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

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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. During 2006-2009 catches have been around 24,000 tons. Catches increased to 26 934 tons in 2010. The increase was due to increased effort in Div. 0B and Div. 1CD. Survey trawlable biomass in Div. 0A and 1A have been relatively stable in recent years, although the estimate from the southern part of Div. 0A was slightly below average for the time series. Survey trawlable biomass in Div. 1CD was estimated to a level slightly above the average for the time series. This also applied to the offshore biomass in the Greenland shrimp fish survey. The recruitment of the 2009 year class in the entire survey area was slightly above average. A recruitment index for the off shore nursery areas showed that the 2009 year class was a little below average. A combined standardized CPUE series from Div. 0A + 1AB decreased slightly between 2009 and 2010, but have been stable since 2001. The combined CPUE series from Div. 1CD+0B declined slightly in 2010 but the CPUE is still among the highest in the time series.

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 1995-2000 the advised TAC for the latter area was 11,000 tons but the TAC was fished almost exclusively in Div. 0B and Div. 1CD. In 2000 there was set an additional TAC of 4,000 tons for Div. 0A+1AB for 2001 and the TAC on 11,000 tons was allocated to Div. 0B and Div. 1CF. The TAC in Div. 0A+ Div. 1AB was in 2002 increased to 8,000 tons for 2003. Total advised TAC for 2004 and 2005 remained at 19,000 tons. In 2006 the advised TAC in Div. 0A+1AB was increased with further 5,000 tons to 13,000 tons. The total advised TAC remained at that level. - 24,000 tons - in 2008 and 2009. In 2010 the TAC for Div. 0B+ Div. 1CF was increased by 3,000 tons to 14,000 tons and the total TAC for Subarea 0+1 (excluding inshore areas in Div. 1A) was 27,000 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 2,927 tons in 1989 to 11,633 tons in 1990. Catches remained at that level in 1991 but increased again in 1992 to 18,457 tons. During 1993-2000 catches have fluctuated between 8,250 and 11,750 tons. Catches increased to 13,760 tons in 2001 and further to 19,716 tons in 2005. In 2006 catches increased to 24,164, remained at that level in 2007 but decreased slightly to 22,071 tons in 2008. Catches increased again to 24,805 tons in 2009 and further to 26,934 tons in 2010 (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 and from 2005 to 2006 was primarily due to an in increase in effort in Div. 0A and Div. 1A. The increase in catches between 2009 and 2010 was due to increased effort in Div. 0B and 1CD.

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 1,087 tons in 1989 to 9,753 tons in 1990. Catches decreased in 1991 to 8,745 tons, to increase again in 1992 to 12,788 tons. Catches then decreased gradually to 3,233 tons in 1995 and fluctuated between 3,924 and 5,438 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 8,107 tons in 2001 and further to 9,201 tons in 2003 and remained at that level in 2004 and 2005. Catches increased to 12,319 in 2006 but decreased slightly to 11,489 tons in 2007 and further to 10,432 tons in 2008. Catches increased again to 12,400 tons in 2009 and further to 13,225 tons in 2010 (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 of about 300 ton, where they have been since 1996 (trial fishery not officially reported), to 3,073 tons in 2001 and further to 4,142 tons in 2003. Catches remained at that level in 2004 and 2005. In 2006 catches increased to 6,634 tons due to increased effort, but decreased to 6,173 tons in 2007 and further to 5,257 tons in 2008. Catches increased again in 2009 to 6,593 tons and remained at that level in 2010 (6,390 tons) (Table 1).

The catches in Div. 0A in 2010 were taken by single trawl (399 tons) and twin trawl (3,346 tons), while 2,645 tons was taken by gill net. The single trawl catches decreased about 1 000 tons and the twin trawl catches increased by approximately the same amount while the gill net catches were almost at the same level compared to 2009. The long lines fishery in the area has apparently stopped. The fishery was prosecuted by Canadian vessels.

Catches in Div. 0B 2010 amounted to 6,835 tons which is an increase from 5,807 tons in 2009 and about 1 000 tons above the level seen in recent years. The increase in catches was due to increased effort. Offshore gillnetters took 2,117 tons while single- and double trawlers took 1,792 tons and 2,813 tons , respectively. The gillnet catches increased with about 700 tons and the single trawl catches with about 1,150 tons while the double trawl caches decreased with a little less than 600 tons, respectively, between 2009 and 2010. A small longline fishery took 113 tons compared to 102 tons in 2009. From inshore Cumberland Sound were reported 33 tons (not included). All catches were taken by Canadian vessels.

Catches in SA1

The catches in Subarea 1 (Div. offshore 1A + Div. 1B-1F) were below 2,500 tons during 1982-1991. In 1992 catches increased to 5,669, decreased to 3,870 tons in 1993 to increase again in 1994 to the 1992 level. During 1995-1999 catches were around 4,500-5,000 tons. Catches increased to 5,728 tons in 2000, remained at that level in 2001 and increased gradually to 9,495 tons in 2003 and remained at this level in 2004 and 2005. Catches increased to 11,945 tons in 2006 due to increased effort by Greenland in Div. 1AB. and remained at that level in 2007 and 2008. In 2009 catches amounted to 12,405 tons and increased further to 13,709 tons in 2010. Almost all catches have been taken offshore (Table 2). The inshore catches amounted to 362 tons in 2010.

Catches in Div. 1AB (mainly in Div. 1A) increased gradually from 575 tons in 2001 to 4,007 tons in 2003 and

remained at that level in 2004-2005. Catches increased again in 2006 to 6,223 and remained at that level during 2007-2010 (6,462 tons in 2010). All catches were taken off shore by trawlers from Faeroe Islands, Russia (SCS 11/11) and Greenland (SCS 11/10).

Catches in Div 1CD have been stable around 5,600 tons in recent years until 2009, but catches increased to 7,307 in 2010 due to increased effort. Catches were taken by vessels from Greenland (SCS 11/10), Norway, EU-Germany (SCS 11/06), Russia (SCS 11/11) and Faeroe Islands. All catches offshore were taken by trawl while 362 tons were taken inshore in Div. 1B-1F, mainly by gill net.

Reported discards in the trawl fishery is small, normally < 1%.

2. Input data

2.1 Research trawl survey

Div. 1C-1D GHL-survey

Since 1997 Greenland has conducted stratified random bottom trawl surveys for Greenland halibut in September-October in NAFO Div. 1C-D at depth between 400 and 1500 m. In 2010 a total 66 hauls were made (SCR 11/009).
The biomass was estimated at 75 522 tons which is an increase compared to 70 966.2 tons in 2009 and slightly above the average for the time series (72 000 tons). The abundance was estimated at $64.868*10^6$ which is an increase compared to $62.507*10^6$ in 2009 but still slightly below the average for the time series ($68.000 *10^6$) (Fig. 2b). The weighted mean catch per tow also showed an increase from 1.36 tons km^{-2} in 2009 to 1.44 tons km^{-2} in 2010 (Fig. 2c). The overall length distribution in Div. 1CD was totally dominated by a mode at 49 cm where the mode use to be at 47-50 cm.

Greenland deep sea survey in Baffin Bay (Div. 1A)

Greenland has conducted surveys primarily aimed at Greenland halibut in the Baffin Bay in 2001, 2004 and 2010. The biomass and abundance of Greenland halibut was in 2010 estimated as 79.332 tons and $1.04*10^8$ specimens, respectively (SCR 11/10). The surveys did not cover the same areas but a comparison of the abundance and biomass in areas covered both in 2001 and 2010 showed a small increase in biomass from 46.521 tons in 2001 to 52.428 tons in 2010 while there was a decrease in abundance from 101.8 mill. in 2001 to 63.5 mill. in 2010. The biomass has hence been relatively constant while there were significantly more and smaller fish in 2001. The biomass in the area covered both in 2004 and 2010 was estimated to 47.244 tons and 38.632 tons, respectively while the abundance was estimated at 58.8 mill. and 54.4 mill., respectively. The length in 2010 ranged from 20 cm to 105 cm. The overall length distribution (weighted by stratum area) was totally dominated by a mode at 45 cm, while the mode was at 46 cm at depths > 800 m. Generally the length distributions in the deeper depth strata were dominated by a single mode and fish size increased with depth as seen in previous surveys.

Canadian deep sea survey in Baffin Bay (Div. 0A)

Canada has conducted surveys in the southern part of Div. 0A in 1999, 2001, 2004, 2006, 2008 and 2010. The biomass has increased gradually from 68,700 tons via 81,000 tons to 86, 200 tons in 2004. The biomass decreased to 52,271 tons in 2006 (Fig. 2d). However, the survey coverage was not complete and two of the four strata missed fell within the depths 1001-1500 m and accounted for 11,000 – 13,000 tons of biomass in previous surveys.

The biomass and abundance was in 2010 estimated to 74,272 tons and $1.1*10^8$ which is slightly below the estimates from 2008 on 77.182 tons 1.16×10^8, respectively (Fig. 2e). Mean biomass per tow decreased from 1.67t/km^2 in 2008 to 1.53 t/km^2 in 2010 which is the lowest in the time series. The overall length distribution ranged from 6 cm to 99 cm with a mode at 39 cm, similar to that seen in previous surveys. (SCR 11/017).

In 2010 the survey also covered the northern part of division 0A from 73°N to 75°35'N, which has not been surveyed since 2004. The biomass and abundance increased from 45,877 tons and 4.85 $10*^7$ to 46,489 tons and $6.74*10^7$,

respectively (Fig. 2e). In 2010 the depth stratum 750-1000 m was not fully surveyed due to ice, which underestimates the biomass and abundance. The mean catch per tow increased from 0.85 ton /km2 to 1.18 ton km2. The increase in mean catch per tow was primarily seen in strata > 1000 m.

The length ranged from 21 to 78 cm with a single mode at 39 cm and there were more small, < 45 cm, fish in 2010 compared to 2004. (SCR 11/017)

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 restratified in 2004 based on better information about depths. All biomass and abundance indices have been recalculated. The recalculation did not change the trends in the development of the different stocks. The trawl was changed in 2005 but the data have been adjusted for that.

Estimated total trawlable biomass of Greenland halibut in the offshore areas (not including Disko Bay) has fluctuated between 9,258 and 31,100 tons during 1992 – 2009. In 2010 the biomass was estimated as 22,487 tons compared to 16,868 tons in 2009 and slightly above the average for the time series which dates back to 1992 (Fig. 2f).

The abundance was estimated at 315 mill compared to 275 mill. in 2009 and also slightly above the time series. The increase in biomass was primarily seen in Div. 1A. As in almost all years most of the abundance was comprised of one-year-old fish (SCR 11/024).

In the inshore Disko Bay the biomass increased from 9,456 tons in 2009 to 12,193 tons but it is still below the level seen in 2003-2006 (28,299 - 16,538 tons). The abundance was estimated as $117*10^6$ compared to $71*10^6$ in 2009.

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 estimated in 2009 was 310 mill. compared to 226 mill. in 2009. The estimate of the 2009 year class is slightly above the average of the times series. The increase between 2009 and 2010 was caused by an increase in abundance in Div. 1A and in Disko Bay (Fig. 3).

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. 4). 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 hour but do not change the trend in the index.

The recruitment index declined since the relatively large 1991 year-class, but the recruitment has been above the level in the 1980's. 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. Until the 2006 year class the recruitment has been around or a little above average. The recruitment of the 2009 year-class was estimated as 497 age-one caught per hour, some what below the average for the time series (570 no per hr) (SCR 11/24).

In Disko Bay the recruitment has been good in recent years although the recruitment of year classes 2002-2005 has been gradually decreasing. The recruitment increased again and the 2006 year class was the third largest on record. The 2007 and 2008 year classes were low but the recruitment increased in 2010 where the 2009 year class was estimated to 927 no hr^{-1}, somewhat above the average for the time series (815 hr^{-1})
Generally there is a steep decline between CPUE at age 1 and age 2 and 3+ which also was observed in the 2010 survey. Further, it has been noted, that the year-classes estimated to be a very strong year-class at age 1 have not shown

up as a particularly strong year-classes at age 5-8 in the fishery catches or in the 1CD survey for Greenland halibut.

2.2 Commercial fishery data.

Length distribution

SA 0

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

The catch in the gill net fishery in Div. 0A was dominated by a mode at 63 cm, similar to that seen in previous years. The length distributions in the single trawl fishery had a mode at 47 cm while the mode in the twin trawl fishery was 49 cm (Fig. 5). The mode use to be around 48 cm in both types of gear.

The length distributions in the single and twin trawl fishery in Div. 0B were very similar with modes around 51 cm, for both types of gear, as seen in recent years (Fig. 5).

SA1

Length frequencies were available from Greenland and Russian trawl fisheries in Div. 1A (SCS 11/11) and from Russian (SCS 11/11) and Norwegian trawl fisheries in Div. 1D.

In Div. 1A the mode was at 48 cm in both the Russian (Fig. 6) and Greenlandic trawl fishery (Fig. 7). In recent years the trawl catches have been dominated by fish on 44-52 cm.

In Div. 1D the catches by Russia and Norway showed clear modes around 50-53 cm (Fig. 8 and 9). The mode in catches has been within this range for several years but there was a tendency towards slightly larger fish especially in the Norwegian fishery than seen in previous years.

Age distribution.

An age length key from Div. 1A and 1D based on scales was presented by Russia (SCS 11/11).

There is considerable uncertainty about accuracy in the current age reading methods (see section in STACREC report) and the age reading procedure is currently under revision hence no age based analysis are presented.

Catch rate

The fleets used for standardization of catch rates are grouped according to NAFO's protocol:

Code for country.

2	CAN-MQ	Canada Maritimes & Quebec
3	CAN-N	Canada Newfoundland
5	FRO	Faroe Islands
6	GRL	Denmark Greenland
7	E/DNK	Denmark Mainland
8	E/FRA-M	France Mainland
9	FRA-SP	France St. Pierre et Miquelon
10	E/DEU	Federal Republic of Germany
14	JPN	Japan
15	NOR	Norway
16	E/POL	Poland

18	ROM	Romania
19	E/ESP	Spain
20	SUN	Union Soviet Socialist Republics
27	CAN-M	Canada Maritimes
28	CAN-Q	Canada Quebec
31	E/LVA	Latvia
32	E/EST	Estonia
33	E/LTU	Lithuania
34	RUS	Russia
38	EU	European Union
39	CAN	Canada
40	CAN-CA	Canada Central & Arctic

All vessels fishing in SA1 have been given the code 6 (Greenland).

Code for Trawl Gear:
Bottom otter trawl (charters),8,OTB
Bottom otter trawl (side or stern not specified),10,OTB
Bottom otter trawl,12,OTB-2
Otter twin trawl,192,OTT

Code forTonnage:

0	Not known
2	0-49.9
3	50-149.9
4	150-499.9
5	500-999.9
6	1000-1999.9
7	2000 and over

Ex. Code 401927 is 40: Canada Central & Arctic, 192: Otter twin trawl, 7: Over 2000 Gross Tonnage

SA0
There have been frequent vessel changes in this fishery over the years and the catch from single and double trawl gear was often aggregated as “otter trawl” catch when this gear was first introduced to the fishery in the early 2000s. Very few of the vessels operating in the fishery in 2010 have been in the fishery for more than 3 years. A standardized catch rate is produced using a General Linear Model. The model was updated in 2011 with the 2010 data. Catches (t) and hours fished with values less than 10 were removed.

Div. 0A
In Div. 0A the standardized CPUE index declined slightly in 2007 but increased in 2008 and 2009 to decrease again in 2010 to about an average level (Fig. 11a). This decrease could also be seen in the un-standardized catch rates for both single and twin trawl gears (Fig. 10a). Standardized trawl gear catch rates for Div. 0A have been relatively stable over the past 10 years (Fig. 11a) (Appendix 1).

Div. 0B
In Div. 0B the overall CPUE index increased to the highest observed level in 2009 but declined again in 2010 to the level seen in the 90’s (Fig. 11c). The decrease was seen for twin trawlers while the CPUE for single trawlers increased (Fig. 10b). (Appendix 4).

SA1
Un-standardized catch rates were available for the Greenland trawl fishery in Div. 1A and 1D (SCS 11/10), and the EU-German fishery in Div. 1D (SCS 11/06). Further, catch rates were available from logbooks submitted to the Greenland authorities. Standardized catch rates were available from the trawl fishery in Div. 1AB and 1CD. Until 2008

the fleets in the catch rate analysis have been grouped by nation, but information about gross tonnage is now available in the Greenland logbook database and the fleets are grouped based on size and gear according to NAFO's protocol. This has not changed the trends in the CPUE series but the SE and CV of the estimates have been reduced significantly. In the GLM model catches (t) and hours fished with values less than 10 are removed.

Div 1AB
Un-standardized catch rates from large (>2000 GT) trawlers in Div 1A have been relatively stable since 2005 around 0.93 ton/hr but showed a slight increase between 2009 to 2010. CPUE for trawlers 1000-2000 Gross Tons single trawlers has been increasing since 2006 but declined between 2009 and 2010 but is still at the highest in the time series (Fig.10c).

Standardized catch rate series, based on logbook data from the Greenland authorities, were available for the offshore trawl fishery in Div. 1AB for the period 2002-2009. Standardized catch rates in Div. 1AB has been declining between 2006 and 2008 but has been increasing since then and is in 2010 on the highest level in the time series (Fig. 11a, Appendix 2).

Div. 1CD
In Div. 1D the EU-German catch rates have been increasing gradually since 2004 but declined in 2010. The catch rate is, however, still above the level seen in 1996 -2005. (SCS 11/06). In Div. 1CD the CPUE for three Greenland vessels fishing there has been fluctuating between 0.55 ton/hr and 0.85 ton/hr since 2000. In 2010 the CPUE was 0.78 ton/hr compared to 0.56 ton/hr in 2009

The un-standardized catch rates for all large single trawlers fishing in Div. 1CD decreased slightly, while a more pronounced decrease was seen for the > 2000 tons twin trawlers between 2009 and 2010. The high catch rates for > 2000 GT single trawlers in 1988 and 1989 is from a single large vessel (4000 GT) and the decrease in catch rates in 2007 for large > 2000 GT twin trawlers was caused by a significant decrease in catch rates from one out of two vessels. Further, the estimate for > 2000 GT single trawlers in 2007 is based on one vessel new in the fishery (Fig.10d).

Standardized catch rate series, based on logbook data from the Greenland authorities, were available for the offshore trawl fishery in Div. 1CD for the period 1988-2010 (Fig.11b). Standardized catch rates in Div. 1CD decreased gradually from 1989-1997 but have shown an increasing trend since then. CPUE decreased between 2009 and 2010 but the CPUE is, however, still among the highest seen in recent years (Appendix 5).

Combined standardized catch rate in Div. 0A-1AB
The combined Div. 0A+1AB standardized CPUE series decreased slightly between 2009 and 2010, but has been stable since 2001 (Fig. 11a) (Appendix 3).

Combined standardized catch rate in Div. 0B-1CD
The combined Div. 0B+1CD standardized CPUE series has been stable in the period 1990-2001, decreased somewhat in 2002 but has increased again and was in 2006 at the highest level seen since 1989. CPUE decreased very slightly in 2007, but increased significantly in 2008 and increased further to the highest level seen since 1989 in 2009. CPUE decreased slightly in 2010 but the CPUE is still among the highest in the time series since 1989. (The high catch rates seen in 1988 and 1989 is from a single very large trawler fishing in Div. 1CD) (Fig. 11d) (Appendix 6).

It is not known how the technical development of fishing gear, etc. has influenced the catch rates. There are indications that the coding of gear type in the log books is not always reliable, which also can influence the estimation of the catch rates. Further, 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 un-standardized and the standardized indices of CPUE should, however, be interpreted with caution.

3. **Assessment**

A Greenland halibut age determination workshop in 2011 concluded that there is considerable uncertainty about accuracy in the current age reading methods (see section in STACREC report) and the age reading procedure is currently under revision hence no age based analysis are up dated..

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 ages 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. No age frequencies were available from the longline fishery in Div. 1D in 2010, hence no catch-curve analysis were made.

3.2 XSA.

Extended Survivors Analysis
An XSA has been run unsuccessfully 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) 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 were 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 had been relatively 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 02/68.

The XSA was run again in 2003 with the 2002 survey and catch data and updated catch data from 2001 (very small changes). The assessment results were considered to be provisional due to problems with the catch-at-age data and the short time series. The assessment was, however, considered to some extent to reflect the dynamics in the stock. The rate of exploitation had been relatively stable in recent years between 0.2-0.3 (F_{bar} 7-13). The summary of the XSA is given in SCR (03/54).

The XSA was not run this year as no catch-at-age data were available for 2003-2010.

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.5. 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 trawls only take a very small proportion of the mature fish), poor estimates of ages of old 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 poorly estimated (the Petersen method). The plot was not updated because there was no aging of Greenland halibut in the recent surveys.

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 unrealisticly 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 change 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 re-samplings).

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 2000-2006 (catches, survey biomass index, and CPUE index) have varied little compared to 1999. An ASPIC was run in 2009, but the outcome of the analysis did not change significantly from the analysis in 1999, mainly because there is very little contrast in the input data and the data series are relative short.

4. Conclusion

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 18,696 tons in 2003 and they remained at that level during 2004-2005. The TAC was increased by 5,000 tons in 2006 and catches increased to 24,164 and the TAC has hence been taken. The increase in catches has been due to increased effort in Div. 0A and Div. 1A. Catches remained at that level in 2007, - 23,416 tons but decreased slightly to 22,380 tons in 2008. Catches increased to 24,805 tons in 2009 and further to 26,934 tons in 2010 due to increased effort in Div. 0B and Div. 1CD.

The biomass in Div. 0A and 1A has been stable in recent years.

The standardized CPUE index for Div. 0A declined slightly in 2007 but increased in 2008 and 2009 to decrease again in 2010 to about an average level. Standardized catch rates in Div. 1AB has been declining between 2006 and 2008 but has been increasing since and is in 2010 on the highest level in the time series. The combined Div. 0A+1AB standardized CPUE series decreased slightly between 2009 and 2010, but has been stable since 2001.
Length frequencies in the fishery in Div 0A and Div. 1AB has been stable in recent years.

The biomass in Div. 1CD increased between 2003 and 2005, but decreased slightly during 2006-2007 to increase to a record high level in 2008. The biomass decreased again in 2009 but increased again in 2010 to a level a little above the average for the time series.

The offshore biomass in the Greenland shrimp survey has been gradually decreasing since 2004, but increased again in 2010 to a level slightly above the average of the time series

The recruitment of the 2002-2006 year class in the entire survey area has been stable but the recruitment of the 2007 and 2008 year classes have been gradually decreasing and the 2008 year class is the lowest level seen since the 1997 year class. The estimate of the 2009 year class is slightly above the average of the times series. The increase between 2009 and 2010 was caused by an increase in abundance in Div. 1A and in Disko Bay

A recruitment index for the off shore nursery areas (Div 1A (south of 70°N) and Div 1B depth > 300 m) showed that the 2009 year class was a little below average.

Standardized CPUE rates in Div. 0B and Div.1CD decreased between 2009 and 2010 but are still among the highest seen since 1994. The combined catch rate for Div. 1CD+0B has showed very little variation during the period 1990-2004, but with an increasing trend since then and the 2009 estimate is the highest seen since 1989. CPUE decreased

between 2009 and 2010 but the CPUE is, however, still among the highest seen in recent years.
Length compositions in the commercial catches in Div. 0B + 1CD have been stable in recent 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 relatively short and show little variability and are not useful for estimating reference points.

6. References

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Treble M. A. 2011. Report on Greenland Halibut caught during the 2010 Trawl Survey in NAFO Division 0A. NAFO SCR 11/017.

Table 1. Greenland halibut catches (metric tons) by year and country for Subarea 0 (Split on Div. 0A and 0B) from 1987 to 2009. 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[e]	01[c]	02[d]	03[f]	4	5	6	7	8	9	10
0A																								
CAN							681		82	576	3		517		2628	3561	4142	3751	4209	6634	6173	5257	6627	6390
POL															445									
TOT 0A							681		82	576	3		517		3073	3561	4142	3751	4209	6634	6173	5257	6627	6390
0B																								
CAN		2	180	844	395	2624	592	402	1859	2354	3868	3924	4267	5438	5034	3910	5059	5771	5789	5585	5318	5175	5622	6835
EST							631																	
FRO	388	963	596	2252	2401	463	1038			578	452													
JAP				113	232	337	252	600	1031	500														
LAV							84																	
NOR			282	5016[b]	3959		373																	
RUS		59	29	1528	1758	9364	4229[a]	3674	261	600														
TOT 0B	388	1024	1087	9753	8745	12788	7199	4676	3151	4032	4320	3924	4267	5438	5034	3910	5059	5771	5789	5585	5318	5175	5622	6835
TOT 0AB	388	1024	1087	9753	8745	12788	7880	4676	3233	4608	4323	3924	4784	5438	8107	7471	9201	9522	9998	12219	11491	10432	12249	13225

[a] The Russian catch is reported as area unknown, but has previously been reported from Div. 0B
[b] Double reported as 10031 tons
[d] Excluding 782 tons reported by error
[e] STACFIS estimate
[f] excluding 2 tons reported by error

Table 2. Greenland halibut catches (metric tons) by year and country for Subarea 1 (Split on Div. 1AB and Div. 1CD) from 1987 to 2010. The Greenland catches are excl. inshore catches in Div. 1A. Offshore catches in Div. 1A prior to 2001 are negligible.

Coun.	87	88	89	90	91	92	93	94	95	96	97	98	99[a]	0	1	2	3[g]	4	5	6	7	8	9	10
1AB																								
GRL															340[c]	1619[c]	3558[c]	3500[c]	3363[bc]	5530[bc]	5596[bc]	5524[bc]	6094[bc]	5682[bc]
RUS															85	279	259	241	549	565	575	570	517	654
FRO														96	150	150	117	153	125	128	125	149	124	126
EU																	73[e]	141[e]						
TOT 1AB														96	575	2048	4007	3908	4037	6223	6296	6243	6735	6462
1CD																								
GRL	1646	605	540	841	933	191	186	872	1399	1876	2312	2295	2529	2659	2012	2284	2059	2102[b]	2380[b]	2430[b]	1805[b]	1888	1457	2491
FRO				54	123	151	128	780			127	125	116	147	150	150	135	150	149	147	150	184	149	152
JPN	855	1576	1300	985	673	2895	1161	820	323															
NOR					611	2432	2344	3119	2472	1785	1893	1338	1360	1590	1550	1734	1423	1364	1456[b]	1379	1441	1452[b]	1501	1572
RUS							5		296	254		543	552	792	829	654	1328	1214	1147	1222	689	763	1056	1214
EU							46	266	527	455	446	350	330	444[b]	537[b]	536	543[d]	665[f]	549	544	1516	1517	1511	1818
TOT 1CD	2501	2181	1840	1880	2340	5669	3870	5857	5017	4370	4778	4651	4887	5632	5078	5358	5488	5495	5681	5722	5601	5804	5670	7247
Total	2501	2181	1840	1880	2340	5669	3870	5857	5017	4370	4778	4651	4887	5728	5653	7406	9495	9403	9718	11945	11897	12047	12404	13709

[a] Excluding 7603 tons reported by error

[b] Reported to the Greenland Fisheries License Control Authority. Statlant 21A data from Div. ICD from Greenland during 2004-2007 include double reported catches.

[c] Offshore catches

[d] Including 2 tons taken in an experimental fishery

[e] Spanish research fishery

[f] Includes 131 tons taken in Spanish research fishery

[g] Excludes 1366 tons reported from Div. 1A by error

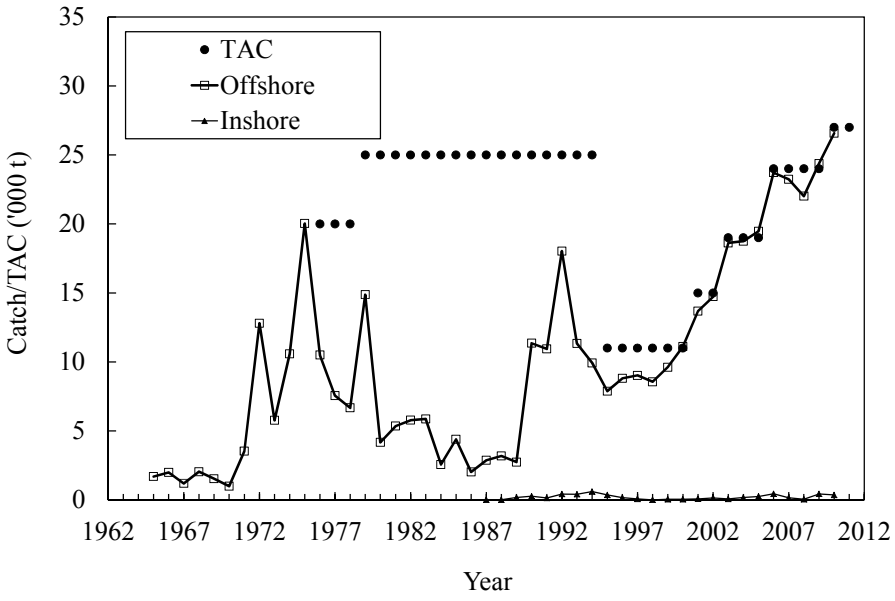

Fig. 1. Catches in SA0 and Div. 1A offshore + Div. 1B-1F and recommended TAC. For TAC before 1995 see text.

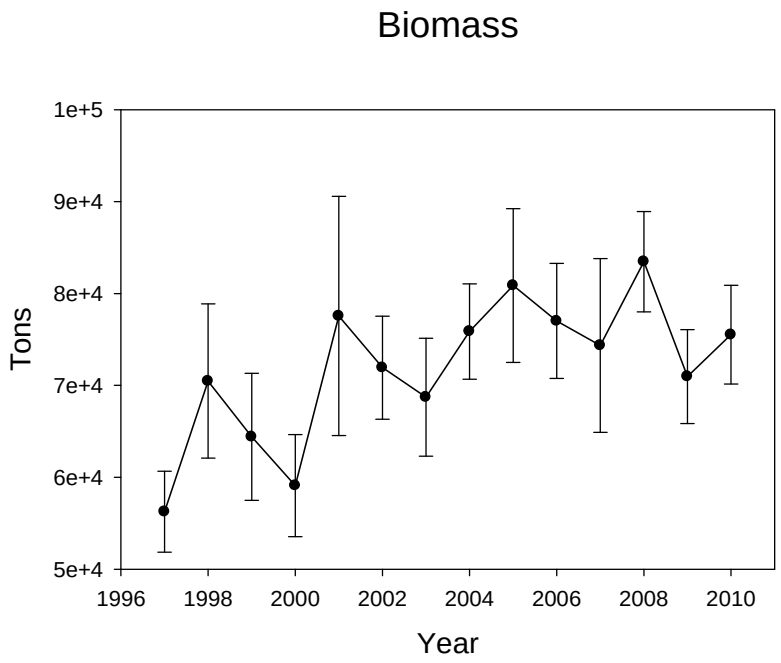

Fig 2a. Biomass with S.E. from the Greenland deep sea survey in Div. 1CD.

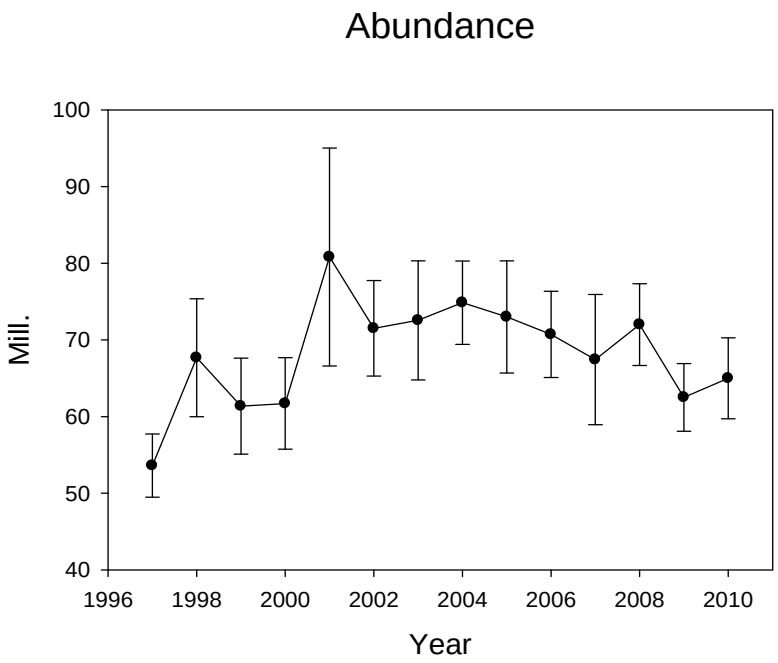

Fig 2b. Abundance with S.E. from the Greenland deep sea survey in 1CD.

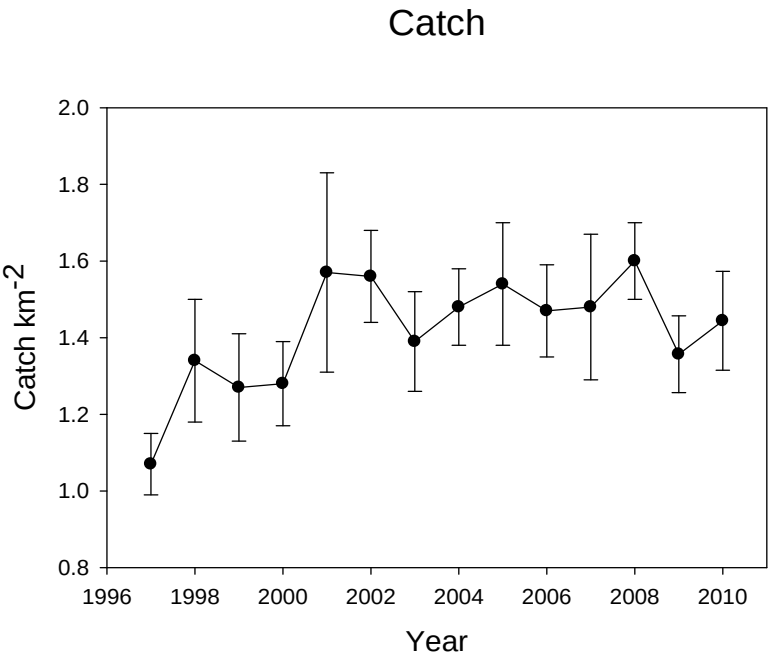

Fig 2c. Mean catch per km^2 swept with S.E. in the Greenland deep sea survey in Div. 1CD.

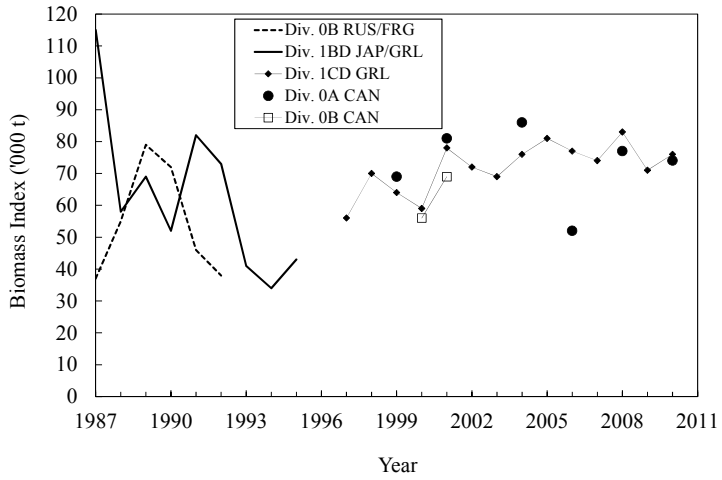

Fig. 2d. Biomass estimates from various surveys in SA 0 and 1. Survey estimates from Div. 0A does not include surveys in the northern part in 2004 and 2010. Note that the survey in Div. 0A in 2006 had incomplete coverage (see text).

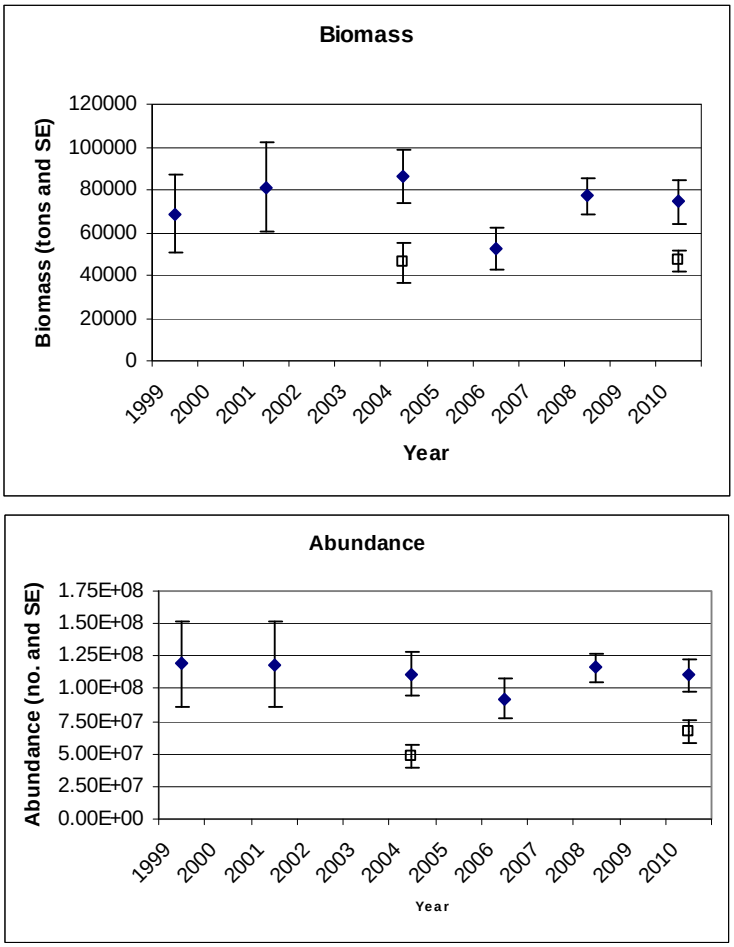

Fig. 2e. Biomass (top) and abundance (bottom) estimates for Greenland halibut in Division 0A-South (solid points) and 0A-North (open points).

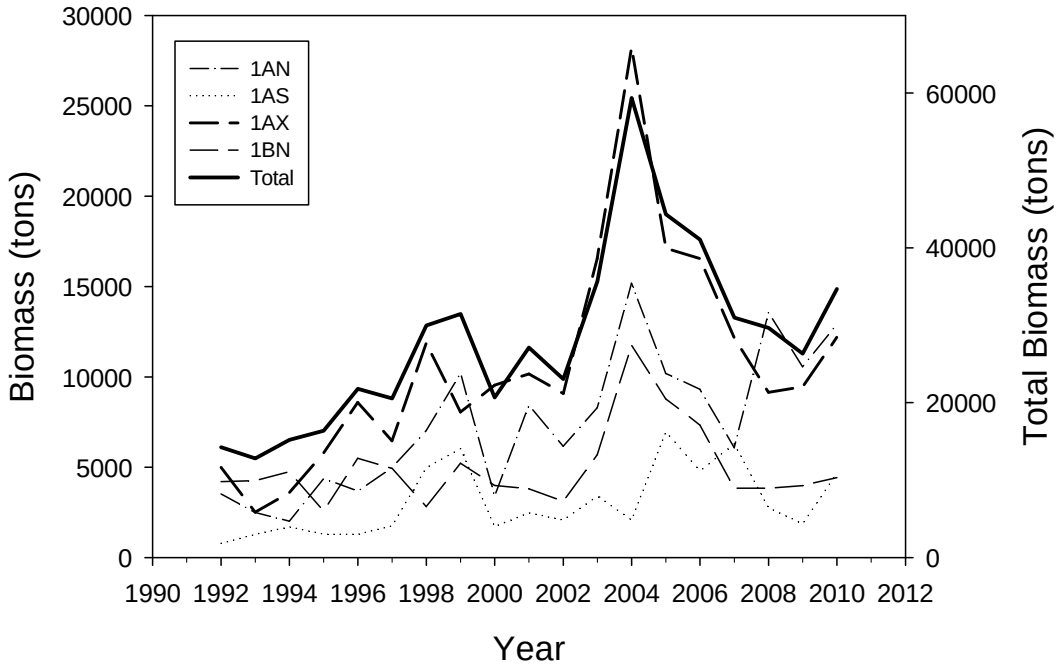

Fig. 2f. Biomass estimates from the Greenland shrimp survey by most important Divisions and in total. Div. 1AX is inshore Disko Bay.

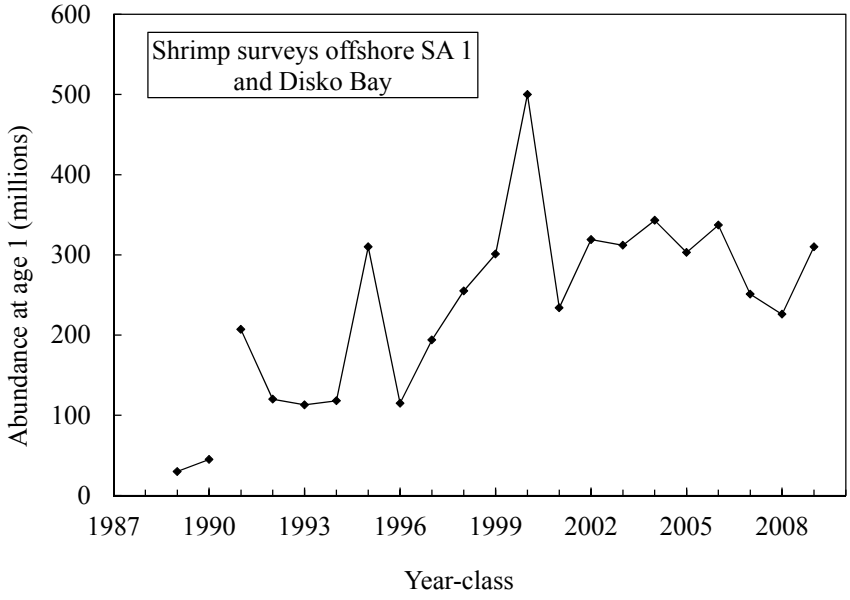

Fig.3. Abundance of age-one Greenland halibut in the entire area covered by the Greenland shrimp survey including inshore Disko Bay and Div. 1AN (North of 70°N)

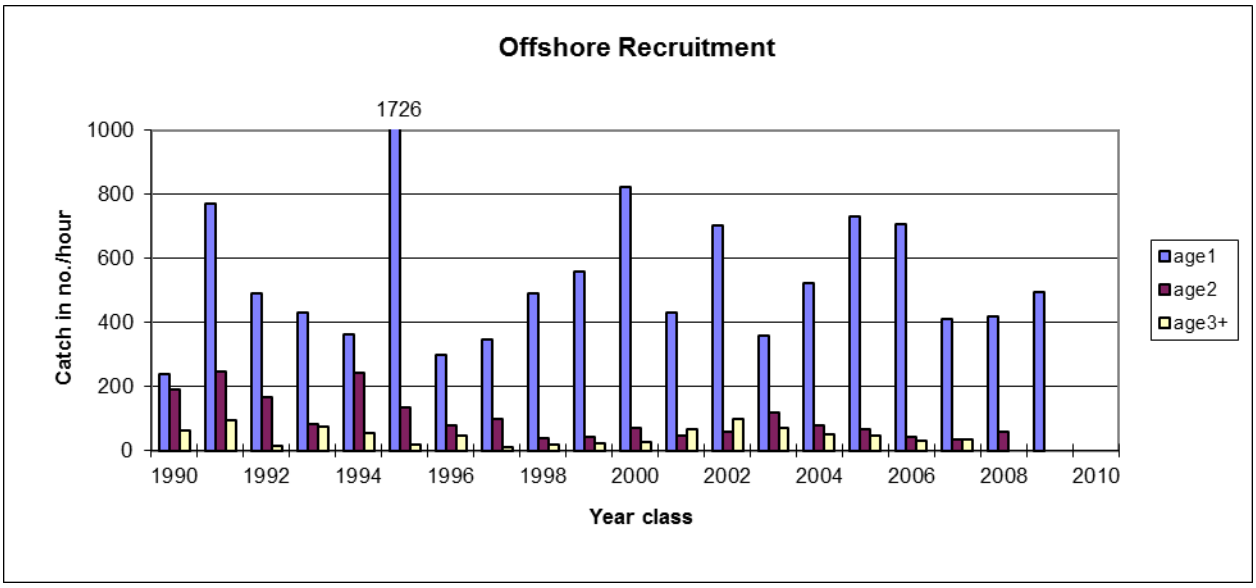

Fig. 4. Year-class strength of Greenland halibut of ages 1-3+ in number per hour trawled in the offshore nursery area (Div 1AS-1B, depths 300-600 m).

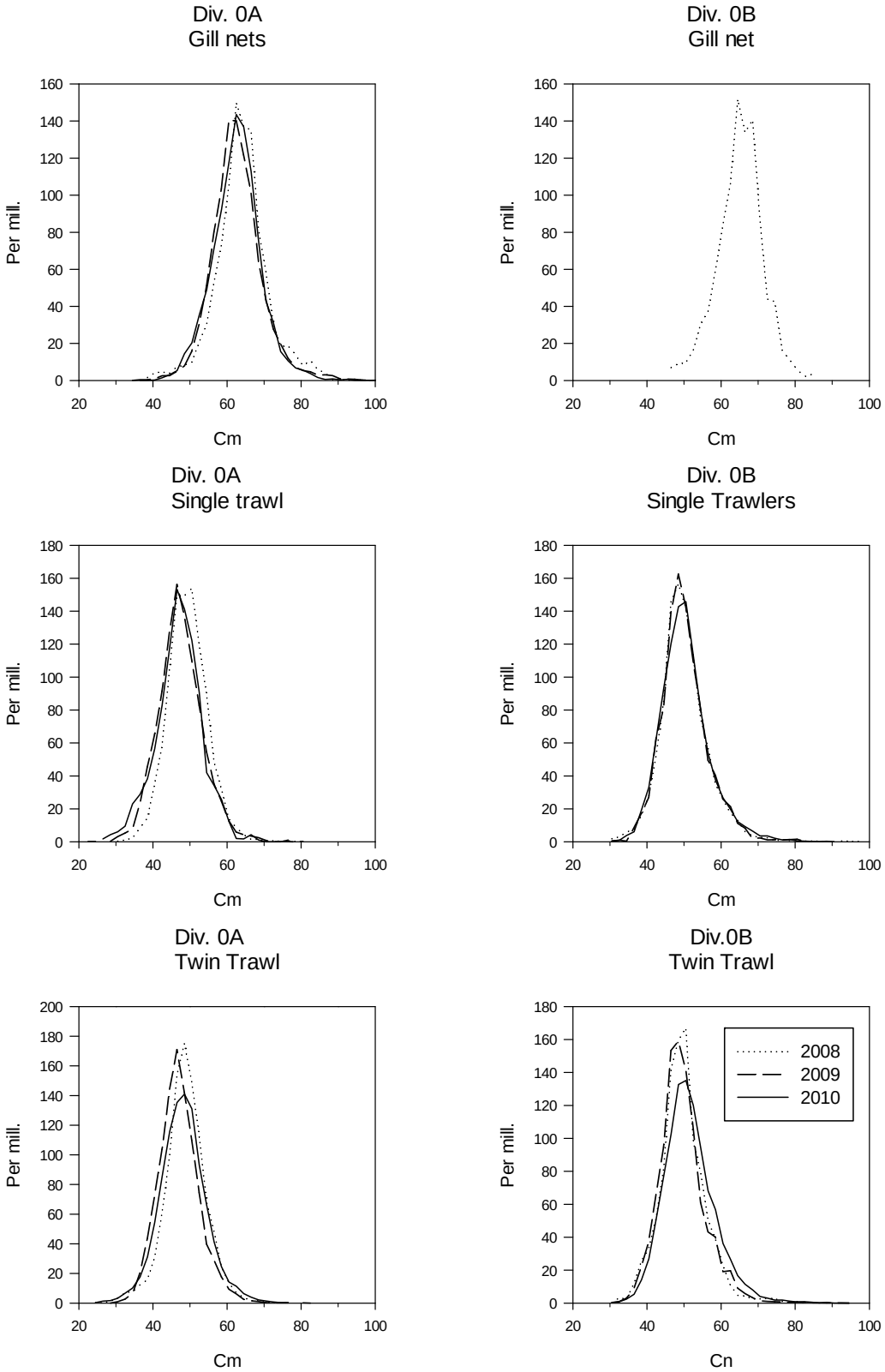

Fig.6a. Length distribution from the fishery in Subarea 0 in 2008-2010 in per mill., 2 cm groups

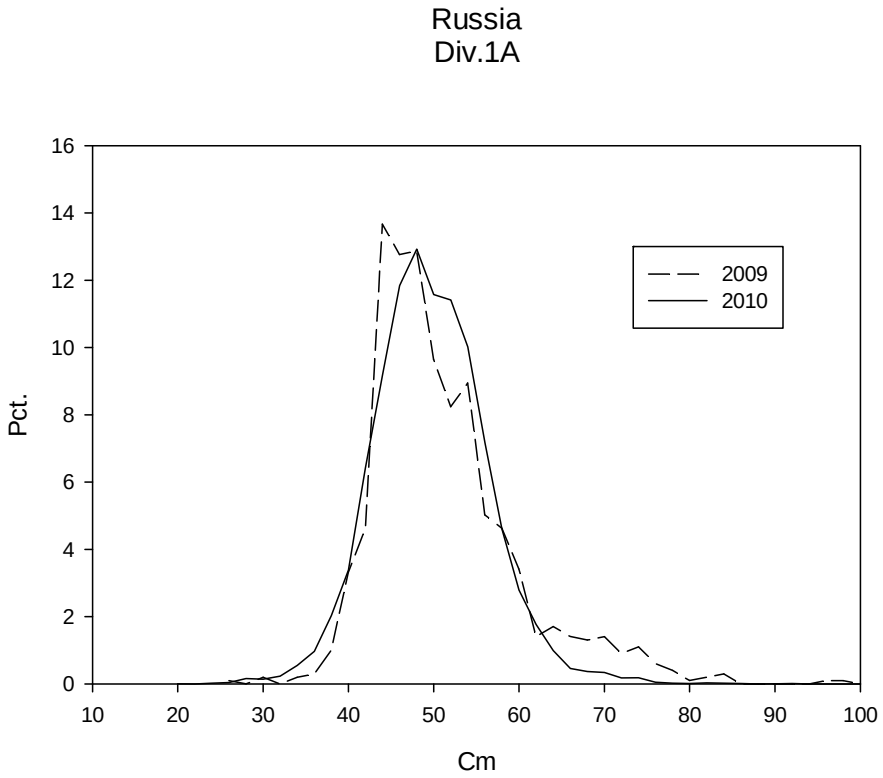

Fig. 7. Length distribution in the Russian trawl fishery in Div. 1A in 2009-2010n percent, 2-cm groups.

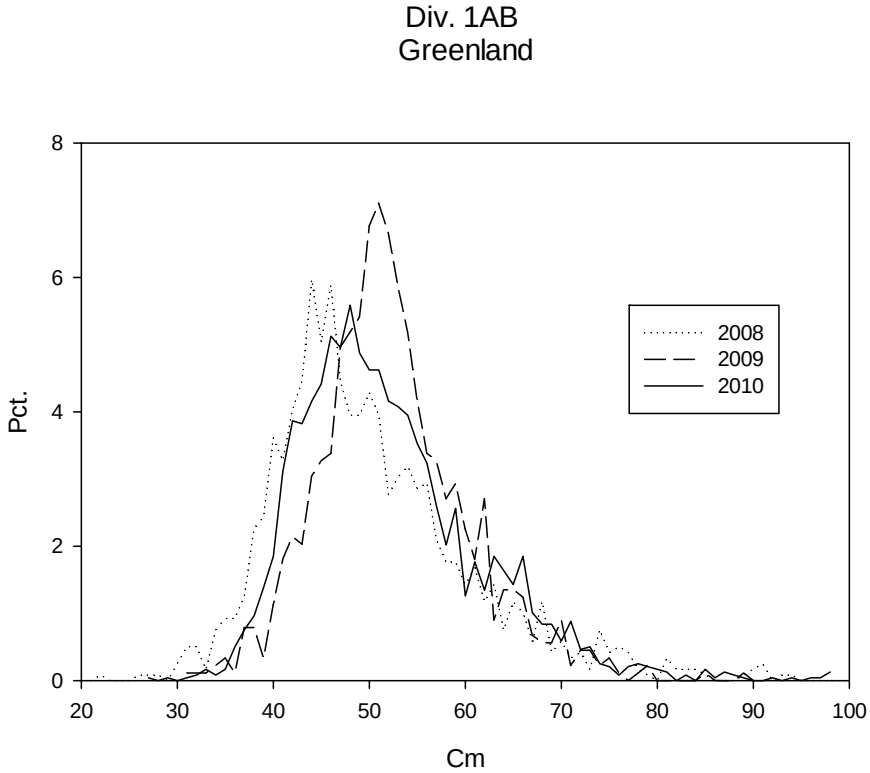

Fig. 7. Length distribution in the Greenland trawl fishery in Div. 1A in 2008-2010n percent, 1-cm groups.

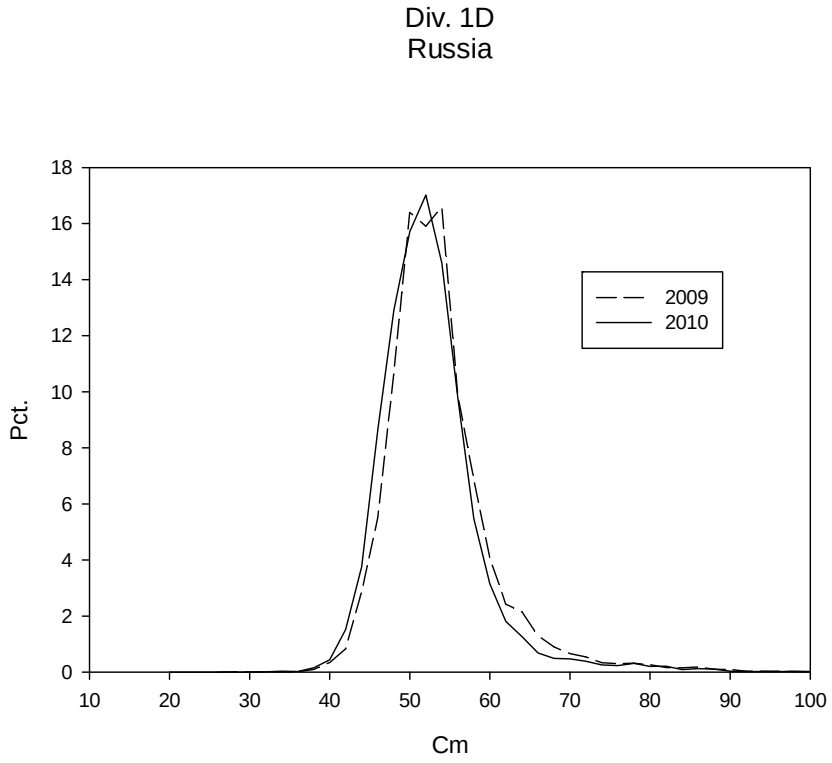

Fig. 8. Length distribution in the Russan trawl fishery in Div. 1D in 2009-2010 in percent, 2-cm groups.

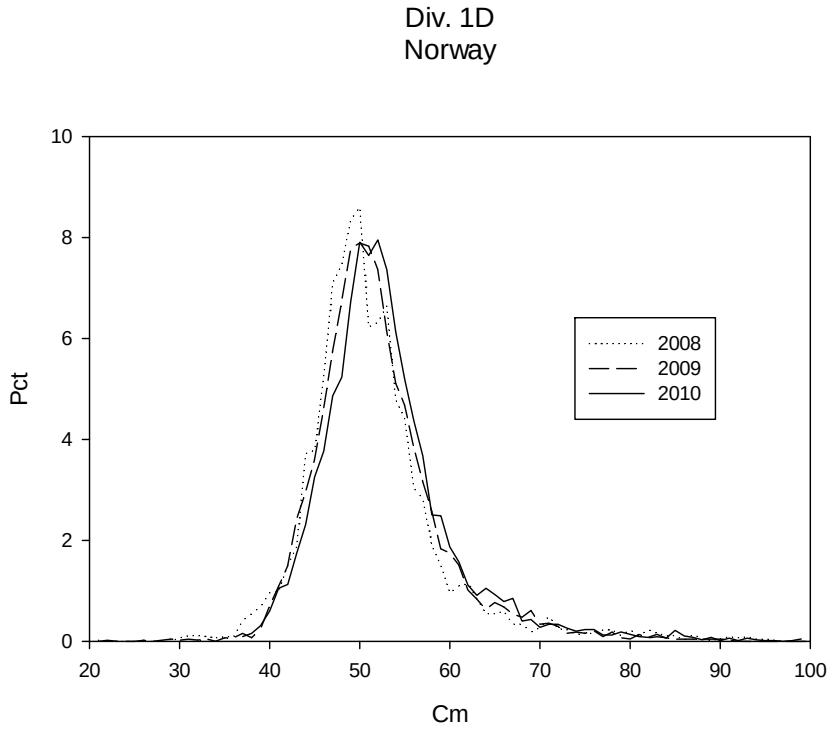

Fig. 9. Length distribution from the Norwegian Trawl fishery in Div. 1A and 1D in 2008-2010, in percent, 1-cm groups.

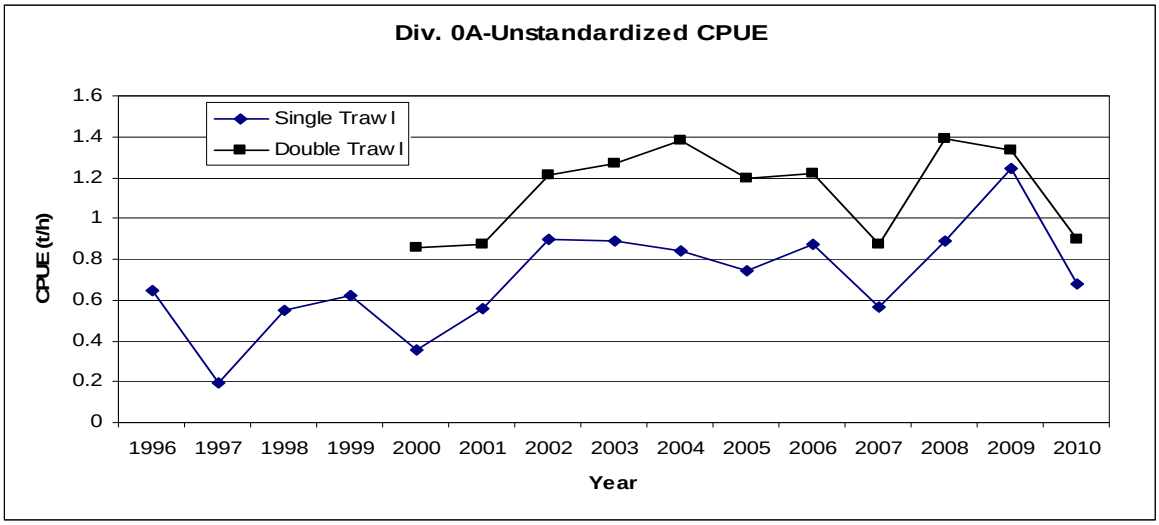

Fig. 10a. Un-standardized CPUE from the trawl fishery in Div. 0A.

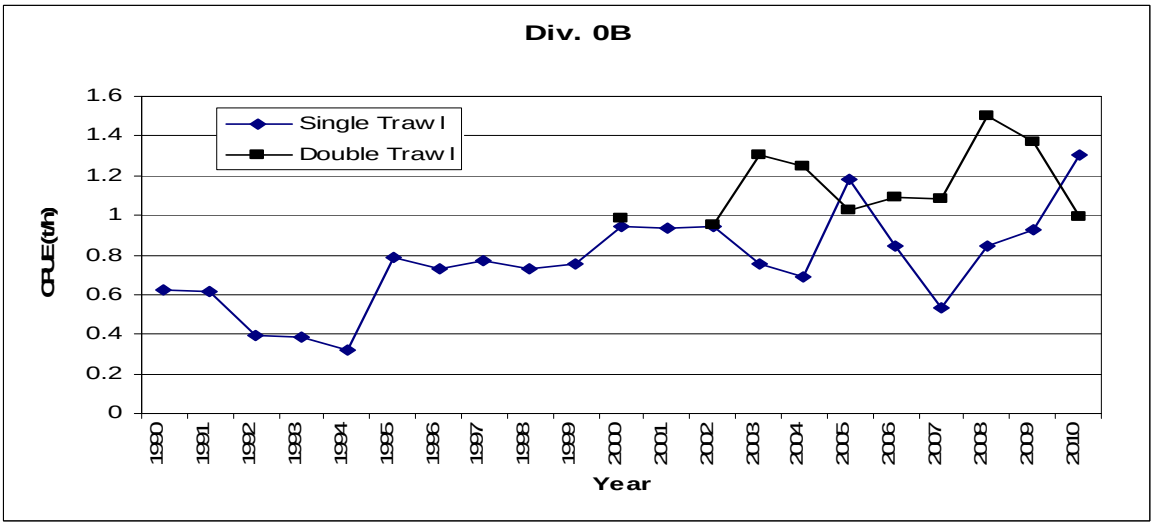

Fig. 10b. Un-standardized CPUE from the trawl fishery in Div. 0B

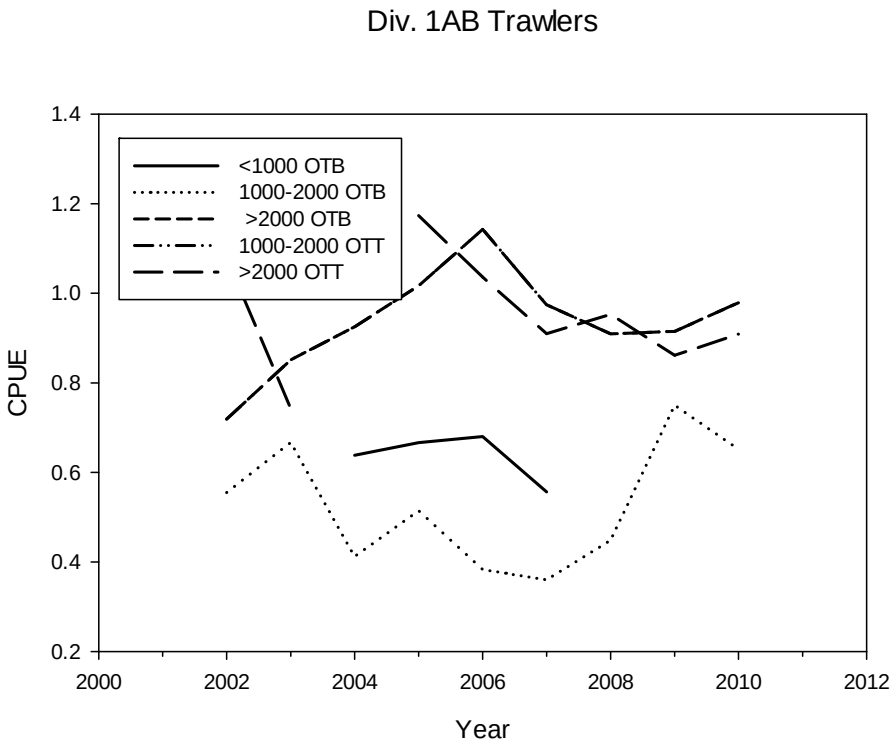

Fig. 10c. Unstandardized trawl CPUE series from Div. 1AB.

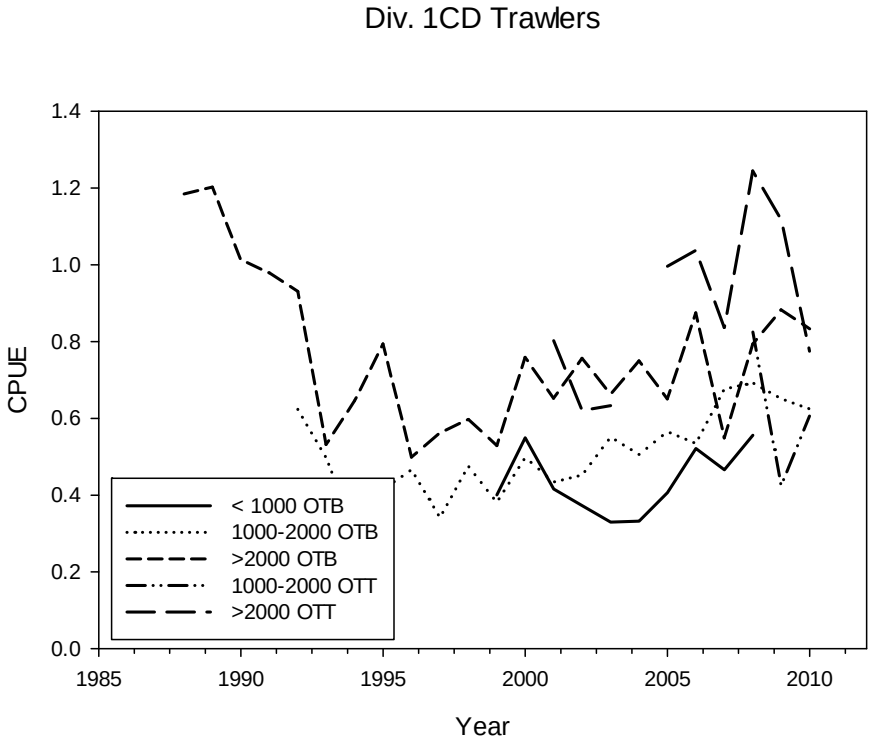

Fig. 10d. Unstandardized catch rates from different fleets fishing in Div. 1CD.

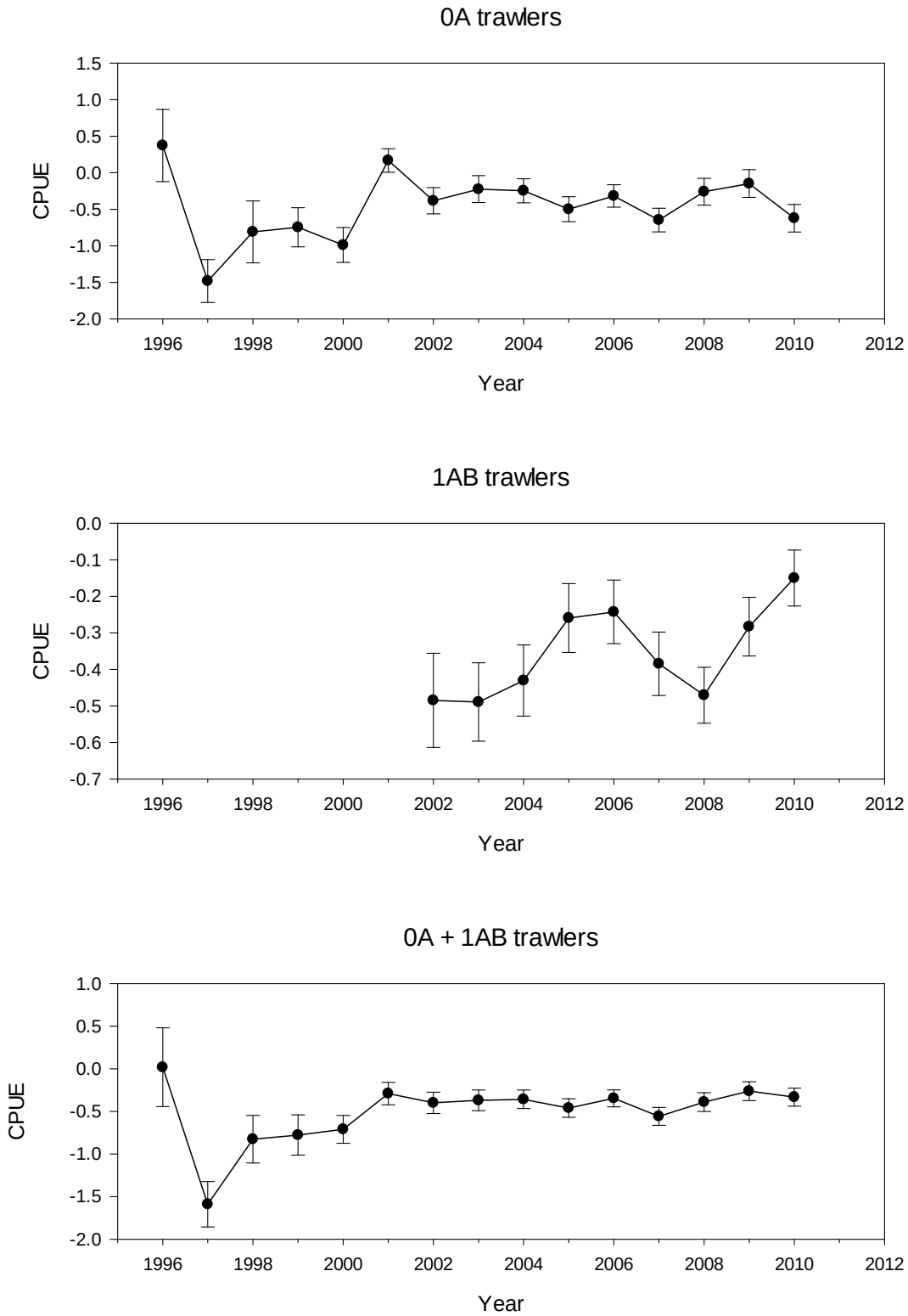

Fig 11a. Standardized CPUE series from trawlers in 0A, Div. 1AB and 0B+1AB combined with +/- S.E.

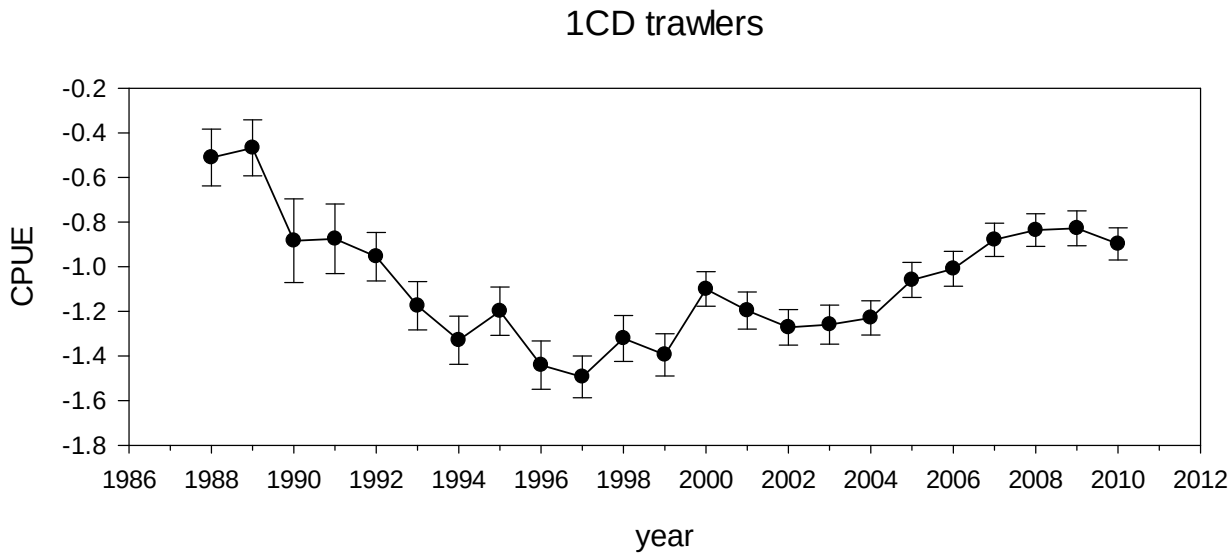

Fig. 11b. Standardized trawl CPUE index from trawlers in Div. 1CD with +/- S.E..

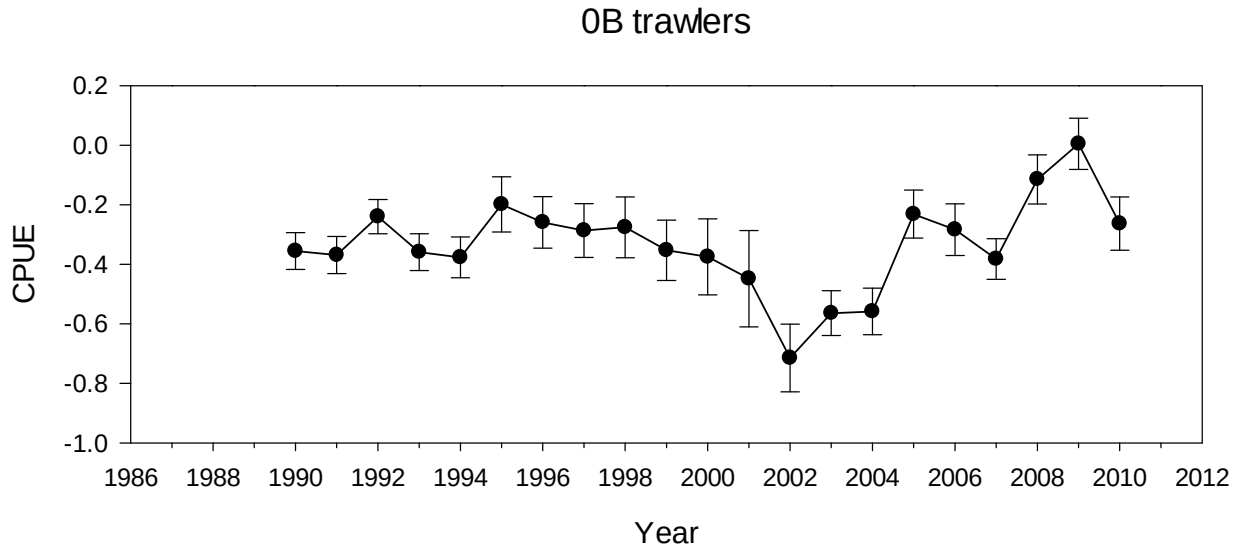

Fig 11c. Standardized CPUE series from trawlers in Div. 0B with +/- S.E.

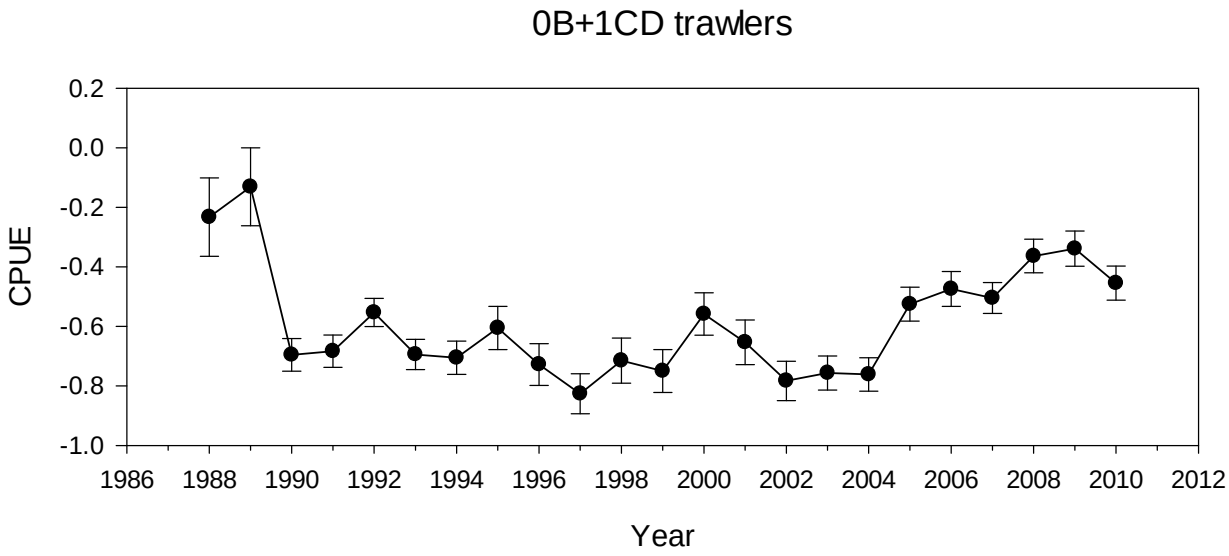

Fig. 11d. Combined standardized trawl CPUE index from trawlers in Div. 0B +1CD with +/- S.E.

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

```
                Greenland halibut, 0A trawlers                        1
                                          09:50 Monday, June 6, 2011

                           The GLM Procedure

                         Class Level Information

Class       Levels  Values

year            15  1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
                    2007 2008 2009 2010

md               6  7 8 9 10 11 12

kode            12  2126 2127 5127 15127 16127 21926 21927 31126 32125
                    33126 51926 51927


                  Number of Observations Read         146
                  Number of Observations Used         146

                    Greenland halibut, 0A trawlers                    2
                                          09:50 Monday, June 6, 2011

                           The GLM Procedure

Dependent Variable: lcph

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

Model                      30   22.88363836    0.76278795     4.86  <.0001

Error                     115   18.03927182    0.15686323

Corrected Total           145   40.92291018


           R-Square     Coeff Var      Root MSE     lcph Mean

           0.559189     -301.0241      0.396060     -0.131571


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

year                       14   10.58382654    0.75598761     4.82  <.0001
md                          5    3.25281286    0.65056257     4.15  0.0017
kode                       11    9.04699895    0.82245445     5.24  <.0001


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

year                       14    7.83648581    0.55974899     3.57  <.0001
md                          5    2.18713907    0.43742781     2.79  0.0205
kode                       11    9.04699895    0.82245445     5.24  <.0001


                                          Standard
Parameter              Estimate              Error    t Value    Pr > |t|

Intercept          -0.396156186 B      0.45029478      -0.88      0.3808
year      1996      0.995481577 B      0.56533175       1.76      0.0809
year      1997     -0.859084877 B      0.32742181      -2.62      0.0099
year      1998     -0.186928686 B      0.42759712      -0.44      0.6628
year      1999     -0.123228887 B      0.27639331      -0.45      0.6565
year      2000     -0.367335007 B      0.24721782      -1.49      0.1400
year      2001      0.791316090 B      0.27343364       2.89      0.0046
year      2002      0.239431734 B      0.20996709       1.14      0.2565
year      2003      0.397114327 B      0.20172919       1.97      0.0514
year      2004      0.375078200 B      0.19246888       1.95      0.0538
year      2005      0.123155989 B      0.19302538       0.64      0.5247
year      2006      0.304549344 B      0.17480528       1.74      0.0841
year      2007     -0.024106026 B      0.17392350      -0.14      0.8900
year      2008      0.362965761 B      0.19428644       1.87      0.0643
year      2009      0.474171451 B      0.20203410       2.35      0.0206
year      2010      0.000000000 B       .                .          .
md        7        -0.475557185 B      0.31184705      -1.52      0.1300
```

md	8	-0.592691516 B	0.29506331	-2.01	0.0469
md	9	-0.588564691 B	0.28652185	-2.05	0.0422
md	10	-0.533893011 B	0.28110264	-1.90	0.0600
md	11	-0.783186679 B	0.27826731	-2.81	0.0057
md	12	0.000000000 B	.	.	.
kode	2126	0.507158911 B	0.34774547	1.46	0.1475
kode	2127	0.565513759 B	0.33029349	1.71	0.0896
kode	5127	-0.499276421 B	0.46106368	-1.08	0.2811
kode	15127	1.216847124 B	0.43845566	2.78	0.0064
kode	16127	-0.545658864 B	0.32338134	-1.69	0.0942
kode	21926	0.944856631 B	0.35148014	2.69	0.0083
kode	21927	0.839017957 B	0.32615912	2.57	0.0114
kode	31126	0.033317162 B	0.47826171	0.07	0.9446
kode	32125	-0.598640667 B	0.32338134	-1.85	0.0667
kode	33126	-0.488068368 B	0.36273482	-1.35	0.1811
kode	51926	1.262244545 B	0.52186996	2.42	0.0171
kode	51927	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.

year	lcph LSMEAN	Standard Error	Pr > |t|
1996	0.37345253	0.49474821	0.4519
1997	-1.48111393	0.29329723	<.0001
1998	-0.80895774	0.42346222	0.0586
1999	-0.74525794	0.26841182	0.0064
2000	-0.98936406	0.23913249	<.0001
2001	0.16928704	0.16066305	0.2942
2002	-0.38259732	0.17932242	0.0350
2003	-0.22491472	0.18416189	0.2245
2004	-0.24695085	0.16481271	0.1368
2005	-0.49887306	0.17009259	0.0041
2006	-0.31747971	0.15362979	0.0410
2007	-0.64613508	0.16120389	0.0001
2008	-0.25906329	0.18296264	0.1595
2009	-0.14785760	0.19010874	0.4383
2010	-0.62202905	0.18905520	0.0013

Appendix 2. Standardized CPUE index from trawlers in Div. 1AB

Greenland halibut, 1AB trawlers 9
13:25 Thursday, May 26, 2011

The GLM Procedure

Class Level Information

Class	Levels	Values
year	9	2002 2003 2004 2005 2006 2007 2008 2009 2010
MD	7	6 7 8 9 10 11 12
kode	5	6125 6126 6127 61926 61927

Number of Observations Read 111
Number of Observations Used 111

Greenland halibut, 1AB trawlers 10
13:25 Thursday, May 26, 2011

The GLM Procedure

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	8.77118713	0.48728817	7.48	<.0001
Error	92	5.99461247	0.06515883		
Corrected Total	110	14.76579960			

R-Square	Coeff Var	Root MSE	lcph Mean
0.594020	-88.94737	0.255262	-0.286981

Source	DF	Type I SS	Mean Square	F Value	Pr > F
year	8	0.56282815	0.07035352	1.08	0.3843
MD	6	2.24785804	0.37464301	5.75	<.0001
kode	4	5.96050094	1.49012524	22.87	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	8	1.36190234	0.17023779	2.61	0.0127
MD	6	2.56934303	0.42822384	6.57	<.0001
kode	4	5.96050094	1.49012524	22.87	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		0.3998463968	B	0.28181353	1.42	0.1593
year	2002	-.3346883684	B	0.13470783	-2.48	0.0148
year	2003	-.3392523662	B	0.11378403	-2.98	0.0037
year	2004	-.2805137175	B	0.10770177	-2.60	0.0107
year	2005	-.1094901560	B	0.10546219	-1.04	0.3019
year	2006	-.0925861360	B	0.10124848	-0.91	0.3629
year	2007	-.2345405319	B	0.09816860	-2.39	0.0189
year	2008	-.3207246077	B	0.09542231	-3.36	0.0011
year	2009	-.1328523818	B	0.09038370	-1.47	0.1450
year	2010	0.0000000000	B	.	.	.
MD	6	-.4411884349	B	0.32933824	-1.34	0.1837
MD	7	-.5944516568	B	0.28007832	-2.12	0.0365
MD	8	-.3658054651	B	0.27324097	-1.34	0.1839
MD	9	-.3028222765	B	0.27174420	-1.11	0.2680
MD	10	-.1068733334	B	0.27179932	-0.39	0.6951
MD	11	-.0840080568	B	0.27352205	-0.31	0.7594
MD	12	0.0000000000	B	.	.	.
kode	6125	-.4204355112	B	0.08767864	-4.80	<.0001
kode	6126	-.5841713442	B	0.07329060	-7.97	<.0001

kode	6127	-.0477725572	B	0.06997049	-0.68	0.4965
kode	61926	-.3428252128	B	0.10489691	-3.27	0.0015
kode	61927	0.0000000000	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.

year	lcph LSMEAN	Standard Error	Pr > |t|
2002	-0.48461850	0.12898370	0.0003
2003	-0.48918250	0.10727715	<.0001
2004	-0.43044385	0.09747630	<.0001
2005	-0.25942029	0.09427780	0.0071
2006	-0.24251627	0.08701490	0.0065
2007	-0.38447066	0.08658778	<.0001
2008	-0.47065474	0.07661259	<.0001
2009	-0.28278251	0.08030777	0.0007
2010	-0.14993013	0.07634206	0.0526

Appendix 3. Standardized CPUE index from trawlers in Div. 0A+1AB.

Greenland halibut, 0A+1AB trawlers 13
09:50 Monday, June 6, 2011

The GLM Procedure

Class Level Information

Class	Levels	Values
year	15	1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
MD	7	6 7 8 9 10 11 12
kode	18	2126 2127 5127 6124 6125 6126 6127 15127 16127 21926 21927 31126 32125 33126 51926 51927 61926 61927

Number of Observations Read 265
Number of Observations Used 265

The GLM Procedure

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	37	40.32533535	1.08987393	7.90	<.0001
Error	227	31.30080795	0.13788902		
Corrected Total	264	71.62614331			

R-Square	Coeff Var	Root MSE	lcph Mean
0.562997	-169.8616	0.371334	-0.218610

Source	DF	Type I SS	Mean Square	F Value	Pr > F
year	14	10.90896734	0.77921195	5.65	<.0001
MD	6	4.24542746	0.70757124	5.13	<.0001
kode	17	25.17094055	1.48064356	10.74	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	14	5.46010939	0.39000781	2.83	0.0006
MD	6	3.00915156	0.50152526	3.64	0.0018
kode	17	25.17094055	1.48064356	10.74	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		0.566367975	B	0.21698310	2.61	0.0097
year	1996	0.351334109	B	0.49266635	0.71	0.4765
year	1997	-1.255992719	B	0.28263287	-4.44	<.0001
year	1998	-0.493235993	B	0.27709136	-1.78	0.0764
year	1999	-0.444007324	B	0.23624316	-1.88	0.0615
year	2000	-0.377256898	B	0.17590183	-2.14	0.0330
year	2001	0.041203803	B	0.17459653	0.24	0.8136
year	2002	-0.066965988	B	0.13510930	-0.50	0.6206
year	2003	-0.037094036	B	0.12234892	-0.30	0.7620
year	2004	-0.024994381	B	0.11482974	-0.22	0.8279
year	2005	-0.127619625	B	0.11430312	-1.12	0.2654
year	2006	-0.013886247	B	0.10544281	-0.13	0.8953
year	2007	-0.224802521	B	0.10545950	-2.13	0.0341
year	2008	-0.056889401	B	0.10881172	-0.52	0.6016
year	2009	0.069796357	B	0.10779496	0.65	0.5180
year	2010	0.000000000	B	.	.	.
MD	6	-0.677860395	B	0.33323461	-2.03	0.0431
MD	7	-0.677437615	B	0.20811541	-3.26	0.0013
MD	8	-0.614695034	B	0.19708141	-3.12	0.0020
MD	9	-0.579043009	B	0.19403226	-2.98	0.0032

MD	10	-0.428324778 B	0.19316636	-2.22	0.0276
MD	11	-0.619676902 B	0.19392139	-3.20	0.0016
MD	12	0.000000000 B	.	.	.
kode	2126	-0.158539448 B	0.12329895	-1.29	0.1998
kode	2127	-0.169098529 B	0.09396306	-1.80	0.0732
kode	5127	-0.875198071 B	0.41229414	-2.12	0.0349
kode	6124	-2.377752414 B	0.31610148	-7.52	<.0001
kode	6125	-0.362956206 B	0.12059064	-3.01	0.0029
kode	6126	-0.580049776 B	0.10417957	-5.57	<.0001
kode	6127	-0.108377113 B	0.09613842	-1.13	0.2608
kode	15127	0.471028016 B	0.26172675	1.80	0.0732
kode	16127	-0.850937301 B	0.27230458	-3.12	0.0020
kode	21926	0.293380974 B	0.12787054	2.29	0.0227
kode	21927	0.133646039 B	0.09089148	1.47	0.1428
kode	31126	-0.704564165 B	0.31162997	-2.26	0.0247
kode	32125	-0.903919104 B	0.27230458	-3.32	0.0011
kode	33126	-0.758025199 B	0.31072062	-2.44	0.0155
kode	51926	0.639083269 B	0.38406292	1.66	0.0975
kode	51927	-0.305278437 B	0.27230458	-1.12	0.2634
kode	61926	-0.318925462 B	0.14803848	-2.15	0.0323
kode	61927	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

year	lcph LSMEAN	Standard Error	Pr > |t|
1996	0.01847939	0.46277021	0.9682
1997	-1.58884744	0.26575329	<.0001
1998	-0.82609071	0.27858900	0.0033
1999	-0.77686204	0.23509983	0.0011
2000	-0.71011162	0.16356516	<.0001
2001	-0.29165092	0.13122460	0.0272
2002	-0.39982071	0.12474756	0.0015
2003	-0.36994876	0.12072312	0.0024
2004	-0.35784910	0.10856705	0.0011
2005	-0.46047435	0.11022470	<.0001
2006	-0.34674097	0.09971282	0.0006
2007	-0.55765724	0.10487280	<.0001
2008	-0.38974412	0.10950766	0.0005
2009	-0.26305836	0.11021530	0.0178
2010	-0.33285472	0.10614219	0.0019

Appendix 4. Standardized CPUE index from trawlers in Div. 0B

Greenland halibut, 0B 17
09:50 Monday, June 6, 2011

The GLM Procedure

Class Level Information

Class	Levels	Values
year	21	1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
md	12	1 2 3 4 5 6 7 8 9 10 11 12
kode	13	2126 2127 3125 5126 5127 14124 15126 15127 20126 20127 21926 21927 41927

Number of Observations Read 543
Number of Observations Used 543

Greenland halibut, 0B 18
09:50 Monday, June 6, 2011

The GLM Procedure

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	43	151.1041791	3.5140507	51.18	<.0001
Error	499	34.2633748	0.0686641		
Corrected Total	542	185.3675540			

R-Square	Coeff Var	Root MSE	lcph Mean
0.815160	-43.33788	0.262038	-0.604640

Source	DF	Type I SS	Mean Square	F Value	Pr > F
year	20	96.69371996	4.83468600	70.41	<.0001
md	11	11.41307004	1.03755182	15.11	<.0001
kode	12	42.99738915	3.58311576	52.18	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	20	6.37109350	0.31855468	4.64	<.0001
md	11	9.73708393	0.88518945	12.89	<.0001
kode	12	42.99738915	3.58311576	52.18	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		0.142017614	B	0.12559678	1.13	0.2587
year	1990	-0.092004156	B	0.10766836	-0.85	0.3932
year	1991	-0.105357339	B	0.10872818	-0.97	0.3330
year	1992	0.023641733	B	0.10411296	0.23	0.8205
year	1993	-0.095875981	B	0.10794330	-0.89	0.3749
year	1994	-0.113127573	B	0.11231119	-1.01	0.3143
year	1995	0.064688306	B	0.12817870	0.50	0.6140
year	1996	0.004457518	B	0.11996481	0.04	0.9704
year	1997	-0.023309093	B	0.11980957	-0.19	0.8458
year	1998	-0.012302840	B	0.12473357	-0.10	0.9215
year	1999	-0.089438099	B	0.12026029	-0.74	0.4574
year	2000	-0.111790511	B	0.14446232	-0.77	0.4394
year	2001	-0.184893919	B	0.17455824	-1.06	0.2900
year	2002	-0.451159551	B	0.12838847	-3.51	0.0005
year	2003	-0.300834346	B	0.09894303	-3.04	0.0025
year	2004	-0.294784480	B	0.10192846	-2.89	0.0040
year	2005	0.031928644	B	0.10432832	0.31	0.7597

year	2006	-0.020286433	B	0.11731683	-0.17	0.8628
year	2007	-0.118762402	B	0.11217678	-1.06	0.2902
year	2008	0.148455320	B	0.10202384	1.46	0.1463
year	2009	0.268162938	B	0.10599118	2.53	0.0117
year	2010	0.000000000	B	.	.	.
md	1	-0.018976509	B	0.10178438	-0.19	0.8522
md	2	0.208229501	B	0.20648026	1.01	0.3137
md	3	0.101862900	B	0.27994390	0.36	0.7161
md	4	0.167055162	B	0.09177348	1.82	0.0693
md	5	0.437886445	B	0.06753706	6.48	<.0001
md	6	-0.008170493	B	0.06868851	-0.12	0.9054
md	7	-0.246190002	B	0.05869327	-4.19	<.0001
md	8	-0.151649187	B	0.05545938	-2.73	0.0065
md	9	-0.231847745	B	0.05309782	-4.37	<.0001
md	10	-0.291417459	B	0.05040315	-5.78	<.0001
md	11	-0.169187950	B	0.05080216	-3.33	0.0009
md	12	0.000000000	B	.	.	.
kode	2126	-0.484063204	B	0.16026508	-3.02	0.0027
kode	2127	-0.260853197	B	0.14225171	-1.83	0.0673
kode	3125	-1.117421192	B	0.17681581	-6.32	<.0001
kode	5126	-0.393583311	B	0.18687331	-2.11	0.0357
kode	5127	-0.163805201	B	0.15797580	-1.04	0.3003
kode	14124	-0.699586118	B	0.16179964	-4.32	<.0001
kode	15126	0.050704082	B	0.16303634	0.31	0.7559
kode	15127	0.035272728	B	0.17532447	0.20	0.8406
kode	20126	-1.014917061	B	0.15485370	-6.55	<.0001
kode	20127	-1.032479996	B	0.15953226	-6.47	<.0001
kode	21926	-0.062787705	B	0.18285072	-0.34	0.7315
kode	21927	0.090766069	B	0.14639305	0.62	0.5355
kode	41927	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

year	lcph LSMEAN	Standard Error	Pr > |t|
1990	-0.35552705	0.06163471	<.0001
1991	-0.36888023	0.06220799	<.0001
1992	-0.23988116	0.05760846	<.0001
1993	-0.35939887	0.06176816	<.0001
1994	-0.37665046	0.06868675	<.0001
1995	-0.19883458	0.09264677	0.0323
1996	-0.25906537	0.08667900	0.0029
1997	-0.28683198	0.09017804	0.0016
1998	-0.27582573	0.10200702	0.0071
1999	-0.35296099	0.10117521	0.0005
2000	-0.37531340	0.12767907	0.0034
2001	-0.44841681	0.16197831	0.0058
2002	-0.71468244	0.11366193	<.0001
2003	-0.56435724	0.07512016	<.0001
2004	-0.55830737	0.07807134	<.0001
2005	-0.23159425	0.08087360	0.0044
2006	-0.28380932	0.08690736	0.0012
2007	-0.38228529	0.06841612	<.0001
2008	-0.11506757	0.08248233	0.1636
2009	0.00464005	0.08619525	0.9571
2010	-0.26352289	0.08970983	0.0035

Appendix 5. Standardized CPUE index for trawlers in Div.1CD.

Greenland halibut, 1CD trawlers 1
13:57 Monday, June 6, 2011

The GLM Procedure

Class Level Information

Class	Levels	Values
year	23	1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
MD	12	1 2 3 4 5 6 7 8 9 10 11 12
kode	6	6124 6125 6126 6127 61926 61927

Number of Observations Read 255
Number of Observations Used 255

The GLM Procedure

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	38	46.53591223	1.22462927	19.30	<.0001
Error	216	13.70502393	0.06344918		
Corrected Total	254	60.24093616			

R-Square	Coeff Var	Root MSE	lcph Mean
0.772496	-45.23399	0.251891	-0.556863

Source	DF	Type I SS	Mean Square	F Value	Pr > F
year	22	16.97685218	0.77167510	12.16	<.0001
MD	11	9.26559241	0.84232658	13.28	<.0001
kode	5	20.29346765	4.05869353	63.97	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	22	11.44457303	0.52020786	8.20	<.0001
MD	11	6.50905271	0.59173206	9.33	<.0001
kode	5	20.29346765	4.05869353	63.97	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		0.176181285	B	0.08775684	2.01	0.0459
year	1988	0.386555728	B	0.13869762	2.79	0.0058
year	1989	0.429776063	B	0.13231871	3.25	0.0013
year	1990	0.013905237	B	0.19096997	0.07	0.9420
year	1991	0.022707732	B	0.16014933	0.14	0.8874
year	1992	-0.057487848	B	0.11560947	-0.50	0.6195
year	1993	-0.277527830	B	0.11390345	-2.44	0.0156
year	1994	-0.431787869	B	0.11434089	-3.78	0.0002
year	1995	-0.301500739	B	0.11386124	-2.65	0.0087
year	1996	-0.543092395	B	0.11391003	-4.77	<.0001
year	1997	-0.595619148	B	0.10020351	-5.94	<.0001
year	1998	-0.424012347	B	0.10913273	-3.89	0.0001
year	1999	-0.497014088	B	0.10233345	-4.86	<.0001
year	2000	-0.202305636	B	0.09630938	-2.10	0.0368
year	2001	-0.298696048	B	0.09106891	-3.28	0.0012
year	2002	-0.374309147	B	0.08804628	-4.25	<.0001
year	2003	-0.361841883	B	0.09517839	-3.80	0.0002
year	2004	-0.331762463	B	0.08810752	-3.77	0.0002
year	2005	-0.161652189	B	0.08906294	-1.82	0.0709
year	2006	-0.111336992	B	0.08662586	-1.29	0.2001

year	2007	0.018066625	B	0.08934786	0.20	0.8399
year	2008	0.061439930	B	0.08465954	0.73	0.4688
year	2009	0.069554957	B	0.09023140	0.77	0.4416
year	2010	0.000000000	B	.	.	.
MD	1	-0.464085518	B	0.10600127	-4.38	<.0001
MD	2	-0.997918954	B	0.13174295	-7.57	<.0001
MD	3	-0.920742463	B	0.26802825	-3.44	0.0007
MD	4	-0.446793943	B	0.19878993	-2.25	0.0256
MD	5	-0.329793894	B	0.12112009	-2.72	0.0070
MD	6	-0.540002139	B	0.09811332	-5.50	<.0001
MD	7	-0.446362613	B	0.08243267	-5.41	<.0001
MD	8	-0.356710684	B	0.07085560	-5.03	<.0001
MD	9	-0.195808656	B	0.06347292	-3.08	0.0023
MD	10	-0.229610785	B	0.06021530	-3.81	0.0002
MD	11	-0.154828264	B	0.06050918	-2.56	0.0112
MD	12	0.000000000	B	.	.	.
kode	6124	-2.518715414	B	0.17228594	-14.62	<.0001
kode	6125	-0.520762290	B	0.06775158	-7.69	<.0001
kode	6126	-0.420343879	B	0.06043998	-6.95	<.0001
kode	6127	-0.083780142	B	0.06212336	-1.35	0.1789
kode	61926	-0.356286712	B	0.13153701	-2.71	0.0073
kode	61927	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.

year	lcph LSMEAN	Standard Error	Pr > |t|
1988	-0.51079922	0.12715622	<.0001
1989	-0.46757888	0.12550199	0.0002
1990	-0.88344971	0.18743468	<.0001
1991	-0.87464721	0.15608169	<.0001
1992	-0.95484280	0.10848720	<.0001
1993	-1.17488278	0.10803150	<.0001
1994	-1.32914282	0.10824753	<.0001
1995	-1.19885569	0.10804607	<.0001
1996	-1.44044734	0.10792765	<.0001
1997	-1.49297410	0.09333595	<.0001
1998	-1.32136729	0.10265405	<.0001
1999	-1.39436903	0.09487131	<.0001
2000	-1.09966058	0.07786678	<.0001
2001	-1.19605100	0.08338719	<.0001
2002	-1.27166409	0.07976671	<.0001
2003	-1.25919683	0.08775249	<.0001
2004	-1.22911741	0.07648849	<.0001
2005	-1.05900714	0.07867719	<.0001
2006	-1.00869194	0.07795895	<.0001
2007	-0.87928832	0.07464305	<.0001
2008	-0.83591502	0.07299695	<.0001
2009	-0.82779999	0.07792803	<.0001
2010	-0.89735495	0.07237406	<.0001

Appendix 6. Combined Standardized CPUE index for trawlers in Div. 1CD and Div. 0B.

Greenland halibut, 0B+1CD trawlers 5
13:57 Monday, June 6, 2011

The GLM Procedure

Class Level Information

Class	Levels	Values
year	23	1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
MD	12	1 2 3 4 5 6 7 8 9 10 11 12
kode	19	2126 2127 3125 5126 5127 6124 6125 6126 6127 14124 15126 15127 20126 20127 21926 21927 41927 61926 61927

Number of Observations Read 798
Number of Observations Used 798

The GLM Procedure

Dependent Variable: lcph

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	51	188.8929709	3.7037837	48.38	<.0001
Error	746	57.1116039	0.0765571		
Corrected Total	797	246.0045748			

R-Square	Coeff Var	Root MSE	lcph Mean
0.767843	-46.94642	0.276690	-0.589373

Source	DF	Type I SS	Mean Square	F Value	Pr > F
year	22	84.16512397	3.82568745	49.97	<.0001
MD	11	19.46916883	1.76992444	23.12	<.0001
kode	18	85.25867807	4.73659323	61.87	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	22	11.88790738	0.54035943	7.06	<.0001
MD	11	9.69533111	0.88139374	11.51	<.0001
kode	18	85.25867807	4.73659323	61.87	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		0.069194974	B	0.07840071	0.88	0.3777
year	1988	0.221441768	B	0.13862652	1.60	0.1106
year	1989	0.323626471	B	0.13725482	2.36	0.0186
year	1990	-0.240871811	B	0.07637055	-3.15	0.0017
year	1991	-0.228685608	B	0.07627386	-3.00	0.0028
year	1992	-0.098949841	B	0.06993411	-1.41	0.1575
year	1993	-0.239930437	B	0.07259257	-3.31	0.0010
year	1994	-0.250674725	B	0.07625462	-3.29	0.0011
year	1995	-0.150770483	B	0.08768271	-1.72	0.0859
year	1996	-0.273506881	B	0.08462887	-3.23	0.0013
year	1997	-0.371501843	B	0.08169613	-4.55	<.0001
year	1998	-0.260340308	B	0.08733681	-2.98	0.0030
year	1999	-0.295106611	B	0.08345550	-3.54	0.0004
year	2000	-0.103952171	B	0.08596005	-1.21	0.2269
year	2001	-0.198898515	B	0.08557273	-2.32	0.0204
year	2002	-0.328365497	B	0.07793895	-4.21	<.0001
year	2003	-0.301714942	B	0.07137767	-4.23	<.0001
year	2004	-0.306617793	B	0.07085914	-4.33	<.0001
year	2005	-0.070695894	B	0.07207757	-0.98	0.3270

year	2006	-0.019847077	B	0.07393683	-0.27	0.7884
year	2007	-0.050313656	B	0.07379267	-0.68	0.4956
year	2008	0.090705569	B	0.06952164	1.30	0.1924
year	2009	0.115339830	B	0.07266344	1.59	0.1129
year	2010	0.000000000	B	.	.	.
MD	1	-0.264147387	B	0.07598579	-3.48	0.0005
MD	2	-0.614517132	B	0.11555950	-5.32	<.0001
MD	3	-0.376249084	B	0.20720684	-1.82	0.0698
MD	4	0.012742020	B	0.08536311	0.15	0.8814
MD	5	0.243330262	B	0.06036713	4.03	<.0001
MD	6	-0.187084654	B	0.05887024	-3.18	0.0015
MD	7	-0.281648493	B	0.04940938	-5.70	<.0001
MD	8	-0.184000085	B	0.04534319	-4.06	<.0001
MD	9	-0.189933581	B	0.04255875	-4.46	<.0001
MD	10	-0.235163484	B	0.04059972	-5.79	<.0001
MD	11	-0.132009833	B	0.04115744	-3.21	0.0014
MD	12	0.000000000	B	.	.	.
kode	2126	-0.272273898	B	0.08906985	-3.06	0.0023
kode	2127	-0.053534286	B	0.06356889	-0.84	0.4000
kode	3125	-0.996383280	B	0.11293689	-8.82	<.0001
kode	5126	-0.033189759	B	0.13026217	-0.25	0.7990
kode	5127	0.079964778	B	0.08056012	0.99	0.3212
kode	6124	-2.517796172	B	0.18321205	-13.74	<.0001
kode	6125	-0.619192507	B	0.07115657	-8.70	<.0001
kode	6126	-0.453107461	B	0.06430413	-7.05	<.0001
kode	6127	-0.092248538	B	0.06544686	-1.41	0.1591
kode	14124	-0.513082071	B	0.08854258	-5.79	<.0001
kode	15126	0.228041589	B	0.09266976	2.46	0.0141
kode	15127	0.203781568	B	0.11441861	1.78	0.0753
kode	20126	-0.819955314	B	0.07387853	-11.10	<.0001
kode	20127	-0.837800173	B	0.08247050	-10.16	<.0001
kode	21926	0.206150160	B	0.12288628	1.68	0.0939
kode	21927	0.298893374	B	0.07155389	4.18	<.0001
kode	41927	0.135921988	B	0.14272246	0.95	0.3412
kode	61926	-0.399441744	B	0.14110682	-2.83	0.0048
kode	61927	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

year	lcph LSMEAN	Standard Error	Pr > |t|
1988	-0.23317014	0.13150569	0.0766
1989	-0.13098543	0.13107668	0.3180
1990	-0.69548372	0.05501407	<.0001
1991	-0.68329751	0.05432120	<.0001
1992	-0.55356175	0.04723752	<.0001
1993	-0.69454234	0.05056006	<.0001
1994	-0.70528663	0.05601180	<.0001
1995	-0.60538239	0.07254943	<.0001
1996	-0.72811879	0.07028766	<.0001
1997	-0.82611375	0.06734480	<.0001
1998	-0.71495221	0.07557571	<.0001
1999	-0.74971852	0.07196034	<.0001
2000	-0.55856408	0.07124494	<.0001
2001	-0.65351042	0.07503380	<.0001
2002	-0.78297740	0.06611944	<.0001
2003	-0.75632685	0.05724548	<.0001
2004	-0.76122970	0.05601240	<.0001
2005	-0.52530780	0.05715847	<.0001
2006	-0.47445898	0.05847770	<.0001
2007	-0.50492556	0.05189631	<.0001
2008	-0.36390634	0.05648160	<.0001
2009	-0.33927207	0.05917322	<.0001
2010	-0.45461190	0.05722662	<.0001