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The Fishery for Northern Shrimp (*Pandalus borealis*) in Denmark Strait / off East Greenland 1978 – 2024.

by

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Abstract

Northern shrimp (*Pandalus borealis*) occurs off East Greenland from Cape Farewell to about 70°N mainly in depths from 250 m and down to about 600 m. North of 65°N the stock spans the adjacent Greenlandic and Icelandic economic zones. Prior to 2011 the stock was assessed as a single population by evaluation of fishery dependent data only. Since 2011 data from research survey was included in the assessment. Data from an annual survey series has been available during the period from 2008 to 2024; however, no survey were performed in the period 2017 to 2019 and in 2021. The stock is managed by catch quotas in the Greenlandic zone. There are no management related restrictions on the fishery in the Icelandic zone. The fishery in the Icelandic zone ceased in 2006.

A multinational fleet of large factory trawlers exploited the stock taking annual catches between 11 500 tons and 14 000 tons from 1994 to 2003. From 2004 until 2016 annual catches decreased to a low level less than 600 tons, but since 2016 the catch has increase to 7 466 tons in 2023. For 2024, the logbooks for one foreign vessel were not available, the catches are included in the total catches but not in the CPUE and effort. The recent catch rate index might not be a reliable index for the biomass from the entire East coast because of the concentrated fishing effort in a restricted area in these years, although the most of the survey biomass are also found in this area.

Introduction

Northern shrimp (*Pandalus borealis*) occurs off East Greenland in ICES Divisions 14b and 5a. The stock is distributed from Cap Farewell, up through the Denmark Strait to about 70°N in depths down to around 800 meters. Most shrimp biomass concentrations occur from 250-600 m. There is no evidence of distinct sub-populations, and the stock is assessed as a single population.

The exploitation of this stock began in the late 1970's initiated by Icelandic trawlers. It soon became a multinational fishery with annual catches increasing rapidly to more than 15 000 tons then catches fluctuated around 12 000 tons until 2003 (Table 1, Fig. 2A). Catches then decreased to 49 tons in 2016. Since then, annual catches have been increasing to 7466 tons in 2023.

The fishery was originally conducted north of 65°N on both sides of the territorial midline between Greenland and Iceland. However, in 1993 a fishery was also initiated in various smaller areas south of 65°N extending south to the Cap Farewell but since 2013 no or very little fishing has been taken place south of 65°N. Access to fishing grounds depends on ice conditions at certain times of the year. Since 2014 the fishing has been concentrated in a small area.



Greenland, EU, the Faroe Islands and Norway fleets have since 2014 participated in the fishery in the Greenlandic zone (see table 1 for details). Vessels taking part in the fishery are large factory trawlers in the range of 1000-4000 GRT. The fishery is managed by a Total Allowable Catch (TAC) in the Greenlandic EEZ. Icelandic vessels operate exclusively in the Icelandic EEZ and the fishery is unrestricted by management initiatives. Annual catches in the Greenlandic zone from 1999 to 2005 accounted for 70-99 % of the total catches. No fishery has since 2006 been conducted in the Icelandic zone.

This paper presents and analyses data from the shrimp fishery off East Greenland to provide a basis for the assessment of the shrimp stock in this area, i.e. time series of catch, fishing effort, geographical distribution and CPUE based biomass indices and indices of harvest rate.

Materials and methods

Raw data

Logbooks from Greenland, Iceland, Faroe Islands and EU since 1980 and from Norway since 2000 supplied data on catch and effort (hours fished) on a haul-by-haul basis. From 1998 approximately 40% of all hauls were performed with double trawl and since 2004 more than 60% of all hauls were performed with double trawl. In 2022 12% of hauls were performed with single trawl, 87% of hauls with double trawl and only 1% with triple trawl. Triple trawl was used by 1-4 vessels in 2020-2024. Initial inclusion of all three trawl types showed no significant difference and it was therefore decided in this year's assessment to treat triple trawl as double trawl in the estimation of standardised CPUE indices and considering these years with triple trawl as "learning" years. The catches in the Greenland EEZ were corrected for "overpacking" according to Hvingel (2003).

For 2024, the logbooks from one foreign vessels were not available. Total catches include catches from this vessels, but it is not possible to included information on CPUE and effort. Based on information from the Greenland Fishery and License Control (GFLK) the fishery is known to have taken in place in the same area as the rest of the fisheries. It is expected that the overall effort will increase when all logbooks are included. It is unknown if there will be an impact on the overall CPUE.

Catches and corresponding effort were compiled by year, month, and areas north and south of 65°N. CPUE was calculated and applied to the total catch of the year to estimate the total annual effort. The geographical distribution of the fishery is shown by plotting the catch and effort by statistical units of 7.5' latitude and 15' longitude (Fig. 4a, b).

Catch rate indices

Three standardised CPUE indices were constructed: one for each of the areas north and south of 65°N and a combined index series representing the total area. The indices were based on logbook data from Greenlandic, Faeroese, EU, and Norwegian vessels, operating exclusively in the Greenlandic zone and from the Icelandic fleet fishing exclusively in the Icelandic zone (north of 65°N). Until 2005 Norwegian fishery data was considered to have too sparse information on the different areas fished and data was therefore not included in the standardized catch rates calculations. In 2006 Norwegian fishery data was included in the catch rates calculations after a positive evaluation of new logbook data from the GFLK, where Norwegian fishery data has been recorded in standard format since 2000.

For the indices of the northern areas and the total areas involves a two-step process. In the first step multiplicative General Linear Modelling (GLM) were used to standardise the CPUE data from the Greenlandic zones separately. The "first step" was performed following the method described in Hvingel *et al.* (2000). The multiplicative models included the following variables: (1) individual vessel fishing power, (2) seasonal availability of shrimp, (3) spatial availability of shrimp, (4) annual mean CPUE and (5) single and double trawl. Input data were mean CPUE by vessel, area, month, trawl type and year. The calculations were done using the SAS statistical software (Anon., 1988). The main effects model was represented in logarithmic form:

$$\ln(\text{CPUE}_{mjkhi}) = \ln(u) + \ln(A_m) + \ln(S_j) + \ln(V_k) + \ln(G_h) + \ln(Y_i) + e_{mjkhi}$$

here CPUE_{ijkhi} is the mean CPUE for vessel k , fishing in area m in month j and trawl type h during year i ($k = 1, \dots, n$;

$m = 1, \dots, a; j = 1, \dots, s; h = 1, 2; i = 1, \dots, y$; $\ln(u)$ is overall mean $\ln(CPUE)$; A_m is effect of the m^{th} area; S_j is the effect of the j^{th} month; V_k is the effect of the k^{th} vessel; G_h is the effect of trawl type; Y_i is the effect of the i^{th} year; e_{mjki} is the error term assumed to be normally distributed $N(0, \sigma^2/n)$, where n is the number of observations in the cell. A two levels trawl effect was introduced to account for the effect of twin trawling. The number of hauls was used as weighting factor. The standardised CPUE indices are the antilog of the year coefficient.

For the model pertaining to the Greenlandic zone 124 vessels were included in the analysis. Prior to 2022 only vessels which have fished for a minimum of three years in the area were included. The year*area cross-effect was calculated to give separate indices for the northern and southern areas.

In the Icelandic zone 126 different Icelandic vessels had been registered in the area from 1987 to 2005. Almost no fishery has been conducted in 2005 (21 tons) and there has been no or very little fishery since 2006. The 61 vessels qualifying for the index were collapsed into 18 groups consisting of 1-8 vessels of equal fishing power. The month effect was reduced to 6 levels. No area effect was included. A two levels trawl effect was introduced to account for the effect of twin trawling.

Results and diagnostically output from the GLM run show that data from the Icelandic zone in 2005 was unsuitable to further analyses and therefore not included. This analysis has not been repeated since 2006 (Siegstad and Hvingel 2006).

The index of the area south of 65°N

From this first step of calculations, the biomass index for the areas south of 65°N came directly as the 'year-area south' cross effect of the Greenlandic zone model (see appendix 1).

The combined index of the area north of 65°N

In the second calculation step the biomass index for the areas north of 65°N was derived by combining the year coefficients of the Icelandic zone model and the year effects for the northern areas in the Greenlandic zone model (i.e. the 'year-area north' cross effect, see appendix 1). A Monte Carlo Markov Chain (MCMC) sampling process was used to construct distributions of likelihoods of possible values of the combined index. This was done within the R using the rjags library programming framework in R (version 4.0.5, R Core Team, 2021). The individual CPUE series for the p^{th} fleet, μ_{pi} , was assumed to reflect an overall biomass series, Y_i , and a constant fleet coefficient, v_p , so that:

$$\mu_{pi} = v_p Y_i \exp(e_{pi})$$

The error, e_{pi} , were assumed distributed with mean zero and variance σ_{pi}^2 . The error term was assumed that e_{pi} , have variances inversely proportional to the area of fishing ground, a_p , covered by fleet p . The factor, a_p , was taken to be the area of sea bottom between 150-600 m. Hence, σ_{pi}^2 was calculated by:

$$\sigma_{pi}^2 = \frac{cv_{pi}^2}{a_p}$$

Where cv_{pi} is the annual fleet specific coefficient of variation as calculated in the GLM-run. The area weighting factors, a_p , for the Greenlandic area north of 65° and the Icelandic zone were estimated to be 0.9 and 0.1, respectively.

The combined index of the total area

In a similar second calculation step a single combined index of the development of the population biomass in the whole area was derived by aggregating the overall year coefficients from the Greenlandic zone model (appendix 2) and the year coefficients from the Icelandic zone model (Siegstad and Hvingel 2006). This was also done by the method described above using an area-weighting factor of 0.875 for the Greenlandic zone data and thus 0.125 for the Icelandic zone data.

Harvest rate indices

Indices of harvest rate were calculated by dividing total annual catch of the area by the respective standardised CPUE indices.

Results and Discussion

Geographical distribution of the fishery

The fishery was originally conducted north of 65°N in the Dohrn bank-Strede bank area on both sides of the territorial midline between Greenland and Iceland and on the slopes of Storfjord Deep. In 1993, a fishery was also initiated south of 65°N in various smaller areas extending south to the Cap Farewell. Since 2013, no or very little fishery has been conducted south of 65°N (Table 2, Fig. 1).

Catch

As the fishery developed, catches increased rapidly to more than 15 000 tons in 1987-88 but declined thereafter to about 9 000 tons in 1992-93 (Fig. 1A, Table 1 and 2). Following the area expansion of the fishery south of 65°N in 1993 catches increased again reaching 11 900 tons in 1994. From 1994 to 2003 catches fluctuated between 11 500 and 14 000 tons (Fig. 1A). In 2004 the catches started decreasing, from 10 000 tons in 2004 to 49 tons in 2016. The catches have since then increased to 7 466 tons in 2023. And was 6 089 tons in the first half of 2024.

In the northern area the amount caught declined by about 85% from 1988 to 2001, i.e., from 15 000 tons to 2 200 tons (Fig. 1A, Table 2). Catches more than doubled in the period 2002-2004 (Table 2, Fig. 1A). Since 2012 the main part of the fisheries has taken place in the northern area.

Catches in the southern area increased from 1 900 tons in 1993 (the first year of fishery in this area) to about 11 700 tons in 2001 (Fig. 1A). Since then, catches in the area south of 65°N has been decreasing. No or very little fishing has been conducted in the southern area since 2012.

Fishing effort

The high increase in catches during the first ten-year period (1980s) was mainly driven by increased fishing effort and peaked in 1989 with nearly 120 000 hours (Fig. 1B, Table 2). The total effort gradually decreased and was at 327 hours in 2016, effort has since increase to 9 267 hours in 2023. Effort for the first half of 2024 was 8 604 hours.

The historic development of fishing effort spent in the northern area follows the one described for the total area closely – except for 2001, where a lot of effort shifted to the south.

In the southern areas, effort increased from about 10 000 hours in 1993 to 25 000 hours in 1997. In 1999 it reached a low of 7 500 hours but increased again to 20 000 hours in 2001. Since then, effort in the southern area has been declining (Fig. 1B, Table 2).

Catch rate

Catch rates (total area) decreased from 298 kg/hr to 109 kg/hr in the period 1981-1989 follow by increasing trend until 2009. From 2010 to 2015 unstandardized catch rates have continuously been declining to the lowest value of 117 kg/hr in the latest 2 decades (Fig. 1C, Table 2). Since 2016, the unstandardized catch rates increased considerably to 900 kg/hr in 2022. The unstandardized catch rates have since decrease and was for the first half of 2024 708 kg/hr.

Unstandardized catch rates in the northern area follow the same trend as the overall figure (Fig. 1C) except for the period 1993 to 2009 when catch rate in the southern area were considerably higher than in the northern area.

In the southern area, unstandardized catch rates increased considerably in the period 1993 to 1999 followed by a general decrease to 2008. The high catch rates observed in the years 2010 to 2012 are based on relatively few hauls.

Standardised catch rate indices

The CPUEs for the southern area in 2011 and from 2013 to 2024 were omitted from the GLMs because of no hauls or very low number of hauls (below 10) conducted.

Results of the two multiplicative models to standardise catch rates showed that all main effects and interaction

between YEAR and AREA were highly significant ($p < 0.001$). The R-squared of the models for Greenland and Iceland were 70% and 78%, respectively (see appendix 1 for the Greenland model).

The combined CPUE index for the total area (Fig. 2, Table 3) show that the CPUE more than halved during the period 1987-1993. It has since increased, and the mean index values increased until the end of the 1990s and stabilized at a level one third above that of 1987. In the subsequent years, the CPUE index was fluctuating without a trend until 2009, where the index more than doubled compared to 1987. From 2010, the index decreased to a low level in 2014 not seen since the beginning of 1990s. In recent years, the index has increased considerably, except for 2021 where there was a drop likely related to a shift in fishing pattern cause by a late start to the fisheries. Usually, the highest CPUE values are found in the first three months of the year. The CPUE index peaked in 2022 and have since decreased, although it remains at a high level. Since 2016 the fishing effort has been relatively small and carried out in a relatively small area.

The CPUE index series of the northern areas (Fig. 2, Table 3) is rather similar to that for the total area, except that during the period when the fishing area expand south of 65°N the CPUE index was at a lower level. The recent years catch rates similarly to index for the total area has been obtained by a relative low fishing effort in a relatively small area.

The CPUE index series of the southern area (Fig. 2, Table 3) increased until 1999 and has since then fluctuated without a trend. No index for the southern area was calculated in 2011 and from 2013 to 2024.

Indices of harvest rate

The standardised effort i.e., the index of harvest rate, have shown a decreasing trend since the mid-1990s for the total area (Table 3, Fig. 3) reaching its lowest levels from 2016 to 2019 and a still at a historic low level. The separate indices for the Northern and Southern areas are also shown in Fig. 3 and they follow the trend seen for the total area. No standardised effort for the southern area was calculated for 2011 and from 2013 to 2024.

Conclusions

Total catches fluctuated around 12 000 tons from 1994 to 2003 (Table 1, Fig. 1A). Catches then decreased to 49 tons in 2016 followed by an increase to 7 466 tons in 2023. Catches in the first half of 2024 were 6 089 tons.

The combined CPUE index for the total area (Fig. 2, Table 3) indicated that the catch rate more than halved during the period 1987-1993. In the succeeding years, the catch rate increased until the end of the 1990s, stabilized at a level one third above that of 1987. From the late 1990s the CPUE index has been fluctuating without a clear trend until 2009, where the index more than doubled compared to 1987. The combined index decreased to the lowest level observed in 2015 followed by an increase to the highest index values in the time series in 2022. In 2021 the index value dropped to below the 2019 value. In 2021 the EU fleet commenced fishing in the area later than previous years due licenses being delay, this have impacted the fishing patterns in 2021. The index has decreased in 2023 and 2024, but remains at a high level.

Since the mid-1990s exploitation rate index (standardized effort) has decreased, being at historical low level in the last six to seven years. The recent years index values have been based on historical low fishing effort in a relative limited area.

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Table 1. Catch (tons) of shrimp by the fishery in Denmark Strait/off East Greenland from 1978 to July 2024. Values for the fishery in the Greenland EEZ by EU, Faeroe Islands, France, Greenland, and Norway are corrected according to Hvingel 2003.

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
North of 65°N																			
EU (DK,EST,LTU)	-	0	878	727	926	255	554	442	626	703	554	454	476	450	199	138	250	302	26
Faroe Islands	-	0	5296	892	922	554	836	843	910	754	847	738	1029	1265	1355	689	462	931	995
France	-	0	63	442	518	364	626	803	976	1305	616	472	62	148	0	0	0	0	0
Greenland	-	0	250	1256	1395	1835	2815	3248	7232	8396	9304	7408	7580	5283	2496	1771	1326	2390	359
Iceland	363	485	759	125	0	43	742	1794	1150	1330	1431	1326	281	465	1750	2553	1514	1151	566
Norway	-	1001	3079	2522	2372	2161	2662	2566	2535	2586	2561	2601	3052	3146	3102	1831	2180	2402	1544
Total	363	1486	10325	5964	6133	5212	8235	9696	13428	15073	15313	12999	12480	10757	8901	6982	5731	7176	3490
South of 65°N																			
Denmark (EU)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	613	731	1167
Faroe Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	280	974	295	402
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1141	3603	2667	5295
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	424	1011	720	1590
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1904	6201	4412	8453
Total area																			
EU (DK,EST,LTU)	-	0	878	727	926	255	554	442	626	703	554	454	476	450	199	198	863	1033	1193
Faroe Islands	-	0	5296	892	922	554	836	843	910	754	847	738	1029	1265	1355	968	1436	1225	1397
France	-	0	63	442	518	364	626	803	976	1305	616	472	62	148	0	0	0	0	0
Greenland	-	0	250	1256	1395	1835	2815	3248	7232	8396	9304	7408	7580	5283	2496	2912	4929	5057	5655
Iceland	363	485	759	125	0	43	742	1794	1150	1330	1431	1326	281	465	1750	2553	1514	1151	566
Norway	-	1001	3079	2522	2372	2161	2662	2566	2535	2586	2561	2601	3052	3146	3102	2255	3190	3122	3133
Total	363	1486	10325	5964	6133	5212	8235	9696	13428	15073	15313	12999	12480	10757	8901	8886	11932	11588	11944
Total all areas	363	1486	10325	5964	6133	5212	8235	9696	13428	15073	15313	12999	12480	10757	8901	8886	11932	11588	11944
Advised TAC	-	-	-	-	4200	4200	4200	5000	-	-	-	100003	100003	100003	8000	5000	5000	5000	5000
Effective TAC ¹	-	-	-	8000	4500	5725	5245	6090	75255	75255	87255	90255	14100	14500	13000	9563	9563	9563	9563

¹For Greenland zone only; no restrictions in Iceland zone

Table 1 (continued). Catch (tons) of shrimp by the fishery in Denmark Strait/off East Greenland from 1978 to July 2024. Values for the fishery in the Greenland EEZ by EU, Faeroe Islands, France, Greenland, and Norway are corrected according to Hvingel 2003.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
North of 65°N																		
EU (DK,EST,LTU)	85	401	793	459	72	816	861	482	304	618	421	389	892	1345	927	1411	1533	434
Faroe Islands	635	1268	867	956	214	1029	1062	894	615	342	319	612	1325	781	0	0	0	0
France	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Greenland	105	646	614	115	650	638	695	578	454	223	802	14	844	426	183	481	170	175
Iceland	2856	1421	769	132	10	1231	703	411	29	0	0	0	0	0	0	0	0	0
Norway	797	1628	1783	2759	1291	1630	2861	2700	2613	2704	1771	1514	883	770	36	2	0	0
Total	4478	5364	4827	4420	2237	5344	6183	5065	4015	3887	3313	2529	3945	3323	1145	1893	1703	609
South of 65°N																		
Denmark (EU)	1657	1300	1095	1900	2473	2309	1827	1022	644	683	431	251	28	101	0	0	0	0
Faroe Island	656	138	453	340	2402	1013	303	255	176	227	169	14	28	0	0	0	0	0
Greenland	4701	3950	4966	5235	4943	4333	4194	3488	2737	316	638	0	447	178	53	215	3	0
Norway	2261	670	378	157	1855	1098	197	186	180	76	48	0	107	0	0	0	0	0
Total	9276	6057	6893	7632	11674	5985	6522	4951	3737	1302	1286	266	610	279	53	215	3	0
Total area																		
EU (DK,EST,LTU)	1742	1701	1888	2358	2545	2548	2688	1504	948	1301	852	640	920	1446	927	1411	1533	434
Faroe Islands	1292	1406	1321	1296	2616	1322	1365	1149	791	569	488	627	1354	782	0	0	0	0
France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greenland	4806	4595	5581	5349	5593	4484	4890	4066	3191	539	1440	14	1292	605	236	696	173	175
Iceland	2856	1421	769	132	10	1231	703	411	29	0	0	0	0	0	0	0	0	0
Norway	3059	2298	2160	2917	3147	1743	3059	2886	2793	2780	1819	1514	990	770	36	2	0	0
Total	13754	11422	11719	12053	13911	11329	12705	10016	7752	5189	4599	2794	4555	3602	1199	2109	1706	609
Total all areas	13754	11422	11719	12053	13911	11242	12637	9985	7752	5189	4599	2794	4555	3602	1199	2109	1706	609
Advised TAC	5000	5000	9600	9600	9600	9600	9600	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	2000
Effective TAC ¹	9563	9563	10600	12600	10600	10600	10600	15043	12400	12400	12400	12400	12835	11835	12400	12400	12400	8300

¹For Greenland zone only; no restrictions in Iceland zone

Table 1 (continued).

Catch (tons) of shrimp by the fishery in Denmark Strait/off East Greenland from 1978 to July 2024. Values for the fishery in the Greenland EEZ by EU, Faeroe Islands, France, Greenland, and Norway are corrected according to Hvingel 2003.

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024 ²
North of 65°N										
EU (DK,EST,LTU)	402	49	178	547	1009	2059	2050	3343	2773	1768
Faroe Islands	0	0	0	0	267	1113	59	0	0	0
France	-	-	-	-	-	-	-	-	-	0
Greenland	174	0	383	0	298	0	958	833	2921	2628
Iceland	0	0	0	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0	1347	1772	1693
Total	576	49	561	547	1574	3172	3067	5523	7466	6089
South of 65°N										
Denmark (EU)	0	0	0	0	2	0	0	0	0	0
Faroe Island	0	0	0	0	0	0	0	0	0	0
Greenland	0	0	0	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	2	0	0	0	0	0
Total area										
EU (DK,EST,LTU, GBR)	402	49	178	547	1011	2059	2050	3343	2773	1768
Faroe Islands	0	0	0	0	267	1113	59	0	0	0
France	0	0	0	0	0	0	0	0	0	0
Greenland	174	0	383	0	298	0	958	833	2921	2628
Iceland	0	0	0	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0	1347	1772	1693
Total	576	49	561	547	1576	3172	3067	5523	7466	6089³
Total all areas	576	49	561	547	1576	3172	3067	5523	7466	6089
Advised TAC	2000	2000	2000	2000	2000	2000	3000	3000	2000	2500
Effective TAC ¹	6100	5300	5300	4300	3384	4750	7000	6850	6850	7850

¹For Greenland zone only; no restrictions in Iceland zone

²Catch until June 30th

³Logbooks from one foreign vessels were not available at the time of this analysis. Total catches have been provided by GFLK.

Table 2. Catch (tons), effort (hrs) and unstandardized Catch-Per-Unit-Effort (kg/hr) by trawlers fishing in Denmark Strait / off East Greenland in areas north and south of 65°N and total area. For 2024 logbooks from one foreign vessels were not available, catches are included, but data on CPUE and Effort were not available.

Year	Area north			Area south			Total area		
	Catch	Effort	CPUE	Catch	Effort	CPUE	Catch	Effort	CPUE
1980	10325	37198	278				10325	37198	278
1981	5964	19986	298				5964	19986	298
1982	6133	23081	266				6133	23081	266
1983	5212	23855	219				5212	23855	219
1984	8235	34983	235				8235	34983	235
1985	9696	62911	154				9696	62911	154
1986	13428	61863	217				13428	61863	217
1987	15073	79881	189				15073	79881	189
1988	15313	109455	140				15313	109455	140
1989	12999	119629	109				12999	119629	109
1990	12480	72736	172				12480	72736	172
1991	10757	78714	137				10757	78714	137
1992	8901	68349	130				8901	68349	130
1993	6982	52381	133	1904	9335	204	8886	61003	146
1994	5731	31417	182	6201	18371	338	11932	49428	241
1995	7176	33953	211	4412	13157	335	11588	46927	247
1996	3490	27029	129	8453	24589	344	11944	51049	234
1997	4478	22175	202	9276	25992	357	13754	47519	289
1998	5364	20881	257	6057	10498	577	11422	31205	366
1999	4827	19388	249	6893	7449	925	11719	25742	455
2000	4420	17474	253	7632	10705	713	12053	28096	429
2001	2237	9822	228	11674	20435	571	13911	29933	465
2002	5344	20052	267	5985	8546	700	11329	22843	496
2003	6183	18053	342	6522	9317	700	12705	25295	502
2004	5065	15848	320	4951	8972	552	10016	27450	365
2005	4015	11249	357	3737	8003	467	7752	19255	403
2006	3887	10414	373	1302	2436	534	5189	12851	404
2007	3313	8976	369	1286	1974	651	4599	10949	420
2008	2529	6106	414	266	585	454	2794	6691	418
2009	3945	6500	607	610	617	989	4555	7117	640
2010	3323	10286	323	280	263	1062	3602	10550	341
2011	1145	3301	347	53	25	2136	1199	3326	360
2012	1893	6343	298	215	170	1267	2109	6513	324
2013	1714	8162	210	3	75	45	1717	8235	208
2014	622	4364	142	0	-	-	622	4374	142
2015	576	4573	126	0	-	-	576	4905	117
2016	49	327	150	0	-	-	49	327	150
2017	561	1633	344	0	-	-	561	1633	344
2018	547	1132	483	0	-	-	547	1132	483
2019	1574	1999	787	2	7	286	1576	2006	786
2020	3172	3727	851	0	10	20	3172	3737	849
2021	3067	4580	670	0	9	44	3067	4589	668
2022	5523	6132	901	0	1	0	5523	6133	900
2023	7466	9266	806	0	2	0	7466	9267	806
2024*	6089	8603	708	0	3	0	6089	8604	708

*until June
30th

Table 3. Means and standard errors (se) of standardised CPUE and effort index values based on logbook information from trawlers fishing in Denmark Strait/off East Greenland in areas north and south of 65°N and total area. Data from one foreign vessel in 2024 were not available at the time of the analysis.

Year	Area north				Area south				Total			
	Std.CPUE		Std. Effort		Std.CPUE		Std. Effort		Std.CPUE		Std. Effort	
	mean	se	mean	se	mean	se	mean	se	mean	se	mean	se
1987	1.00	-	1.00	-					1.00	-	1.00	-
1988	0.95	0.09	1.07	0.11					0.99	0.10	1.02	0.10
1989	0.67	0.07	1.28	0.13					0.68	0.07	1.27	0.13
1990	0.79	0.08	1.04	0.11					0.81	0.08	1.02	0.11
1991	0.69	0.07	1.03	0.10					0.71	0.07	1.01	0.10
1992	0.46	0.05	1.30	0.13					0.57	0.06	1.04	0.11
1993	0.54	0.05	0.86	0.09	1.00	-	1.00	-	0.54	0.06	1.09	0.12
1994	1.05	0.12	0.36	0.04	2.22	0.08	1.47	0.15	1.50	0.16	0.53	0.06
1995	0.87	0.09	0.55	0.06	1.86	0.09	1.24	0.12	1.18	0.13	0.65	0.07
1996	0.77	0.09	0.30	0.04	2.60	0.08	1.70	0.12	1.50	0.16	0.53	0.06
1997	1.07	0.14	0.28	0.04	2.50	0.08	1.95	0.14	1.85	0.21	0.49	0.05
1998	1.36	0.17	0.26	0.03	2.82	0.09	1.13	0.16	1.93	0.22	0.39	0.04
1999	1.18	0.16	0.27	0.04	3.67	0.11	0.99	0.11	2.19	0.26	0.35	0.04
2000	1.44	0.17	0.20	0.02	3.66	0.09	1.10	0.11	2.32	0.27	0.34	0.04
2001	1.28	0.18	0.12	0.02	2.72	0.08	2.25	0.10	2.32	0.27	0.40	0.05
2002	1.32	0.17	0.27	0.04	3.29	0.09	0.95	0.19	2.58	0.30	0.29	0.03
2003	1.20	0.14	0.34	0.04	2.81	0.09	1.22	0.09	1.97	0.23	0.43	0.05
2004	1.41	0.16	0.24	0.03	2.17	0.11	1.20	0.11	1.79	0.21	0.37	0.04
2005	1.33	0.17	0.20	0.03	2.76	0.12	0.71	0.13	2.02	0.25	0.25	0.03
2006	1.48	0.19	0.17	0.02	2.62	0.13	0.26	0.08	2.00	0.26	0.17	0.02
2007	1.28	0.16	0.17	0.02	2.87	0.15	0.23	0.03	1.71	0.22	0.18	0.02
2008	1.63	0.23	0.10	0.01	1.81	0.25	0.08	0.03	2.01	0.29	0.09	0.01
2009	2.36	0.31	0.11	0.01	3.48	0.23	0.09	0.02	2.77	0.38	0.11	0.02
2010	1.22	0.15	0.18	0.02	2.80	0.34	0.05	0.02	1.50	0.20	0.16	0.02
2011	1.36	0.24	0.06	0.01	-	-	-	-	1.60	0.30	0.05	0.01
2012	1.08	0.16	0.12	0.02	4.00	0.38	0.03	0.00	1.35	0.21	0.10	0.02
2013	0.70	0.10	0.16	0.02	-	-	-	-	0.90	0.14	0.13	0.02
2014	0.55	0.10	0.08	0.01	-	-	-	-	0.74	0.14	0.06	0.01
2015	0.49	0.08	0.08	0.01	-	-	-	-	0.62	0.12	0.06	0.01
2016	0.70	0.35	0.005	0.002	-	-	-	-	0.97	0.54	0.00	0.002
2017	1.17	0.26	0.032	0.007	-	-	-	-	1.35	0.33	0.03	0.01
2018	1.82	0.41	0.020	0.005	-	-	-	-	2.25	0.56	0.02	0.004
2019	2.94	0.54	0.035	0.007	-	-	-	-	3.40	0.67	0.03	0.006
2020	3.24	0.49	0.065	0.010	-	-	-	-	4.05	0.65	0.05	0.008
2021	2.58	0.43	0.079	0.013	-	-	-	-	3.23	0.57	0.06	0.011
2022	3.24	0.46	0.113	0.016	-	-	-	-	4.06	0.61	0.09	0.014
2023	2.61	0.37	0.189	0.027	-	-	-	-	3.31	0.50	0.15	0.023
2024*	2.12	0.31	0.191	0.028	-	-	-	-	2.76	0.43	0.15	0.023

* Until July

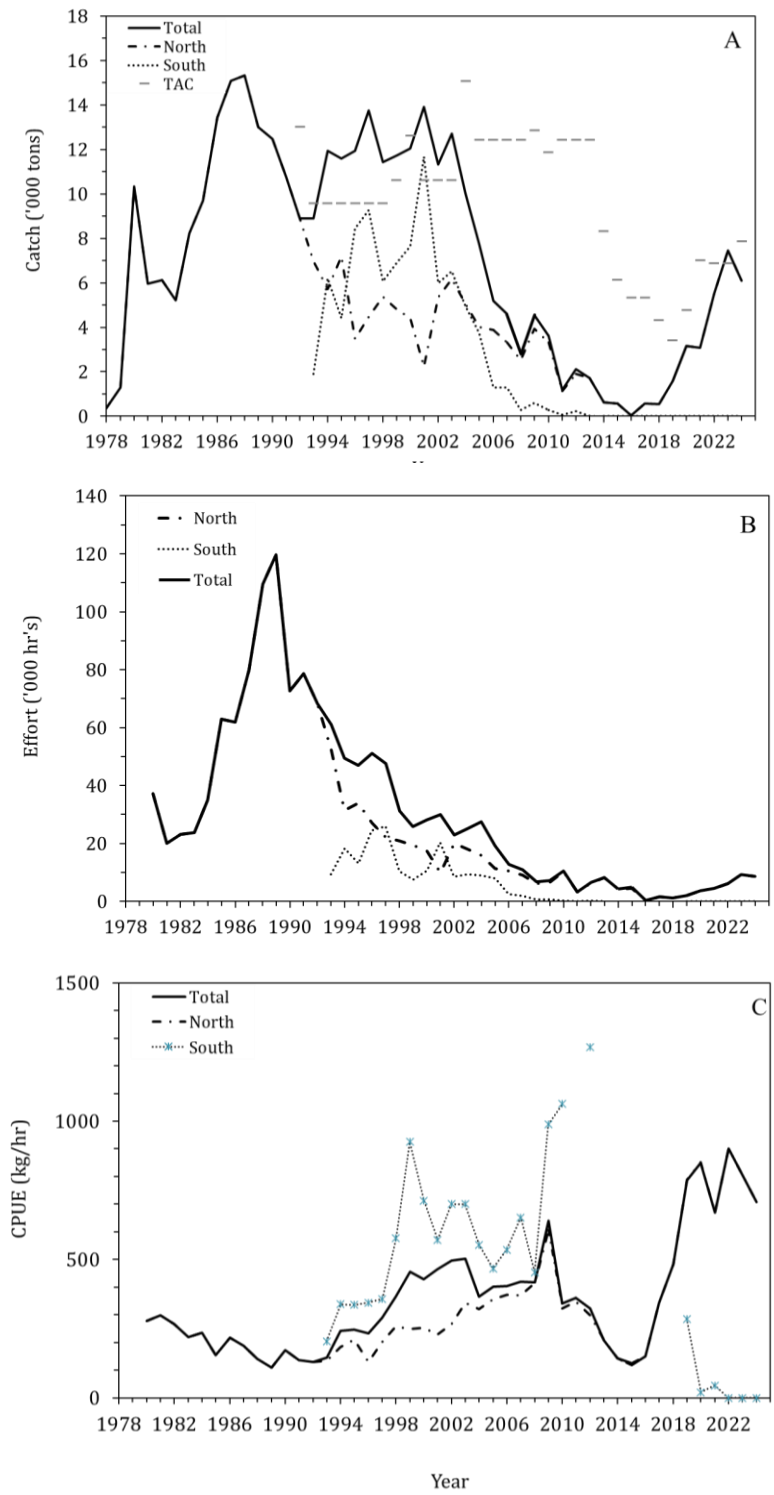


Figure 1. Catch (A), fishing effort (B) and catch-per-unit-effort (C) by shrimp trawlers fishing in Denmark Strait/off East Greenland. Series are given for the areas north and south of 65°N and overall. (Data for 2024 is part-years data, until June 30th). Catch (A) include all catches, effort and CPUE are based on available logbooks. Logbooks from one foreign vessel in 2024 were not available at the time of the analysis, catch are included in the catch figure but no information on CPUE and effort where available.

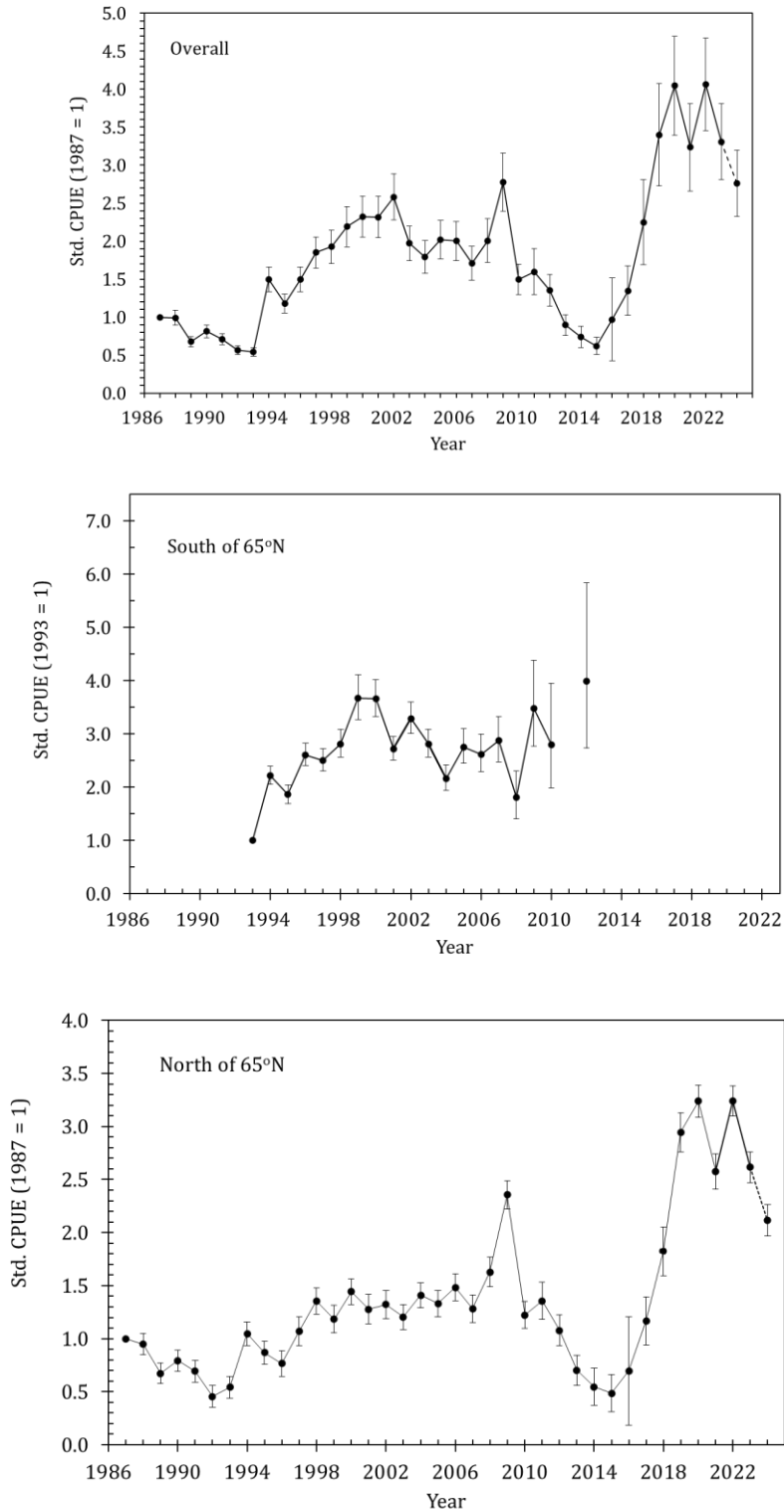


Figure 2. Standardized Catch-Per-Unit-Effort indices of the shrimp fishery in Denmark Strait and off East Greenland in the areas south of 65°N, overall fishery north of 65°N (both in Greenland and Iceland EEZ), and overall standardized CPUE for the stock (Estimates for 2024 are based on data until June 30th). No index for the southern area has been calculated since 2012 due to a low number of hauls (less than 10 each year).

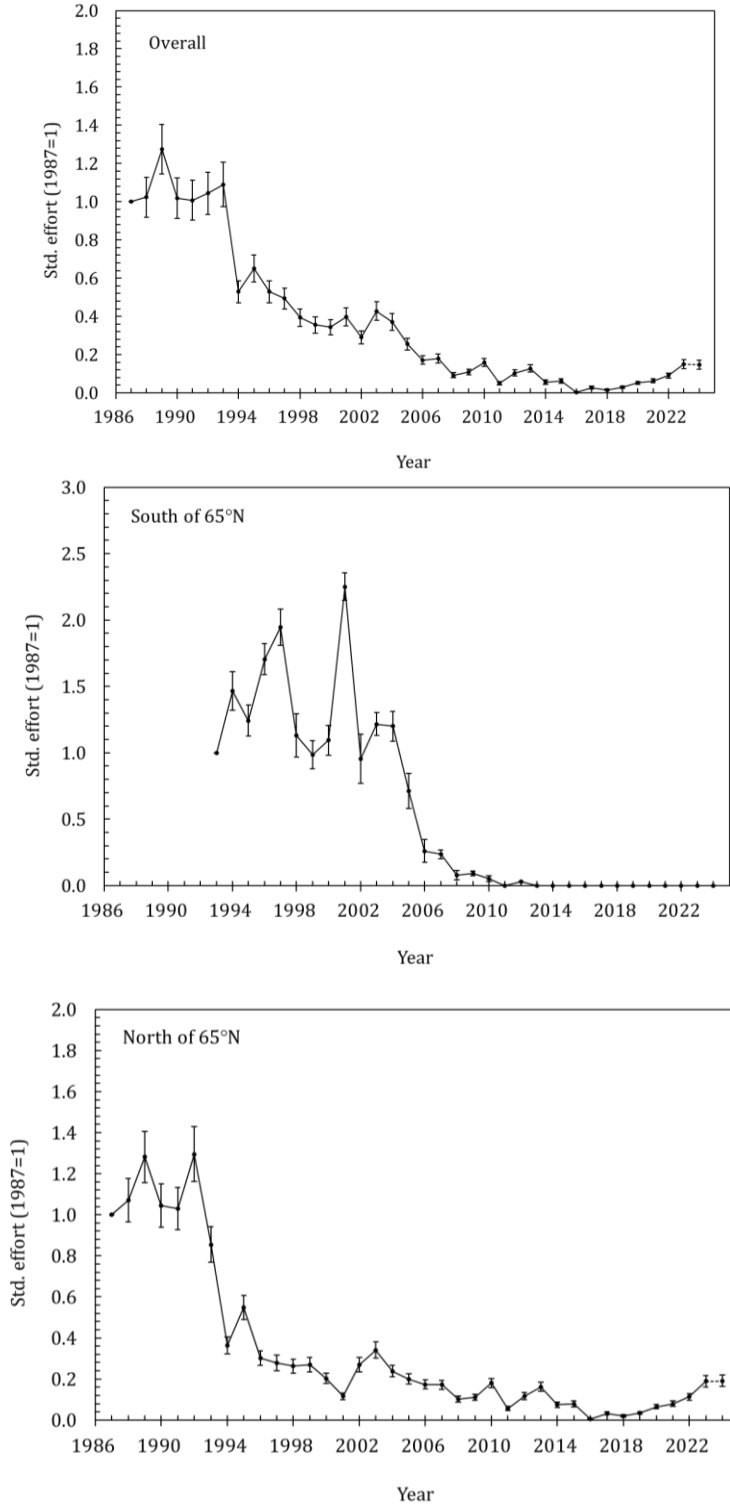


Figure 3. Standardised effort indices of the shrimp fishery in Denmark Strait and off East Greenland in the areas north of 65°N, south of 65°N and overall (Estimates for 2024 are based on data until June 30th).

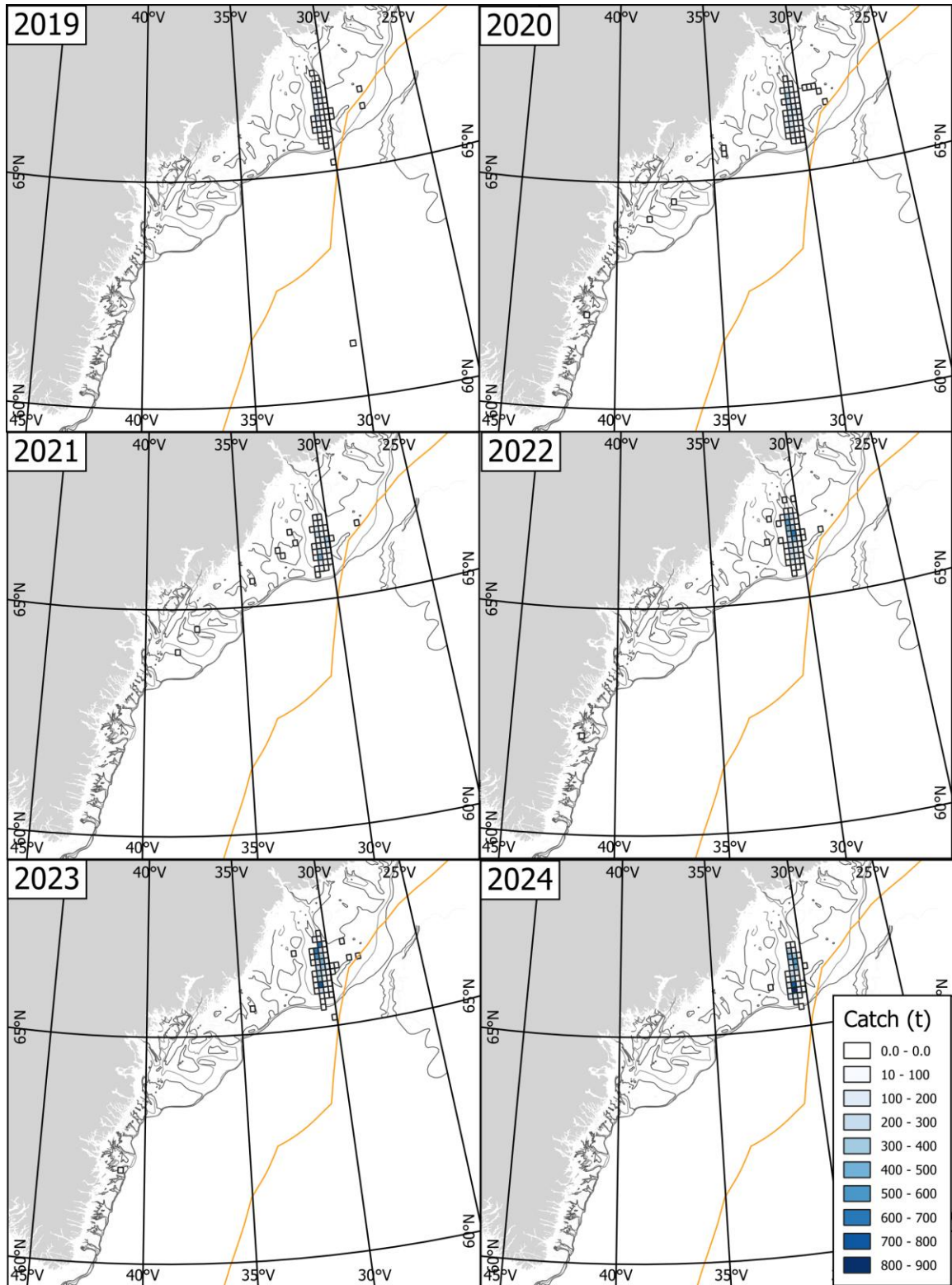


Figure 4a. Thematic mapping of different levels of catch in the shrimp fishery in Denmark Strait/off East Greenland 2019-2024 (2024 until July. 2024 does not including data for one foreign vessels). Grey lines show depths of 200, 300, 400 and 600 m. Yellow line shows EEZ boundary.

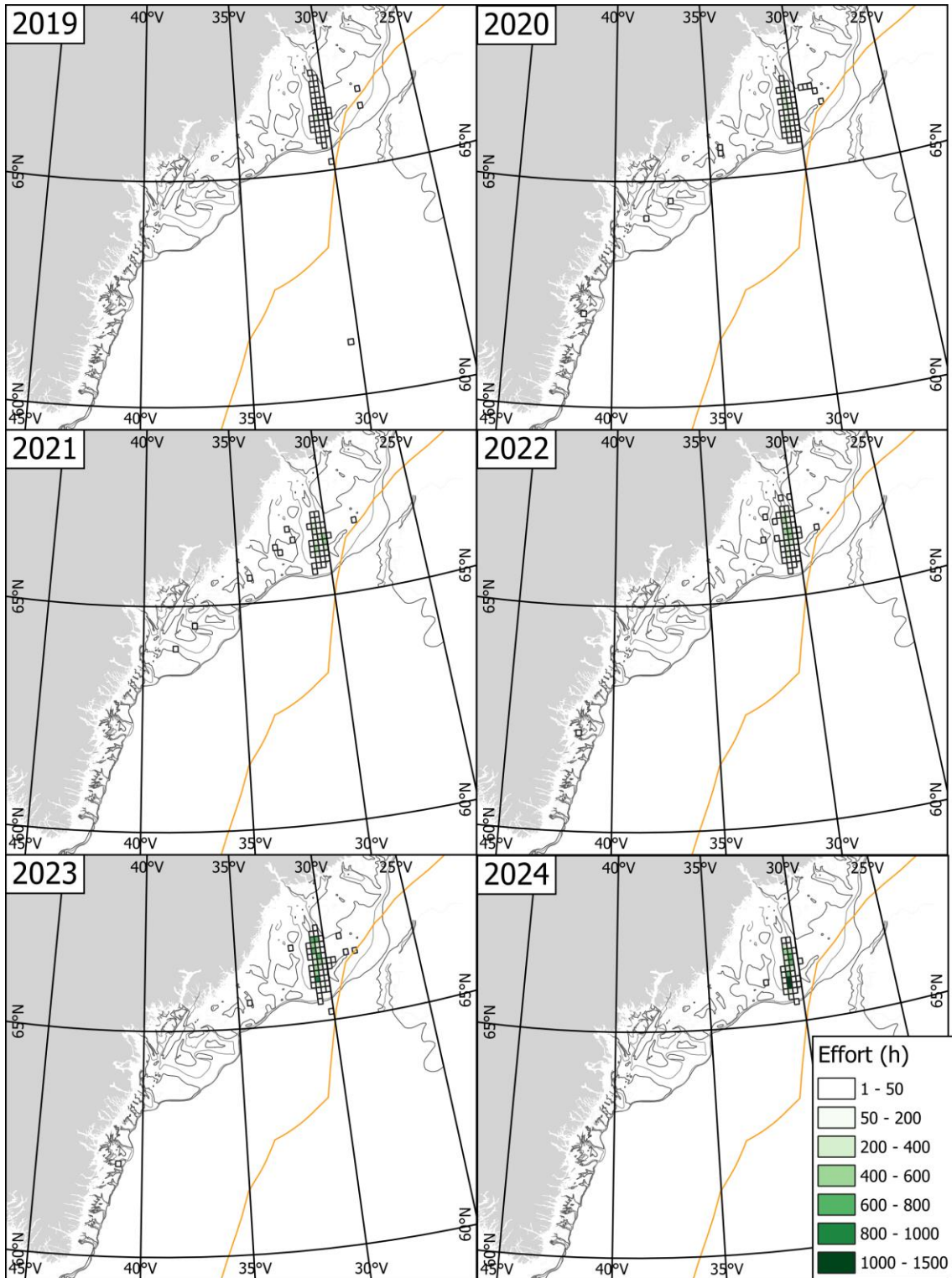


Figure 4b. Thematic mapping of different levels of effort in the shrimp fishery in Denmark Strait/off East Greenland 2019-2024 (2024 until July. 2024 does not including data from one foreign vessels). Grey lines show depths of 200, 300, 400 and 600 m. Yellow line shows EEZ boundary.

Appendix 1. Results and diagnostic outputs from GLM run of model for standardising CPUE in the Greenlandic zone including the area effect. Data from Greenlandic, Faeroese, Norway and EU vessels.

The SAS System

The GLM Procedure

Class Level Information

Class	Levels	Values
BAAD	114	E001 E003 E004 E005 E006 E007 E008 E009 E010 E011 E012 E013 E014 E015 E017 E018 E019 E020 E021 E022 E023 E024 E025 E026 E027 E028 E029 E030 E031 E032 E033 E034 E035 E036 E037 E038 E039 E040 E041 E042 E043 E044 E045 E046 E047 E048 E049 E050 E051 E052 E053 E054 E055 E056 E057 E058 E059 E060 E061 E062 E063 E064 E065 E066 E067 E068 E069 E070 E071 E072 E073 E074 E075 E076 E077 E078 E079 E080 E081 E082 E083 E085 E086 E087 E088 E089 E090 E091 E092 E093 E094 E096 E099 E100 E101 E102 E103 E104 E105 E106 E107 E108 E109 E110 E113 E114 E116 E117 E118 E119 E121 E122 E123 E124
YEAR	38	1987 1988 1989 1990 1991 1992 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 9999
MONTH	12	1 2 3 4 5 6 7 8 9 10 11 12
AREA	2	21 22
X	2	2 9

Number of Observations Read 3604

Number of Observations Used 3604

The SAS System

The GLM Procedure

Dependent Variable: LNCPUE

Weight: Hauls

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	181	61145.77604	337.82197	44.98	<.0001
Error	3422	25698.91325	7.50991		
Corrected Total	3603	86844.68929			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.704082	210.8869	2.740422	1.299474

Source	DF	Type I SS	Mean Square	F Value	Pr > F
BAAD	113	37634.89357	333.05216	44.35	<.0001
YEAR*AREA	56	18845.95951	336.53499	44.81	<.0001
MONTH	11	4642.48610	422.04419	56.20	<.0001
AREA	0	0.00000	.	.	.
X	1	22.43686	22.43686	2.99	0.0840

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BAAD	113	10015.38378	88.63171	11.80	<.0001
YEAR*AREA	55	13056.40896	237.38925	31.61	<.0001
MONTH	11	4633.41539	421.21958	56.09	<.0001
AREA	1	1081.47886	1081.47886	144.01	<.0001
X	1	22.43686	22.43686	2.99	0.0840

Parameter	Estimate	Standard Error	t Value	Pr > t
Intercept	1.295130615	B 0.33862698	3.82	0.0001
BAAD E001	-1.256313052	B 0.35863135	-3.50	0.0005
BAAD E003	-1.126551275	B 0.34001524	-3.31	0.0009
BAAD E004	-1.181185663	B 0.35576868	-3.32	0.0009
BAAD E005	-1.209043254	B 0.35854220	-3.37	0.0008
BAAD E006	-0.894033049	B 0.35283233	-2.53	0.0113
BAAD E007	-1.073239565	B 0.34997461	-3.07	0.0022
BAAD E008	-0.887007439	B 0.34109603	-2.60	0.0093
BAAD E009	-0.812630841	B 0.35252579	-2.31	0.0212
BAAD E010	-1.083986941	B 0.33648806	-3.22	0.0013



Parameter	Estimate	Standard Error	t Value	Pr > t
BAAD E011	-1.069809696	B 0.34164868	-3.13	0.0018
BAAD E012	-0.902724748	B 0.39724995	-2.27	0.0231
BAAD E013	-1.017963020	B 0.35739028	-2.85	0.0044
BAAD E014	-0.957478036	B 0.33796372	-2.83	0.0046
BAAD E015	-0.983765942	B 0.34024978	-2.89	0.0039
BAAD E017	-0.831481768	B 0.34316210	-2.42	0.0154
BAAD E018	-0.905416452	B 0.34179993	-2.65	0.0081
BAAD E019	-0.806533971	B 0.37177878	-2.17	0.0301
BAAD E020	-0.959445122	B 0.35604918	-2.69	0.0071
BAAD E021	-0.560655288	B 0.34906436	-1.61	0.1083
BAAD E022	-0.905685429	B 0.33907368	-2.67	0.0076
BAAD E023	-0.729631081	B 0.37728302	-1.93	0.0532
BAAD E024	-0.782292527	B 0.33396545	-2.34	0.0192
BAAD E025	-0.528689982	B 0.34565669	-1.53	0.1262
BAAD E026	-0.547942116	B 0.35572771	-1.54	0.1236
BAAD E027	-0.709718358	B 0.33565033	-2.11	0.0345
BAAD E028	-0.851199570	B 0.36144982	-2.35	0.0186
BAAD E029	-0.815549760	B 0.34037757	-2.40	0.0166
BAAD E030	-0.773265327	B 0.34103416	-2.27	0.0234
BAAD E031	-0.726752776	B 0.33558322	-2.17	0.0304
BAAD E032	-0.899148792	B 0.36304112	-2.48	0.0133
BAAD E033	-0.713082028	B 0.50907340	-1.40	0.1614
BAAD E034	-0.746391406	B 0.35250945	-2.12	0.0343
BAAD E035	-0.221964574	B 0.34017268	-0.65	0.5141
BAAD E036	-0.561016819	B 0.36664864	-1.53	0.1261
BAAD E037	-0.683796796	B 0.33700376	-2.03	0.0425
BAAD E038	-0.488967459	B 0.34339416	-1.42	0.1546
BAAD E039	-0.400305474	B 0.33912846	-1.18	0.2379
BAAD E040	-0.365383339	B 0.33802399	-1.08	0.2798
BAAD E041	-0.480884411	B 0.34512969	-1.39	0.1636
BAAD E042	-0.436088308	B 0.33792016	-1.29	0.1970
BAAD E043	-0.586478253	B 0.33484196	-1.75	0.0799
BAAD E044	-0.520866582	B 0.33318256	-1.56	0.1181
BAAD E045	-0.577993249	B 0.34440923	-1.68	0.0934
BAAD E046	-0.610496035	B 0.33954333	-1.80	0.0723

Parameter	Estimate	Standard Error	t Value	Pr > t
BAAD E047	-0.556752391	B 0.33675646	-1.65	0.0984
BAAD E048	-0.547305364	B 0.33593677	-1.63	0.1034
BAAD E049	-0.642273701	B 0.33480250	-1.92	0.0551
BAAD E050	-0.324784820	B 0.34075752	-0.95	0.3406
BAAD E051	-0.566537100	B 0.33765906	-1.68	0.0935
BAAD E052	-0.531104396	B 0.33928441	-1.57	0.1176
BAAD E053	-0.451820229	B 0.37434432	-1.21	0.2275
BAAD E054	-0.541998921	B 0.33718135	-1.61	0.1081
BAAD E055	-0.346532589	B 0.34270028	-1.01	0.3120
BAAD E056	-0.225494036	B 0.33196769	-0.68	0.4970
BAAD E057	-0.454618056	B 0.34146266	-1.33	0.1832
BAAD E058	-0.390347690	B 0.35874697	-1.09	0.2766
BAAD E059	-0.210349060	B 0.37441357	-0.56	0.5743
BAAD E060	-0.335019725	B 0.34143521	-0.98	0.3266
BAAD E061	-0.313055351	B 0.33037679	-0.95	0.3434
BAAD E062	-0.396810597	B 0.33570403	-1.18	0.2373
BAAD E063	-0.336046996	B 0.34333905	-0.98	0.3278
BAAD E064	-0.343486573	B 0.33663073	-1.02	0.3076
BAAD E065	-0.367609572	B 0.34907385	-1.05	0.2924
BAAD E066	-0.456070119	B 0.35742553	-1.28	0.2020
BAAD E067	-1.042436736	B 0.51058838	-2.04	0.0413
BAAD E068	-0.370756406	B 0.36499032	-1.02	0.3098
BAAD E069	-0.279224064	B 0.33644451	-0.83	0.4066
BAAD E070	-0.183110504	B 0.33372674	-0.55	0.5833
BAAD E071	-0.237052982	B 0.33393242	-0.71	0.4778
BAAD E072	-0.262506641	B 0.34191700	-0.77	0.4427
BAAD E073	-0.380845040	B 0.34979272	-1.09	0.2763
BAAD E074	-0.224088536	B 0.33596460	-0.67	0.5048
BAAD E075	-0.142779196	B 0.33823240	-0.42	0.6730
BAAD E076	-0.241518237	B 0.33817484	-0.71	0.4752
BAAD E077	-0.124582226	B 0.34983150	-0.36	0.7218
BAAD E078	-0.119307083	B 0.33520281	-0.36	0.7219
BAAD E079	0.048138014	B 0.37237124	0.13	0.8971
BAAD E080	-0.110353724	B 0.35605541	-0.31	0.7566
BAAD E081	-0.087577657	B 0.34116482	-0.26	0.7974

Parameter	Estimate	Standard Error	t Value	Pr > t
BAAD E082	-0.042896766	B 0.38135579	-0.11	0.9104
BAAD E083	-0.027056540	B 0.35110056	-0.08	0.9386
BAAD E085	-0.974558144	B 0.38235335	-2.55	0.0109
BAAD E086	-0.605755203	B 0.49173687	-1.23	0.2181
BAAD E087	-0.147508837	B 0.39164685	-0.38	0.7065
BAAD E088	-1.182964164	B 0.40481202	-2.92	0.0035
BAAD E089	-1.186292720	B 0.37888762	-3.13	0.0018
BAAD E090	-0.947163975	B 0.42004770	-2.25	0.0242
BAAD E091	-1.003528465	B 0.43949864	-2.28	0.0225
BAAD E092	-1.280912632	B 0.41064473	-3.12	0.0018
BAAD E093	-1.877135855	B 0.62598811	-3.00	0.0027
BAAD E094	-0.849806247	B 0.39944801	-2.13	0.0335
BAAD E096	-0.878871521	B 0.36794028	-2.39	0.0170
BAAD E099	-1.371391242	B 0.38375665	-3.57	0.0004
BAAD E100	-0.792322776	B 0.80624965	-0.98	0.3258
BAAD E101	-0.326549131	B 0.38020098	-0.86	0.3905
BAAD E102	0.061495735	B 0.38314056	0.16	0.8725
BAAD E103	-0.382719950	B 0.38519315	-0.99	0.3205
BAAD E104	-0.674114882	B 0.38993276	-1.73	0.0839
BAAD E105	-0.397074586	B 0.45096061	-0.88	0.3786
BAAD E106	-0.931440398	B 0.47046742	-1.98	0.0478
BAAD E107	-0.717505539	B 0.42197966	-1.70	0.0892
BAAD E108	-1.180703844	B 0.37537116	-3.15	0.0017
BAAD E109	0.454037944	B 0.39642785	1.15	0.2522
BAAD E110	-0.603751522	B 0.39109268	-1.54	0.1227
BAAD E113	-0.890610302	B 0.49146633	-1.81	0.0701
BAAD E114	-0.386793073	B 0.38305738	-1.01	0.3127
BAAD E116	-1.147357970	B 1.61756113	-0.71	0.4782
BAAD E117	0.873708534	B 1.02662239	0.85	0.3948
BAAD E118	-1.358088640	B 0.43833907	-3.10	0.0020
BAAD E119	-1.390450797	B 0.42045180	-3.31	0.0010
BAAD E121	0.048062253	B 0.34431941	0.14	0.8890
BAAD E122	-0.244864134	B 0.36040415	-0.68	0.4969
BAAD E123	0.065143693	B 0.38517343	0.17	0.8657
BAAD E124	0.000000000	B .	.	.

Parameter	Estimate		Standard Error	t Value	Pr > t
YEAR*AREA 1987 21	0.456772449	B	0.07505601	6.09	<.0001
YEAR*AREA 1988 21	0.260555465	B	0.07102655	3.67	0.0002
YEAR*AREA 1989 21	-0.124360322	B	0.06958494	-1.79	0.0740
YEAR*AREA 1990 21	0.061835494	B	0.06962589	0.89	0.3745
YEAR*AREA 1991 21	-0.109478137	B	0.06813009	-1.61	0.1082
YEAR*AREA 1992 21	-0.340942407	B	0.07058272	-4.83	<.0001
YEAR*AREA 1994 21	0.318169588	B	0.08637607	3.68	0.0002
YEAR*AREA 1994 22	0.797270222	B	0.07888694	10.11	<.0001
YEAR*AREA 1995 21	0.138115427	B	0.07817705	1.77	0.0774
YEAR*AREA 1995 22	0.623107604	B	0.09442309	6.60	<.0001
YEAR*AREA 1996 21	0.015898578	B	0.09484749	0.17	0.8669
YEAR*AREA 1996 22	0.957112569	B	0.08045527	11.90	<.0001
YEAR*AREA 1997 21	0.411389507	B	0.12248033	3.36	0.0008
YEAR*AREA 1997 22	0.917492122	B	0.08396052	10.93	<.0001
YEAR*AREA 1998 21	0.730167470	B	0.10607464	6.88	<.0001
YEAR*AREA 1998 22	1.035056372	B	0.09381035	11.03	<.0001
YEAR*AREA 1999 21	0.536159739	B	0.11086565	4.84	<.0001
YEAR*AREA 1999 22	1.299856735	B	0.11335445	11.47	<.0001
YEAR*AREA 2000 21	0.674206213	B	0.09339640	7.22	<.0001
YEAR*AREA 2000 22	1.297314453	B	0.09447552	13.73	<.0001
YEAR*AREA 2001 21	0.533803873	B	0.11536680	4.63	<.0001
YEAR*AREA 2001 22	1.001877910	B	0.08257683	12.13	<.0001
YEAR*AREA 2002 21	0.523046540	B	0.11429823	4.58	<.0001
YEAR*AREA 2002 22	1.191607533	B	0.09015545	13.22	<.0001
YEAR*AREA 2003 21	0.494869480	B	0.09241512	5.35	<.0001
YEAR*AREA 2003 22	1.034793110	B	0.09207486	11.24	<.0001
YEAR*AREA 2004 21	0.648867194	B	0.08849812	7.33	<.0001
YEAR*AREA 2004 22	0.773755312	B	0.10972976	7.05	<.0001
YEAR*AREA 2005 21	0.567193427	B	0.09563714	5.93	<.0001
YEAR*AREA 2005 22	1.013691184	B	0.11834189	8.57	<.0001
YEAR*AREA 2006 21	0.674503693	B	0.09980591	6.76	<.0001
YEAR*AREA 2006 22	0.963454003	B	0.13353262	7.22	<.0001
YEAR*AREA 2007 21	0.529300815	B	0.09990544	5.30	<.0001
YEAR*AREA 2007 22	1.055502595	B	0.14707092	7.18	<.0001
YEAR*AREA 2008 21	0.763584168	B	0.11214864	6.81	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > t
YEAR*AREA 2008 22	0.591237520	B	0.24545929	2.41	0.0161
YEAR*AREA 2009 21	1.136279098	B	0.10469868	10.85	<.0001
YEAR*AREA 2009 22	1.247415315	B	0.22994099	5.42	<.0001
YEAR*AREA 2010 21	0.481930302	B	0.09821703	4.91	<.0001
YEAR*AREA 2010 22	1.030704141	B	0.34252195	3.01	0.0026
YEAR*AREA 2011 21	0.566835796	B	0.14957956	3.79	0.0002
YEAR*AREA 2012 21	0.349571440	B	0.11796465	2.96	0.0031
YEAR*AREA 2012 22	1.385295079	B	0.37945444	3.65	0.0003
YEAR*AREA 2013 21	-0.079654517	B	0.11483922	-0.69	0.4880
YEAR*AREA 2014 21	-0.346248494	B	0.15103517	-2.29	0.0219
YEAR*AREA 2015 21	-0.462621483	B	0.14826976	-3.12	0.0018
YEAR*AREA 2016 21	-0.399396118	B	0.44765059	-0.89	0.3723
YEAR*AREA 2017 21	0.387568518	B	0.19852657	1.95	0.0510
YEAR*AREA 2018 21	0.828936575	B	0.20115140	4.12	<.0001
YEAR*AREA 2019 21	1.336005980	B	0.15778979	8.47	<.0001
YEAR*AREA 2020 21	1.446552892	B	0.12377609	11.69	<.0001
YEAR*AREA 2021 21	1.210816825	B	0.13985630	8.66	<.0001
YEAR*AREA 2022 21	1.451678971	B	0.11410140	12.72	<.0001
YEAR*AREA 2023 21	1.235101920	B	0.11610959	10.64	<.0001
YEAR*AREA 2024 21	1.021945895	B	0.12100663	8.45	<.0001
YEAR*AREA 9999 21	-0.548591217	B	0.07357140	-7.46	<.0001
YEAR*AREA 9999 22	0.000000000	B	.	.	.
MONTH 1	0.341979832	B	0.02937864	11.64	<.0001
MONTH 2	0.321717785	B	0.02918394	11.02	<.0001
MONTH 3	0.193394407	B	0.03016179	6.41	<.0001
MONTH 4	0.162778123	B	0.03498712	4.65	<.0001
MONTH 5	0.070845189	B	0.03957780	1.79	0.0735
MONTH 6	-0.106699529	B	0.07257300	-1.47	0.1416
MONTH 7	0.342803767	B	0.07152537	4.79	<.0001
MONTH 8	0.067109087	B	0.05198615	1.29	0.1968
MONTH 9	-0.260345926	B	0.05017344	-5.19	<.0001
MONTH 10	-0.252324500	B	0.04322731	-5.84	<.0001
MONTH 11	-0.263730393	B	0.03702209	-7.12	<.0001
MONTH 12	0.000000000	B	.	.	.
AREA 21	0.000000000	B	.	.	.

Parameter	Estimate	Standard Error	t Value	Pr > t
AREA 22	0.000000000	B .	.	.
X 2	0.050834332	B 0.02940990	1.73	0.0840
X 9	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.

Appendix 2. Results and diagnostic outputs from GLM run of model for standardising CPUE in the Greenlandic zone not including the area effect. Data from Greenlandic, Faeroese, Norway and EU vessels.

The SAS System

The GLM Procedure

Dependent Variable: LNCPUE

Weight: Hauls

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	176	68132.2693	387.1152	43.91	<.0001
Error	4032	35548.4653	8.8166		
Corrected Total	4208	103680.7346			

R-Square Coeff Var Root MSE LNCPUE Mean

0.657135 217.0248 2.969273 1.368172

Source	DF	Type I SS	Mean Square	F Value	Pr > F
BAAD	120	43091.58275	359.09652	40.73	<.0001
YEAR	44	21715.20695	493.52743	55.98	<.0001
MONTH	11	3258.77312	296.25210	33.60	<.0001
X	1	66.70644	66.70644	7.57	0.0060

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BAAD	120	17216.54339	143.47119	16.27	<.0001
YEAR	44	21974.70156	499.42504	56.65	<.0001
MONTH	11	3276.28891	297.84445	33.78	<.0001
X	1	66.70644	66.70644	7.57	0.0060

Parameter	Estimate		Standard Error	t Value	Pr > t
Intercept	1.764338510	B	0.36256177	4.87	<.0001
BAAD E001	-1.623835540	B	0.38487533	-4.22	<.0001
BAAD E003	-1.213580239	B	0.36772220	-3.30	0.0010
BAAD E004	-1.190575216	B	0.37887699	-3.14	0.0017
BAAD E005	-1.163994716	B	0.38795734	-3.00	0.0027
BAAD E006	-1.174796618	B	0.38132510	-3.08	0.0021
BAAD E007	-1.131300801	B	0.37844203	-2.99	0.0028
BAAD E008	-1.093563949	B	0.36867479	-2.97	0.0030
BAAD E009	-1.078393163	B	0.38111946	-2.83	0.0047
BAAD E010	-1.068208836	B	0.36360389	-2.94	0.0033

Parameter	Estimate		Standard Error	t Value	Pr > t
BAAD E011	-1.034199264	B	0.36961658	-2.80	0.0052
BAAD E012	-1.049387119	B	0.42943929	-2.44	0.0146
BAAD E013	-0.978553789	B	0.38667926	-2.53	0.0114
BAAD E014	-0.975228420	B	0.36533517	-2.67	0.0076
BAAD E015	-0.941115236	B	0.36808157	-2.56	0.0106
BAAD E016	-0.900284029	B	0.38433554	-2.34	0.0192
BAAD E017	-0.900570498	B	0.37117048	-2.43	0.0153
BAAD E018	-0.900936759	B	0.36963811	-2.44	0.0148
BAAD E019	-0.894810211	B	0.39360285	-2.27	0.0231
BAAD E020	-0.889765144	B	0.38523450	-2.31	0.0210
BAAD E021	-0.906305920	B	0.37629211	-2.41	0.0161
BAAD E022	-0.861541077	B	0.36609865	-2.35	0.0187
BAAD E023	-0.880115462	B	0.40761600	-2.16	0.0309
BAAD E024	-0.849589232	B	0.36145466	-2.35	0.0188
BAAD E025	-0.804481156	B	0.37357538	-2.15	0.0313
BAAD E026	-0.782937794	B	0.38470165	-2.04	0.0419
BAAD E027	-0.787633864	B	0.36305813	-2.17	0.0301
BAAD E028	-0.769054001	B	0.38729468	-1.99	0.0471
BAAD E029	-0.760849318	B	0.36823929	-2.07	0.0389
BAAD E030	-0.749166828	B	0.36896938	-2.03	0.0424
BAAD E031	-0.735923733	B	0.36287253	-2.03	0.0426
BAAD E032	-1.089289691	B	0.39259932	-2.77	0.0056
BAAD E033	-0.725221518	B	0.54765019	-1.32	0.1855
BAAD E034	-0.710257288	B	0.38142372	-1.86	0.0627
BAAD E035	-0.475183577	B	0.36808148	-1.29	0.1968
BAAD E036	-0.692282069	B	0.39692770	-1.74	0.0812
BAAD E037	-0.662416036	B	0.36452480	-1.82	0.0693
BAAD E038	-0.650787771	B	0.37162183	-1.75	0.0800
BAAD E039	-0.645019731	B	0.36687984	-1.76	0.0788
BAAD E040	-0.636906033	B	0.36552855	-1.74	0.0815
BAAD E041	-0.637692579	B	0.37334456	-1.71	0.0877
BAAD E042	-0.616330940	B	0.36571072	-1.69	0.0920
BAAD E043	-0.623515747	B	0.36234675	-1.72	0.0854
BAAD E044	-0.582473532	B	0.36058461	-1.62	0.1063
BAAD E045	-0.570830333	B	0.37061865	-1.54	0.1236

Parameter	Estimate		Standard Error	t Value	Pr > t
BAAD E046	-0.572768720	B	0.36731418	-1.56	0.1190
BAAD E047	-0.567653718	B	0.36424558	-1.56	0.1192
BAAD E048	-0.550648353	B	0.36332377	-1.52	0.1297
BAAD E049	-0.539356452	B	0.36192423	-1.49	0.1362
BAAD E050	-0.525109037	B	0.36865775	-1.42	0.1544
BAAD E051	-0.515103151	B	0.36506727	-1.41	0.1583
BAAD E052	-0.509636317	B	0.36625550	-1.39	0.1642
BAAD E053	-0.529959040	B	0.40534320	-1.31	0.1911
BAAD E054	-0.492097758	B	0.36463133	-1.35	0.1772
BAAD E055	-0.451849358	B	0.36999131	-1.22	0.2221
BAAD E056	-0.340821540	B	0.35950262	-0.95	0.3432
BAAD E057	-0.385645157	B	0.36819329	-1.05	0.2950
BAAD E058	-0.382674949	B	0.38801836	-0.99	0.3241
BAAD E059	-0.287356921	B	0.39500118	-0.73	0.4670
BAAD E060	-0.396499812	B	0.36976399	-1.07	0.2836
BAAD E061	-0.325996184	B	0.35776142	-0.91	0.3622
BAAD E062	-0.305204321	B	0.36283987	-0.84	0.4003
BAAD E063	-0.288035173	B	0.36755687	-0.78	0.4333
BAAD E064	-0.257158915	B	0.36381562	-0.71	0.4797
BAAD E065	-0.223192820	B	0.37616101	-0.59	0.5530
BAAD E066	-0.208925804	B	0.38110404	-0.55	0.5836
BAAD E067	-0.186584738	B	0.48549725	-0.38	0.7008
BAAD E068	-0.400755419	B	0.39526877	-1.01	0.3107
BAAD E069	-0.164039269	B	0.36332464	-0.45	0.6517
BAAD E070	-0.150694323	B	0.36094635	-0.42	0.6763
BAAD E071	-0.123631754	B	0.36097923	-0.34	0.7320
BAAD E072	-0.171305655	B	0.36800161	-0.47	0.6416
BAAD E073	-0.106337699	B	0.37319413	-0.28	0.7757
BAAD E074	-0.076484939	B	0.36302568	-0.21	0.8331
BAAD E075	-0.048992026	B	0.36520049	-0.13	0.8933
BAAD E076	-0.033311266	B	0.36493726	-0.09	0.9273
BAAD E077	-0.059952107	B	0.37587144	-0.16	0.8733
BAAD E078	0.020276691	B	0.36207236	0.06	0.9553
BAAD E079	0.015733109	B	0.40295069	0.04	0.9689
BAAD E080	0.076848379	B	0.37916819	0.20	0.8394

Parameter	Estimate		Standard Error	t Value	Pr > t
BAAD E081	0.108624058	B	0.36565069	0.30	0.7664
BAAD E082	0.165205895	B	0.40318506	0.41	0.6820
BAAD E083	0.346732758	B	0.36961397	0.94	0.3483
BAAD E084	1.603831718	B	1.75196451	0.92	0.3600
BAAD E085	-1.082049324	B	0.41219459	-2.63	0.0087
BAAD E086	-0.783316252	B	0.53262382	-1.47	0.1415
BAAD E087	-0.241215181	B	0.42423481	-0.57	0.5697
BAAD E088	-1.817934070	B	0.43473767	-4.18	<.0001
BAAD E089	-1.436829027	B	0.40937477	-3.51	0.0005
BAAD E090	-1.086459931	B	0.45441314	-2.39	0.0169
BAAD E091	-1.364509999	B	0.47482917	-2.87	0.0041
BAAD E092	-1.594965104	B	0.44197482	-3.61	0.0003
BAAD E093	-2.151527037	B	0.67622072	-3.18	0.0015
BAAD E094	-1.195221913	B	0.43107750	-2.77	0.0056
BAAD E096	-0.965733990	B	0.39853698	-2.42	0.0154
BAAD E097	0.328119000	B	1.75268139	0.19	0.8515
BAAD E098	0.537489672	B	2.99119569	0.18	0.8574
BAAD E099	-1.320736119	B	0.41528085	-3.18	0.0015
BAAD E100	-1.244227046	B	0.87201495	-1.43	0.1537
BAAD E101	-0.253993111	B	0.41136812	-0.62	0.5370
BAAD E102	0.173493234	B	0.41457727	0.42	0.6756
BAAD E103	-0.337278426	B	0.41685613	-0.81	0.4185
BAAD E104	-0.808579410	B	0.42232756	-1.91	0.0556
BAAD E105	-0.321213524	B	0.48814662	-0.66	0.5106
BAAD E106	-0.853240470	B	0.50934736	-1.68	0.0940
BAAD E107	-0.617902527	B	0.45674820	-1.35	0.1762
BAAD E108	-1.118360626	B	0.40620766	-2.75	0.0059
BAAD E109	0.429328426	B	0.42940585	1.00	0.3175
BAAD E110	-0.663551979	B	0.42367668	-1.57	0.1174
BAAD E111	1.311723670	B	2.99119544	0.44	0.6610
BAAD E112	-0.667084497	B	0.88981564	-0.75	0.4535
BAAD E113	-0.970829422	B	0.53239616	-1.82	0.0683
BAAD E114	-0.668759873	B	0.41367584	-1.62	0.1060
BAAD E115	-1.089027556	B	0.45688358	-2.38	0.0172
BAAD E116	-1.157605672	B	1.75246526	-0.66	0.5089

Parameter	Estimate		Standard Error	t Value	Pr > t
BAAD E117	0.893563001	B	0.61881775	1.44	0.1488
BAAD E118	-1.327298135	B	0.47441968	-2.80	0.0052
BAAD E119	-1.528006371	B	0.40847728	-3.74	0.0002
BAAD E121	0.005878975	B	0.37302002	0.02	0.9874
BAAD E122	-0.435488282	B	0.39032051	-1.12	0.2646
BAAD E123	0.047967430	B	0.41728997	0.11	0.9085
BAAD E124	0.000000000	B	.	.	.
YEAR 1980	0.398072543	B	0.27372049	1.45	0.1459
YEAR 1981	0.398273691	B	0.25510687	1.56	0.1186
YEAR 1982	-0.059793322	B	0.57856594	-0.10	0.9177
YEAR 1983	0.218792052	B	0.30797160	0.71	0.4775
YEAR 1984	0.744542422	B	0.25098724	2.97	0.0030
YEAR 1985	0.231748763	B	0.12120791	1.91	0.0559
YEAR 1986	0.275753630	B	0.06948406	3.97	<.0001
YEAR 1988	-0.184550910	B	0.04817730	-3.83	0.0001
YEAR 1989	-0.601504980	B	0.04868340	-12.36	<.0001
YEAR 1990	-0.387103105	B	0.04856966	-7.97	<.0001
YEAR 1991	-0.545679092	B	0.04912585	-11.11	<.0001
YEAR 1992	-0.779700007	B	0.05454676	-14.29	<.0001
YEAR 1993	-0.817357132	B	0.05507508	-14.84	<.0001
YEAR 1994	0.232635538	B	0.05707764	4.08	<.0001
YEAR 1995	-0.009880265	B	0.05622376	-0.18	0.8605
YEAR 1996	0.247247031	B	0.05793522	4.27	<.0001
YEAR 1997	0.495659725	B	0.06364202	7.79	<.0001
YEAR 1998	0.576421592	B	0.06972248	8.27	<.0001
YEAR 1999	0.698631098	B	0.07808618	8.95	<.0001
YEAR 2000	0.690884718	B	0.06931772	9.97	<.0001
YEAR 2001	0.670382383	B	0.06849902	9.79	<.0001
YEAR 2002	0.798722114	B	0.07316307	10.92	<.0001
YEAR 2003	0.540859611	B	0.06955492	7.78	<.0001
YEAR 2004	0.428340450	B	0.07416970	5.78	<.0001
YEAR 2005	0.521523804	B	0.08021981	6.50	<.0001
YEAR 2006	0.511899956	B	0.08480581	6.04	<.0001
YEAR 2007	0.354126412	B	0.08705085	4.07	<.0001
YEAR 2008	0.509392092	B	0.10408907	4.89	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > t
YEAR 2009	0.835685480	B	0.09700581	8.61	<.0001
YEAR 2010	0.220835247	B	0.09164975	2.41	0.0160
YEAR 2011	0.257804197	B	0.15364935	1.68	0.0934
YEAR 2012	0.109151528	B	0.11468404	0.95	0.3413
YEAR 2013	-0.299108442	B	0.11266482	-2.65	0.0080
YEAR 2014	-0.512536460	B	0.15466977	-3.31	0.0009
YEAR 2015	-0.680453923	B	0.15118546	-4.50	<.0001
YEAR 2016	-0.596627189	B	0.48194382	-1.24	0.2158
YEAR 2017	0.055422954	B	0.20767896	0.27	0.7896
YEAR 2018	0.563625937	B	0.21186692	2.66	0.0078
YEAR 2019	1.009158072	B	0.16321176	6.18	<.0001
YEAR 2020	1.203953058	B	0.12312716	9.78	<.0001
YEAR 2021	0.969848033	B	0.14221515	6.82	<.0001
YEAR 2022	1.212088778	B	0.11162465	10.86	<.0001
YEAR 2023	1.006400630	B	0.11381030	8.84	<.0001
YEAR 2024	0.821581273	B	0.11875443	6.92	<.0001
YEAR 9999	0.000000000	B	.	.	.
MONTH 1	0.207598324	B	0.02968302	6.99	<.0001
MONTH 2	0.205075541	B	0.02964718	6.92	<.0001
MONTH 3	0.114744725	B	0.03070250	3.74	0.0002
MONTH 4	0.152303471	B	0.03558265	4.28	<.0001
MONTH 5	0.005519756	B	0.04071442	0.14	0.8922
MONTH 6	-0.068668345	B	0.07519437	-0.91	0.3612
MONTH 7	0.411631062	B	0.06823381	6.03	<.0001
MONTH 8	0.149343193	B	0.05050190	2.96	0.0031
MONTH 9	-0.238955692	B	0.05121815	-4.67	<.0001
MONTH 10	-0.254512244	B	0.04354109	-5.85	<.0001
MONTH 11	-0.225901250	B	0.03682829	-6.13	<.0001
MONTH 12	0.000000000	B	.	.	.
X 2	-0.084100480	B	0.03057488	-2.75	0.0060
X 9	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.