Northwest Atlantic Fisheries Organization

Serial No. N7241 **NAFO SCR Doc. 21/043**

NAFO/ICES PANDALUS ASSESSMENT GROUP – 1-5 NOVEMBER 2021

The Fishery for Northern Shrimp (*Pandalus borealis*) in Denmark Strait / off East Greenland 1978 – 2021.

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 2020; 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 600t, but since 2016 the catch has increase to 3172 tons in 2020. Preliminary data for 2021 show a decrease in catch. However, in 2021 the EU fleet commenced fishing later than normal due to a delay in licenses, this are likely to have impacted the fishing pattern. The recent catch rate index might not be a reliable index for the biomass from the entire East coast because of the low fishing effort in a restricted area in these years.

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 150-600 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 3 172 tons in 2020. The catch for the first half of 2021 was at 2 370 tons.

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. At any time, access to fishing grounds depends on ice conditions. 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. 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 2021 only 4% of hauls were performed with single trawl, 54% of hauls with double trawl and 42% with triple trawl. Triple trawl was used by one vessel in 2020 and by two vessels in 2021. 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 two years with triple trawl as "learning" years. The catches in the Greenland EEZ were corrected for "overpacking" according to Hvingel (2003).

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 Greenland Fishery and License Control (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:

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

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,...,n; m = 1,...,a; j = 1,...,s; h = 1,2; i = 1,...,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 119 vessels were included in the analysis. This is a change from previous years where 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 3 172 tons in 2020. In the first half of 2021 the catches have dropped slightly to 2 370 tons.

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), followed by a decrease to 49 tons in 2016. The catch has since 2016 been increasing and reached 3 172 tons in 2020. Catches in the first half of 2021 decrease slightly to 2 369 tons.

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 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 3 737 hours in 2020. Effort for the first half of 2021 was 2 862 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 849 kg/hr in 2020 which is the highest in the timeseries. Unstandardized catch rates from the first half of 2021 showed a slight decrease to 825 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 2021 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 68% 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 improved, 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. In 2021 the index value is below the 2019 and 2020 index values. This may be 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. 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 2021.

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 2021.

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 3172 tons in 2020. The 2021 catch for the first half of 2021 are 2369 tons and lower than 2020.

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 2020. 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.

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 2021. Values for the fishery in the Greenland EEZ by EU, Faroe 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

[1]For 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 2021. Values for the fishery in the Greenland EEZ by EU, Faroe 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[2]
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

[1]For Greenland zone only; no restrictions in Iceland zone

[2]Catch until July

Table 1. (continued). Catch (tons) of shrimp by the fishery in Denmark Strait/off East Greenland from 1978 to July 2021. Values for the fishery in the Greenland EEZ by EU, Faroe Islands, France, Greenland, and Norway are corrected according to Hvingel 2003.

	2015	2016	2017	2018	2019	2020	2021[2]
North of 65°N							
EU (DK,EST,LTU)	402	49	178	547	1009	2059	1353
Faroe Islands	0	0	0	0	267	1113	59
France	-	-	-	-	-	-	-
Greenland	174	0	383	0	298	0	958
Iceland	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0
Total	576	49	561	547	1574	3172	2369
South of 65°N							
Denmark (EU)	0	0	0	0	2	0	0
Faroe Island	0	0	0	0	0	0	0
Greenland	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0
Total	0	0	0	0	2	0	0
Total area							
EU (DK,EST,LTU, GBR)	402	49	178	547	1011	2059	1353
Faroe Islands	0	0	0	0	267	1113	59
France	0	0	0	0	0	0	0
Greenland	174	0	383	0	298	0	958
Iceland	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0
Total	576	49	561	547	1576	3172	2370
Total all areas	576	49	561	547	1576	3172	2370
Advised TAC	2000	2000	2000	2000	2000	2000	3000
Effective TAC[1]	6100	5300	5300	4300	3384	4750	7000

[1]For Greenland zone only; no restrictions in Iceland zone

[2]Catch until June 30th

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.

	Area north			Area south			Total area		
Year	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*	2369	2862	828	0	9	44	2370	2871	825

*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.

	Area north				Area south				Total			
	Std.CPUE		Std. Effort		Std.CPUE		Std. Effort		Std.CPUE		Std. Effort	
Year	mean	se	mean	se	mean	se	mean	se	mean	se	mean	se
1987	1.00	-	1.00	-					1.00	-	1.00	-
1988	0.93	0.09	1.09	0.11					0.98	0.10	1.04	0.11
1989	0.66	0.06	1.31	0.12					0.66	0.07	1.30	0.13
1990	0.78	0.08	1.06	0.10					0.80	0.08	1.04	0.11
1991	0.68	0.07	1.05	0.10					0.69	0.07	1.03	0.11
1992	0.54	0.05	1.09	0.11					0.55	0.06	1.07	0.11
1993	0.44	0.04	1.05	0.11	1.00	-	1.00	-	0.53	0.06	1.12	0.12
1994	1.04	0.11	0.37	0.04	2.28	0.08	1.43	0.14	1.47	0.16	0.54	0.06
1995	0.86	0.09	0.55	0.06	1.90	0.09	1.22	0.11	1.16	0.13	0.66	0.07
1996	0.77	0.09	0.30	0.04	2.64	0.08	1.68	0.11	1.46	0.16	0.54	0.06
1997	1.04	0.14	0.29	0.04	2.53	0.08	1.92	0.13	1.77	0.20	0.52	0.06
1998	1.33	0.17	0.27	0.03	2.88	0.09	1.10	0.16	1.87	0.22	0.41	0.05
1999	1.14	0.15	0.28	0.04	3.73	0.11	0.97	0.10	2.09	0.25	0.37	0.05
2000	1.39	0.17	0.21	0.03	3.69	0.09	1.09	0.11	2.21	0.26	0.36	0.04
2001	1.23	0.17	0.12	0.02	2.74	0.08	2.24	0.10	2.19	0.26	0.42	0.05
2002	1.29	0.17	0.27	0.04	3.34	0.09	0.94	0.18	2.49	0.29	0.30	0.04
2003	1.18	0.14	0.35	0.04	2.84	0.09	1.21	0.08	1.90	0.22	0.44	0.05
2004	1.36	0.15	0.25	0.03	2.19	0.11	1.19	0.11	1.72	0.21	0.39	0.05
2005	1.30	0.16	0.21	0.03	2.78	0.12	0.71	0.13	1.95	0.25	0.26	0.03
2006	1.44	0.18	0.18	0.02	2.65	0.13	0.26	0.08	1.92	0.25	0.18	0.02
2007	1.24	0.16	0.18	0.02	2.90	0.15	0.23	0.03	1.63	0.22	0.19	0.02
2008	1.56	0.22	0.11	0.01	1.83	0.25	0.08	0.03	1.91	0.28	0.10	0.01
2009	2.28	0.30	0.11	0.01	3.52	0.23	0.09	0.02	2.66	0.37	0.11	0.02
2010	1.19	0.15	0.19	0.02	2.86	0.34	0.05	0.02	1.44	0.20	0.17	0.02
2011	1.30	0.23	0.06	0.01	-	-	-	-	1.52	0.29	0.05	0.01
2012	1.03	0.15	0.12	0.02	4.06	0.38	0.03	0.00	1.28	0.20	0.11	0.02
2013	0.67	0.09	0.17	0.02	-	-	-	-	0.85	0.13	0.13	0.02
2014	0.51	0.09	0.08	0.01	-	-	-	-	0.70	0.13	0.06	0.01
2015	0.46	0.08	0.08	0.01	-	-	-	-	0.59	0.11	0.06	0.01
2016	0.68	0.34	0.005	0.002	-	-	-	-	0.93	0.52	0.00	0.002
2017	1.17	0.26	0.032	0.007	-	-	-	-	1.31	0.32	0.03	0.01
2018	1.80	0.43	0.020	0.005	-	-	-	-	2.18	0.58	0.02	0.004
2019	2.84	0.52	0.037	0.007	-	-	-	-	3.24	0.65	0.03	0.006
2020	3.11	0.46	0.068	0.010	-	-	-	-	3.87	0.62	0.05	0.009
2021*	2.28	0.44	0.069	0.013	-	-	-	-	2.91	0.61	0.05	0.011

* Until June 30th

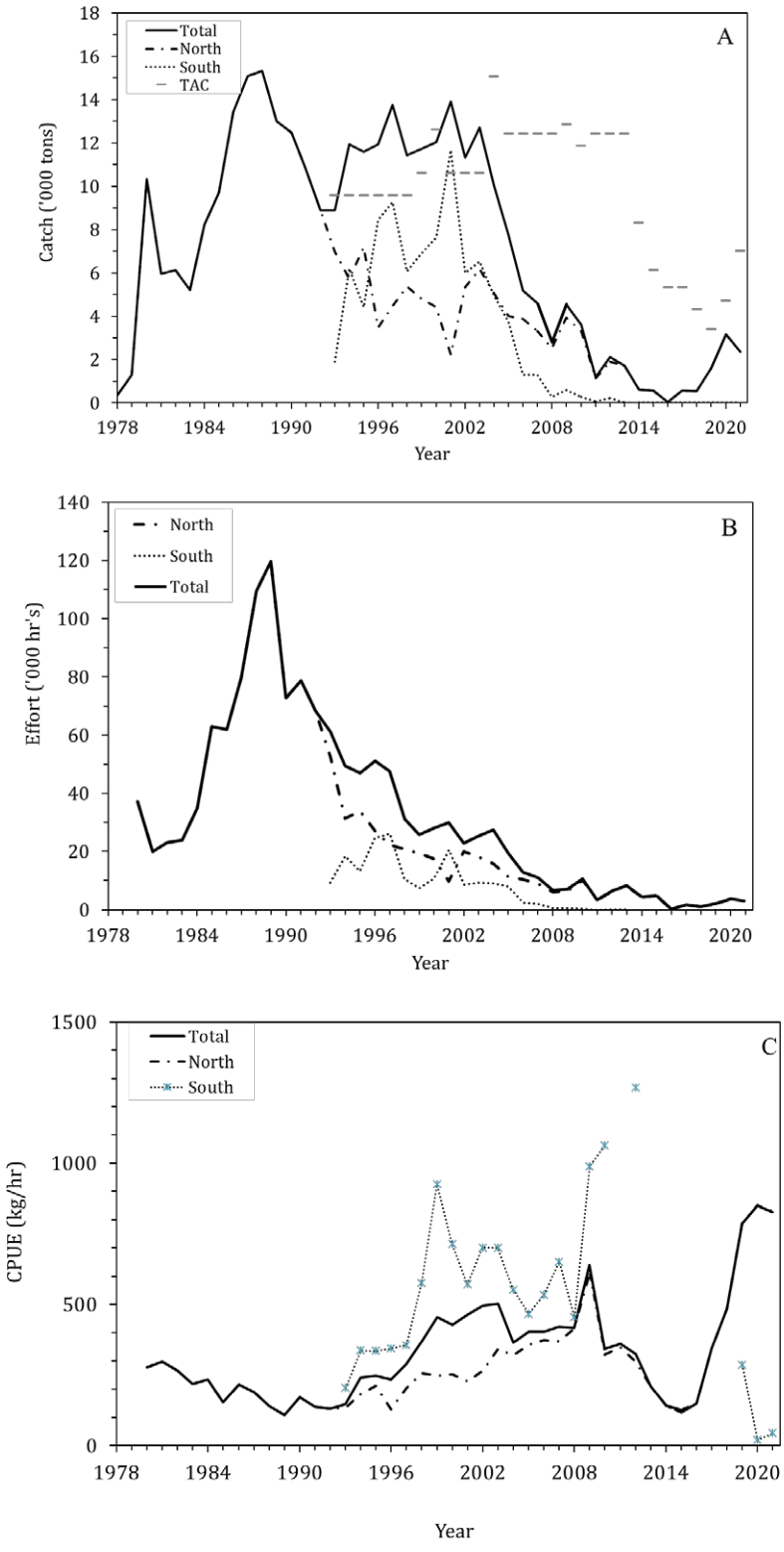

Figure 1. Catch (A), fishing effort (B) and catch-per-unit-effort (C) by shrimp trawlers fishing in Denmark Strait/off East Greenland. Series are given for the areas north and south of 65°N and overall. (Data for 2021 is part-years data, until June 30th).

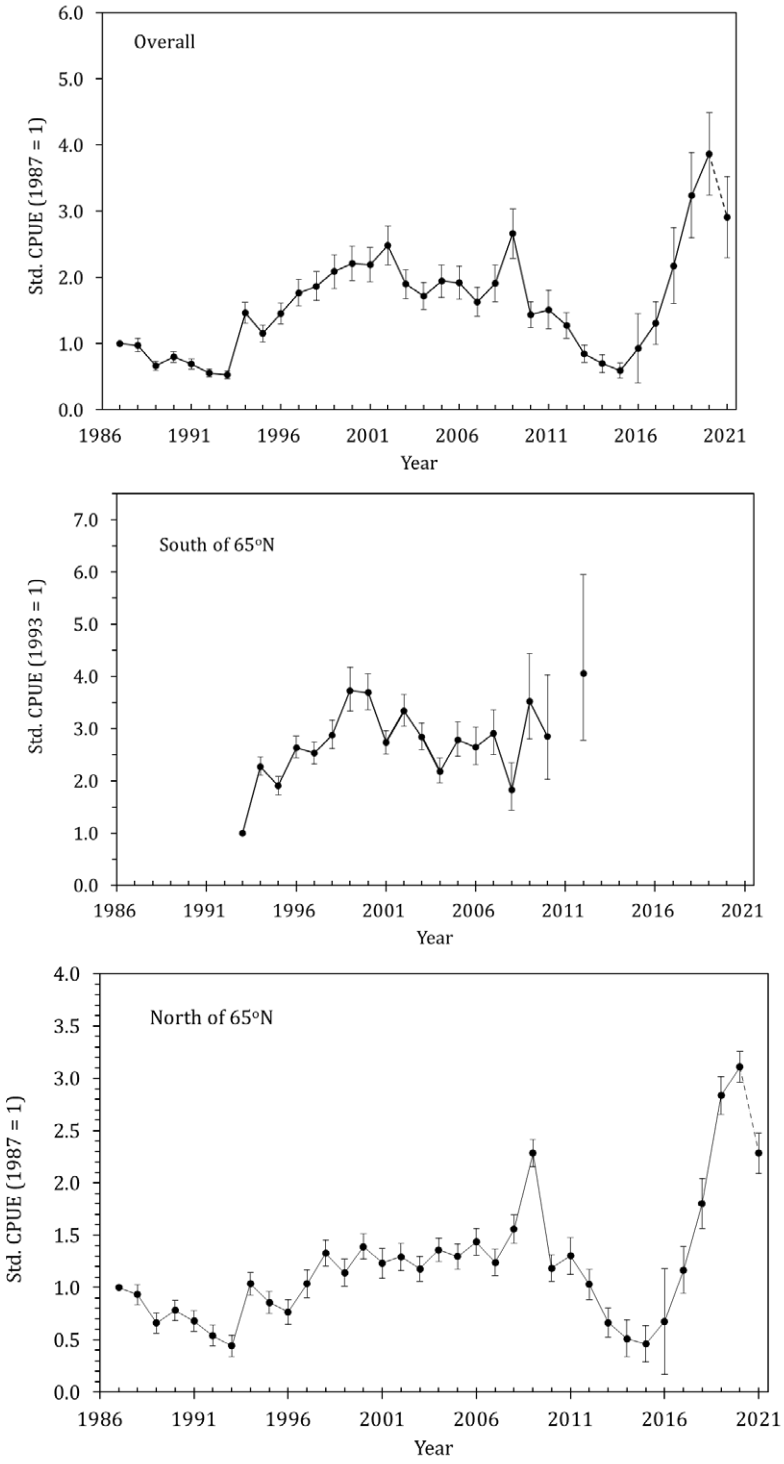

Figure 2. Standardized Catch-Per-Unit-Effort indices of the shrimp fishery in Denmark Strait and off East Greenland in the areas south of 65°N, overall fishery north of 65°N (both in Greenland and Iceland EEZ), and overall standardized CPUE for the stock (Estimates for 2021 are based on data until June 30th). No index for the southern area has been calculated since 2012 due to a low number of hauls (less than 10 each year).

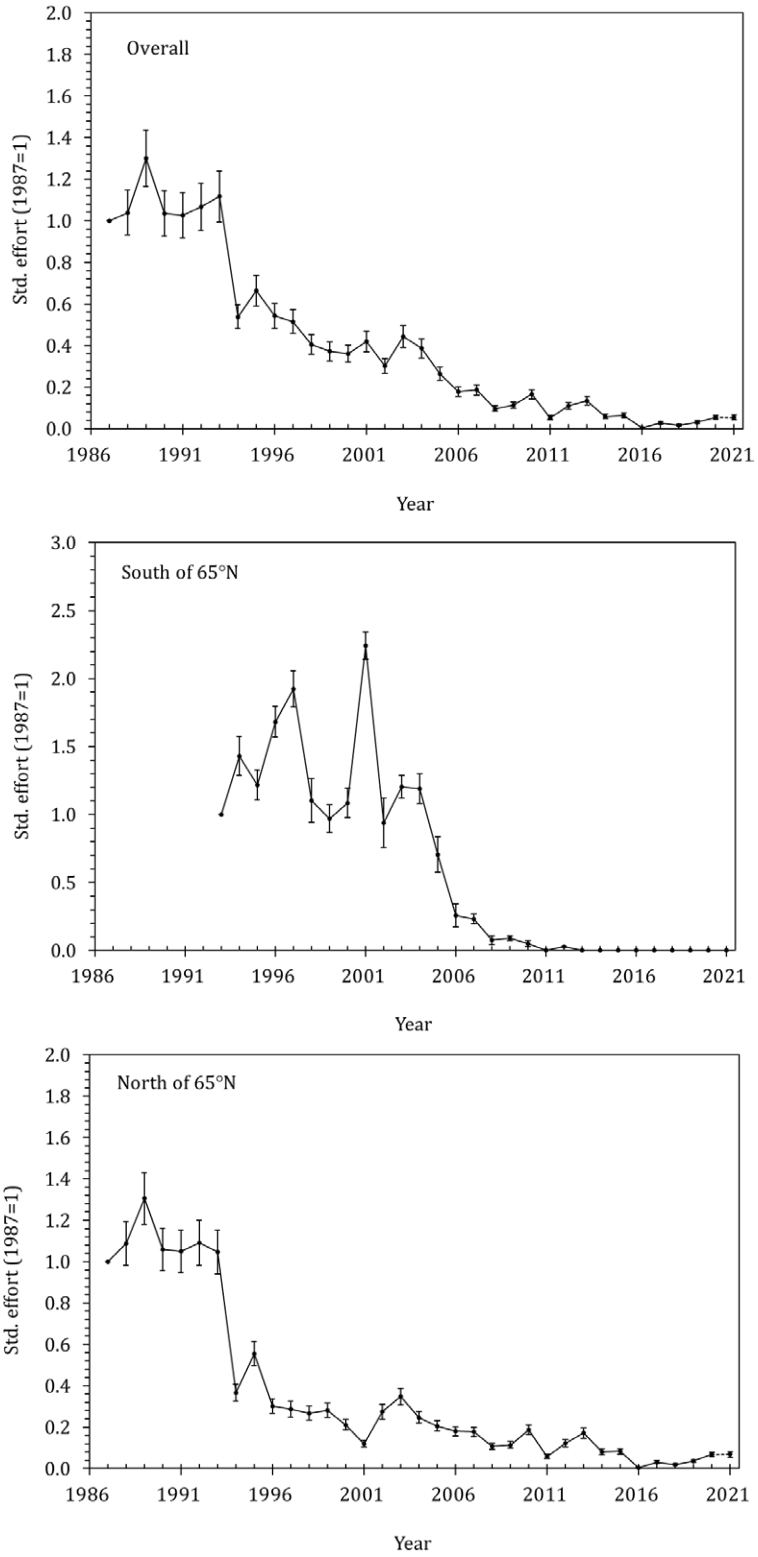

Figure 3. Standardised effort indices of the shrimp fishery in Denmark Strait and off East Greenland in the areas north of 65°N, south of 65°N and overall (Estimates for 2021 are based on data until June 30th).

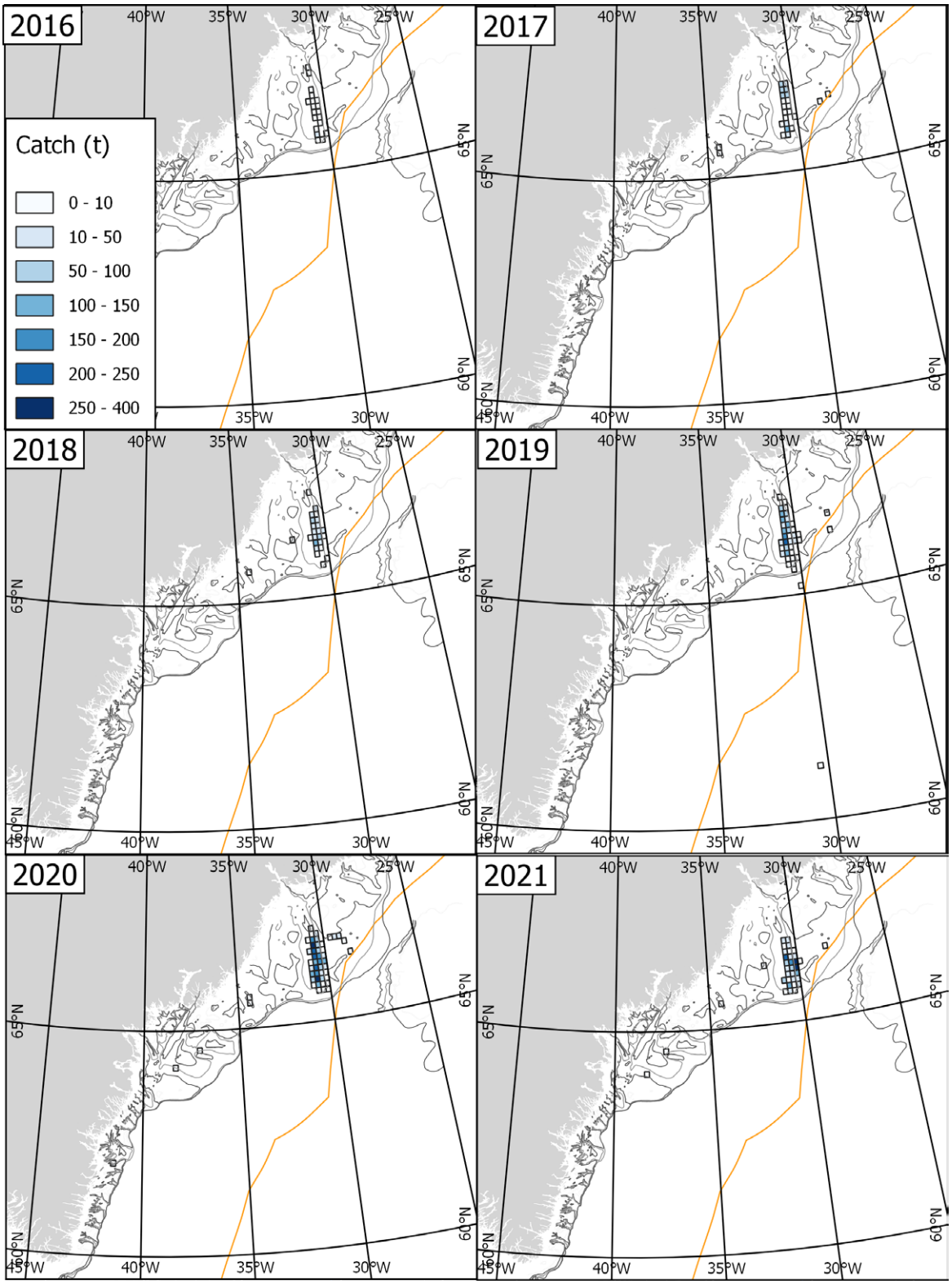

Figure 4a. Thematic mapping of different levels of catch in the shrimp fishery in Denmark Strait/off East Greenland 2016-2021 (2021 until July). Grey lines show depths of 200, 300, 400 and 600 m. Yellow line shows EEZ boundary.

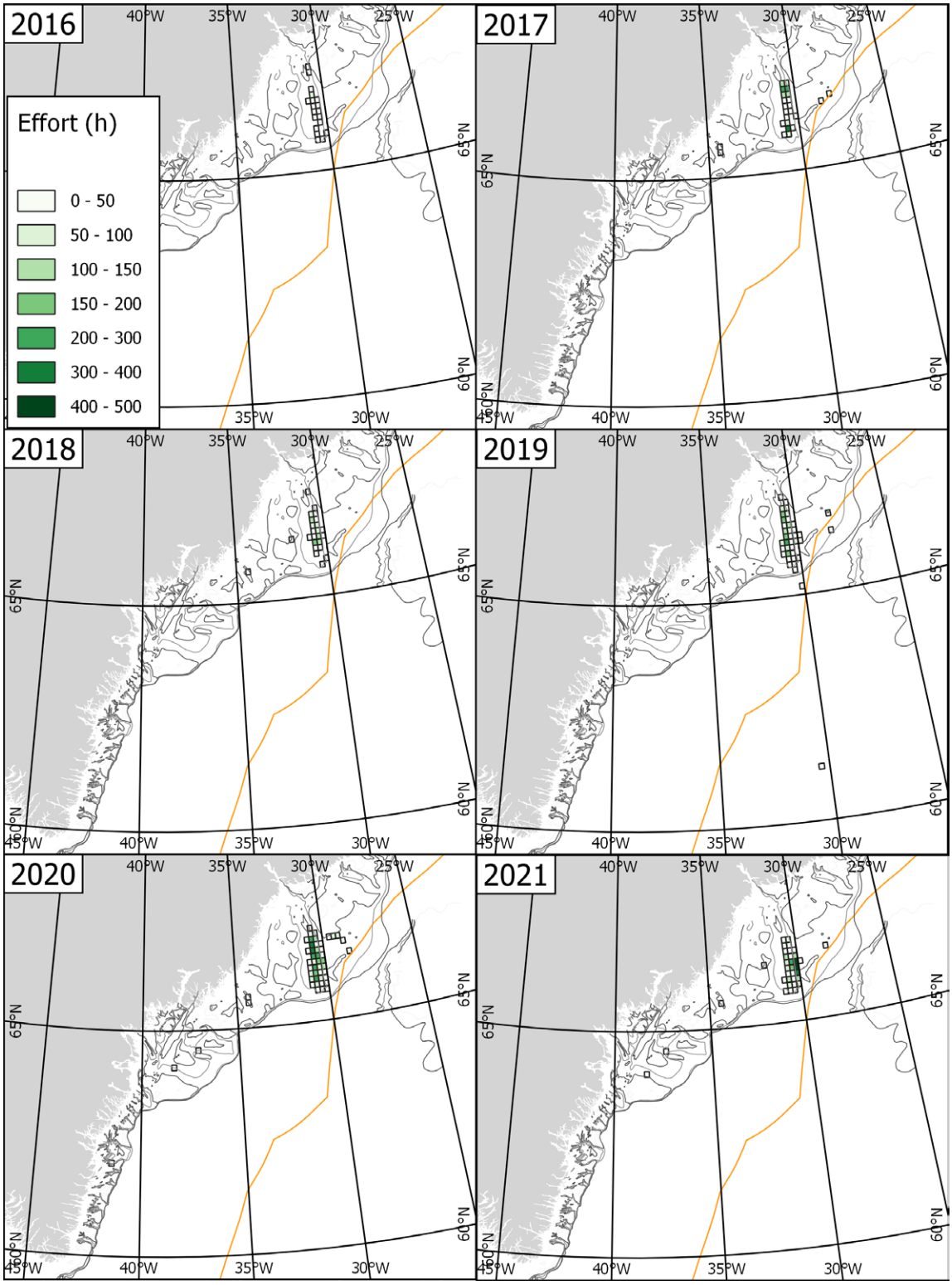

Figure 4b. Thematic mapping of different levels of effort in the shrimp fishery in Denmark Strait/off East Greenland 2016-2021 (2021 until July). Grey lines show depths of 200, 300, 400 and 600 m. Yellow line shows EEZ boundary.

Appendix 1. Results and diagnostical 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	111	E001 E002 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
YEAR	35	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 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 3542

Number of Observations Used 3542

The SAS System

The GLM Procedure

Dependent Variable: LNCPUE

Weight: Hauls

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	175	54864.33268	313.51047	41.31	<.0001
Error	3366	25543.24206	7.58860		
Corrected Total	3541	80407.57475			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.682328	220.0573	2.754742	1.251829

Source	DF	Type I SS	Mean Square	F Value	Pr > F
BAAD	110	32278.57015	293.44155	38.67	<.0001
YEAR*AREA	53	18155.25591	342.55200	45.14	<.0001
MONTH	11	4394.83568	399.53052	52.65	<.0001
AREA	0	0.00000	.	.	.
X	1	35.67094	35.67094	4.70	0.0302

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BAAD	110	10104.07957	91.85527	12.10	<.0001
YEAR*AREA	52	11941.25935	229.63960	30.26	<.0001
MONTH	11	4383.39900	398.49082	52.51	<.0001
AREA	1	1367.57111	1367.57111	180.21	<.0001
X	1	35.67094	35.67094	4.70	0.0302

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	-0.140537617	B	0.26831705	-0.52	0.6005
BAAD E001	0.174347210	B	0.29329622	0.59	0.5523
BAAD E002	0.252665745	B	0.29372881	0.86	0.3897
BAAD E003	0.290341475	B	0.26825178	1.08	0.2792
BAAD E004	0.238181837	B	0.28823637	0.83	0.4087

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E005	0.205076430	B	0.29236195	0.70	0.4831
BAAD E006	0.544717971	B	0.28898573	1.88	0.0595
BAAD E007	0.360002540	B	0.28484160	1.26	0.2064
BAAD E008	0.540128814	B	0.27413507	1.97	0.0489
BAAD E009	0.608009090	B	0.28875962	2.11	0.0353
BAAD E010	0.342804931	B	0.26359705	1.30	0.1935
BAAD E011	0.347399281	B	0.27089675	1.28	0.1998
BAAD E012	0.522314004	B	0.34235819	1.53	0.1272
BAAD E013	0.399419163	B	0.29064466	1.37	0.1695
BAAD E014	0.459196005	B	0.26626384	1.72	0.0847
BAAD E015	0.434237846	B	0.26886742	1.62	0.1064
BAAD E017	0.583197398	B	0.27269161	2.14	0.0325
BAAD E018	0.510525098	B	0.27111985	1.88	0.0598
BAAD E019	0.616290977	B	0.30839785	2.00	0.0458
BAAD E020	0.458463982	B	0.28914829	1.59	0.1129
BAAD E021	0.874201750	B	0.28356236	3.08	0.0021
BAAD E022	0.510265411	B	0.26746248	1.91	0.0565
BAAD E023	0.695439457	B	0.31849390	2.18	0.0291
BAAD E024	0.638507969	B	0.26285174	2.43	0.0152
BAAD E025	0.897873457	B	0.27998230	3.21	0.0014
BAAD E026	0.883165029	B	0.29234050	3.02	0.0025
BAAD E027	0.708629459	B	0.26312979	2.69	0.0071
BAAD E028	0.562858651	B	0.29510797	1.91	0.0566
BAAD E029	0.601176534	B	0.26931908	2.23	0.0257
BAAD E030	0.641150159	B	0.27035658	2.37	0.0178
BAAD E031	0.689057197	B	0.26313748	2.62	0.0089
BAAD E032	0.699128039	B	0.26596661	2.63	0.0086
BAAD E033	0.695905244	B	0.46981930	1.48	0.1386
BAAD E034	0.666217166	B	0.28456407	2.34	0.0193
BAAD E035	1.054702357	B	0.29018824	3.63	0.0003
BAAD E036	0.865843336	B	0.30557596	2.83	0.0046
BAAD E037	0.733768319	B	0.26481970	2.77	0.0056

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E038	0.945741543	B	0.27768976	3.41	0.0007
BAAD E039	1.028454699	B	0.27198156	3.78	0.0002
BAAD E040	1.060080079	B	0.27100434	3.91	<.0001
BAAD E041	0.945259482	B	0.27986351	3.38	0.0007
BAAD E042	0.983428958	B	0.27039558	3.64	0.0003
BAAD E043	0.833840708	B	0.26353671	3.16	0.0016
BAAD E044	0.903462677	B	0.26243725	3.44	0.0006
BAAD E045	0.838863963	B	0.27423649	3.06	0.0022
BAAD E046	0.808133854	B	0.26788156	3.02	0.0026
BAAD E047	0.858535570	B	0.26431897	3.25	0.0012
BAAD E048	0.868868308	B	0.26340910	3.30	0.0010
BAAD E049	0.773643237	B	0.26158304	2.96	0.0031
BAAD E050	1.102610866	B	0.27385441	4.03	<.0001
BAAD E051	0.849679957	B	0.26532086	3.20	0.0014
BAAD E052	0.882329858	B	0.26757272	3.30	0.0010
BAAD E053	0.980659375	B	0.31640571	3.10	0.0020
BAAD E054	0.874782699	B	0.26502402	3.30	0.0010
BAAD E055	1.079921590	B	0.27669377	3.90	<.0001
BAAD E056	1.241116343	B	0.26824208	4.63	<.0001
BAAD E057	0.963465260	B	0.27084291	3.56	0.0004
BAAD E058	1.023719748	B	0.29178760	3.51	0.0005
BAAD E059	1.212976189	B	0.31494809	3.85	0.0001
BAAD E060	1.100613047	B	0.27698850	3.97	<.0001
BAAD E061	1.109373913	B	0.26225969	4.23	<.0001
BAAD E062	1.018912521	B	0.26317414	3.87	0.0001
BAAD E063	1.081728614	B	0.27319022	3.96	<.0001
BAAD E064	1.081793242	B	0.26839596	4.03	<.0001
BAAD E065	1.054825508	B	0.28038108	3.76	0.0002
BAAD E066	0.965700973	B	0.29283543	3.30	0.0010
BAAD E067	0.377916539	B	0.46914434	0.81	0.4206
BAAD E068	1.070060515	B	0.30673881	3.49	0.0005
BAAD E069	1.137616214	B	0.26389895	4.31	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E070	1.231736021	B	0.26039630	4.73	<.0001
BAAD E071	1.184401135	B	0.26176430	4.52	<.0001
BAAD E072	1.175975989	B	0.29283304	4.02	<.0001
BAAD E073	1.043099112	B	0.28222804	3.70	0.0002
BAAD E074	1.193097730	B	0.26321248	4.53	<.0001
BAAD E075	1.284329725	B	0.27168309	4.73	<.0001
BAAD E076	1.181519062	B	0.26668205	4.43	<.0001
BAAD E077	1.304455813	B	0.28716794	4.54	<.0001
BAAD E078	1.298893207	B	0.26279985	4.94	<.0001
BAAD E079	1.469672167	B	0.31333509	4.69	<.0001
BAAD E080	1.318331172	B	0.29422952	4.48	<.0001
BAAD E081	1.336988117	B	0.27166399	4.92	<.0001
BAAD E082	1.387954943	B	0.34117544	4.07	<.0001
BAAD E083	1.399449250	B	0.28468008	4.92	<.0001
BAAD E085	0.425589734	B	0.32396309	1.31	0.1890
BAAD E086	-0.208427559	B	0.92297399	-0.23	0.8214
BAAD E087	1.242133668	B	0.56040382	2.22	0.0267
BAAD E088	0.239528400	B	0.35122666	0.68	0.4953
BAAD E089	0.256748987	B	0.31996124	0.80	0.4224
BAAD E090	0.485656718	B	0.36769142	1.32	0.1866
BAAD E091	0.432881163	B	0.39092101	1.11	0.2682
BAAD E092	0.126240166	B	0.35687611	0.35	0.7236
BAAD E093	-0.455261386	B	0.59452368	-0.77	0.4439
BAAD E094	0.590632337	B	0.34446183	1.71	0.0865
BAAD E096	0.744097012	B	0.37847634	1.97	0.0494
BAAD E099	0.047050274	B	0.32274250	0.15	0.8841
BAAD E100	0.629768634	B	0.78329987	0.80	0.4215
BAAD E101	1.095845456	B	0.31822715	3.44	0.0006
BAAD E102	1.488911538	B	0.32199634	4.62	<.0001
BAAD E103	1.028852538	B	0.32503095	3.17	0.0016
BAAD E104	0.774891307	B	0.33606098	2.31	0.0212
BAAD E105	1.026800538	B	0.40086584	2.56	0.0105

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E106	0.482254273	B	0.42361900	1.14	0.2550
BAAD E107	0.703862870	B	0.36808934	1.91	0.0559
BAAD E108	0.235054944	B	0.31303745	0.75	0.4528
BAAD E109	2.535243965	B	0.47947080	5.29	<.0001
BAAD E110	0.440502704	B	1.16459463	0.38	0.7053
BAAD E113	0.541538037	B	0.45057780	1.20	0.2295
BAAD E114	1.047597428	B	0.32523174	3.22	0.0013
BAAD E116	0.268851225	B	1.61225425	0.17	0.8676
BAAD E117	2.310755794	B	1.01123828	2.29	0.0224
BAAD E118	0.029280059	B	0.38234137	0.08	0.9390
BAAD E119	0.000000000	B	.	.	.
YEAR*AREA 1987 21	0.484038063	B	0.07406067	6.54	<.0001
YEAR*AREA 1988 21	0.291280577	B	0.06982163	4.17	<.0001
YEAR*AREA 1989 21	-0.097834912	B	0.06825842	-1.43	0.1519
YEAR*AREA 1990 21	0.094366589	B	0.06835496	1.38	0.1675
YEAR*AREA 1991 21	-0.081871857	B	0.06665626	-1.23	0.2194
YEAR*AREA 1992 21	-0.307534193	B	0.06928150	-4.44	<.0001
YEAR*AREA 1994 21	0.353692903	B	0.08519005	4.15	<.0001
YEAR*AREA 1994 22	0.822467507	B	0.07757607	10.60	<.0001
YEAR*AREA 1995 21	0.175084763	B	0.07696537	2.27	0.0230
YEAR*AREA 1995 22	0.644166859	B	0.09364420	6.88	<.0001
YEAR*AREA 1996 21	0.064376027	B	0.09242597	0.70	0.4862
YEAR*AREA 1996 22	0.970305696	B	0.07934089	12.23	<.0001
YEAR*AREA 1997 21	0.419583386	B	0.11816485	3.55	0.0004

Parameter	Estimate		Standard Error	t Value	Pr > |t|
YEAR*AREA 1997 22	0.928624508	B	0.08291862	11.20	<.0001
YEAR*AREA 1998 21	0.753628813	B	0.10565155	7.13	<.0001
YEAR*AREA 1998 22	1.058307259	B	0.09322342	11.35	<.0001
YEAR*AREA 1999 21	0.539829336	B	0.10933816	4.94	<.0001
YEAR*AREA 1999 22	1.316368572	B	0.11309016	11.64	<.0001
YEAR*AREA 2000 21	0.683125449	B	0.09230133	7.40	<.0001
YEAR*AREA 2000 22	1.305675028	B	0.09355012	13.96	<.0001
YEAR*AREA 2001 21	0.541102530	B	0.11446276	4.73	<.0001
YEAR*AREA 2001 22	1.006439991	B	0.08094857	12.43	<.0001
YEAR*AREA 2002 21	0.546772389	B	0.11388024	4.80	<.0001
YEAR*AREA 2002 22	1.206749223	B	0.08912608	13.54	<.0001
YEAR*AREA 2003 21	0.518668640	B	0.09165260	5.66	<.0001
YEAR*AREA 2003 22	1.044455143	B	0.09122503	11.45	<.0001
YEAR*AREA 2004 21	0.658045311	B	0.08686865	7.58	<.0001
YEAR*AREA 2004 22	0.781645348	B	0.10910524	7.16	<.0001
YEAR*AREA 2005 21	0.587487937	B	0.09421476	6.24	<.0001
YEAR*AREA 2005 22	1.023742530	B	0.11744720	8.72	<.0001
YEAR*AREA 2006 21	0.687226838	B	0.09904581	6.94	<.0001
YEAR*AREA 2006 22	0.973897572	B	0.13329205	7.31	<.0001
YEAR*AREA	0.539312053	B	0.09932808	5.43	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
2007 21					
YEAR*AREA 2007 22	1.066203930	B	0.14709929	7.25	<.0001
YEAR*AREA 2008 21	0.765534564	B	0.11172542	6.85	<.0001
YEAR*AREA 2008 22	0.605971414	B	0.24627119	2.46	0.0139
YEAR*AREA 2009 21	1.150241961	B	0.10416706	11.04	<.0001
YEAR*AREA 2009 22	1.259697105	B	0.23062651	5.46	<.0001
YEAR*AREA 2010 21	0.496634297	B	0.09752738	5.09	<.0001
YEAR*AREA 2010 22	1.049496607	B	0.34392849	3.05	0.0023
YEAR*AREA 2011 21	0.568032061	B	0.14954387	3.80	0.0001
YEAR*AREA 2012 21	0.348018494	B	0.11782255	2.95	0.0032
YEAR*AREA 2012 22	1.401651729	B	0.38107484	3.68	0.0002
YEAR*AREA 2013 21	-0.088438572	B	0.11488396	-0.77	0.4415
YEAR*AREA 2014 21	-0.364763743	B	0.15237476	-2.39	0.0167
YEAR*AREA 2015 21	-0.465577480	B	0.14871705	-3.13	0.0018
YEAR*AREA 2016 21	-0.391187793	B	0.44975061	-0.87	0.3845
YEAR*AREA 2017 21	0.428686506	B	0.20141693	2.13	0.0334
YEAR*AREA 2018 21	0.853427215	B	0.21452049	3.98	<.0001
YEAR*AREA 2019 21	1.342997057	B	0.15784890	8.51	<.0001
YEAR*AREA 2020 21	1.450829618	B	0.12360479	11.74	<.0001
YEAR*AREA 2021 21	1.122058940	B	0.16617491	6.75	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
YEAR*AREA 9999 21	-0.516988723	B	0.07208023	-7.17	<.0001
YEAR*AREA 9999 22	0.000000000	B	.	.	.
MONTH 1	0.329095797	B	0.02960977	11.11	<.0001
MONTH 2	0.300389141	B	0.02948704	10.19	<.0001
MONTH 3	0.177524774	B	0.03053579	5.81	<.0001
MONTH 4	0.158610288	B	0.03565176	4.45	<.0001
MONTH 5	0.087270003	B	0.04045658	2.16	0.0311
MONTH 6	-0.080650550	B	0.07471279	-1.08	0.2805
MONTH 7	0.339021311	B	0.07196616	4.71	<.0001
MONTH 8	0.060460803	B	0.05233410	1.16	0.2481
MONTH 9	-0.270085530	B	0.05053273	-5.34	<.0001
MONTH 10	-0.260131078	B	0.04348306	-5.98	<.0001
MONTH 11	-0.259483668	B	0.03721322	-6.97	<.0001
MONTH 12	0.000000000	B	.	.	.
AREA 21	0.000000000	B	.	.	.
AREA 22	0.000000000	B	.	.	.
X 2	0.064677819	B	0.02983177	2.17	0.0302
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 diagnostical outputs from GLM run of model without area interaction for standardising CPUE in Greenlandic zone. Data from Greenlandic, Faeroese, Norway and EUvessels.

The SAS System

The GLM Procedure

Class Level Information

Class	Levels	Values
BAAD	118	E001 E002 E003 E004 E005 E006 E007 E008 E009 E010 E011 E012 E013 E014 E015 E016 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 E084 E085 E086 E087 E088 E089 E090 E091 E092 E093 E094 E096 E097 E098 E099 E100 E101 E102 E103 E104 E105 E106 E107 E108 E109 E110 E111 E112 E113 E114 E115 E116 E117 E118 E119
YEAR	42	1980 1981 1982 1983 1984 1985 1986 1988 1989 1990 1991 1992 1993 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 9999
MONTH	12	1 2 3 4 5 6 7 8 9 10 11 12
X	2	2 9

Number of Observations Read 4151

Number of Observations Used 4151

The SAS System

The GLM Procedure

Dependent Variable: LNCPUE

Weight: Hauls

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	170	62848.18087	369.69518	41.59	<.0001
Error	3980	35375.45854	8.88831		
Corrected Total	4150	98223.63940			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.639848	224.8960	2.981326	1.325647

Source	DF	Type I SS	Mean Square	F Value	Pr > F
BAAD	117	38549.95614	329.48680	37.07	<.0001
YEAR	41	21166.56449	516.25767	58.08	<.0001
MONTH	11	3077.69529	279.79048	31.48	<.0001
X	1	53.96495	53.96495	6.07	0.0138

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BAAD	117	17372.52340	148.48311	16.71	<.0001
YEAR	41	21419.68789	522.43141	58.78	<.0001
MONTH	11	3094.27980	281.29816	31.65	<.0001
X	1	53.96495	53.96495	6.07	0.0138

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	0.230806965	B	0.19925992	1.16	0.2468
BAAD E001	-0.060653466	B	0.24007870	-0.25	0.8006
BAAD E002	0.239468156	B	0.24459576	0.98	0.3276
BAAD E003	0.332076120	B	0.20862544	1.59	0.1115
BAAD E004	0.348828550	B	0.22479554	1.55	0.1208
BAAD E005	0.374173877	B	0.24304241	1.54	0.1238
BAAD E006	0.399961880	B	0.23709195	1.69	0.0917

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E007	0.439650408	B	0.23204679	1.89	0.0582
BAAD E008	0.468939055	B	0.21580936	2.17	0.0298
BAAD E009	0.480193032	B	0.23727084	2.02	0.0431
BAAD E010	0.480913183	B	0.19972834	2.41	0.0161
BAAD E011	0.507587689	B	0.21198601	2.39	0.0167
BAAD E012	0.514988288	B	0.30917443	1.67	0.0959
BAAD E013	0.562718974	B	0.24034467	2.34	0.0193
BAAD E014	0.570686723	B	0.20506232	2.78	0.0054
BAAD E015	0.600627211	B	0.20888633	2.88	0.0041
BAAD E016	0.635862824	B	0.23048097	2.76	0.0058
BAAD E017	0.639825567	B	0.21512081	2.97	0.0030
BAAD E018	0.640442521	B	0.21212023	3.02	0.0026
BAAD E019	0.649824920	B	0.24997843	2.60	0.0094
BAAD E020	0.651709424	B	0.23845235	2.73	0.0063
BAAD E021	0.662906555	B	0.22798570	2.91	0.0037
BAAD E022	0.679233566	B	0.20479500	3.32	0.0009
BAAD E023	0.682855069	B	0.27757087	2.46	0.0139
BAAD E024	0.703246196	B	0.20048244	3.51	0.0005
BAAD E025	0.758591686	B	0.22446705	3.38	0.0007
BAAD E026	0.780820366	B	0.24274040	3.22	0.0013
BAAD E027	0.760220368	B	0.20091625	3.78	0.0002
BAAD E028	0.770481304	B	0.24196127	3.18	0.0015
BAAD E029	0.779809222	B	0.20961383	3.72	0.0002
BAAD E030	0.789846803	B	0.21117075	3.74	0.0002
BAAD E031	0.806852477	B	0.19992537	4.04	<.0001
BAAD E032	0.819177474	B	0.20460163	4.00	<.0001
BAAD E033	0.819532262	B	0.46184535	1.77	0.0761
BAAD E034	0.827599207	B	0.23216181	3.56	0.0004
BAAD E035	0.871395672	B	0.23905660	3.65	0.0003
BAAD E036	0.869759280	B	0.26149509	3.33	0.0009
BAAD E037	0.880706884	B	0.20296290	4.34	<.0001
BAAD E038	0.914502692	B	0.22194527	4.12	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E039	0.918112166	B	0.21343034	4.30	<.0001
BAAD E040	0.925724394	B	0.21151588	4.38	<.0001
BAAD E041	0.923552860	B	0.22493494	4.11	<.0001
BAAD E042	0.939410436	B	0.21141004	4.44	<.0001
BAAD E043	0.928315599	B	0.20157850	4.61	<.0001
BAAD E044	0.972727928	B	0.19972667	4.87	<.0001
BAAD E045	0.969253229	B	0.21164108	4.58	<.0001
BAAD E046	0.969755954	B	0.20753546	4.67	<.0001
BAAD E047	0.974820093	B	0.20248040	4.81	<.0001
BAAD E048	0.992469342	B	0.20094970	4.94	<.0001
BAAD E049	1.000970093	B	0.19779096	5.06	<.0001
BAAD E050	1.036236619	B	0.21631980	4.79	<.0001
BAAD E051	1.025788402	B	0.20352067	5.04	<.0001
BAAD E052	1.028909819	B	0.20561461	5.00	<.0001
BAAD E053	1.033343772	B	0.27583519	3.75	0.0002
BAAD E054	1.050637579	B	0.20327043	5.17	<.0001
BAAD E055	1.111463802	B	0.21901634	5.07	<.0001
BAAD E056	1.238337116	B	0.20829293	5.95	<.0001
BAAD E057	1.153732884	B	0.20839947	5.54	<.0001
BAAD E058	1.159629346	B	0.24274840	4.78	<.0001
BAAD E059	1.260884821	B	0.25888044	4.87	<.0001
BAAD E060	1.170925681	B	0.22094291	5.30	<.0001
BAAD E061	1.235905124	B	0.19910115	6.21	<.0001
BAAD E062	1.238026465	B	0.20051713	6.17	<.0001
BAAD E063	1.249381236	B	0.20514895	6.09	<.0001
BAAD E064	1.303951756	B	0.20735932	6.29	<.0001
BAAD E065	1.320979603	B	0.22259478	5.93	<.0001
BAAD E066	1.348373121	B	0.23480796	5.74	<.0001
BAAD E067	1.374041857	B	0.38261353	3.59	0.0003
BAAD E068	1.172676952	B	0.26238010	4.47	<.0001
BAAD E069	1.377516583	B	0.20065573	6.87	<.0001
BAAD E070	1.389849317	B	0.19596686	7.09	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E071	1.426343930	B	0.19824186	7.19	<.0001
BAAD E072	1.439862763	B	0.23381080	6.16	<.0001
BAAD E073	1.445058866	B	0.22007400	6.57	<.0001
BAAD E074	1.466177796	B	0.20047118	7.31	<.0001
BAAD E075	1.513536174	B	0.21139371	7.16	<.0001
BAAD E076	1.516341998	B	0.20504920	7.40	<.0001
BAAD E077	1.504214834	B	0.23045209	6.53	<.0001
BAAD E078	1.565176729	B	0.19950714	7.85	<.0001
BAAD E079	1.573055432	B	0.27159036	5.79	<.0001
BAAD E080	1.640741013	B	0.23486186	6.99	<.0001
BAAD E081	1.662607244	B	0.20775601	8.00	<.0001
BAAD E082	1.784361576	B	0.28705728	6.22	<.0001
BAAD E083	1.902515764	B	0.21508743	8.85	<.0001
BAAD E084	3.191987774	B	1.73312160	1.84	0.0656
BAAD E085	0.450299364	B	0.28450782	1.58	0.1136
BAAD E086	0.027473199	B	0.97805554	0.03	0.9776
BAAD E087	1.333708365	B	0.57194414	2.33	0.0198
BAAD E088	-0.256699237	B	0.31659731	-0.81	0.4175
BAAD E089	0.143297013	B	0.27964127	0.51	0.6084
BAAD E090	0.483594853	B	0.34244283	1.41	0.1580
BAAD E091	0.205931403	B	0.36983980	0.56	0.5777
BAAD E092	-0.045997761	B	0.32584221	-0.14	0.8877
BAAD E093	-0.585647717	B	0.60866556	-0.96	0.3360
BAAD E094	0.382357367	B	0.31080227	1.23	0.2187
BAAD E096	0.813261637	B	0.35651377	2.28	0.0226
BAAD E097	1.882455055	B	1.73405156	1.09	0.2777
BAAD E098	2.073596135	B	2.98783720	0.69	0.4877
BAAD E099	0.220990216	B	0.28423936	0.78	0.4369
BAAD E100	0.313400346	B	0.82190456	0.38	0.7030
BAAD E101	1.289600899	B	0.27833732	4.63	<.0001
BAAD E102	1.722225978	B	0.28337281	6.08	<.0001
BAAD E103	1.198719061	B	0.28757911	4.17	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
BAAD E104	0.760568200	B	0.30266826	2.51	0.0120
BAAD E105	1.224745731	B	0.38337909	3.19	0.0014
BAAD E106	0.685680119	B	0.41128324	1.67	0.0956
BAAD E107	0.926813927	B	0.34302346	2.70	0.0069
BAAD E108	0.421174221	B	0.27152630	1.55	0.1209
BAAD E109	2.635581293	B	0.47678691	5.53	<.0001
BAAD E110	0.496129465	B	1.24375560	0.40	0.6900
BAAD E111	2.853791058	B	2.98779551	0.96	0.3396
BAAD E112	0.881617764	B	0.83824450	1.05	0.2930
BAAD E113	0.592362540	B	0.44383462	1.33	0.1821
BAAD E114	0.896517105	B	0.28683647	3.13	0.0018
BAAD E115	0.449977920	B	0.33710008	1.33	0.1820
BAAD E116	0.383058487	B	1.73297956	0.22	0.8251
BAAD E117	2.463613944	B	0.54366349	4.53	<.0001
BAAD E118	0.192123419	B	0.36412631	0.53	0.5978
BAAD E119	0.000000000	B	.	.	.
YEAR 1980	0.386610412	B	0.27480189	1.41	0.1595
YEAR 1981	0.390067574	B	0.25609450	1.52	0.1278
YEAR 1982	-0.059863249	B	0.58089821	-0.10	0.9179
YEAR 1983	0.223611025	B	0.30917529	0.72	0.4696
YEAR 1984	0.757557041	B	0.25194658	3.01	0.0027
YEAR 1985	0.234891105	B	0.12165568	1.93	0.0536
YEAR 1986	0.287103546	B	0.06933947	4.14	<.0001
YEAR 1988	-0.180571465	B	0.04830283	-3.74	0.0002
YEAR 1989	-0.600624294	B	0.04874563	-12.32	<.0001
YEAR 1990	-0.382500950	B	0.04867352	-7.86	<.0001
YEAR 1991	-0.545708630	B	0.04897678	-11.14	<.0001
YEAR 1992	-0.777697841	B	0.05443900	-14.29	<.0001
YEAR 1993	-0.821790863	B	0.05483551	-14.99	<.0001
YEAR 1994	0.234227735	B	0.05688217	4.12	<.0001
YEAR 1995	-0.010421855	B	0.05622471	-0.19	0.8530
YEAR 1996	0.239460396	B	0.05780699	4.14	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
YEAR 1997	0.468883162	B	0.06340153	7.40	<.0001
YEAR 1998	0.565704145	B	0.06990528	8.09	<.0001
YEAR 1999	0.671056154	B	0.07788930	8.62	<.0001
YEAR 2000	0.662549022	B	0.06910835	9.59	<.0001
YEAR 2001	0.634723498	B	0.06790622	9.35	<.0001
YEAR 2002	0.779652058	B	0.07309870	10.67	<.0001
YEAR 2003	0.523022381	B	0.06952430	7.52	<.0001
YEAR 2004	0.404068739	B	0.07363270	5.49	<.0001
YEAR 2005	0.506230994	B	0.07968687	6.35	<.0001
YEAR 2006	0.489041078	B	0.08484558	5.76	<.0001
YEAR 2007	0.328579554	B	0.08724520	3.77	0.0002
YEAR 2008	0.479346988	B	0.10435168	4.59	<.0001
YEAR 2009	0.814891105	B	0.09728991	8.38	<.0001
YEAR 2010	0.203534078	B	0.09184609	2.22	0.0267
YEAR 2011	0.226189131	B	0.15414871	1.47	0.1424
YEAR 2012	0.071867041	B	0.11520123	0.62	0.5328
YEAR 2013	-0.334461996	B	0.11348085	-2.95	0.0032
YEAR 2014	-0.549374499	B	0.15656942	-3.51	0.0005
YEAR 2015	-0.712493612	B	0.15214184	-4.68	<.0001
YEAR 2016	-0.622059854	B	0.48388767	-1.29	0.1987
YEAR 2017	0.044787325	B	0.21093834	0.21	0.8319
YEAR 2018	0.540320345	B	0.22678028	2.38	0.0172
YEAR 2019	0.980164062	B	0.16380907	5.98	<.0001
YEAR 2020	1.177136239	B	0.12361506	9.52	<.0001
YEAR 2021	0.867255290	B	0.17290525	5.02	<.0001
YEAR 9999	0.000000000	B	.	.	.
MONTH 1	0.194402595	B	0.02985603	6.51	<.0001
MONTH 2	0.186109915	B	0.02987662	6.23	<.0001
MONTH 3	0.101606726	B	0.03101268	3.28	0.0011
MONTH 4	0.149758090	B	0.03612219	4.15	<.0001
MONTH 5	0.018806575	B	0.04150351	0.45	0.6505
MONTH 6	-0.041948977	B	0.07716712	-0.54	0.5867

Parameter	Estimate		Standard Error	t Value	Pr > |t|
MONTH 7	0.405114714	B	0.06857569	5.91	<.0001
MONTH 8	0.142435796	B	0.05075612	2.81	0.0050
MONTH 9	-0.247687788	B	0.05150019	-4.81	<.0001
MONTH 10	-0.261644859	B	0.04372212	-5.98	<.0001
MONTH 11	-0.223846882	B	0.03694835	-6.06	<.0001
MONTH 12	0.000000000	B	.	.	.
X 2	-0.076282393	B	0.03095836	-2.46	0.0138
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.