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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 Division 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 Catches.

In 1995 the commercial offshore fishery in Division 1A was limited to 13 tons taken by a Japanese trawler. In previous years only insignificant commercial catches were taken in the area, also few catches derives from exploratory fishery.

The main inshore fishing grounds for Greenland halibut are in Division 1A, where total landings amounted to 17,903 tons in 1995, comprising 99.5 % of the total inshore landings in Greenland. Additional 8 tons were landed in the northernmost settlement of Greenland, Qaanaq. The inshore landings in Division 1A were around 7,000 tons in the late 1980's, but increased steadily to 14,000 tons in 1994 and reached record high 18,000 tons in 1995 (Table 1). In recent years the inshore landings are rather evenly distributed throughout the year.

The fishery is traditionally performed with longlines from small open boats, or by means of dog slegdes, typically in the inner parts of the ice fjords at depths between 500 to 800 m. In the middle of the 1980's gillnets were introduced to the inshore fishery, and were used more commonly in the following years. In 1989 gillnets and longlines accounted equally for the Greenland halibut catches in Division 1A, but since then the annual proportion of catches from each gear has varied considerably. Longline catches comprised 73 % in 1994 and 76 % in 1995.

There are no restrictions on longline design, and most often 3 mm handlines are used; larger 20-30 foot vessels are using 5 mm lines. There are no restrictions on hook size. During

introduction of gillnets to the fishery several gillnet types were used (from salmon and cod fishery) which lead to heavy losses of gear. This was followed by a ban of using gillnets in the innermost parts of the fjords, to avoid 'ghost fishing' problems. Furthermore gillnets must have a minimum mesh size on 110 mm (half-mesh), and new rules are under preparation demanding use of sufficient heavy materials in gear design, plus owner identification of the gear. Lost gillnets are a main course of longline losses (Bech, 1995).

The landings are sorted by gear. Longline landings are considered more valuable than gillnet landings, giving nearly the double price. All landings are sorted by weight in classes: 1.0 to 1.5 kg, 1.5 to 3.5 kg and above 3.5 kg. The category of large fish (>3.5 kg) gives almost twice the price as fish lesser than 3.5 kg.

The inshore fishery in Division 1A is located in three areas: Ilulissat, Uummannaq and Upernavik (Fig. 1) and there are no quotas on the fishery.

Ilulissat.
The Greenland halibut fishery is conducted in, and in front of an ice fjord in the immediate vicinity of Ilulissat town, and in an ice fjord north of Ilulissat, Torssukattâk. Use of gillnets is prohibited in the innermost part of the ice fjords.

The catches at Ilulissat 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 tons, however in 1995 catches reached a historic high of 7,400 tons (Table 1). Longline catches comprised 67 % in 1994 and 66 % in 1995.

Uummannaq.
Uummannaq area is a large system of ice fjords, where fishery is conducted. The main fishing ground is the southernmost fjord, Qarajaq Ice fjord. 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 in 1995 catches reached 7,234 tons, the highest recorded (Table 1). In 1994 longline catches comprised 57 % of the landings at Uummannaq, and in 1995 76 %.

Upernavik.
The northernmost area consist of a large number of ice fjords. The main fishing grounds are Upernavik Ice fjord, Tussaq and Gieseckes Ice fjord, all north of Upernavik town. Use of gillnets is prohibited.

The catches in Upernavik area have increased steadily from 1,600 tons in 1987 to 4,800 tons in 1994. In 1995 the catch decreased to 3,269 tons (Table 1).

3. Input Data.

3.1 Research Longline Fishery.
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 Ilulissat, 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 1995 the research longline vessel 'Adolf Jensen' covered the fjord areas of Upernavik and Uummannaq. A total of 52 longline settings with 54,000 hooks were performed.

3.2 Commercial Fishery Data.

3.2.1 Analysis of Commercial Samples.
Due to variations in age determinations and age reading problems in 1994, it was analysed whether or not changes in age readings were reflected as real changes in length frequencies from commercial fishery. Hence samples from 1988 to 1995 were tested for significant changes in mean length and compared to catch-at-age data.

The analysis was performed by the distribution-free bootstrap method. 10,000 bootstraps (resamples) were provided to commercial samples separated by gear and pooled by year (Fig. 2). Long line data for Ilulissat 1991 and 1992 were poorly sampled, and data from Upernavik 1991 were

not representative for the commercial fishing grounds. No commercial data were available from Uummannaq and Upernavik in 1991 and 1992. Furthermore 1995-data only includes samples taken during winter ice-fishing.

The analysis was also performed to test for changes in mode and median. Because the results were rather identical and mean length is the parametre most often referred to, only results from the analysis of mean length were used (Figs. 3 to 7).

3.2.2 Catch-Curve Analysis.
In order to get information on the level of fishing mortality in previous years a catch-curve analysis was provided to samples from the commercial longline fishery taken in the three areas during the years 1987 to 1995. The analysis was, if possible performed on separate samples considered representative for longline fishing. Small samples from the same location and same season were pooled. This was most often the case with samples taken during the winter ice-fishing. Average Z-values obtained were weighted by season, resulting in estimates of Z for each area per year. F was obtained by subtracting M which was set to 0.15 (Table 4).

In Ilulissat (Fig.8) age-length keys for 1993, 1994 and 1995 were available. The 1993 age-length key was used on the years 1992 to 1987. No data were available for winter 1991 and summer 1992.

In Uummannaq (Fig.9) age-length keys were available for 1993, 1994 and 1995. 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 (Fig.10) 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.

3.2.3 Yield per Recruit Analysis.
A Yield per recruit analysis was performed for each area. An average of mean weight-at-age for the period 1993 to 1995 was used in Ilulissat and Uummannaq. In Upernavik 1994 and 1995 data were used. Missing weight-at-age data were estimated by age-weight regressions. Numbers of recruits were set to a constant in each area.

F-pattern used was the relative F-at-age. In order to calculate relative F-at-age, stock composition was estimated by use of catch-curves. Ages 10 to 14 was assumed fully recruited to the gear, and stock composition of ages 5 to 9 and 15 to 18 was calculated by extrapolation of ln(N) of ages 10 to 14. Relative F was then calculated by comparing longline and gillnet catches with the estimated stock composition. For longlines assuming that all ages older than the first fully recruited age are equally selected. Values were weighted, taking into account the catch by season and gear (Table 8).

3.2.4 Analysis of Size-Categories in Landings.
When sold commercial landings of Greenland halibut are separated in price-classes based on weigth. Fish between 1.0 and 3.5 kg are here referred to as 'small fish', while fish above 3.5 kg are referred to as 'large fish'.

In order to examine any changes in commercial catch compositions, the proportion of 'small fish' in commercial landings was analysed for the years 1990 to 1995 (Fig. 11).

3.2.5 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 5, 6, 7). 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. However due to changes in age-reading personal, the 1994 samples were re-read and 1994 catch-at-age data re-calculated by the use of a new age-length key. Due to insufficient sampling, gill-net data were pooled within the year at Ilulissat 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 was considered non-representative.

In 1995 age-length keys were obtained for all three areas.

3.2.6 Bycatches in Commercial Shrimp Fishery.
Data from a commercial shrimp trawler on bycatches of juvenile Greenland halibut, were compared to the Greenland trawl survey. The total annual bycatch in Divisions 1A to 1F was estimated

(Engelstoft, 1996).

3.3 Recruitment Data.
A recruitment index was provided from the Greenland trawl survey (Jørgensen & Bech, 1996). The survey is a stratified random designed survey conducted annually from July to September. 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 (Bech, 1995).

By use of the Petersen-method ages 1, 2 and 3 were separated from catches taken during the period 1988 to 1995. 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 yearclasses to visualize the relative yearclass strength, and allowing to follow the three first years of the respective yearclasses where data are available (Figs. 12 and 14).

Spawning stock biomass (SSB) was calculated for the years 1988 to 1995 by assuming knife-edge maturity ogive, thereby using ages 10 to 18 in catch in numbers from offshore areas. A stock-recruitment plot was based on the standardized CPUE-values for the respective year classes (Figs. 13 and 15).

3.4 Biological Data.
A meristic study was presented, comparing vertebral counts from Greenland halibut caught in 1995 at Upernavik, Uummannaq, Baffin Bay and Davis Strait (Rasmussen et. al., 1996). The results were also compared to earlier studies, concluding that Greenland halibut from the four areas derived from same spawning area or spawning areas with same environmental conditions. The variation between years are larger than the variation between areas.

4. **Assessment**

4.1 Catch Curve Analysis.
Fishing mortality was estimated by means of catch-curves (Table 4). F values at Ilulissat were within the range 0.42-0.70 giving a mean F_{1995} of 0.54. In Uummannaq the F values were within the range 0.90-1.60 with a mean F_{1995} of 1.31. At Upernavik the F values were within the range 0.33-0.60 with a mean F_{1995} of 0.43.

4.2 Biological Reference Points.
A Yield per recruit analysis was performed for each area. At Ilulissat $F_{0.1}$ was estimated to 0.23 and F_{max} to 0.41. As the F_{1995} was estimated to 0.54, the exploitation of the inshore stock in Disko Bay is well beyond F_{max} (Fig. 16). At Uummannaq $F_{0.1}$ was estimated to 0.23 and F_{max} to 0.43. The F_{1995} value was 1.31, and far beyond F_{max} (Fig. 17). At Upernavik $F_{0.1}$ was estimated to 0.22, F_{max} was 0.37 and F_{1995} was estimated to 0.43 (Fig. 18). In the long term a higher yield per recruit could be obtained by lowering the fishing mortality.

4.3 Survey Results.
In Upernavik CPUE and mean-length values decreased from 1994 to 1995 (Tables 2 and 3). In Uummannaq CPUE and mean-length increased since the last surveyed year, 1993. However, the 1993-1995 level is below values obtained from surveys since the 1960's.

4.4 Bootstrap Analysis of Commercial Samples.
At Ilulissat the mean length in longline (Fig.3) and gillnet catches (Fig. 4) has decreased significantly since the late 1980's. There was no clear trend in data except that the mean length in gillnet catches has decreased significantly every year since 1993. Mean length in longline catches has been constant since 1993. Compared with the catch-at-age data (Table 5) there was no clear correlation. The decrease in mean length observed since the late 1980's, may be observed as a shift in catch-at-age data, from a mode at ages 9 to 11 in 1988 to 1990, to ages 8 to 10 in 1993 to 1995.

At Uummannaq there was a rather clear trend in both longline catches (Fig. 5) and gillnet catches (Fig. 6). A constant mean length level in 1988 to 1990 and then a significant decrease nearly every year until 1995. Compared to catch-at-age data (Table 6) the decreasing mean length level is followed by a shift in the catches towards younger fish. The mode in 1988 to 1990 was at age 12, while in 1993 to 1995 the mode was at ages 10 and 11.

At Upernavik there was no clear trend in data giving a variable mean length (Fig. 7). However compared to catch-at-age data (Table 7) there was a very fine correlation between mean length and

the mode in catch-at-age. Conspicuous was the 1994 data where a significant decreasing mean length was followed by a shift in catches towards younger fish (from a mode at ages 11-14 to age 9). In 1994 a large-scale fishing was attempted in the area.

4.5 Analysis of F-level.
At Ilulissat there was an increasing trend in F-values over the period, in accordance with increasing landings (Fig. 8).

At Uummannaq F-values were generally very high (above 1.0) during the period. F was rather constant in the period 1987 to 1990, but increased somewhat in 1993 and 1995 (Fig. 9).

At Upernavik the F-level in 1993 to 1995 was higher than in the period 1988 to 1990 (fig. 10).

4.6 Analysis of Size Categories in Landings.
At Ilulissat the proportion of small fish landed has increased parallel to the increasing catch level, constituting approximately 70 % in 1990 and 85 % in 1995 (Fig.11).

At Uummannaq the proportion of the little category in landings was around 40 % in 1990 and increased to about 55 % in 1991, but has been rather stable since.

At Upernavik the proportion of small fish in the landings has been stable between 30 to 35 % since 1990.

4.7 Recruitment.
In the offshore nursery grounds the recruitment has been declining since the large 1991 yearclass (Fig. 12) and the 1994 yearclass seemed at an average level, but the SSB was the lowest recorded (Fig. 13).

In Disko Bay however, the 1994 yearclass was above average, reaching the level of the strong 1991 yearclass (Fig. 14). There was no clear trend in following yearclasses through the years in the inshore area (Fig. 14) which reflects a complex relationship to the offshore nursery grounds and spawning stock, influenced by water currents, temperature and mortality of recruits. This may underline the difficulties in determine the proportion of recruits which goes to the inshore fishing grounds.

4.8 Bycatch Data.
The total bycatch of juvenile Greenland halibut in the commercial shrimp fishery was estimated to to about 1,500 tons or 21 million individuals annually, the main part taken at the nursery grounds.

4.9 Comments on the Assessment.
Ilulissat.
The level of F and proportion of small fish in catches has increased with increased landings. This is supported by a significant decrease of mean length in landings since 1990, and a tendency towards younger fish in catches.

Uummannaq.
The F-level seems extremely high, and has increased in recent years. The proportion of small fish in landings is rather stable, but the mean length in landings has decreased significantly during the years, which is followed by a shift towards younger fish in landings. CPUE and mean length from surveys had decreased since 1960's.

Upernavik.
The F-level has increased but is the lowest in Division 1A. The proportion of small fish in landings is stable at a low level and there is no significant decrease of mean length in landings, but a variation, which is reflected in catch-at-age data. CPUE and mean length from surveys had decreased since 1994.

General Comments.
Data for maturity ogive were not available. The recruitment level of the 1991 yearclass was above average. The level had decreased since, but appeared higher than in the late 1980's. In the inshore nursery area the recruitment level was very high, but apparently complex relations to the offshore nursery ground and spawning stock, made interpretations of the proportion of recruitment to the fjords difficult. A considerable amount of recruits are lost as bycatches in commercial shrimp trawls at both offshore and inshore nursery grounds.

The F-values estimated by catch curves were considered unreliable due to their high level, and missing accordance with the landings. Furthermore, the high level was not followed by tendencies towards collapse of the age structure in the stock. Other factors than fishing should be considered influencing the F-level, such as migration in and out of, possibly, limited fishing grounds, and fluctuations in recruitment. Apparently great differences in the length frequencies from samples taken during summer and winter, suggested that different stock-components could be exploited in the different seasons. This makes the catch curve analysis sensible to insufficient sampling.

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, should trends in effort be compared to trends in F.

As the catch curve analysis were considered unreliable, it was not possible to obtain recent F-values, and the results of the yield per recruit analysis could not be accepted. The quality of input data impede an analytical assessment (VPA) and exact allowable catch figures can therefore not be provided.

Sufficiency in sampling seems to be a crucial point in this assessment, because of the big differences in catch compositions from winter ice-fishery and summer fishery.

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Table 1. Landings of Greenland halibut (tons) in Division 1A, distributed on main fishing grounds: Ilulissat, Uummannaq and Upernavik. Unknown in 1A=catches from unknown areas in 1A.

Area/yr	1987	1988	1989	1990	1991	1992	1993	1994	1995
Ilulissat	2258	2670	2781	3821	5372	6577	5367	5201	7400
Uummannaq	2897	2920	2859	2779	3045	3067	3916	4004	7234
Upernavik	1634	777	1253	1245	1495	2156	3805	4844	3269
Unknown in 1A	407	636	599	507	17	133	-	-	-
1A	7196	7003	7492	8352	9929	11933	13088	14049	17903

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

Area/year	1962	1985	1986	1987	1993	1994	1995
Ilulissat	-	-	8.3	16.5	3.1	3.1	-
Uummannaq	4.6	13.7	-	8.6	2.8	-	6.6
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
Ilulissat	-	62.4	53.5	62.2	55.9	56.5	-
Uummannaq	67.8	70.5	-	61.8	57.5	-	57.8
Upernavik	-	-	-	-	-	64.6	60.8

Table 4. Estimates of fishing mortality (F) from catch curve analysis on commercial samples from 1987 to 1995.

Area/year	1987	1988	1989	1990	1991	1992	1993	1994	1995
Ilulissat	0.42	0.16	0.24	0.51	0.40	0.45	0.51	0.80	0.54
Uummannaq	1.09	1.01	1.01	0.88	-	-	1.20	0.98	1.31
Upernavik	-	0.35	0.41	0.48	-	-	0.42	0.58	0.43

Table 5. Catch at age of Greenland halibut in 1988-1995 at Ilulissat, in Disko Bay.

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

Table 6. Catch at age of Greenland halibut in Uummannaq area in 1988-1995. - indicates insufficient sampling.

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

Table 7. Catch at age of Greenland halibut in Upernavik area 1988-1995. - indicates insufficient sampling.

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

Table 8. Input data for the Yield/recruit analysis, 1995. Mean weight at age (kg) and relative F values for Greenland halibut in Subarea 1A from samplings in 1995.

Area	Ilulissat		Uummannaq		Upernavik	
age	mean wgt.	relative F	mean wgt.	relative F	mean wgt.	relative F
5	0.628	0	0.558	0	0.492	0
6	0.889	0	0.815	0	0.750	-0.1549
7	1.198	0.3453	1.136	0.079	1.099	0.2575
8	1.670	0.7672	1.477	0.6147	1.600	0.4393
9	2.067	0.8903	2.007	0.8059	2.126	0.5319
10	2.579	1.0	2.578	0.9135	2.754	0.6408
11	2.988	0.9892	3.015	1.0	3.468	0.7169
12	3.723	0.8866	3.642	0.9632	4.225	0.8175
13	4.644	0.8752	4.219	0.9606	5.234	0.8864
14	5.457	0.66	4.953	0.7959	5.939	1.0
15	6.668	0.6838	5.637	0.7632	7.582	1.0
16	7.439	0.66	6.333	0.7632	8.751	1.0
17	8.761	0.66	7.931	0.7632	10.204	1.0
18	9.245	0.66	9.594	0.7632	12.356	1.0

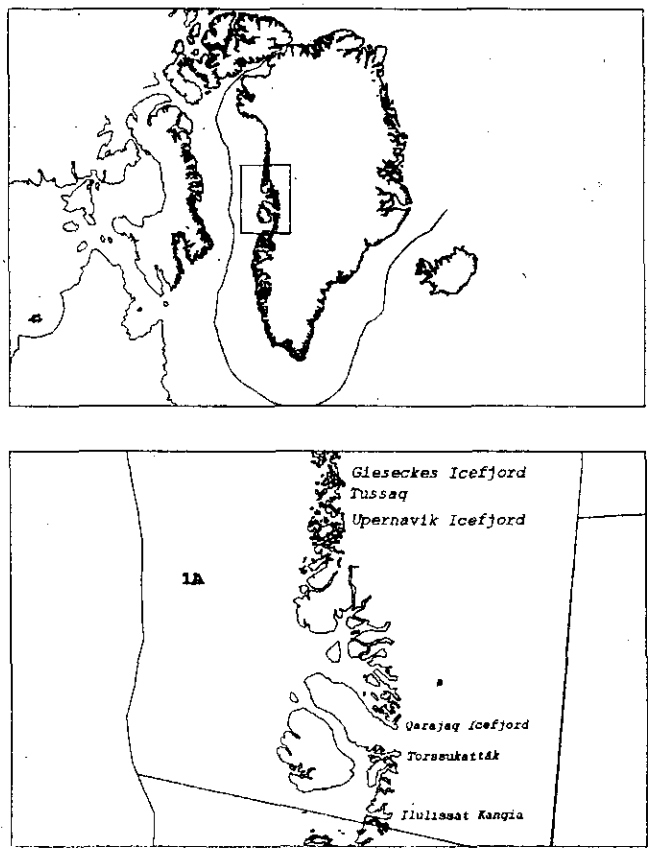


Fig 1. Location of main inshore fishing grounds for Greenland halibut in Division 1A.

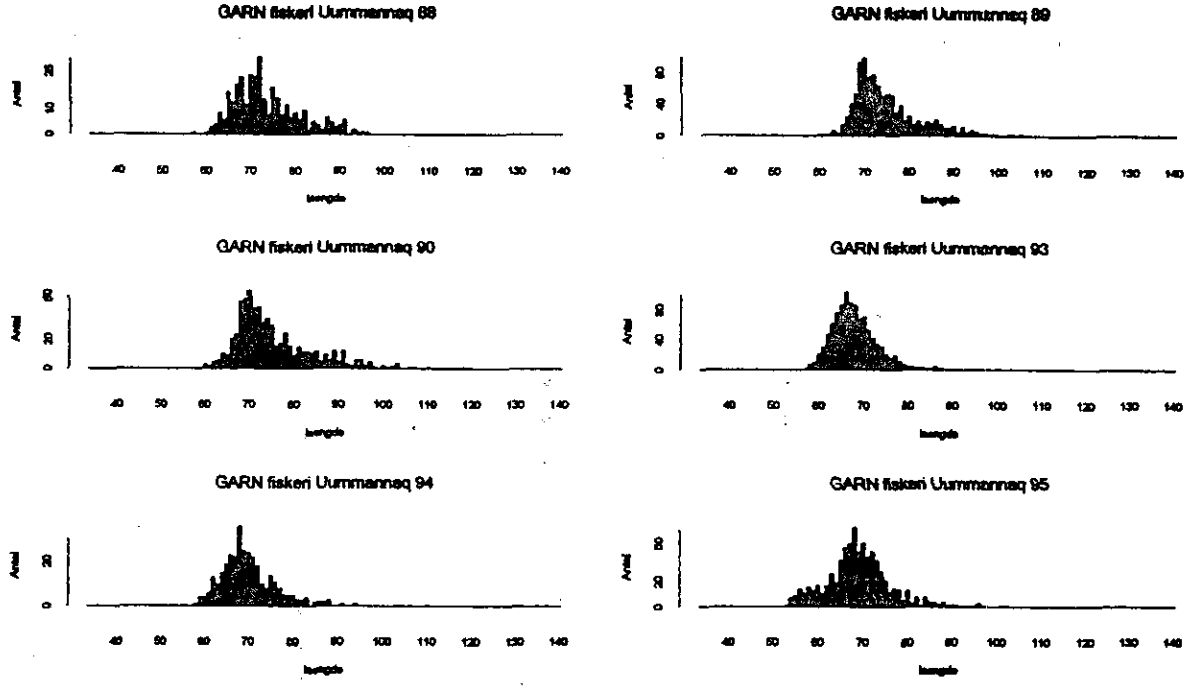
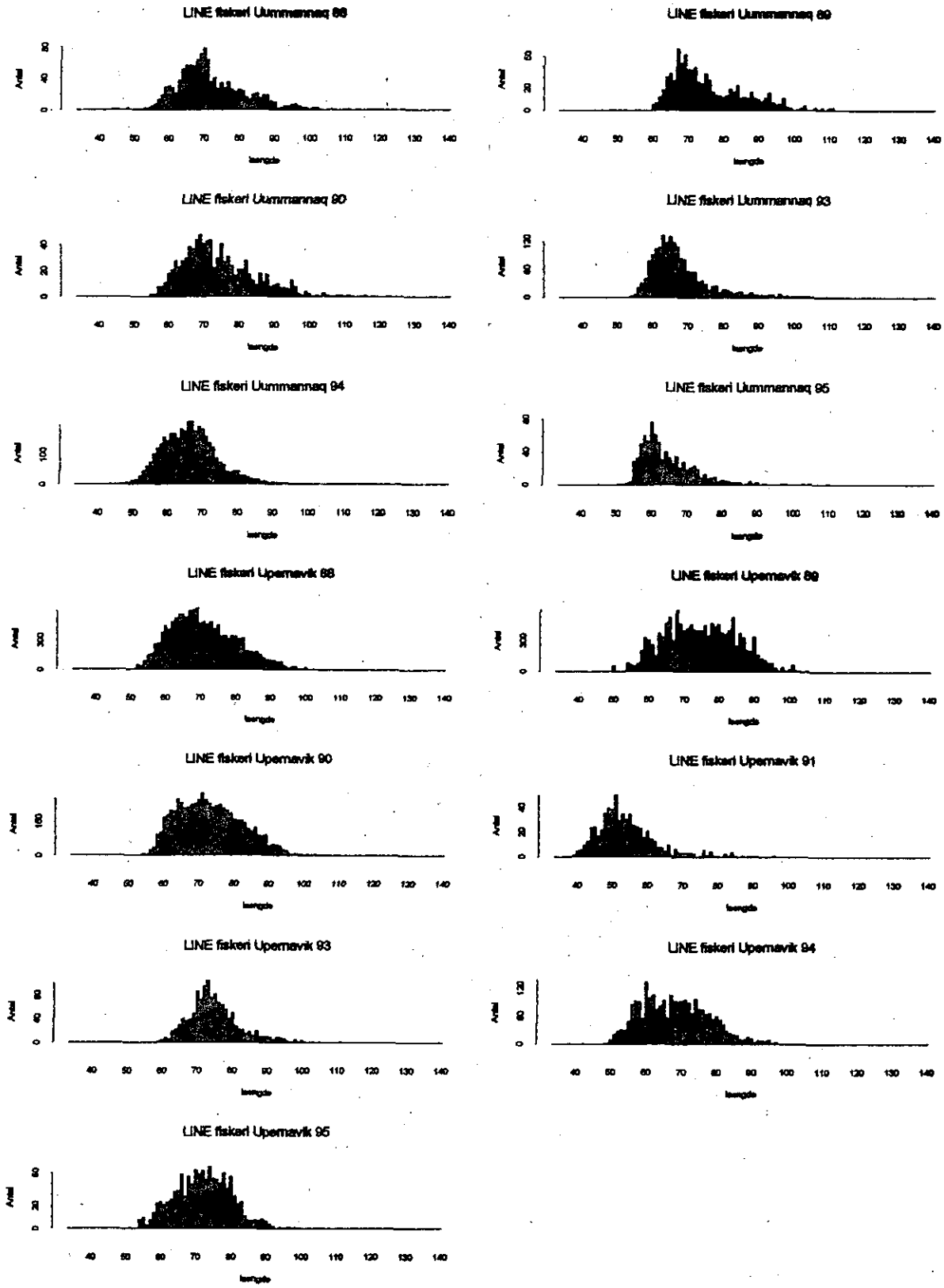


Fig. 2. Length distributions (1 cm-groups) from commercial landings taken in the period 1988 to 1995, used in bootstrap analysis. GARN fiskeri=gillnet fishery; LINE fiskeri=longline fishery; antal=number; laengde=length (cm).Continues.



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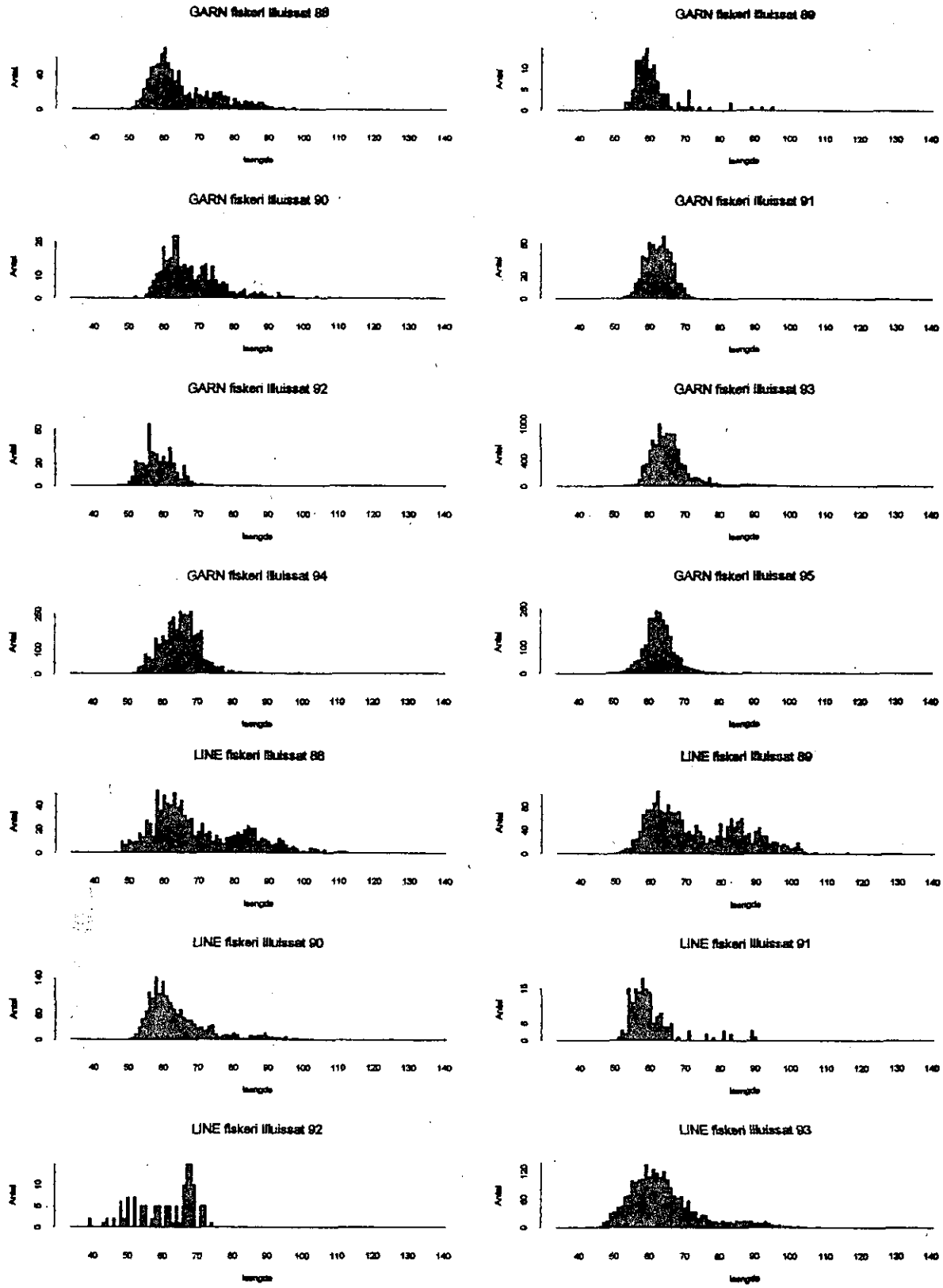

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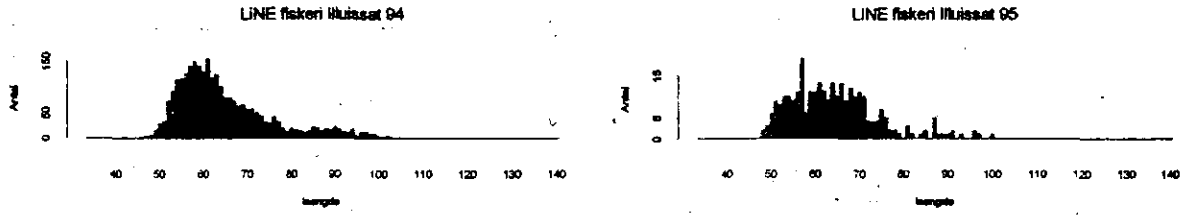

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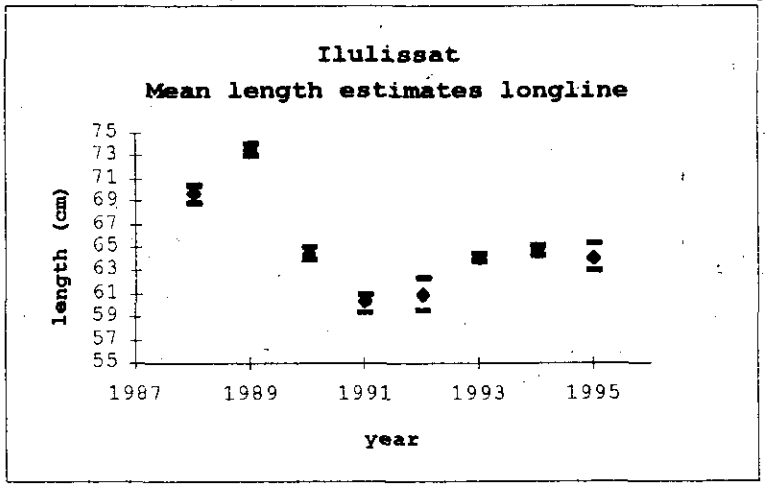

Fig. 3. Mean length estimates of longline catches at Ilulissat after 10,000 bootstraps given with 95% confidence limits.

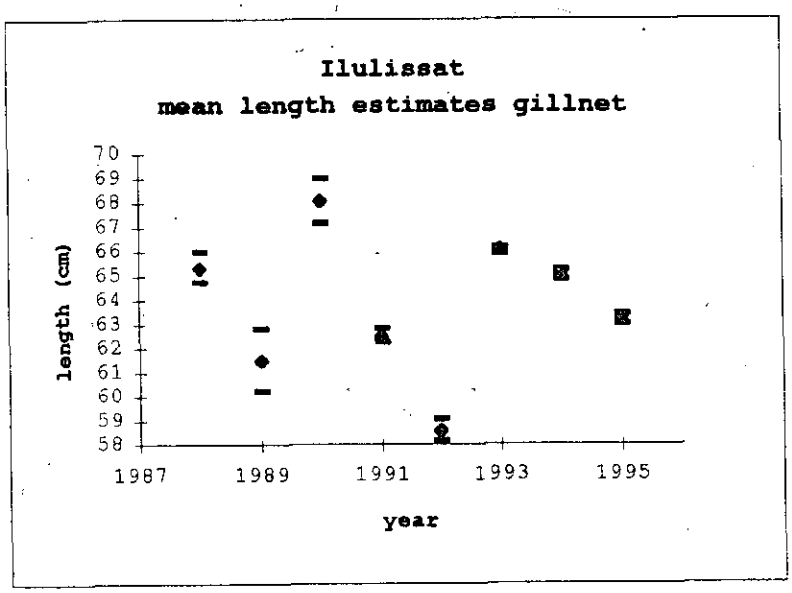

Fig. 4. Mean length estimates of gillnet catches at Ilulissat, after 10,000 bootstraps given with 95 % confidence limits.

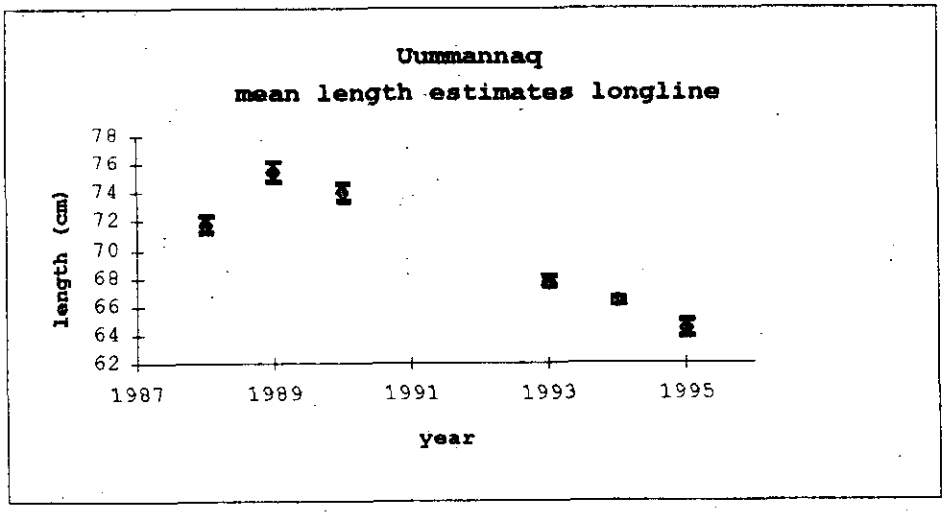

Fig. 5. Mean length estimates of longline catches at Uummannaq after 10,000 bootstraps given with 95 % confidence limits.

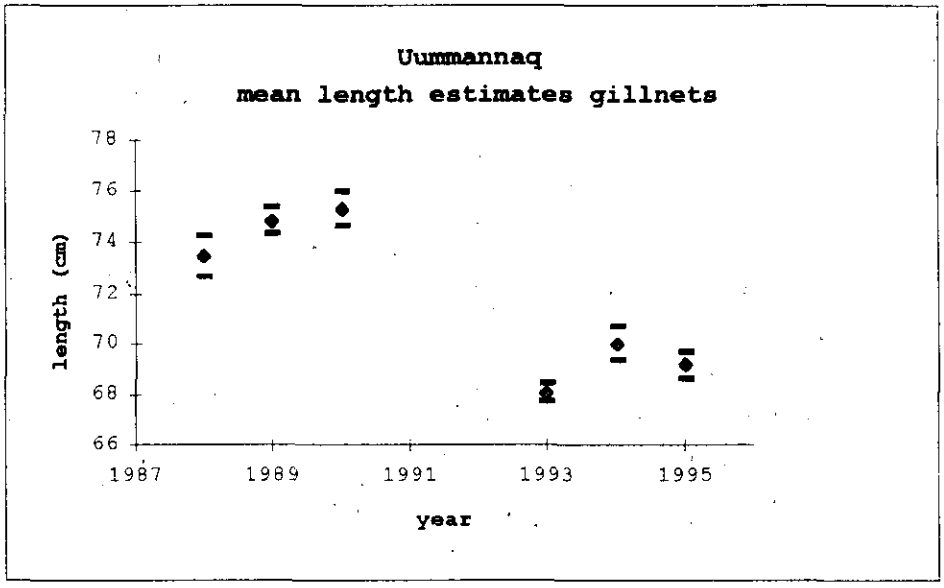

Fig. 6. Mean length estimates of gillnet catches at Uummannaq after 10,000 bootstraps given with 95 % confidence limits.

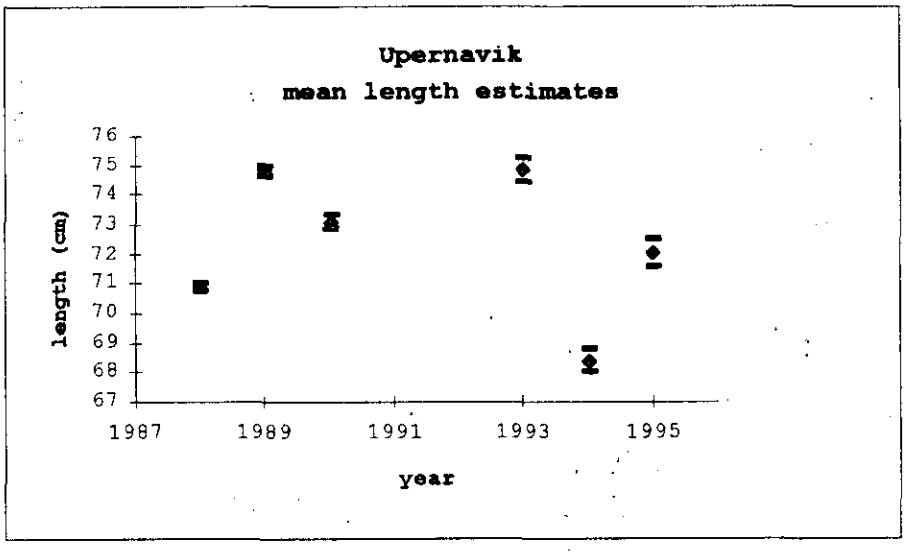

Fig 7. Mean length estimates of commercial catches at Upernavik after 10,000 bootstraps given with 95 % confidence limits.

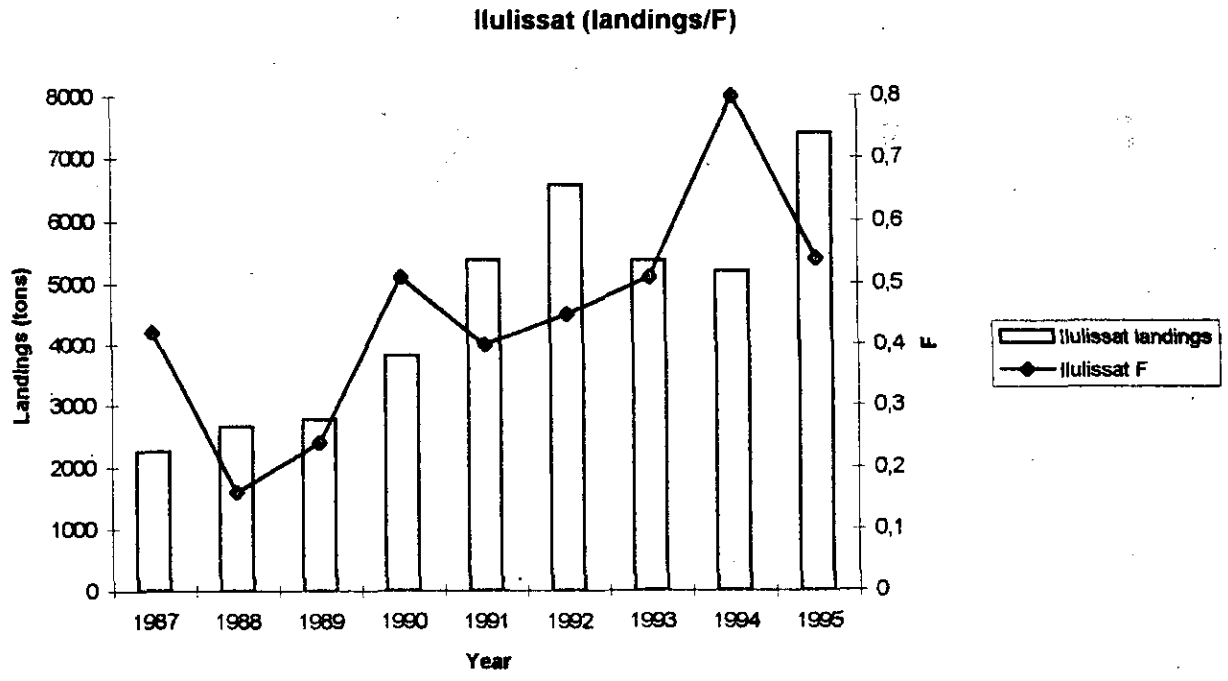

Fig. 8. Plot of landings and estimated F-values from Ilulissat in the period 1987 to 1995

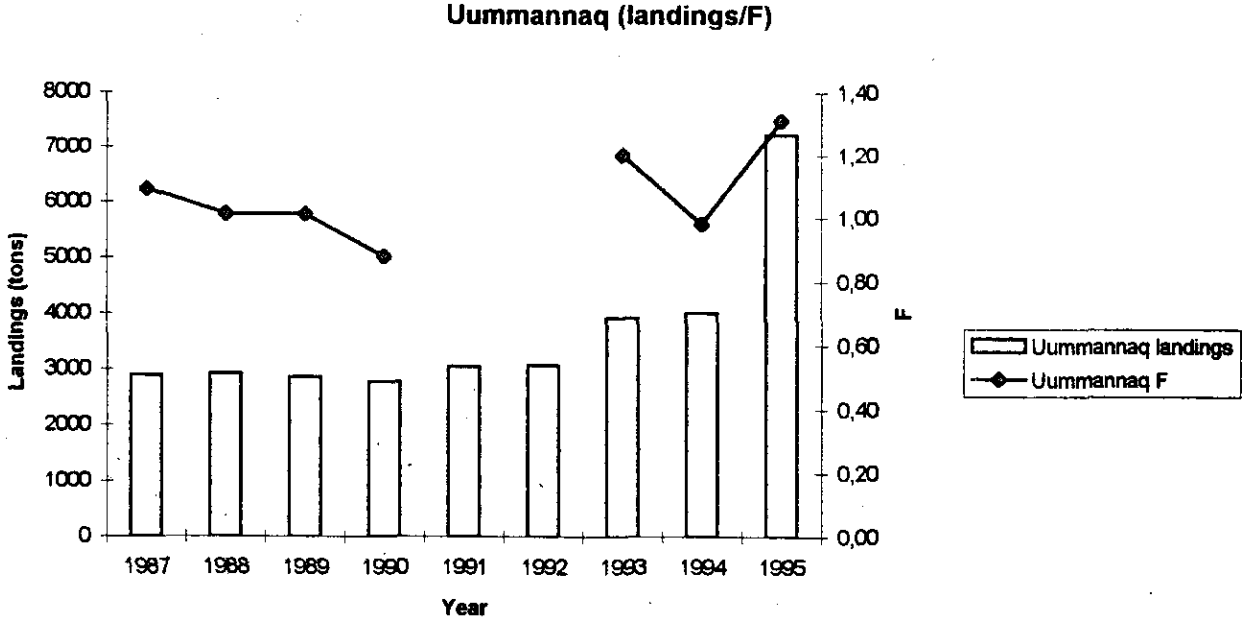

Fig. 9. Plot of landings and estimated F-values from Uummannaq in the period 1987 to 1995

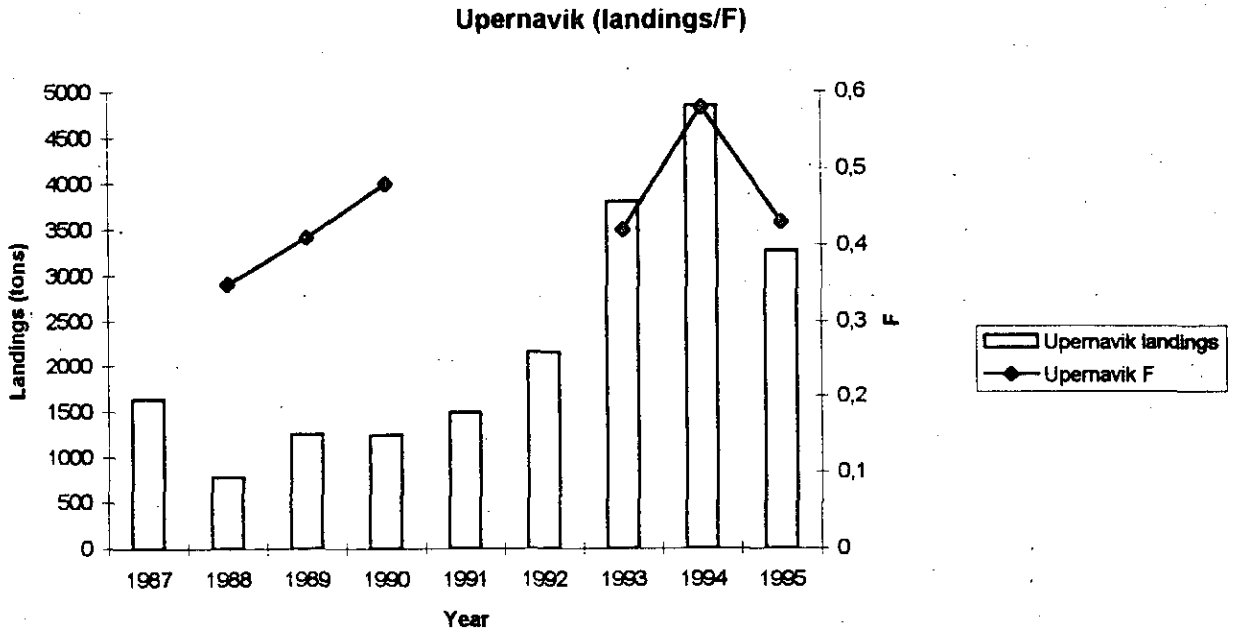

Fig. 10. Plot of landings and estimated F-values from Upernavik in the period 1987 to 1995.

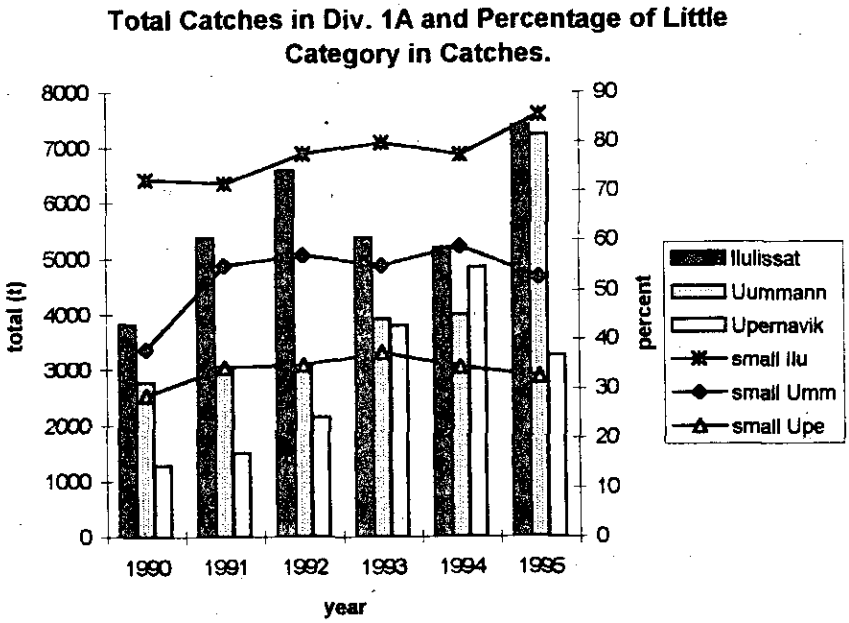

Fig. 11. Plot of catches in the three areas and the respective proportions of small fish in catches during the period 1990 to 1995.

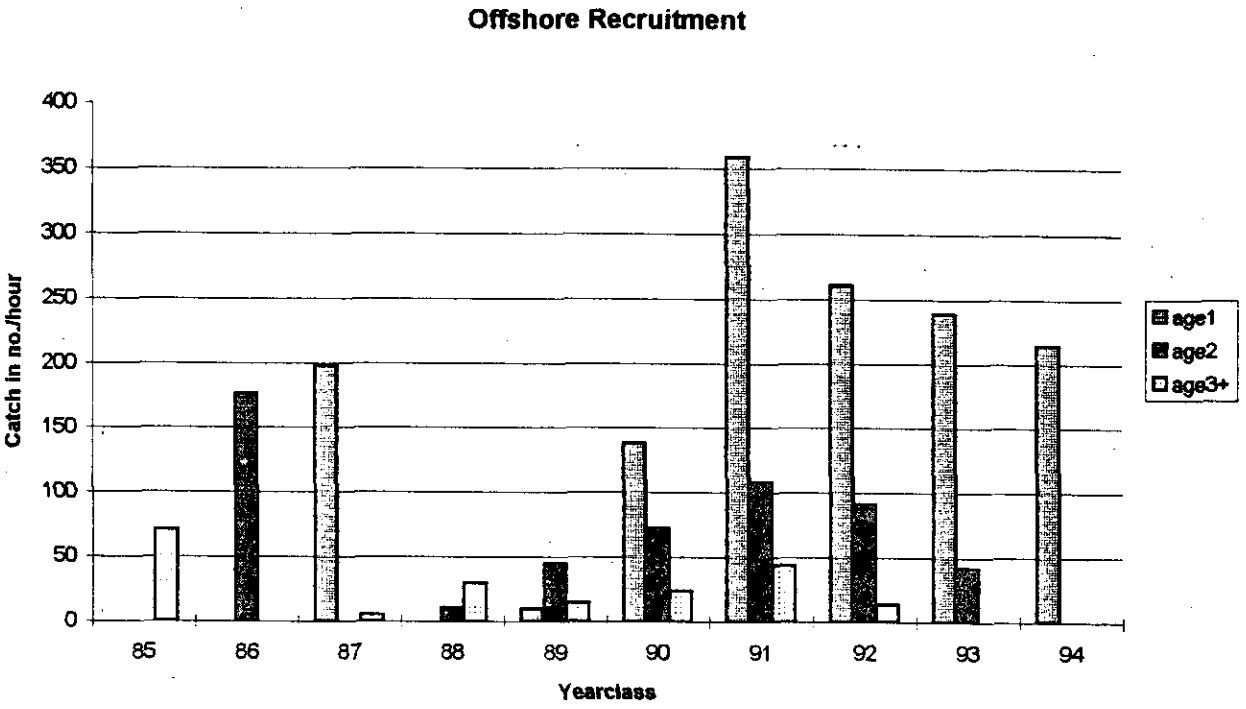

Fig. 12. Yearclass strength plotted as catch in numbers per hour, standardized index. The respective yearclasses can be followed to age 3 in data from Greenland trawl survey. Missing values are due to missing observations.

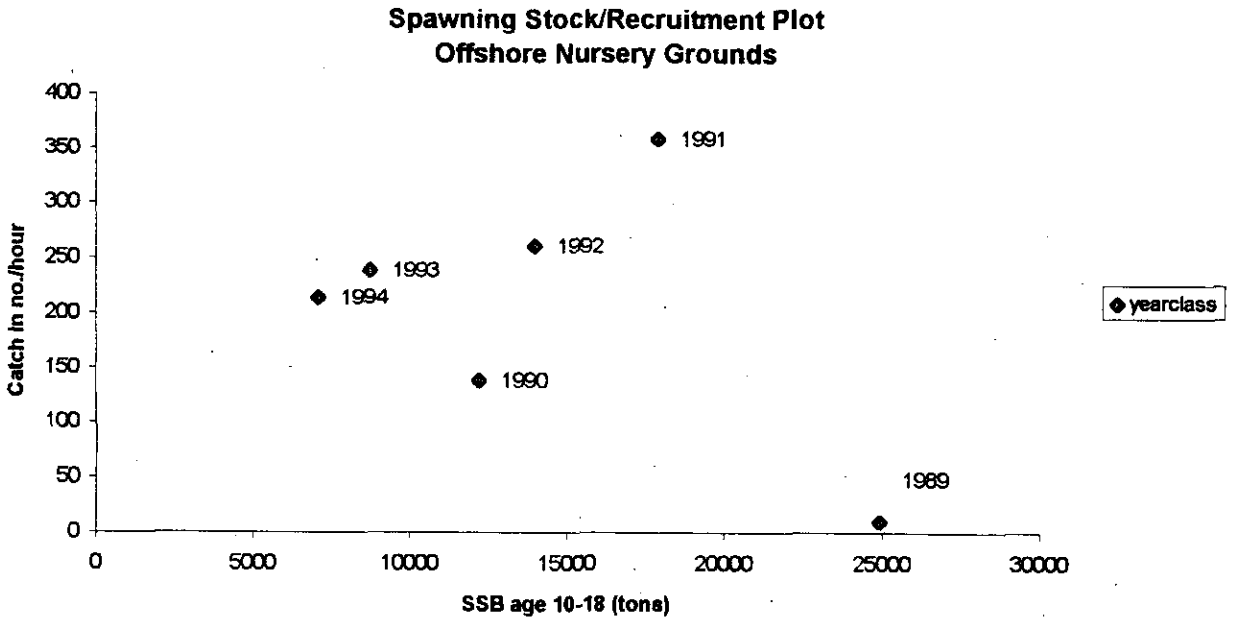

Fig. 13. Stock-recruitment plot from the offshore nursery grounds. Yearclasses are plotted as standardized indices to the offshore spawning stock biomass, estimated for their respective year of spawning.

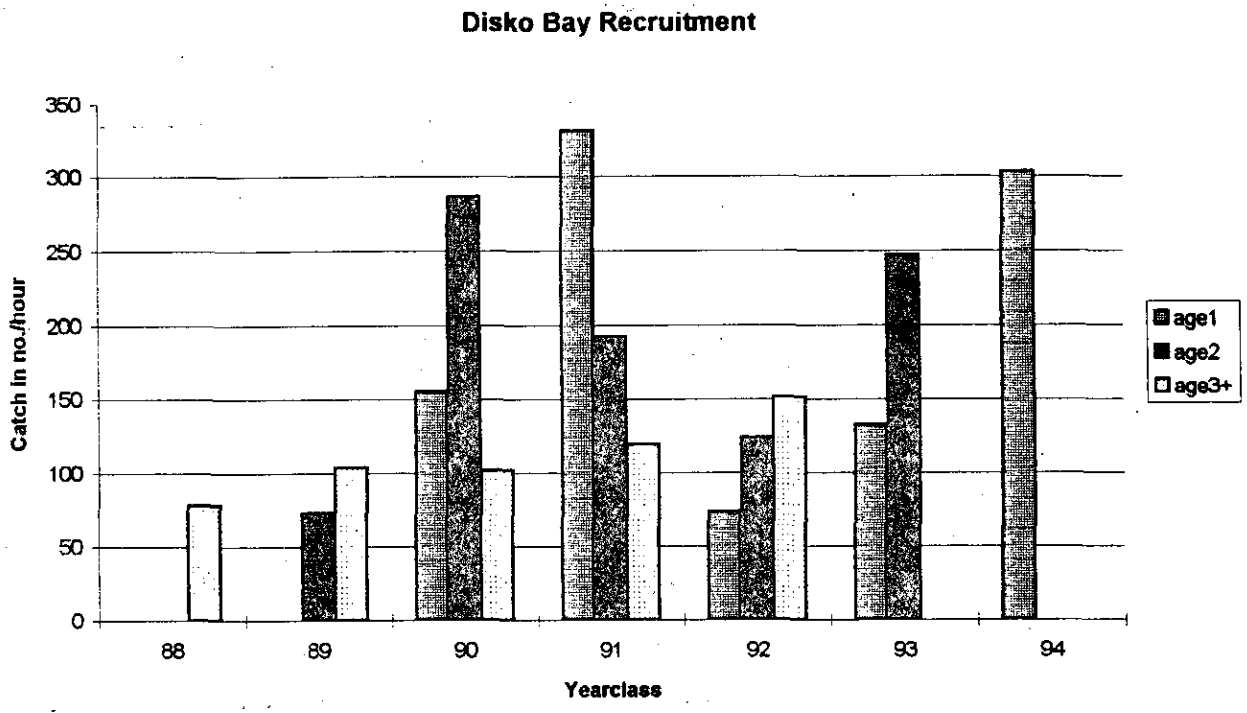

Fig. 14. Yearclass strength of recruits in the inshore area, plotted as catch in numbers per hour, standardized index. The respective yearclasses can be followed to age 3 in data from Greenland trawl survey. Missing values are due to missing observations.

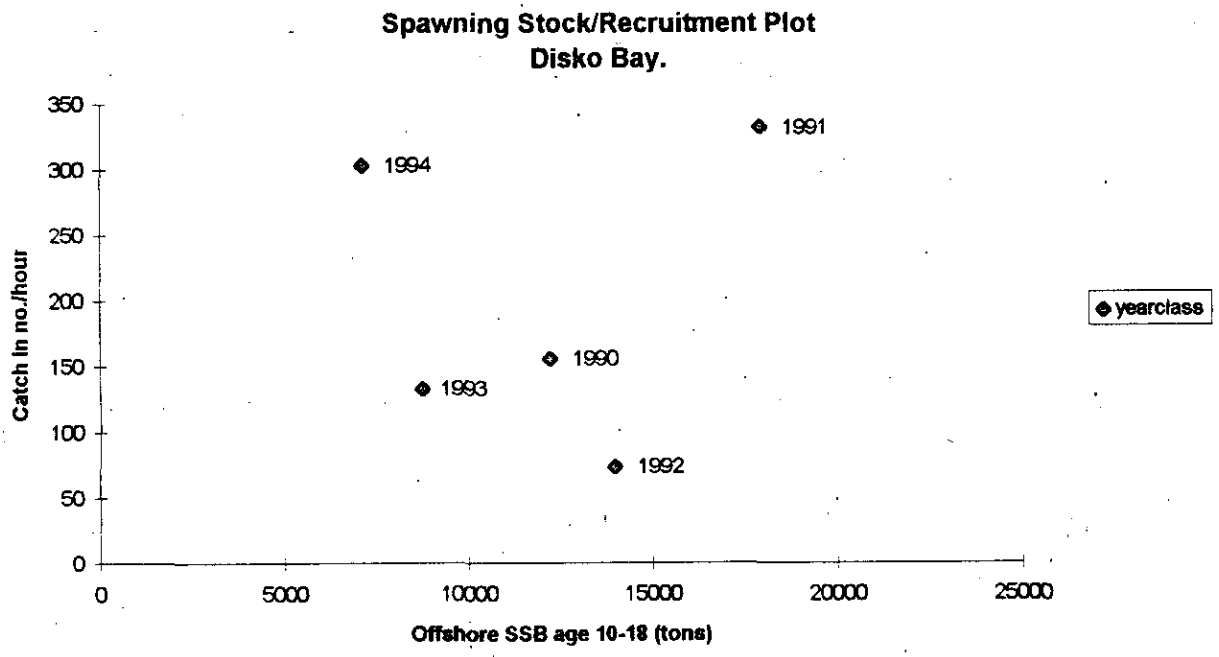

Fig. 15. Stock-recruitment plot from the inshore nursery grounds. Yearclasses are plotted as standardized indices to the offshore spawning stock biomass, estimated for their respective year of spawning.

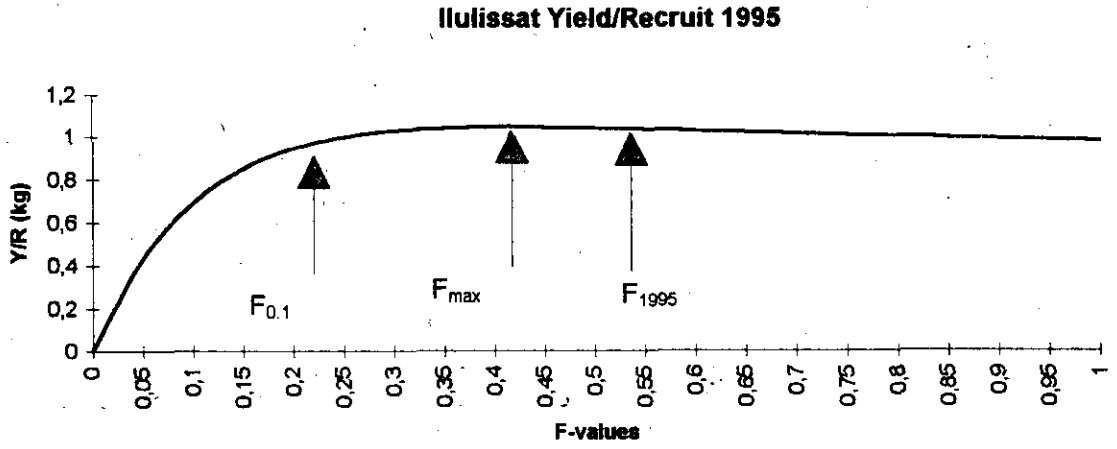

Fig. 16. Yield/recruit curve for Ilulissat 1995.

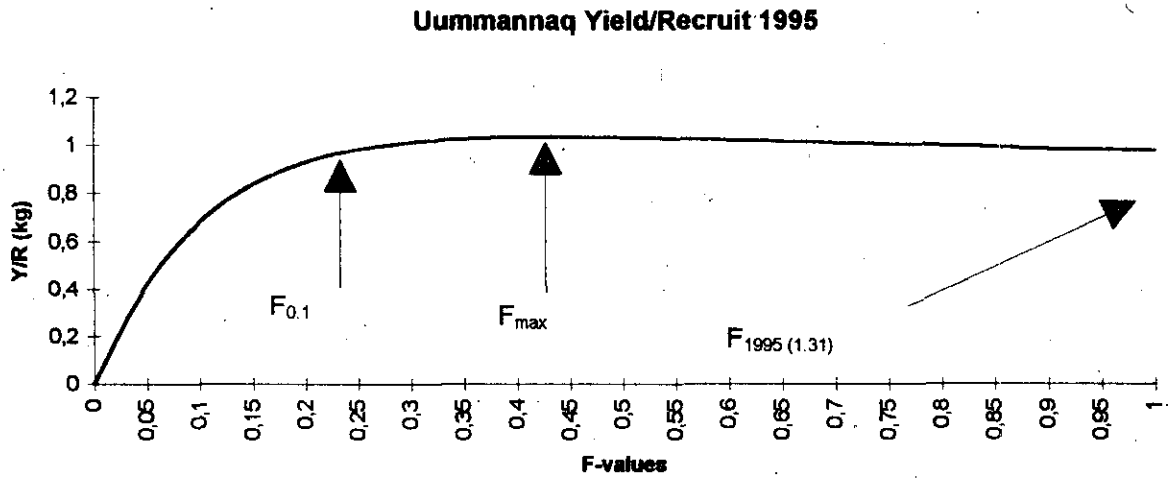

Fig. 17. Yield/recruit curve for Uummannaq 1995.

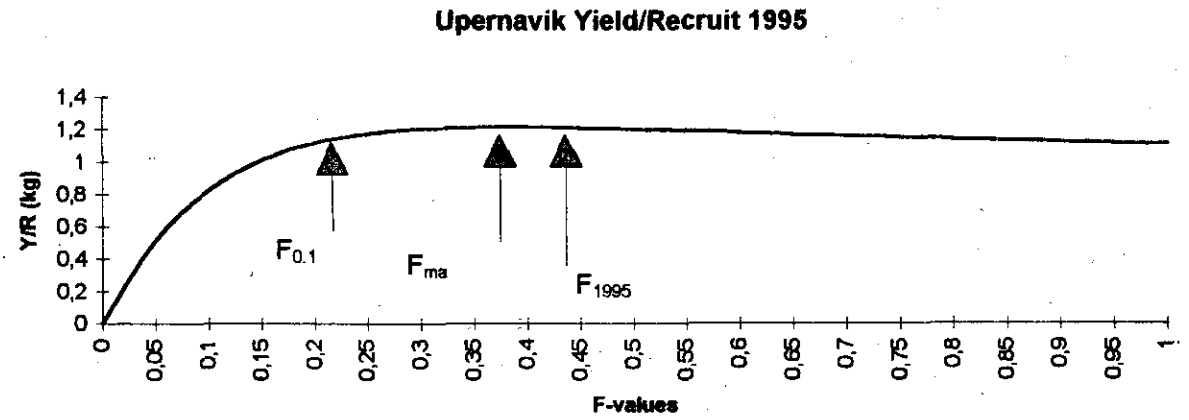

Fig. 18. Yield/recruit curve for Upernavik 1995.