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Pandalus montagui in the West Greenland shrimp fishery, 2001–2010.

by

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Abstract

Logbook data from 2001–2010 was analysed to elicit information on the occurrence of *Pandalus montagui* in the West Greenland fishery for *P. borealis*. *P. montagui* is unreliably reported in logbooks: some fleet segments never report it in logbooks, and in others, some ships log catching *montagui* on unconvincingly rare occasions while others log it far more often and apparently more accurately. A very few vessels report *montagui* on average as high as 5–10% of their catch of *borealis*. The reported catch of *montagui* averaged 0.6% of that of *borealis*, varied from year to year and could be as high as 2%; the true total could be two or three times that. Catch composition is verified at the point of sale and the weight of *montagui* is not withdrawn from the vessel's quota for *borealis*.

Montagui was caught in shallower waters than *borealis*, and has low tolerance for water deeper than about 280 m. Little *montagui* was caught north of 68°20'N; to the south it is frequently caught at the margins of the gullies between the banks. Some fishing grounds for *montagui* are small and well defined, but the species is almost always caught as mixed catches with *P. borealis*. For individual vessels, catching *montagui* is episodic and comes in bursts interspersed with periods, often long, when *montagui* is not caught. These episodes might be prolonged by vessels seeking to eke out their quotas of *borealis*.

Introduction

A trawl fishery for the cold-water prawn or Northern Shrimp *Pandalus borealis* is prosecuted on the West Greenland continental shelf. A related species, *P. montagui*, known as the striped pink shrimp or Aesop shrimp, also occurs in those waters, with a distribution that overlaps that of *P. borealis*, and is liable to be (by-)caught in the fishery. The stock of *P. montagui* appears to persist, although no measures for regulating the catches of this species in the West Greenland fishery have been enacted. The Greenland Self-Government has asked the NAFO Scientific Council for advice on measures that might be taken in the fishery for the Northern Shrimp *Pandalus borealis* in West Greenland that would ensure that the stock of *Pandalus montagui* would remain within safe biological limits.

The present document is intended to contribute to this discussion by presenting some characteristics of the distribution of the species and of its occurrence in the fishery according as it has been possible to find them out from an analysis of fishery logbooks.

Material and Methods

Logbooks were selected for vessels fishing in West Greenland on licences for Northern Shrimp (PRA) for 2001–2010; in connection with the assessment of *P. borealis*, logbook data is downloaded annually from a confidential database maintained by the Greenland Fishery and Licence Control (GFLK) and used to update confidential registers kept by the Greenland Institute for Natural Resources (GN). The data headers identify the ship in several ways, of which the radio call-signal is that most used by GN in analysing data; data lines define the date, the start and end times and positions of the haul, the gear used, and the catches and discards of several species. The paper logbooks used give little space for detailed recording, particularly of bycatches.

The data has not been exhaustively analysed for this document. I have not analysed catch rate, either by time or distance or with respect to the fishing power of the vessel. I have identified catches with significant proportions of *montagui* and summarised their distribution by depth, by time, and by area, and attempted to draw provisional conclusions on the behaviour of the fishery and the distribution of the species. There are a lot of reasons to query the reliability of the data as regards *absolute* values, and there seems to be good reason to doubt the uniform reliability of recording and reporting of catches, so I have had to be selective, on a subjective basis, in using the logbooks. I have tried to get the best information by comparing *montagui* with *borealis* for restricted sets of data.

Owing to limits on the size of Excel spreadsheets, and of the size data series in Excel charts, some data sets have been sub-sampled before plotting.

Data was also fetched from the records of an annual research trawl survey carried out by GN in West Greenland waters. This survey was originally, and is still principally, directed to estimating the biomass of *P. borealis*, and its design is therefore not ideally adapted to other investigations. However, the survey does include some few stations trawled outside the main depth range of *P. borealis*. Station data records the swept area, calculated from presumed trawl geometry, monitored door-spread, and haul length between start and end points, and the total catch of shrimps with the proportions of *borealis* and *montagui*.

Results and Discussion

Vessels with 109 call signals submitted logbooks in the West Greenland shrimp fishery between 2001 and 2010. The annual log-book reported catch of *P. montagui* was usually near to 0.5% of the reported catch of *P. borealis*, but with some year-to-year variation and large deviations in some years. In 2008 and 2009 almost no *montagui* was reported, but in 2007 it was at nearly 1.5% of *borealis* (Fig 1.). The 10-year average ratio was 0.6%.

Of the vessels in the fishery, only 27 recorded catches of *P. montagui*. All were sea-going trawlers of about 500 GT or more, mostly factory trawlers with permission to process (at most 75% of) their catches on board, although there were two freezer trawlers.

The coastal fleet of small trawlers fishes bulk shrimps landed for shore processing in Greenland. It does not record *montagui* separately in logbooks. Instead, it tends to record all its catches as ‘PR99’—bulk shrimps undifferentiated by size. When the catch is landed and its sale is negotiated, the catch is sampled to evaluate its quality and price, the proportion of *montagui* being one of the determining factors, and information on catches of *montagui* in the coastal fishery is therefore only available from sales sheets. The quota drawdown is the sold weight of *P. borealis*, excluding *montagui*, and is therefore apt to be less than the logbook-recorded catch. The coastal fleet fishes principally in 5 statistical areas. Areas 1 and 2 are Hare I., Vaigat and Disko Bay, where *P. montagui* has very seldom been recorded by the West Greenland trawl survey, and catches in these two areas probably contain little *montagui*. However, area 3 in the mouth of Disko Bay, area 7 in the Holsteinsborg Dyb, and area 13 in Julianehåb Bay all contain sites in which *montagui* occurs, sometimes in high densities both absolutely and relative to *borealis*. Catches by the coastal fleet in these areas will sometimes contain admixtures of *P. montagui*.

Among the 27 vessels that recorded catches of *montagui*, the records varied, and some appeared to be of doubtful reliability. There were several vessels that recorded *montagui* with unconvincing rarity: 4 of them, with 33 years of

fishing between them, recorded *montagui* 10 times in 25 197 hauls, although they fished some of the time in areas where *montagui* is not rare (Fig. 2). It seems unlikely that this constitutes complete recording. ‘Reliable recorders’ were deemed to comprise 12 vessels that recorded *montagui* in at least 1% of hauls. In order to find out where those vessels did not catch *montagui*, 30 000 hauls with less than 5% *montagui* (of which 29 795 had zero *montagui*) were randomly selected.

In trawlers with on-board processing, *montagui* and *borealis* are not weighed separately; the catch is sampled from the holding tank and the proportions of the two species are estimated. From the final weight of the combined catch, the weights of the separate species can be reckoned. The proportions of *montagui* and *borealis* are often, or usually, judged at some even percentage, as is shown by patterning in the data (Fig. 3).

In the offshore fleet, practice varies. Some companies have markets that will take *montagui* on almost an equal footing with *borealis*; others take stronger measures to avoid catching *montagui*. Therefore the status of *montagui* can vary from being an unwanted bycatch through being a retained bycatch to being a targetted species. Among other effects, this means that the average proportion of *montagui* varies from ship to ship.

Catches of *montagui* relative to *borealis*.

Over the 10 years, the 27 vessels with catches of *montagui* accounted for 70 % of the recorded catch of *P. borealis* (including discards). Their recorded catches of *montagui* were 0.85% of their recorded catches of *borealis*, but annual proportions varied from almost zero, in 2008 and 2009, to over 2%, in 2007.

The 12 ‘reliable recorders’ accounted for 34% of the catch of *borealis*, but 94% of the catch of *montagui*. In 2001–2010 their catch of *montagui* averaged 1.7% of their catch of *borealis*, and this might represent an upper bound on the overall average for the entire fishery.

Even among the ‘reliable recorders’ the proportion *montagui* varied from ship to ship. The lower limit to be included was, as above, *montagui* in 1% of hauls, but 3 of the 12 recorded *montagui* in over 15% of hauls. One of them was only in the fishery for one year in 2001–2010 while the other two had 6 and 7 years in; the average reported proportion *montagui* for the three was 7.6%. *Montagui* catch rates at this level probably imply a certain level of directed fishing for *montagui*, and probably also that some ships have available to them customers who are prepared to take catches high in *montagui*. These ships are therefore prepared to fish for *borealis* in areas where *montagui* tends to occur, and will also tolerate catches with high, or very high, proportions of *montagui*. This is especially true when ships start to run short of quota for *borealis*; they then turn to *montagui* as a way to continue fishing.

However, even among the ‘reliable recorders’, little *montagui* is caught in clean catches. Almost all is in mixed catches (Fig. 4). This is in marked contradistinction from *borealis*—almost all *borealis* is caught as clean catches, even by the ‘reliable recorders’ of catches of *montagui* (Fig. 4).

Distribution by depth.

Pandalus montagui is known to favour shallower waters than *P. borealis*, and this distinction has been consistently recorded in trawl surveys in West Greenland. The depth distributions of the catches reported by the Greenland fleet are consistent with this. Catches of *montagui* start shallower than 100 m, are relatively evenly distributed between about 170 and 280 m, and decrease quite abruptly in deeper waters (Fig. 5) The median catch depth is 212.5 m. *Borealis* appears first in small amounts at about 130 m, but its distribution extends to deeper than 400m. (In the 1990s, the fishery was catching *borealis* in deeper water still—down to about 520 m in 1991–1994.) Its median catch depth in 2001–2010 has been 257.5 m, 45 m deeper than *montagui*. Its deep limit is less marked than that for *montagui*—its depth ogee is more sinuous—and the depth difference between the two species at the 90th percentile of catch is 85 m (359.5 m vs 274.5). These distributions are of catches, not of available biomass or relative density, so they might reflect fishing preferences as well as the relative abundance of the animals.

Distribution by area.

Figures 6–9 give a comprehensive and consistent picture of the distribution of catches of *P. montagui*, relative to the catch of *borealis*, by the fishery along the West Greenland coast, as indicated by the large-vessel fleet. (Note that some of these vessels are fishing on inshore licences, as is indicated by their fishing patterns, which include inner Disko Bay, Vaigat and inner Holsteinsborg Dyb and its contiguous fjords.) The catches with significant fractions of *montagui* are distributed between about Kangaatsiaq at 68°15'N and south to about 61°N. There is a marked area of concentration of catches near shore off Kangaatsiaq, in the gully between north-east Store Hellefiskebanke and the coast, but catches with large fractions of *montagui* hardly occur north of there. Some of these ships fish in Disko Bay and Vaigat, but they don't catch *montagui* there. The species is rare north and west of Store Hellefiske Banke—where the fishery for *borealis* is intense and productive—and catches over 50% *montagui* are rare in Holsteinsborg Dyb. From the southern part of the Sukkertoppen Dyb and south to about Paamiut *montagui* is more frequently a higher proportion of the catch, mostly along the edges of the gullies between the banks, and less frequently in their deeper centres. These vessels reported some fishing in Julianehåb Bugt in 2001–2010 (Figure 6), but few *montagui* catches

The information on catches from the West Greenland trawl survey tends to confirm these distributions. The survey was never designed to study the distribution, or estimate the biomass, of *P. montagui*, having long been directed towards estimating the biomass of *P. borealis*. Furthermore, the survey is catholic in its coverage of the presumed range of *borealis* and generates a high proportion of small catches, whereas the fishery fishes where the shrimps are. However, shallow-water stations added to the shrimp survey to provide information on the stocks of groundfishes also inform on the distribution of *P. montagui* relative to that of *P. borealis*, bearing in mind that neither species is abundant in shallow water. In the standard analyses survey data on *montagui* is worked up on the same basis, including the depth range and stratification selected, as was put in place to study *borealis*, although *montagui* favours shallower water. The biomass ratio of *montagui* to *borealis* is therefore probably underestimated—more *montagui* than *borealis* is missed in shallow water.

Survey catches that comprise over 10% *P. montagui* are nearly non-existent north of Store Hellefiskebanke, but there have been a few, over the years, on the bank itself in water shallower than 150m. I emphasise that many of these shallow-water catches are very small, even if *montagui* does compose more than 10%, and these areas are absent from the distribution of *montagui* shown by the fishery data because the industry doesn't fish on top of the banks. Survey catches comprising over 10% *montagui* are relatively frequent on Lille Hellefiskebanke, and south from there they occur on the edges of the banks and form a chain along the shelf edge. They are also relatively frequent in Julianehåb Bay, compared with the paucity of *montagui* hauls there in the fishery data; but most of the fishing there is by the coastal fleet, which doesn't report *montagui* anyway.

Distribution in time

Catching *montagui*, at the level of the individual vessel, is very sporadic (Fig. 10). Vessels can go long periods without reporting any *montagui*, and then for periods of days or weeks will frequently have catches with high proportions. This could sometimes be a result of unintentionally encountering an area with higher densities of *montagui*, but could also, or at other times, result from intentionally fishing known *montagui* areas because of a shortage of *borealis* quota. Fig. 11 maps the catches of the vessel in Fig. 10 from xx through xx. During this period, the vessel fished in a relatively small area, but even within that, the catches containing *montagui* were taken in a tightly circumscribed area on the north-eastern edge of Store Hellefiskebanke, while the catches without *montagui* were taken elsewhere and more widely spread.

Catch rates of *borealis* are close to constant over the year—perhaps 20% lower in January through March, and slightly higher in June, July and August, and the variation from year to year is not great. This is what one would expect given that *borealis* is the mainstay of a year-round fishery. The 10-year average of catches of *montagui* has a more strongly seasonal pattern. Catch rates are close to the average from early November until mid-April, and then they double until early July. In late summer and early fall they decrease to about 60% of the annual average. But the year-to-year deviations from the average are very large, so that the average has little meaning—which given the episodic nature of catches by individual vessels is not surprising.

Discussion

Montagui is almost invariably caught in mixed catches. The coastal fleet, landing all its catch at shore stations in W. Greenland, does not record *montagui* in its logbooks, but the proportion of *montagui* in the catch is estimated from catch sampling at the point of sale, and the price paid is adjusted accordingly, *montagui* fetching a lower price. It is not expected by either fleet that the catches of *montagui*, whether entered in the logbook by the skipper or reckoned by the buyer on shore, will be withdrawn from the quota for *borealis*. At the moment, therefore, the fishery for *montagui*—to the extent that it is at all a directed fishery—appears to be regulated only by the quota drawdowns due to the invariably accompanying catch of *borealis*.

Conclusions

Measures to ensure that the stock of *montagui* remains within safe biological limits might be:

the first and obvious measure to take, and a *sine qua non* for almost any other measure whatever, would be to radically improve the reporting of catches of *montagui* in a consistent manner for all fleet components, and to have catch records that are accessible and transparent. Playing guessing games with the catch records is a poor basis for any kind of stock management.

do nothing. This course of action could be defended by reasoning that *montagui* and *borealis* overlap in their distribution to such an extent that as long as adequate measures remained in place to regulate the fishery for *borealis*, the stock of *montagui* would be well enough protected. The overlap could be said to be such that it would be impossible even intentionally to go out and seriously deplete the stock of *montagui* by bottom-trawl fishing without at the same time catching prohibitively large quantities of *borealis*. Although the fishery for *montagui* has been unregulated for decades, it is still possible for vessels to catch over 10 tons of *montagui* in a single haul.

set a shallow limit on bottom-trawl fishing for *borealis*, between about 68°15'N and, say, 60°45'N, of, say, 170 m. To do so would protect *montagui* to some extent, would have little effect on the fishery for *borealis*, and might benefit the stock of *borealis* by protecting smaller shrimps not yet recruited to the fishery as well as the smaller sizes of recruits.

designate *montagui* as a bycatch species within the existing regulations, with accompanying strictures on continuing to fish in the same place if bycatch proportions exceed a prescribed limit. This would essentially close the present (semi-)directed fishery for *montagui* and unless one of the following two suggestions were adopted would make *montagui* a completely protected species in spite of its commercial value.

set TAC limits on *montagui*. I.e. develop this as a regulated fishery. It is unlikely that any quantitative assessment of *montagui* would be possible, as neither CPUE nor survey data would give good indices of the stock biomass. This measure would entail a new licence structure, quotas, and so on. The cost of administering it might be high.

manage the two species as a joint, i.e. undifferentiated, fishery with a joint TAC. This would entail a radical revision of the present assessment and management procedures.

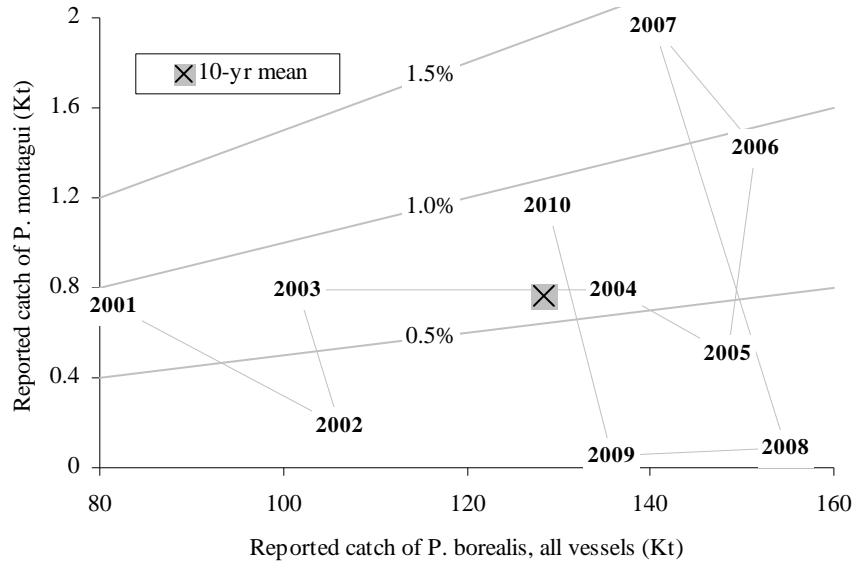


Figure 1. *Pandalus montagui* in the West Greenland shrimp fishery: annual and average reported catches of *P. borealis* and *P. montagui* in 2001–2010 by all vessels in the West Greenland fishery.

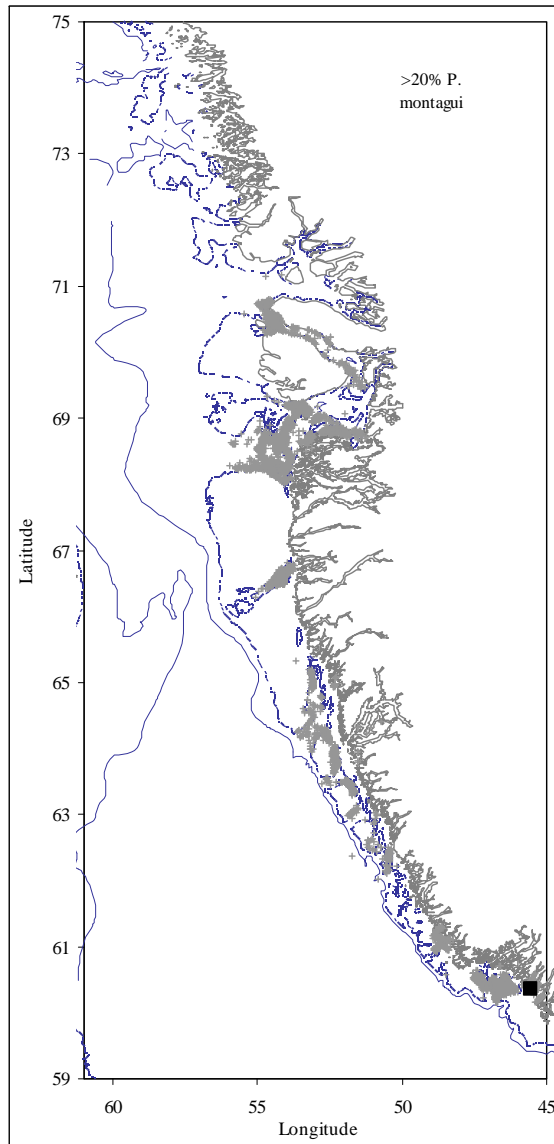


Figure 2a. *Pandalus montagui* in the West Greenland shrimp fishery: partial reporting: positions of 9443 hauls by a coastal vessel reporting one catch of *P. montagui*

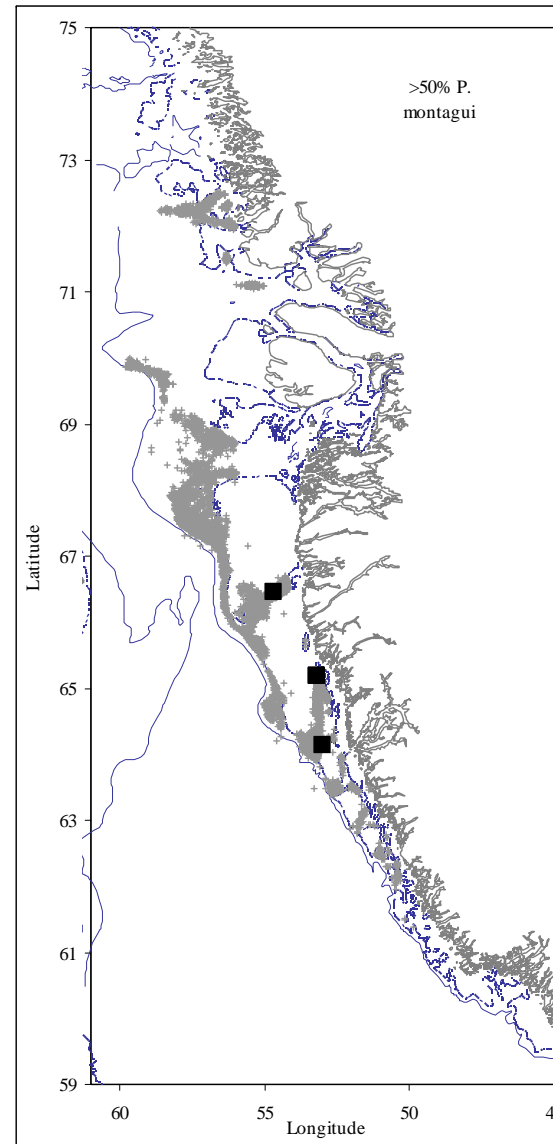


Figure 1b: *Pandalus montagui* in the West Greenland shrimp fishery: partial reporting: positions of 9438 hauls by an offshore vessel reporting four catches of *P. montagui*.

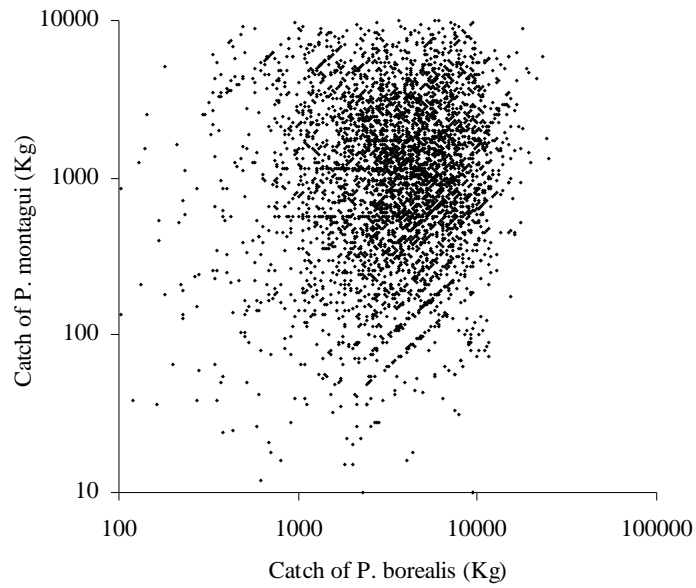


Figure 3. *Pandalus montagui* in the West Greenland shrimp fishery: weights of 4277 catches of *P. montagui* and *P. borealis* recorded by fishing vessels that recorded catches of *P. montagui* in 2001–2010.

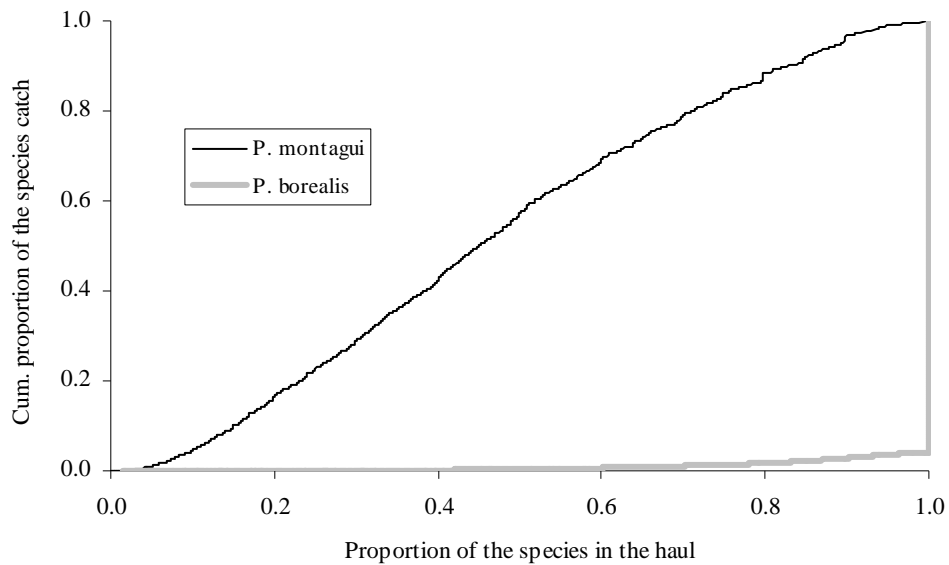


Figure 4. *Pandalus montagui* in the West Greenland shrimp fishery: cumulative proportion of the total catch of *P. borealis* and of *P. montagui* against proportion of the species in the catch of a single haul. (*P. montagui*, all reported catches, *P. borealis*, sample data, 30 000 hauls, from ‘reliable reporters’ only.)

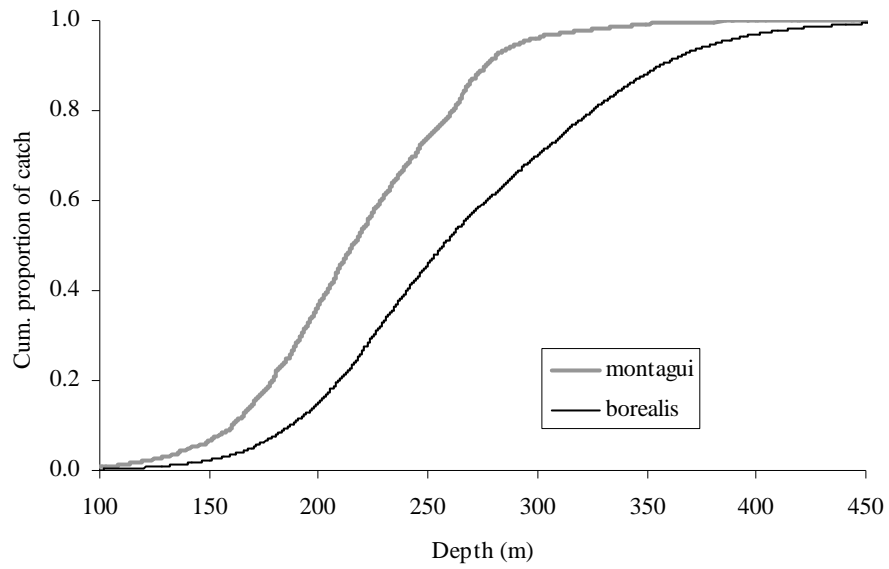


Figure 5: *Pandalus montagui* in the West Greenland shrimp fishery: cumulative distributions by depth of catches reported as *P. borealis* in a random sample of 30 000 hauls totalling 185 Kt and of *P. montagui* in 4277 hauls totalling 7.7 Kt in 2001–2010 by fishing vessels reporting catches of *P. montagui* in that period.

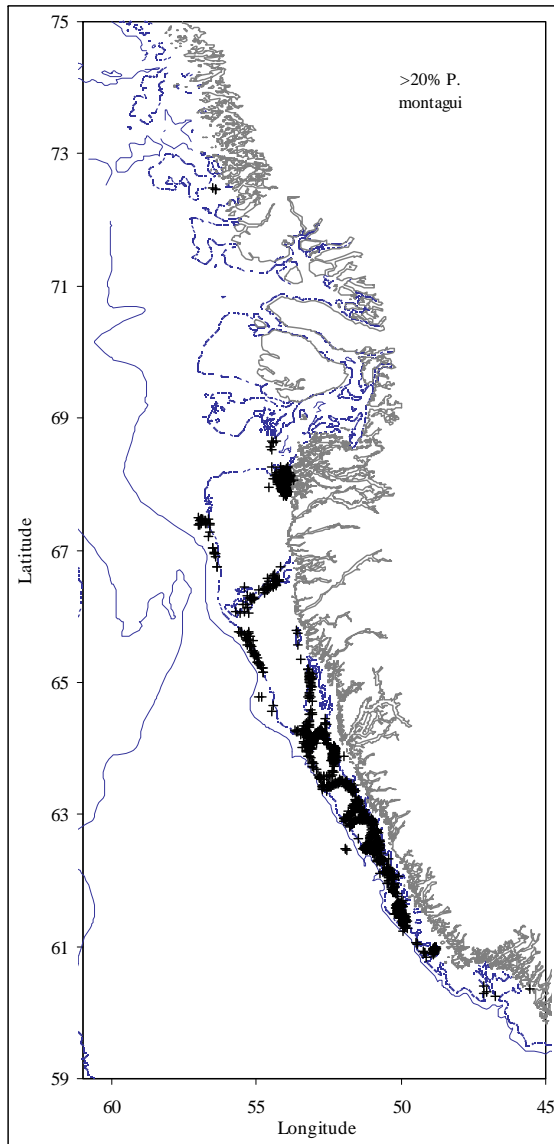


Figure 6: *Pandalus montagui* in the West Greenland shrimp fishery: positions of 2244 hauls in 2001–2010 by fishing vessels reporting catches of *P. montagui*, in which *P.m.* composed at least 20% of the catch.

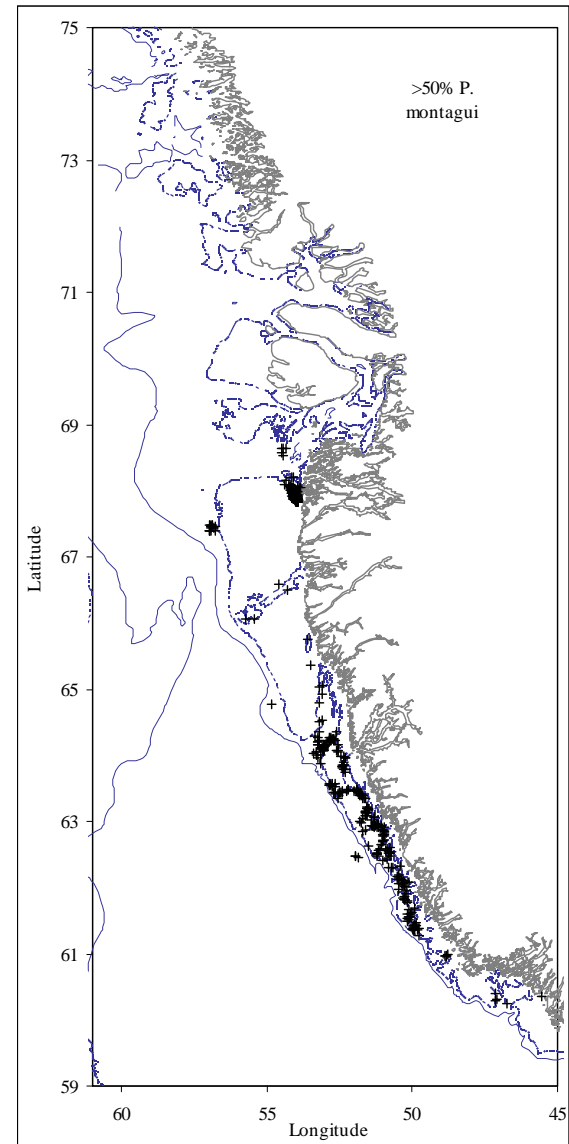


Figure 7: *Pandalus montagui* in the West Greenland shrimp fishery: positions of 739 hauls in 2001–2010 by fishing vessels reporting catches of *P. montagui*, in which *P.m.* composed at least 50% of the catch.

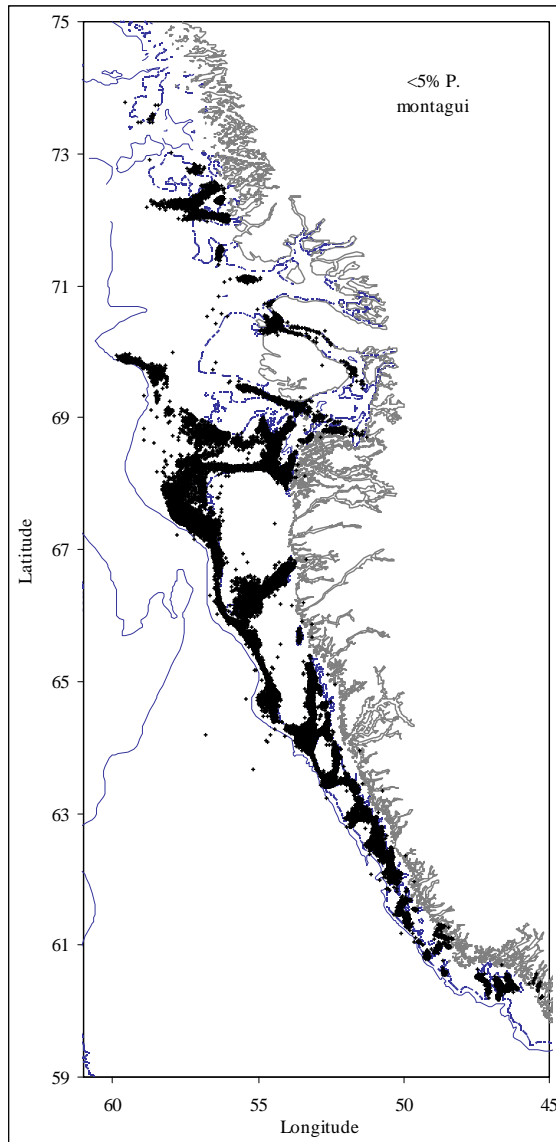


Figure 8: *Pandalus montagui* in the West Greenland shrimp fishery: positions of a sample of 30 000 hauls in which *P. montagui* composed less than 5% of the shrimp catch, in 2001–2010, by fishing vessels ‘reliably reporting’ catches of *montagui* in that period.

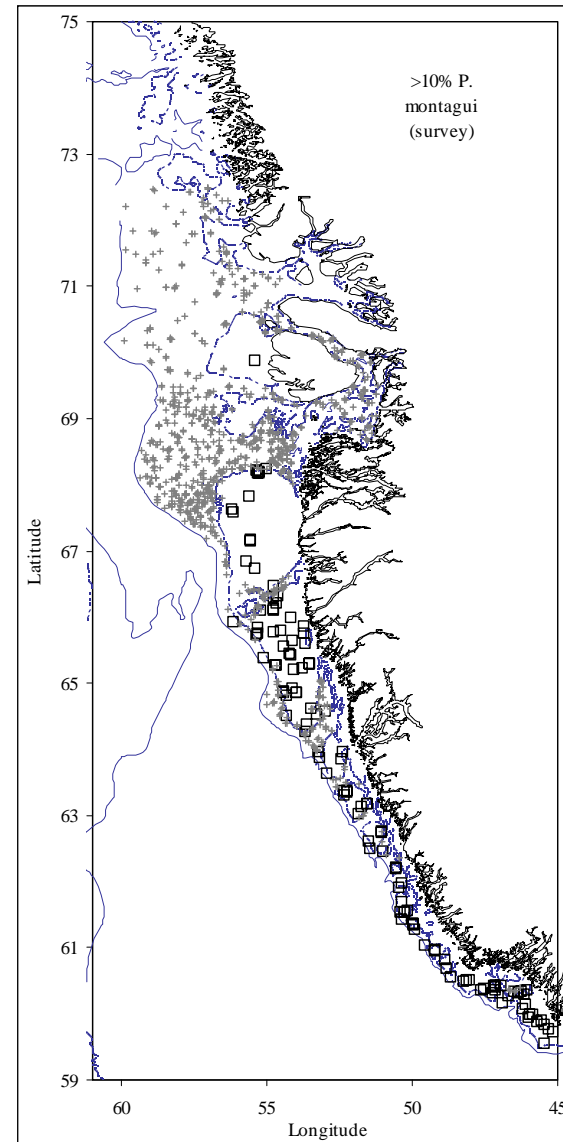


Figure 9: *Pandalus montagui* in the West Greenland shrimp fishery: positions of 161 survey hauls in which *P. montagui* composed at least 10% of the shrimp catch, 2001–2010 (NB some catches were very small); and of 1096 survey hauls in which less than 10% was *montagui* and at least 5 kg of shrimps were caught.

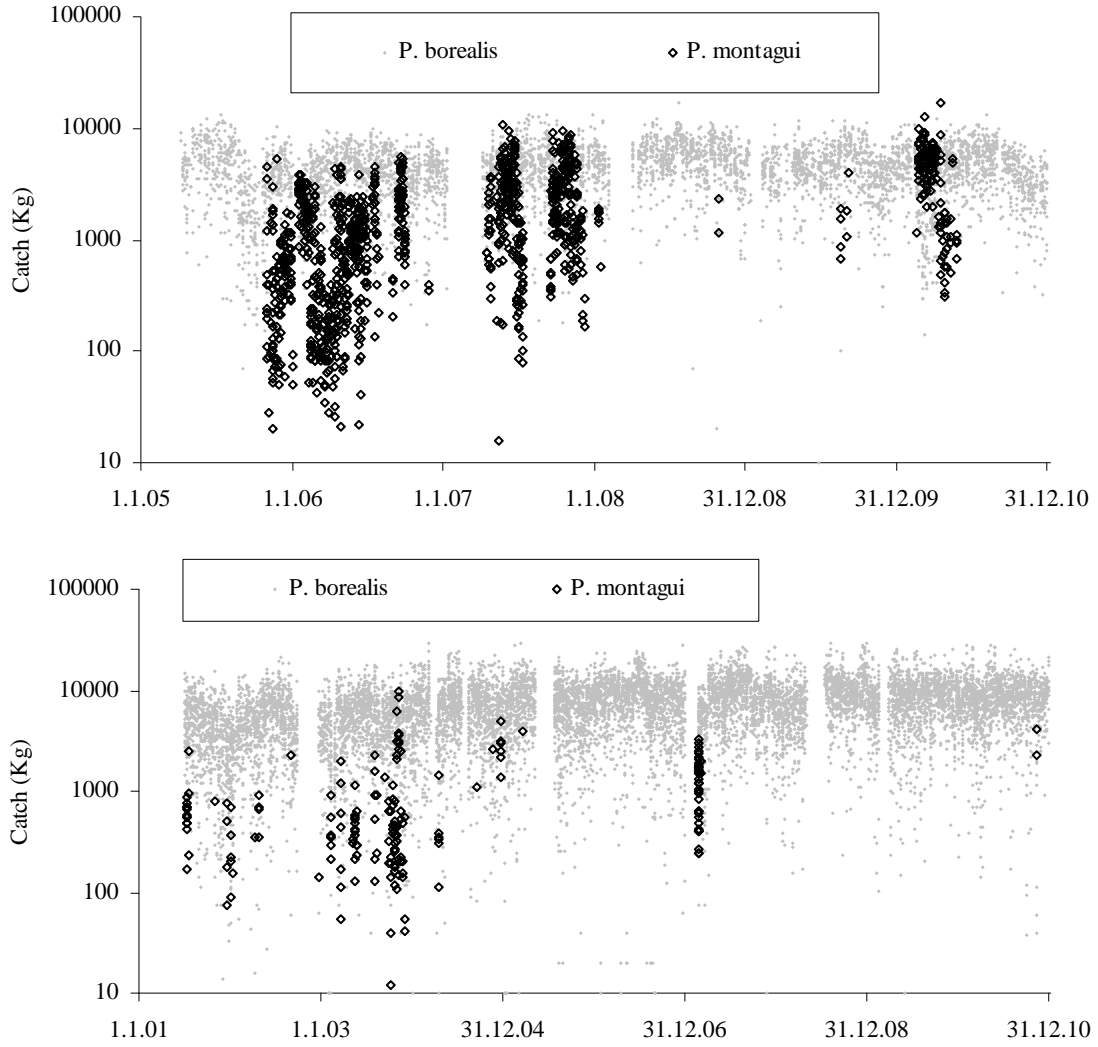


Figure 10. *Pandalus montagui* in the West Greenland shrimp fishery: episodic catching of *montagui*: catches of *P. montagui* and *P. borealis* by date for two ships considered 'reliable reporters' of *montagui*.

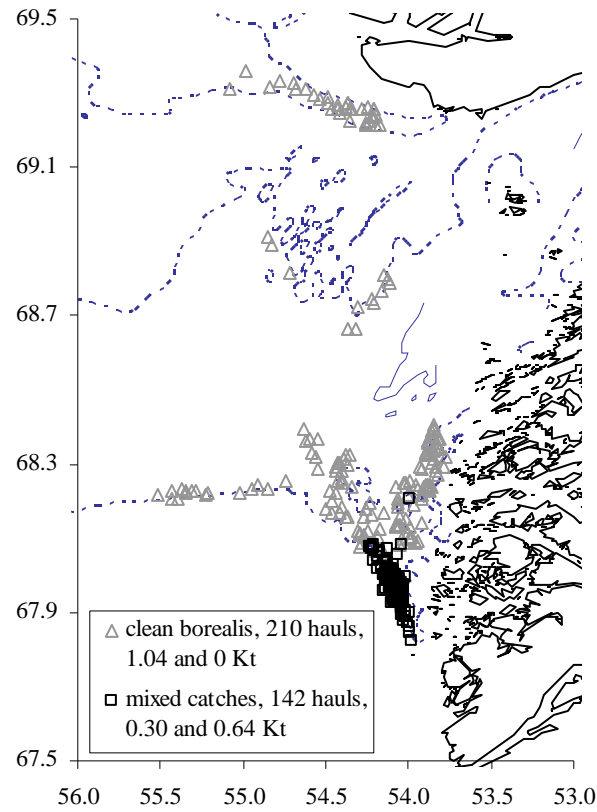


Figure 11: *Pandalus montagui* in the West Greenland shrimp fishery: 4 months' fishing positions for a vessel reporting many mixed catches in that period.

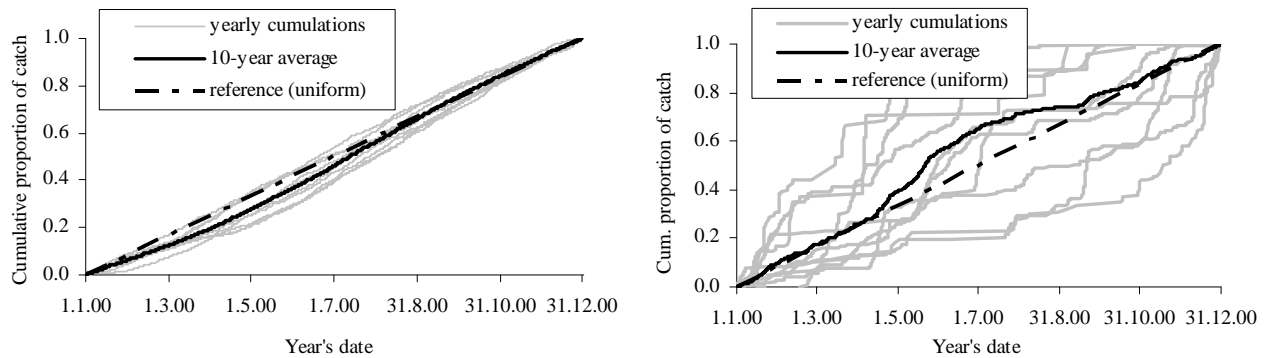


Figure 12. *Pandalus montagui* in the West Greenland shrimp fishery: seasonal distribution of catches of *P. borealis* and *P. montagui*, 2001–2010.