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The Fishery for Northern Shrimp (*Pandalus borealis*) off West Greenland, 1970–2022

by

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**Abstract**

The Northern shrimp (*Pandalus borealis*) occurs on the continental shelf off West Greenland in NAFO Divisions 0A and 1A–1F in depths between approximately 150 and 600 m. Greenland fishes this stock in Subarea 1, Canada in Div. 0A. The species is assessed in these waters as a single stock and managed by catch control. The fishery has been pursued over time by four fleets: Greenland small-vessel inshore; Greenland KGH offshore; Greenland recent offshore, and Canadian offshore.

Before 2000, catch peaked in 1992 at 105 000 tons but then decreased to around 80 000 tons by 1998 owing to management measures. Increases in allowed takes were subsequently accompanied by increased catches. The logbook recorded catches in 2005 and 2006, around 157 000 tons, were the highest recorded. In the following years, and because of declining biomass, catches decreased to a recent low level in 2015 at 72 256 tons. However, since 2016 catches and TACs have in line with biomass increased, and the total catches was in 2021 114 348 tons in Greenland EEZ and 221 tons in Canadian EEZ.

The enacted TAC for Greenland in 2022 is set at 113 777 tons and a TAC of 1 223 tons were set for Canada, by the Greenland Self-government. The projected catch for 2022 is set at 120 000 tons. It is expected that the Greenlandic fleet will fish little more than the TAC, due to leftovers of quota from 2021. The enacted TAC for Canada in 2022 is 16 291 tons, no fishery has been conducted yet and expected catch for 2022 is unknown.

The overall combined CPUE index fluctuated without trend by a factor of 1½ between 1976 and 1987. It then dropped precipitously to the lowest levels in the series in 1989–91, then fell to uniform lower levels until the mid-1990s. It has since increased markedly, reaching a plateau in 2004–08 of about twice its 1997 value. From 2009 to 2013, the standardised CPUE index decreased and was in 2013, 72% of the 2008 value. In the following years catch rate continuously increased to a high level in 2017, since decreasing to a 20% lower value in 2020. However, this trend stopped in 2021 where CPUE increased and preliminary data from 2022 indicated to be at a comparable high value.

According to logbook records, the early fishery was concentrated in NAFO Division 1B, but from the late 1980s the fishery spread southwards, and by 1996–98 Divisions 1C–1F were producing nearly 70% of the catches. However, these southern areas have since become less important and the fishery, which moved northwards, is now concentrated in Division 1B and 1A where more than 80% of the catches have been conducted since 2007.



## Introduction—the Fishery

The West Greenland stock of Northern shrimp (*Pandalus borealis*) is distributed on the continental shelf off West Greenland between about 60°N and about 74°N; densities are highest in water between 150 and 550 m deep. On the West Greenland shelf, the Greenland EEZ comprises NAFO Subarea 1 (Div. 1A–1F), and the Canadian EEZ is a westward bulge of the shelf across the mid-line at the eastern edge of Div. 0A, between about 67°24'N and 68°40'N. 'Shrimp Fishing Area 1' (SFA1), consisting of Div. 0A east of 60°30'W, has been defined by Canada since 1994. Its least depth is 270 m; its greatest E-W extent of waters shallower than 600 m is about 24 n.mi. The geographical fishery in Greenlandic EEZ is distributed from the South (approx. 60°N) to 76°N in the North (Fig. 4).

A bottom-trawl fishery began in Greenland inshore areas in 1935. In 1970 a multinational offshore fishery started to develop, and landings increased, to approximately 153 000 tons in 2006 (Table 1). Catches were first restricted in 1977 and the fishery has since been managed by Total Allowable Catch (TAC). TACs have at sometimes been allocated to subdivisions of the stock area in Greenland waters. This was mainly done, by limiting catches in northern areas (north variously of 72°52'N, 71°00'N, or 68°00'N). From 1993 the species has been assessed as a single stock, and since 2002 a single TAC has been enacted for NAFO Subarea 1. In NAFO Subarea 1 the fishery was limited to Greenlandic vessels from 1981 through 2002, but quotas have since been allocated to EU vessels under fisheries agreements with Greenland.

Three types of licences are issued to Greenland vessels in Subarea 1 (Fig. 1). A fleet of 8 Greenlandic offshore trawlers and 1 EU vessel, all with on-board production licences must stay 3 n.mi. outside the baseline (but can fish to the baseline between 61°N and 65°N from 1 Nov. to 31 March) and are further excluded from 5 'shrimp boxes' extending up to 47 n.mi. west from the baseline; they fish from an offshore quota. (The EU quota is also fished offshore and for the assessment is treated as part of the Greenland offshore fishery). A fleet of 21 vessels fishing on the coastal quota are vessels without production licences, which may fish anywhere, thus having privileged access to the 'shrimp boxes' and to good grounds inside the baseline in Julianehåb Bay, Disko Bay, Vaigat, and fjords. Coastal quotas are mostly restricted to vessels under 75 GRT/120 GT, but there are trawlers of several hundred tons that fish on coastal quotas. The coastal fleet generally ices its catch and lands it at shore stations for processing, and Greenland vessels with on-board production licences are also required to land 25% of their catches. The total coastal quota is fixed by law at 43% of the Greenland TAC. Individual Transferable Quotas (ITQs) were introduced in the Greenlandic fishery in 1991. Transfer of quotas between the coastal and the offshore fleet has been allowed since 2009. Vessels above 50 GRT have been required to keep fishery logbooks since 1986, and all vessels since 1997.

In earlier years, the true weight of packages produced on board was often greater than the nominal weight, which was the weight both invoiced and recorded in the logbook. This practice of 'overpacking' led to systematic underreporting. Since 2004 logbook entries have been required to correspond to live catch weight (G.H. 2003), and earlier catch data was corrected (Hvingel 2004) by 21–25%. TAC advice is based on the perceived ability of the stock to withstand reported catches, so upward adjustment of historical catch reports has led to an increase in advised TACs.

The tactical management of the Greenland fishery has been partly based on weights caught, and partly on weights traded. Even after elimination of overpacking the quota drawdowns for shrimps sold to shore stations in Greenland by any fleet component remained less than the live weight by an allowance for crushed or broken shrimps, included in the landing but not in the sale (G.H. 1996). The stock assessment, the advice, and the enacted TACs and quotas were based on analysis of live-caught weights, but quota draw downs and tactical fishery management were partly based on such, smaller, traded weights, so annual catches, recorded in logbooks as live-caught weight, were apt to exceed TACs. From 1 January 2011 quotas are required to be drawn down by the amount caught, without allowances for shrimps landed in poor condition (G.H. 2010).

However, many catches, especially those taken in shallower waters, contain some admixture of *Pandalus montagui*. Hitherto, catches of *P. montagui* have often not been distinguished in logbooks from *borealis*, especially by vessels fishing bulk shrimps for landing in Greenland, the proportion of *montagui* being estimated by sampling the catch at the point of sale. Quota drawdowns were then restricted to the estimated weight of *borealis* and logbook records could in this way still come to exceed quotas. However, *P. montagui* is now among the species protected by by-catch regulations (G.H. 2011) and logbooks should record at least estimated catches of this species (G.H. 2010).

A license holder who fishes out his quota may apply to start fishing the following year's quota from 15 November, and license holders with quotas unfished at the end of the year may apply to fish them until 30 April in the following year. These concessions can lead to accumulation of unfished quotas (G.H. 2012).

Gear restrictions in Greenland include a cod-end mesh size of at least 40 mm stretched and from 2000 sorting grids with 22-mm bar spacing to reduce fin-fish bycatch (G.H. 2011). Other measures to limit bycatch include a requirement to move at least 5 n.mi. if bycatch exceeds 5% of the catch (G.H. 2011).

Regulations now in force in Greenland to protect bottom habitats (G.H. 2011) include the use of rolling rockhopper ground gear, and toggle chains of 72 mm or longer to keep trawl netting off the bottom. Waters between 64°10'N and 65°15'N from the shore to 3 n.mi. outside the baseline (comprising about 650 n.mi.<sup>2</sup>), an area in which there are high concentrations of sponge and coral beds, have been closed to shrimp trawling. Vessels are required to report live coral catches of 60 kg or more and live sponge catches of 800 kg or more to the Licensing Authority and to move a minimum of 2 n.mi. from any place at which such catches are taken before continuing to fish. In addition, the authorities have authority to close areas which can be considered 'vulnerable marine areas'. 'New fishing areas' in West Greenland have been defined as lying North of 74°N and special regulations are in force for protecting vulnerable habitats there. Nevertheless, back in the mid and late 80's, a shrimp fishery has been conducted at the east side of Isfeld banke.

The fishery in SFA 1 is restricted to Canadian vessels. From 1996 to 2007 on average about 8 vessels (range 5–12) participated. Since then, the number of ships has varied, with 0 to 2 ships fishing in 2008-2009 and 2012-2013, 7 ships fishing in 2010 and 10 ships fishing in 2011. Only few vessels have been fishing in that area in the most recent year. Catches are nominally subject to individual quotas; a quota can be retroactively adjusted to cover an overrun, with a corresponding correction in a later year. Logbooks from the Canadian fishery in SFA1 have been available from 1979 to 2011 and only aggregated catch data from 2010 - 2021. The geographical distribution of the effort has been unknown over the past years, due to the lack access to the Canadian logbooks.

For the Canadian fishery in SFA 1 observer logbooks record all catches, including non-target species, in detail, as well as technical details of each set. Minimum mesh sizes ranging from 24 to 52 mm have been used, but 89% of catches have been taken with 40–46 mm mesh; 63% with 42, 43 or 45 mm. Since 1993, grates with bar spacing from 19 to 55 mm have been used, but 83% of catches (with bar spacing recorded) have been taken with bar spacing's of 22 or 28 mm, and 93% with spacing's in that range.

There is no procedure or formula agreed between the two range states, Greenland and Canada, for setting or sharing a TAC on the stock. Instead, they set TACs independently. The Greenland Government has instituted a practice of deciding on a TAC for the entire stock and setting aside a part of that TAC (1%) to allow for the Canadian interest, the proportion being reckoned based on habitat area, recent catches, and recent survey estimates of stock biomass in the respective EEZs. The EU quota is also deducted from the Greenland TAC before dividing the remainder between the coastal fleet (43%) and the offshore fleet (57%) quotas.

## Material and Methods

### Fleet Data

Logbook records were analysed to follow the recent development of the fleet and the fishery. Two Greenland fleets were defined. Vessels were classified as 'offshore' or 'coastal' from information including license type and tonnage, but mostly relying on the mapping of fishing positions (Fig. 4a,b). Coastal vessels fish mostly in statistical Areas 1 (Disko Bay), 2 (Vaigat), 3 (Disko Bay mouth) and 13 (Julianehåb Bay), and in statistical Area 7 (the Holsteinsborg Deep), they fish east of about 54°W into the coast and fjords (Fig. 4a,b). Offshore vessels do not have permission to fish in statistical Areas 1, 2 and part of statistical Area 13, but fish in statistical Areas 4 and 6 north and west of Store Hellefiske Banke. In statistical Area 7 they fish west of about 54°W. Only the offshore fleet fishes in statistical Area 0 and -1 (Fig. 4b). Both fleets' fish in statistical Areas 8–12, but the offshore fleet more than the coastal fleet, and only the offshore fleet are fishing in statistical Area 0 and -1.

The number of vessels providing logbook data for the West Greenland fishery was used to track fleet size, and the distribution of catches between vessels was assessed by an 'effective' fleet size calculated using Simpson's

(1949) diversity index  $D = 1 / \sum_i p_i^2$  where  $p_i$  is the proportion of the total catch taken by the  $i^{\text{th}}$  vessel. If

this index is much lower than the nominal fleet size, it indicates large differences in annual catch between different vessels, while if it is close to the nominal fleet size, all ships are catching about the same amount. Nominal and effective fleet sizes were calculated for the offshore and coastal fleets separately and for the total fleet (Fig. 1).

### Catch Data

Sources for catch data comprised: STATLANT 21A (sum of 'N Prawn' and 'Shrimps (NS)'); weekly and annual summaries of quota drawdowns ('kvotetræk') from the Greenlandic Fishery and Licence Control (GFLK); logbooks from vessels fishing in Greenlandic waters; and the Canadian Atlantic 'Quota Reports' from the website of the Canadian Department of Fisheries and Oceans (Kingsley 2007) as well as the private version distributed by Wojciech Walkusz, DFO. These sources are all (on-line) electronic databases, not printed documents, and are therefore labile; audit trails, if they exist, are not easily accessible. For years up to 1998, the catch series for the Greenland fishery was taken from existing SCR Documents, incorporating a correction for earlier overpacking (Kingsley 2007). For 1999 to 2001, STATLANT 21A data fetched in July 2007 was corrected for overpacking using the correction factors of SCR 03/74 (Hvingel 2003). For 2002 and 2003, Greenland logbooks were used as the source of catch data, again using correction factors for overpacking. This catch series for 1999 to 2003 was close to the values used in SCR 04/75 (Hvingel 2004). For years from 2004 on, Greenland logbooks were used without correction.

For analyzing CPUE data and standardising CPUE series, the following catch correction measures were used:

- the coastal fleet of small vessels, which land iced raw shrimps for processing by shore stations, was assumed not to have changed its practices as a result of the 2004 change in the laws, and no correction was applied.
- for the sea-going fleet, for which summary statistics were available as 'large' 'small' and 'unsorted', a correction of 15% was applied to reported catches of 'large' shrimp before 2004 and of 42% to catches of 'small' and 'unsorted'.

Up to 2006, no catch corrections had been used in standardising CPUE series, and in 2007 an overall average catch correction had been applied to all catches from both fleets.

The Canadian fishery in SFA1 has 100% observer coverage, and a comprehensive data record based on observer logbooks was provided in August 2013 by T. Siferd. However, from 2011 no logbook data from the Canadian fishery in SFA1 have been available.

### CPUE Analyses

Catch and effort data from logbooks are analysed with standard linear models to create fleet-specific series of annual catch-per-unit-effort (CPUE) indices, standardised for changes in fleet composition and fishing power and for variation in the distribution of the fishery. These were combined to give a single standard CPUE series as an index of the biomass densities available to the fishery.

CPUE was analysed separately for four different fleets (Hvingel *et al.*, 2000). The 'KGH index' was derived from catches in the early offshore fishery, executed by 7 sister trawlers (722 GRT) operated by Den Kongelige Grønlandske Handel (KGH—the Royal Greenland Trading Company). This fishery only covered Div. 1A and part of Div. 1B and data from statistical Areas 3, 4, 6 and 7 (Fig. 4) for the years 1976–1990 was incorporated in the index. During this period, this small fleet had a near monopoly of the fishery and enjoyed fishing conditions somewhat different from those in subsequent years when the fishery became more populous. 6 of the 7 vessels were grouped; months were reduced to 10 levels and statistical Areas 4, 6 and 7 were combined. This analysis was not repeated and results from Hvingel (2004) were incorporated into the present analysis.

Catch and effort data from Greenlandic vessels above 50 GRT fishing in Subarea 1 was used in calculating CPUE indices for the more recent fishery. Standardised series of annual CPUE indices were obtained by analysing catch and effort data with multiplicative models that included the following effects: (1) a vessel effect (its fishing power, and the skill of its men), (2) a month effect (seasonal fishability of the shrimp and the fishing grounds), (3) an area effect and (4) a year effect (overall year-to-year changes in CPUE). All vessels of participation in the fishery are included in the model. Statistical Areas were defined *ad hoc* based on distinct fishing grounds (Fig. 4). The multiplicative model was linearised as:

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

where  $\text{CPUE}_{mjki}$  is the observed (logbook) mean CPUE for vessel (or vessel class)  $k$ , fishing in area  $m$  in month  $j$  in year  $i$ ;  $\ln(u)$  is overall mean  $\ln(\text{CPUE})$ ;  $A_m$  is the area effect;  $S_j$  is the month effect;  $V_k$  is the vessel effect;  $G_h$  is the effect of gear type;  $Y_i$  is the year effect; the residuals  $\epsilon_{mjki}$  are assumed to be distributed  $N(0, \sigma^2/n)$  where  $n$  is the number of observations in the cell and  $\sigma^2$  is the residual variance. The model was fitted with SAS Proc GLM (SAS Institute 1988). Vessel effects were sorted by value, month and area effects were kept in their natural order, and then to reduce the number of empty cells in the model neighboring classes of effect variables were combined if a pairwise contrast of their effects had an  $F$  statistic less than one; however, we note that such posterior grouping of class variables based on similar effect values causes uncertainty and lead to be underestimated. The posterior grouping of class variables was dropped in 2019, as the effect on the year effect

were negligible. The year effects were then used as standardised annual CPUE indices in assessment models. They are assumed (based on the central limit theorem) to be (approximately) normally distributed.

The offshore fleet has recently been active north of 69°12'5" to 76° N and beyond, so two statistical Area 0 and Area -1 has been defined (Fig. 4) and in 2013 and 2016 respectively, was for the first time included in the GLM calculation of year effect on CPUE (for all years).

The 'Offshore' index covers the most recent 35 years of the offshore production fishery in NAFO Div. 1A to 1F. 57 vessels were included providing data since 1987. All statistical Areas – 1, 0 and 3–13 have been included in the analysis as well as the months of fishing.

Checks of keyed data files against logbooks for 2007–08 showed that double-trawl hauls were often keyed as single trawl, but the reverse error was less frequent. Double-trawling vessels in the present offshore fleet use double trawls in over 80% of hauls. Therefore, for ships with much double-trawling activity, only double-trawl data was used. This reverses earlier practice up to 2009, according to which only single-trawl data was used. Since 2007 double- and single-trawl data has been completely checked and corrected. The use of double trawl was not recorded prior to 1995, therefore, if a vessel used double trawls in 1995 and the following years, any data for the vessel prior to 1995 were not included in the CPUE analysis. In 2020 one vessel began using triple trawl and hauls taken with triple trawl is included in the CPUE index.

A 'Coastal' index was based on vessels below 80 GRT or 210 GT, which have privileged access to the inshore grounds. Some larger vessels holding coastal quotas and, according to their logbook records, fishing only in coastal areas were included in this analysis. This part of the fishery is prosecuted largely in areas around Disko Island in Div. 1A and 1B shown as statistical Areas 1, 2 and 3 in Fig. 4, but is also active in some inshore areas further south, especially in statistical Area 7 and in previous years in statistical Areas 11–13. Statistical Areas 1–3, 7 and 13 were included in the analysis.

A consolidated file of data on 61 624 hauls from the Canadian fishery in SFA 1 was available for 1979 through 2011. No Canadian logbook data have been available since 2011 resulting in removal of the Canadian CPUE index.

One unified series of standardised CPUE, covering 1976–2022 was derived by combining these three index series, considered for each year to be a set of independent estimates of how much the biomass differed from its size in the reference year, set to be 1990. For each year, the values from the several series were combined by weighting. Their reported uncertainties could be considered to comprise three factors: for each series, the overall size of the uncertainties reflects how much data there was, how well the model fitted, and generally how well the data was arranged to estimate differences from the reference year, while within the series, each value reflected how suitably the data was arranged to estimate it relative to the values for the other years. However, neither separately nor collectively did they betoken the importance of the fleet in the fishery nor how well, relative to other fleets, its catch rates should consequently be supposed to follow changes in *total* stock size. An additional weighting was therefore applied in combining the year-effects series, so

$$A_{yf} \sim N(\bar{A}_y, \sigma_{yf}^2) \text{ where } \sigma_{yf}^2 = \hat{\sigma}_{yf}^2 / w_f$$

the  $A_{yf}$ —GLM-estimated year effects for fleet  $f$ —being considered to be Normally distributed about a series of overall year effects  $\bar{A}_y$  with individual error variances  $\sigma_{yf}^2$  whose relative sizes were calculated from the individual error variances estimated by the GLM— $\hat{\sigma}_{yf}^2$ —and weights  $w_f$  assigned on the basis of the area fished by fleet  $f$ . The weights  $w_f$  for the KGH, Greenland offshore and Greenland coastal fleets were assigned as 0.376, 0.434, and 0.191. The year effects were fitted using Bayesian methods on the OpenBUGS platform and were given uninformative uniform prior distributions.

Until 2017, A Canadian CPUE index was included in the combine CPUE index. In 2018 it was decided to remove the index from the combine index, due to difficulties obtaining the logbook data and catch/effort and CPUE information from the Canadian fishery in SFA1 since 2012. Because Canadian catches in SFA1 are very low, removing this index from the combine CPUE index, have no influence on the perception of the trajectory of CPUE over time.

The standardisation method used accounts for the increase in efficiency from renewal of the fleet but does not account for technological improvements to existing vessels. Examination of records of motor power changes in the GFLK fleet database showed very few real changes in motor power. Hvingel *et al.* (2000) considered the possible effects that upgrading ships, crews, or electronics might have on CPUE series, which are always liable to be over-optimistic in respect of the historical trend of stock biomass.

### Distribution of the Fishery

To aid in interpreting the time trajectory of CPUE estimates, the distribution of the fishery and its change with time were also examined. Catch and effort were allocated to the same statistical Areas as those used for the GLM standardisation of CPUE and summed up by year and statistical Area, and by year and NAFO Division. The distribution of catch and effort between areas or Divisions was plotted and was also summarised by Simpson's diversity index to calculate an 'effective' number of statistical Areas or Divisions being fished.

### Distribution by depth

The distribution by depth of catches of *P. borealis* recorded in Greenland logbooks was analysed in 2011 for the period 1991–2010, in 5-year periods, both overall and separately for the offshore and coastal fleets (Kingsley 2011).

### Biological Sampling

Currently a minor program for sampling from the fishery for obtaining data on length, sex or weight of individual shrimps.

### *Pandalus montagui* in the West Greenland fishery

Aesop shrimp *P. montagui* occurs off West Greenland. Most *montagui* is caught in mixed catches, but mixed catches have in the past often—even usually—not been identified in logbooks, especially by the fleet fishing iced bulk shrimps. Logbook records have therefore presumably underestimated catches of *montagui* (Kingsley 2011), but the recording of *montagui* reported has improved in recent years (Nedergaard pers. comm.).

## **Results and Discussion**

### Evolution of the fishery: TACs, effort and catches

Logbook data available since 1975 gives a picture of the evolution of the fishery. The first logbook data shows a small fishery comprising 1 or 2 vessels taking small catches in a restricted area, increasing to a fleet of the 7 sister trawlers of the KGH fleet. Nominal and effective sizes of this homogeneous fleet were nearly the same (Fig. 1a). After 1984 more vessels entered the fishery and the offshore fleet became larger and more heterogeneous, reaching a peak in the late 1980s (Fig. 1b). Since then, a progressive rationalization has forced a reduction in nominal fleet numbers, and the fleet has also returned close to its initial level of homogeneity (Fig. 1).

The early logbook records from the coastal fleet, in the early 1990s, also show a small, homogeneous fleet, but this is artificial: vessels had to be under 80 tons to be in the coastal fishery, but below 50 tons didn't have to

complete logbooks, so coastal vessels submitting logbooks were all much the same size (Fig. 1c). After 1997 all trawlers had to report, so the nominal size of the coastal fleet, as shown by logbooks, quadrupled from 24 to 94. However, the small ships were catching so few shrimps that the effective size of the coastal fleet only doubled, from 16 to 33, and the effective size of the total shrimp fleet changed little (Fig. 1c). Rationalization and modernization have driven the nominal size of the coastal fleet down by 85 % since 1997, but its effective size has decreased by only 2/3, as many of the smallest vessels have left the fishery and the fleet has become less diverse (Fig. 1c).

Canada sets autonomous TACs for SFA1 that in 1991–2010 averaged 154% of the estimated survey biomass in that area (Kingsley 2011, Burmeister et al. 2014). In those 20 years, catches in SFA1 did not exceed 90% of the TAC and averaged 31% of it (Table 1). The catches therefore appear, overall, to be *de facto* unregulated; they average near to 50% of the estimated survey biomass. From 2011 to 2021 TACs for SFA1 have ranged from 8 500 to 16 291 t and in 2022 TAC was 16 219 t. Averaged estimated biomass for the entire time series is 7 500 t (Burmeister and Rig  t, 2020). Catches in 2011 – 2021 ranged from 0 to 3001 tons with an average of about 1 100 t. SFA1 is such a small proportion of the total distribution area that an unregulated fishery there seems unlikely to threaten the continued existence of the stock, given that this is not a highly migratory species. In 2011–2021 Canadian catches averaged approx. 0.4% of the estimated survey biomass in the entire stock distribution area (Burmeister et al., 2019, 2020). The projected catch for Canada from Div. 0A in 2022 is expected to be in the region of zero t (person comm. W. Walkusz, DFO Can.).

Total catch increased from about 10 000 t in the early 1970s to more than 105 000 t in 1992 (Table 1 and Fig. 2). Actions by the Greenlandic authorities to reduce effort, as well as fishing opportunities elsewhere for the Canadian fleet, caused catches to decrease to about 80 000 t by 1998. Total catches in Greenland EEZ increased to an average over 150 000 t in 2005 to 2008 but have since decreased to 72 256 t in 2015. Since 2016, the catches have been increasing in conjunction with increasing TACs and was in 2021, 114 348 t. The projected catch in Greenland EEZ for 2022 is 120 000 t.

From 1975, when the offshore fishery was well established, through 1984 annual unstandardised effort increased slightly from about 75 000 hr to about 100 000 hr (Table 1, Fig. 3). In the subsequent years the offshore fleet was considerably enlarged, and effort went up by almost a factor of three, reaching 250 000 hr in 1991–92. Unstandardised effort has since decreased to low about 80 000 hr in 2015 because of management measures, reduced activity in Div. 0A (Table 1) and a generally increased fishing efficiency. Over the past years unstandardised effort steadily increased to about 100 000 hr. in line with enhanced catches and TAC.

The trajectory of the standardised effort time series agrees with that of the unstandardised (Fig. 3). After 1992, when it reached its highest value, standardised effort decreased steadily—overall by about 35%—to a minimum in 1998–2000. The standardised effort increased by 20% from 2000 to 2002, followed by continuous decline by approximately 3% annually until 2015. Since 2018, standardized effort has been increasing, but is still below the historic value which might be due to increasing performance and technology of the trawlers (e.i, they are spending less time to catch the same amount as in the early 2000). The drop in unstandardised effort index for both the coastal and offshore fleet in 2022, is an effect of six months data (1 Jan. to 30 Jun. 2022). As shown the past years, the decline will not be pronounced when including all year around data.

### Spatial and seasonal distribution

Until 1988 the fishing grounds in Div. 1B were the most important. The offshore fishery subsequently expanded southward, and after 1990 catches in Div. 1C–D, taken together, began to exceed those in Div. 1B. However, since 1998 catch and effort in southern West Greenland have continually decreased, and since 2008 effort in Div. 1F has been virtually nil. The fishery has moved north and, since 2009, at least 80% of the total catch was taken in Div. 1A and 1B (Fig. 5a, Fig. 6, Table 3, Table 4, b).



In the more recent years most effort has been conducted in statistical Area 2 and Area 3 (Disko Bay and the mouth of Disko Bay), Area 0 (Offshore between 69°12'5 N and 74° N), Area 7 (Holsteinsborg Dyb) and West of Disko Bay (area 4 and area 5) whereas, less of 2% has been harvested in Melville Bay (area -1) (Fig. 8). In general, and for the past 15 years, more than 80% of the total catches has been harvested north of 66°N (Fig. 8, Fig. 7a, Fig. 5b)). This is consistent with results from the survey, in which the proportion of survey biomass in the northern Areas has been high since 2003 (Fig. 2b in Burmeister and Rigét 2020). Over the most recent five years, catches seem to spread over a slightly larger area, compared to 2005 – 2015 (Fig. 6a), and average mean latitude has since 2018 been stable at 67.8 deg N (Fig. 6b).

Fishing activity, happen during all months a year, but with some variation the amount of catch taken during summer and wintertime. The most recent 10 year, appears to have a more uniform seasonal distribution, where catches are somewhat divided equally between annual quarters (Table 5).

### Depth distribution

The depth distribution of catches has shifted significantly over the most recent 20 years. In 1991–1994 the median depth by weight for all catches was 347 m, and catches extended down to 547 m (99<sup>th</sup> percentile). 12 years later, in 2003–2006, the median catch was taken 100 m shallower at 247 m. The median depth for the offshore and the coastal fleets changed by almost the same. In 2007–2010 the median depth distribution for the offshore fleet increased again, nearly back to where it was in 1999–2002, but the depth distributions for catches in the coastal fleet stayed almost the same as in 2003–2006 (Fig. 10a, Fig. 10b and Fig. 10c). In the following years depth distributions of catches was continuous increasing and has in the most previous years (2015-2018) been 288 m, and is comparable to observations from 2019-2022 at 274 m.

### By-catch and discard

The logbook-reported at-sea discard of shrimps (*Pandalus borealis*), mostly for quality reasons by production trawlers, has remained less than 1% by weight of total catch throughout 1975–2021 (Table 6). However, these statistics do not include shrimps discarded for quality reasons from land processing stations ('vragrejer'). Placing observers on offshore vessels in 1991 may have improved the reporting of discard—hence an apparent increase—while an improved market for smaller shrimps may have offset a corresponding effect of observers on the reported discard of shrimps.

Bycatch of fish—especially juvenile—in small-mesh shrimp trawls was partly solved by the development of sorting grids that deflect fish, but not shrimps, out of the trawl through escape openings. In the most recent years, registered annual discards of fish have been below 1% of total shrimp catch, but fish discard reports are based on visual estimates of weight, not on physical weighing, and errors are likely. An EU project<sup>1</sup> to verify the quantity of bycatch and the accuracy reported by both captain and observer was initiated in the mid 2000'ties. It was found from observations, including the weighing of bycatch of 166 hauls on 7 vessels covering fishery in in NAFO Div. 1B–1E, that reports by captain and observer tended to agree on the bycatch weight. However, not necessarily at the correct value, but the presence of the scientific assistant probably affected the estimates made by the captain and the observer. This resulted in an improvement of the registration of bycatch and were on average larger—at 1.2–3.2% of the shrimp catch—than logbook reports on average indicate (Sünksen 2007).

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<sup>1</sup> 'CEDER: Catch, Effort and Discard Monitoring in Real Time'

### Catch per unit of effort

Logbook data for selected ships from four fleets were analysed using SAS PROC GLM (see Appendices 1–3) to give standardised series and unified by fitting a separate model. All fleets included in the analysis exploit(ed) mainly shrimp greater than 17 mm cpl. CPUEs were standardized by linearized multiplicative models including terms for vessel, month, gear type, year, and statistical area. Standardized CPUE series were done separately for three different fleets (Figure 3.3); the early offshore fleet fishing in Div. 1A and part of 1B (KGH-index, 1976-1990), the present offshore fleet fishing in Subarea 1 (1987-2022) and the coastal fleet fishing in coastal and inshore areas (1989-2022). CPUE for the Canadian fleet fishing in Div. 0A has not been updated because it is not possible to receive new logbook information from Canada. In the recent years the CPUE of the coastal fleet has slightly decreased while the CPUE of the offshore fleet increased from 2016 to 2017 and dropped little from 2018 to 2020. The declining trend has stopped and CPUE increased in 2021. The overall combined index has in the most recent years been on a high level, dropped little from 2018 – 2020, but increased in 2021 and half year data from 2022 indicating CPUE likely will remain stable (Table 2, Fig. 9).

Standardized CPUE index in the Canadian fishery in SFA1 has always varied more from year to year and has never stayed closely in step with the Greenland fleets. CPUE for the Canadian fleet fishing in Div. 0A has not been updated since 2011 because it is not possible to receive new logbook information from Canada (Table 2). Only unstandardized CPUE data has been available since 2012 and those value are considerably lower compared to unstandardized CPUE values from Greenland EEZ (Table1b and 3b).

### *Pandalus montagui*

The Aesop, or striped pink, shrimp *Pandalus montagui* is in general not highly sought after by the Greenland fishery, and few vessels catch much of it. Its presence lowers the price paid for bulk shrimps and can exclude catches from markets for the highest-quality products. Nonetheless, some vessels, sometimes, have made protracted series of catches, some large, with unusually high proportions of *montagui*. The offshore fleet records catch of *montagui*, estimated by sampling from the on-board holding tank, in logbooks. The coastal fleet fishing bulk shrimps for processing on shore has not recorded *P. montagui* in its logbooks; weights of *borealis* and *montagui* have been reckoned from catch samples taken at the point of sale. Logbook records of *montagui* catches have in the past been an underestimate, while logbook records of *borealis* catches have been an overestimate.

From 1995 logbook reports included overall annual catches of *P. montagui* in the range of about 100 tons to a 2014 peak of 4944 tons (Table 6); for 27 vessels recording catches of *P. montagui* in 2001–2010, the (under-) reported catch of *montagui* averaged under 1% of the catch of *borealis* (Kingsley 2011). In 2011 the catch of *montagui* was 2% of the catch of *borealis* which rose to 3% in 2012 and in 2013 further increased to 5%, but by-catch of *montagui* have since dropped to less than 1% since 2017 (Table 6). There were indications of increased biomass of *P. montagui* in the mid- and late 1990s (Kannevorff, 2003), but survey estimates of biomass have been low since the turn of the century (Rig  t and Burmeister 2017, Rig  t and Burmeister 2018). The effect of the fishery for *borealis* on the stock of *montagui* has not been evaluated and was of some concern. Since 2012 *P. montagui* has been included among the species for which a moving rule is in force for reducing bycatch, and efforts are being made to have fleets fishing in Greenland waters record catches of these shrimps better (G.H. 2011).

Based on the logbooks from five offshore fleets a standardized CPUE index series (2001-2022) was derived using GLM including the factors year, area, month, and fleet weighted with the number of hauls (Fig. 11). Throughout the period, the CPUE index has fluctuated with an increasing tendency in the period after 2010 to 2016 compared to previous years, dropped significantly in 2017 and has continued the decline until 2020, but increased little in 2021.

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**Table 1a.** *P. borealis* in W. Greenland: Catch limits, effort, catch and CPUE, SA 1 up to 73°30'N, 1970–1989.

| Year | TAC (t) |         |       | Catch (t) |         |       |          | Catch (t) | Effort           |         |       |              | CPUE           |         |       |            |
|------|---------|---------|-------|-----------|---------|-------|----------|-----------|------------------|---------|-------|--------------|----------------|---------|-------|------------|
|      | SA 1*   | Div. 0A | Total | SA 1      |         |       | Div. 0A  | Total     | SA 1             | Div. 0A | Total | Total        | SA 1           | Div. 0A | Total | Std. Total |
|      |         |         |       | Offshore  | Inshore | Total | Offshore |           | Unstd. ('000 hr) |         |       | Std. (index) | Unstd. (kg/hr) |         |       | (1990=1)   |
| 1970 | no      | no      | no    | 1243      | 9272    | 10515 | 0        | 10515     | -                | -       | -     | -            | -              | -       | -     | -          |
| 1971 | no      | no      | no    | 1978      | 9615    | 11593 | 0        | 11593     | -                | -       | -     | -            | -              | -       | -     | -          |
| 1972 | no      | no      | no    | 3786      | 8076    | 11862 | 0        | 11862     | -                | -       | -     | -            | -              | -       | -     | -          |
| 1973 | no      | no      | no    | 6785      | 8745    | 15530 | 0        | 15530     | -                | -       | -     | -            | -              | -       | -     | -          |
| 1974 | no      | no      | no    | 15967     | 11070   | 27038 | 0        | 27038     | -                | -       | -     | -            | -              | -       | -     | -          |
| 1975 | no      | no      | no    | 36977     | 9570    | 46547 | 0        | 46547     | 74.2             | -       | 74    | -            | 628            | -       | 628   | -          |
| 1976 | no      | no      | no    | 52993     | 8030    | 61023 | 392      | 61415     | 80.1             | -       | 80    | 0.49         | 762            | -       | 766   | 1.48       |
| 1977 | -       | -       | 36000 | 42578     | 8580    | 51158 | 457      | 51615     | 73.1             | -       | 73    | 0.44         | 699            | -       | 706   | 1.39       |
| 1978 | -       | 1000    | 41000 | 33835     | 8360    | 42195 | 122      | 42317     | 84.2             | -       | 84    | 0.46         | 501            | -       | 503   | 1.10       |
| 1979 | -       | 2000    | 31500 | 32852     | 8250    | 41102 | 1732     | 42834     | 72.4             | -       | 72    | 0.51         | 568            | -       | 592   | 0.99       |
| 1980 | -       | 2500    | 32000 | 44916     | 8250    | 53166 | 2726     | 55892     | 80               | 11.6    | 92    | 0.56         | 665            | 235     | 610   | 1.20       |
| 1981 | 35000   | 5000    | 40000 | 40295     | 8250    | 48545 | 5284     | 53829     | 88.2             | 16.6    | 105   | 0.57         | 551            | 318     | 514   | 1.13       |
| 1982 | 34800   | 5000    | 39800 | 43979     | 8250    | 52229 | 2064     | 54293     | 81.1             | 8.1     | 89    | 0.45         | 644            | 256     | 609   | 1.43       |
| 1983 | 34625   | 5000    | 39625 | 42553     | 8250    | 50803 | 5413     | 56216     | 89               | 26.1    | 115   | 0.53         | 571            | 208     | 488   | 1.27       |
| 1984 | 34925   | 5000    | 39925 | 42414     | 8250    | 50664 | 2142     | 52806     | 85               | -       | 85    | 0.53         | 596            | -       | 621   | 1.19       |
| 1985 | 42120   | 6120    | 48240 | 54888     | 8250    | 63138 | 3069     | 66207     | 129.1            | 23.6    | 153   | 0.62         | 489            | 130     | 433   | 1.28       |
| 1986 | 42120   | 6120    | 48240 | 65019     | 8250    | 73269 | 2995     | 76264     | 133.4            | -       | 133   | 0.68         | 554            | -       | 576   | 1.33       |
| 1987 | 40120   | 6120    | 46240 | 64161     | 7613    | 71774 | 6095     | 77869     | 137.1            | 17.7    | 155   | 0.61         | 524            | 344     | 503   | 1.53       |
| 1988 | 40120   | 6120    | 46240 | 56479     | 11256   | 67735 | 5881     | 73616     | 152.9            | 14.9    | 168   | 0.76         | 443            | 395     | 439   | 1.15       |
| 1989 | 45245   | 7520    | 52765 | 58890     | 14546   | 73436 | 7235     | 80671     | 179.6            | 19.7    | 199   | 0.91         | 409            | 367     | 405   | 1.05       |

\* in 1981–1995 quotas applied to the offshore area only



**Table 1b.** *P. borealis* in W. Greenland: Catch limits, effort, catch, and CPUE, SA 1 up to 76°N, 1990–2022. (2022 is only preliminary data from January 1<sup>st</sup> to June 30<sup>rd</sup>).

| Year | TAC (t) |         |        | Catch (t) |         |        |          |        | Effort           |         |       |            | CPUE           |         |       |            |
|------|---------|---------|--------|-----------|---------|--------|----------|--------|------------------|---------|-------|------------|----------------|---------|-------|------------|
|      | SA 1*   | Div. 0A | Total  | SA 1      |         |        | Div. 0A  | Total  | SA 1             | Div. 0A | Total | Total Std. | SA 1           | Div. 0A | Total | Total Std. |
|      |         |         |        | Offshore  | Inshore | Total  | Offshore |        | Unstd. ('000 hr) |         |       | (1990=1)   | Unstd. (kg/hr) |         |       | (1990=1)   |
| 1990 | 45245   | 7520    | 52765  | 62800     | 14993   | 77793  | 6177     | 83970  | 210              | 14      | 224   | 1.00       | 371            | 433     | 375   | 1.00       |
| 1991 | 46225   | 8500    | 54725  | 66817     | 17884   | 84701  | 6788     | 91489  | 231              | 20      | 250   | 1.04       | 367            | 346     | 365   | 1.05       |
| 1992 | 44200   | 8500    | 52700  | 75341     | 22653   | 97994  | 7493     | 105487 | 234              | 17      | 251   | 1.12       | 418            | 451     | 421   | 1.12       |
| 1993 | 40600   | 8500    | 49100  | 65894     | 19627   | 85522  | 5491     | 91013  | 206              | 12      | 218   | 0.97       | 415            | 450     | 417   | 1.12       |
| 1994 | 42300   | 8500    | 50800  | 68109     | 19930   | 88039  | 4766     | 92805  | 210              | 15      | 225   | 0.99       | 420            | 312     | 412   | 1.12       |
| 1995 | 39500   | 8500    | 48000  | 66955     | 18072   | 85027  | 2361     | 87388  | 185              | 7       | 192   | 0.85       | 460            | 322     | 455   | 1.23       |
| 1996 | 63922   | 8500    | 72422  | 62368     | 19095   | 81463  | 2632     | 84095  | 165              | 9       | 174   | 0.78       | 495            | 293     | 484   | 1.28       |
| 1997 | 64600   | 8500    | 74800  | 62743     | 14868   | 77611  | 517      | 78128  | 185              | 1       | 186   | 0.74       | 420            | 412     | 420   | 1.25       |
| 1998 | 60729   | 7650    | 68379  | 69156     | 10406   | 79562  | 933      | 80495  | 153              | 3       | 155   | 0.67       | 521            | 353     | 518   | 1.44       |
| 1999 | 73500   | 9350    | 82850  | 71203     | 18948   | 90152  | 2046     | 92198  | 165              | 5       | 170   | 0.68       | 547            | 398     | 543   | 1.62       |
| 2000 | 77675   | 9350    | 87025  | 73013     | 23365   | 96378  | 1590     | 97968  | 156              | 3       | 159   | 0.65       | 617            | 613     | 617   | 1.78       |
| 2001 | 92950   | 9350    | 102300 | 79291     | 20010   | 99301  | 3625     | 102926 | 158              | 6       | 164   | 0.72       | 627            | 602     | 626   | 1.71       |
| 2002 | 91150   | 12040   | 103190 | 107195    | 21729   | 128925 | 6247     | 135172 | 173              | 9       | 182   | 0.79       | 744            | 695     | 741   | 2.04       |
| 2003 | 101000  | 14167   | 115167 | 104237    | 18799   | 123036 | 7137     | 130173 | 124              | 8       | 133   | 0.70       | 989            | 846     | 980   | 2.22       |
| 2004 | 135352  | 14167   | 149519 | 121658    | 20653   | 142311 | 7021     | 149332 | 130              | 12      | 142   | 0.73       | 1095           | 569     | 1049  | 2.43       |
| 2005 | 134000  | 18452   | 152452 | 128068    | 21910   | 149978 | 6921     | 156899 | 129              | 9       | 139   | 0.74       | 1159           | 744     | 1131  | 2.51       |
| 2006 | 134000  | 18380   | 152380 | 127747    | 25441   | 153188 | 4127     | 157315 | 126              | 5       | 131   | 0.74       | 1215           | 884     | 1203  | 2.52       |
| 2007 | 134000  | 18417   | 152417 | 116674    | 25571   | 142245 | 1945     | 144190 | 114              | 2       | 116   | 0.66       | 1248           | 872     | 1241  | 2.59       |
| 2008 | 127300  | 18417   | 145717 | 119797    | 34092   | 153889 | 0        | 153889 | 119              | -       | 119   | 0.67       | 1292           | -       | 1292  | 2.72       |
| 2009 | 114570  | 15583   | 130153 | 97051     | 37978   | 135029 | 429      | 135458 | 119              | -       | 119   | 0.65       | 1134           | -       | -     | 2.47       |
| 2010 | 114570  | 15583   | 130153 | 94596     | 33513   | 128109 | 5561     | 133670 | 118              | 7       | 125   | 0.67       | 1081           | 839     | 1068  | 2.37       |
| 2011 | 124000  | 15583   | 139583 | 78437     | 44222   | 122659 | 1274     | 123933 | 108              | 3       | 111   | 0.59       | 1139           | 399     | 1118  | 2.49       |
| 2012 | 101675  | 12750   | 114425 | 76090     | 39875   | 115965 | 5        | 115970 | 111              | 0       | 111   | 0.60       | 1047           | 56      | 1047  | 2.30       |
| 2013 | 89263   | 11333   | 100596 | 65797     | 29582   | 95379  | 2        | 95381  | 95               | 0       | 95    | 0.56       | 1002           | 120     | 1002  | 2.02       |
| 2014 | 86316   | 11333   | 97649  | 60768     | 27997   | 88765  | 0        | 88765  | 86               | -       | 86    | 0.49       | 1035           | -       | 1035  | 2.17       |
| 2015 | 74061   | 8500    | 82561  | 49246     | 23008   | 72254  | 2        | 72256  | 67               | 0       | 67    | 0.38       | 1076           | 34      | 1076  | 2.27       |
| 2016 | 85801   | 10625   | 96426  | 56593     | 27763   | 84356  | 1163     | 85519  | 78               | 3       | 78    | 0.42       | 1078           | 421     | 1092  | 2.41       |
| 2017 | 88957   | 12750   | 101707 | 63037     | 26332   | 89369  | 3001     | 92370  | 74               | 7       | 74    | 0.41       | 1216           | 452     | 1257  | 2.71       |
| 2018 | 99998   | 14875   | 114873 | 68942     | 24247   | 93189  | 1689     | 94878  | 80               | 4       | 80    | 0.45       | 1159           | 422     | 1180  | 2.53       |
| 2019 | 105000  | 14875   | 119875 | 77589     | 24388   | 101977 | 2463     | 104440 | 91               | 7       | 91    | 0.52       | 1122           | 333     | 1149  | 2.37       |
| 2020 | 110000  | 15229   | 125229 | 86181     | 26936   | 113117 | 641      | 113758 | 103              | 3       | 103   | 0.63       | 1103           | 256     | 1109  | 2.14       |
| 2021 | 115000  | 15937   | 130937 | 88250     | 26098   | 114348 | 221      | 115000 | 95               | -       | 95    | 0.56       | 1206           | -       | 1213  | 2.45       |
| 2022 | 115000  | 16291   | 131291 | 45140     | 13103   | 58243  | 0        | 151292 | 44               | -       | 44    | 0.76       | 1328           | -       | 3450  | 2.39       |

\* 1981-1995 TAC for offshore only. # Projections based on information received from GFLK and DFO.

**Table 2.** *P. borealis* in W. Greenland, SA 1 up to 76°N': Standardised (1990=1) CPUE series for 4 fleets and a combined standardized CPUE series. \* relative i.q.r.: the interquartile range divided by the median.  
\*2022 is only preliminary data

| Year | KGH    |          | Offshore |          | Coastal |          | Canada SFA1 |          | Combined |          |
|------|--------|----------|----------|----------|---------|----------|-------------|----------|----------|----------|
|      | median | rel. iqr | median   | rel. iqr | median  | rel. iqr | median      | rel. iqr | median   | rel. iqr |
| 1976 | 1.660  | 0.124    |          |          |         |          |             |          | 1.478    | 0.208    |
| 1977 | 1.556  | 0.082    |          |          |         |          |             |          | 1.386    | 0.149    |
| 1978 | 1.230  | 0.082    |          |          |         |          |             |          | 1.096    | 0.145    |
| 1979 | 1.113  | 0.080    |          |          |         |          |             |          | 0.990    | 0.146    |
| 1980 | 1.340  | 0.082    |          |          |         |          |             |          | 1.192    | 0.146    |
| 1981 | 1.266  | 0.077    |          |          |         |          |             |          | 1.126    | 0.141    |
| 1982 | 1.611  | 0.083    |          |          |         |          |             |          | 1.435    | 0.149    |
| 1983 | 1.423  | 0.081    |          |          |         |          |             |          | 1.266    | 0.149    |
| 1984 | 1.338  | 0.079    |          |          |         |          |             |          | 1.191    | 0.147    |
| 1985 | 1.432  | 0.077    |          |          |         |          |             |          | 1.274    | 0.141    |
| 1986 | 1.490  | 0.077    |          |          |         |          |             |          | 1.324    | 0.144    |
| 1987 | 1.787  | 0.080    | 1.530    | 0.028    |         |          | —           | —        | 1.511    | 0.058    |
| 1988 | 1.465  | 0.079    | 1.151    | 0.024    | 1.177   | 0.053    | —           | —        | 1.156    | 0.053    |
| 1989 | 1.086  | 0.088    | 1.084    | 0.023    | 0.887   | 0.040    | 1.114       | 0.110    | 1.050    | 0.050    |
| 1990 | 1.000  | 0.000    | 1.000    | 0.000    | 1.000   | 0.000    | 1.000       | 0.000    | 1.000    | 0.000    |
| 1991 |        |          | 1.057    | 0.021    | 0.978   | 0.036    | 0.795       | 0.095    | 1.046    | 0.051    |
| 1992 |        |          | 1.126    | 0.022    | 1.072   | 0.036    | 0.861       | 0.103    | 1.119    | 0.050    |
| 1993 |        |          | 1.111    | 0.023    | 1.129   | 0.035    | 0.935       | 0.098    | 1.116    | 0.051    |
| 1994 |        |          | 1.139    | 0.023    | 1.010   | 0.034    | 0.652       | 0.095    | 1.120    | 0.051    |
| 1995 |        |          | 1.270    | 0.024    | 1.024   | 0.035    | 0.765       | 0.102    | 1.230    | 0.052    |
| 1996 |        |          | 1.325    | 0.025    | 1.071   | 0.036    | 0.616       | 0.100    | 1.283    | 0.052    |
| 1997 |        |          | 1.280    | 0.026    | 1.095   | 0.036    | —           | —        | 1.251    | 0.054    |
| 1998 |        |          | 1.455    | 0.029    | 1.327   | 0.039    | 0.609       | 0.135    | 1.440    | 0.056    |
| 1999 |        |          | 1.660    | 0.030    | 1.426   | 0.035    | 0.880       | 0.129    | 1.623    | 0.057    |
| 2000 |        |          | 1.748    | 0.032    | 1.771   | 0.035    | 1.067       | 0.137    | 1.782    | 0.057    |
| 2001 |        |          | 1.691    | 0.033    | 1.661   | 0.035    | 1.106       | 0.116    | 1.714    | 0.058    |
| 2002 |        |          | 2.008    | 0.030    | 2.038   | 0.035    | 1.318       | 0.107    | 2.044    | 0.056    |
| 2003 |        |          | 2.234    | 0.030    | 2.060   | 0.036    | 1.579       | 0.113    | 2.218    | 0.057    |
| 2004 |        |          | 2.483    | 0.030    | 2.153   | 0.035    | 1.180       | 0.107    | 2.430    | 0.056    |
| 2005 |        |          | 2.625    | 0.030    | 2.077   | 0.035    | 1.261       | 0.117    | 2.511    | 0.056    |
| 2006 |        |          | 2.584    | 0.031    | 2.197   | 0.036    | 1.443       | 0.141    | 2.520    | 0.058    |
| 2007 |        |          | 2.583    | 0.032    | 2.481   | 0.036    | 1.388       | 0.141    | 2.594    | 0.057    |
| 2008 |        |          | 2.737    | 0.032    | 2.518   | 0.035    | —           | —        | 2.721    | 0.058    |
| 2009 |        |          | 2.543    | 0.034    | 2.137   | 0.036    | —           | —        | 2.465    | 0.059    |
| 2010 |        |          | 2.488    | 0.034    | 1.957   | 0.036    | 2.055       | 0.182    | 2.370    | 0.060    |
| 2011 |        |          | 2.532    | 0.035    | 2.220   | 0.036    | 0.250       | 0.305    | 2.486    | 0.059    |
| 2012 |        |          | 2.346    | 0.034    | 2.046   | 0.036    | —           | —        | 2.301    | 0.059    |
| 2013 |        |          | 1.995    | 0.034    | 1.981   | 0.039    | —           | —        | 2.021    | 0.059    |
| 2014 |        |          | 2.139    | 0.035    | 2.148   | 0.040    | —           | —        | 2.171    | 0.062    |
| 2015 |        |          | 2.244    | 0.037    | 2.221   | 0.042    | —           | —        | 2.273    | 0.062    |
| 2016 |        |          | 2.458    | 0.037    | 2.157   | 0.040    | —           | —        | 2.413    | 0.061    |
| 2017 |        |          | 2.940    | 0.037    | 2.036   | 0.041    | —           | —        | 2.713    | 0.063    |
| 2018 |        |          | 2.746    | 0.037    | 1.892   | 0.040    | —           | —        | 2.527    | 0.063    |
| 2019 |        |          | 2.583    | 0.036    | 1.777   | 0.039    | —           | —        | 2.373    | 0.062    |
| 2020 |        |          | 2.262    | 0.037    | 1.747   | 0.039    | —           | —        | 2.142    | 0.063    |
| 2021 |        |          | 2.589    | 0.037    | 1.978   | 0.040    | —           | —        | 2.446    | 0.063    |
| 2022 |        |          | 2.463    | 0.047    | 2.040   | 0.055    | —           | —        | 2.385    | 0.073    |

**Table 3a.** *P. borealis* in W. Greenland: Annual catch, effort and CPUE of the shrimp fishery on the West Greenland shelf by NAFO Divisions. Data from logbooks, weighted up to annual 'agreed' catch.

| Year | Agreed Catch ('000 tons) |      |      |      |      |     |      | Corrected, Unstandardised Effort ('000 hr) |      |      |      |      |      |      | Unstandardised CPUE (agreed kg/hr) |     |     |     |     |     |     |
|------|--------------------------|------|------|------|------|-----|------|--------------------------------------------|------|------|------|------|------|------|------------------------------------|-----|-----|-----|-----|-----|-----|
|      | 0A                       | 1A   | 1B   | 1C   | 1D   | 1E  | 1F   | 0A                                         | 1A   | 1B   | 1C   | 1D   | 1E   | 1F   | 0A                                 | 1A  | 1B  | 1C  | 1D  | 1E  | 1F  |
| 1975 | 0                        | 0    | 44.6 | 2    | 0    | 0   | 0    | -                                          | 0    | 70.5 | 3.6  | 0    | 0    | 0    | -                                  | -   | 632 | 551 | -   | -   | -   |
| 1976 | 0.4                      | 0    | 54.7 | 6.3  | 0    | 0   | 0    | -                                          | 0.1  | 70.1 | 8    | 0.1  | 0.8  | 1.1  | -                                  | -   | 780 | 785 | -   | -   | 40  |
| 1977 | 0.5                      | 0.2  | 47.8 | 3.1  | 0.1  | 0   | 0    | -                                          | 0.5  | 67.8 | 4.4  | 0.5  | 0    | 0    | -                                  | 357 | 705 | 691 | 253 | -   | -   |
| 1978 | 0.1                      | 0.5  | 40.9 | 0.5  | 0.2  | 0   | 0    | -                                          | 1.4  | 80.7 | 1.3  | 0.8  | 0    | 0    | -                                  | 382 | 507 | 416 | 259 | -   | -   |
| 1979 | 1.7                      | 4.8  | 35.7 | 0.5  | 0    | 0   | 0    | -                                          | 6.7  | 64.1 | 1.5  | 0.1  | 0    | 0    | -                                  | 719 | 557 | 348 | 112 | -   | -   |
| 1980 | 2.7                      | 14.6 | 35   | 3.3  | 0.3  | 0   | 0    | 11.6                                       | 21.2 | 53.3 | 4.9  | 0.5  | 0    | 0    | 235                                | 690 | 655 | 668 | 596 | -   | -   |
| 1981 | 5.3                      | 5.7  | 37.5 | 5.3  | 0    | 0   | 0    | 16.6                                       | 11.2 | 66.4 | 10.4 | 0.1  | 0    | 0    | 318                                | 511 | 564 | 510 | 409 | -   | -   |
| 1982 | 2.1                      | 0.8  | 43.2 | 8.2  | 0    | 0   | 0    | 8.1                                        | 1.7  | 65.7 | 13.5 | 0.1  | 0    | 0    | 256                                | 472 | 657 | 604 | 388 | -   | -   |
| 1983 | 5.4                      | 0.5  | 40.5 | 9.4  | 0.5  | 0   | 0    | 26.1                                       | 0.9  | 69.5 | 17.8 | 0.9  | 0    | 0    | 208                                | 559 | 582 | 528 | 531 | -   | 614 |
| 1984 | 2.1                      | 1.2  | 30.4 | 17   | 2.1  | 0   | 0    | -                                          | 2.7  | 51.1 | 28.4 | 2.7  | 0    | 0.1  | -                                  | 431 | 595 | 598 | 785 | -   | 47  |
| 1985 | 3.1                      | 8.1  | 35.5 | 14.9 | 4.7  | 0   | 0    | 23.6                                       | 28.7 | 66.2 | 25.6 | 8.7  | 0    | 0    | 130                                | 282 | 536 | 580 | 540 | -   | -   |
| 1986 | 3                        | 26.3 | 32.4 | 9.2  | 6    | 0   | 0    | -                                          | 54.2 | 55.2 | 14.1 | 9.6  | 0.1  | 0.1  | -                                  | 485 | 586 | 649 | 624 | 273 | -   |
| 1987 | 6.1                      | 19.4 | 43.7 | 7.3  | 1.3  | 0   | 0    | 17.7                                       | 54.4 | 67.9 | 10.7 | 4.2  | 0    | 0    | 344                                | 357 | 644 | 685 | 324 | -   | -   |
| 1988 | 5.9                      | 12.4 | 47.5 | 7.1  | 0.5  | 0   | 0.1  | 14.9                                       | 40.9 | 94.3 | 14.7 | 2    | 0    | 1    | 395                                | 302 | 504 | 486 | 268 | -   | 153 |
| 1989 | 7.2                      | 16.3 | 33.8 | 12.9 | 10   | 0   | 0.5  | 19.7                                       | 47.3 | 77.7 | 30.5 | 19.8 | 0    | 4.2  | 367                                | 343 | 435 | 422 | 507 | -   | 111 |
| 1990 | 6.2                      | 12.2 | 30   | 22.7 | 12.4 | 0   | 0.5  | 14.3                                       | 42.3 | 77.5 | 56.1 | 30.8 | 0    | 2.8  | 433                                | 288 | 387 | 405 | 403 | -   | 165 |
| 1991 | 6.8                      | 12.6 | 32.9 | 18.8 | 19.6 | 0.6 | 0.2  | 19.6                                       | 37   | 90   | 52.6 | 49.2 | 0.7  | 1.3  | 346                                | 341 | 365 | 357 | 398 | 824 | 191 |
| 1992 | 7.5                      | 16.3 | 32.8 | 19.9 | 23.4 | 5   | 0.6  | 16.6                                       | 49.3 | 76.2 | 48   | 51.7 | 7.8  | 1.3  | 451                                | 330 | 431 | 415 | 452 | 642 | 497 |
| 1993 | 5.5                      | 7.6  | 36.3 | 15.8 | 18.1 | 4.5 | 3.2  | 12.2                                       | 22.9 | 82   | 41.3 | 44.3 | 8    | 7.6  | 450                                | 331 | 442 | 383 | 410 | 559 | 425 |
| 1994 | 4.8                      | 7.3  | 33.7 | 15.9 | 19.9 | 7   | 4.2  | 15.3                                       | 23.3 | 84.1 | 40.9 | 42.7 | 9.6  | 9.3  | 312                                | 313 | 401 | 390 | 467 | 736 | 450 |
| 1995 | 2.4                      | 6.9  | 27.2 | 15.5 | 22   | 8.6 | 4.9  | 7.3                                        | 20.9 | 69.2 | 33.8 | 40.8 | 12.3 | 7.9  | 322                                | 330 | 393 | 458 | 539 | 696 | 624 |
| 1996 | 2.6                      | 5.4  | 22.4 | 16.8 | 23.3 | 8.3 | 5.3  | 9                                          | 18.4 | 51   | 35   | 39.3 | 11.8 | 9.1  | 293                                | 293 | 439 | 481 | 594 | 700 | 579 |
| 1997 | 0.5                      | 7.3  | 20.2 | 11.5 | 22.6 | 8.5 | 7.6  | 1.3                                        | 43.7 | 53.7 | 24   | 39.2 | 11.6 | 12.6 | 412                                | 167 | 376 | 477 | 576 | 730 | 605 |
| 1998 | 0.9                      | 4.5  | 22.6 | 13.5 | 21.1 | 8.7 | 9    | 2.6                                        | 20   | 48.9 | 25.4 | 34.2 | 10.6 | 13.5 | 353                                | 226 | 463 | 532 | 618 | 817 | 671 |
| 1999 | 2                        | 8.8  | 28.5 | 14.6 | 19.1 | 8.3 | 10.9 | 5.1                                        | 34.2 | 58.9 | 22.5 | 27.1 | 9.2  | 12.9 | 398                                | 259 | 484 | 650 | 704 | 902 | 839 |



**Table 3b.** *P. borealis* in W. Greenland: Annual catch, effort and CPUE of the shrimp fishery on the West Greenland shelf by NAFO Divisions. Data from logbooks, weighted up to annual 'agreed' catch. \*2022 is only preliminary data

| Year  | Agreed Catch ('000 tons) |      |      |      |      |     |      | Corrected, Unstandardised Effort ('000 hr) |      |      |      |      |      |      | Unstandardised CPUE (agreed kg/hr) |      |      |      |      |      |      |
|-------|--------------------------|------|------|------|------|-----|------|--------------------------------------------|------|------|------|------|------|------|------------------------------------|------|------|------|------|------|------|
|       | 0A                       | 1A   | 1B   | 1C   | 1D   | 1E  | 1F   | 0A                                         | 1A   | 1B   | 1C   | 1D   | 1E   | 1F   | 0A                                 | 1A   | 1B   | 1C   | 1D   | 1E   | 1F   |
| 2000  | 1.6                      | 14.8 | 29.2 | 15   | 19   | 7   | 11.5 | 2.6                                        | 36.2 | 51.7 | 20.3 | 26.2 | 7.7  | 14.1 | 613                                | 409  | 564  | 737  | 727  | 909  | 810  |
| 2001  | 3.6                      | 14.4 | 27.4 | 17.1 | 20.8 | 8   | 11.6 | 6                                          | 41   | 49.2 | 21.1 | 27.4 | 7.7  | 11.8 | 602                                | 351  | 557  | 810  | 760  | 1029 | 980  |
| 2002  | 6.2                      | 15.2 | 43.5 | 26.5 | 25   | 8.5 | 10.3 | 9                                          | 41.6 | 58.7 | 27.5 | 28.2 | 7    | 10.4 | 695                                | 365  | 741  | 963  | 888  | 1216 | 989  |
| 2003  | 7.1                      | 13.9 | 42.4 | 24.8 | 23.1 | 8   | 10.8 | 8.4                                        | 32.6 | 41.6 | 17.2 | 17.5 | 5.3  | 10.1 | 842                                | 427  | 1019 | 1438 | 1321 | 1510 | 1064 |
| 2004  | 7.0                      | 13.8 | 55.0 | 33.6 | 24.6 | 5.7 | 9.6  | 12.3                                       | 33.4 | 51.2 | 18.1 | 13.3 | 2.8  | 11.2 | 569                                | 413  | 1074 | 1853 | 1857 | 2019 | 856  |
| 2005  | 6.9                      | 11.3 | 73.0 | 33.6 | 18.0 | 5.4 | 8.7  | 9.3                                        | 23.1 | 58.6 | 16.5 | 10.6 | 5.2  | 15.5 | 744                                | 488  | 1244 | 2039 | 1700 | 1039 | 565  |
| 2006  | 4.1                      | 13.8 | 81.0 | 23.7 | 19.3 | 9.8 | 5.5  | 4.7                                        | 21.5 | 60.6 | 12.3 | 11.2 | 10.0 | 10.6 | 884                                | 642  | 1336 | 1932 | 1730 | 984  | 519  |
| 2007  | 1.9                      | 26.5 | 84.8 | 9.1  | 12.0 | 8.7 | 1.1  | 2.2                                        | 27.2 | 63.3 | 5.6  | 8.6  | 7.0  | 2.3  | 872                                | 973  | 1340 | 1635 | 1406 | 1241 | 473  |
| 2008  | 0.0                      | 42.3 | 96.1 | 6.7  | 4.4  | 4.4 | 0.1  | 0.0                                        | 36.3 | 71.4 | 4.3  | 3.1  | 3.9  | 0.1  | -                                  | 1165 | 1345 | 1562 | 1410 | 1119 | 1170 |
| 2009  | 0.4                      | 48.1 | 71.9 | 5.0  | 6.5  | 3.6 | 0.0  | 0.1                                        | 46.5 | 63.1 | 3.6  | 3.8  | 2.1  | 0.0  | -                                  | 1034 | 1140 | 1377 | 1702 | 1738 | -    |
| 2010  | 5.6                      | 50.9 | 63.4 | 6.2  | 6.6  | 1.1 | 0.0  | 6.6                                        | 55.2 | 56.5 | 3.2  | 3.1  | 0.5  | 0.0  | 839                                | 922  | 1122 | 1928 | 2132 | 2123 | -    |
| 2011  | 1.3                      | 46.9 | 54.2 | 7.9  | 10.9 | 2.7 | 0.0  | 3.2                                        | 56.4 | 41.6 | 3.7  | 5.0  | 1.0  | 0.0  | 399                                | 832  | 1303 | 2127 | 2176 | 2852 | -    |
| 2012  | 0.0                      | 45.7 | 45.3 | 6.3  | 12.0 | 6.4 | 0.3  | 0.1                                        | 56.2 | 42.7 | 3.4  | 5.5  | 2.7  | 0.2  | 56                                 | 812  | 1061 | 1851 | 2187 | 2364 | 1745 |
| 2013  | 0.0                      | 33.9 | 39.2 | 6.6  | 10.6 | 4.6 | 0.6  | 0.0                                        | 45.5 | 36.0 | 4.2  | 6.3  | 2.9  | 0.3  | 120                                | 745  | 1088 | 1586 | 1664 | 1575 | 2189 |
| 2014  | 0.0                      | 37.9 | 38.3 | 4.0  | 6.2  | 1.6 | 0.7  | 0.0                                        | 47.4 | 29.8 | 2.8  | 4.3  | 1.1  | 0.3  | -                                  | 801  | 1285 | 1444 | 1436 | 1450 | 1971 |
| 2015  | 0.0                      | 28.6 | 30.0 | 4.7  | 5.4  | 1.8 | 1.8  | 0.1                                        | 34.2 | 24.4 | 2.7  | 3.8  | 1.1  | 0.9  | 34                                 | 836  | 1230 | 1749 | 1411 | 1670 | 1902 |
| 2016  | 1.2                      | 32.6 | 36.6 | 5.9  | 5.7  | 2.2 | 1.2  | 2.8                                        | 37.7 | 32.6 | 3.2  | 3.3  | 1.0  | 0.5  | 421                                | 865  | 1124 | 1870 | 1744 | 2162 | 2382 |
| 2017  | 3.0                      | 36.3 | 35.4 | 10.9 | 5.1  | 1.4 | 0.3  | 6.6                                        | 38.1 | 27.7 | 4.6  | 2.6  | 0.4  | 0.1  | 452                                | 951  | 1277 | 2357 | 1990 | 3679 | 3030 |
| 2018  | 1.7                      | 30.8 | 37.7 | 15.5 | 7.3  | 1.8 | 0.0  | 4.5                                        | 35.5 | 31.5 | 8.0  | 4.7  | 0.7  | 0.0  | 378                                | 868  | 1197 | 1953 | 1563 | 2449 | 500  |
| 2019  | 2.5                      | 28.5 | 54.9 | 10.2 | 7.0  | 1.5 | 0.0  | 7.4                                        | 35.4 | 46.1 | 5.2  | 3.5  | 0.7  | 0.0  | 333                                | 804  | 1191 | 1969 | 1991 | 1985 | 0    |
| 2020  | 0.6                      | 33.0 | 61.9 | 9.4  | 7.3  | 1.2 | 0.2  | 3.1                                        | 40.7 | 53.0 | 5.2  | 3.2  | 0.4  | 0.1  | 207                                | 811  | 1168 | 1828 | 2267 | 2830 | 2676 |
| 2021  | 0.2                      | 53.9 | 13.1 | 11.5 | 4.5  | 0.0 | 0.0  | 0.7                                        | 43.2 | 43.4 | 4.2  | 3.1  | 0.9  | 0.0  | 311                                | 1246 | 302  | 2743 | 1455 | 28   | 1000 |
| 2022* | 0.0                      | 46.6 | 2.6  | 5.1  | 3.9  | 0.0 | 0.0  | 0.0                                        | 13.8 | 24.9 | 1.3  | 2.7  | 1.1  | 0.0  | -                                  | 3382 | 105  | 4031 | 1434 | 1    | 59   |

\*Projected



**Table 4a.** *P. borealis* in W. Greenland; Distribution (%) columns sum to 100) of catches between Divisions in NAFO Subarea 1 by 5-year period.

|           | 5-year-period |       |       |       |       |       |       |       |       |
|-----------|---------------|-------|-------|-------|-------|-------|-------|-------|-------|
|           | 80–84         | 85–89 | 90–94 | 95–99 | 00–04 | 05–09 | 10–14 | 15–19 | 20–24 |
| 1A        | 9.2           | 23.4  | 12.8  | 8.1   | 12.1  | 19.4  | 39.1  | 35.5  | 29.8  |
| 1B        | 72.1          | 56.1  | 38.3  | 29.1  | 33.7  | 55.4  | 43.6  | 44.1  | 54.0  |
| 1C        | 17.4          | 13.9  | 21.5  | 17.2  | 20.0  | 10.6  | 5.6   | 10.7  | 7.0   |
| 1D        | 1.3           | 6.4   | 21.5  | 26.1  | 19.0  | 8.2   | 8.4   | 6.9   | 6.6   |
| 1E        | 0.0           | 0.0   | 4.0   | 10.2  | 6.2   | 4.3   | 3.0   | 2.0   | 2.6   |
| 1F        | 0.0           | 0.2   | 2.1   | 9.3   | 9.0   | 2.1   | 0.3   | 0.7   | 0.1   |
| Diversity | 1.8           | 2.5   | 3.9   | 4.8   | 4.6   | 2.7   | 2.8   | 3.0   | 2.6   |

**Table 4b** *P. borealis* in W. Greenland; Distribution (%) columns sum to 100) of fishing effort<sup>1</sup> between Divisions in NAFO Subarea 1 by 5-year period.

|           | 5-year-period |       |       |       |       |       |       |       |       |
|-----------|---------------|-------|-------|-------|-------|-------|-------|-------|-------|
|           | 80–84         | 85–89 | 90–94 | 95–99 | 00–04 | 05–09 | 10–14 | 15–19 | 20–24 |
| 1A        | 9.3           | 30.5  | 15.9  | 17.4  | 26.5  | 25.4  | 50.3  | 46.4  | 40.5  |
| 1B        | 71.4          | 49.9  | 37.7  | 33.3  | 34.5  | 52.2  | 39.9  | 41.6  | 50.2  |
| 1C        | 18.1          | 12.6  | 21.9  | 15.8  | 13.0  | 7.0   | 3.3   | 6.0   | 4.4   |
| 1D        | 1.1           | 6.0   | 20.0  | 20.2  | 13.7  | 6.1   | 4.7   | 4.6   | 3.8   |
| 1E        | 0.0           | 0.0   | 2.4   | 6.3   | 4.0   | 4.6   | 1.6   | 1.0   | 1.0   |
| 1F        | 0.0           | 0.9   | 2.1   | 7.0   | 8.3   | 4.7   | 0.1   | 0.4   | 0.0   |
| Diversity | 1.8           | 2.8   | 3.9   | 4.6   | 4.3   | 2.9   | 2.4   | 2.5   | 2.4   |

<sup>1</sup>unstandardised single-trawl-equivalent time

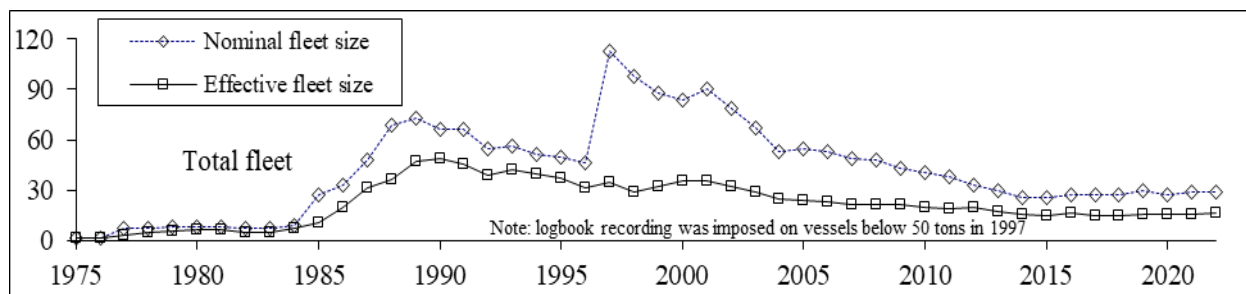
**Table 5.** *P. borealis* in W. Greenland: Catch by month 1976–2022, summed from vessel logs and weighted up to total catch. \*2022 is only preliminary data

| Year  | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1976  | 5778  | 736   | 0     | 0     | 154   | 10861 | 10457 | 11588 | 11398 | 8369  | 1985  | 89    |
| 1977  | 3062  | 3145  | 2229  | 2780  | 3736  | 5565  | 5972  | 5052  | 4321  | 6459  | 5682  | 3612  |
| 1978  | 971   | 366   | 152   | 777   | 5829  | 6620  | 6134  | 6348  | 4506  | 3601  | 3529  | 3483  |
| 1979  | 2428  | 540   | 5245  | 6444  | 6184  | 5252  | 4298  | 3904  | 2352  | 1563  | 3007  | 1617  |
| 1980  | 4651  | 5383  | 4976  | 5892  | 7072  | 7453  | 6656  | 5226  | 5499  | 2508  | 0     | 576   |
| 1981  | 3564  | 3555  | 2964  | 4279  | 7157  | 4890  | 7118  | 7121  | 4476  | 3171  | 3431  | 2103  |
| 1982  | 3422  | 709   | 1     | 2441  | 8342  | 7738  | 6784  | 7803  | 4738  | 6907  | 4239  | 1168  |
| 1983  | 37    | 247   | 577   | 2029  | 7655  | 7838  | 9260  | 6855  | 5952  | 6785  | 5625  | 3357  |
| 1984  | 45    | 494   | 4426  | 7258  | 7881  | 8490  | 7800  | 3765  | 2408  | 4429  | 4310  | 1498  |
| 1985  | 2109  | 3513  | 5362  | 3419  | 5318  | 7221  | 6889  | 9117  | 6051  | 8733  | 6047  | 2429  |
| 1986  | 3388  | 3200  | 3607  | 5392  | 4757  | 9422  | 8665  | 6898  | 8119  | 14642 | 5217  | 2958  |
| 1987  | 3094  | 1798  | 4931  | 6404  | 7907  | 8627  | 10797 | 8590  | 8170  | 9368  | 5161  | 3023  |
| 1988  | 2318  | 2913  | 3589  | 7443  | 7636  | 7663  | 8835  | 8384  | 9110  | 7529  | 5412  | 2785  |
| 1989  | 2513  | 3029  | 4344  | 7873  | 6499  | 10254 | 13429 | 9699  | 6996  | 7883  | 4749  | 3403  |
| 1990  | 4097  | 4286  | 4952  | 8453  | 9011  | 8972  | 8997  | 8225  | 7393  | 7087  | 7957  | 4540  |
| 1991  | 4103  | 3653  | 4056  | 3834  | 6416  | 9439  | 11591 | 9941  | 8654  | 10243 | 11233 | 8326  |
| 1992  | 4695  | 3591  | 6037  | 6724  | 8463  | 11196 | 11442 | 10880 | 11384 | 13591 | 10274 | 7210  |
| 1993  | 2639  | 3164  | 4357  | 5950  | 7670  | 7991  | 8703  | 9659  | 10350 | 12584 | 11009 | 6937  |
| 1994  | 4321  | 3905  | 6566  | 8553  | 7342  | 7165  | 9656  | 9408  | 10678 | 11705 | 7942  | 5565  |
| 1995  | 3851  | 5268  | 7792  | 10378 | 8138  | 7761  | 8575  | 8931  | 8398  | 8010  | 6283  | 4004  |
| 1996  | 4028  | 6409  | 7885  | 9144  | 8873  | 8793  | 8842  | 9446  | 8570  | 6118  | 3302  | 2684  |
| 1997  | 3634  | 5995  | 6273  | 6562  | 7664  | 8185  | 9514  | 8061  | 7882  | 7277  | 5035  | 2047  |
| 1998  | 8625  | 6420  | 5896  | 9980  | 10438 | 10505 | 10308 | 5015  | 5366  | 3549  | 2634  | 1758  |
| 1999  | 5035  | 5648  | 7382  | 8133  | 9390  | 8547  | 11074 | 8738  | 8348  | 8203  | 6625  | 5075  |
| 2000  | 4440  | 6528  | 7491  | 9121  | 9738  | 11435 | 11580 | 8573  | 7934  | 6922  | 8377  | 5830  |
| 2001  | 4287  | 5471  | 6248  | 5763  | 8624  | 11195 | 12545 | 12011 | 9930  | 10981 | 8163  | 7708  |
| 2002  | 8815  | 5971  | 7985  | 11485 | 12324 | 12234 | 15668 | 14696 | 12415 | 11495 | 12711 | 9373  |
| 2003  | 8561  | 7984  | 10616 | 11832 | 12708 | 11228 | 10886 | 11542 | 14117 | 11901 | 10915 | 7881  |
| 2004  | 8439  | 9047  | 9341  | 12989 | 14820 | 14539 | 13469 | 10477 | 16044 | 15194 | 13265 | 11707 |
| 2005  | 10695 | 8782  | 12726 | 14837 | 15193 | 15076 | 15775 | 16301 | 13581 | 12903 | 10449 | 10579 |
| 2006  | 12785 | 11920 | 14185 | 11116 | 14430 | 11138 | 15719 | 15802 | 15251 | 13153 | 12505 | 9312  |
| 2007  | 5517  | 8820  | 10584 | 13624 | 13544 | 13726 | 17126 | 14775 | 14224 | 11436 | 10121 | 10693 |
| 2008  | 8989  | 7386  | 9007  | 12488 | 13827 | 15429 | 18407 | 15311 | 14414 | 12982 | 13608 | 12039 |
| 2009  | 10993 | 8126  | 4321  | 9183  | 12422 | 12698 | 14606 | 16683 | 12642 | 12892 | 12352 | 8540  |
| 2010  | 8277  | 7237  | 8289  | 9462  | 11250 | 13953 | 15135 | 14385 | 12147 | 12508 | 10697 | 10329 |
| 2011  | 10197 | 9253  | 11831 | 10877 | 10480 | 10265 | 12523 | 9615  | 8883  | 10221 | 11472 | 8317  |
| 2012  | 9399  | 8623  | 5839  | 10089 | 10780 | 10026 | 11486 | 11514 | 9169  | 9684  | 10728 | 8632  |
| 2013  | 8008  | 6725  | 8487  | 9366  | 8866  | 8539  | 7115  | 8764  | 7064  | 8112  | 7711  | 6621  |
| 2014  | 7224  | 7900  | 7734  | 10055 | 6767  | 7169  | 7623  | 7580  | 6893  | 6839  | 7435  | 5545  |
| 2015  | 6855  | 4863  | 3536  | 5629  | 6411  | 5804  | 5641  | 6516  | 6678  | 6759  | 7214  | 6347  |
| 2016  | 7758  | 7534  | 6949  | 7162  | 5630  | 5977  | 7431  | 7427  | 7371  | 7425  | 8418  | 6439  |
| 2017  | 8185  | 7670  | 3726  | 5370  | 7637  | 6613  | 8158  | 7838  | 8733  | 7957  | 10543 | 9941  |
| 2018  | 9729  | 6906  | 4930  | 6957  | 8176  | 9327  | 9383  | 8451  | 7827  | 8037  | 7971  | 7187  |
| 2019  | 9047  | 8537  | 8290  | 10746 | 9884  | 7644  | 9117  | 8002  | 6875  | 8671  | 8328  | 9295  |
| 2020  | 9811  | 8042  | 9430  | 10513 | 10476 | 9412  | 10413 | 10003 | 8681  | 8904  | 9228  | 8840  |
| 2021  | 10439 | 9077  | 6477  | 9808  | 9033  | 9272  | 11523 | 10955 | 9497  | 10965 | 9054  | 8464  |
| 2022* | 13051 | 9165  | 4038  | 10661 | 11932 | 9396  |       |       |       |       |       |       |

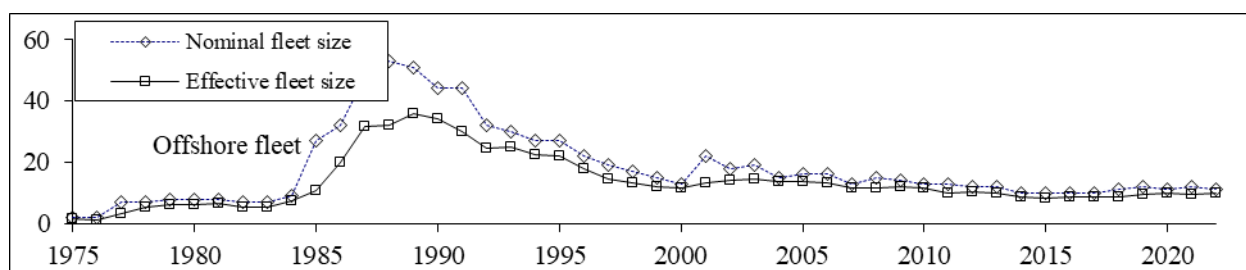
**Table 6.** *P. borealis* in W. Greenland: Discards, and landed catch reported<sup>1</sup> as *P. montagui*, in NAFO Subarea 1.

| Year  | <i>P. borealis</i> |             | <i>P. montagui</i> |            | <i>P. borealis</i><br>Catch |
|-------|--------------------|-------------|--------------------|------------|-----------------------------|
|       | discard (tons)     | discard (%) | landed (tons)      | %-by catch |                             |
| 1975  | 0                  | 0.00        | 0                  |            |                             |
| 1976  | 0                  | 0.00        | 0                  |            |                             |
| 1977  | 0                  | 0.00        | 0                  |            |                             |
| 1978  | 0                  | 0.00        | 0                  |            |                             |
| 1979  | 0                  | 0.00        | 0                  |            |                             |
| 1980  | 0                  | 0.00        | 0                  |            |                             |
| 1981  | 0                  | 0.00        | 0                  |            |                             |
| 1982  | 0                  | 0.00        | 0                  |            |                             |
| 1983  | 0                  | 0.00        | 0                  |            |                             |
| 1984  | 0                  | 0.00        | 0                  |            |                             |
| 1985  | 151                | 0.24        | 0                  |            |                             |
| 1986  | 110                | 0.15        | 0                  |            |                             |
| 1987  | 189                | 0.25        | 0                  |            |                             |
| 1988  | 216                | 0.31        | 0                  |            |                             |
| 1989  | 196                | 0.27        | 0                  |            |                             |
| 1990  | 265                | 0.34        | 0                  |            | 49729                       |
| 1991  | 406                | 0.48        | 0                  |            | 52392                       |
| 1992  | 335                | 0.34        | 0                  |            | 56748                       |
| 1993  | 251                | 0.29        | 0                  |            | 54822                       |
| 1994  | 332                | 0.38        | 5                  |            | 56538                       |
| 1995  | 476                | 0.56        | 563                | 1.0%       | 53633                       |
| 1996  | 323                | 0.40        | 772                | 1.5%       | 51407                       |
| 1997  | 310                | 0.40        | 422                | 0.7%       | 63913                       |
| 1998  | 314                | 0.39        | 1253               | 2.3%       | 54356                       |
| 1999  | 197                | 0.22        | 4                  | 0.0%       | 70099                       |
| 2000  | 268                | 0.28        | 305                | 0.4%       | 76350                       |
| 2001  | 382                | 0.38        | 881                | 1.1%       | 81060                       |
| 2002  | 648                | 0.50        | 225                | 0.2%       | 105473                      |
| 2003  | 639                | 0.52        | 967                | 0.9%       | 100963                      |
| 2004  | 762                | 0.54        | 831                | 0.6%       | 135213                      |
| 2005  | 753                | 0.50        | 512                | 0.3%       | 147687                      |
| 2006  | 865                | 0.56        | 1444               | 1.0%       | 150533                      |
| 2007  | 741                | 0.52        | 2003               | 1.4%       | 139657                      |
| 2008  | 860                | 0.56        | 89                 | 0.1%       | 153889                      |
| 2009  | 710                | 0.53        | 53                 | 0.0%       | 135029                      |
| 2010  | 739                | 0.58        | 1168               | 0.9%       | 128109                      |
| 2011  | 720                | 0.59        | 2324               | 1.9%       | 122659                      |
| 2012  | 587                | 0.51        | 3121               | 2.6%       | 115965                      |
| 2013  | 491                | 0.52        | 4944               | 4.9%       | 95379                       |
| 2014  | 443                | 0.50        | 1357               | 1.5%       | 88765                       |
| 2015  | 325                | 0.45        | 2027               | 2.7%       | 72254                       |
| 2016  | 329                | 0.39        | 3176               | 3.6%       | 84356                       |
| 2017  | 405                | 0.45        | 664                | 0.7%       | 89369                       |
| 2018  | 429                | 0.46        | 133                | 0.1%       | 93189                       |
| 2019  | 403                | 0.40        | 29                 | 0.0%       | 101977                      |
| 2020  | 452                | 0.40        | 36                 | 0.0%       | 113117                      |
| 2021  | 505                | 0.44        | 149                | 0.1%       | 114348                      |
| 2022* | 250                | 0.43        | 450                | 0.8%       | 58243                       |

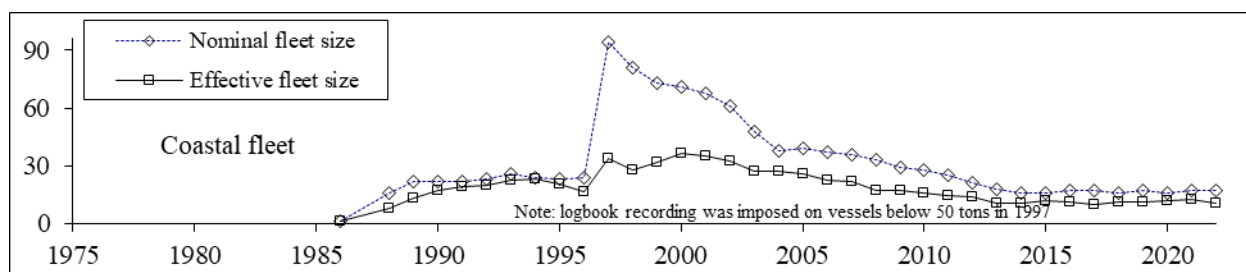
<sup>1</sup>the coastal fleet does not report *P. montagui* separately in logbooks. Information on how much *montagui* that fleet catches is captured at the point of sale and is recorded on sales slips.\* 2022: projected from part-year's data.



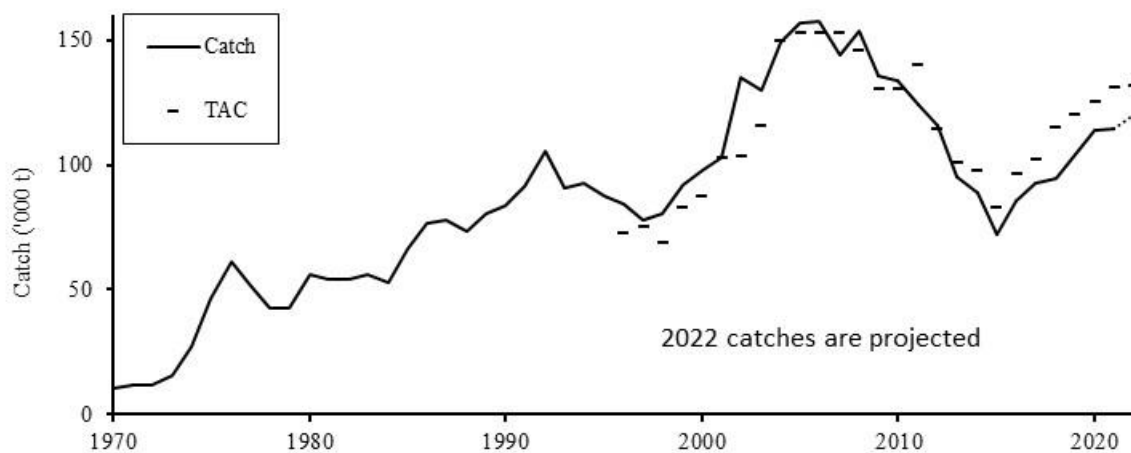
**Figure 1a.** *P. borealis* in W. Greenland: Nominal and effective sizes of the Greenland trawler fleet, 1975–2022, from logbook records.



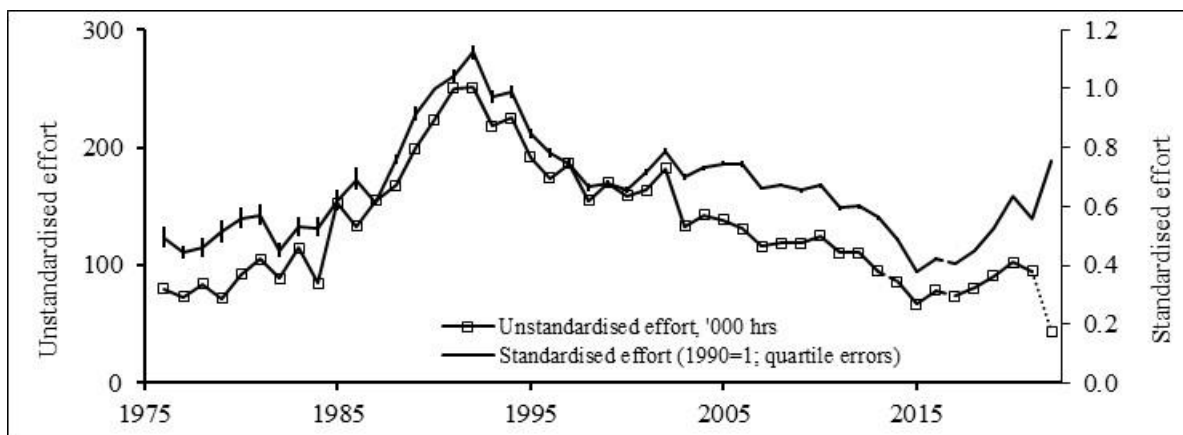
**Figure 1b.** *P. borealis* in W. Greenland: Nominal and effective sizes of the Greenland offshore trawler fleet, 1975–2022, from logbook records.



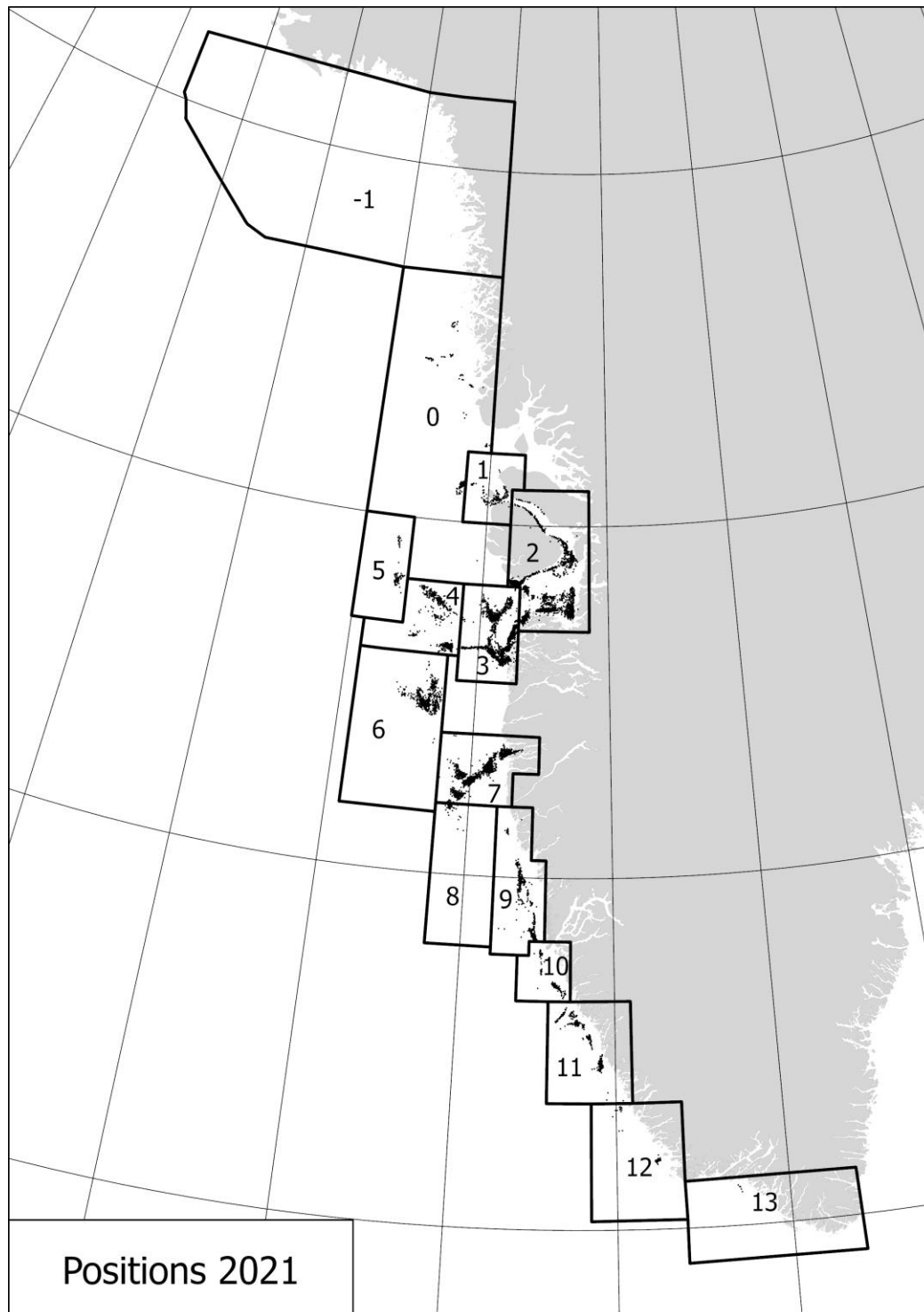
**Figure 1c.** *P. borealis* in W. Greenland: Nominal and effective sizes of the Greenland coastal trawler fleet, 1986–2022, from logbook records.



**Figure 2.** *P. borealis* in W. Greenland: Catches in NAFO Subarea 1 and Canadian SFA 1, 1970–2022. 2022 is projected catch.



**Figure 3.** *P. borealis* in W. Greenland: Fishing effort applied in NAFO Subarea 1, 1970–2022. 2022 is on part-year's data.

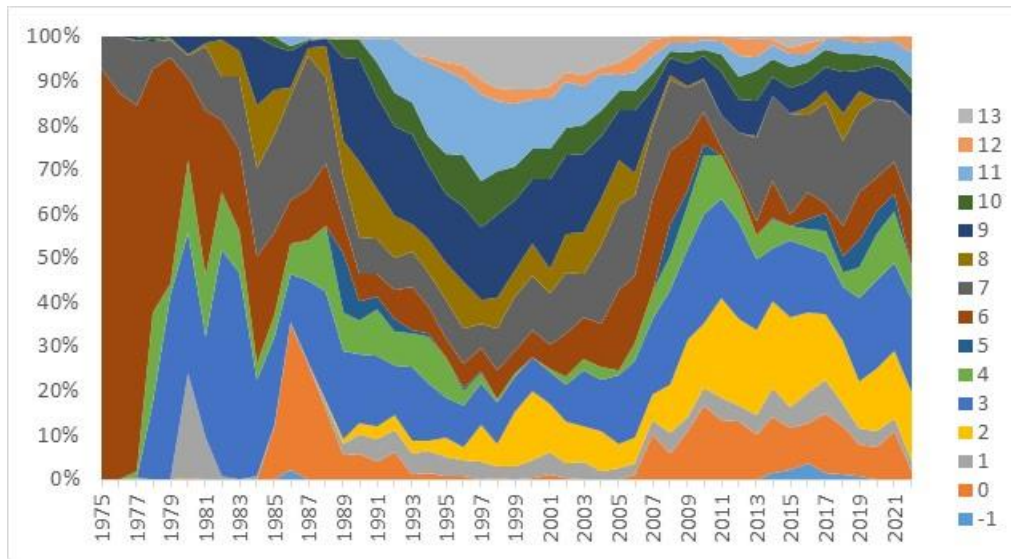


**Figure 4a.** *P. borealis* in W. Greenland: positions of 20 786 hauls by the Greenland coastal fleet in NAFO Subarea 1 up to 76°N from January the 1 to December the 31, 2021. Statistical Areas in green frames. 200 meter depth contour dotted purple line and 600 meter depth contour solid black line.

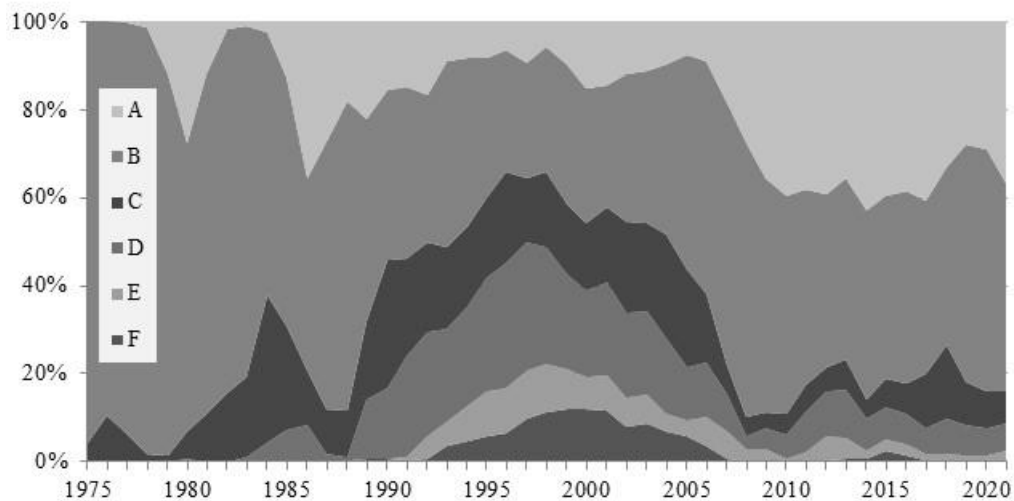


**Figure 4b.** *P. borealis* in W. Greenland: positions of 8 258 hauls by the Greenland offshore fleet in NAFO Subarea 1 up to 76°N from January the 1 through June 2022. Statistical Areas in green frames. 200 meter depth contour dotted purple line and 600 meter depth contour solid purple line.

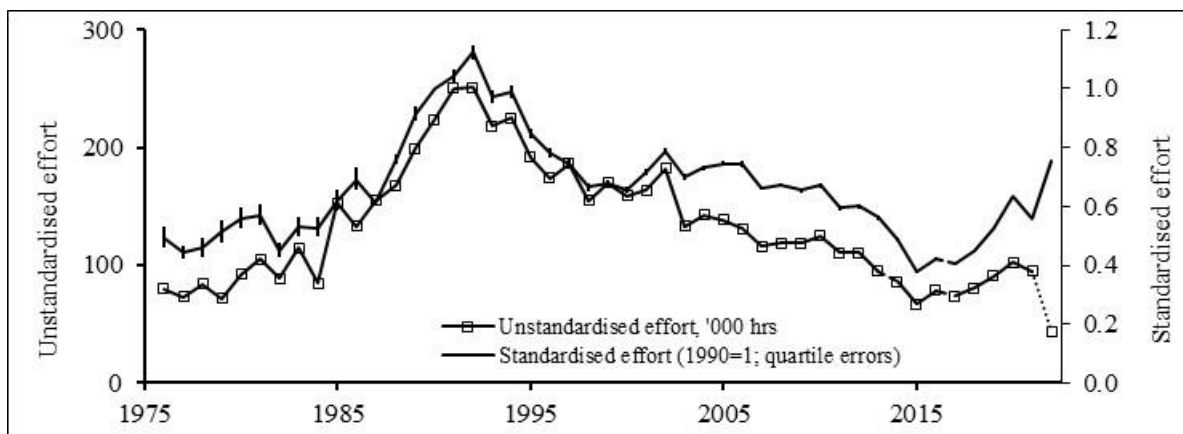




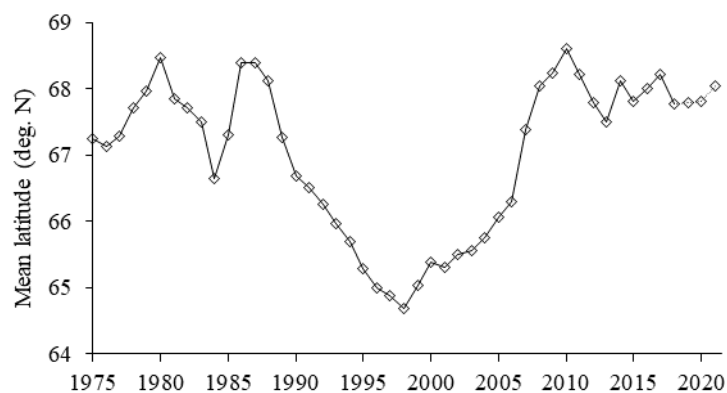
**Figure 5a.** *P. borealis* in W. Greenland: Distribution of the logbook-recorded catch between statistical Areas in Greenland waters, 1975-2022. (The light band that starts broad on the left-hand side is Area 6; the light band at the top is Area 0, the dark wedge at the very bottom from 1992 to 2007 is Area 13.)



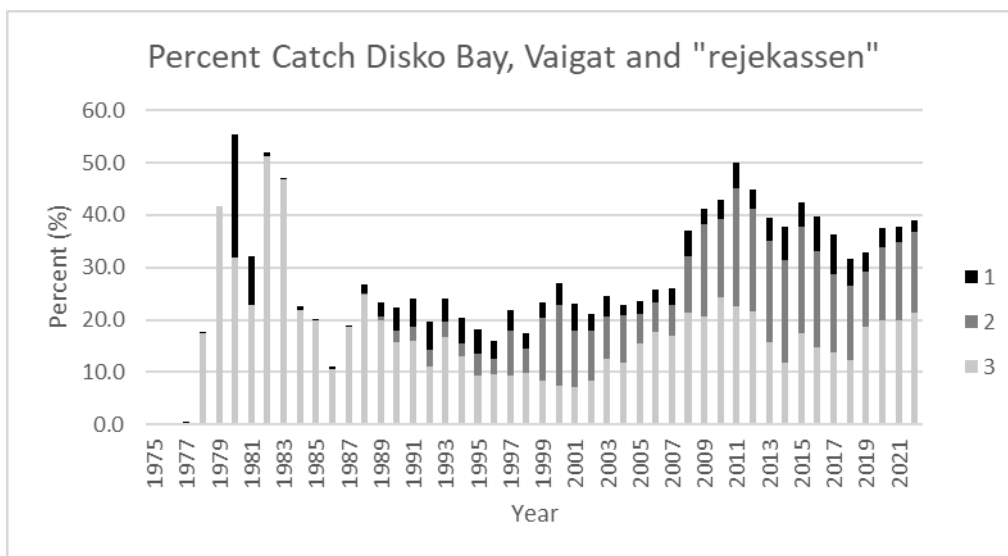
**Figure 5b.** *P. borealis* in W. Greenland: Distribution of the logbook-recorded catch between NAFO Divisions in Subarea 1 up to 76° N, 1975-2022.



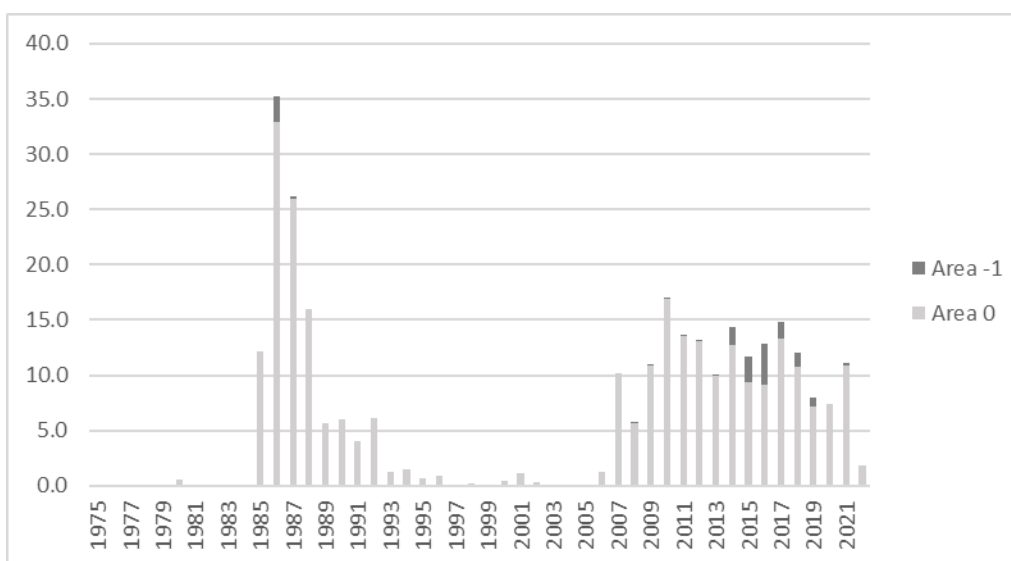
**Figure 6a.** *P. borealis* in W. Greenland: diversity indices for the distribution of logbook-recorded catch between statistical Areas in Greenland waters, 1975–2022. 2022 is on part-year's data.



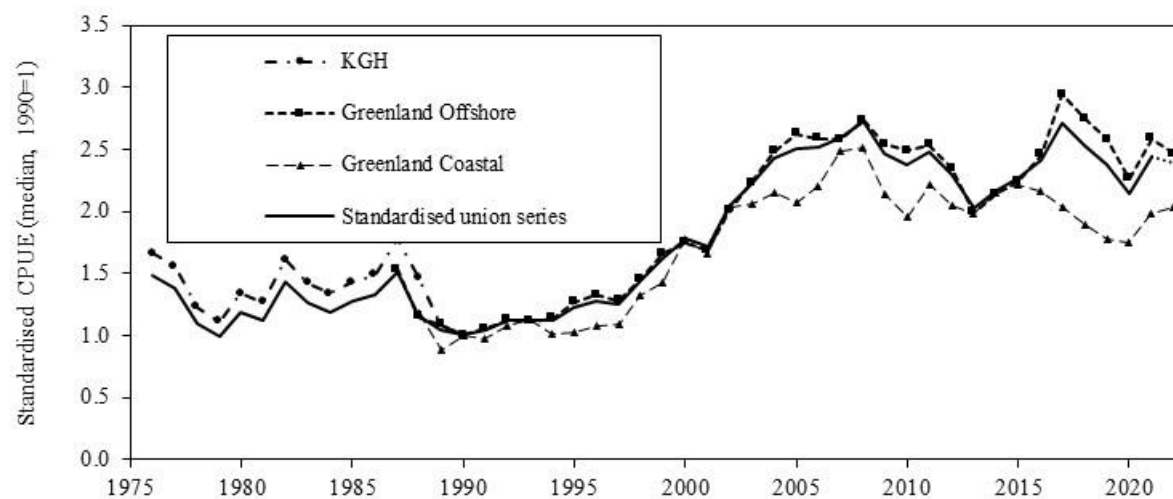
**Figure 6b.** *P. borealis* in W. Greenland: diversity indices for the distribution of logbook-recorded catch between statistical Areas in Greenland waters, 1975–2022. 2022 is on part-year's data.



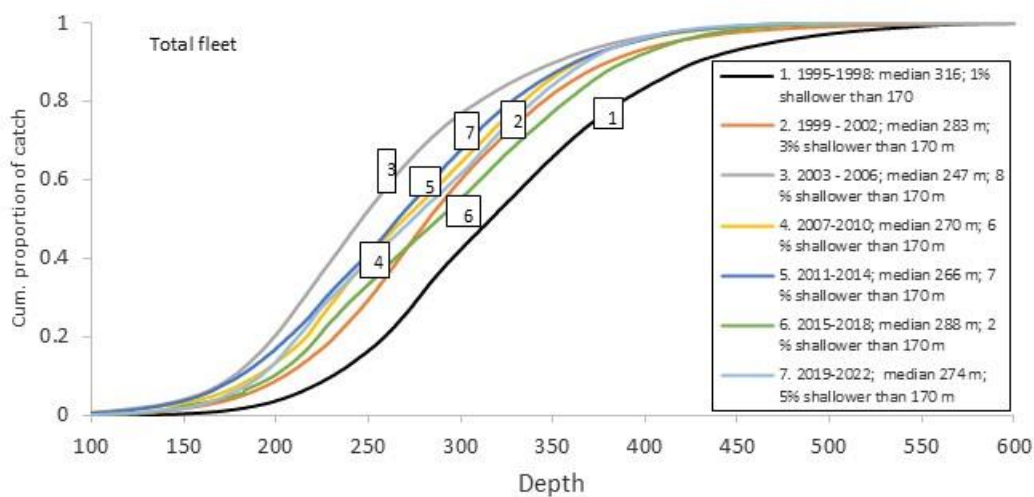
**Figure 7a.** *P. borealis* in W. Greenland: distribution of catches in the Disko Bay Area (statistical Areas 1, 2 and 3) 1990–2022. 2022 is on part-year's data.



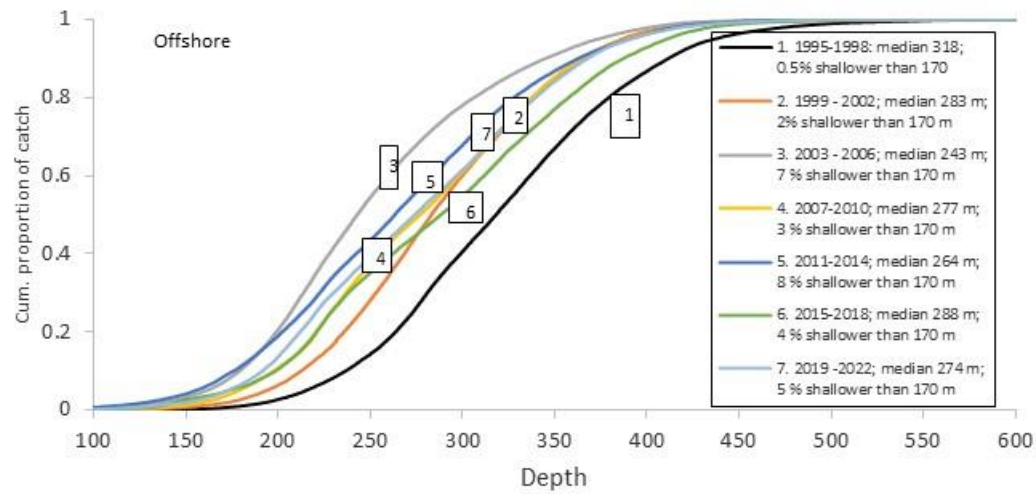
**Figure 8.** *P. borealis* in W. Greenland: catches taken in statistical area 0 and -1 as a percentage of total catches, 1990–2022. 2022 is on part-year's data.



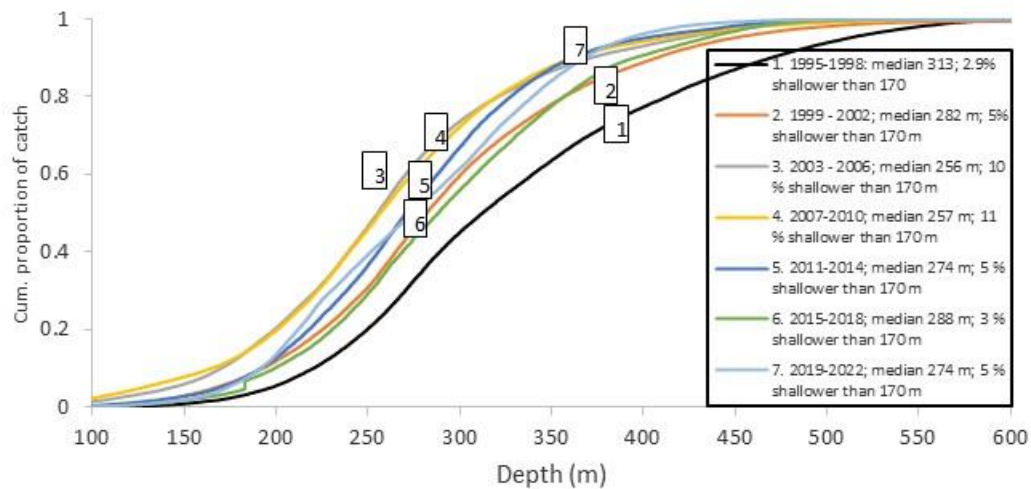
**Figure 9.** *P. borealis* in W. Greenland: standardized (1990=1) CPUE series from three fleets and a standardized union series 1976–2022. 2022 is on part-year's data.



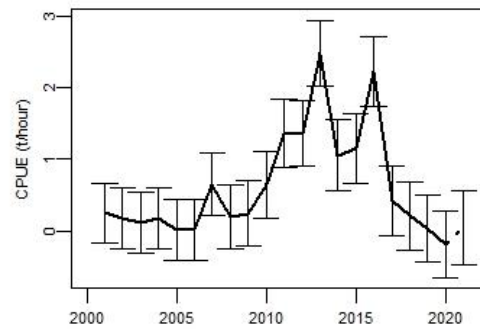
**Figure 10a.** *P. borealis* in W. Greenland: standardized (1990=1) CPUE series from all fleets and a standardized union series 1976–2022. 2022 is on part-year's data.



**Figure 10b.** *P. borealis* in W. Greenland: standardized (1990=1) CPUE series from offshore fleets and a standardized union series 1976–2022. 2022 is on part-year's data.



**Figure 10c.** *P. borealis* in W. Greenland: standardised (1990=1) CPUE series from coastal fleets and a standardised union series 1976–2022. 2022 is on part-year's data.



**Figure 11.** *P. montagui* in W. Greenland. Standardized CPUE series from 5 offshore fleets 2008 - 2021. 2021 is on part-year's data. Error bars show 95% confidence limits. Not updated in 2022, due to very low catches of *P. montagui* in 2021 and 2022.

## Appendix I: A standardised CPUE series for the Greenland Offshore fleet.

The SAS System

The GLM Procedure

Dependent Variable: LNCPUE

Weight: hauls

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

Model 117 258927.6676 2213.0570 718.97 <.0001

Error 23686 72907.2585 3.0781

Corrected Total 23803 331834.9261

R-Square Coeff Var Root MSE LNCPUE Mean

0.780291 66.42481 1.754444 2.641248

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

VESSEL 58 234874.6501 4049.5629 1315.62 <.0001

MONTH 11 3194.9111 290.4465 94.36 <.0001

area 11 5939.1255 539.9205 175.41 <.0001

year 35 13999.5522 399.9872 129.95 <.0001

HOLD 2 919.4287 459.7143 149.35 <.0001

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

VESSEL 58 24028.04089 414.27657 134.59 <.0001

MONTH 11 2227.60704 202.50973 65.79 <.0001

area 11 5101.46886 463.76990 150.67 <.0001

year 35 13775.54125 393.58689 127.87 <.0001

HOLD 2 919.42868 459.71434 149.35 <.0001

Parameter Estimate Standard

Error t Value Pr > |t|

Intercept 2.058654621 B 0.09621165 21.40 <.0001

VESSEL hh01 -0.651419905 B 0.08081395 -8.06 <.0001

VESSEL hh02 -0.659175849 B 0.07090882 -9.30 <.0001

VESSEL hh03 -0.520562042 B 0.07216459 -7.21 <.0001

VESSEL hh04 -0.457865770 B 0.07127907 -6.42 <.0001



VESSEL hh05 -0.446191470 B 0.07204182 -6.19 <.0001  
 VESSEL hh06 -0.421992953 B 0.07360185 -5.73 <.0001  
 VESSEL hh07 -0.245104768 B 0.07223153 -3.39 0.0007  
 VESSEL hh08 -0.246535633 B 0.06805886 -3.62 0.0003  
 VESSEL hh09 -0.250656171 B 0.07009021 -3.58 0.0003  
 VESSEL hh10 -0.231472837 B 0.06855630 -3.38 0.0007  
 VESSEL hh11 -0.191851869 B 0.06752651 -2.84 0.0045  
 VESSEL hh12 -0.166550977 B 0.06881804 -2.42 0.0155  
 VESSEL hh13 -0.169404261 B 0.07006810 -2.42 0.0156  
 VESSEL hh14 -0.115574962 B 0.06893233 -1.68 0.0936  
 VESSEL hh15 -0.129827070 B 0.06813433 -1.91 0.0567  
 VESSEL hh16 -0.116797006 B 0.06933088 -1.68 0.0921  
 VESSEL hh17 -0.123775517 B 0.06874027 -1.80 0.0718  
 VESSEL hh18 -0.111563839 B 0.06854788 -1.63 0.1036  
 VESSEL hh19 -0.098327892 B 0.06776664 -1.45 0.1468  
 VESSEL hh20 -0.101613141 B 0.06572158 -1.55 0.1221  
 VESSEL hh21 0.179417462 B 0.06736882 2.66 0.0077  
 VESSEL hh22 -0.085643681 B 0.06904386 -1.24 0.2148  
 VESSEL hh23 0.227488725 B 0.07401393 3.07 0.0021  
 VESSEL hh24 -0.037589967 B 0.06946786 -0.54 0.5884  
 VESSEL hh25 -0.021627165 B 0.06829563 -0.32 0.7515  
 VESSEL hh26 0.244130361 B 0.06608672 3.69 0.0002  
 VESSEL hh27 0.050906442 B 0.07124564 0.71 0.4749  
 VESSEL hh28 0.310458858 B 0.06753820 4.60 <.0001  
 VESSEL hh29 0.087875624 B 0.06671333 1.32 0.1878  
 VESSEL hh30 0.369764657 B 0.06648699 5.56 <.0001  
 VESSEL hh31 0.397272214 B 0.06576847 6.04 <.0001  
 VESSEL hh32 0.425660262 B 0.07121290 5.98 <.0001  
 VESSEL hh33 0.146957229 B 0.06838512 2.15 0.0316  
 VESSEL hh34 0.445475709 B 0.07035720 6.33 <.0001  
 VESSEL hh35 0.420434865 B 0.06561414 6.41 <.0001





VESSEL hh36 0.442522537 B 0.10964567 4.04 <.0001  
 VESSEL hh37 0.199922289 B 0.06836059 2.92 0.0035  
 VESSEL hh38 0.233712986 B 0.07233713 3.23 0.0012  
 VESSEL hh39 0.501824995 B 0.06540094 7.67 <.0001  
 VESSEL hh40 0.312534008 B 0.06797904 4.60 <.0001  
 VESSEL hh41 0.325512850 B 0.07512568 4.33 <.0001  
 VESSEL hh42 0.342430028 B 0.06724340 5.09 <.0001  
 VESSEL hh43 0.607940314 B 0.06482999 9.38 <.0001  
 VESSEL hh44 0.611908596 B 0.06602995 9.27 <.0001  
 VESSEL hh45 0.606224967 B 0.06474260 9.36 <.0001  
 VESSEL hh46 0.662501163 B 0.06462712 10.25 <.0001  
 VESSEL hh47 0.480037658 B 0.06775707 7.08 <.0001  
 VESSEL hh48 0.472132262 B 0.06593191 7.16 <.0001  
 VESSEL hh49 0.476094826 B 0.06633229 7.18 <.0001  
 VESSEL hh50 0.482756924 B 0.06818074 7.08 <.0001  
 VESSEL hh51 0.637842272 B 0.06859842 9.30 <.0001  
 VESSEL hh52 0.614059631 B 0.06778747 9.06 <.0001  
 VESSEL hh53 0.777015539 B 0.06701451 11.59 <.0001  
 VESSEL hh54 0.375132067 B 0.09138793 4.10 <.0001  
 VESSEL hh55 0.234283517 B 0.06717868 3.49 0.0005  
 VESSEL hh56 0.705396786 B 0.06935759 10.17 <.0001  
 VESSEL hh57 0.740142291 B 0.07871702 9.40 <.0001  
 VESSEL hh58 0.821789174 B 0.09497259 8.65 <.0001  
 VESSEL hh59 0.000000000 B ...  
 MONTH 1 -0.013621420 B 0.01370069 -0.99 0.3201  
 MONTH 2 0.045534583 B 0.01379827 3.30 0.0010  
 MONTH 3 0.073757443 B 0.01334353 5.53 <.0001  
 MONTH 4 0.126596460 B 0.01272711 9.95 <.0001  
 MONTH 5 0.020353121 B 0.01247584 1.63 0.1028  
 MONTH 6 0.199362452 B 0.01270616 15.69 <.0001  
 MONTH 7 0.209841306 B 0.01248924 16.80 <.0001

MONTH 8 0.098318186 B 0.01248653 7.87 <.0001  
 MONTH 9 0.068746694 B 0.01258779 5.46 <.0001  
 MONTH 10 0.061226972 B 0.01267952 4.83 <.0001  
 MONTH 11 0.043673155 B 0.01277316 3.42 0.0006  
 MONTH 12 0.000000000 B ...  
 area -1 -1.190061742 B 0.03915894 -30.39 <.0001  
 area 0 -0.422630223 B 0.02137492 -19.77 <.0001  
 area 3 -0.070574830 B 0.02178258 -3.24 0.0012  
 area 4 -0.313379129 B 0.02100253 -14.92 <.0001  
 area 5 -0.409042251 B 0.02464754 -16.60 <.0001  
 area 6 -0.187476961 B 0.02042886 -9.18 <.0001  
 area 7 -0.234250707 B 0.02037676 -11.50 <.0001  
 area 8 -0.219586255 B 0.02079770 -10.56 <.0001  
 area 9 -0.211804859 B 0.01975866 -10.72 <.0001  
 area 10 -0.189415611 B 0.02086821 -9.08 <.0001  
 area 11 -0.148208701 B 0.02018891 -7.34 <.0001  
 area 12 0.000000000 B ...  
 year 1987 0.425486383 B 0.02055659 20.70 <.0001  
 year 1988 0.140522300 B 0.01803297 7.79 <.0001  
 year 1989 0.080495052 B 0.01732388 4.65 <.0001  
 year 1991 0.055125938 B 0.01593098 3.46 0.0005  
 year 1992 0.118364872 B 0.01631462 7.26 <.0001  
 year 1993 0.105081018 B 0.01675582 6.27 <.0001  
 year 1994 0.129866913 B 0.01686794 7.70 <.0001  
 year 1995 0.239175808 B 0.01747843 13.68 <.0001  
 year 1996 0.281724357 B 0.01862124 15.13 <.0001  
 year 1997 0.247065074 B 0.01963254 12.58 <.0001  
 year 1998 0.375198644 B 0.02116267 17.73 <.0001  
 year 1999 0.506524217 B 0.02202386 23.00 <.0001  
 year 2000 0.558300045 B 0.02352636 23.73 <.0001  
 year 2001 0.525251359 B 0.02413320 21.76 <.0001

year 2002 0.697106046 B 0.02244028 31.06 <.0001  
 year 2003 0.803714796 B 0.02232319 36.00 <.0001  
 year 2004 0.909373323 B 0.02239743 40.60 <.0001  
 year 2005 0.965010620 B 0.02245437 42.98 <.0001  
 year 2006 0.949502379 B 0.02260883 42.00 <.0001  
 year 2007 0.949068691 B 0.02358327 40.24 <.0001  
 year 2008 1.006735294 B 0.02369775 42.48 <.0001  
 year 2009 0.933387795 B 0.02501560 37.31 <.0001  
 year 2010 0.911642154 B 0.02514480 36.26 <.0001  
 year 2011 0.928961351 B 0.02564593 36.22 <.0001  
 year 2012 0.852561925 B 0.02522654 33.80 <.0001  
 year 2013 0.690469989 B 0.02536066 27.23 <.0001  
 year 2014 0.760208404 B 0.02631396 28.89 <.0001  
 year 2015 0.808479715 B 0.02775157 29.13 <.0001  
 year 2016 0.899440138 B 0.02751419 32.69 <.0001  
 year 2017 1.078543345 B 0.02721607 39.63 <.0001  
 year 2018 1.010022512 B 0.02720305 37.13 <.0001  
 year 2019 0.949011996 B 0.02695667 35.21 <.0001  
 year 2020 0.816346615 B 0.02727254 29.93 <.0001  
 year 2021 0.951294975 B 0.02769847 34.34 <.0001  
 year 2022 0.901304207 B 0.03495649 25.78 <.0001  
 year 2090 0.000000000 B ...

HOLD 1 -0.082308207 B 0.06687141 -1.23 0.2184

HOLD 2 0.097406996 B 0.06639035 1.47 0.1423

HOLD 3 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 II: A standardised CPUE series for the Greenland Coastal fleet.**

The SAS System

The GLM Procedure

Dependent Variable: LNCPUE

Weight: Hauls



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

Model 84 59332.11549 706.33471 237.19 <.0001

Error 12792 38094.38249 2.97798

Corrected Total 12876 97426.49798

R-Square Coeff Var Root MSE LNCPUE Mean

0.608994 85.91452 1.725684 2.008606

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

area 4 3281.42571 820.35643 275.47 <.0001

MONTH 11 3161.09545 287.37231 96.50 <.0001

VESSEL 35 29182.83488 833.79528 279.99 <.0001

year 34 23706.75945 697.25763 234.14 <.0001

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

area 4 2979.73682 744.93420 250.15 <.0001

MONTH 11 2457.37842 223.39804 75.02 <.0001

VESSEL 35 11816.46104 337.61317 113.37 <.0001

year 34 23706.75945 697.25763 234.14 <.0001

Parameter Estimate Standard

Error t Value Pr > |t|

Intercept 1.982253102 B 0.03438471 57.65 <.0001

area 1 -0.292774912 B 0.01568564 -18.67 <.0001

area 2 -0.379068463 B 0.01465800 -25.86 <.0001

area 3 -0.153303882 B 0.01442487 -10.63 <.0001

area 7 -0.303418034 B 0.01563351 -19.41 <.0001

area 13 0.000000000 B...

MONTH 1 -0.032239455 B 0.01779333 -1.81 0.0700

MONTH 2 -0.023209490 B 0.01874580 -1.24 0.2157

MONTH 3 0.122044540 B 0.01838214 6.64 <.0001

MONTH 4 0.265852097 B 0.01694315 15.69 <.0001

MONTH 5 0.126425972 B 0.01608657 7.86 <.0001

MONTH 6 0.153570955 B 0.01623000 9.46 <.0001



MONTH 7 0.204319580 B 0.01646148 12.41 <.0001  
 MONTH 8 0.131111500 B 0.01666119 7.87 <.0001  
 MONTH 9 0.034351708 B 0.01668885 2.06 0.0396  
 MONTH 10 -0.003282990 B 0.01640306 -0.20 0.8414  
 MONTH 11 0.026373573 B 0.01662590 1.59 0.1127  
 MONTH 12 0.000000000 B ...  
 VESSEL cc01 -0.884613304 B 0.04242738 -20.85 <.0001  
 VESSEL cc02 -0.809640605 B 0.05974406 -13.55 <.0001  
 VESSEL cc03 -0.731728909 B 0.04640194 -15.77 <.0001  
 VESSEL cc04 -0.730179651 B 0.03902809 -18.71 <.0001  
 VESSEL cc05 -0.719076123 B 0.03828391 -18.78 <.0001  
 VESSEL cc06 -0.618179896 B 0.03164829 -19.53 <.0001  
 VESSEL cc07 -0.604411459 B 0.04039046 -14.96 <.0001  
 VESSEL cc08 -0.605299925 B 0.03657186 -16.55 <.0001  
 VESSEL cc09 -0.464887694 B 0.03006824 -15.46 <.0001  
 VESSEL cc10 -0.538533201 B 0.04198758 -12.83 <.0001  
 VESSEL cc11 -0.510790119 B 0.02896957 -17.63 <.0001  
 VESSEL cc12 -0.506597613 B 0.02886448 -17.55 <.0001  
 VESSEL cc13 -0.450763606 B 0.03000517 -15.02 <.0001  
 VESSEL cc14 -0.425202231 B 0.03099372 -13.72 <.0001  
 VESSEL cc15 -0.455885659 B 0.02767493 -16.47 <.0001  
 VESSEL cc16 -0.391063645 B 0.02811093 -13.91 <.0001  
 VESSEL cc17 -0.379869591 B 0.02794613 -13.59 <.0001  
 VESSEL cc18 -0.342145167 B 0.03095114 -11.05 <.0001  
 VESSEL cc19 -0.321914607 B 0.02654545 -12.13 <.0001  
 VESSEL cc20 -0.301541240 B 0.02699546 -11.17 <.0001  
 VESSEL cc21 -0.307492075 B 0.02732896 -11.25 <.0001  
 VESSEL cc22 -0.281061611 B 0.02659715 -10.57 <.0001  
 VESSEL cc23 -0.287150461 B 0.02670349 -10.75 <.0001  
 VESSEL cc24 -0.309391711 B 0.02712846 -11.40 <.0001  
 VESSEL cc25 -0.255748407 B 0.02903753 -8.81 <.0001



VESSEL cc26 -0.239923466 B 0.02696572 -8.90 <.0001  
 VESSEL cc27 -0.251632005 B 0.03309920 -7.60 <.0001  
 VESSEL cc28 -0.256616765 B 0.02976685 -8.62 <.0001  
 VESSEL cc29 -0.246008137 B 0.02715748 -9.06 <.0001  
 VESSEL cc30 -0.170915301 B 0.04032013 -4.24 <.0001  
 VESSEL cc31 -0.032883072 B 0.02986103 -1.10 0.2708  
 VESSEL cc32 -0.120473576 B 0.03438391 -3.50 0.0005  
 VESSEL cc33 -0.085929218 B 0.03510128 -2.45 0.0144  
 VESSEL cc34 0.043584928 B 0.03098044 1.41 0.1595  
 VESSEL cc35 0.466466406 B 0.02879985 16.20 <.0001  
 VESSEL cc38 0.000000000 B ...  
 year 1988 0.162889744 B 0.03929523 4.15 <.0001  
 year 1989 -0.119751843 B 0.02937667 -4.08 <.0001  
 year 1991 -0.022512899 B 0.02634495 -0.85 0.3928  
 year 1992 0.069679704 B 0.02641733 2.64 0.0084  
 year 1993 0.121062878 B 0.02620589 4.62 <.0001  
 year 1994 0.009934531 B 0.02556244 0.39 0.6976  
 year 1995 0.023777313 B 0.02594440 0.92 0.3594  
 year 1996 0.068818826 B 0.02701060 2.55 0.0109  
 year 1997 0.090371615 B 0.02642831 3.42 0.0006  
 year 1998 0.283075204 B 0.02911293 9.72 <.0001  
 year 1999 0.354881466 B 0.02597204 13.66 <.0001  
 year 2000 0.571378915 B 0.02606271 21.92 <.0001  
 year 2001 0.507672490 B 0.02566164 19.78 <.0001  
 year 2002 0.712189016 B 0.02584436 27.56 <.0001  
 year 2003 0.722922539 B 0.02650723 27.27 <.0001  
 year 2004 0.766942119 B 0.02566539 29.88 <.0001  
 year 2005 0.731076816 B 0.02597352 28.15 <.0001  
 year 2006 0.787287072 B 0.02680719 29.37 <.0001  
 year 2007 0.908720479 B 0.02694954 33.72 <.0001  
 year 2008 0.923559679 B 0.02609003 35.40 <.0001

year 2009 0.759599478 B 0.02640742 28.76 <.0001  
 year 2010 0.671405553 B 0.02664968 25.19 <.0001  
 year 2011 0.797477384 B 0.02673341 29.83 <.0001  
 year 2012 0.716087025 B 0.02686521 26.65 <.0001  
 year 2013 0.683789237 B 0.02888602 23.67 <.0001  
 year 2014 0.764492905 B 0.02988799 25.58 <.0001  
 year 2015 0.797908845 B 0.03148317 25.34 <.0001  
 year 2016 0.768628225 B 0.02961749 25.95 <.0001  
 year 2017 0.711133603 B 0.03039633 23.40 <.0001  
 year 2018 0.637695650 B 0.02984327 21.37 <.0001  
 year 2019 0.574827961 B 0.02900890 19.82 <.0001  
 year 2020 0.558053445 B 0.02908259 19.19 <.0001  
 year 2021 0.682328252 B 0.02945730 23.16 <.0001  
 year 2022 0.713088787 B 0.04045341 17.63 <.0001  
 year 2090 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.