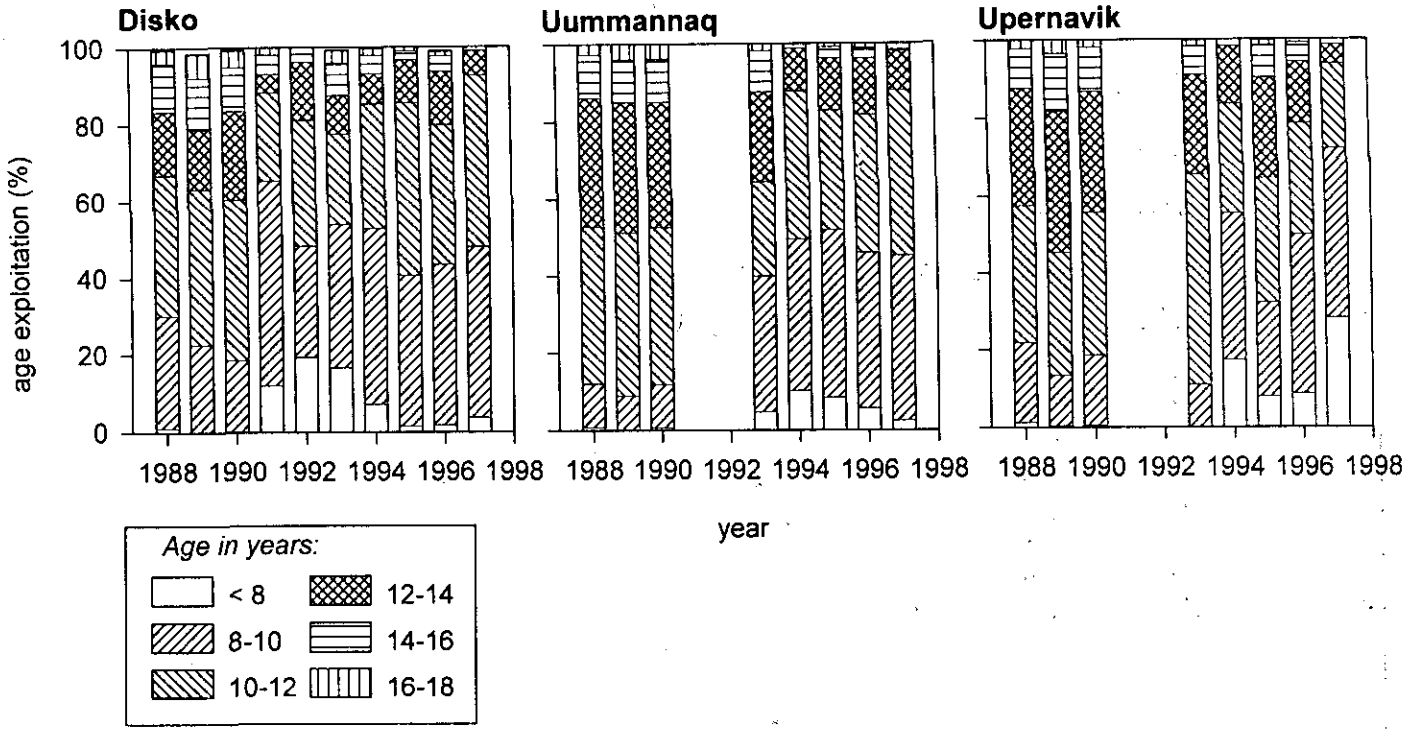


Figure 12
The development in exploitation of the different age groups expressed as percentages for each year.

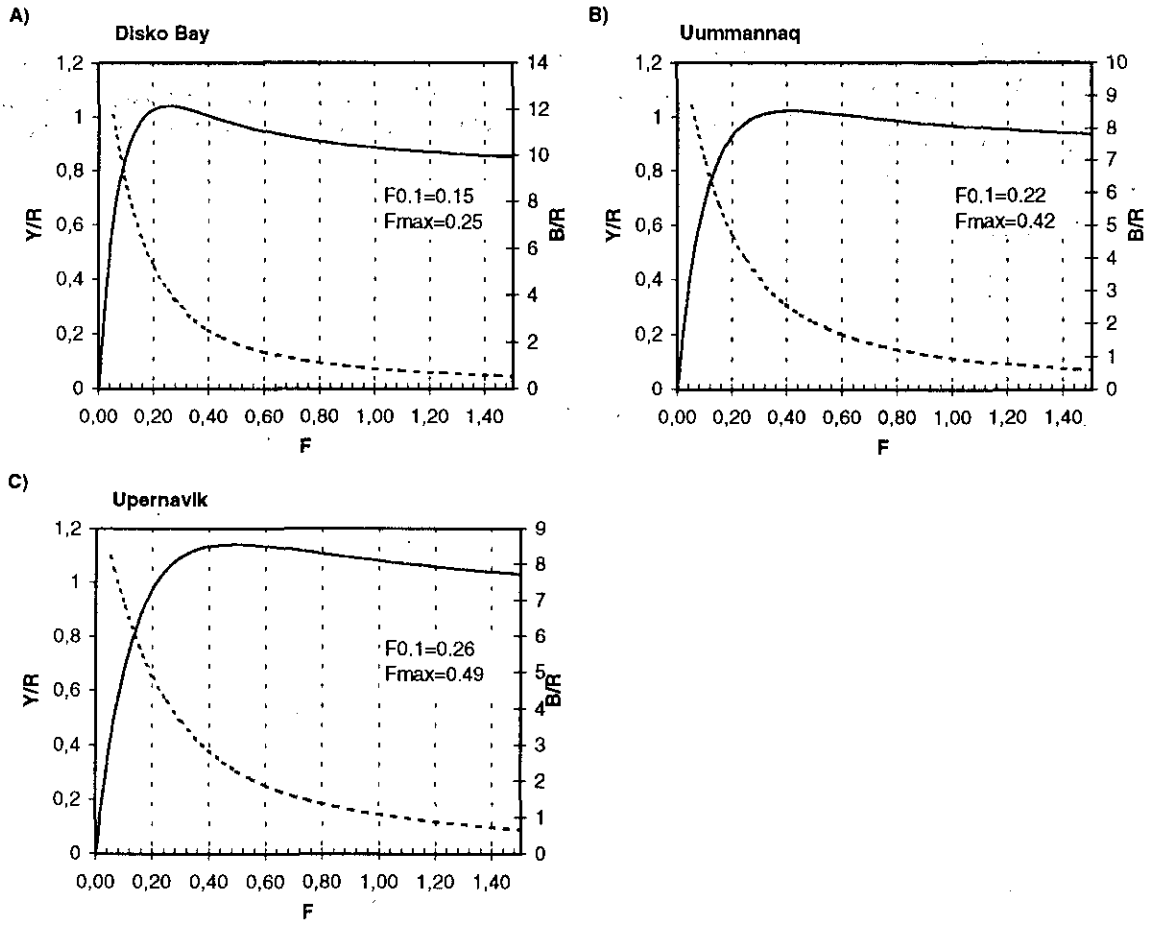


Figure 13
A) Yield per Recruit and Spawning Stock biomass per Recruit curve in the Disko Bay area.
B) Yield per Recruit and Spawning Stock biomass per Recruit curve in the Uumannaq area.
C) Yield per Recruit and Spawning Stock biomass per Recruit curve in the Upernavik area.

Appendix:

Figures using the 1997 age-length key:

Catch in numbers in 1997

	Catch in numbers (Thousand)		
Age	Disko Bay	Ummanaq	Upernavik
5	0	0	0
6	4	0	0
7	242	0	20
8	698	160	346
9	1208	658	628
10	1313	886	587
11	648	698	373
12	159	167	161
13	25	59	58
14	13	20	23
15	9	5	11
16	2	1	2
17	2	1	0
Total	4322	2653	2209

Fishing mortality obtained from catch-curves based on catch composition in longlines catches in each of the three areas and for summer / winter. Age-groups 10-14 were used for the linear regressions for all samples. 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 mortaity M was set to 0.15.

Area	F
Upernavik	0.41
Uumannaq	0.60
Disko bay	1.07