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The Fishery for Northern Shrimp (*Pandalus borealis*) off West Greenland, 1970–2024

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 fluctuated, and the total catches was in 2023 113 223 tons in Greenland EZZ and zero catches in in Canadian EEZ.

The enacted TAC for Greenland in 2024 is set at 102 500 tons and a TAC of 786 tons were set for Canada, by the Greenland Self-government. The projected catch for 2024 is set at 102 500 tons. The enacted TAC for Canada in 2024 is 13 490 tons, no fishery has been conducted yet and catch for 2024 is expected to be below 1 ton.

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 mid1990s. 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 34% lower value in 2023. Preliminary data from 2024 indicated a further decline in 2024 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 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 licenses 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 licenses 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 licenses, 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 licenses 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 are 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.[2]), 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'ties, a shrimp fishery has been conducted at the east side of Isfjeld 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 $D = 1 \Big/ \sqrt{\sum_i p_i^2}$ where p_i is the proportion of the total catch taken by the ith 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:

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

where $CPUE_{mjki}$ 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 $\ln(CPUE)$; 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 ε_{mjki} are assumed to be distributed $N(0,\sigma^2/n)$ where n is the number of observations in the cell and σ^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 are 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 haven been available since 2011 resulting in removal of the Canadian CPUE index.

One unified series of standardised CPUE, covering 1976–2024 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 seperately 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

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

the A_{yf}—GLM-estimated year effects for fleet f—being considered to be Normally distributed about a series of overall year effects $\overline{A}_y$ with individual error variances σ_{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 2023 TACs for SFA1 have ranged from 8 500 to 16 291 t and in 2024 TAC was 13 490 t. Averaged estimated biomass for the entire time series is 7 500 t (Burmeister and Rigét, 2020). Catches in 2011 – 2023 ranged from 0 to 3001 tons with an average of about 918 t. SFA1 is such a small proportion of the total distribution area that it seems unlikely to threaten the continued existence of the stock, given that this is not a highly migratory species. In 2011–2023 Canadian catches averaged approx. 0.3% of the estimated survey biomass in the entire stock distribution area (Burmeister et al., 2019, 2023). The projected catch for Canada from Div. 0A in 2024 is expected to be in the region of less than 1 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, but declined in 2023 in conjunction with decreasing TAC and was in 2023, 113 223 t. It was 3 223 tons more than the agreed TAC, due to banking and borrowing rules (see method section for further explanation). The projected catch in Greenland EEZ for 2024 is 102 500 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 a low level of 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 2024, is an effect of six months data (1 Jan. to 30 Jun. 2023). As shown in 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 17 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 Buch 2023). 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 of the year, but with some variation the amount of catch taken during summer and wintertime. The most recent 11 years, 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 (99th 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 both inshore and offshore catches were continuous increasing and has in the most past years (2015-2018) been 288 m and is comparable to observations from 2019-2022 at 274 m and dropped to 267m in 2023.

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 1975–2022 (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[1] 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 the fishery 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 to 3.2% of the shrimp catch—than logbook reports on average indicate (Sünksen 2007).

Catch per unit of effort

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 9, Table 2 and table 3.b); the early offshore fleet fishing in Div. 1A and part of 1B (KGH-index, 1976-1990), the present offshore fleet fishing in Subarea 1 (1987-2024) and the coastal fleet fishing in coastal and inshore areas (1989-2024). 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 year CPUE slightly decrease for the coastal fleet, stopped in 2021 and CPUE has since remain stable. CPUE of the offshore fleet increased to 2017 and has since declined. Partial data from 2024 indicate a further decline in CPUE for the offshore fleet component to a relative low value compared to the past ten years (Table 2, Fig. 9). The decline in the preliminary CPUE, could be an effect of the sea ice which could have limited the trawlers to smaller fishing grounds in the southern part (south of 65 N) with lower densities of shrimps and preventing the trawlers fishing at the more northern fishing grounds with higher densities of shrimps. Nevertheless, 2024 hasn't been an abnormal year for sea ice coverage, but the sea ice was gone later than compared to before 2021. The combine CPUE index has been declining to a low value in 2024 and is the lowest value since 2013.

The three CPUE series are combined by assuming they all reflect the overall biomass series scaled by a constant fleet factor, and that the errors had mean zero and variances inversely proportional to the fishing ground of the fleet. The estimation was done in a Bayesian framework.

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

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[1] 'CEDER: Catch, Effort and Discard Monitoring in Real Time'

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 (Kanneworff, 2003), but survey estimates of biomass have been low since the turn of the century (Rigét and Burmeister 2017, Rigét 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 (2001-2023) 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, 1990–2024. (2024 is only preliminary data from January 1st to June 30rd).

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	1.04
1992	44200	8500	52700	75341	22653	97994	7493	105487	234	17	251	1.13	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	0.75	420	412	420	1.25
1998	60729	7650	68379	69156	10406	79562	933	80495	153	3	155	0.67	521	353	518	1.43
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	0.66	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	2.21
2004	135352	14167	149519	121658	20653	142311	7021	149332	130	12	142	0.73	1095	569	1049	2.42
2005	134000	18452	152452	128068	21910	149978	6921	156899	129	9	139	0.75	1159	744	1131	2.51
2006	134000	18380	152380	127747	25441	153188	4127	157315	126	5	131	0.75	1215	884	1203	2.51
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	0.66	1134	-	-	2.46
2010	114570	15583	130153	94596	33513	128109	5561	133670	118	7	125	0.67	1081	839	1068	2.36
2011	124000	15583	139583	78437	44222	122659	1274	123933	108	3	111	0.60	1139	399	1118	2.47
2012	101675	12750	114425	76090	39875	115965	5	115970	111	0	111	0.60	1047	56	1047	2.28
2013	89263	11333	100596	65797	29582	95379	2	95381	95	0	95	0.56	1002	120	1002	2.01
2014	86316	11333	97649	60768	27997	88765	0	88765	86	-	86	0.49	1035	-	1032	2.16
2015	74061	8500	82561	49246	23008	72254	2	72256	67	0	67	0.38	1076	34	1076	2.26
2016	85801	10625	96426	56593	27763	84356	1163	85519	78	3	81	0.42	1078	421	1055	2.40
2017	88957	12750	101707	63037	26332	89369	3001	92370	74	7	80	0.41	1216	452	1153	2.70
2018	99998	14875	114873	68942	24247	93189	1689	94878	80	4	84	0.45	1159	422	1124	2.51
2019	105000	14875	119875	77589	24388	101977	2463	104440	91	7	98	0.53	1122	333	1062	2.34
2020	110000	15229	125229	86181	26936	113117	641	113758	103	3	106	0.64	1103	207	1076	2.12
2021	115000	15937	130937	88250	26098	114348	221	114569	95	1	96	0.57	1206	311	1199	2.40
2022	115000	16291	131291	91031	27108	118139	0.49	118139	99	1	99	0.65	1197	140	1189	2.18
2023	110000	15538	125538	85064	28159	113223	0	113223	102	-	48	0.65	1112	-	2359	2.07
2024*	102500	13490	115990	34481	11011	45492	0	45492	44	-	48	0.30	1037	-	948	1.79

* 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. 2024 is only preliminary data.

Year	KGH median	KGH rel. iqr	Offshore median	Offshore rel. iqr	Coastal median	Coastal rel. iqr	Canada SFA1 median	Canada SFA1 rel. iqr	Combined median	Combined rel. iqr
1976	1.660	0.124							1.477	0.204
1977	1.556	0.082							1.384	0.150
1978	1.230	0.082							1.094	0.149
1979	1.113	0.080							0.989	0.148
1980	1.340	0.082							1.191	0.150
1981	1.266	0.077							1.125	0.141
1982	1.611	0.083							1.433	0.150
1983	1.423	0.081							1.267	0.149
1984	1.338	0.079							1.191	0.145
1985	1.432	0.077							1.275	0.145
1986	1.490	0.077							1.322	0.143
1987	1.787	0.080	1.526	0.028			–	–	1.509	0.056
1988	1.465	0.079	1.151	0.024	0.887	0.053	–	–	1.157	0.053
1989	1.086	0.088	1.087	0.023	1.000	0.039	1.114	0.110	1.051	0.050
1990	1.000	0.000	1.000	0.000	0.978	0.038	1.000	0.000	1.000	0.000
1991			1.056	0.022	1.072	0.035	0.795	0.095	1.044	0.050
1992			1.123	0.022	1.129	0.035	0.861	0.103	1.116	0.050
1993			1.109	0.023	1.010	0.035	0.935	0.098	1.115	0.051
1994			1.137	0.023	1.024	0.034	0.652	0.095	1.118	0.051
1995			1.268	0.024	1.071	0.035	0.765	0.102	1.226	0.051
1996			1.321	0.025	1.095	0.036	0.616	0.100	1.278	0.052
1997			1.275	0.027	1.326	0.035	–	–	1.246	0.054
1998			1.450	0.029	1.426	0.039	0.609	0.135	1.433	0.057
1999			1.655	0.030	1.769	0.035	0.880	0.129	1.616	0.056
2000			1.744	0.032	1.658	0.035	1.067	0.137	1.778	0.057
2001			1.689	0.033	2.023	0.034	1.106	0.116	1.710	0.057
2002			2.005	0.030	2.061	0.035	1.318	0.107	2.038	0.056
2003			2.225	0.030	2.150	0.036	1.579	0.113	2.212	0.056
2004			2.479	0.030	2.077	0.034	1.180	0.107	2.423	0.056
2005			2.622	0.030	2.194	0.035	1.261	0.117	2.506	0.056
2006			2.581	0.031	2.478	0.036	1.443	0.141	2.512	0.057
2007			2.579	0.032	2.513	0.036	1.388	0.141	2.588	0.058
2008			2.737	0.032	2.130	0.035	–	–	2.718	0.057
2009			2.540	0.034	1.950	0.035	–	–	2.457	0.059
2010			2.485	0.034	2.209	0.036	2.055	0.182	2.359	0.059
2011			2.520	0.035	2.039	0.036	0.250	0.305	2.471	0.059
2012			2.333	0.034	1.975	0.036	–	–	2.283	0.059
2013			1.987	0.034	2.138	0.039	–	–	2.013	0.061
2014			2.130	0.036	2.211	0.040	–	–	2.163	0.061
2015			2.237	0.037	2.146	0.042	–	–	2.264	0.064
2016			2.448	0.037	2.029	0.040	–	–	2.399	0.063
2017			2.926	0.037	1.885	0.041	–	–	2.695	0.062
2018			2.736	0.037	1.771	0.040	–	–	2.513	0.062
2019			2.546	0.036	1.743	0.039	–	–	2.343	0.061
2020			2.225	0.036	1.974	0.039	–	–	2.115	0.061
2021			2.530	0.037	1.897	0.039	–	–	2.402	0.061
2022			2.239	0.037	1.956	0.043	–	–	2.176	0.062
2023			2.071	0.037	1.920	0.043	–	–	2.069	0.063
2024			1.739	0.045	1.000	0.058	–	–	1.790	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. ***2024 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	42.1	53.9	8.3	7.3	2.8	0.0	0.7	43.2	43.4	4.2	3.1	0.9	0.0	311	974	1240	1971	2381	3143	1000
2022	0.0	41.2	56.5	5.5	9.5	5.6	0.0	0.0	46.0	41.8	3.8	5.1	2.0	0.0	140	894	1350	1459	1873	2838	59
2023	0.0	48.3	47.9	3.6	9.7	3.7	0.0	0.0	49.4	44.0	2.3	4.8	1.3	0.0	-	978	1089	1543	2007	2934	0
2024*	0.0	10.8	28.8	0.8	3.2	1.9	0.0	0.0	13.4	26.2	1.0	2.3	1.0	0.0	-	809	1098	820	1403	1908	-

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	34.8
1B	72.1	56.1	38.3	29.1	33.7	55.4	43.6	44.1	49.4
1C	17.4	13.9	21.5	17.2	20.0	10.6	5.6	10.7	5.5
1D	1.3	6.4	21.5	26.1	19.0	8.2	8.4	6.9	7.3
1E	0.0	0.0	4.0	10.2	6.2	4.3	3.0	2.0	3.0
1F	0.0	0.2	2.1	9.3	9.0	2.1	0.3	0.7	0.0
Diversity	1.8	2.5	3.9	4.8	4.6	2.7	2.8	3.0	2.7

Table 4b. *P. borealis* in W. Greenland; Distribution (%; columns sum to 100) of fishing effort[1] 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	43.6
1B	71.4	49.9	37.7	33.3	34.5	52.2	39.9	41.6	47.2
1C	18.1	12.6	21.9	15.8	13.0	7.0	3.3	6.0	3.7
1D	1.1	6.0	20.0	20.2	13.7	6.1	4.7	4.6	4.2
1E	0.0	0.0	2.4	6.3	4.0	4.6	1.6	1.0	1.3
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

[1]unstandardised single-trawl-equivalent time

Table 5. *P. borealis* in W. Greenland: Catch by month 1976–2024, summed from vessel logs and weighted up to total catch. 2024 is only preliminary data.

AAR	_TYPE_	_FREQ_	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUM
1975	0	3										17	194	92	303
1976	0	10	133	17			3	249	240	265	258	189	45	2	1401
1977	0	12	339	348	247	308	412	615	659	551	458	699	627	398	5661
1978	0	12	119	45	19	95	711	808	748	773	544	435	430	425	5152
1979	0	12	421	94	909	1117	1072	910	745	677	374	215	323	268	7125
1980	0	10	794	785	832	1006	1090	1176	1137	892	938	428			9078
1981	0	12	721	719	600	866	1448	941	1170	1081	767	517	567	426	9823
1982	0	12	503	104	0	359	1226	1137	969	1030	613	940	623	172	7676
1983	0	12	5	34	79	279	1052	1070	1078	764	677	772	709	461	6980
1984	0	12	9	103	923	1514	1632	1768	1613	719	324	784	884	295	10568
1985	0	12	521	868	1325	845	1314	1784	1702	1494	1495	2158	1494	600	15600
1986	0	12	1190	1124	1267	1894	1671	3209	2955	2483	2987	4990	1534	1039	26343
1987	0	12	1500	872	2391	3105	3834	4112	4887	3771	3630	4097	2502	1466	36167
1988	0	12	1478	1858	2288	4746	4869	4887	5058	4617	4902	3591	3129	1768	43191
1989	0	12	1581	1906	2733	4954	4089	6172	7048	5483	3935	3791	2374	2141	46207
1990	0	12	2619	2740	3166	5404	5760	5735	5019	4478	4162	3462	4282	2902	49729
1991	0	12	2538	2259	2509	2372	3969	5838	6395	5033	4658	5351	6320	5150	52392
1992	0	12	2719	2079	3496	3894	4901	6484	6262	5337	4807	6980	5613	4175	56747
1993	0	12	1692	2028	2793	3814	4917	5122	5358	5274	5549	7253	6574	4447	54821
1994	0	12	2775	2508	4217	5493	4715	4601	5915	5086	6322	6722	4610	3574	56538
1995	0	12	2429	3323	4915	6546	5133	4870	5201	5204	4853	4895	3754	2512	53635
1996	0	12	2542	4044	4976	5770	5599	5549	5502	5435	4901	3610	1785	1694	51407
1997	0	12	2992	4937	5166	5404	6311	6738	7833	6630	6491	5970	3756	1686	63914
1998	0	12	5893	4386	4028	6818	7131	7177	7039	3399	3254	2333	1696	1201	54355
1999	0	12	3915	4392	5740	6324	7301	6646	8611	6446	5683	5956	5138	3946	70098
2000	0	12	3517	5171	5934	7225	7714	9058	8495	6273	6222	5483	6636	4619	76347
2001	0	12	3500	4466	5100	4704	7039	9138	9462	8766	7170	8758	6664	6292	81059
2002	0	12	7212	4884	6531	9394	10071	9626	11885	10426	8317	9371	10089	7668	105474
2003	0	12	7025	6551	8711	9709	10428	9113	7714	7877	10020	8700	8645	6467	100960
2004	0	12	8018	8596	8875	12341	14081	12972	12115	9135	13257	13304	11766	10752	135212
2005	0	12	10532	8648	12532	14610	14961	14255	14537	14636	11132	11846	9675	10322	147686
2006	0	12	12563	11713	13939	10923	14108	10925	15363	15119	13450	11826	11663	8941	150533
2007	0	12	5417	8660	10391	13376	13298	13467	16030	14233	13122	11228	9937	10498	139657
2008	0	12	8989	7386	9007	12488	13827	15429	18407	15311	14414	12982	13608	12039	153887
2009	0	12	10993	8126	4321	9183	12422	12698	14606	16683	12642	12892	11923	8540	135029
2010	0	12	8277	7237	8289	9462	11250	13910	13047	12870	11539	12259	10615	9354	128109
2011	0	12	9454	8856	11831	10877	10480	10265	12521	9526	8866	10195	11471	8317	122659
2012	0	12	9399	8623	5839	10089	10780	10026	11486	11514	9164	9684	10728	8632	115964
2013	0	12	8008	6725	8487	9366	8866	8539	7115	8764	7064	8112	7711	6621	95378
2014	0	12	7224	7900	7734	10055	6767	7169	7623	7580	6893	6893	7435	5545	88764
2015	0	12	6855	4863	3536	5629	6411	5804	5641	6516	6678	6759	7214	6347	72253
2016	0	12	7661	7437	6852	7065	5533	5880	7334	7330	7274	7328	8321	6342	84357
2017	0	12	7935	7420	3476	5120	7387	6363	7908	7588	8483	7707	10293	9691	89371
2018	0	12	9588	6765	4789	6816	8035	9186	9242	8310	7686	7896	7830	7046	93189
2019	0	12	8842	8332	8085	10541	9679	7439	8912	7797	6670	8466	8123	9090	101976
2020	0	12	9758	7989	9377	10460	10423	9359	10360	9950	8628	8851	9175	8787	113117
2021	0	12	10421	9059	6459	9790	9015	9254	11505	10937	9479	10947	9036	8446	114348
2022	0	12	13051	9165	4038	10661	11940	9970	11282	11762	8834	9856	9841	7739	118139
2023	0	12	8974	5847	6497	11444	11258	11092	11549	10328	9412	10673	9329	6818	113221
2024	0	6	7606	5349	5795	9052	9171	8518							45491

Table 6. *P. borealis* in W. Greenland: Discards, and landed catch reported[1] as *P. montagui,* in NAFO Subarea 1.

Year	P. borealis		P. montagui		P. borealis 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	515	0.44	272	0.2%	118127
2023	475	0.42	179	0.2%	113223
2024*	178	0.39	154	0.3%	45492

*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.* 2024: projected from part-year's data.
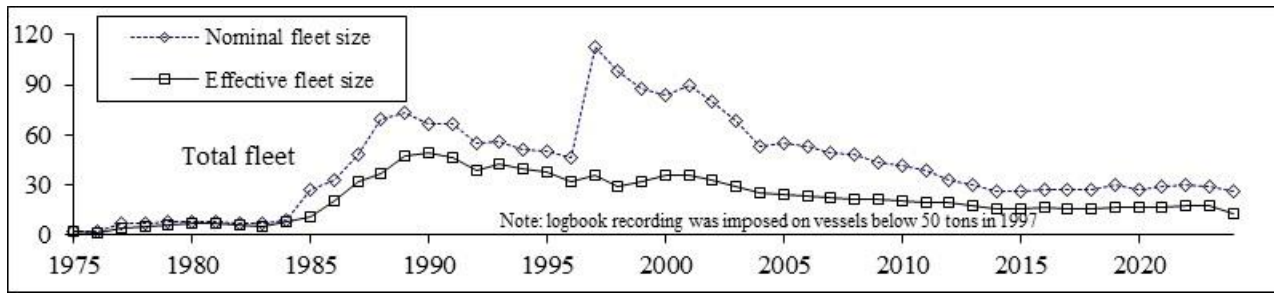
Figure 1a.   *P. borealis* in W. Greenland: Nominal and effective sizes of the Greenland trawler fleet, 1975–2024, from logbook records.
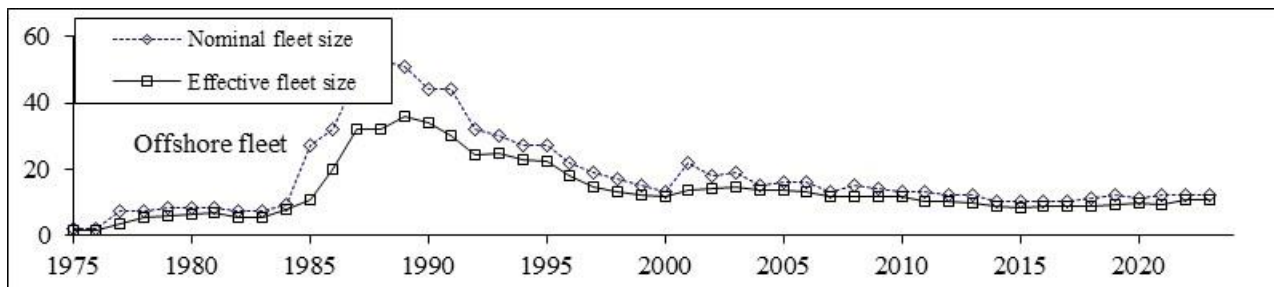

Figure 1b.   *P. borealis* in W. Greenland: Nominal and effective sizes of the Greenland offshore trawler fleet, 1975–2024, from logbook records.
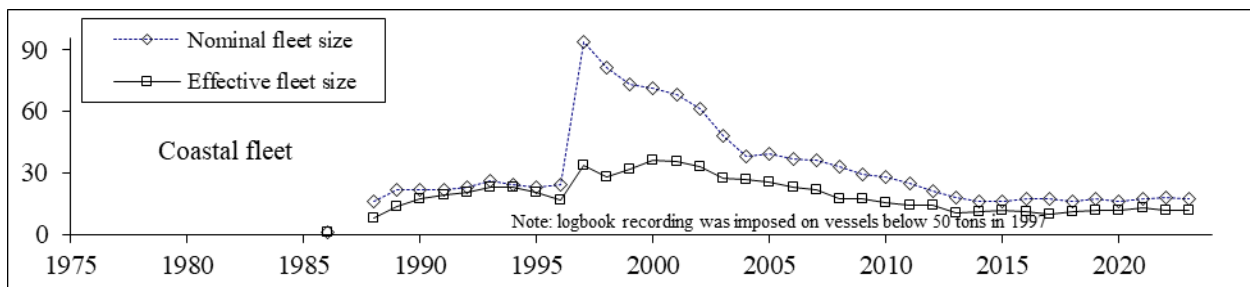

Figure 1c.   *P. borealis* in W. Greenland: Nominal and effective sizes of the Greenland coastal trawler fleet, 1986–2024, from logbook records.
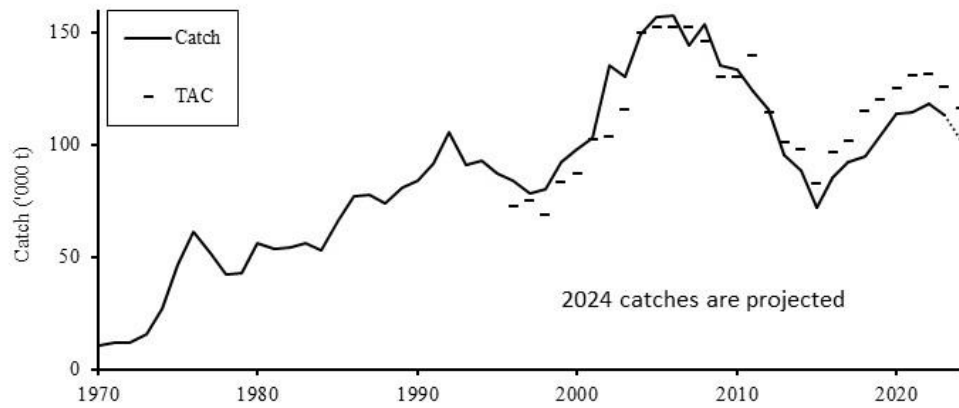
Figure 2.   *P. borealis* in W. Greenland: Catches in NAFO Subarea 1 and Canadian SFA 1, 1970–2024. 2024 is projected catch.
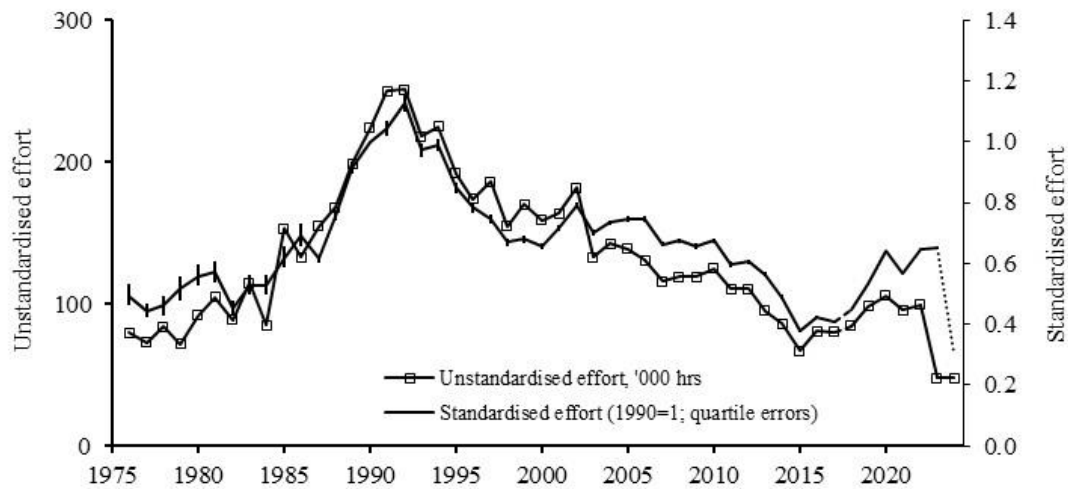
Figure 3.   *P. borealis* in W. Greenland: Fishing effort applied in NAFO Subarea 1, 1970–2024. 2024 is on part-year's data.
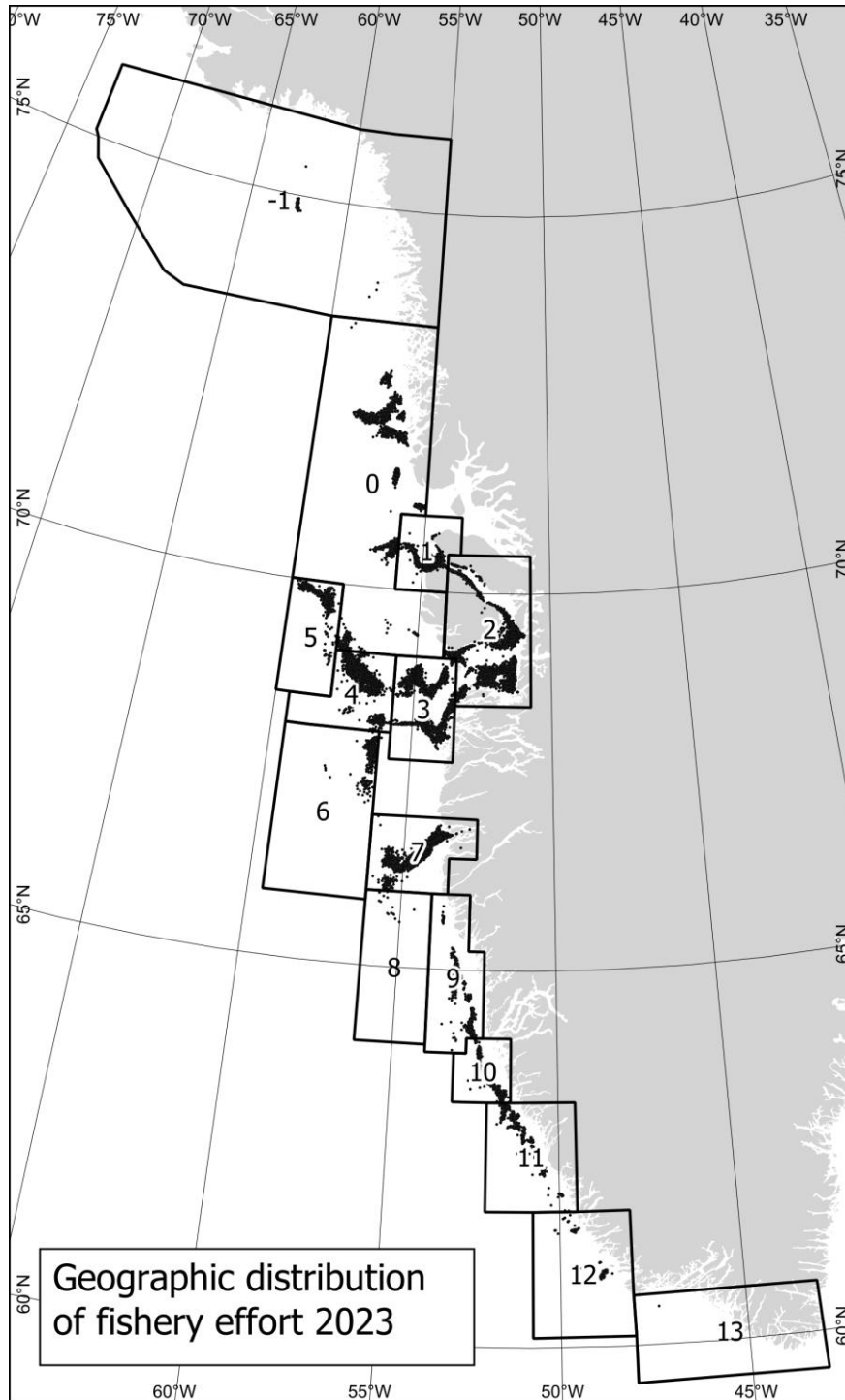
Figure 4a. *P. borealis* in W. Greenland: positions of 19 788 hauls by the Greenland coastal fleet in NAFO Subarea 1 up to 76°N from January the 1 to December the 31, 2023. Statistical Areas in green frames. 200-meter depth contour dotted purple line and 600 meter depth contour solid black line.
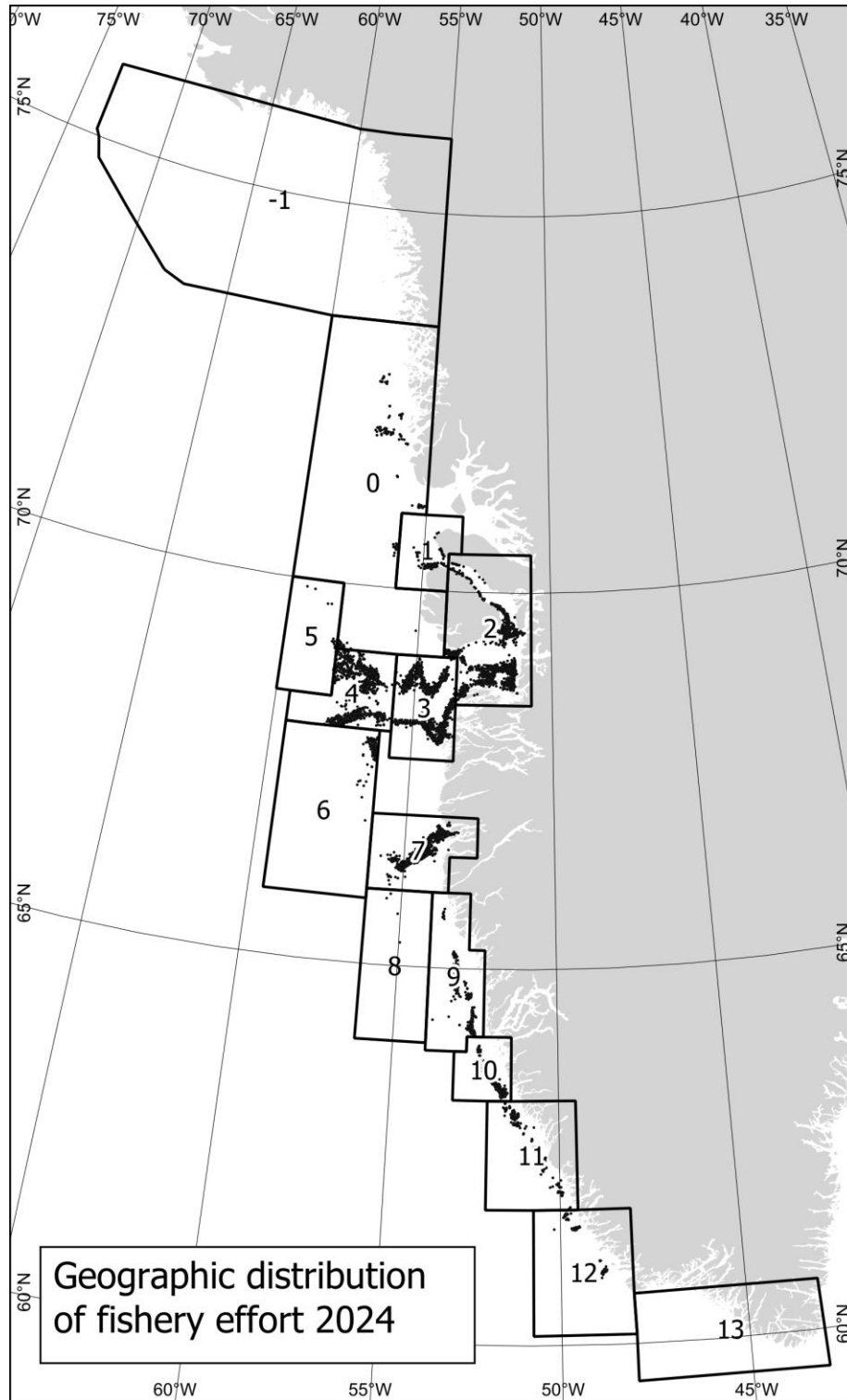
Figure 4b. *P. borealis* in W. Greenland: positions of 8 309 hauls by the Greenland offshore fleet in NAFO Subarea 1 up to 76°N from January the 1 through June 2024. Statistical Areas in green frames. 200-meter depth contour dotted purple line and 600 meter depth contour solid purple line.
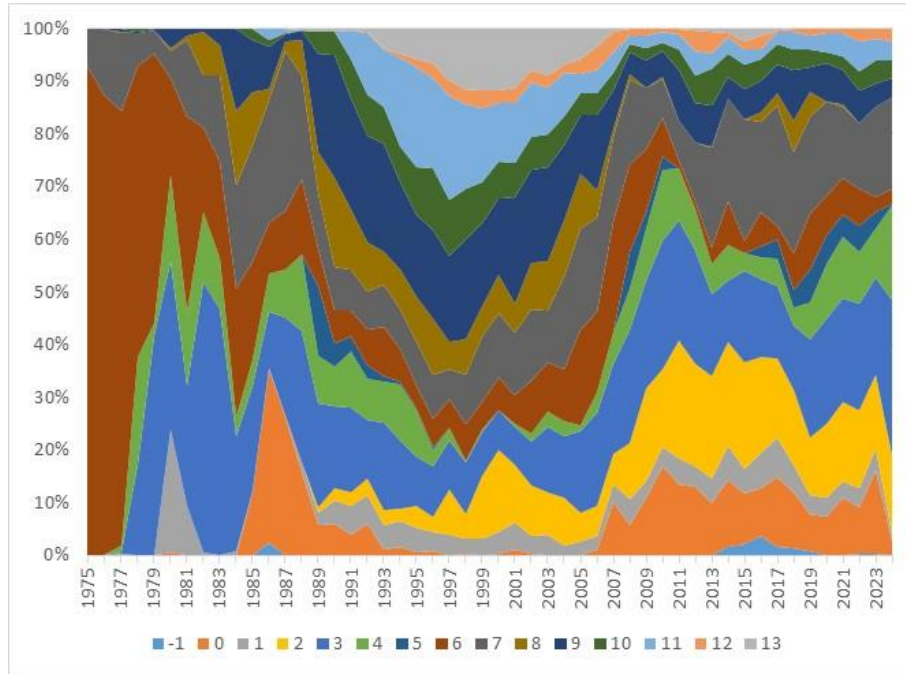
Figure 5a. *P. borealis* in W. Greenland: Distribution of the logbook-recorded catch between statistical Areas in Greenland waters, 1975-2024. (The light band that starts broad on the left-hand side is Area 6; the light band at the top is Area 0, the dark wedge at the very bottom from 1992 to 2007 is Area 13.)
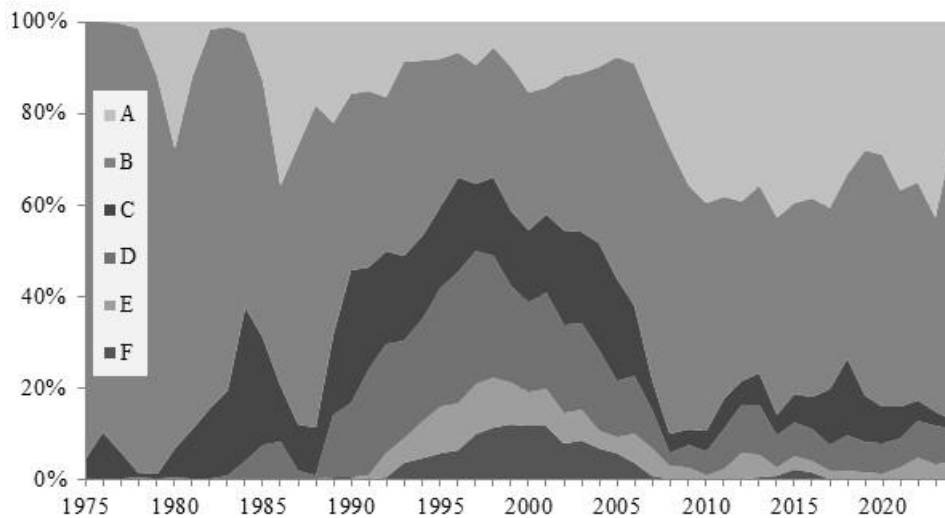
Figure 5b. *P. borealis* in W. Greenland: Distribution of the logbook-recorded catch between NAFO Divisions in Subarea 1 up to 76° N, 1975-2024.
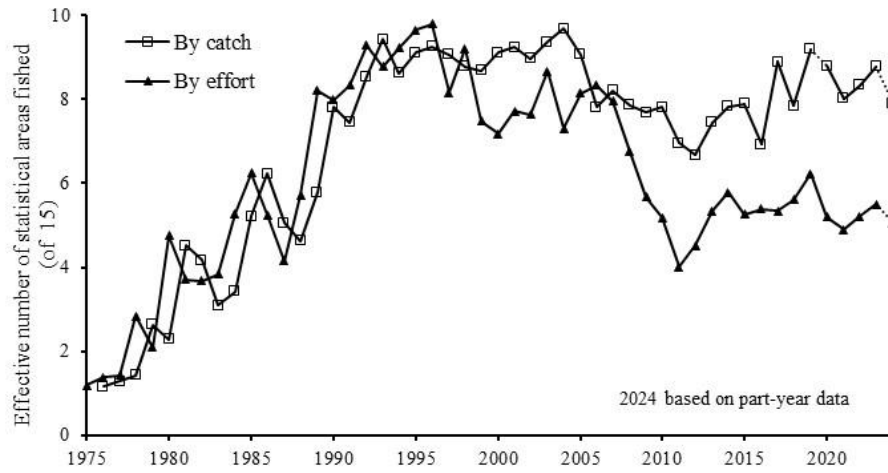
Figure 6a. *P. borealis* in W. Greenland: diversity indices for the distribution of logbook-recorded catch between statistical Areas in Greenland waters, 1975–2024. 2024 is on part-year's data.
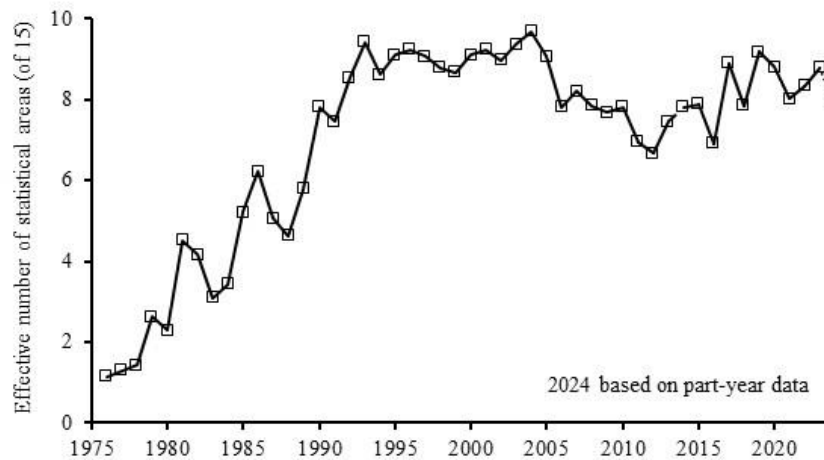

Figure 6b. *P. borealis* in W. Greenland: diversity indices for the distribution of logbook-recorded catch between statistical Areas in Greenland waters, 1975–2024. 2024 is on part-year's data.
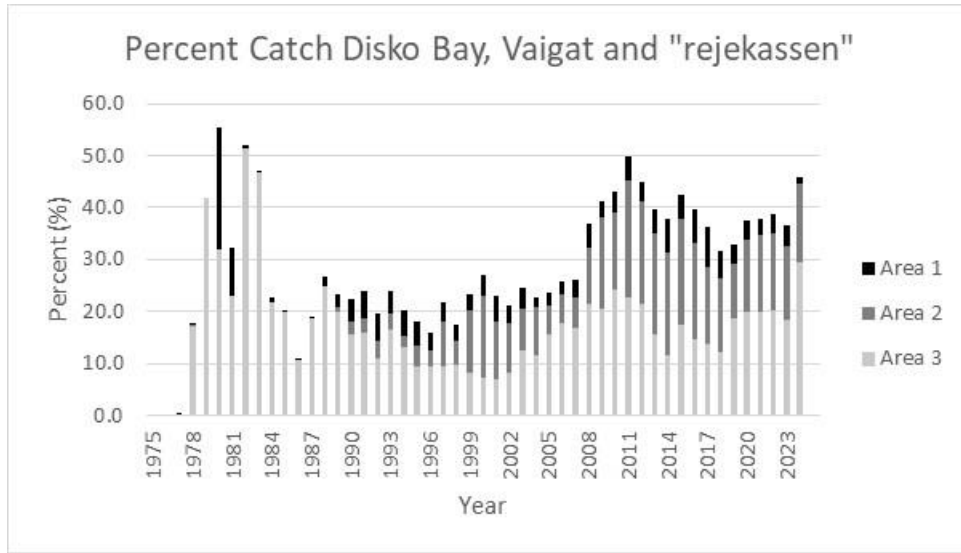
Figure 7a. *P. borealis* in W. Greenland: distribution of relative catches in the Disko Bay Area (statistical Areas 1, 2 and 3) 1990–2024. 2024 is on part-year's data.
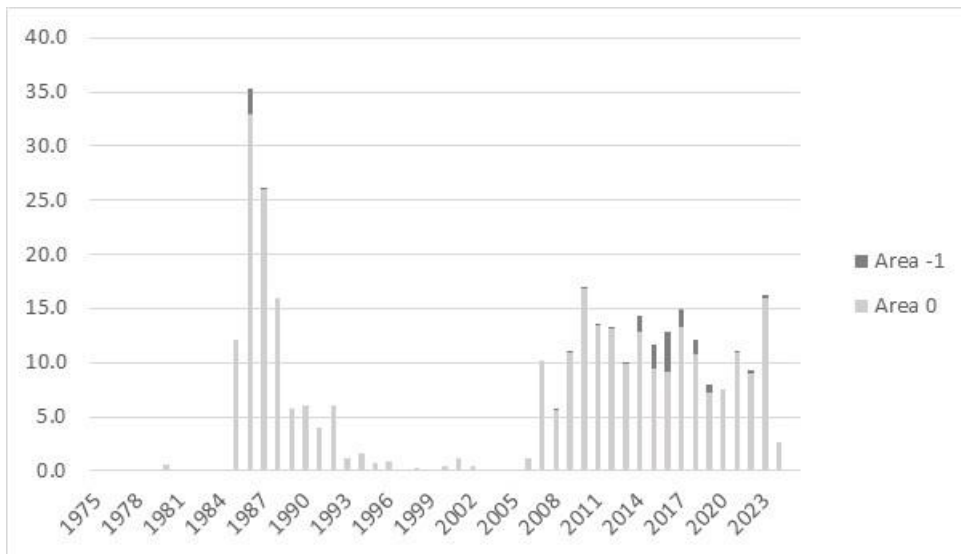

Figure 8. *P. borealis* in W. Greenland: catches taken in statistical area 0 and -1 as a percentage of total catches, 1990–2024. 2024 is on part-year's data.
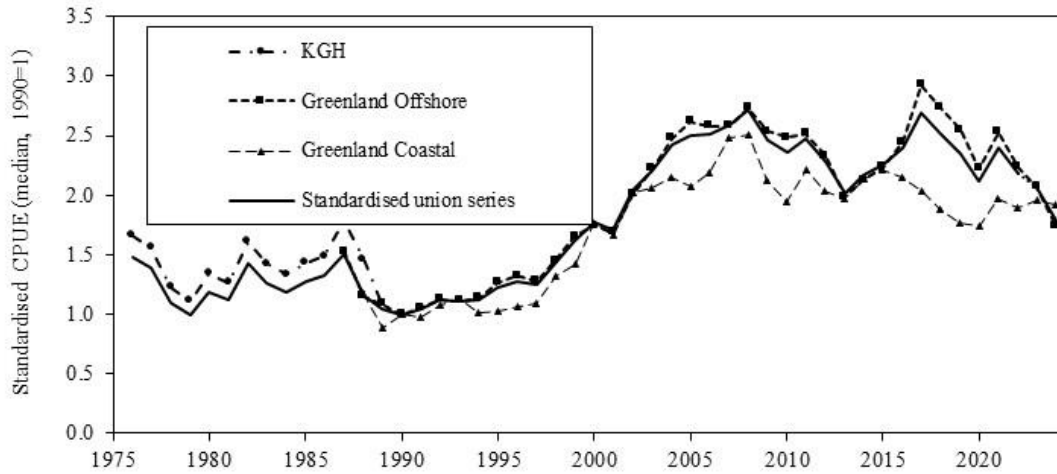
Figure 9. *P. borealis* in W. Greenland: standardized (1990=1) CPUE series from three fleets and a standardized union series 1976–2024. 2024 is on part-year's data.

Figure 10a. *P. borealis* in W. Greenland: standardized (1990=1) CPUE series from all fleets and a standardized union series 1976–2024. 2024 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 1976–2024. 2024 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 1976–2024. 2024 is on part-year's data.
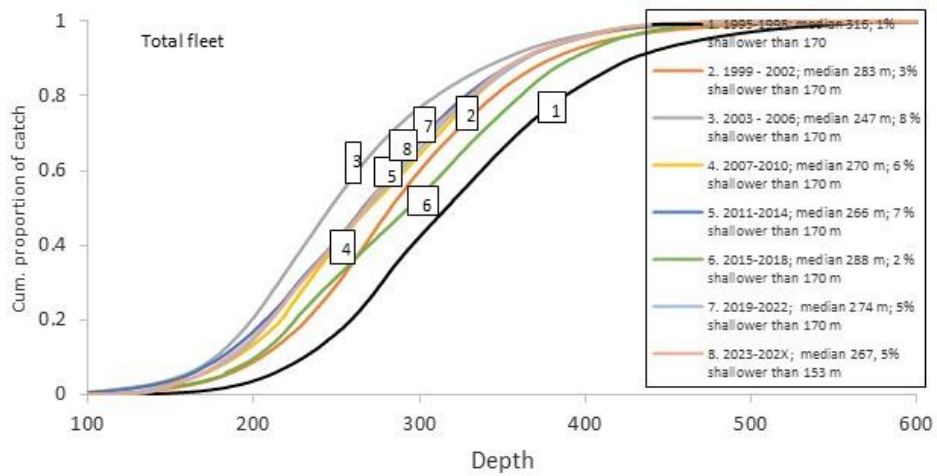
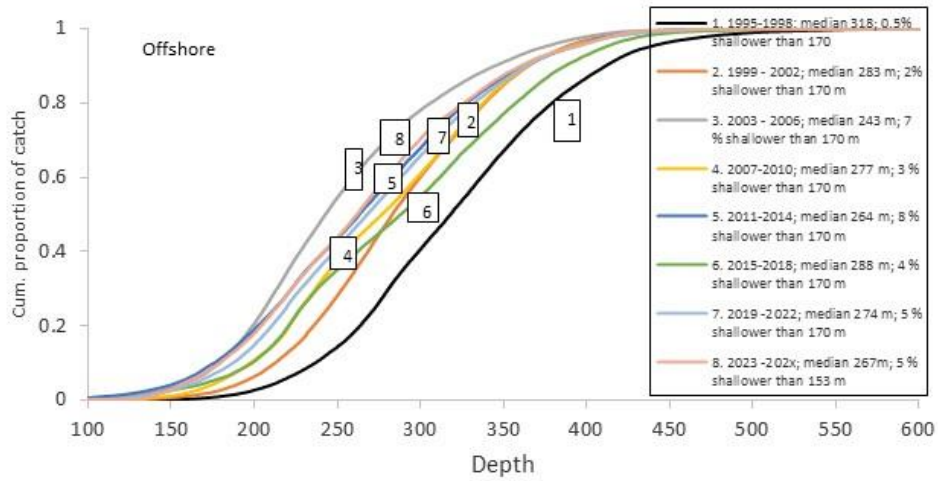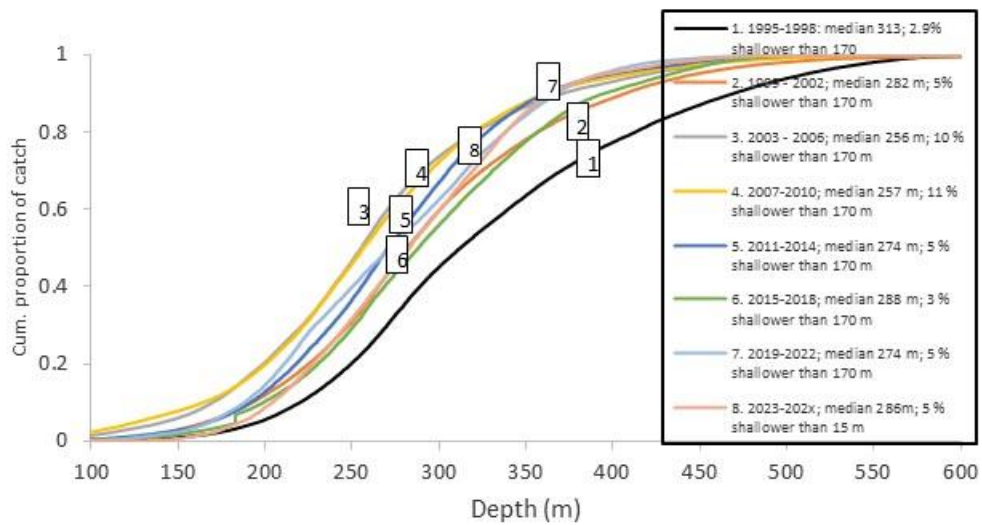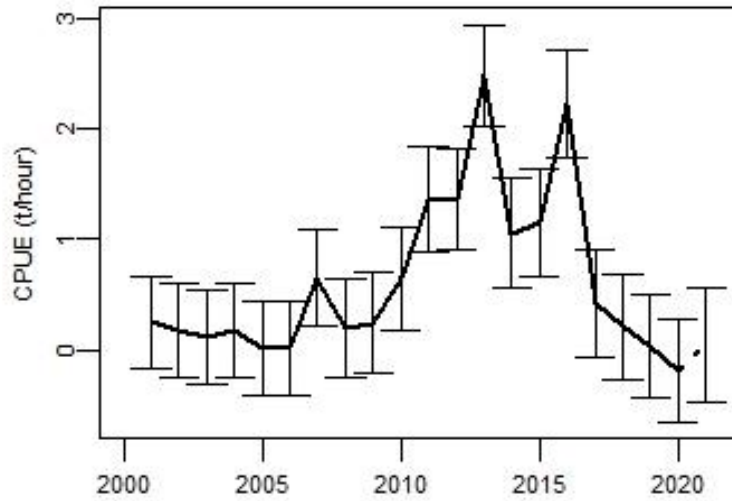**Figure 11.** *P. montagui* in W. Greenland. Standardized CPUE series from 5 offshore fleets 2008 - 2021. 2021 is on part-year's data. Error bars show 95% confidence limits. Not updated in 2022-2024, due to very low catches of *P. montagui* in 2021 - 2024.

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

Dependent Variable: LNCPUE

Weight: hauls

Source	DF	Sum of Squares		Mean Square	F Value	Pr > F
Model	119	268826.0313	2259.0423	731.68	<.0001	
Error	24933	76980.3668	3.0875			
Corrected Total		25052	345806.3981			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.777389	65.87748	1.757125	2.667262

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VESSEL	58	243765.4826	4202.8531	1361.25	<.0001
MONTH	11	3297.2242	299.7477	97.08	<.0001
area	11	6110.1786	555.4708	179.91	<.0001
year	37	14757.5033	398.8514	129.18	<.0001
HOLD	2	895.6427	447.8214	145.04	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VESSEL	58	25208.97253	434.63746	140.77	<.0001
MONTH	11	2431.87775	221.07980	71.61	<.0001
area	11	5481.62621	498.32966	161.40	<.0001
year	37	14597.59932	394.52971	127.78	<.0001
HOLD	2	895.64271	447.82136	145.04	<.0001

Parameter	Estimate		Standard		
Error	t Value	Pr > |t|			
Intercept	2.229499635	B	0.05995749	37.18	<.0001
VESSEL hh01	-0.766991895	B	0.06221956	-12.33	<.0001
VESSEL hh02	-0.775299766	B	0.04862982	-15.94	<.0001
VESSEL hh03	-0.638895411	B	0.05044301	-12.67	<.0001
VESSEL hh04	-0.575568489	B	0.04912680	-11.72	<.0001
VESSEL hh05	-0.564473107	B	0.05030692	-11.22	<.0001
VESSEL hh06	-0.539126405	B	0.05249836	-10.27	<.0001
VESSEL hh07	-0.363188603	B	0.05054561	-7.19	<.0001
VESSEL hh08	-0.361455130	B	0.04438197	-8.14	<.0001
VESSEL hh09	-0.367172043	B	0.04745499	-7.74	<.0001

VESSEL hh10	-0.346994896	B	0.04518149	-7.68	<.0001
VESSEL hh11	-0.307396994	B	0.04356427	-7.06	<.0001
VESSEL hh12	-0.283151755	B	0.04555680	-6.22	<.0001
VESSEL hh13	-0.285895991	B	0.04742297	-6.03	<.0001
VESSEL hh14	-0.232512939	B	0.04574490	-5.08	<.0001
VESSEL hh15	-0.246279644	B	0.04450463	-5.53	<.0001
VESSEL hh16	-0.233186526	B	0.04630747	-5.04	<.0001
VESSEL hh17	-0.241063252	B	0.04541423	-5.31	<.0001
VESSEL hh18	-0.229263553	B	0.04513055	-5.08	<.0001
VESSEL hh19	-0.214689658	B	0.04394406	-4.89	<.0001
VESSEL hh20	-0.222674214	B	0.04066347	-5.48	<.0001
VESSEL hh21	0.067582818	B	0.04334423	1.56	0.1190
VESSEL hh22	-0.204603393	B	0.04587386	-4.46	<.0001
VESSEL hh23	0.116303627	B	0.05309390	2.19	0.0285
VESSEL hh24	-0.156245320	B	0.04651902	-3.36	0.0008
VESSEL hh25	-0.139429783	B	0.04475321	-3.12	0.0018
VESSEL hh26	0.152694345	B	0.04089268	3.73	0.0002
VESSEL hh27	-0.066733500	B	0.04916947	-1.36	0.1747
VESSEL hh28	0.198082317	B	0.04358062	4.55	<.0001

VESSEL hh29	-0.028646302	B	0.04230392	-0.68	0.4983
VESSEL hh30	0.261423341	B	0.04192625	6.24	<.0001
VESSEL hh31	0.291961348	B	0.04078879	7.16	<.0001
VESSEL hh32	0.318556359	B	0.04907551	6.49	<.0001
VESSEL hh33	0.031488065	B	0.04487273	0.70	0.4829
VESSEL hh34	0.337249735	B	0.04782136	7.05	<.0001
VESSEL hh35	0.316503585	B	0.04053144	7.81	<.0001
VESSEL hh36	0.336261962	B	0.09680704	3.47	0.0005
VESSEL hh37	0.081889398	B	0.04483672	1.83	0.0678
VESSEL hh38	0.118003984	B	0.05070100	2.33	0.0199
VESSEL hh39	0.394373666	B	0.04018275	9.81	<.0001
VESSEL hh40	0.194227942	B	0.04425074	4.39	<.0001
VESSEL hh41	0.211839182	B	0.05463853	3.88	0.0001
VESSEL hh42	0.227012513	B	0.04315034	5.26	<.0001
VESSEL hh43	0.511759930	B	0.03902709	13.11	<.0001
VESSEL hh44	0.503283078	B	0.04116240	12.23	<.0001
VESSEL hh45	0.493746078	B	0.03901002	12.66	<.0001
VESSEL hh46	0.537616040	B	0.03876047	13.87	<.0001
VESSEL hh47	0.358919924	B	0.04389413	8.18	<.0001

VESSEL hh48	0.352338842	B	0.04100877	8.59	<.0001
VESSEL hh49	0.354799245	B	0.04167941	8.51	<.0001
VESSEL hh50	0.363908061	B	0.04456611	8.17	<.0001
VESSEL hh51	0.547837399	B	0.04251751	12.88	<.0001
VESSEL hh52	0.564495471	B	0.04156107	13.58	<.0001
VESSEL hh53	0.706575579	B	0.04193264	16.85	<.0001
VESSEL hh54	0.269349636	B	0.07556051	3.56	0.0004
VESSEL hh55	0.130551838	B	0.04295199	3.04	0.0024
VESSEL hh56	0.616292878	B	0.04361478	14.13	<.0001
VESSEL hh57	0.643566332	B	0.04885802	13.17	<.0001
VESSEL hh58	0.688749994	B	0.04962815	13.88	<.0001
VESSEL hh59	0.000000000	B	.	.	.
MONTH 1	0.001713162	B	0.01334610	0.13	0.8979
MONTH 2	0.050383127	B	0.01346517	3.74	0.0002
MONTH 3	0.073050077	B	0.01305619	5.60	<.0001
MONTH 4	0.141372796	B	0.01244271	11.36	<.0001
MONTH 5	0.029390342	B	0.01218164	2.41	0.0158
MONTH 6	0.207222077	B	0.01240737	16.70	<.0001
MONTH 7	0.221355600	B	0.01219901	18.15	<.0001

MONTH 8	0.109664146	B	0.01219536	8.99	<.0001
MONTH 9	0.076527826	B	0.01229155	6.23	<.0001
MONTH 10	0.069417297	B	0.01237557	5.61	<.0001
MONTH 11	0.048873837	B	0.01247229	3.92	<.0001
MONTH 12	0.000000000	B	.	.	.
area -1	-1.183817739	B	0.03841720	-30.81	<.0001
area 0	-0.428367466	B	0.02073323	-20.66	<.0001
area 3	-0.078836912	B	0.02110428	-3.74	0.0002
area 4	-0.337387354	B	0.02040133	-16.54	<.0001
area 5	-0.438951855	B	0.02382761	-18.42	<.0001
area 6	-0.204784109	B	0.01993032	-10.28	<.0001
area 7	-0.258689757	B	0.01981251	-13.06	<.0001
area 8	-0.234294888	B	0.02033246	-11.52	<.0001
area 9	-0.224044039	B	0.01923498	-11.65	<.0001
area 10	-0.196925535	B	0.02032613	-9.69	<.0001
area 11	-0.152371701	B	0.01968076	-7.74	<.0001
area 12	0.000000000	B	.	.	.
year 1987	0.422839167	B	0.02056224	20.56	<.0001
year 1988	0.140840212	B	0.01804923	7.80	<.0001

year 1989	0.083198326	B	0.01733756	4.80	<.0001
year 1991	0.054772373	B	0.01594919	3.43	0.0006
year 1992	0.116086472	B	0.01633486	7.11	<.0001
year 1993	0.103780360	B	0.01676854	6.19	<.0001
year 1994	0.128400033	B	0.01688104	7.61	<.0001
year 1995	0.237138856	B	0.01749020	13.56	<.0001
year 1996	0.278643915	B	0.01863441	14.95	<.0001
year 1997	0.243194196	B	0.01964492	12.38	<.0001
year 1998	0.371548377	B	0.02117822	17.54	<.0001
year 1999	0.503866053	B	0.02204100	22.86	<.0001
year 2000	0.555992708	B	0.02354724	23.61	<.0001
year 2001	0.523925539	B	0.02415725	21.69	<.0001
year 2002	0.695819272	B	0.02245828	30.98	<.0001
year 2003	0.799919195	B	0.02233283	35.82	<.0001
year 2004	0.907827954	B	0.02240879	40.51	<.0001
year 2005	0.964087422	B	0.02246118	42.92	<.0001
year 2006	0.948007720	B	0.02261061	41.93	<.0001
year 2007	0.947254898	B	0.02359986	40.14	<.0001
year 2008	1.007033832	B	0.02371429	42.47	<.0001

year 2009	0.931981365	B	0.02503835	37.22	<.0001
year 2010	0.910335868	B	0.02516359	36.18	<.0001
year 2011	0.924337565	B	0.02565681	36.03	<.0001
year 2012	0.847173160	B	0.02524060	33.56	<.0001
year 2013	0.686588212	B	0.02537854	27.05	<.0001
year 2014	0.756278984	B	0.02633213	28.72	<.0001
year 2015	0.805336020	B	0.02776835	29.00	<.0001
year 2016	0.895205162	B	0.02752582	32.52	<.0001
year 2017	1.073539533	B	0.02721090	39.45	<.0001
year 2018	1.006653922	B	0.02720069	37.01	<.0001
year 2019	0.934564999	B	0.02671570	34.98	<.0001
year 2020	0.799778815	B	0.02679843	29.84	<.0001
year 2021	0.928406451	B	0.02710569	34.25	<.0001
year 2022	0.805841753	B	0.02728565	29.53	<.0001
year 2023	0.728165987	B	0.02708390	26.89	<.0001
year 2024	0.553453336	B	0.03335527	16.59	<.0001
year 2090	0.000000000	B	.	.	.
HOLD 1	-0.129147444	B	0.03727125	-3.47	0.0005
HOLD 2	0.041255168	B	0.03652480	1.13	0.2587

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 I: A standardised CPUE series for the Greenland inshore 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

ource 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.