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Assessment of the Greenland halibut Stock Component in NAFO Subarea 0 + Division 1A Offshore + Divisions 1B-1F

by

O.A. Jørgensen

Greenland Institute of Natural Resources
Pilestræde 52, Box 2151, DK-1016 Copenhagen

Abstract

The paper presents the background and the input parameters from research surveys and the commercial fishery to the assessment of the Greenland halibut stock component in NAFO Subarea 0 + Div. 1A offshore + Div.1B-1F. Catches peaked at 18,000 tons in 1992 but have been stable around 10,000 tons since then. The catch composition has been stable in recent years. Survey trawlable biomass in Div. 1CD was in 1999 estimated as 59,000 tons, which is a minor decrease from 70,000 tons estimated in 1998. In a new survey covering Div. 0B the biomass was estimated at 56,000 tons. Recruitment estimates at age 1 of the 1992-94 year-classes were lower than the presumably good 1991 year-class, but are still considered to be at or above average for the last decade. The 1995 year-class was estimated to be the best in the series. The 1996 and 1997 year-classes were estimated to be slightly below the average of the last decade while the 1998 and 1999 year-classes are above. A combined standardised CPUE index from Div. 0 and Div. 1CD has showed a minor increase compared to 1999, but the index has been stable during 1990-2000.

SCR.: 01/23,35,42,43; SCS Doc.:01/11,15,13,15,21.

1. TAC, description of the fishery and nominal catches.
(Catch figures for 2000 are from STATLANT 21A or from various other sources. In the latter case the reference is given in the text).

Between 1979 and 1994 a TAC has been set at 25,000 tons for SA 0+1, including Div. 1A inshore. In 1994 it was decided to make separate assessments for the inshore area in Div. 1A and SA 0 + Div. 1A offshore + Div.1B-1F. From 1995-2001 the advised TAC for the latter area has been 11,000 tons. In 2000 there was set an additional TAC on 4,000 tons for Div. 0A+1A for 2001.

In the period 1982-1989 nominal catches of Greenland halibut in SA 0 + Div. 1A offshore + Div.1B-1F fluctuated between 300 and 4,500 tons. Catches increased from 2,200 in 1989 tons to 10,500 in 1990. Catches stayed at that level in 1991 but increased again in 1992 to 18,100, the highest in the time series. Since then catches have been about 10,000 tons. The catch amounted to 10,713 tons in 2000. The increase in catches from 1989 to 1990 was due to a new trawl fishery by Canada and Norway and increased effort by Russia and Faeroe Islands in Div. 0B, while the increase from 1991 to 1992 was caused by a further increase in effort by Russia in Div. 0B and an increase in fishing activity in SA 1.

In 1983 annual catches in Div. 0B were about 4,500 tons. Catches then dropped to a level of 1,000 tons or lower, where they remained until they increased from 907 tons in 1989 to 9,498 tons in 1990. Catches decreased in 1991 to

8,606 tons, to increase again in 1992 to 12,358 tons. Catches then decreased gradually to 4,274 tons in 1994, but increased again to about 5,300 tons in 1995 and stayed at level until 1997. In 1998 catches dropped to 4,370 tons and they stayed at that level in 1999 where catches were 4,567 tons. In 2000 the catches increased to 5,438 tons including 45 tons taken in Cumberland Sound (SCR Doc. 01/43, SCS Doc. 01/15) (Table 1), all taken by Canada. Trawlers, including a twin trawler, took just over 50% of the catches, 521 tons were taken by longliners and 1,903 tons by gill-netters.

The catches in Subarea 1 (Div. offshore 1A Div. + 1B-1F) were below 1,600 tons during the period 1982-1990. In 1991 catches increased to 2,376 tons and were around 5,500 tons in the period 1992-1995, but decreased to around 4,500 in the period 1996-1998. Catches increased slightly to 5,076 tons in 1999 and 5 275 tons in 2000. Almost all catches were taken offshore. Trawlers from Greenland (SCS Doc. 01/21), EU-Germany, Norway and Russia (SCS Doc. 01/11) took 4,243 tons and Grenlandic gilnetter took 772 tons. Further 259 tons taken by trawlers were not reported. Almost all the catches were taken in Div. 1D except 151 tons taken during a research fishery north of 68 50N. Inshore catches were estimated to 1 tons. (Table 2).

2. Input data

2.1 Research trawl survey

1CD GHL-survey

Since 1997 Greenland has conducted stratified random bottom trawl surveys in September-October for Greenland halibut in NAFO Div. 1CD at depth between 400 and 1500 m. In 2000 30 hauls were made (SCR Doc. 01/23). The biomass and abundance was estimated at 59,092 tons and 61.710 10^6 specimens, which is a statistically insignificant (95% level) decrease in biomass from 64,398 tons in 1999 and a statistically insignificant (95% level) increase in abundance from 61.366x10^6 specimens. The 2000 estimate of biomass and abundance is within the range of the other estimates in the short time series and not statistically different from them (70,474 tons and 67.667x10^6 specimens in 1998 and 56,260 tons and 53.613x10^6 specimens in 1997). The highest densities were found at depths > 1200 in Div. 1D. Three small strata, which normally yield biomasses and abundances < 1,500 tons and 1x10^6 individuals, were not covered in 2000. The over all length distribution was dominated by a mode around 45 cm with two smaller modes at 43 and 47 cm. Previously the most dominant mode has been around 47-48 cm. The over all age distribution in 2000 was dominated by a mode around age 6 as in 1998. In 1999 the mode was at age 7.

Shrimp -survey

Since 1988 annual trawl surveys with a shrimp trawl have been conducted off West Greenland in July-September. The survey covers the area between 59°N and 72°30'N (Div. 1A-1F), from the 3-mile limit to the 600-m depth contour line. Estimated total trawlable biomass of Greenland halibut in the offshore areas (- Disko Bay) has fluctuated between 6,800 and 15,020 tons during 1992 – 1999. In 2000 the biomass was estimated at 8,525 tons, which is a decrease from 15,020 tons estimated in 1999. The abundance was estimated at 190x10^6, which is a small decrease from 199x10^6 estimated in 1999. The decrease in Biomass was seen in most Divisions but was by far most pronounced Div. 1AN (SCR Doc. 01/35). The decrease in abundance was mainly seen in Div. 1AN, while there was a small increase in most of the nursery area ((Div.1AS, 1BN). Almost all the catches were comprised of one-year-old fish (86%).

In the Disko Bay the biomass and abundance was estimated at 9,608 tons and 160x10^6, which is an increase from 8,117 tons and 94x10^6 estimated in 1999. Both the biomass and the abundance estimates are the second highest recorded in the time series (since 1991).

The biomass in the nursery area (1AS and 1B) was estimated at 4,998 tons compared to 7,517 tons in 1999. The abundance was estimated at 125x10^6 compared to 121x10^6 in 1999. The abundance estimate from 2000 is above the level in 1990-1991 and 1997-1999, but below the 1992-1996 levels (145-342x10^6).

0B GHL-survey

In October 2000 a stratified random bottom trawl survey was conducted in Div. 0B covering depths between 401 and 1500 m (SCR 01/42). The survey was conducted by the same vessel and used the same gear as the survey in Div.

1CD. The biomass was estimated at 56,212 tons and the abundance at $74.6x10^6$, respectively. The highest densities were found between 1001 and 1250 m. Length ranged from 7 to 92 cm with modes at 19 and 43-45 cm Ages ranged from 0 to 19 years, with the highest abundance at age five (1995 year-class).

The length distributions in the three surveys are shown in fig.1.

Recruitment

A recruitment index was provided from the Greenland shrimp trawl survey. By means of the Petersen-method ages 1, 2 and 3+ were separated in the survey catches in the nursery area (Div. 1AS-1B) for the period 1988 to 2000. Catches were standardized as catch in number per hour as described in Bech (1995). Data were plotted by year-classes to visualize the relative year-class strength and development in relative abundance (Fig. 2).

The recruitment index has been declining since the presumably large 1991 year-class, but the recruitment has been above the level in the 1980s. The recruitment increased again with the 1995-year-class, which was the largest on record. With a mean catch of 246 one year old specimens per hour the 1999 year-class in the off shore recruitment area seems to be a little above average for the time series. In Disko Bay catches of one year old fish is the second largest on record (983 specimens per hour). The very large 1997 year-class has almost disappeared as age 3.

SSB/Recruitment

The relation between the spawning stock in numbers (ages 10-18) in Div. 1CD from the joint Japan/Greenland survey and the Greenland 1CD survey and recruitment, given as the number of fish age 1 in the total survey area estimated from the Greenland shrimp trawl survey, is shown in Fig 3. Note that the coverage in 1989 and 1990 was incomplete and that there was no survey in 1996. The over all recruitment of the 1999 year-class was the second largest in the timeseries. This is caused by a combination of very good recruitment in the Disk Bay and above average recruitment in the offshore areas (SCR Doc. 01/35).

2.2 Commercial fishery data.

Length and age distribution

Catch-at-age data were available from the EU/German offshore trawl fishery in Div. 1D (SCS 01/13) and from length frequencies from Greenlandic trawlers (SCS 01/21) combined with age data from the GHL survey in Div. 1CD. Catch-at-age in the gillnet fishery in 1CD (772 tons) was estimated using Canadian data.

Catch-at-age by gear (trawl, twin trawl, longlines and gill net and for gears combined was available from SA 0 (SCR 01/43). Table 3 and 4 shows catch-at-age and weight-at-age, respectively.

The age distributions for trawl, longline and gillnets, respectively, are given in Fig. 4.

Age 7 is the most dominant in the trawl fishery as seen in most years. The mode in the age distribution in the gill net was at 11 while it was at age 10 in 1998 (no 1999 data). The mode in the longline fishery was at age 9 as in 1999.

Mean weight at age

The overall mean weight at age for the ages 7-12 in the commercial offshore fishery has been stable in resent years (Table 4). There is a decrease in mean weight at age for fish older than 12 years between 1999 and 2000. This decrease is only seen in the Greenland data (SCR 01/23), but influence the overall mean weight at age. The decrease is probably caused by misinterpretation of the otoliths.

Catch rate

Unstandardized catch rates were taken from logbooks from the trawl fishery Div. 1CD and from (SCS Doc. 01/13) for EU(German) trawlers during 1996-1999. The catch rates from the Greenland, German and Norway fleets showed minor increases compared to 1999, but they are still at the same level as in resent years. The increase in the Greenland catch rates is to some extend caused by the introduction of a large new trawler. The other Greenland trawler engaged in the fishery showed however also an increase between 1999 and 2000. Fig. 5.

Standardized catch rate series from the offshore trawl fishery in SA0 (0B) was available for the period 1990-1998 and they showed stable catch rates during the period (SCR Doc. 99/47).

Standardized catch rate series were available for the offshore trawl fishery in SA1 (1CD) for the period 1988-2000 based on available logbook data and data from the EU-German trawl fishery (SCS Doc. 01/13).

The standardized catch rates in SA 1 dropped from 1989-1990 but has been stable since then and showed a small increase in 2000 (Fig. 6). The increase was caused by small increases in German, Norwegian and Greenlandi catch rates. (Fig. 6).

A combined standardized catch rate for SA0 and SA1 was made based on the data from the two areas. The catch rates were stable in the period 1988-1989 (one large vessel in SA1 only and catches < 2600 tons), but dropped in 1990. From then on the catch rates haven been stable with minor fluctuations but with a small increase from 1999 to 2000 (Fig. 6, Appendix 1). A Canadian twin trawler fishing for the first year in SA 0 is not included. Due to frequency of fleet changes in the fishery in both SA0 and SA1, and the few data from SA0 in 2001, the standardized indices of CPUE should however be treated with caution.

3. Assessment.

3.1 Yield per Recruit Analysis.

The level of total mortality has in 1994-1996 been estimated by means of catch-curves using data from the offshore longline fishery in Div. 1D. Z was estimated from regression on age 15-21. A relative F-at-age was derived from the catch curve analysis, where the trawl, longline and gillnet catches were weighed and scaled to the estimated stock composition. In all three years STACFIS considered that the estimation of Z was based on too limited samples and represented too small a part of the fishery and that the outcome of the catch curve analysis were too uncertain to be used in the yield per recruit analysis. In 2000 data were sampled from the Canadian longline fishery (521 tons) representing less than 5% the catches, hence no Catch-curve analysis was attempted.

3.2 XSA/ separable VPA.

XSA

An XSA has been run unsuccessful several times during the 1990'ies, using a survey series covering 1987-1995 as tuning. STAFIS considered the XSA's unsuitable for an analytic assessment due to high log-catchability residuals and S.E.'s and systematic shift in the residuals by year. Further, a retrospective plot of F_{bar} showed poor convergence. In 1999 the XSA analyses was rerun including the latest two years surveys (1997-1998, new vessel and gear) (not presented) but the outcome of the analysis has not improved. An XSA analysis was not attempted this year.

Separable VPA

In 2000 a number of combinations of F and S were used to estimate numbers at age from a separable VPA. Average q's were estimated for each combination using the survey data from the Greenland Greenland halibut survey (age 5-16) 1997-1999 and population estimates from the separable VPA. The average q's were used to estimate survey based population numbers. The ln-transformed sum of the residuals of the difference between the separable VPA estimated population number at age and the estimates from the survey was minimized in order to find the most appropriate combination of F and S to be used as input parameters in a separable VPA. In 1999 the most appropriate F and S was estimated at F=0.5 for age 8 and S=1.8.

The output is shown in Appendix 2 in SCR Doc. 00/38. There is seen a systematic shift in the residuals from 1994 to 1995. This is probably caused by the introduction of the gill net fishery in Div 0B and the increase in the longline catches in 1995. Hence the assumption of constant exploitation pattern has not been fulfilled. The estimated biomasses are about 1/3 of what should be expected from the swept area estimates from Div. 1CD and the pattern of the development in the estimated biomasses does not fit the pattern observed in the surveys, especially not at the beginning of the period. The recruitment at age 5 in 1999 is estimated to be almost two times larger than in the pervious years. The 1994 year-class was estimated to be among the smallest from the shrimp survey.

Further, it should be pointed out that there have been inconsistencies in the aging during the years because of poor sampling. In SA1 age length key from the Canadian fishery in 0B (1997), German fishery (1998), Russian fishery (1998) and Greenlandic surveys (various years) have been used and there has been considerable variation in the interpretation of the otolith. Further, samples from gill net have been used to raise longline catches and visa versa.

This year the most appropriate input parameters used as input parameters in a separable VPA was estimated at F=0.9 and S=2.0. The outcome of the analysis has, however, not improved and is not presented.

3.3 Spawning stock/recruitment relations.

A spawning stock/recruitment plot based on the available observations from the joint Japan/Greenland survey and the Greenland survey is shown in Fig. 3. No further analysis of spawning stock recruitment relationships have been made due to few observations distributed on two different surveys, poor estimate of spawning stock biomass (survey trawl only take a small proportion of the mature fish, the survey covers only a restricted part of the area covered by the assessment, further, knife edge maturity ogive was applied). Further, the age of the recruits is relatively poor estimated (the Petersen method).

3.4 ASPIC

ASPIC was run in 1999 with standardized CPUE data and a biomass index as inputs. Three CPUE series were available, one series covering Div. 0B during the period 1990-1998, one covering Div. 1CD during the period 1987-1998 and a series combining the two data sets. The biomass index was from 1CD and covered the period 1987-1995 and 1997-1998. Several runs showed that the combined CPUE series from Div. 0B+1CD fitted the total catch data best in terms of r^2 and “total objective function”. Runs with biomass alone gave relatively bad fits in terms of “total objective function” and r^2 and the modeled population trajectory declining drastically over the period. Runs with the CPUE series from 0B gave unrealistic high B_{msy} and negative r^2. The run with the combined CPUE series showed, however, that sensitivity analysis should be run, because “the B1-ratio constraint term contributed to loss”. Several runs with different realistic values for the constraint did not solve the problem. Further, the coverage index and nearness index was equal in all runs. Several runs with different constraints on r and MSY were tried but it did changes the outcome of the analysis. Removing the three first years from the input data gave negative r^2. To get measures of variance the run with the combined CPUE series was bootstrapped (500 resamplings).

The results showed that estimated fishing moralities 1987-1998 have been less than the (bias-reduced) estimate of F_{msy} (0.22) except for one year (1992).

A number of essential parameters are quite imprecisely estimated (r, q, F_{msy}), and it is considered that the estimates of MSY and F_{msy} were not precise enough to be used.

The input parameters from 1999 (catches, survey biomass index, and CPUE index) have only changed very little compared to previous year and it was not expected that the outcome of an ASPIC analysis would change significantly, hence the analysis was not attempted.

4. Prognosis

Since catches peaked with 18.000 tons in 1992 they have been stable at around 10.000 tons. The age composition in the catches seems stable. Standardized catch rates in Div. 1CD have increased slightly from 1999 to 2000, and the catch rates from Div. 1CD seems to be a little above average level for the period 1990-1999. The combined catch rate has showed very little variation during the period.

Survey biomass decreased slight from 1998 to 2000 (59,092 tons) but was higher than in 1997. The length distribution in the survey 1999 showed a mode around 43-47 cm, where it used to be around 46-48 cm in previous year's surveys. A new survey covering Div. 0B gave an estimated biomass of 56,212 tons. The length distribution showed a broad mode around 19cm and 43-45 cm. The recruitment increased further in 2000 and seems to be well above average.

5. Biological reference points.

Yield per recruit analysis or other age-based methods are not available, for estimating biological reference points. Biomass indices and CPUE series are relative short and show little variability and are not useful for estimating reference points.

6. References

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Table 1. Greenland halibut catches (metric tons) by year and country for Subarea 0 from 1987 to 2000.

	Year													
Country	87	88	89	90	91	92	93	94	95[a]	96[a]	97[a]	98[a]	99[a]	00[a]
CAN	-	2	-	589	256	2194	883	-	1656	2293	3805	4370	4601	5438
EST	-	-	-	-	-	-	631	-	-	-	-	-	-	
FRO	388	963	596	2252	2401	463	1038	-	-	3013	-	-	-	
JAP	-	-	-	113	232	337	252	600	1031	500	-	-	-	
LAV	-	-	-	-	-	-	83	-	-	-	-	-	-	
NOR	-	-	282	5016[d]	3959	-	373	-	-	-	-	-	-	
RUS	-	59	29	1528	1758	9364	4229[b]	3674	261	915	-	-	-	
TOTAL	388	1024	907	9498	8606	12358	7489	4274	5299[c]	6721	5740[e]	4370	4601[f]	5438[g]

[a] Provisional data.
[b] The Russian catch is reported as area unknown, but has previously been reported from 0B
[c] Including 2351 tons non-reported.
[d] Dobbel reported as 10031 tons
[e] Including 1935 tons non-reported
[f] Including 34 tons from Cumberland Sound
[g] Including 45 tons from Cumberland sound

Table 2. Greenland halibut catches (metric tons) by year and country for Subarea 1 from 1987 to 2000.

	Year													
Country	87	88	89	90	91	92	93	94	95[a]	96[a]	97[a]	98[a]	99[a]	00[a]
GRL (excl. 1A inshore)	-	-	-	-	965	227	213	885	1405	1880	2312	2295	2622	2657
FRO	-	-	-	54	123	151	128	780	142	128	127	-	-	-
JPN	907	1581	1300	988	677	2902	1198	820	337	-	-	-	-	-
NOR	-	-	-	-	611	2432	2344	3119	2472	1839	1893	1339	1356	1115
RUS	-	-	-	-	-	-	5	-	296	254	-	543	552	800
EU	-	-	-	-	-	-	46	266	527	455	446	350	415	444
1A-F (excl. 1A inshore)	907	1581	1300	1042	2376	5712	3934	5870	5179	4556	4778	4527	5076[b]	5275[c]

[a] Provisional data.
[b] Including 131 tons non-reported.
[c] Including 259 tons non-reported.

Table 3. Catch numbers at age

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE														
5	2	1	1	4	20	53	241	254	163	169	60	76	270	417
6	31	29	36	87	318	678	651	862	608	646	428	378	1122	1109
7	182	190	244	592	1742	2967	2422	2472	2147	2429	1951	818	1767	1681
8	296	354	409	1711	2679	4311	2356	1692	1209	2014	2401	1140	1170	1146
9	193	245	212	1356	1418	2604	1048	954	721	872	1152	905	669	774
10	77	115	75	711	533	951	590	294	359	415	481	583	372	502
11	40	80	47	359	221	398	224	183	298	208	256	430	234	443
12	18	61	48	195	144	231	130	159	257	158	127	209	183	291
13	10	58	44	189	108	158	72	125	131	76	100	155	171	179
14	9	46	42	115	60	85	59	58	93	64	22	99	95	69
15	6	35	26	67	36	45	37	55	93	43	13	19	60	75
16	3	15	12	17	6	23	26	34	44	38	12	4	38	16
17	4	4	1	3	2	1	4	10	19	14	0	0	18	4
+gp	2	1	0	0	0	0	2	7	10	22	0	0	6	6
TOT.NU	873	1234	1197	5406	7287	12505	7862	7159	6152	7168	7003	4816	6175	6712
TONS	1295	2605	2207	10540	10982	18070	11423	10144	10478	11277	10518	8897	9677	10713

Table 4. Catch weights at age (kg)

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE														
5	0.29	0.29	0.29	0.33	0.34	0.33	0.58	0.43	0.48	0.51	0.36	0.50	0.54	0.53
6	0.51	0.51	0.51	0.54	0.54	0.56	0.72	0.62	0.65	0.67	0.55	0.71	0.70	0.72
7	0.74	0.74	0.74	0.79	0.79	0.80	0.96	0.91	0.93	0.93	0.86	0.97	0.98	1.00
8	1.08	1.08	1.08	1.10	1.12	1.13	1.26	1.26	1.33	1.37	1.27	1.25	1.28	1.30
9	1.41	1.42	1.42	1.52	1.57	1.59	1.80	1.72	1.81	1.89	1.83	1.57	1.65	1.71
10	1.97	2.05	2.00	2.11	2.27	2.28	1.43	2.19	2.41	2.47	2.37	2.24	2.25	2.26
11	2.58	2.80	2.68	2.94	3.22	3.02	3.25	2.73	2.93	3.17	3.01	3.09	2.70	2.84
12	3.52	3.88	3.73	3.90	4.24	4.02	4.10	3.43	3.69	4.03	3.84	3.84	3.67	3.59
13	4.64	5.01	4.87	4.96	5.50	5.33	5.26	4.48	4.54	5.06	4.93	4.74	4.72	4.22
14	5.79	6.16	6.20	6.26	6.82	6.76	6.17	5.75	5.64	5.95	5.70	6.04	5.59	5.19
15	6.61	7.44	7.65	7.96	8.33	7.76	7.42	6.58	6.66	7.29	6.79	6.60	6.66	5.84
16	7.99	8.88	9.36	9.90	9.89	8.58	8.04	7.36	7.81	8.63	8.00	13.45	7.73	7.33
17	9.56	9.86	9.56	11.86	9.56	11.95	9.24	9.42	10.19	9.16			9.11	8.59
+gp		11.33					10.25	11.15	11.00	11.10			11.01	9.00

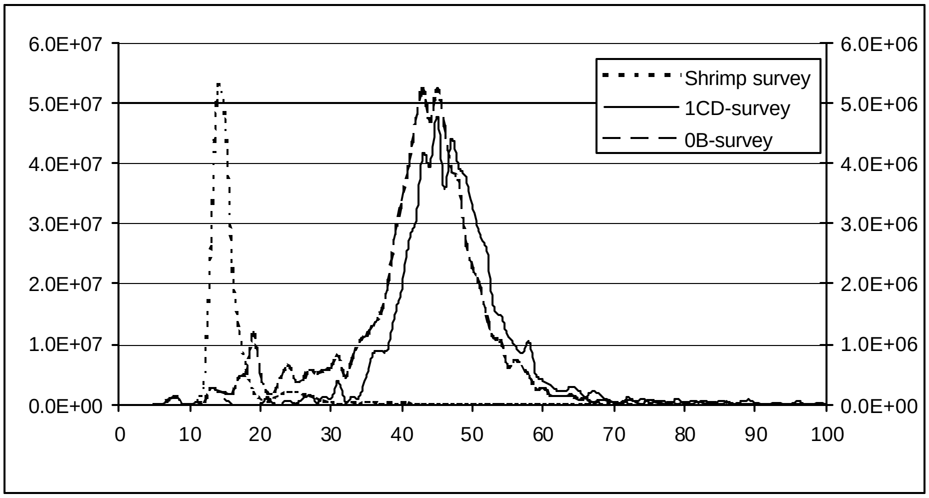

Fig. 1. Length frequencies of Greenland halibut in the Greenland shrimp survey (left y-axis), the Greenland surveys in Div. 1CD and the Canadian survey in Div. 0B (right y-axis).

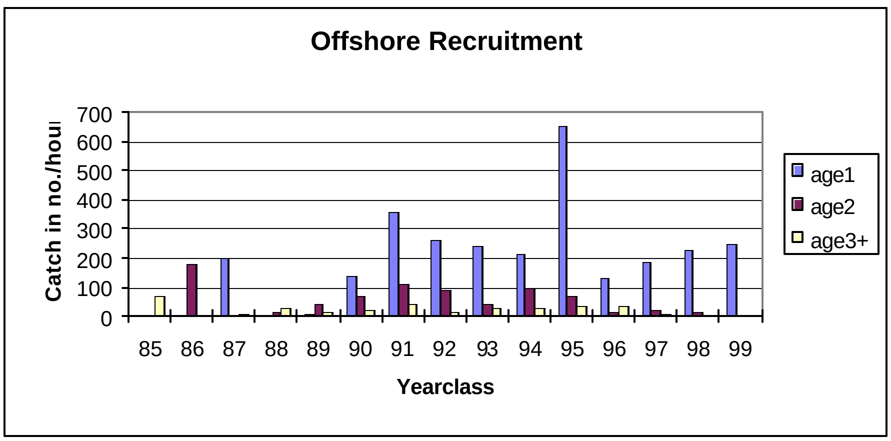

Fig. 2. Year-class strength of Greenland halibut of ages 1-3+ in number per hour trawled in the offshore nursery area.

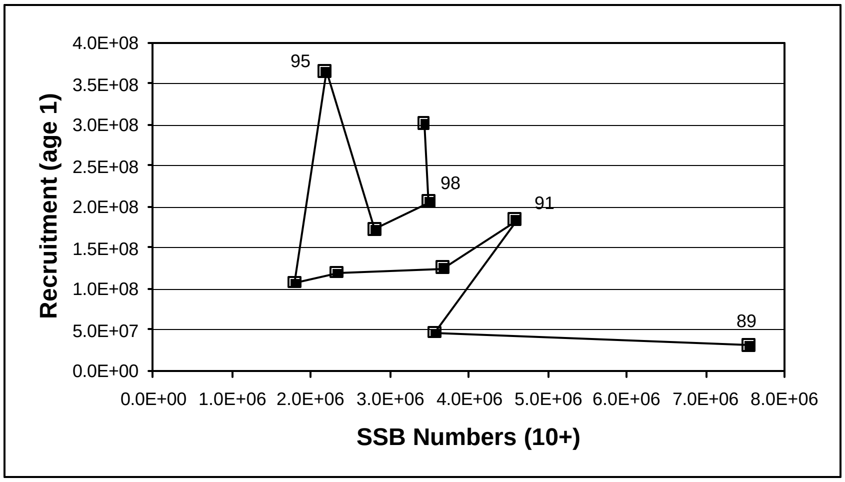

Fig. 3. Spawning stock in numbers (ages 10-18 in Div.1CD from the joint Japan/Greenland survey and the Greenland survey (1997-2000)) plotted vs number of fish age 1 the following year estimated from the Greenland shrimp trawl survey including the Disko Bay. Note pure coverage in 1989 and 1990 and that there was no survey in 1996.

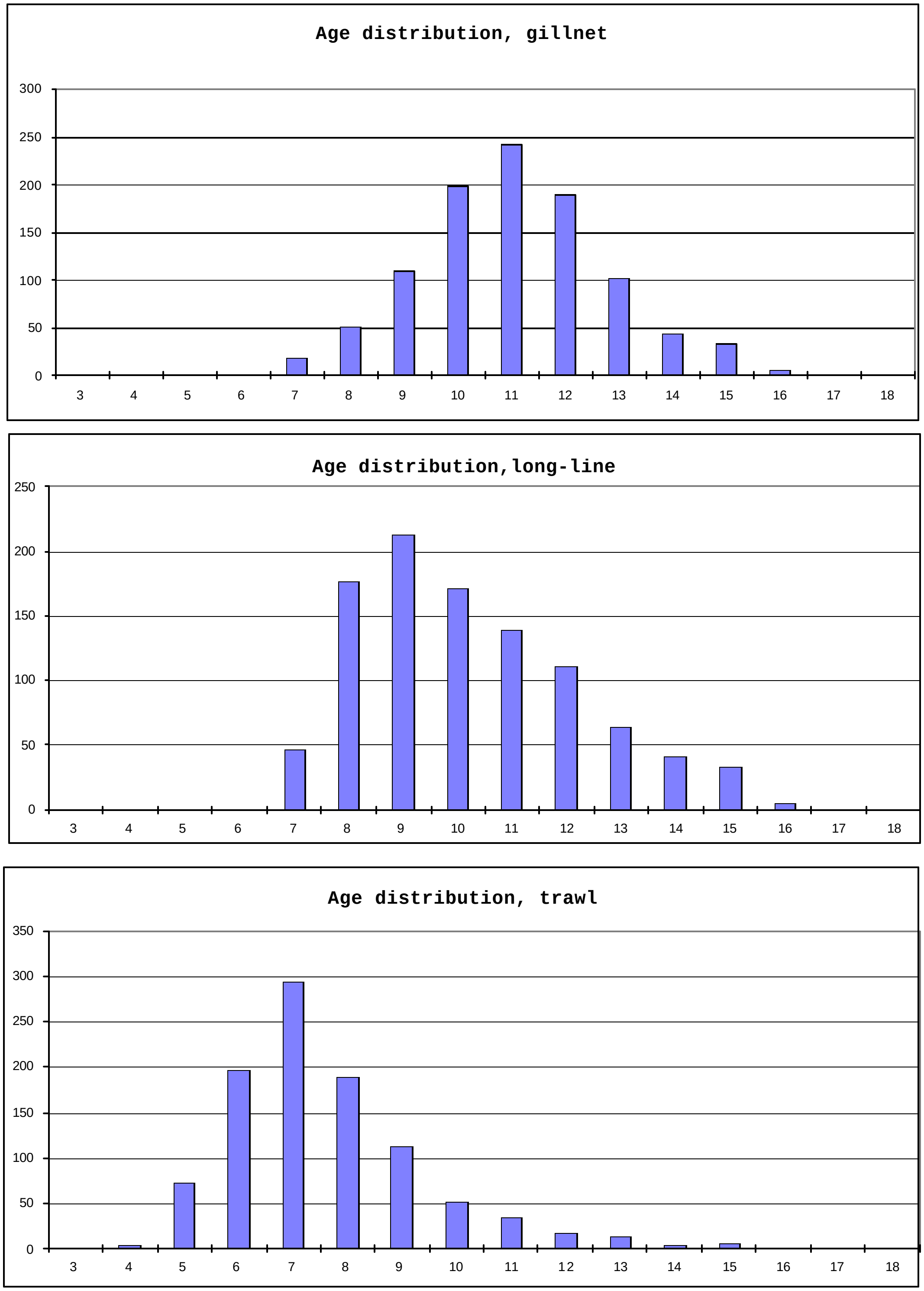

Fig 4. Age distribution in the longline, trawl and gill net fishery in SA 0+1 in 2000 in per mill.

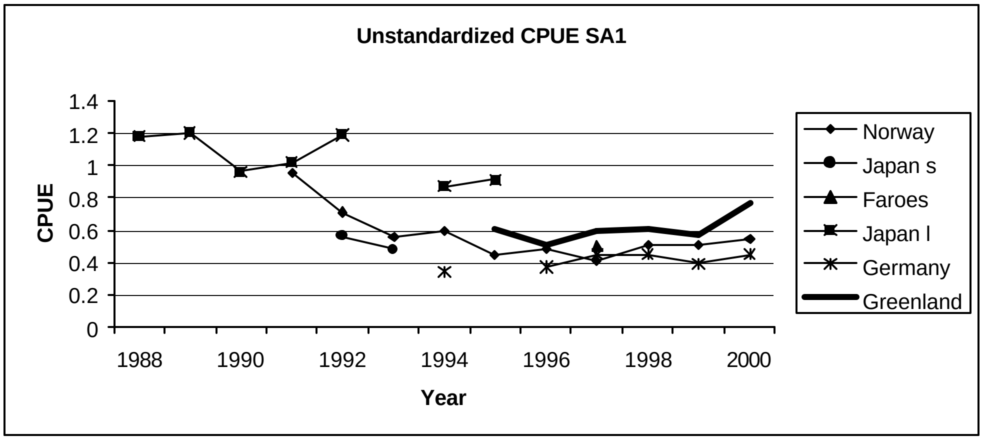

Fig. 5. Unstandardized trawl CPUE series from Div. 1CD.

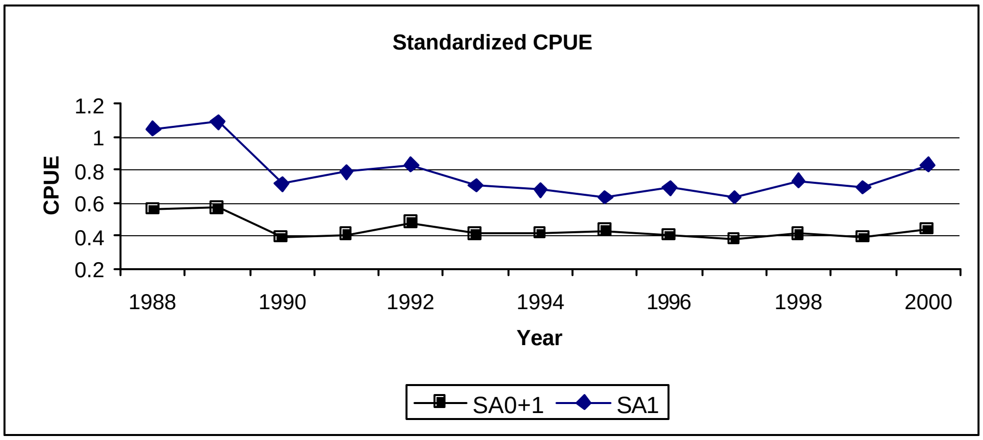

Fig. 6. Standardized trawl CPUE indices from SA1 (Div. 1CD) and SA0+1 (not corrected for retransformation).

Appendix 1. Combined standardized CPUE index SA0+1

The GLM Procedure

Class Level Information

Class	Levels	Values
YR	13	1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
MD	11	1 2 4 5 6 7 8 9 10 11 12
CGT	19	2 3 4 5 6 7 8 9 10 2126 2127 5126 5127 14124 14125 15126 15127 20126 20127

Number of observations 491

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	40	94.1786007	2.3544650	44.77	<.0001
Error	450	23.6669501	0.0525932		
Corrected Total	490	117.8455508			

R-Square	Coeff Var	Root MSE	lcph Mean
0.799170	-30.76949	0.229332	-0.745323

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YR	12	38.77668199	3.23139017	61.44	<.0001
MD	10	7.16528707	0.71652871	13.62	<.0001
CGT	18	48.23663164	2.67981287	50.95	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	12	2.29148885	0.19095740	3.63	<.0001
MD	10	5.71981089	0.57198109	10.88	<.0001
CGT	18	48.23663164	2.67981287	50.95	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		-0.825223268	B	0.09429451	-8.75	<.0001
YR	1988	0.241828208	B	0.16013414	1.51	0.1317
YR	1989	0.262394031	B	0.14912460	1.76	0.0792
YR	1990	-0.121612658	B	0.08237816	-1.48	0.1406
YR	1991	-0.074084407	B	0.08287261	-0.89	0.3718
YR	1992	0.086888520	B	0.08232196	1.06	0.2918
YR	1993	-0.064122659	B	0.08344789	-0.77	0.4426
YR	1994	-0.063532892	B	0.08611952	-0.74	0.4611
YR	1995	-0.024889260	B	0.09288785	-0.27	0.7889
YR	1996	-0.084252251	B	0.07707963	-1.09	0.2750
YR	1997	-0.152115851	B	0.07458705	-2.04	0.0420
YR	1998	-0.066761300	B	0.07371787	-0.91	0.3656
YR	1999	-0.118938045	B	0.07697933	-1.55	0.1230
YR	2000	0.000000000	B	.	.	.
MD	1	-0.442627294	B	0.17651501	-2.51	0.0125
MD	2	-1.086330919	B	0.24569472	-4.42	<.0001
MD	4	-0.481855436	B	0.26477748	-1.82	0.0694
MD	5	-0.038346128	B	0.13200362	-0.29	0.7716
MD	6	-0.820761214	B	0.15283824	-5.37	<.0001
MD	7	-0.401252457	B	0.05921729	-6.78	<.0001
MD	8	-0.288044093	B	0.05194863	-5.54	<.0001
MD	9	-0.340773632	B	0.04766680	-7.15	<.0001

MD	10	-0.356036182 B	0.04536719	-7.85	<.0001
MD	11	-0.204638014 B	0.04597378	-4.45	<.0001
MD	12	0.000000000 B	.	.	.
CGT	2	0.365847257 B	0.08398303	4.36	<.0001
CGT	3	0.748182815 B	0.11103771	6.74	<.0001
CGT	4	0.354093987 B	0.12077270	2.93	0.0035
CGT	5	0.462111807 B	0.10037847	4.60	<.0001
CGT	6	0.495168574 B	0.17863065	2.77	0.0058
CGT	7	1.109171068 B	0.07720765	14.37	<.0001
CGT	8	0.265166952 B	0.08270207	3.21	0.0014
CGT	9	0.600172956 B	0.08276932	7.25	<.0001
CGT	10	0.894582395 B	0.14391093	6.22	<.0001
CGT	2126	0.394573907 B	0.07614444	5.18	<.0001
CGT	2127	0.821035807 B	0.06505331	12.62	<.0001
CGT	5126	0.714877335 B	0.11374702	6.28	<.0001
CGT	5127	0.908970675 B	0.05852665	15.53	<.0001
CGT	14124	0.323071793 B	0.05751501	5.62	<.0001
CGT	14125	0.544840558 B	0.14538279	3.75	0.0002
CGT	15126	1.093297727 B	0.06471854	16.89	<.0001
CGT	15127	1.052311197 B	0.08439400	12.47	<.0001
CGT	20126	0.018497434 B	0.03950064	0.47	0.6398
CGT	20127	0.000000000 B	.	.	.

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