Northwest Atlantic Fisheries Organization

Serial No. N5262 **NAFO SCR Doc. 06/39**

SCIENTIFIC COUNCIL MEETING – JUNE 2006

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

O.A. Jørgensen

Danish Institute for Fisheries Research. Charlottenlund Slot, DK 2920 Charlottenlund, Denmark

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 13 184 tons in 2001 and further to 19 954 tons 2003 primarily due to increases in catches in Div. 0A and 1A. Catches have stayed at that level in 2004 and 2005 (19,881 tons). Survey trawlable biomass in Div. 1CD increased between 2003 and 2005 to 80 800 tons which is well above the average for the time series. The biomass in the Greenland shrimp survey was above average for the time series. The recruitment of age one has been above average in resent years for the time series, which dates back to 1988. Standardized CPUE indices from 0B and 1CD have showed an increasing trend since 2002 and the combined CPUE series also showed an increase and the CPUE is in 2005 at the level seen in 1990-2001.

1. TAC, description of the fishery and nominal catches.

TAC

Between 1979 and 1994 a TAC was 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 was 11 000 tons. In 2000 there was set an additional TAC on 4 000 tons for Div. 0A+1AB for 2001. This TAC was in 2002 increased to 8 000 tons for 2003. The total advised TAC for 2004 and 2005 remained at 19 000 tons.

Catches in SA 0 + Div. 1A offshore + Div.1B-1F

During 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 tons in 1990. Catches stayed at that level in 1991 but increased again in 1992 to 18 100. During 1993-2000 catches have fluctuated between 8 300 and 11 400 tons. Catches increased to 13 184 tons in 2001 and increased further *via* 15 236 tons in 2002 to record high 19 954 tons in 2003 and catches at his level since then (19,881 in 2005) (Fig. 1). 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 2003 was primarily due to an in increase in effort in Div. 0A and Div. 1A but there was also seen an increase in the catches in Div. 0B between 2002 and 2003. The distribution of catches between 0A+1AB and 0B-1C-F has been stable in recent years.

Catches in SA 0

In 1983 annual catches in SA 0 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. Until 2000 almost all catches in SA 0 were taken in Div. 0B. In 2001 a commercial fishery started in Div. 0A. Catches in SA 0 increased to 7 662 tons in 2001 and further to 10 355 tons in 2003, dropped slightly in 2004 to 9 367 tons to increase again to 10 134 tons in 2005 (Table 1).
The increase in catches seen since 2000 was mainly 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 4 278 tons in 2003. Catches in Div. 0A dropped to 3 740 tons in 2004, but increased again to 4 268 tons in 2005

The catches in Div. 0A in 2005 were mainly taken by trawl and twin trawl, while 1 118 tons was taken by gill net. The long lines fishery in the area has apparently stopped. The fishery was prosecuted by Canadian vessels.

Catches in Div. 0B 2005 amounted to 5 866 tons which is at the level seen in recent years. The 2005 catch figure excludes 9 tons taken inshore in Cumberland Sound on longlines. Offshore, longliners took 631 tons and gillnetters 1 681 tons while single- and double trawlers took 3 554 tons. All catches were taken by Canadian vessels.

Catches in SA1

The catches in Subarea 1 (Div. offshore 1A Div. + 1B-1F) were below 1 600 tons during 1982-1990. In 1991 catches increased to 2 376 tons and were around 5 500 tons in the period 1992-1994, but decreased to 4 500- 5 300 in the period 1995-2000. Catches increased from 5 522 in 2001 further to 7 368 tons in 2002 and 9 598 tons in 2003 and stayed at level in 2004 and 2005 (9 747 tons). Almost all catches have been taken offshore (Table 2). The inshore catches in 2005 in Div. 1B-1F amounted to 250 tons.

Catches in Div. 1AB (mainly in Div. 1A) increased gradually from 573 tons in 2001 to 4 153 tons in 2004, but decreased slightly in 2005 to 3 989 tons including 2 tons taken inshore in Div. 1B. All offshore catches in Div. 1AB were taken by trawlers from Faeroe Islands, Russia (SCS Doc. 06/7), and Greenland (SCS Doc. 06/13).

Catches in Div 1CD amounted to 5 578 tons, the same as in 2004. Catches were taken by vessels from Greenland (SCS Doc. 06/xx), Norway, EU/Germany, Russia (SCS Doc. 06/7) and Faeroe Islands. Almost all catches off shore were taken by trawl except 237 tons taken by longlines. 248 tons were taken inshore in Div. 1C-1F, mainly by gill net.

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 NAFO Div. 1C-D at depth between 400 and 1 500 m. In 2005 in total 61 hauls were made (SCR Doc. 06/27). The biomass and abundance Greenland halibut in Div. 1C-D was estimated at 80 865.4 tons and $73.001*10^6$ individuals compared to 75,869 tons and $74.859*10^6$ in 2004. The mean catch per km^2 swept increased from 1.48 tons in 2004 to 1.54 tons in 2005. Both the biomass and the abundance was above average for the time series. The highest densities were found at 1 000-1 200 m in Div. 1C and 1 000-1 500 m in Div. 1D. The overall length distribution in Div. 1C-D was dominated by a mode at 48 cm and the age distribution was dominated by a mode at age 7.

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. The survey area was restratificated in 2004 based on better information about depths and all biomass and abundance indices have been recalculated. The recalculation did not change the trends in the development of the different stocks. Estimated total trawlable biomass of Greenland halibut in the offshore areas (- Disko Bay) has fluctuated between 9 258 and 31 100 tons during 1992-2004. In 2005 the biomass was estimated as 23 634 tons which is a decrease compared to record high 31 100 tons in, but the 2005 estimate is still the second largest on record. The abundance was estimated at 267 mill. in 2005, close to 269 mill estimated in 2004. The highest abundance was seen in Div. 1AN (north of 70°N). As in recent years most of the abundance was comprised of one-year-old fish, but there were more older fish in the catches compared to previous years (SCR Doc. 06/28).

In the inshore Disko Bay the biomass was estimated at 14 859 tons compared to record high 28 229 tons estimated in 2004. The 2005 estimate is the third largest on record. The abundance was estimated at 140 $*10^6$, which is the lowest seen since 1999 There was a relatively higher proportion of two- and three-year-old fish in the catches compared to previous years.

The biomass in the nursery area (1AS and 1B) was estimated at 13 925 in 2005 compared to 14 981 tons in 2004. The abundance was estimated at 158 mill. in 2005 compared to 107 mill. in 2004.

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.The number of one-year-old fish in the total survey area including Disko Bay increased gradually from 1996 to a peak of 500 million in 2001. The number of one-year old fish was in 2005 298 million, which is above average and close to the 314 million estimated in 2004 (Fig. 2).

Further, a recruitment index was provided from the off shore nursery area in Div. 1AS-1B. 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. 3). In recent years the allocation of stations in the shrimp trawl survey has 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 >300 m only. This generally increases the mean number per tow but not the trend in the index.

The recruitment index has been declining since the relatively 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. Since then the recruitment has been around average, which also applied to the 2004 year-class (522 fish per hour, average 1987-2003 year-class: 518). In Disko Bay the recruitment have been good in recent years although the recruitment has been decreasing in latest couple of years. The 2004 year-class was, however, also above average.

SSB/Recruitment

The relation between the spawning stock in numbers (age 10+) in Div. 1CD estimated from the joint Japan/Greenland survey and the 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. 4. The over all recruitment of the 2004 year-class was well above average. Note that there was no survey in 1996.

2.2. **Biological studies**

Maturity of Greenland halibut in Subarea 0 (SCR 06/5).

Information on maturity of Greenland halibut from Subarea 0 is lacking. However, maturity data was collected on surveys conducted in the area between 1999 and 2004. This study examined maturity data and produced estimates of

proportion mature at length for males and females for Div. 0A and 0B. L_{50} was higher in Div. 0A than in Div. 0B for both males and females. There was significant interannual variation in maturity at length for both sexes. The larger size at maturity in Div. 0A than in Div. 0B is consistent with a migration of fish to Div. 0B to spawn as they become adults, but could also be due to a prolonged adolescence or a multi-year maturation cycle caused by limitations on somatic growth in the colder environment found in Div. 0A.

Length at maturity and stomach contend of Greenland halibut in Div. 1D (SCR Doc. 06/15).

The L_{50} was estimated to 44 cm (age 6) for males and 62 cm (age 9) for females in Division 1D in the Russian trawl fishery. In total 2274 stomachs of which 352 contained food, were sampled from the Russian trawl fishery in Div. 1D. The diet of Greenland halibut consisted mainly of squids (70.7%) and shrimps (3.9%) but a number of fish species were also observed.

2.3. **Commercial fishery data**

Length distribution

SA 0

Length distributions were available from the single trawl, twin trawl and gill net fishery in Div. 0A and from gill net and single and twin trawl combined in Div. 0B.

In Div. 0A the length frequencies in the trawl fishery showed modes at 46-48 cm and 48-50 cm for single and twin trawl, respectively. Modes around 48-50 cm were also seen in the previous years. The catches in the gill net fishery was dominated by fish between 50 and 70 cm as in previous years and showed a mode at 54-56 cm (Fig. 5).

The length distribution in the trawl fishery (single and twin trawl combined) in Div. 0B was dominated by a mode around 46 cm, where it has been at 48 cm in previous years in the single trawl fishery. The length distribution for gillnet fixed gears combined showed a mode at 64 cm.

SA1

Length frequencies were available from the Russian trawl fishery in Div. 1D (SCS Doc. 06/15) and from the Norwegian trawl and longline fishery in Div. 1D.

The catch composition in the Russian and Norwegian trawl fishery in Div. 1D showed modes at 48 and 50 cm respectively (Fig. 6), while the catches in the small Norwegian longline fishery was dominated by fish between 50 and 80 cm. (Fig. 6).

Age distribution

Catch at age was available from the Russian trawl fishery in Div. 1D. Ages 6 and 7 dominated the catches (Fig. 7).

The Norwegian trawl length frequencies in Div. was converted to age frequency using an age length key sampled during the Greenland deep sea survey in Div. 1CD. The catches were dominated by fish age 6 to 8 (Fig. 7).

Norwegian longline length frequencies were converted to age frequencies using a Russian age-length key (SCS Doc. 06/7). The catches were dominated by ages 8 to 14 (Fig. 8)

No catch-at-age information was available from SA0 and the catch-at-age and mean-weight-at-age, in Tables 3 and 4, respectively, has not been updated.

Catch rate

Unstandardized catch rates were available from the Greenland trawl fishery in Div. 1A and 1D (SCS Doc. 06/13) and the Russian trawl fishery in Div. 1ABD (SCR Doc. 06/15). Further, catch rates were available from logbooks submitted to the Greenland authorities

Div.1AB

Unstandardized catch rates from Greenland twin trawlers were stable in Div. 1A between 2001 and 2002 (1.09 ton/hr) but decreased to 0.87 ton/hour in 2003 to increase again in 2004 to 0.95 ton/hr and further to 1.11 tons per hour in 2005. The Russian catch rates (Div. 1.AB and small and large trawlers combined (SCR Doc. 06/15)) were stable between 2004 and 2005 and the Faroese catch decreased from 0.87 ton/hr in 2004 to 0.55 ton/hr in 2005. This is however above the level in 2001-2003 (Fig. 9).

1CD

The unstandraized catch rates from the Greenland fishery in Div. 1CD decreased from 0.87 to 0.75 ton/hr between 2002 and 2003 but increased again in 2004 to 0.78 ton/hr and further to 0.99 ton/hr in 2005. Catch rates from the Norwegian, Russian (SCR Doc. 06/15) and Faroese fleets fishing in Div. 1CD also showed an increase between 2004 and 2005 (Fig. 10).

The standardized CPUE series from trawlers in Div. 0B was updated. The index decreased gradually from 1995 to 2002, but has been increasing since then and is now at the same level as in the early 1990s (Appendix 1) (Fig. 11a).

Standardized catch rate series, based on logbook data from the Greenland authorities and data from the EU-German trawl fishery (SCS Doc. 05/9), were available for the offshore trawl fishery in Div. 1CD for the period 1988-2005. The logbooks included represented 72.4% of the trawl catches in Div.1 CD in 2005.

The standardized catch rates in Div. 1CD dropped gradually from 1989-1996 but has been stable since then with an increasing trend and the catch rates also increased slightly between 2004 and 2005 (Fig. 11 b) (Appendix 2).

The combined (Div. 0B+1CD) standardized CPUE series has been stable in the period 1990-2001, dropped somewhat in 2002 but has increased again since then, and is in 2005 at the level seen in 1990-2001 (Appendix 3) (Fig. 11c).

Due to the frequency of fleet changes in the fishery in both SA0 and SA1 and change in fishing grounds in Div. 0A and 1A, both the unstandardized and the standardized indices of CPUE should, however, be interpreted 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 was too uncertain to be used in the yield per recruit analysis. Age frequencies were available from the longline fishery in Div. 1D 2005 fishery, but the catches only represented about 1 % of the total catches in the assessment area, 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 1987-1995 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) but the outcome of the analysis did not improve.

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 in 2003 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.

The XSA was not run this year as no catch-at-age data were available for 2003-2005.

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. 4. 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 1987-1998 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 not 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 mortalities 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 2000-2005 (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 until 2000. Since then catches have gradually increased to 19 954 tons in 2003 and they have stayed at that level since, and the TAC has hence been taken. The increase in catches have primarily been due to increased effort in Div. 0A and Div. 1A.

The biomass in Div. 1CD increased between 2003 and 2005 and is well above the average for the period 1997-2004.

The biomass in the Greenland shrimp survey was above average both in the offshore area and overall for the period 1992-2004.

The recruitment of age one in the entire survey area has been above average the last three years, and an recruitment index for the offshore nursery areas showed that the 2004 year-class was around average.

Length compositions in the commercial catches have been stable in recent years

Standardized catch rates in Div. OB decreased between 1995 and 2002, but has been increasing since then and is in 2005 at the level of the early 1990s. In Div 1CD standardized catch rates has been increasing slightly since 1996. The combined catch rate for Div. 1C-D+0B has showed very little variation during the period 1988-2005.

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

Bech, G. 1995. Recruitment of Greenland halibut at West Greenland. NAFO SCR Doc. 95/19.

Jørgensen, O.A. 2005. Survey for Greenland halibut in NAFO Divisions 1CD, 2004. NAFO SCR Doc. 05/13.

Jørgensen, O.A. 2005. Survey for Greenland halibut in Northern Part of Baffin Bay. NAFO Divisions 1A, 2005. NAFO SCR Doc. 05/14.

Ratz H.-J., C. Stransky and M. Stein. 2005. German research report for 2004. SCS Doc. 05/9.

Siegstad, H. 2005. Denmark/Greenland Research Report for 2004. SCS Doc. 05/14.

Sünksen, K., M. Storr-Paulsen and O.A. Jørgensen. 2005. Biomass and Abundance of Demersal Fish Stocks off West Greenland Estimated from the Greenland shrimp survey, 1988-2004. NAFO SCR Doc. 05/39.

Treble M. A., Summary of data from the offshore commercial fishery for Greenland halibut in Subarea 0. NAFO SCR Doc. 04/44.

Vaskov A.A., K. Gorchinsky, T. M. Igashov, S. P. Melinkov, I.K Sigaev and V.A. Rikhter. 2006. Russian Research Report for 2005. NAFO SCS Doc. 06/7.

Table 1. Greenland halibut catches (metric tons) by year and country for Subarea 0 (Split on Div. 0A and 0B) from 1987 to 2005. Minor (300 ton or less) catches from Div. 0A are included in some of the 0B catches prior to 2001.

	Year																		
Count	87	88	89	90	91	92	93	94	95	96	97	98	99	00[a]	01[ad]	02[ae]	03[af]	04[a]	05[a]
0A																			
CAN															2183	3800	4278	3740	4268
POL															445				
0B																			
CAN		2		589	256	2194	883		1941	2354	3871	3924	4784	5438	5034	3186	4709	5627	5866
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									782			
RUS		59	29	1528	1758	9364	4229[b]	3674	261	915							1368		
TOT	388	1024	907	9498	8606	12358	7489	4274	3233	4608	4323	3924	4784	5438	7662	7768	10355	9367	10134

[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, and 2 tons reported by error
[e] Excluding 370 tons double reported and 782 tons reported by error
[f] Excluding 1366 tons double reported

Table 2. Greenland halibut catches (metric tons) by year and country for Subarea 1 (Split on Div. 1AB and Div. 1CD) from 1987 to 2005. The Greenland catches are excl. inshore catches in Div. 1A. Offshore catches in Div. 1A prior to 2001 are negligible.

	Year																		
Coun.	87	88	89	90	91	92	93	94	95	96	97	98	99	00[a]	01[a]	02[a]	03[a]	04[a]	05[a]
1AB																			
GRL															340[d]	1571[d]	3476[d]	3621[d]	3363[d]
RUS															85	279	259	241	500
FRO														96	148	150	146[c]	150[c]	126[c]
NOR																	77		
EU																	73	141[f]	
1CD																			
GRL					965	227	213	885	1405	1880	2312	2295	2549	2657	2657	2294[c]	2199	2185	2380
FRO				54	123	151	128	780			127	242	116	147	150	150	152[c]	150[c]	148[c]
JPN	907	1581	1300	988	677	2902	1198	820	337										
NOR					611	2432	2344	3119	2472	1785	1893	1338	1360	1360	1419	1734	1345	1364	1456[c]
RUS							5		296	254		543	552	792	829	654	1328	1214	1224
EU							46	266	527	455	446	350	330	444	537	536	543[e]	665[g]	550
Total	907	1581	1300	1042	2376	5712	3934	5870	5037	4374	4778	4769	4907[b]	5251	5522	7368	9598	9731	9747

[a] Provisional data.
[b] Excluding 7603 tons reported by error
[c] Reported to the Greenland authorities
[d] Offshore catches
[e] Including 2 tons taken in an experimental fishery
[f] Spanish research fishery
[g] Includes 131 tons taken in Spanish research fishery

Table 3. Catch-at-age in numbers. Not updated for 2003 - 2005.

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
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	1995	1909	1988

Table 4. Catch weights at age (kg) Not updated for 2003-2005.

R	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

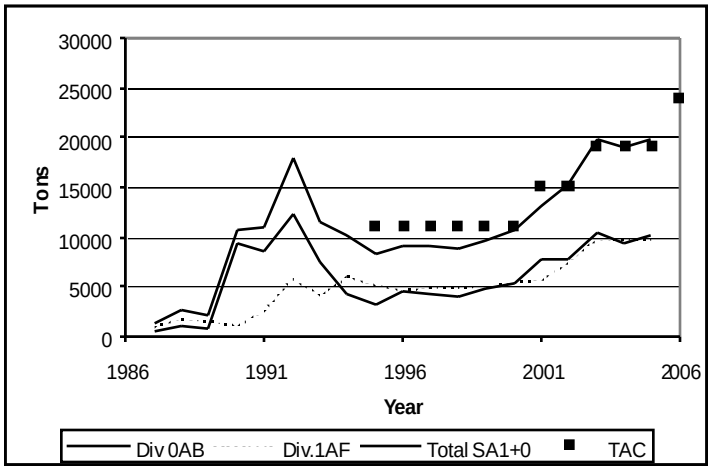


Fig. 1. Catches in SA0 and Div. 1A offshore + Div. 1B-1F and recommended TAC. For TAC before 1995 see text.

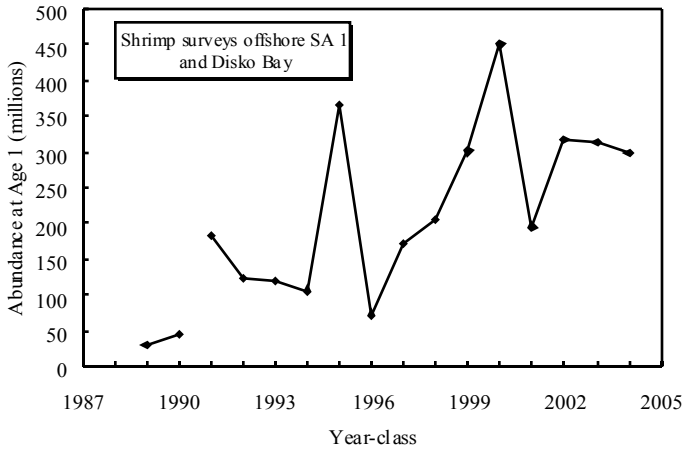


Fig.2. Abundance of age one Greenland halibut in the entire area covered by the Greenland shrimp survey including inshore Disko Bay and Div. 1AN (North of 70°N)

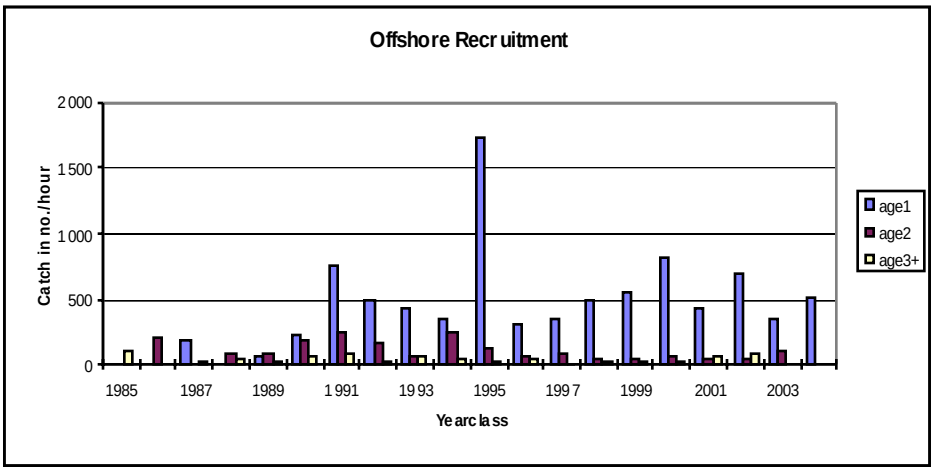


Fig. 3. Year-class strength of Greenland halibut of ages 1-3+ in number per hour trawled in the offshore nursery area (Div 1AS-1B, depths > 300 m).

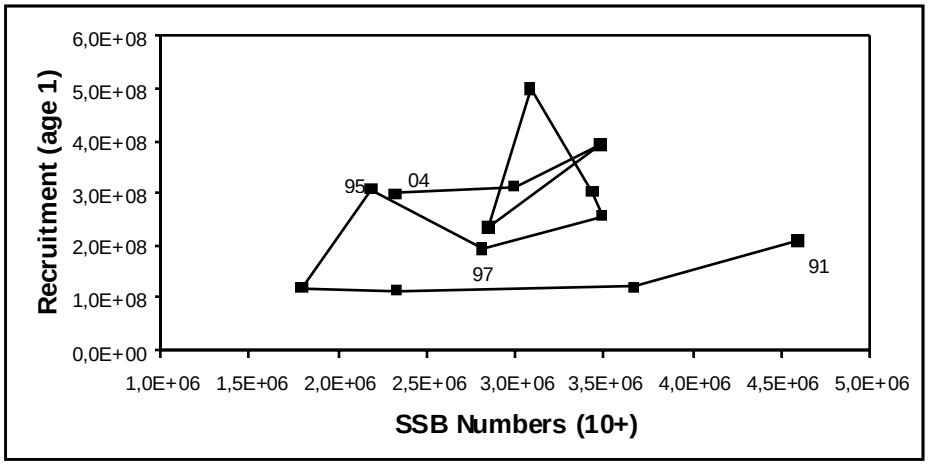
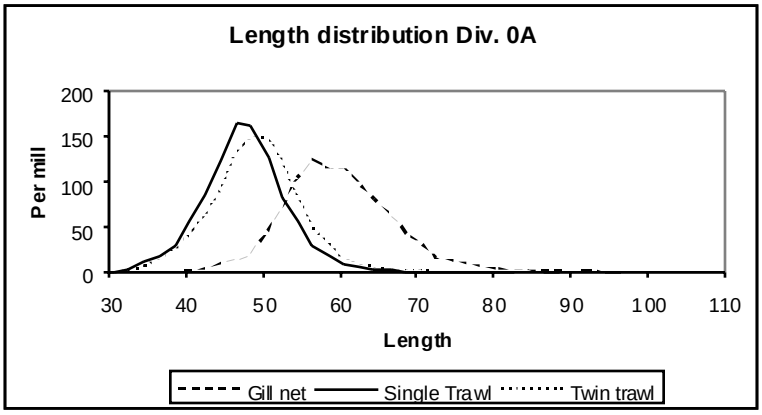


Fig. 4. Spawning stock in numbers (ages 10-18 in Div.1CD from the joint Japan/Greenland survey and the Greenland survey (1997-2001) plotted vs number of fish age 1 the following year estimated from the Greenland shrimp trawl survey including the Disko Bay. Figures denotes year-class. Note there was no deep sea survey in 1996.



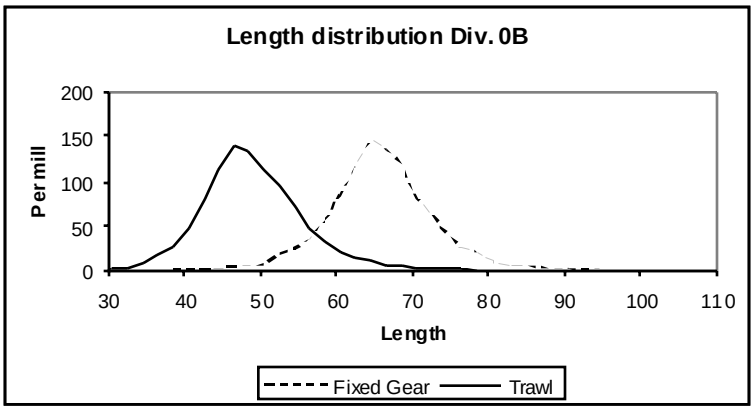


Fig 5. Length distribution from the fishery in Div 0AB in 2005.

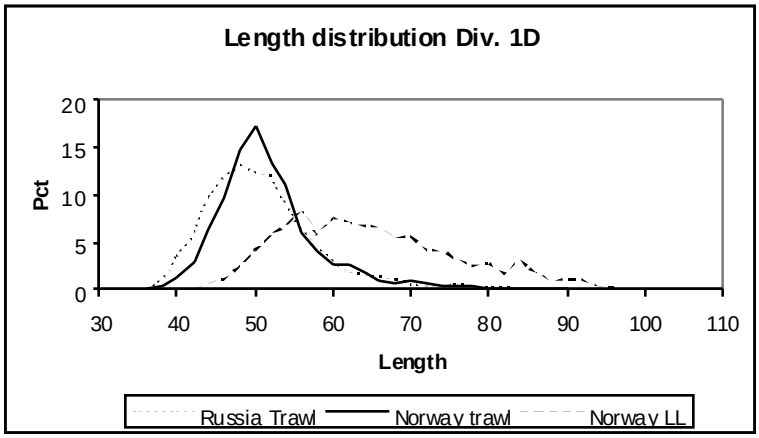


Fig. 6. Length distribution in the trawl and long line fishery in Div.1D in 2005.

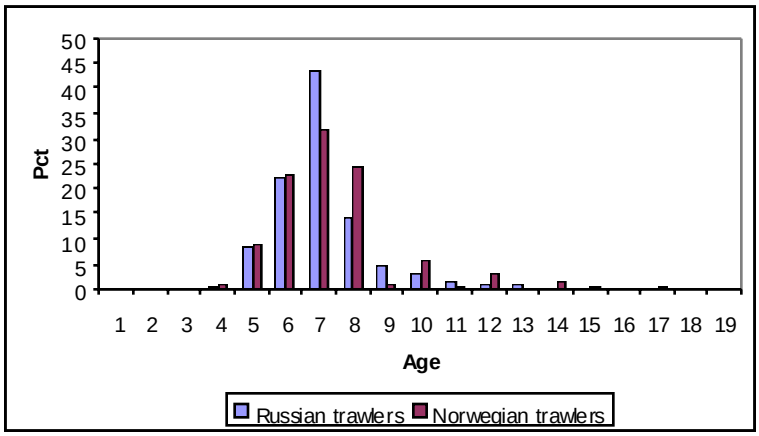


Fig. 7. Age distribution in the Russian and Norwegian trawl fishery in Div. 1D in 2005.

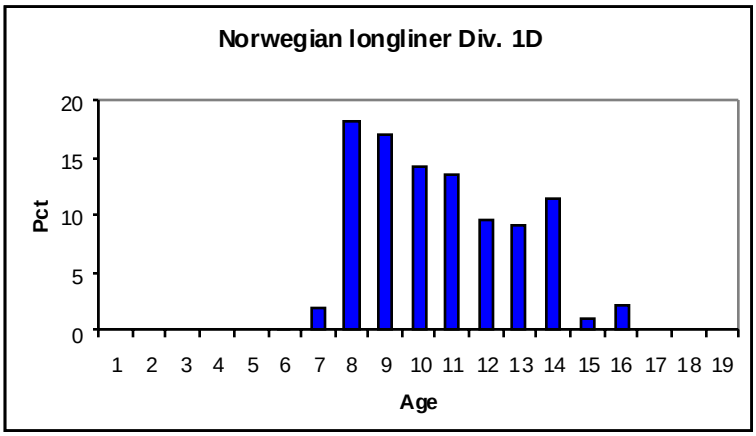


Fig. 8. Age distribution in the Norwegian longline fishery in 1D in 2005.

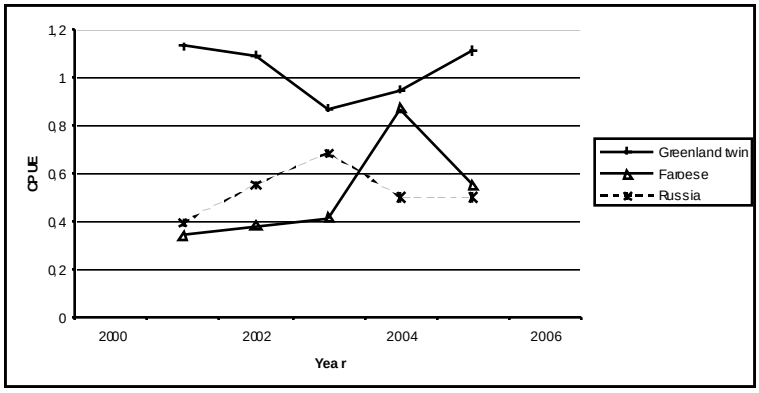


Fig. 9. Unstandardized trawl CPUE series from Div. 1AB.

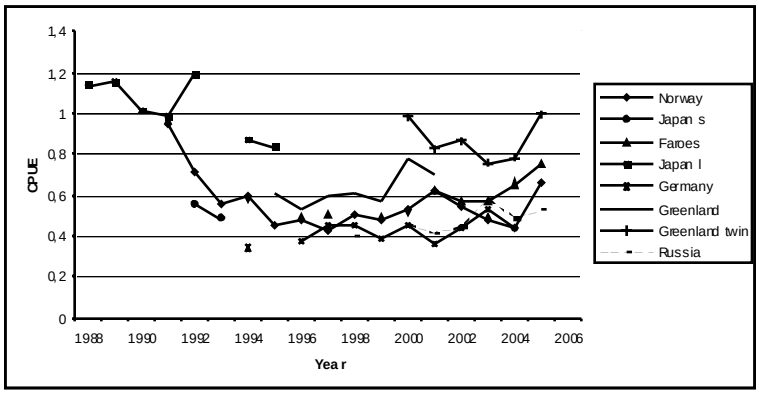


Fig. 10. Unstandardized catch rates from different fleets fishing in Div. 1CD.

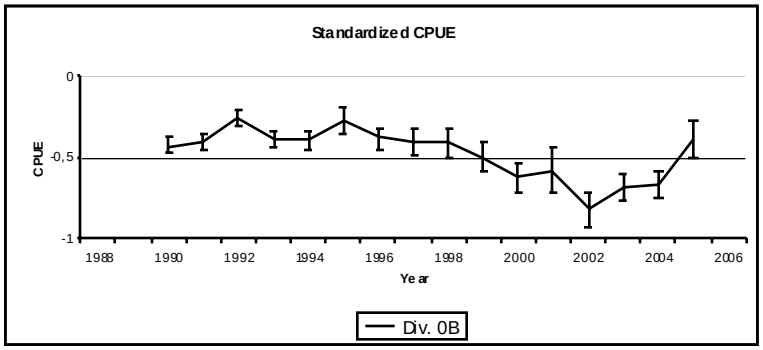


Fig 11a. Standardized CPUE series from trawlers in Div. 0B with +/- S.E.

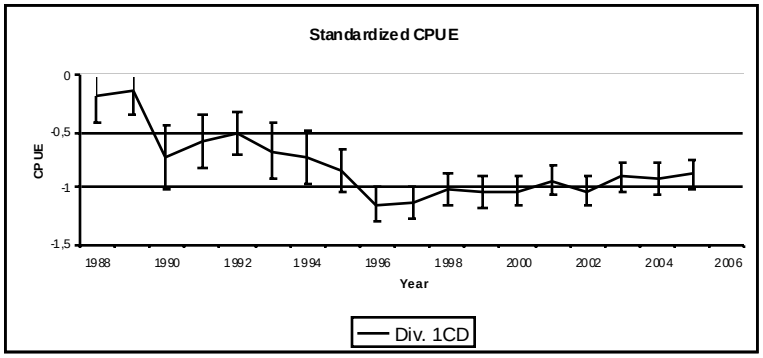


Fig. 11b. Standardized trawl CPUE index from trawlers in Div. 1CD with +/- S.E.

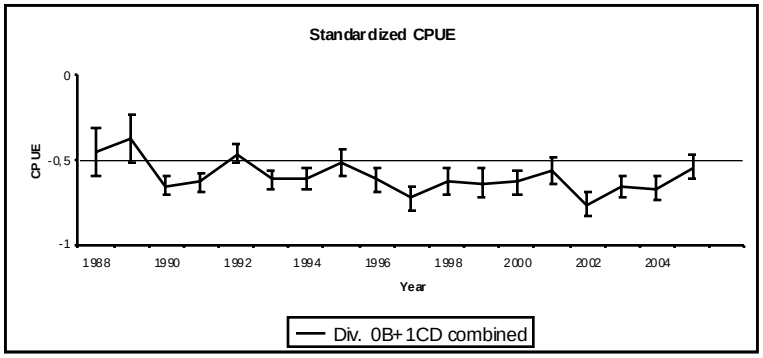


Fig. 11c. Combined standardized trawl CPUE index from trawlers in Div. 0B +1CD with +/- S.E.

Appendix 1. Standardized CPUE index from trawlers in Div. 0B

Greenland halibut, 0B trawlers 31
21:37 Tuesday, June 6, 2006

The GLM Procedure

Class Level Information

Class	Levels	Values
YR	16	1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
md	10	1 4 5 6 7 8 9 10 11 12
CGT	11	2126 2127 5126 5127 14124 14125 15126 15127 20126 20127 31927

Number of Observations Read 435
Number of Observations Used 435

Greenland halibut, 0B trawlers 32
21:37 Tuesday, June 6, 2006

The GLM Procedure

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	34	93.4925567	2.7497811	50.83	<.0001
Error	400	21.6408021	0.0541020		
Corrected Total	434	115.1333588			

R-Square	Coeff Var	Root MSE	lcph Mean
0.812037	-31.55055	0.232598	-0.737225

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YR	15	51.53361516	3.43557434	63.50	<.0001
md	9	4.96876910	0.55208546	10.20	<.0001
CGT	10	36.99017239	3.69901724	68.37	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	15	2.59832322	0.17322155	3.20	<.0001
md	9	4.61443108	0.51271456	9.48	<.0001
CGT	10	36.99017239	3.69901724	68.37	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		0.286518826	B	0.12784528	2.24	0.0256
YR	1990	-0.039952354	B	0.12860963	-0.31	0.7562
YR	1991	-0.025113055	B	0.12898034	-0.19	0.8457
YR	1992	0.120096603	B	0.12769397	0.94	0.3475
YR	1993	-0.006960892	B	0.12934898	-0.05	0.9571
YR	1994	-0.015014871	B	0.13216360	-0.11	0.9096
YR	1995	0.108130693	B	0.14198851	0.76	0.4468
YR	1996	0.005839566	B	0.13447985	0.04	0.9654
YR	1997	-0.023710591	B	0.13431210	-0.18	0.8600
YR	1998	-0.025216423	B	0.13752158	-0.18	0.8546
YR	1999	-0.105729152	B	0.13334038	-0.79	0.4283
YR	2000	-0.139931877	B	0.15348518	-0.91	0.3625
YR	2001	-0.181786002	B	0.17318145	-1.05	0.2945
YR	2002	-0.423871658	B	0.13293407	-3.19	0.0015
YR	2003	-0.292687537	B	0.11848777	-2.47	0.0139
YR	2004	-0.272494749	B	0.11744796	-2.32	0.0208

Greenland halibut, 0B trawlers 33

21:37 Tuesday, June 6, 2006

The GLM Procedure

Dependent Variable: lcph

Parameter		Estimate		Standard Error	t Value	Pr > |t|
YR	2005	0.000000000	B	.	.	.
md	1	0.027939819	B	0.15621804	0.18	0.8581
md	4	0.038406907	B	0.10944081	0.35	0.7258
md	5	0.290786179	B	0.08503089	3.42	0.0007
md	6	0.012747507	B	0.08355002	0.15	0.8788
md	7	-0.305933037	B	0.06219825	-4.92	<.0001
md	8	-0.196425366	B	0.05576705	-3.52	0.0005
md	9	-0.286925593	B	0.05310761	-5.40	<.0001
md	10	-0.324487678	B	0.05018266	-6.47	<.0001
md	11	-0.178842705	B	0.05095918	-3.51	0.0005
md	12	0.000000000	B	.	.	.
CGT	2126	-0.799748525	B	0.12458911	-6.42	<.0001
CGT	2127	-0.359428904	B	0.08640173	-4.16	<.0001
CGT	5126	-0.520521757	B	0.13807297	-3.77	0.0002
CGT	5127	-0.326280326	B	0.10816082	-3.02	0.0027
CGT	14124	-0.893959780	B	0.11423650	-7.83	<.0001
CGT	14125	-0.824608227	B	0.16174174	-5.10	<.0001
CGT	15126	-0.127333569	B	0.11476745	-1.11	0.2679
CGT	15127	-0.156292277	B	0.12847311	-1.22	0.2245
CGT	20126	-1.207160809	B	0.10636929	-11.35	<.0001
CGT	20127	-1.224392385	B	0.11168185	-10.96	<.0001
CGT	31927	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|
1990	-0.43113661	0.04841697	<.0001
1991	-0.41629731	0.04739232	<.0001
1992	-0.27108766	0.04526511	<.0001
1993	-0.39814515	0.04845554	<.0001
1994	-0.40619913	0.05542054	<.0001
1995	-0.28305357	0.07702546	0.0003
1996	-0.38534469	0.06801836	<.0001
1997	-0.41489485	0.07975627	<.0001
1998	-0.41640068	0.09277508	<.0001
1999	-0.49691341	0.09224351	<.0001
2000	-0.53111614	0.11697525	<.0001
2001	-0.57297026	0.14619044	0.0001
2002	-0.81505592	0.10699474	<.0001
2003	-0.68387180	0.08156230	<.0001
2004	-0.66367901	0.08400078	<.0001
2005	-0.39118426	0.11350967	0.0006

Appendix 2. Standardized CPUE index for trawlers in Div.1CD.

```
Greenland halibut, 1CD trawlers                                   1
                                                 17:54 Sunday, June 4, 2006

                            The GLM Procedure

                         Class Level Information

Class       Levels  Values

YR              18  1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
                    1999 2000 2001 2002 2003 2004 2005

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 Read         189
                  Number of Observations Used         189

                      Greenland halibut, 1CD trawlers                     2
                                                 17:54 Sunday, June 4, 2006

                            The GLM Procedure

Dependent Variable: lcph

 Source                     DF       Sum of Squares   Mean Square  F Value  Pr > F

 Model                      35   25.73350003    0.73524286     9.20  <.0001

 Error                     153   12.22799373    0.07992153

 Corrected Total           188   37.96149376


            R-Square     Coeff Var      Root MSE     lcph Mean

            0.677884     -47.62090      0.282704     -0.593655


 Source                     DF     Type I SS   Mean Square  F Value  Pr > F

 YR                         17   11.26730887    0.66278287     8.29  <.0001
 MD                         10    7.26605750    0.72660575     9.09  <.0001
 CGT                         8    7.20013366    0.90001671    11.26  <.0001


 Source                     DF   Type III SS   Mean Square  F Value  Pr > F

 YR                         17    2.32210465    0.13659439     1.71  0.0464
 MD                         10    6.24189208    0.62418921     7.81  <.0001
 CGT                         8    7.20013366    0.90001671    11.26  <.0001

 Parameter              Estimate             Standard Error    t Value    Pr > |t|

 Intercept           0.060217838 B      0.10417630       0.58      0.5641
 YR        1988      0.698509309 B      0.31024259       2.25      0.0258
 YR        1989      0.748193851 B      0.30305406       2.47      0.0147
 YR        1990      0.153670879 B      0.33579214       0.46      0.6479
 YR        1991      0.291437604 B      0.30115617       0.97      0.3347
 YR        1992      0.366644961 B      0.27009799       1.36      0.1766
 YR        1993      0.210175893 B      0.32385905       0.65      0.5173
 YR        1994      0.155778440 B      0.31222150       0.50      0.6185
 YR        1995      0.034315315 B      0.24897452       0.14      0.8906
 YR        1996     -0.263432652 B      0.11596823      -2.27      0.0245
 YR        1997     -0.254684736 B      0.10914063      -2.33      0.0209
 YR        1998     -0.128931124 B      0.10662611      -1.21      0.2285
 YR        1999     -0.162316853 B      0.11793129      -1.38      0.1707
 YR        2000     -0.143729716 B      0.09629933      -1.49      0.1376
 YR        2001     -0.044542472 B      0.10005954      -0.45      0.6568
 YR        2002     -0.137622304 B      0.10174058      -1.35      0.1782
 YR        2003     -0.021148489 B      0.10230122      -0.21      0.8365
 YR        2004     -0.030405371 B      0.10373576      -0.29      0.7698
```

YR	2005	0.000000000 B	.	.	.
MD	1	-0.487582381 B	0.18521362	-2.63	0.0093
MD	2	-1.464054330 B	0.25586474	-5.72	<.0001
MD	4	-0.567907597 B	0.32910381	-1.73	0.0864
MD	5	-0.569494548 B	0.19381802	-2.94	0.0038
MD	6	-0.828358314 B	0.15233383	-5.44	<.0001
MD	7	-0.633285040 B	0.13026370	-4.86	<.0001
MD	8	-0.344216062 B	0.09982656	-3.45	0.0007
MD	9	-0.152625228 B	0.08395035	-1.82	0.0710
MD	10	-0.194160933 B	0.07858823	-2.47	0.0146
MD	11	-0.171976388 B	0.07909622	-2.17	0.0312
MD	12	0.000000000 B	.	.	.
CGT	2	-0.507999025 B	0.07818333	-6.50	<.0001
CGT	3	-0.538752122 B	0.29575319	-1.82	0.0705
CGT	4	-0.560681367 B	0.08788804	-6.38	<.0001
CGT	5	-0.813101562 B	0.32152699	-2.53	0.0125
CGT	6	-0.533733262 B	0.10773810	-4.95	<.0001
CGT	7	-0.146898977 B	0.27789572	-0.53	0.5978
CGT	8	-0.639158352 B	0.08318694	-7.68	<.0001
CGT	9	-0.302220462 B	0.08958731	-3.37	0.0009
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	-0.18259552	0.22826103	0.4250
1989	-0.13291098	0.22623647	0.5577
1990	-0.72743395	0.27423307	0.0088
1991	-0.58966722	0.22778165	0.0106
1992	-0.51445986	0.18794012	0.0069
1993	-0.67092893	0.24558037	0.0070
1994	-0.72532639	0.24153806	0.0031
1995	-0.84678951	0.18633718	<.0001
1996	-1.14453748	0.14458236	<.0001
1997	-1.13578956	0.13746095	<.0001
1998	-1.01003595	0.13715498	<.0001
1999	-1.04342168	0.14506603	<.0001
2000	-1.02483454	0.12891980	<.0001
2001	-0.92564730	0.13085099	<.0001
2002	-1.01872713	0.13150881	<.0001
2003	-0.90225332	0.13256350	<.0001
2004	-0.91151020	0.13372247	<.0001
2005	-0.88110483	0.12156378	<.0001

Appendix 3. Combined Standardized CPUE index for trawlers in Div. 1CD and Div. 0B.

```
                    Greenland halibut,  0B+1CD trawlers                    98
                                          14:41 Wednesday, June 14, 2006

                            The GLM Procedure

                         Class Level Information

Class       Levels  Values

YR              18  1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
                    1999 2000 2001 2002 2003 2004 2005

MD              11  1 2 4 5 6 7 8 9 10 11 12

CGT             20  2 3 4 5 6 7 8 9 10 2126 2127 5126 5127 14124 14125
                    15126 15127 20126 20127 31927


                  Number of Observations Read         624
                  Number of Observations Used         624

                    Greenland halibut, 0B+1CD trawlers                     99
                                          14:41 Wednesday, June 14, 2006

                            The GLM Procedure

Dependent Variable: lcph

                                    Sum of
 Source                     DF       Squares   Mean Square  F Value  Pr > F

 Model                      46   116.0403413     2.5226161    36.60  <.0001

 Error                     577    39.7702602     0.0689259

 Corrected Total           623   155.8106015


            R-Square     Coeff Var      Root MSE     lcph Mean

            0.744753     -37.84381      0.262537     -0.693740


 Source                     DF     Type I SS   Mean Square  F Value  Pr > F

 YR                         17   46.39292300    2.72899547    39.59  <.0001
 MD                         10   12.18263775    1.21826378    17.67  <.0001
 CGT                        19   57.46478053    3.02446213    43.88  <.0001


 Source                     DF   Type III SS   Mean Square  F Value  Pr > F

 YR                         17    2.51686072    0.14805063     2.15  0.0048
 MD                         10    5.85956908    0.58595691     8.50  <.0001
 CGT                        19   57.46478053    3.02446213    43.88  <.0001


                                              Standard
 Parameter                Estimate                Error    t Value    Pr > |t|

 Intercept             0.308421160 B      0.10718381        2.88      0.0042
 YR         1988       0.069800668 B      0.16279278        0.43      0.6683
 YR         1989       0.145629579 B      0.16311660        0.89      0.3723
 YR         1990      -0.135330258 B      0.09134086       -1.48      0.1390
 YR         1991      -0.107079590 B      0.09254063       -1.16      0.2477
 YR         1992       0.054761318 B      0.09111145        0.60      0.5481
 YR         1993      -0.102372832 B      0.09362015       -1.09      0.2746
 YR         1994      -0.094452921 B      0.09862550       -0.96      0.3386
 YR         1995      -0.029217173 B      0.10368152       -0.28      0.7782
 YR         1996      -0.132974337 B      0.08396752       -1.58      0.1138
 YR         1997      -0.190014103 B      0.08144135       -2.33      0.0200
 YR         1998      -0.088479141 B      0.08171176       -1.08      0.2793
 YR         1999      -0.105244956 B      0.08551348       -1.23      0.2189
 YR         2000      -0.083742990 B      0.07787012       -1.08      0.2826
 YR         2001      -0.045888635 B      0.08136418       -0.56      0.5730
 YR         2002      -0.190805616 B      0.07882026       -2.42      0.0158
```

YR	2003	-0.090343996 B	0.07485125	-1.21	0.2279
YR	2004	-0.105085776 B	0.07513444	-1.40	0.1625
YR	2005	0.000000000 B	.	.	.
MD	1	-0.282844010 B	0.12064803	-2.34	0.0194
MD	2	-1.210966124 B	0.19978657	-6.06	<.0001
MD	4	-0.139416597 B	0.10772855	-1.29	0.1961
MD	5	0.043829050 B	0.08102929	0.54	0.5888
MD	6	-0.263372708 B	0.07684415	-3.43	0.0007
MD	7	-0.335515881 B	0.05792411	-5.79	<.0001
MD	8	-0.207036611 B	0.05029699	-4.12	<.0001
MD	9	-0.228433153 B	0.04640228	-4.92	<.0001
MD	10	-0.256359868 B	0.04388134	-5.84	<.0001
MD	11	-0.146795802 B	0.04468767	-3.28	0.0011
MD	12	0.000000000 B	.	.	.
CGT	2	-0.809505262 B	0.09797779	-8.26	<.0001
CGT	3	-0.457413826 B	0.15897683	-2.88	0.0042
CGT	4	-0.797146826 B	0.10706693	-7.45	<.0001
CGT	5	-0.730035572 B	0.15226606	-4.79	<.0001
CGT	6	-0.742055737 B	0.12044459	-6.16	<.0001
CGT	7	-0.080350029 B	0.12953458	-0.62	0.5353
CGT	8	-0.882414959 B	0.10175184	-8.67	<.0001
CGT	9	-0.647570167 B	0.10050400	-6.44	<.0001
CGT	10	-0.242921355 B	0.10295986	-2.36	0.0186
CGT	2126	-0.789484833 B	0.13064084	-6.04	<.0001
CGT	2127	-0.358560407 B	0.08910045	-4.02	<.0001
CGT	5126	-0.438760282 B	0.13956737	-3.14	0.0018
CGT	5127	-0.269101166 B	0.10706035	-2.51	0.0122
CGT	14124	-0.864760662 B	0.11762346	-7.35	<.0001
CGT	14125	-0.657453035 B	0.16721552	-3.93	<.0001
CGT	15126	-0.101874625 B	0.11841212	-0.86	0.3900
CGT	15127	-0.134751189 B	0.13509674	-1.00	0.3190
CGT	20126	-1.169008948 B	0.10814192	-10.81	<.0001
CGT	20127	-1.192068950 B	0.11463630	-10.40	<.0001
CGT	31927	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	-0.46521385	0.14359946	0.0013
1989	-0.38938494	0.14367641	0.0069
1990	-0.67034478	0.05559245	<.0001
1991	-0.64209411	0.05477701	<.0001
1992	-0.48025321	0.05099268	<.0001
1993	-0.63738735	0.05491251	<.0001
1994	-0.62946744	0.06189461	<.0001
1995	-0.56423170	0.07674493	<.0001
1996	-0.66798886	0.06279401	<.0001
1997	-0.72502863	0.06727122	<.0001
1998	-0.62349366	0.07112597	<.0001
1999	-0.64025948	0.07508207	<.0001
2000	-0.61875751	0.06813967	<.0001
2001	-0.58090316	0.07283303	<.0001
2002	-0.72582014	0.06934443	<.0001
2003	-0.62535852	0.06391031	<.0001
2004	-0.64010030	0.06463820	<.0001
2005	-0.53501452	0.06789811	<.0001