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

by

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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 during 1993-2000. Catches increased to 13 285 tons in 2001, primarily due to increased effort in Div. 0A and further to 15 136 tons in 2002, primarily due to increased effort in Div. 1A. The catch composition has been stable in recent years. Survey trawlable biomass in Div. 1CD was in 2002 estimated at 72 000 tons, which is the second highest in the six year survey series. The recruitment of age one has been increasing during the latest years but decreased to a level a little below average for the time series, which dates back to 1988. A standardised CPUE index from Div. 1CD has showed a minor decrease between 2001 and 2001 but CPUE was about average for the 1990-2002 period. An unstardardized CPUE from the single-trawl and twin trawl fishery in Div 0A showed an increase compared to 2001.

1. TAC, Description of the Fishery and Nominal Catches

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 for 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. This TAC was in 2002 increased to 8 000 tons for 2003.

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 tons in 1989 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 fluctuated between 8 300 and 11 400 tons. The catch amounted to 10 700 tons in 2000 and catches increased to 13 200 tons in 2001. The catches increased further to 1 5236 in 2002. 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. The increase in catches between 2000 and 2002 was due to an in increase in effort in Div. 0A and Div. 1A.

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 3 233 tons in 1995 and fluctuated between 4 000 and 5 300 tons between 1996 and 2000. Catches increased to 7 662 tons in 2001 to increase further to 7 768 tons in 2002 (Table 1). (SCR Doc. 03/50)

The increase in catches was due to an increased effort in Div. 0A where catches increased from a level about 300 ton, where they have stayed since 1996, to 2 628 tons in 2001 and further to 3 800 tons in 2002. About 30% of the catches were taken by longlines. Of the trawl catches 70% was taken by twin trawl. The fishery was prosecuted by Canadian vessels and vessels from Faeroe Islands, Poland, Russia, Lithuania, Latvia, Estonia and Norway fishing on a Canadian license

Catches in Div. 0B amounted to 3968 tons, including 106 tons from Cumberland Sound. Longliners took 449 tons and gillnetters 1 572 tons. Trawlers took 1 841 tons. All catches were taken by Canadian vessels.

(Poland has in STATLANT 21A reported 445 tons taken in Div. 0A in 2001, but these catches are included in the Canadian catches. In 2002 Russia has reported 370 tons form 0A that are included in the Canadian catches and Norway and Faeroe Island has reported 782 and 2 tons, respectively, from Div. 0B by error).

The catches in Subarea 1 (Div. offshore 1A Div. + 1B-1F) were below 1 600 tons during 1982-90. In 1991 catches increased to 2 376 tons and were around 5 500 tons in the period 1992-1994, but decreased to around 4 500- 5 300 tons in the period 1995-2000. Catches increased from 5 522 tons in 2001 to 7 368 tons in 2002. Almost all catches were taken offshore (Table 2).

Catches in Div. 1AB (almost exclusively Div. 1A) increased from 575 tons in 2001 to 2 000 tons in 2002. Most of it was taken by trawl, but gillnets and long lines were also employed. Vessels from Faeroe Islands, Russia and Greenland participated in the fishery.

Catches in Div 1CD amounted to 5 368 tons of which 4 085 tons taken by trawlers from Greenland (SCS Doc. 03/16), Norway (SCR Div. 03/33), EU/GER (SCS Doc. 03/8) and Faeroe Islands. Further, 629 tons were taken by gillnets and longlines (mainly gill net (SCS Doc. 03/16)) and 654 tons were taken by trawl and longlines (mainly trawl 03/6)

When catch data from research reports and STATLANT 21 catches have been conflicting the 21A catches have been used unless anything else has been stated.

2. **Input Data**

2.1 **Research trawl survey**

Div. 1C-1D GHL-survey

Since 1997 Greenland has conducted stratified random bottom trawl surveys in September-October for Greenland halibut in Div. 1C-D at depth between 400 and 1 500 m. In 2002 in total 35 hauls were made (SCR Doc. 03/20). The biomass and abundance Greenland halibut in Div. 1C-D was estimated at 71 932 tons and 71.510×10^6 individuals which is an statistically insignificant (95%) decrease compared to 77 5540 tons and 80.814×10^6 specimens in 2001, but above the level seen since 1997 (56 000-70 000 tons). (The increase in biomass between 2000 and 2001 was due to one large catch). Three strata, which traditionally yield biomasses <1 500 tons were not covered in 2002. The highest densities were found at depths 1 000-1 400 m in Div. 1D.

The over all length distribution in Div. 1C-D was dominated by a mode at 47 cm. The age distribution was dominated by a mode at age 6 as in 2000 and 2001.

Greenland 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 15 339 tons during 1992-2001. In 2002 the biomass was estimated at 14 825 tons

which is a decrease from 15 339 in 2001, but still above average for the time series. The abundance was estimated at 208 mill., which is a decrease from 330 mill in 2001 (the second highest in the time series), and a little below average for the time series. The highest abundance was seen in Div. 1AN (north of 69°30'N. The reduction in abundance was almost exclusively seen in the nursery area Div. 1AS (south of 69°30'N) and 1BN (North of 67°N). In recent years almost all the catches have been comprised by one-year-old fish, but in 2002 two-year-old fish were also relatively abundant in the catches.

In the Disko Bay the biomass was estimated at 8 838 tons in 2002 compared to 10 552 tons in 2001, but the biomass is still above the average for the time series. The abundance was more than halved from the record high 201×10^6 specimens in 2001 to an estimate a little below average for the time series on 95 mill. in 2002. As in the offshore area catches were comprised of both one and two year old fish.

The biomass in the nursery area (Div. 1AS and 1B) was estimated at 6 847 tons compared to 6 876 tons in 2001 and above average for the time series. The abundance was estimated at 115×10^6 compared to 238×10^6 in 2001. The abundance estimate from 2002 well below average for the time series.

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 2001. 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. 1). In recent years the allocation of stations in the shrimp trawl survey have been changed in order to minimize the variance in the estimation of biomass and abundance of shrimp. To minimize the effect of that the CPUE index has been recalculated using stations > 250 m only. This generally increases the numbers but not the trend in the index.

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. The 1996 year-class seemed to be small but the recruitment has increased gradually until the 2000 year-class. With a mean catch of 431.6 one year old specimens per hour the 2001 year-class was estimated to be a little below average for the last decade. In Disko Bay catches of one year old fish was estimated as 913 specimens per hour, slightly above average for the last decade.

SSB/Recruitment

The relation between the spawning stock in numbers (age 10+) in Div. 1C-D estimated from the joint Japan/Greenland survey and the Greenland Greenland halibut 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 2. The over all recruitment of the 2001 year- class was above the recruitment of the 1989-94 year-classes but below the recruitment since then, except the 1997 year-class. Note that the coverage in 1989 and 1990 was incomplete and that there was no survey in 1996.

2.2 **Biological Investigations**

Comparison of mean-length-at-age between Greenland halibut from the Barents Sea and West Greenland (n=104, ages 4-10) showed that mean-length-at ages was almost identical in the two areas. Further, a length weight relationship was presented. (SCR Doc. 03/033).

A total of 2 081 Greenland halibut have been tagged in Cumberland Sound (Div. 0B) since 1994. Of this 16 fish have been recaptured, all, except two, in the inshore areas (SCR Doc. 03/41).

2.3 **Commercial Fishery Data**

Length and age distribution

SA 0

Length distributions were available from the fishery in Div. 0A and Div. 0B (SCR Doc. 03/50). 38% of the fish caught by trawl in Div. 0A were <46 cm compared to 21% by longline while 21% of the Greenland halibut taken in the trawl fishery in Div. 0B were < below 46 cm (SCR Doc. 03/50).

Catch-at-age by gear (longline and gillnet combined and single trawl and twin trawl combined) and all gears combined for Div. 0A. Catch-at-age by gear (longline and trawl (single trawl and twin trawl combined) and gears combined for Div. 0B. (SCR Doc. 03/50).

SA1

Length frequencies were available from the trawl fishery in Div. 1A and from the trawl and gillnet fishery in Div.1CD together with length frequencies from the Norwegian trawl fishery in Div. 1CD (SCR Doc. 03/33), and from the Russian trawl fishery in Div. 1AD (SCS Doc. 03/6). The mean length in the Norwegian catches showed a remarkable drop from 56.2 cm to 50.7 cm which is close to what is usually seen.

Length frequencies by area are shown in Fig. 3 and 4 and for the gill net fishery in Div. 1C in Fig 5.

Trawl catches in SA1 (including minor catches by a Russian longliner as the Russian catches were not separated by gear), were raised to catch-at-age based on length frequency data from Russian, German and Faeroe Island vessels combined with an age length key from the Greenland Deep-Sea survey in Div. 1CD. Catch-at-age in the gillnet (and longline fishery) together with the inshore catches in Div. 1B-1F (41 tons) was estimated using length frequencies from the gill net fishery in Div. 1C combined with the Div. 1CD survey age-length-key.

Tables 3 and 4 shows catch-at-age and weight-at-age, respectively. The catch-at-age has been relatively stable in recent years as well as the overall mean weight at age for the ages 7-14.

The age distribution in Div. 0A+1AB and Div. 0B+1CD, respectively, are given in Fig. 6 and 7. Age 7 is the most dominant age in the fishery in both areas, but there seems to be a little more older fish in the catches in Div. 0B+1CD.

Catch rate

Unstandadized catch rates were available from the trawl fishery in Div. 0A from 1996-2002 (SCR Doc. 03/50). The catch rate for single trawlers have fluctuated during the years but increased from 2000 to 2002 to an above average level. The catches prior to 2001 were, however, small. The catch rates for twintrawlers were stable between 2000 and 2001 but increased in 2002. (Fig. 8).

Unstandardized catch rates were available from the Greenland trawl fishery in Div. 1A and 1D (SCS 03/16 and from the Norwegian trawl fishery in Div. 1CD (SCR Doc. 03/33). The catch rates were stable in Div 1A between 2001 and 2002 (1.14 ton/hr) (one trawler). The catch rates in Div. 1D are included in the analyses mentioned below. The Norwegian catch rates in Div. 1C in 2002 were very high: 2.68 tons/hr. No obs. from 2001. The Catch rates in Div. 1D dropped from 0.63 tons/hr in 2001 to 0.49 tons/hr in 2001. This was, at least to some extent, due to the inclusion of some low catch rates from June-August in 2002 in which period there was no fishing in 2001. (Information from logbooks submitted to the Greenland authorities).

Unstandardized catch rates were estimated from logbooks from the trawl fishery in SA submitted to the Greenland authorities and for EU/German trawlers during 1996-2002 (SCS Doc. 03/9) including data from September-December (Fig. 9). The catch rates from vessels from Norway, Faeroe Islands and Russia dropped slightly, while the catch rates from the Greenland twin trawlers and EU-Germany increased slightly compared to 2001. All catch rates are, however, at the same level as in recent years.

Standardized catch rate series, based on available logbook data and data from the EU-German trawl fishery (SCS Doc. 03/9), were available for the offshore trawl fishery in Div. 1CD for the period 1988-2001 (Appendix 1).

The standardized catch rates in Div. 1CD dropped from 1989-1990 but has been stable since then but showed a small decrease between 2001 and 2002 and is now about average from the period (Fig. 10).

The combined catch rate from OB and 1CD could not be updated in 2003 due to lack of data from 0B (Fig. 10).

Due to the frequency of fleet changes in the fishery in both SA0 and SA1 both the unstandardized and 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 1994-96 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. Age frequencies were available from the longline fishery in Div. 0A. The sample, however, only represented 7.5% of the total catches. Further, the age composition peaked at age 7 as in the trawl catches, and the catch composition is not considered to reflect the age composition in the stock, hence no Catch-curve analysis were made made.

3.2 **XSA**

Extended Survivors Analysis

An XSA has been run unsuccessful several times during the 1990s, using a survey series covering 1987-95 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 (1997-98, new vessel and gear) (not presented) but the outcome of the analysis has not improved.

An XSA analysis was run using the stock data for SA 0+1, calibrated with trawl survey data (age 5-15) from the Greenland deep-sea surveys (1997-2001) in Div. 1CD. The assessment results are considered to be provisional due to problems with the catch-at-age data and the short time series, the assessment is, however, considered to reflect the dynamics in the stock. The rate of exploitation has been relative stable in recent years between 0.2-0.3 (F_{bar} 7-13). The input parameters to the analysis and the outcome of the analysis is given in (SCR Doc. 02/68)

The XSA was run again this year with the 2002 survey and catch data and updated catch data from 2001 (very small changes). The assessment results are considered to be provisional due to problems with the catch-at-age data and the short time series. The assessment is, however, considered to some extend to reflect the dynamics in the stock. The rate of exploitation has been relative stable in recent years between 0.2-0.3 (F_{bar} 7-13). The summary of the XSA is given in SCR Doc. 03/54.

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. 2. 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 very small proportion of the mature fish, the survey covers only a restricted part of the area covered by the assessment, and 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 1987-98 and a series combining the two data sets. The biomass index was from Div. 1CD and covered the period 1987-95 and 1997-98. 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 Div. 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 1987-98 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 2000-2002 (catches, survey biomass index, and CPUE index) have only varied little compared to 1999, 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. Catches increased to 13 285 tons in 2001, primarily due to increased effort in Div. 0A, and further to 15 136 primarily due to increased effort in Div. 1A. The age composition in the catches seems stable. Standardized catch rates in Div. 1C-D have been stable during the last decade, and although the catch rate dropped slightly between 2001 and 2002 the catch rate in 2002 seems to be at an average level for the period 1990-2002. The combined catch rate for Div. 1C-D+0B has showed very little variation during the period (not updated in 2002 and 2003). Unstandardized catch rates for Div. 0A increased from 2001 to 2002. Catch rates from one trawler in 1A was stable between 2001 and 2002.

Survey biomass have increased between 1999 and 2001 in Div 0A, between 2000 and 2001 in Div. 0B and 1CD, where it was the highest seen in the five year long survey series. The biomass dropped slightly between 2001 and 2002 but is still above average for the period 1997-2002. Biomass in the Greenland shrimp survey decreased from the second largest level seen since 1988 to a level around the average for the period 1992-2002. The recruitment of age one, which has been increasing in recent years, dropped to the second lowest level for the period 1995-2000 but above the level seen during the period 1989-94. A provisional XSA estimated the exploitation rate has been relatively stable, between 0.2-0.3, during resent years.

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. Acknowledgement

Thanks to Chris Darby for his work with the XSA.

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Table 1. Greenland halibut catches (metric tons) by year and country for Subarea 0 from 1987 to 2002. Minor (300 ton or less) catches from Div. 0A are included in some of the Div. 0B catches prior to 2001.

	Year															
Country	87	88	89	90	91	92	93	94	95	96	97	98	99	00[a]	01[ad]	02[ae]
0A																
CAN															2628	3800
0B																
CAN	-	2	-	589	256	2194	883	-	1941	2354	3871	3924	4784	5438	5034	3968
EST	-	-	-	-	-	-	631	-	-	-	-	-	-	-	-	-
FRO	388	963	596	2252	2401	463	1038	-	-	839	452	-	-	-	-	-
JAP	-	-	-	113	232	337	252	600	1031	500	-	-	-	-	-	-
LAV	-	-	-	-	-	-	83	-	-	-	-	-	-	-	-	-
NOR	-	-	282	5016[c]	3959	-	373	-	-	-	-	-	-	-	-	-
RUS	-	59	29	1528	1758	9364	4229[b]	3674	261	915	-	-	-	-	-	-
TOTAL	388	1024	907	9498	8606	12358	7489	4274	3233	4608	4323	3924	4784	5438	7662	7768

[a] Provisional data.
[b] The russian catch is reported as area unknown, but has previously been reported from 0B
[c] Dobbel reported as 10031 tons
[d] Excluding 445 tons double reported
[e] Excluding 370 tons double reported and 784 tons reported by error

Table 2. Greenland halibut catches (metric tons) by year and country for Subarea 1 from 1987 to 2002. The Greenland catches is excl. the inshore catches in Div. 1A. Offshore catches in Div. 1A prior to 2001 are negligible.

	Year															
Country	87	88	89	90	91	92	93	94	95	96	97	98	99	00[a]	01[a]	02[a]
1AB																
GRL															340	1571[c]
RUS															85	279
FRO															150[c]	150
1CD																
GRL	-	-	-	-	965	227	213	885	1405	1880	2312	2295	2549	2657	2012	2294[c]
FRO	-	-	-	54	123	151	128	780	-	-	127	242	116	243	150[c]	150
JPN	907	1581	1300	988	677	2902	1198	820	337	-	-	-	-	-	-	-
NOR	-	-	-	-	611	2432	2344	3119	2472	1785	1893	1338	1360	1115	1419	1734
RUS	-	-	-	-	-	-	5	-	296	254	-	543	552	792	829	654
EU	-	-	-	-	-	-	46	266	527	455	446	350	330	444	537	536
1A-F (excl. 1A inshore)	907	1581	1300	1042	2376	5712	3934	5870	5037	4374	4778	4769	4907[b]	5251	5522	7368

[a] Provisional data.
[b] Excluding 7603 tons reported by error
[c] Reported to the Greenland authorities

Table 3. Catch numbers at age.

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE																
5	2	1	1	4	20	53	241	254	152	151	41	71	262	415	69	570
6	31	29	36	87	318	678	651	862	522	530	311	372	1092	1106	978	1975
7	182	190	244	592	1742	2967	2422	2472	1628	1818	1556	677	1759	1677	3212	4252
8	296	354	409	1711	2679	4311	2356	1692	940	1575	2110	1187	1174	1144	1802	1791
9	193	245	212	1356	1418	2604	1048	954	558	660	1042	900	672	772	1154	617
10	77	115	75	711	533	951	590	294	259	306	438	572	375	501	776	476
11	40	80	47	359	221	398	224	183	228	160	232	422	234	443	503	347
12	18	61	48	195	144	231	130	159	188	127	118	205	184	291	273	149
13	10	58	44	189	108	158	72	125	104	64	96	153	172	178	101	209
14	9	46	42	115	60	85	59	58	80	57	21	98	95	68	50	75
15	6	35	26	67	36	45	37	55	85	39	13	19	61	75	21	168
16	3	15	12	17	6	23	26	34	41	36	12	4	37	17	10	74
17	4	4	1	3	2	1	4	10	18	13	0	0	18	4	5	23
+gp	2	1	0	0	0	0	2	7	10	22	0	0	7	6	3	49
TOT.NUM	873	1234	1197	5406	7287	12505	7862	7159	4813	5558	5994	4688	6166	6717	8957	10917
TONS	1295	2605	2207	10540	10982	18070	11423	10144	8270	8982	9101	8693	9691	10689	13184	15136

Table 4. Catch weights at age (kg)

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE																
5	0.29	0.29	0.29	0.33	0.34	0.33	0.58	0.43	0.49	0.52	0.36	0.50	0.54	0.53	0.48	0.48
6	0.51	0.51	0.51	0.54	0.54	0.56	0.72	0.62	0.66	0.69	0.55	0.74	0.70	0.72	0.67	0.70
7	0.74	0.74	0.74	0.79	0.79	0.80	0.96	0.91	0.94	0.94	0.86	1.00	0.98	1.00	0.91	0.96
8	1.08	1.08	1.08	1.10	1.12	1.13	1.26	1.26	1.34	1.38	1.27	1.24	1.28	1.29	1.30	1.30
9	1.41	1.42	1.42	1.52	1.57	1.59	1.80	1.72	1.81	1.91	1.83	1.54	1.66	1.71	1.76	1.85
10	1.97	2.05	2.00	2.11	2.27	2.28	1.43	2.19	2.37	2.48	2.38	2.22	2.25	2.26	2.29	2.20
11	2.58	2.80	2.68	2.94	3.22	3.02	3.25	2.73	2.89	3.18	3.01	3.08	2.74	2.84	2.91	2.82
12	3.52	3.88	3.73	3.90	4.24	4.02	4.10	3.43	3.62	4.04	3.84	3.84	3.68	3.59	3.51	3.32
13	4.64	5.01	4.87	4.96	5.50	5.33	5.26	4.48	4.44	5.05	4.93	4.74	4.73	4.23	4.31	3.93
14	5.79	6.16	6.20	6.26	6.82	6.76	6.17	5.75	5.61	5.95	5.69	6.04	5.58	5.19	5.60	5.20
15	6.61	7.44	7.65	7.96	8.33	7.76	7.42	6.58	6.65	7.34	6.79	6.60	6.68	5.85	6.09	5.38
16	7.99	8.88	9.36	9.90	9.89	8.58	8.04	7.36	7.77	8.64	8.00	13.45	7.75	7.32	7.08	7.02
17	9.56	9.86	9.56	11.86	9.56	11.95	9.24	9.42	10.19	9.18			9.08	5.60	8.94	8.61
+gp		11.33					10.25	11.15	11.00	11.10			11.10	9.00	11.22	10.97

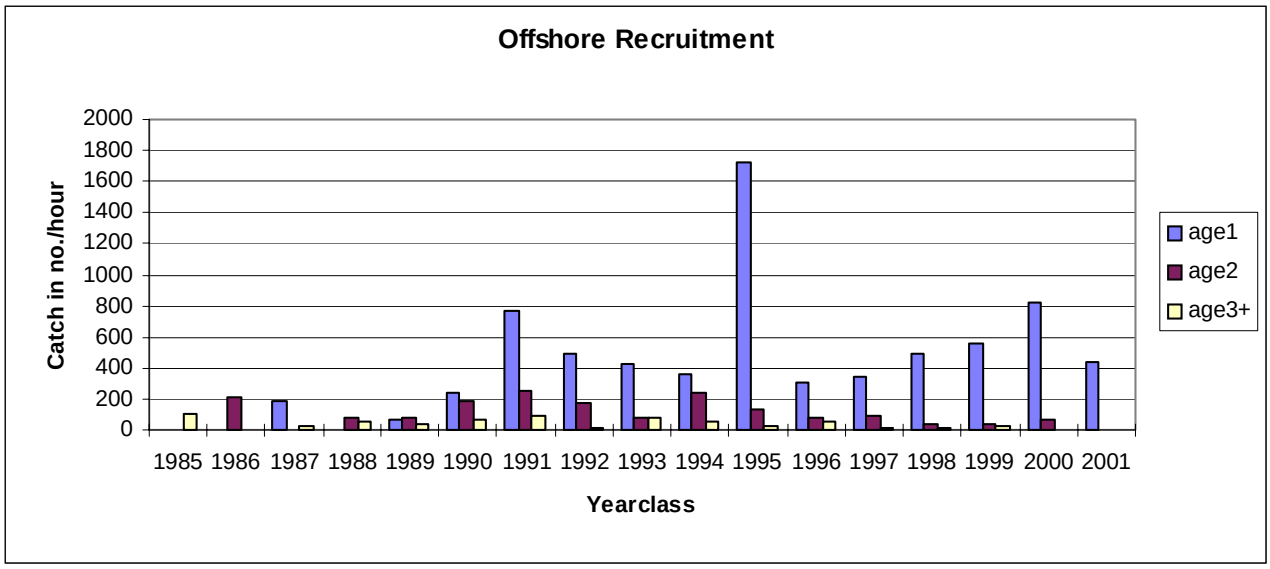

Fig. 1. Year-class strength of Greenland halibut of ages 1-3+ in number per hour trawled in the offshore nursery area.

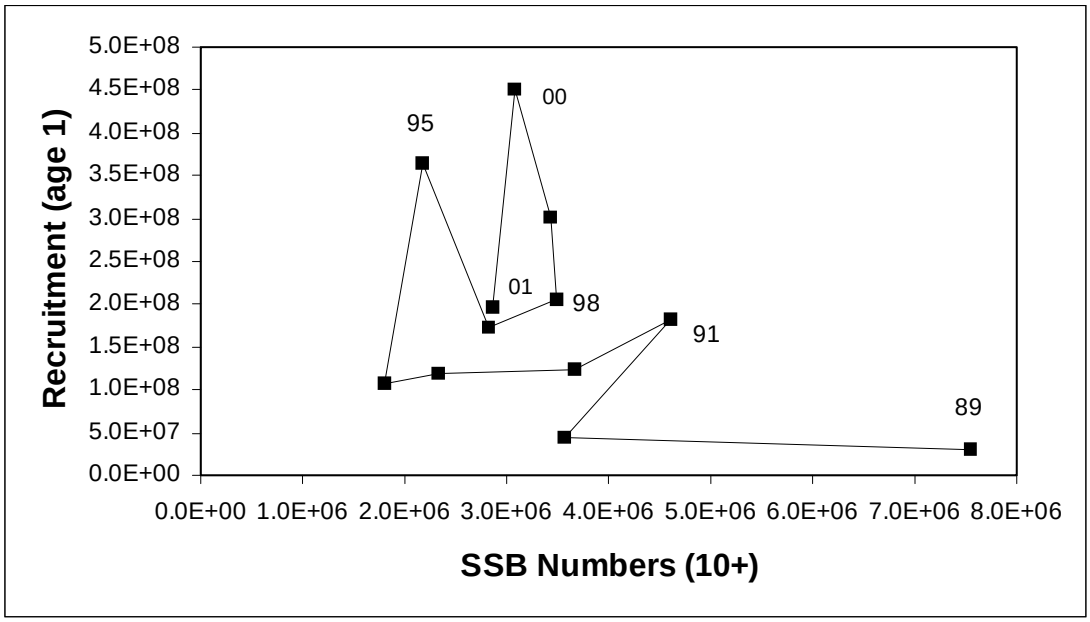

Fig. 2. Spawning stock in numbers (ages 10-18 in Div.1CD from the joint Japan/Greenland survey and the Greenland survey (1997-2001) plotted vs number of fish age 1 the following year estimated from the Greenland shrimp trawl survey including the Disko Bay. Note pure coverage in 1989 and 1990 and that there was no survey in 1996.

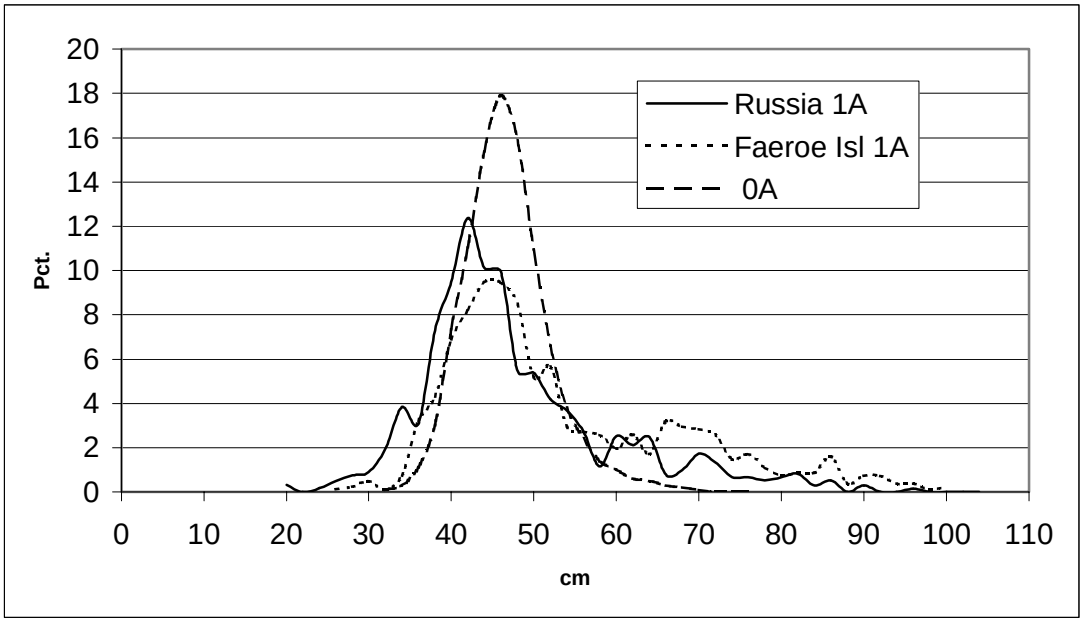

Fig. 3. Length distribution from the trawl fishery in Div. 0A and 1A.

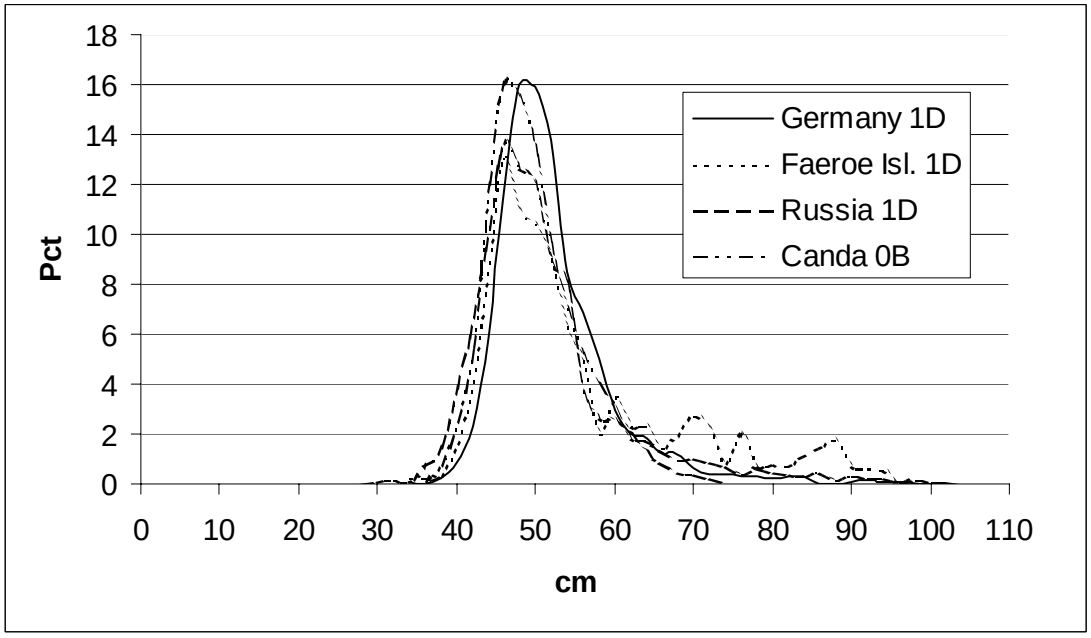

Fig 4. Length distribution from the trawl fishery in Div 0B and 1D.

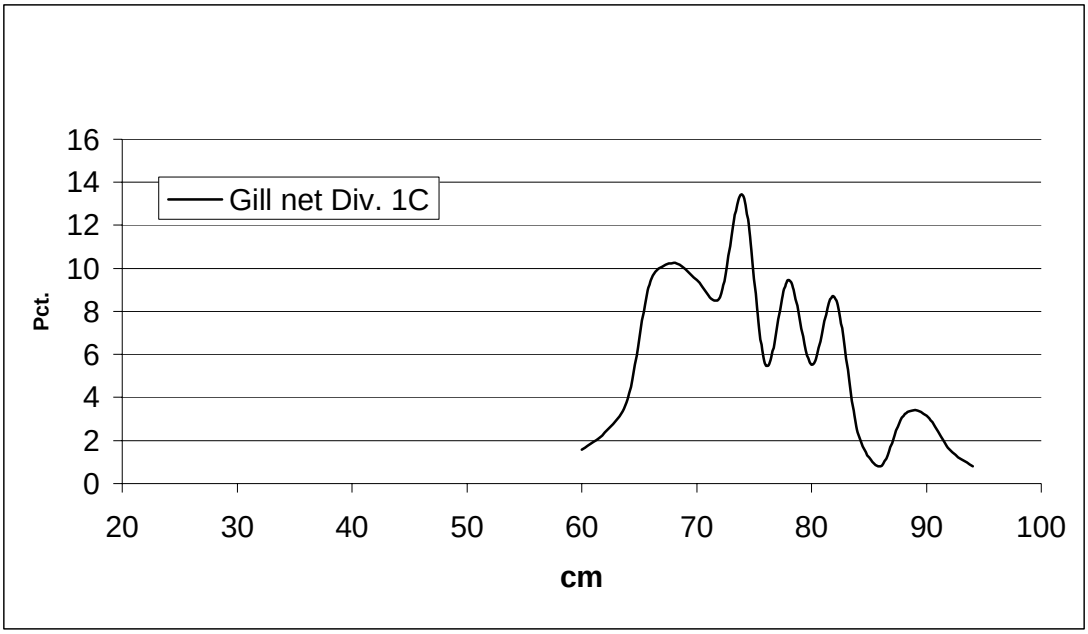

Fig. 5. Length distribution form the gill net fishery in Div. 1C

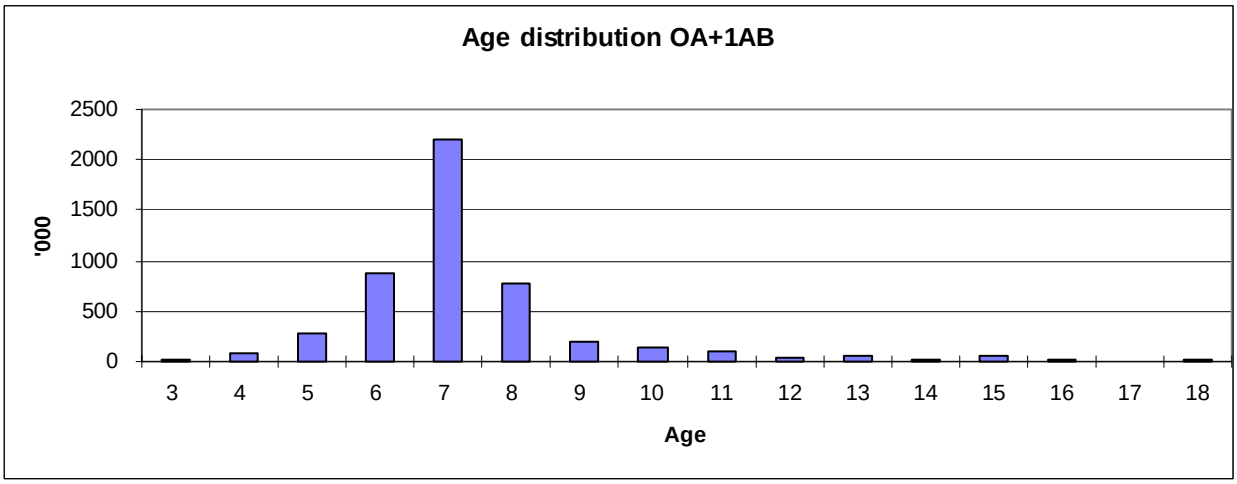

Fig. 6. Age distribution in the fishery in Div. 0A and 1AB.

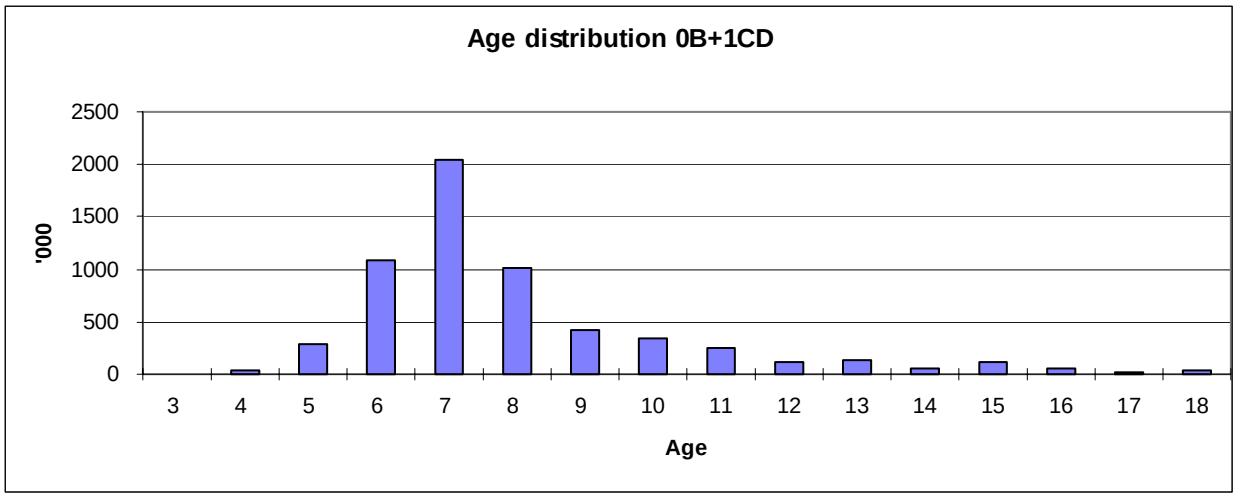

Fig. 7. Age distribution in the fishery in Div. 0B and 1CD.

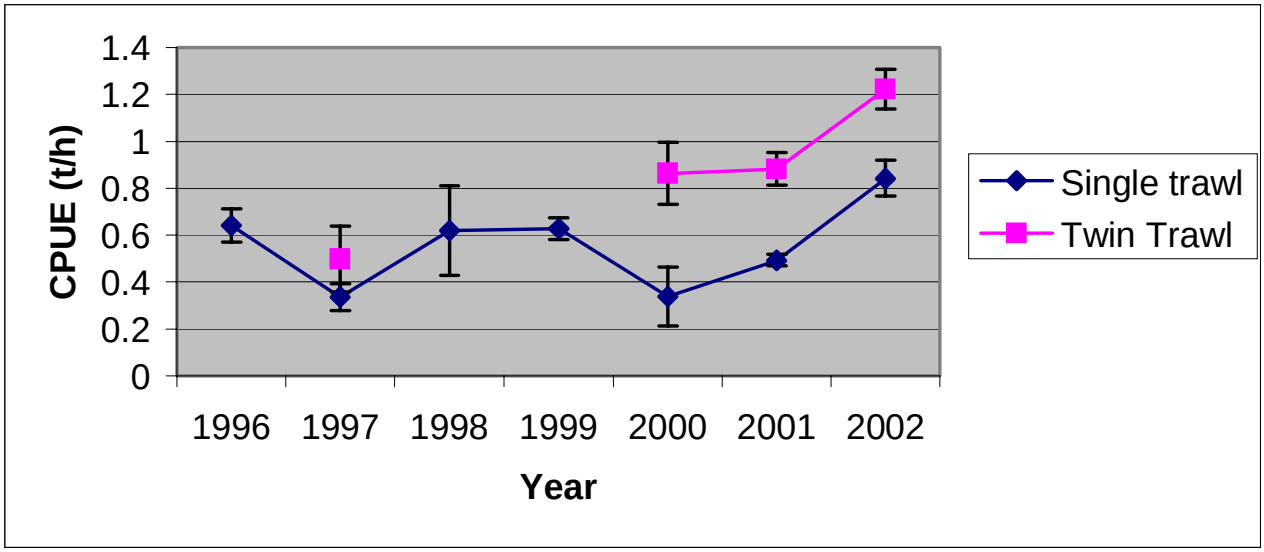

Fig. 8. Unstandardized CPUE for single and twin trawl in Div. 0A during 1996-2002.

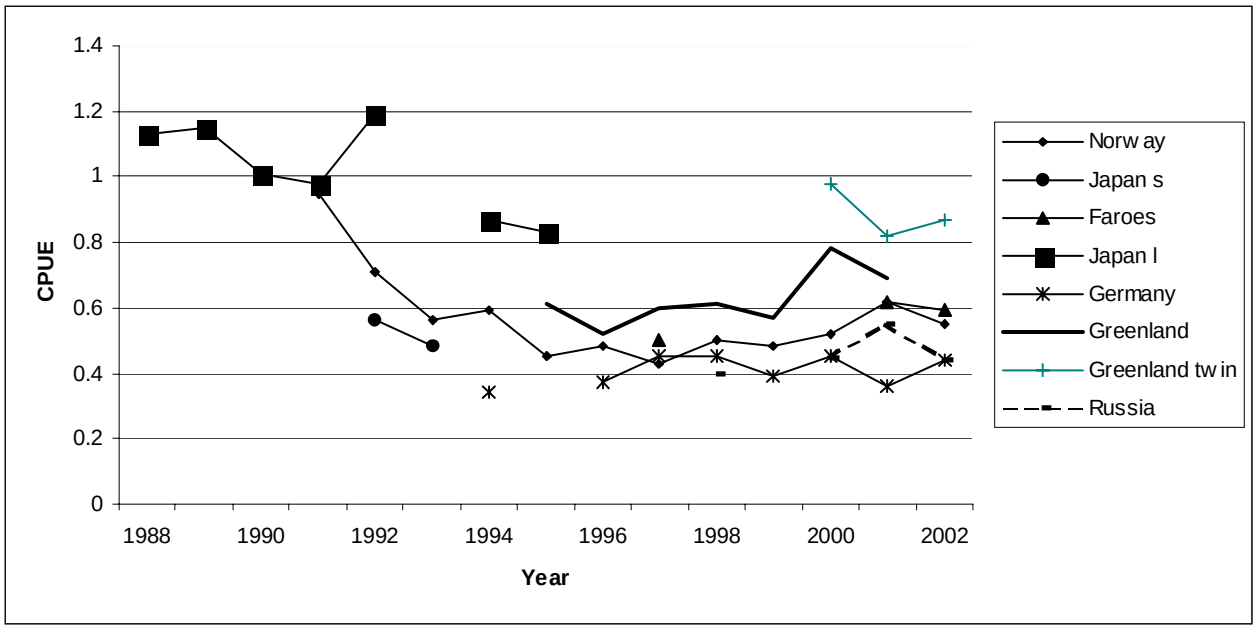

Fig. 9. Unstandardized trawl CPUE series from Div. 1CD for the month September-December.

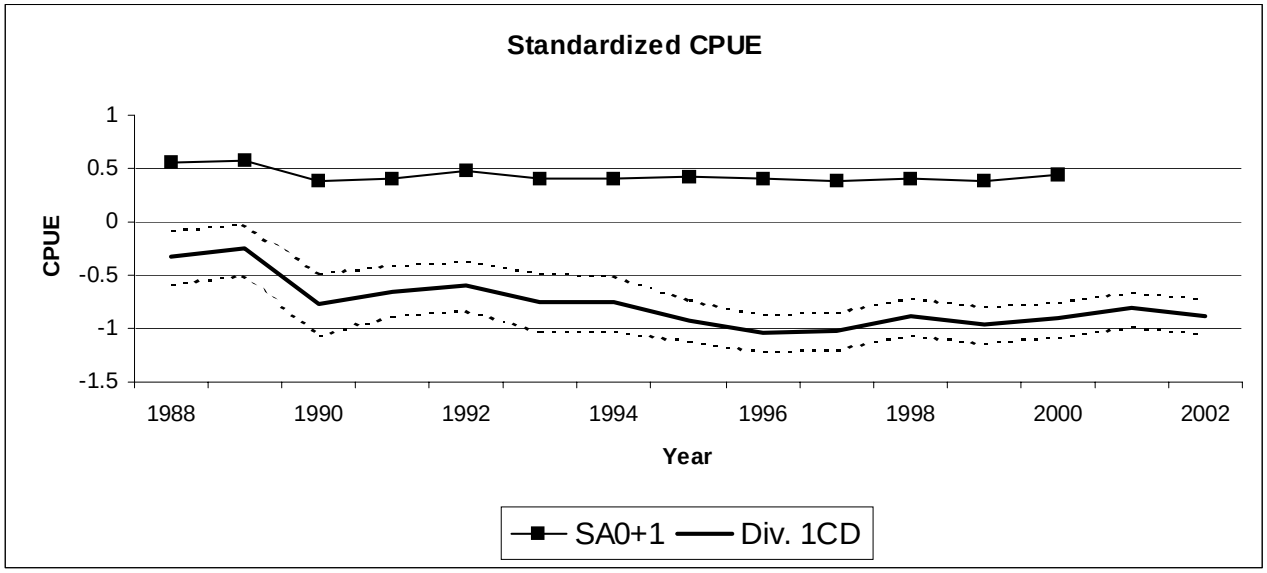

Fig. 10. Standardized trawl CPUE indices from SA1 (Div. 1CD) with +/- S.E. and SA0+1 combined.

APPENDIX 1. Standardized CPUE index Div.1CD.

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The GLM Procedure

Class Level Information

Class	Levels	Values
YR	15	1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
MD	11	1 2 4 5 6 7 8 9 10 11 12
CGT	9	2 3 4 5 6 7 8 9 10

Number of observations 136
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The GLM Procedure

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	21.02708937	0.65709654	8.68	<.0001
Error	103	7.79340476	0.07566412		
Corrected Total	135	28.82049414			

R-Square	Coeff Var	Root MSE	lcph Mean
0.729588	-46.13058	0.275071	-0.596288

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YR	14	10.99122278	0.78508734	10.38	<.0001
MD	10	4.65895415	0.46589541	6.16	<.0001
CGT	8	5.37691245	0.67211406	8.88	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	14	1.36916819	0.09779773	1.29	0.2248
MD	10	3.09666448	0.30966645	4.09	<.0001
CGT	8	5.37691245	0.67211406	8.88	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		-0.031201748 B		0.11297797	-0.28	0.7830
YR	1988	0.547755976 B		0.37703989	1.45	0.1493
YR	1989	0.618641721 B		0.37049260	1.67	0.0980
YR	1990	0.108804302 B		0.39157696	0.28	0.7817
YR	1991	0.232756640 B		0.36546185	0.64	0.5256
YR	1992	0.281804447 B		0.36161514	0.78	0.4376
YR	1993	0.132327640 B		0.39397712	0.34	0.7376
YR	1994	0.119552368 B		0.37313271	0.32	0.7493
YR	1995	-0.040991171 B		0.29639530	-0.14	0.8903
YR	1996	-0.154116725 B		0.11505621	-1.34	0.1834
YR	1997	-0.135918857 B		0.10846918	-1.25	0.2130
YR	1998	-0.013195791 B		0.10669458	-0.12	0.9018
YR	1999	-0.082317743 B		0.11947247	-0.69	0.4924
YR	2000	-0.029966058 B		0.09610686	-0.31	0.7558
YR	2001	0.062683005 B		0.09791616	0.64	0.5235
YR	2002	0.000000000 B		.	.	.

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The GLM Procedure

Dependent Variable: lcph

Parameter		Estimate		Standard Error	t Value	Pr > |t|
MD	1	-0.370343037	B	0.21840257	-1.70	0.0930
MD	2	-1.199372460	B	0.44952792	-2.67	0.0089
MD	4	-0.474139947	B	0.32604721	-1.45	0.1489
MD	5	-0.246502542	B	0.23964463	-1.03	0.3061
MD	6	-0.803131347	B	0.17145634	-4.68	<.0001
MD	7	-0.645136579	B	0.16659867	-3.87	0.0002
MD	8	-0.386424395	B	0.12284714	-3.15	0.0022
MD	9	-0.182290503	B	0.09397486	-1.94	0.0551
MD	10	-0.192618583	B	0.08835427	-2.18	0.0315
MD	11	-0.146667109	B	0.08891045	-1.65	0.1021
MD	12	0.000000000	B	.	.	.
CGT	2	-0.536013834	B	0.10694934	-5.01	<.0001
CGT	3	-0.382294428	B	0.36190392	-1.06	0.2933
CGT	4	-0.616563155	B	0.12643926	-4.88	<.0001
CGT	5	-0.628413898	B	0.39381865	-1.60	0.1136
CGT	6	-0.701503728	B	0.14485390	-4.84	<.0001
CGT	7	0.001506290	B	0.34633050	0.00	0.9965
CGT	8	-0.675249131	B	0.10836777	-6.23	<.0001
CGT	9	-0.275722951	B	0.11189893	-2.46	0.0154
CGT	10	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.

The GLM Procedure
Least Squares Means

YR	lcph LSMEAN	Standard Error	Pr > |t|
1988	-0.32967245	0.24659084	0.1842
1989	-0.25878671	0.24441798	0.2922
1990	-0.76862413	0.28558618	0.0083
1991	-0.64467179	0.24476086	0.0097
1992	-0.59562398	0.22665632	0.0099
1993	-0.74510079	0.26830997	0.0065
1994	-0.75787606	0.25676432	0.0039
1995	-0.91841960	0.19025964	<.0001
1996	-1.03154516	0.17573622	<.0001
1997	-1.01334729	0.16974290	<.0001
1998	-0.89062422	0.17159984	<.0001
1999	-0.95974617	0.17636239	<.0001
2000	-0.90739449	0.16444965	<.0001
2001	-0.81474543	0.16645023	<.0001
2002	-0.87742843	0.16797551	<.0001

APPENDIX 2.

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 7-13,
1987,	14404,	39385,	17325,	1295,	.0747,	.0510,
1988,	20009,	46413,	18771,	2605,	.1388,	.0816,
1989,	21190,	54243,	20372,	2207,	.1083,	.0550,
1990,	19762,	67431,	25382,	10540,	.4153,	.2595,
1991,	16956,	71489,	26712,	10982,	.4111,	.2261,
1992,	17641,	72775,	27830,	18070,	.6493,	.4076,
1993,	17429,	76631,	28168,	11423,	.4055,	.2474,
1994,	18019,	68056,	25395,	10144,	.3994,	.2296,
1995,	13432,	70032,	27247,	8270,	.3035,	.1733,
1996,	13542,	76521,	31982,	8982,	.2808,	.1519,
1997,	17154,	68378,	30850,	9101,	.2950,	.1983,
1998,	15370,	72870,	32597,	8693,	.2667,	.2057,
1999,	19517,	77011,	32820,	9691,	.2953,	.1911,
2000,	24540,	78093,	27507,	10689,	.3886,	.2451,
2001,	29150,	82831,	27909,	13184,	.4724,	.3432,
2002,	53879,	98363,	26154,	15136,	.5787,	.2981,
Arith. Mean ,	20750,	70033,	26689,	9438,	.3427,	.2103,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1						