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An assessment of the inshore Greenland halibut stock component in NAFO Division 1A

by

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1. Introduction

The Greenland halibut stock component in Div. 1A 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 & 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 17,262 tons in 1996, comprising 98.74 % 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 and have reached a level around 18,00 tons in recent years (Fig. 2 and Table 1). In 1996 catches were rather even distributed over the year but with a tendency toward higher catches around August (Fig.3 and Table 2).
The fishery is traditionally performed with longlines from small open boats below 20 GRT, or by means of dog sledges, typically 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. 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 1998. Gillnet fishery in 1996 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 comprised 73% in 1994, 76% in 1995 and 74% in 1996. The catches allocated on gear throughout the year are shown in figure 3 and Table 2.
The landings 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.

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). Use of gillnets is prohibited in the innermost part of the ice fjords.
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 1995 and 1996 catches reached historic high levels, 7,400 tons in 1995 and 7,837 tons in 1996 (Fig. 2 and Table 1). Longline catches comprised 66% both in 1995 and 1996.

Uummannaq

Uummannaq area is a large system of icefjords where fishery is conducted. The main fishing ground is in the southernmost fjord, Qarajaq Ice fjord (Fig. 1). Use of gillnets is prohibited in the inner parts of the fjords.
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 1996 the catches had declined from the high level in 1995 to 4,579 tons. *Tthe longline catches comprised* 76% in 1995 and 70% in 1996.

Upernavik

The northernmost area consist of a large number of ice fjords. The main fishing grounds are Upernavik Ice fjord, Naajaat and Gieseckes Ice fjord, all north of Upernavik town (Fig. 1). Use of gillnets is prohibited.
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 the total catch was 4,846 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-August 1996 the research longline vessel 'Adolf Jensen' covered the fjord areas of Disko Bay and Uummannaq. A total of 56 longline settings with 71614 hooks were performed. Mean CPUE values and length for Greenland halibut in the different areas are shown in Table 3 and 4. A comparison between CPUE values in the period 1993-96 in the specific areas was done by an analyse of variance (ANOVA) The natural logarithm to CPUE was used as input and the discrete variables year, field-area code and depth was used in a main-effects model. In this analyse the Disko Bay was divided in the two areas Ilulissat and Torssukatak as they can be consider to be separate fishing grounds.

3.1.2 Trawl surveys

The survey is a stratified random designed survey conducted annually from 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, 1997).

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 commercial landings was analysed for the years 1990 to 1996 (Fig. 6). It should be noted that a change in size-class have been made in 1996 as fish above 3.5 kg formerly was classified as large. No attempt was made to correct for the change in weight for the 'large fish'.

Random sampling of commercial gillnet and longline landings was carried out in the three main areas in February/Marts and again in August in order to get length distributions (Fig. 7).

3.2.2 Estimation of fishing mortality.

In order to estimate the level of fishing mortality, catch-curve analyses were performed. Z-values were obtained from catch-curves of single samples considered representative for catch composition of longlines within an area and for a season. 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.

In Disko Bay age-length keys for 1993, 1994, 1995 and 1996 were available. The 1993 age-length key was used on the years 1987 to 1992. No data were available for winter 1991 and summer 1992.

In Uummannaq age-length keys were available for 1993, 1994, 1995 and 1996. The 1993 age-length key was used on the years 1990 to 1988. No data were available for 1991, 1992 and summer 1989.

In Upernavik age-length keys were available for the years 1994 and 1995. As the 1995 age-length key was considered most representative, it was used on the years 1993 and 1990 to 1988. No data were available for 1991, 1992, summer 1993 and winter 1988. In 1996 the age length key from Uumannaq was allocated to Upernavik.

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 1996 was used in Ilulissat and Uummannaq. In Upernavik data was only available for the period 1994 to 1996. Missing weight-at-age data were estimated by age-weight regressions. Calculations were performed on single recruits in each area. M was set to 0.15.

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, and calculations for 1991 to 1994 are described in Bech, 1995. Due to insufficient sampling, gill-net data were pooled within the year at Disko Bay and Uummannaq in 1994 and 1995. Catch-at-age data for Upernavik 1993 were obtained by using the Upernavik age-length key from 1995. Catch-at-age data for 1991 were omitted because the data were considered non-representative. In 1996 age-length keys were obtained for the Disko Bay and Uummannaq area. The age-length key obtained for Uummannaq was applied to Upernavik, since no otolith sampling were carried out in this area.

3.3 Recruitment data.

A recruitment index was provided from the Greenland trawl survey (Engelstoft and Jørgensen, 1997).

By use of the Petersen-method ages 1, 2 and 3 were separated from catches taken during the period 1988 to 1995. In 1996 the age composition was estimated from an age-length key during the survey. Catches of age 1, age 2 and age 3+ were standardized as catch in number per hour as described in Bech, 1995. Data were plotted as year classes to visualize the relative year-class strength, and allowing to follow the three first years of the respective year classes where data are available (Figs. 9 and 11).

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. A stock-recruitment plot was based on the standardized CPUE-values for the year class one (Figs. 10 and 12).

3.4 Biological data.

Inshore tagging of Greenland halibut has been continued in 1996. No recaptures have so far been recorded outside the tagging area for tagging in the fjords of Div. 1A (unpublished data). Therefore the assumption that the stock in the tree main areas are considered as separate local stocks can be maintained.

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 4). However, looking at the surveys in 1993 to 1996 no clear trend in short time is observed (Fig. 5) -for the Ilulissat area mean-length have increased; in Torssukatak the mean-length have fallen in 1996 compared to 1993 and 1995, also in Upernavik a decline is observed while the Uummannaq showed a weak increase in mean length.

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). The analyse of CPUE obtained at the standardized surveys with research vessel Adolf Jensen in the period 1993 to 1996 showed that; 1) In the Ilulissat area, no statistical significant was found for any of the parameters, however a tendency to lower CPUE with time was observed. 2) In the Torssukatak area, a significant difference between the areas investigated, but not between the years. 3) In the Ummannaq area, a tendency to increased CPUE with time was observed however, not statistical significant. 4) In the Upernavik area, a significant decrease was found between 1994 and 1995. It should be noted that residuals for all four areas showed a strong tendency to a positive correlation with CPUE. In figure 4 the CPUE (index-value using the least square means, in order to take unbalanced sampling between years into account) for the four fishing ground is shown.

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_{1996} of 0.44; at Uummannaq F_{1996} of 0.41 and at Upernavik F_{1996} of 0.0.

The F values estimates in 1996 are considerably lower than estimates of fishing mortality for the previous years. As the fishery is expected to exploit different age-components in the different seasons and different localities, the basis for a catch-curve analysis may be violated. Furthermore, the age readings may be considered unreliable due to change in perception by the otolith reader. Therefore a decrease in F was not considered to reflect the actual exploration of the stock. Previous information suggest that effort has been stable or increasing (Bech *et al*, 1996).

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 0.22 and F_{max} to 0.38. As the F_{1996} was estimated to 0.44, the exploitation of the inshore stock in Disko Bay is beyond F_{max} (Fig. 13A).

At Uummannaq $F_{0.1}$ was estimated to 0.25 and F_{max} to 0.47. The F_{1996} value was 0,25 (Fig. 13B).

At Upernavik $F_{0.1}$ was estimated to 0.19, F_{max} was 0.31 and F_{1995} was estimated to 0.0 (Fig. 13C).

4.4 Analysis of size distribution in landings.

A general trend to a decrease of the category 'large' in the landings for the different fishing grounds is observed on figure 6. However, a significant decline is only evident for the Uummannaq area. When comparing 1995 with 1996 an increase is seen for tree of the four areas, but this could be because of the change of the weight-class categories (as mentioned in 3.21).

Length measurements from the commercial longline landings in the period 1993 to 1996 in Ilulissat, Uummannaq and Upernavik did not show any clear tendency (Fig. 7). The figure indicates that the fishery are taking place on smaller sub-components of the stock as size differences is observed between summer and winter and changes in size seems to be related with season.

4.5 Age composition in landings

For all three areas a downward trend in age composition of the commercial catches was observed (Fig. 8). A linear regression showed the highest decline in the commercial landings in Uummannaq (α=-0.35 year^{-1}, P=0.004), while the trend in Upernavik (α=-0.23 year^{-1}, P=0.28) and Disko Bay (α=-0.07 year^{-1}, P=0.68) where not as evident. The age composition in the Disko Bay was the youngest in the time series.

4.6 Recruitment.

The recruitment has been declining since the presumably large 1991 year-class. The 1995 yearclass seems, however, to be the largest on record (Fig. 8). The mean catch of 1 year old fish was about 650 specimens per hour compared to about 350 for the 1991 year-class. The figure in 1996 was, however, to some extent driven by one large catch. Is this catch excluded from the calculations mean catch per hour was 467 specimens, still well above the 1991 level. Catches of one year old fish in Disko Bay was also the highest on record (Fig. 11), a large number of one year old fish were seen outside the traditional nursery area, especially north of Disko Island.

The standardized CPUE-values for age 1 from the Greenland trawl survey is plotted against SSB at spawning time (Fig. 10 & 12). Although the SSB in 1995 is the second lowest recorded the recruitment of age 1 in 1996 is the highest in the time series. As no maturity data was available, there should not be put too much effort into the interpretation of the present relationship.

4.6 State of the stock components.

Disko Bay (Ilulissat).
Catches have been increasing continuously in the past 10 years from about 2,000 t to about 8,000 t. However, 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 suggest 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 apear to be affected in latest years by the increasing fishery. 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 overfishing.

Uummannag
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. In 1996 catches decreased to 4,500 t. 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 and catch composition also showed a minor increase in mean length. Yield per recruit analysis and estimation of present fishing mortality suggest a F level at about $F_{0.1}$. The stock component in Uummannaq appears to be affected by the increasing fishery in respect to abundance and stock composition.
The estimated low fishing mortality is considered an underestimate, due to methodological violations as mentioned elsewhere. 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 further growth overfishing.

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 4,500 t in recent years. Catch composition has changed continuously in the period to include exploitation of younger age-groups. Survey results in 1994 and 1995 suggest a decrease in total abundance and a decrease in mean length in stock composition. Yield per recruit analysis and estimation of present fishing mortality suggest a low exploitation level with F below $F_{0.1}$. The stock component in Upernavik apears to be in relative good condition as a change in catch compositions is expected for a newly virgin component.
The estimated low fishing mortality is considered an underestimate, due to methodological violations as mentioned elsewhere. 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 risking growth overfishing.

4.7 General comments.
Maturity-at-age data were not available.

The fishing mortalities estimated from catch curves should be interpreted very carefully. The inshore fishery do, contrary to offshore fishery, takes place on smaller sub-components dependant 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. Joint NAFO/ICES activities on age validation is established on this issue and continues its work (ICES/NAFO, 1997).

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. It is unclear yet what impact the commercial shrimp fishery have on the survival on the small Greenland halibut.

The connection between the offshore and inshore stocks implies that recruitment failure in the offshore spawning stock due to high fishing mortality, will have severe implications for the recruitment to the inshore stocks.

Recruitment indices suggest that the strong year-classes 1991 and 1995 *could be* entering the fishery in the future.

A reliable dataserie on catch at age for Disko Bay is being established for the period 1985 to 1996, and attempts will be made in the future to use these data for a historic description of the stock and hopefully for catch prognoses. The lack or scarcity of tuning data impedes the work.

Measures 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.

5. References.

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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. *The last column indicates recent catch level (expressed as the mean landings during the last 3 years).*

Area/year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	*Recent catch*
Disko Bay	2258	2670	2781	3821	5372	6577	5367	5201	7400	7837	*6813*
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234	4579	*5272*
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	2403	4846	*4031*
Unknown	407	636	599	507	17	133					
Total in 1A	7196	7003	7492	8352	9929	11933	13088	14049	17037	17262	

Table 2. Landings in NAFO Div. 1A in 1996 allocated on gear for each month in procent.

Gear/month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Longline	2.50	5.0	5.2	7.4	4.6	4.3	9.6	12.3	9.6	6.2	3.5	4.0	74.2
Gillnet	2.20	3.1	2.5	2.1	4.2	2.9	3.2	0.7	0.8	0.7	0.2	0.9	23.6
Unknown							0.3	0.6	1.0	0.2			2.2
Total	4.8	8.1	7.7	9.5	8.9	7.1	13.1	13.7	11.4	7.2	3.7	4.9	

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

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

Table 4. Mean length (cm) from catches taken in inshore longline surveys.

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

Table 5. 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
Disko Bay	0.42	0.16	0.24	0.51	0.40	0.45	0.51	0.80	0.54	0.44
Uummannaq	1.09	1.01	1.01	0.88	-	-	1.20	0.98	1.31	0.25
Upernavik	-	0.35	0.41	0.48	-	-	0.42	0.58	0.43	0.00

Table 6. Catch at age of Greenland halibut in 1988-1996 in Disko Bay area.

	Catch in numbers (thou.)								
age/year	1988	1989	1990	1991	1992	1993	1994	1995	1996
4	0	0	0	5	34	7	0	0	0
5	0	0	0	5	92	15	3	0	8
6	1	0	0	11	122	62	15	0	1
7	9	0	1	279	332	280	112	45	47
8	59	14	24	806	476	479	281	459	323
9	182	106	141	535	390	339	539	639	941
10	173	121	185	333	451	280	396	798	651
11	132	94	188	238	532	240	190	463	454
12	73	49	126	76	309	122	91	185	273
13	63	33	80	45	140	91	50	127	145
14	65	39	59	67	92	112	45	27	75
15	38	31	42	57	18	75	41	36	44
16	18	19	23	35	0	57	21	12	31
17	11	14	15	7	0	12	10	15	5
18	4	8	6	2	0	10	1	0	33
19	0	0	0	0	0	7	3	0	0
20	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	1	0	0
Total	827	529	890	2501	2988	2186	1781	2808	3031

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

	Catch in numbers (thou.)								
age/year	1988	1989	1990	1991	1992	1993	1994	1995	1996
5	0	0	0	-	-	0	0	0	1
6	0	0	0	-	-	0	0	0	0
7	1	0	1	-	-	9	24	6	6
8	5	2	3	-	-	45	105	217	76
9	20	9	15	-	-	200	226	564	308
10	52	35	47	-	-	202	271	601	279
11	121	98	108	-	-	142	346	413	286
12	143	120	121	-	-	138	139	414	232
13	121	99	101	-	-	104	105	219	142
14	96	76	82	-	-	158	34	138	69
15	49	38	42	-	-	93	12	49	28
16	23	19	20	-	-	28	0	28	11
17	13	14	15	-	-	19	0	17	1
18	4	6	6	-	-	0	2	4	14
19	0	0	0	-	-	0	0	0	0
20	0	0	0	-	-	0	0	1	0
21	0	0	0	-	-	1	0	0	0
Total	648	516	563	-	-	1141	1264	2671	1453

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

	Catch in numbers (thou.)								
age/year	1988	1989	1990	1991	1992	1993	1994	1995	1996
5	0	0	0	-	-	0	0	0	3
6	0	0	0	-	-	0	2	0	0
7	0	0	0	-	-	0	51	13	16
8	6	2	2	-	-	2	188	55	114
9	33	16	17	-	-	16	316	84	359
10	55	34	41	-	-	86	217	128	275
11	80	59	62	-	-	252	239	133	238
12	74	66	57	-	-	268	154	147	206
13	68	69	52	-	-	143	155	117	151
14	62	73	48	-	-	95	51	103	90
15	31	40	25	-	-	40	23	45	48
16	13	18	11	-	-	29	0	28	26
17	7	10	5	-	-	10	0	8	4
18	2	3	1	-	-	5	0	3	9
19	0	0	0	-	-	1	0	1	0
20	0	0	0	-	-	1	0	2	0
21	0	0	0	-	-	0	0	0	0
Total	431	389	323	-	-	947	1394	867	1538

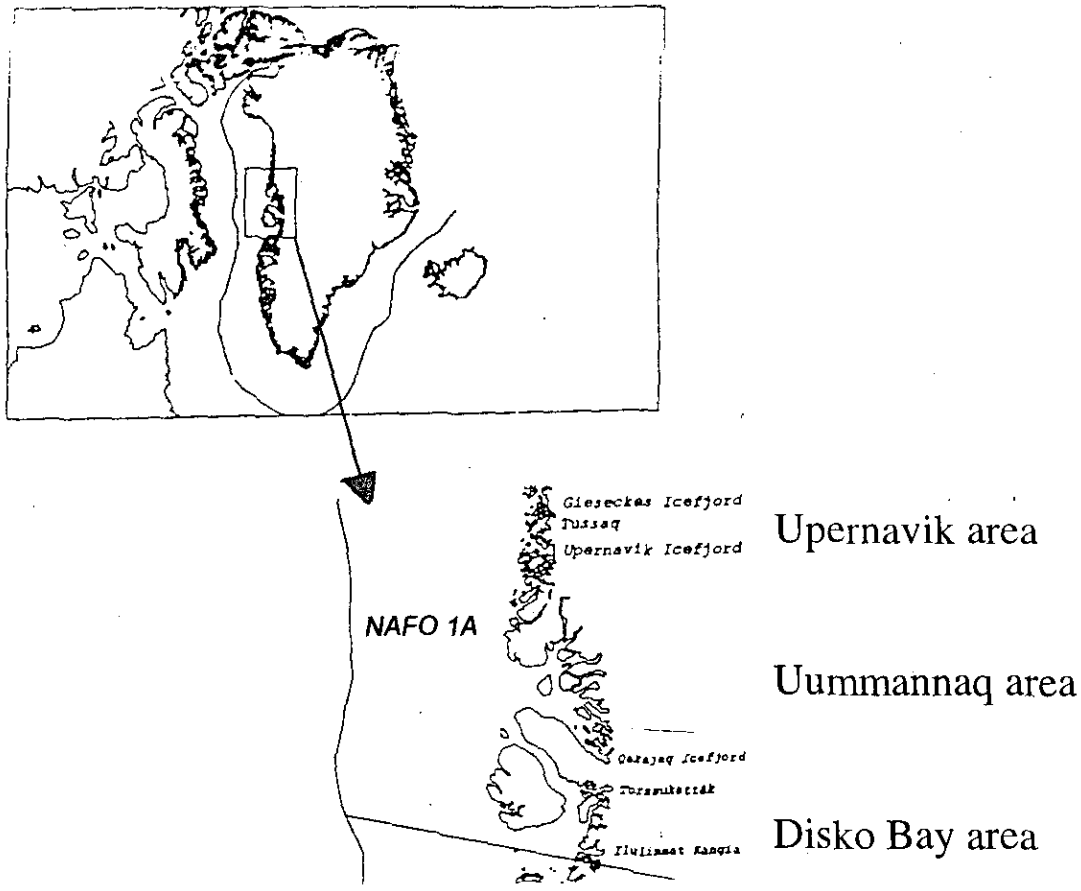

Figure 1.
Location of main inshore fishing grounds for Greenland halibut in Div.1A.

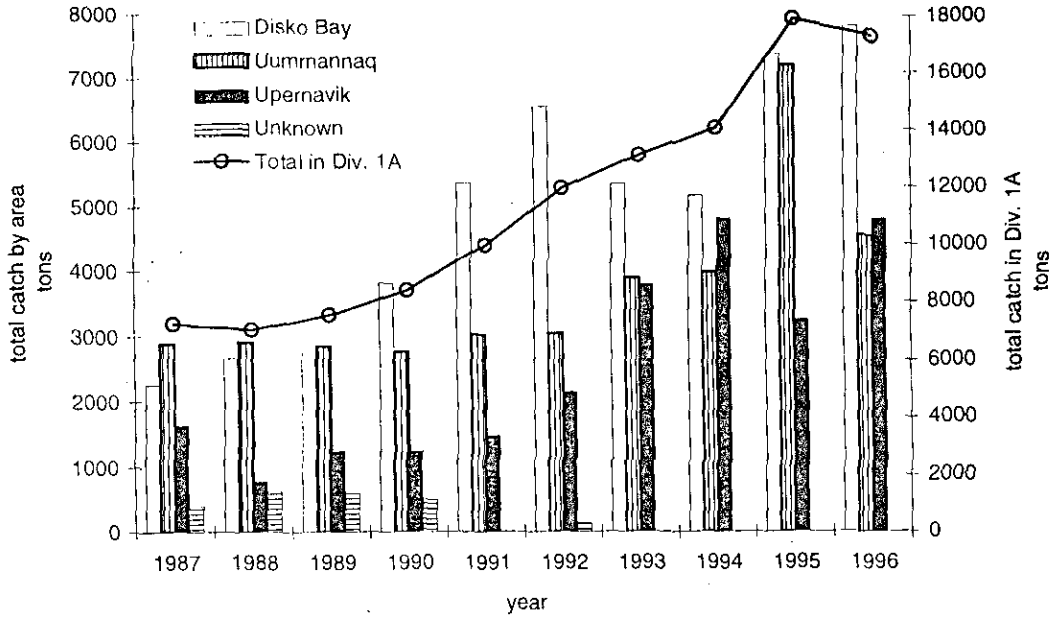

Figure 2.
Landings in NAFO Div. 1A in the period 1987-1996 for the tre main fishing areas.

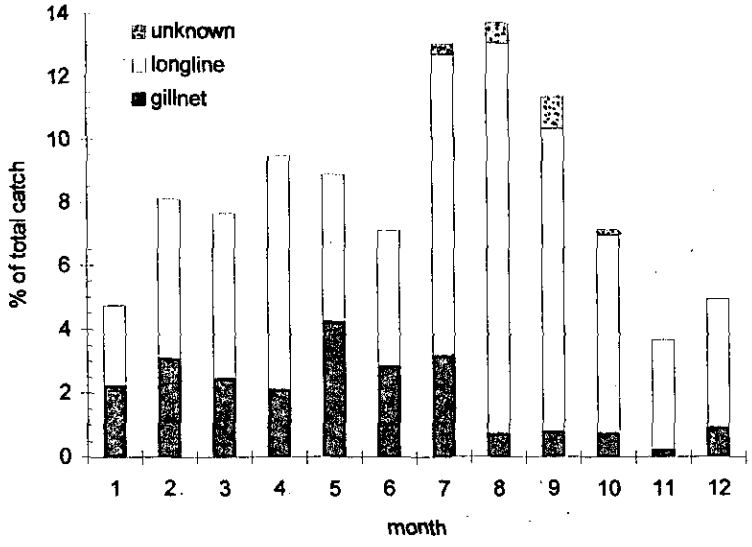

Figure 3
Landings in NAFO Div.1A in 1996 allocated on gear. The total nominal catch was 17,267 tons in 1996.

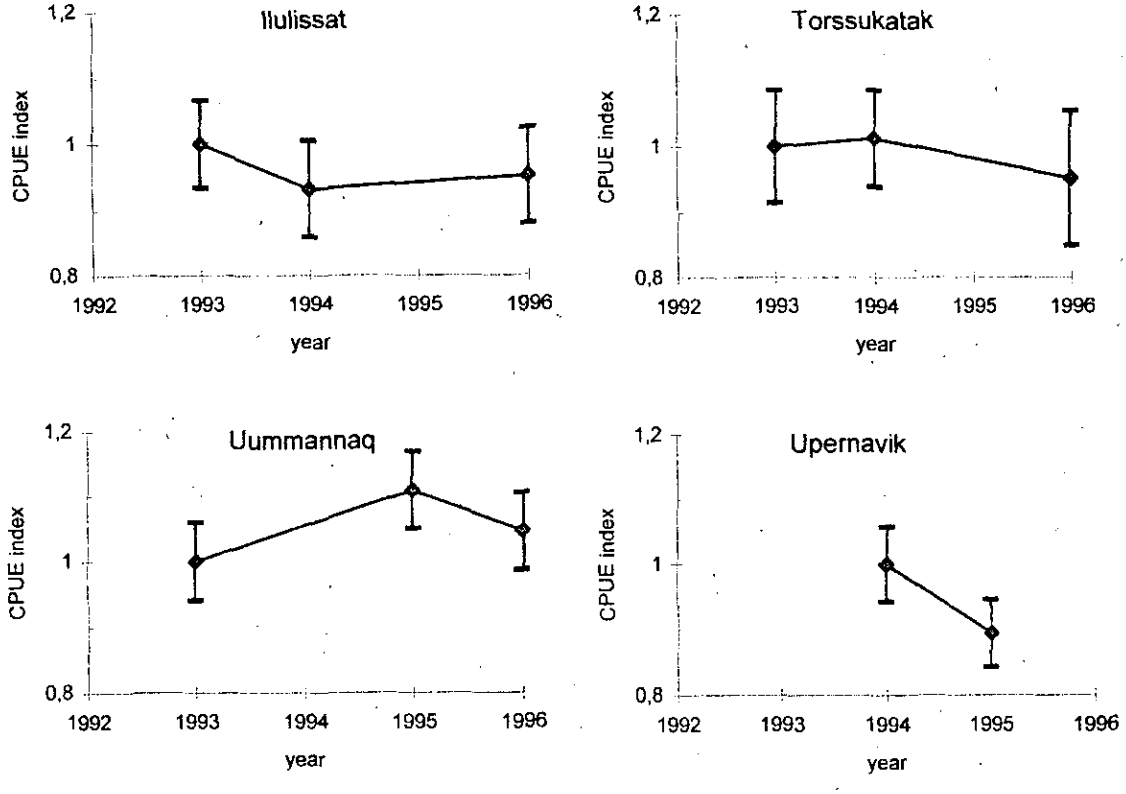

Figure 4
CPUE for research longline surveys expressed as index-value using the least square means of ln (CPUE) +/- S.E.

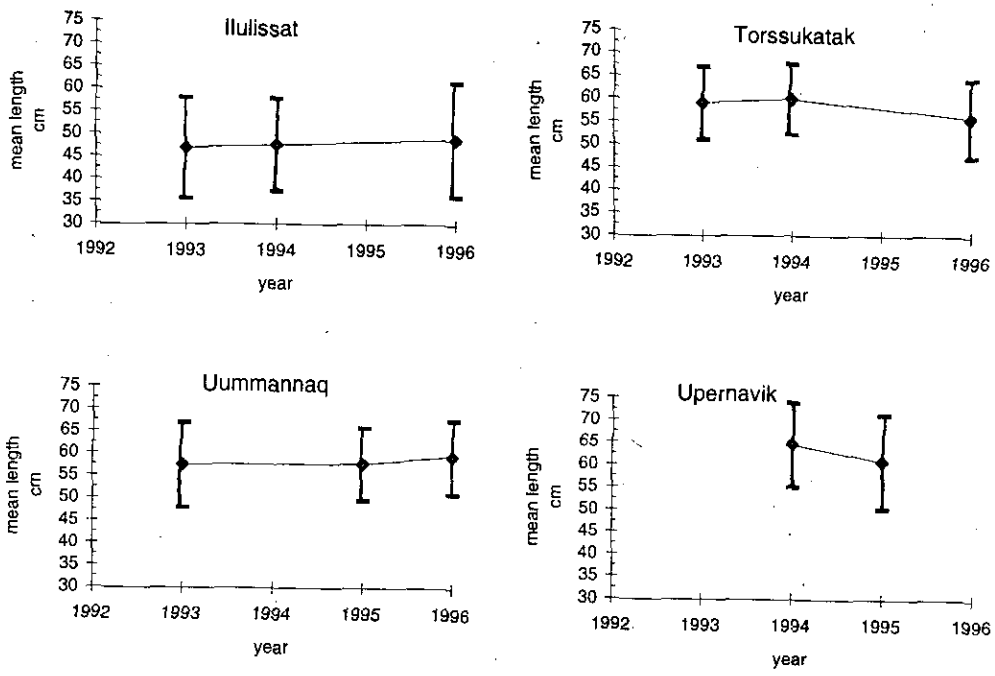

Figure 5
Mean length for research longline surveys in 1996. +/- S.D.

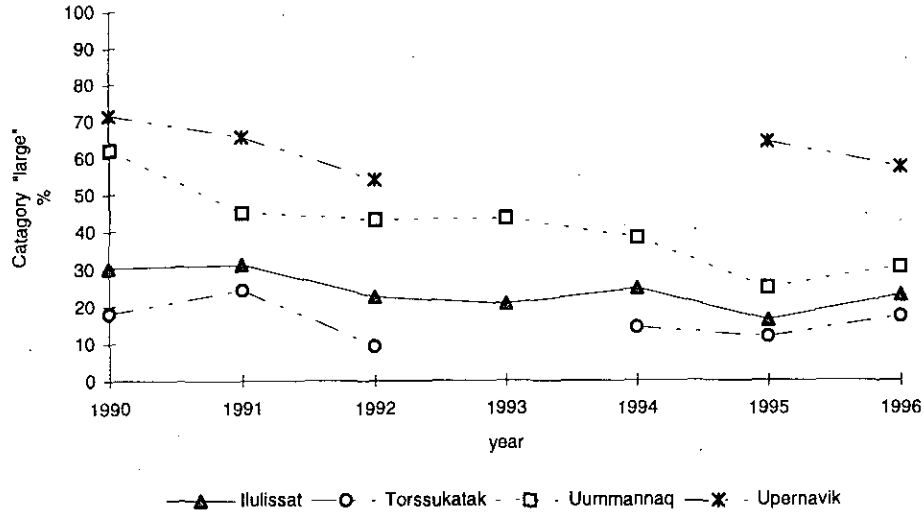

Figure 6
Respective proportion of catagory 'large fish' (see text for complete describtion) in the Disko Bay (div. in Ilulissat and Torssukatak), Uummannaq and Upernavik.

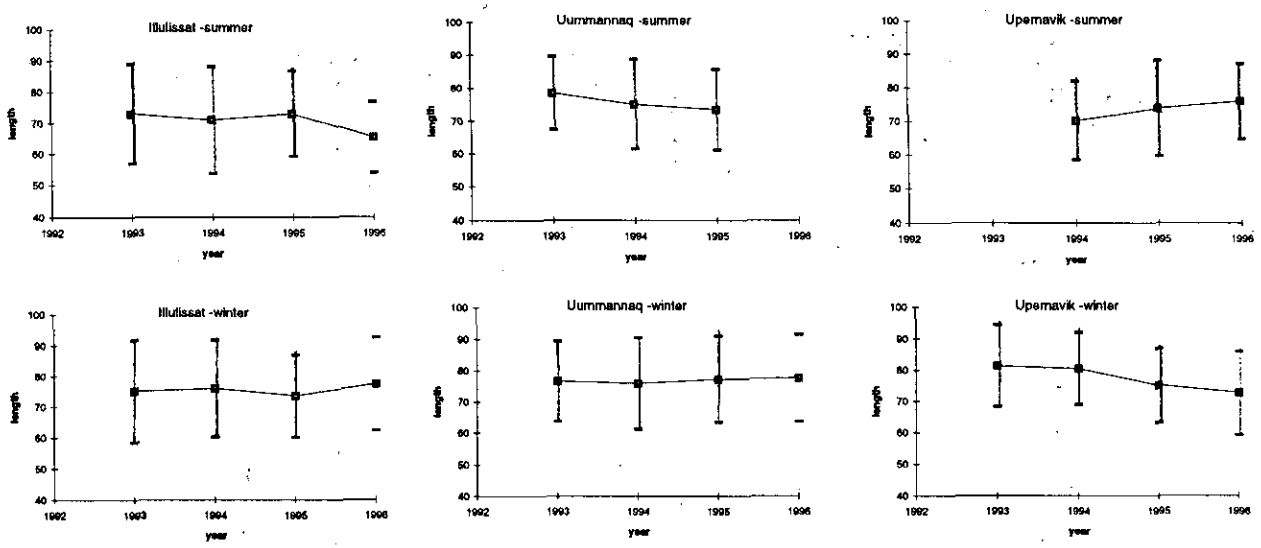

Figure 7
Mean length of Greenland halibut in commercial longline catches from Ilulissat, Uummannaq and Upernavik.. +/- S.D.

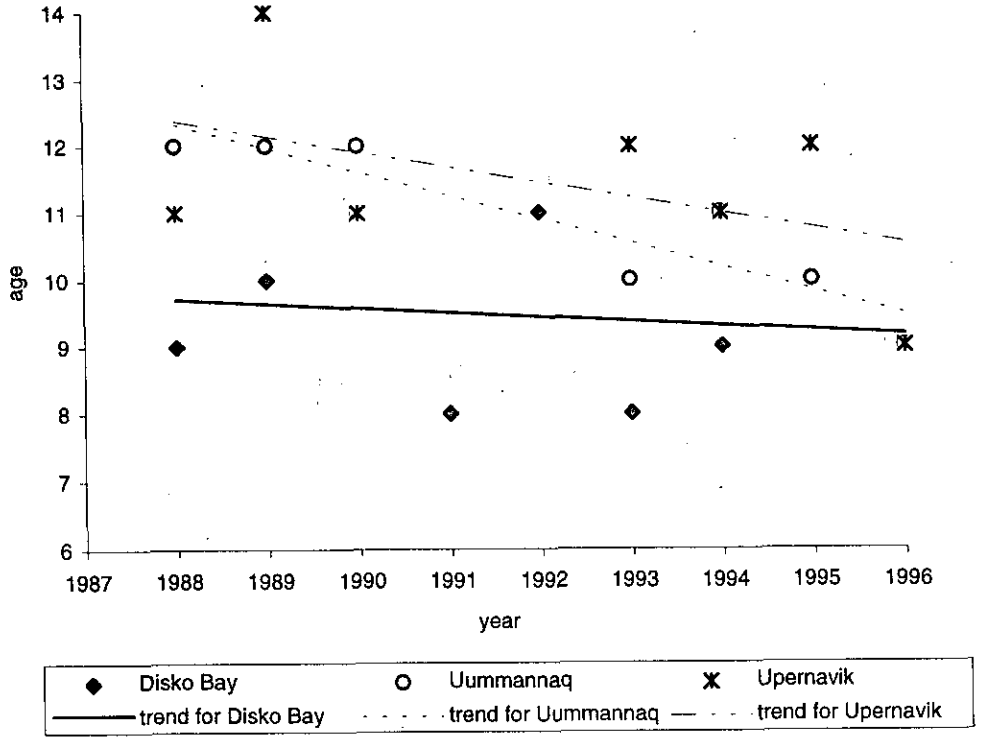

Figure 8
Age of mamimum catch rate in the commercial fishery in Disko Bay, Uummannaq and Upernavik. Linear regression lines are indicated on the figure. *Disko Bay* α=-0.07 year^{-1}, P=0.68, R=0.16; *Uummannaq* α=-0.35 year^{-1}, P=0.004, R=0.91; *Upernavik* α=-0.23 year^{-1}, P=0.28, R=0.47.

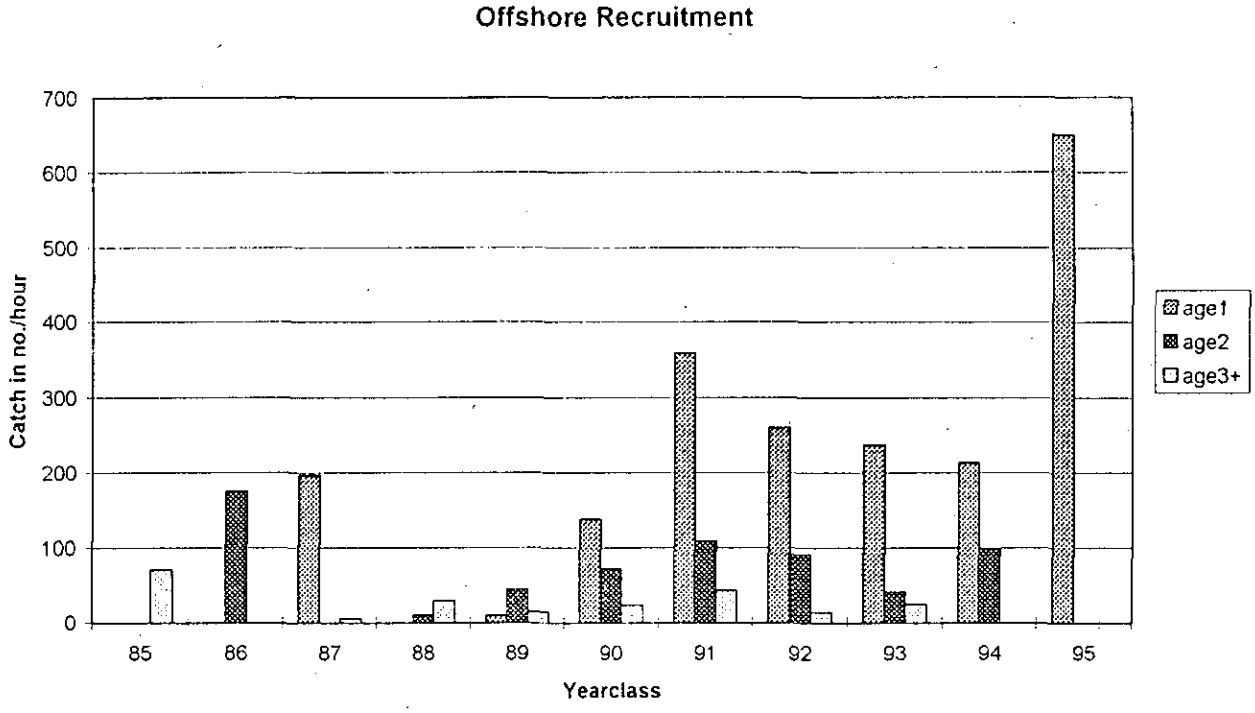

Figure 9
Year-class strength of recruits in the offshore area, plotted as catch in numbers per hour, standardized index. The respective year-classes can be followed to age 3 in data from Greenland trawl survey. Mising values are due to missing observations.

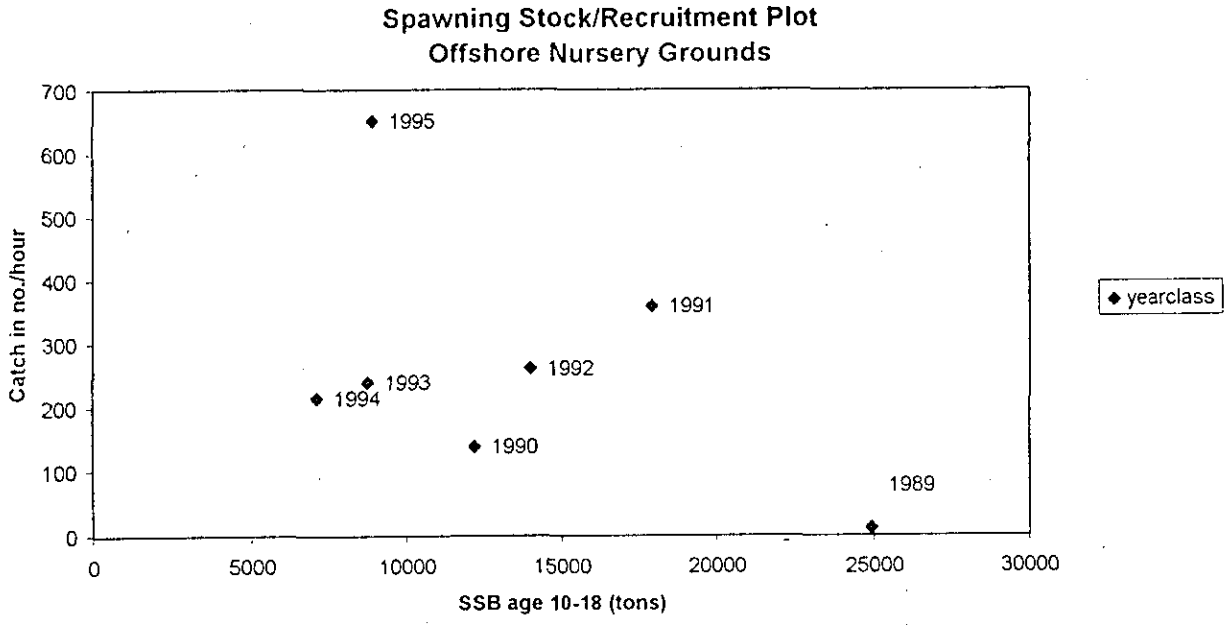

Figure 10
Stock-recruitment plot from the offshore nursery grounds. Yearclasses are plotted as standardized indices to the offshore spawning stock biomass, estimated for their respective year of spawning.

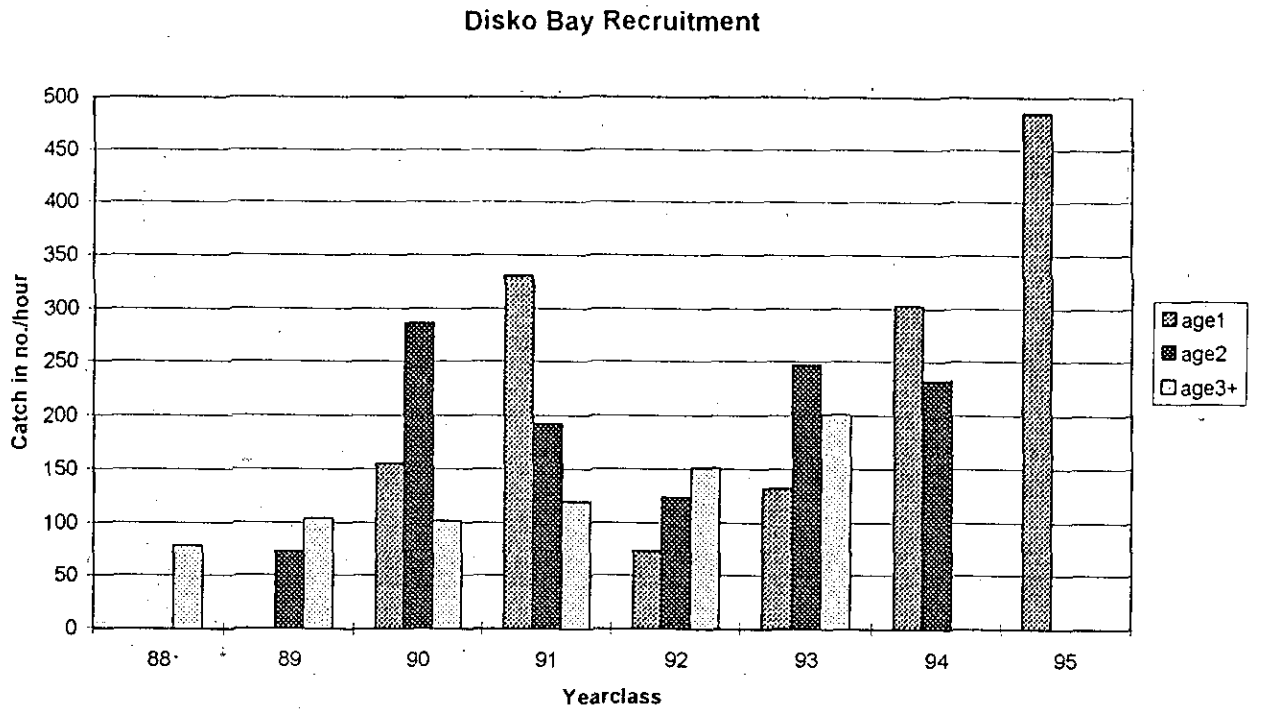

Figure 11
Year-class strength of recruits in the inshore area,plotted as catch in numbers per hour, standardized index. The respective year-classes can be followed to age 3 in data from Greenland trawl survey. Mising values are due to missing observations.

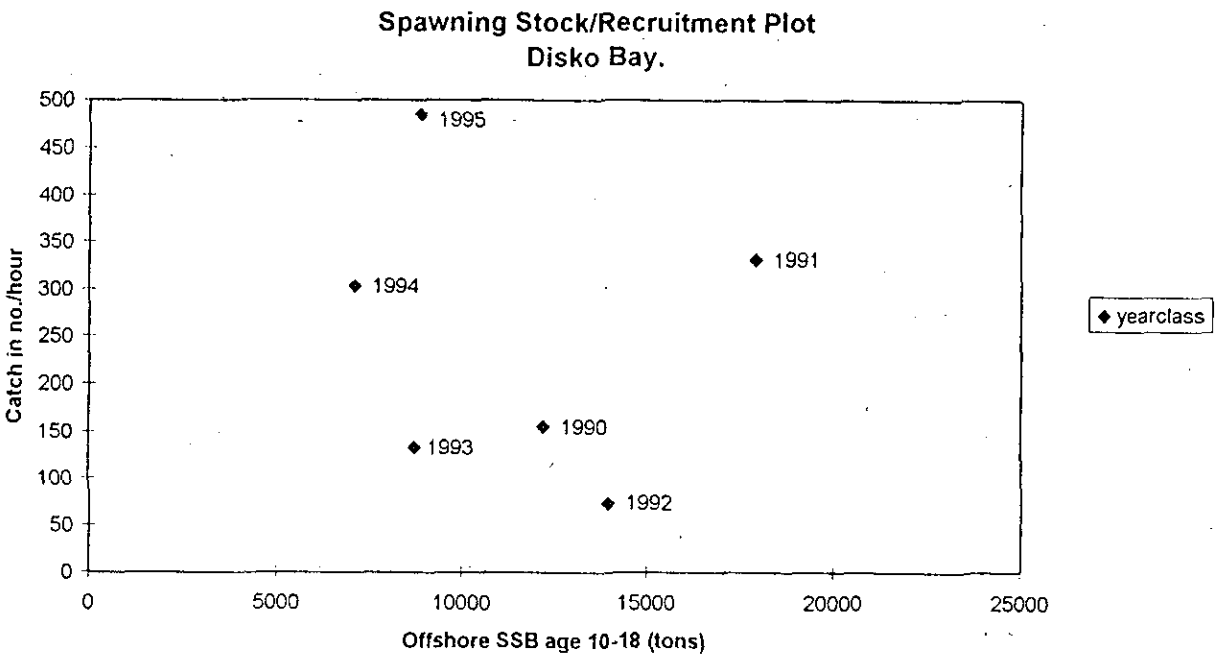

Figure 12
Stock-recruitment plot from the inshore nursery grounds. Yearclasses are plotted as standardized indices to the offshore spawning stock biomass, estimated for their respective year of spawning.

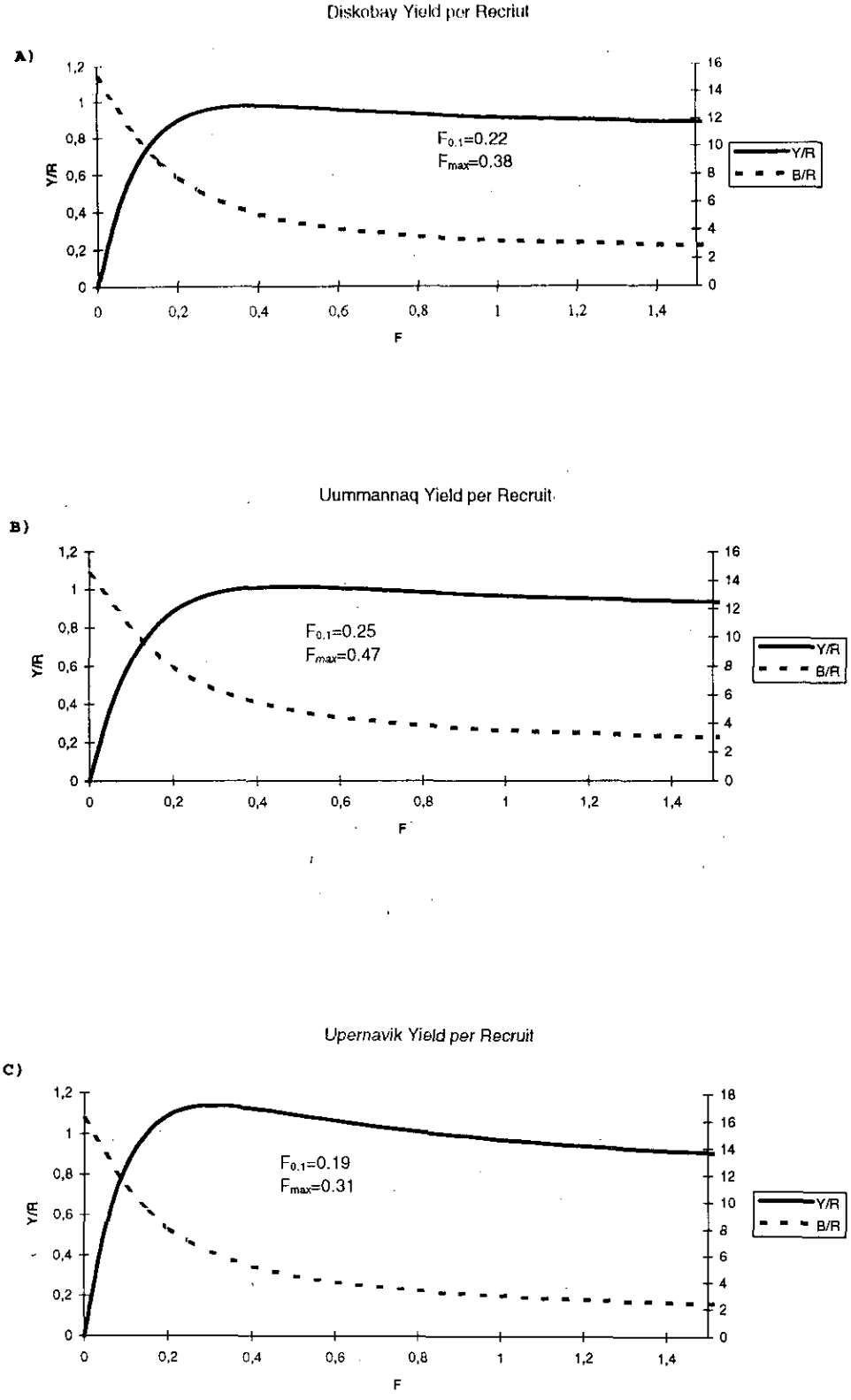

Figure 13

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.