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CPU Series for the West Greenland Shrimp Fishery

by

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Introduction

Series of annual average CPU values are considered a usable index of stock biomass. They are usually obtained by analysis of variance of the log. of the catch:effort ratio, controlling for the effect of nuisance variables such as fleet composition and the time of year when, or the area in which, the effort was applied. A standard (but not inevitable) tool for such analyses is SAS PROC GLM. Such series are used in assessing the stock of northern shrimp in West Greenland.

Catch reporting in the West Greenland fishery has suffered recent upheavals. Up to 2003, logbook records under-reported catches, owing to a prevalent system of overpacking under which packed weight exceeded nominal weight, the nominal weight, however, being that recorded in the logbook and on sales slips. From 2004 logbook records have been required to be the live weight of the catch and overpacking has been forbidden, and in 2003 a series of annual correction factors was presented to the NAFO Scientific Council (SCR Doc. 03/74); the corrections to annual reported catches were generally 21–24%. For shrimp produced[1] on board by the sea-going fleet the logbook entry for the 'live weight' is arrived at in practice by adding a correction factor to the packed weight. Discards are separately recorded in the logbooks.

The upshot of the altered reporting practices, as regards the construction of acceptable catch series for use in assessments, was presented in NAFO SCR Docs 03/74 and 07/66. However, the change in reporting practices will also have affected apparent catch:effort ratios, and this question has not before now been completely or satisfactorily resolved. This document presents a review of recent treatments of catch:effort analyses and proposes a system for selecting and pooling data and applying catch correction factors.

History

CPU analyses carried out up to 2005 for the recent Greenland shrimp fishery in West Greenland waters considered two fleets—a deepwater fleet of large trawlers and a coastal fleet of small ones—and calculated separate series of annual relative CPU values. The nominal dividing line was a tonnage limit of 120 GT, in accordance with the regulation of access to the fishery—also nominal—enacted by the Home Rule Government. The deepwater fleet is licensed to process its catch on board to produce consumer products, with the reservation of being obliged to land 25% of its catch for processing in Greenland. With general criteria for inclusion that ships should be over 50 GRT and should have been active in the fishery for 3 years, the resulting lists included 40 deepwater trawlers and 26 coastal vessels.

[1] i.e. prepared and packed as a consumer product.

The offshore fleet has restrictions on where it can fish: it is excluded from Disko Bay, Vaigat and Julianehåb Bay and from fishing close to the coast. In accordance with these differences in fishing area, CPU analyses were historically carried out for the coastal fleet only for statistical areas (StA) 1, 2, and 3 (i.e. Disko Bay, its mouth, and Vaigat), and for the deepwater fleet only for StA 4–13 (all the rest of the W. Greenland shrimp grounds, including Julianehåb Bay).

However, a number of vessels not included in the deepwater fleet do take a significant proportion of their catch in areas outside Disko Bay, especially in the inshore part of StA 7—the Holsteinsborg Deep—and in StA 13 which includes Julienehåb Bay. In fact, some of them fish little in StA 1–3. In 2006, some of these vessels were included with the deepwater fleet in the CPU analysis for StA 4–13 in order to ensure that their effort in these areas was not ignored (SCR Doc. 06/61). This affected the CPU trajectory for the deepwater fleet and was in fact wrong, because these extra included vessels do not fish in the same parts of these more southerly areas as the offshore vessels do, but fish closer inshore.

Therefore in 2007 a more radical revision of the standardisation of CPU series was undertaken (SCR Doc. 07/69). Shiplists were reviewed using:

- historical lists—less useful for vessels that had recently entered the fishery;

- GFLK database information on licence type and tonnage—more complete for newer vessels, but often lacking from the database for vessels that had left the fishery in the more distant past, and in any case not completely reliable as a guide to the areas that a vessel might fish, owing to divers incompletely recorded dispensations from regulations on access to the fishery;

- the mapped distribution of fishing effort from logbook records: 'coastal' vessels fish in StA 1, 2 and 3, the inshore part of StA 7, and StA 13, and may also fish a little in StA 9–12, while offshore vessels do not fish in StA 1, 2 or 13, but do fish in the offshore part of StA 7 and on the outer shelf break in StA 4, 6, and 8. Only one vessel—of 800 GT—has been found that breaks this pattern and fishes everywhere.

These 2007 revised shiplists were run with and without StA 3, seeing that it has historically been included in the set of statistical areas used for the coastal fleet. It made very little difference.

Another change needed was the inclusion of the 'overpacking corrections' in the CPUE analyses. The available information gave an overall correction that had apparently been applied to catches in logbooks dating from before 2004 to estimate the live-caught weight used in catch series for assessments. However, while this correction had been included in the catch series, it had not been included in the CPUE analyses, so that CPUE estimates based on logbook entries from 2004 and after, owing to more complete recording of catches, were boosted relative to those from 2003 and earlier. However, this boost was camouflaged in CPUE series that were continually increasing anyway. In 2007 a remedy was attempted by applying these correction factors across the board to the logbook reported catches, increasing catches, and therefore CPUEs, in 2003 and earlier by 21–23%. An apparent effect was to cause the CPUE series for the offshore fleet to diverge from that for the coastal fleet, whereas their relative trajectories had previously agreed fairly well. It transpired on subsequent investigation that the coastal fleet had not changed its practice significantly as a result of the change in the law in 2004. So in 2008, instead of using a single correction across the board, the catches by the coastal fleet were not corrected at all, and for the offshore fleet catches recorded as 'large' shrimps were corrected by adding 15% before 2004 and 'small' and 'unsorted' were corrected by 42%. This pretty much returned the offshore and coastal CPUE series to their previous agreement.

A further problem lay in the treatment of double- and single-trawl data. The historical practice was to use only single-trawl hauls in standardising annual CPUE indices. However, in recent years the offshore fleet has come to consist of almost all double-trawl-equipped vessels, and they use double trawls for up to 95% of their hauls. Furthermore, the keying of double- and single-trawl data has an error rate that is comparable to recent proportions of single-trawl hauls for many of the big ships. So using only single-trawl data for the offshore fleet implies using only a small fraction of the data, and most of that, wrong. In the 2007 assessment, therefore, both double- and single-trawl data was used, a double-trawl effect being included in the GLM; this for both the Greenland offshore and the Canadian fleets. In 2008, a further investigation showed that there wasn't any data on double or single trawl before 1995, so if a vessel was using double trawls in 1995 and after its data for 1994 and before was not used. Also in 2008 a thorough check of the keyed data for 2007–08 showed that keying double trawls as single was much more common than keying single trawls as double, so using only only data keyed as doubletrawl would give a more accurate data set.

To explore the effects of these changes, runs have been carried out for the offshore fleet with:

- the 2007 data set, using the 2005, 2006, and 2007 ship lists and the 2006 coding, i.e. with single trawl only and no overpacking correction;

- the 2007 ship list with the 2006 (single trawl, no catchcorrection), 2007 single and double trawl (with catch correction) and 2008 (double trawl, larger catch correction) coding;

For the coastal fleet, the effects of removing the catch correction and changing the selection of areas were investigated by comparing the results of GLM runs using:

- 2007 data and shiplist with areas 1–3 and 7–13 (as used in 2007) and overall catch corrections;

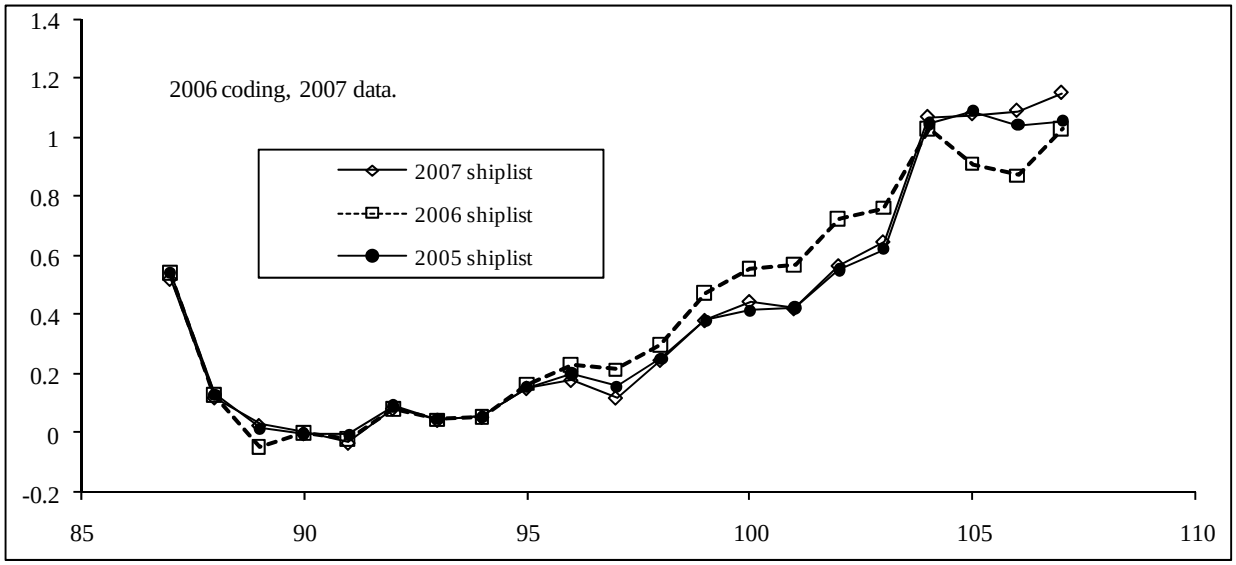
- 2008 data and shiplist with 1–3 and 7–13;

- 2008 data and shiplist with areas 1–3, 7, and 13 only;

- 2008 data and shiplist with areas 1–3 only;

Results and Discussion

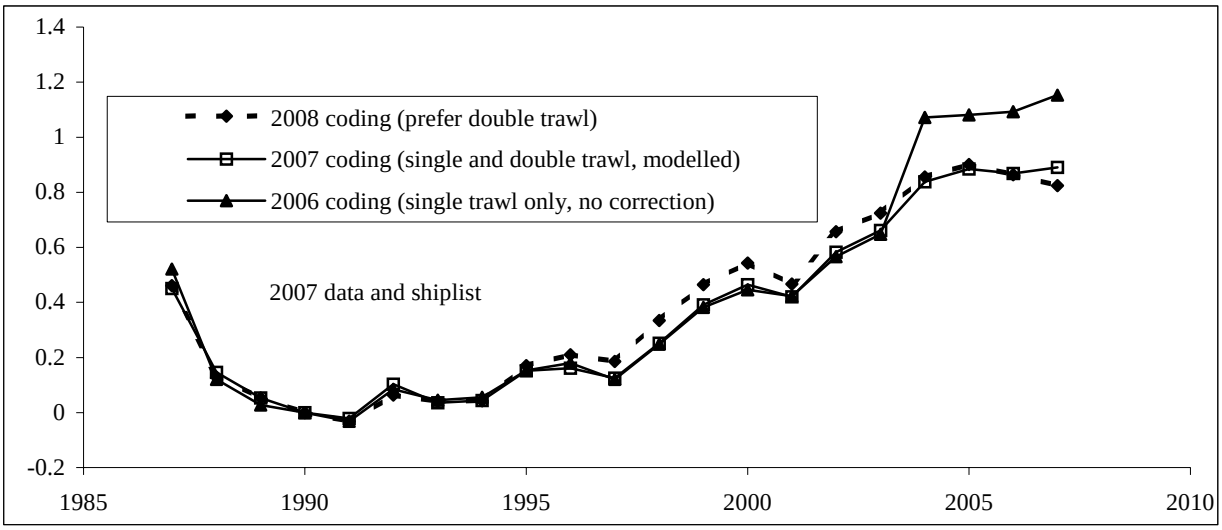
The effect of the change made to the offshore ship list in 2006 is shown in the following Figure[2], where the lists used in 2005 and 2007 gave similar results, but diverged widely from the results for 2006 which had included additional ships, not meeting other criteria for inclusion in the offshore list but fishing in areas 7–13. These extra ships were taken out of the offshore ship list again in 2007 when these southern areas were added to the data included in the CPUE standardisation for the coastal fleet. All these CPUE series were calculated without applying any correction for overpacking, and the large increase in apparent CPUE from 2003 to 2004 is now evident.

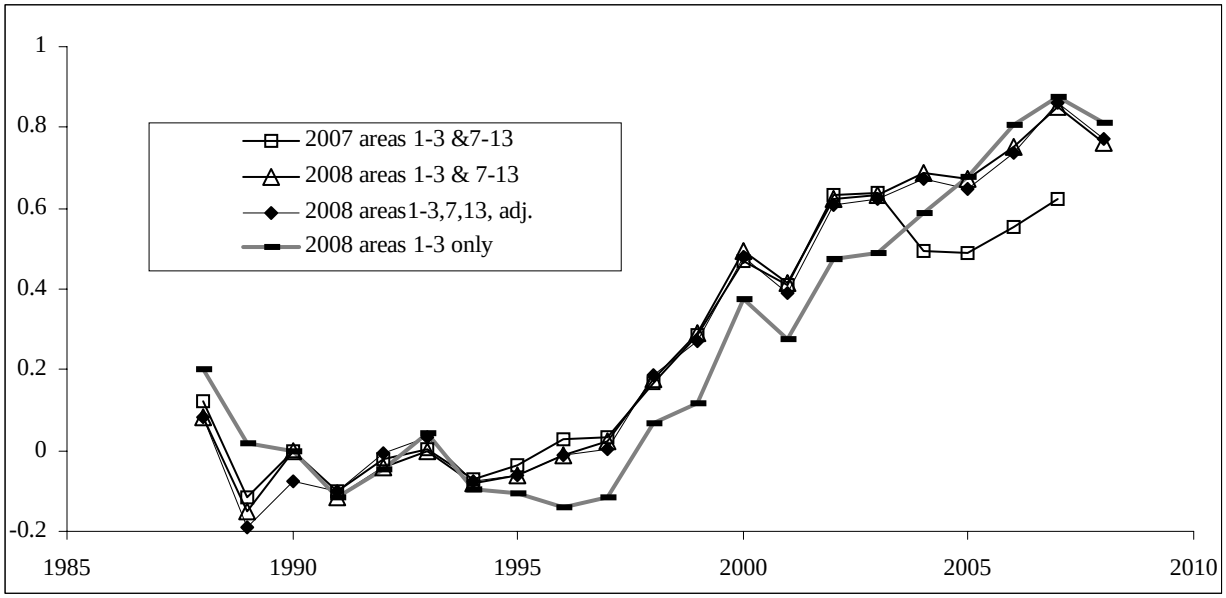


The next Figure (below) compares the effects of the different treatments used for single- and double-trawl data and for applying catch corrections in the offshore fishery. With no correction, as in the 2006 analysis, CPUE increased a lot from 2003 to 2004. The two different catch corrections applied in 2007—21 to 24% across the board—and in 2008—15% on 'large' shrimps and 42% on 'small' and 'unsorted'—do not appear to have had very different effects, but as would be expected have much reduced estimated CPUEs in 2004 and after compared with the estimates

[2] All these Figures plot logged CPUEs, and most series are standardised to 1990=0.

without catch corrections. Exactly to what degree the 2004 change in the regulations, requiring logbooks to record the live weight of catches, dislocates the CPUE series between 2003 and 2004 is a question that may never get a satisfactory answer. The different treatments of the single- and double-trawl data do not seem to have had much effect; the 2008 coding which uses only double-trawl data gave slightly higher relative CPUEs in about 1995–2004 and a more significant down-turn in 2007. There is a bigger effect on the estimated standard errors of the year effects, which increase a lot after about 2001 if only single-trawl data is used.





As has been said above, in many years there is significant fishing effort in areas 7–13 by vessels not included in the offshore fleet. Including this fishing effort in the CPUE series by expanding the ship list used to standardise the offshore CPUE series for these areas seems ill advised. Therefore, in 2007 and 2008 the CPUE calculations for the coastal fleet were expanded to include these more southerly areas. The next Figure (below) compares results from including all areas in the coastal-fleet CPUE calculations with those from including only areas 1–3, as was formerly the practice, and areas 1–3, 7 and 13 which are the areas where the coastal fleet mostly fishes. Areas 8–12 don't seem to have much effect: the 2008 results look much the same with or without them, although there are differences in 1989–90. But leaving out areas 7 and 13, to include only areas 1–3, appears to give lower estimated CPUEs, relative to other periods, for the late 1990s and early 2000s when the southern areas were producing much of the catch. In 2002–2005, when the all-area index was hesitating, the area-1–3 index increased more definitely. However, when trying to produce a series that is intended to index the fishable biomass of the stock there is not much reason to omit areas which in some periods were productively fished and held a significant fraction of the

biomass being exploited by a fleet segment. The effect of applying a catch correction to the coastal fleet can be seen in the drop in CPUE from 2003 to 2004 in the results used in the 2007 assessment; this was probably incorrect, as there is now little reason to think that the coastal fleet changed its practice very much in response to the change in the regulations, and has not been applied in 2008. The changes in the coastal-fleet ship list between 2007 and 2008 were few, and their effects have not been separately investigated.

Conclusion

The ship lists and catch corrections used in 2008 look reasonable and an improvement over those used in 2007. A completely accurate correction to CPUE values for the effect of the 2004 change in regulations might, however, never be achieved. 'Offshore' and 'coastal' ships can be identified mostly from where they fish and the two fleet segments provide biomass index data for largely distinct fishing grounds. The treatment of double- and single-trawl data remains a problem, partly because of inaccurate keying, but it looks from the estimated uncertainties of the relative CPUE values as though the former practice of using only single-trawl data in standardising CPUEs has to be altered. An option not explored here would be to ignore the data on single- and double-trawl and consider each ship to have, on average, a constant practice.

References

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Appendix: Statistical areas used in standardising CPUEs (also NAFO Divisions).