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Studies in 2001 on the End Effect of the Skjervøy 3000 Trawl in the West Greenland Shrimp Survey

by

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Abstract

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Trawl tows in the offshore part of the West Greenland survey for northern shrimp *Pandalus borealis* have over the last 3 years been shortened from a 60-minute standard to a mixture of 15 and 30 minutes; the average in 2001 was about 24 minutes. Trawl end effect may become significant when tows are shortened. The end effect of the Skjervøy 3000 shrimp trawl was studied in 2001by experimental fishing. Zero-length hauls were made in which the trawl was hauled either as soon as the bobbin chain reached the bottom or when a tow would normally be considered to start, and the end effect calculated by referring to the density estimated from a standard survey tow fished in the same place. A chain of short tows, each starting where the previous one stopped, of alternating durations, was also fished, and the end effect calculated by comparing the catches in adjacent tows.

Nine zero-length hauls associated with 30-minute survey stations made unexpectedly large catches and the end effect was estimated at up to 9 minutes; two others associated with a 15-minute tow made catches more in line with expectation and yielded an estimate of end effect of about 1.3 minutes before the tow would normally start. The chain of alternating-length tows yielded an estimate of the end effect of about 1.2 minutes. The mixed tow durations in the main surveys of 1999 and 2000 gave estimates of end effect of 2.7 minutes, but in 2001 the estimate from the main survey, excluding the experimental fishing, was –5.5 minutes. Possible reasons for this include a rather clumped distribution of the shrimp biomass in some survey strata in 2001.

Introduction

A research trawl survey is a component of the assessment process for the stock of northern shrimp *P. borealis* fished off West Greenland. The survey has been carried out annually since 1988. At the start, all tows in the shrimp fishing grounds other than Disko Bay lasted one hour. Since 1998 tows have been shortened, at first experimentally but more recently as a change in standard survey practice (Carlsson *et al*., 2000). In the 2001 survey, 82 tows lasted between 11 and 17 min, of which 69 lasted 15 min, and 138 lasted between 20 and 31 min, of which 126 lasted 30 min. The mean tow length was 23.9 min.

There is no evidence so far that shortening the tows in this way has made the survey less precise. The short-range variation in density has been measured and appears to be small, so extending tows beyond 20 mins or so adds little information on the local density (Kingsley *et al*., in press). This result is largely borne out by the overall precision of the survey, which has not deteriorated with shortening the tows (Kanneworff and Wieland, in prep.); but simultaneous changes in the method of allocating stations to strata have confounded this comparison.

However, trawl tows in the West Greenland shrimp survey are defined as beginning when the trawl doors have spread the wings and pulled the head-rope down close to its stable position and the net has nearly reached its final shape. There is abundant evidence that a shrimp trawl starts catching shrimp well before this, possibly even before the bobbin chain reaches the bottom. Therefore, shorter tows would tend to produce higher estimates of density as the end-effect catch, which is presumably relatively fixed, comes to represent a higher proportion of the catch in a shorter tow. In the 1999 and 2000 surveys, tows lasting different lengths of time were mixed in the survey strata, and the catches were examined for evidence of an end effect in trawling. On average over the two years, an end effect equivalent to about 2.7 minutes of trawling was detected (Kingsley *et al*., in press).

In the 2001 West Greenland survey, some experimental trawling was carried out to estimate the magnitude of the end effect. This document describes these studies and presents their results.

Methods

End-effect studies were fished in the frame of the main West Greenland shrimp survey, and used the same basic fishing practices. Stations were only fished between 0700 and 1900 UTC. Trawling speed was about 3 knots. A *Skjervøy 3000* shrimp trawl with a 20-mm cod-end was used with *Greenland Perfect* doors. Standard wire length was 2.4 times depth. The sinking and settling of the trawl was monitored by the signal from a Furuno® trawl-eye mounted on the head-rope. Swept area was calculated from the change in GPS position between the start and end of the tow, and from the average of the door-spreads reported by Scanmar® sensors. The catches of shrimp were weighed and recorded. Samples of shrimp were sorted by species and weighed, and individual *P. borealis* were measured.

Three different fishing methods were used for the investigation of end effect. Two of them were different kinds of zero-length haul. In the first kind, the trawl was hauled as soon as the centre of the bobbin chain had settled on the bottom, defined as the point at which the echo from the bobbin chain displayed on the trawl-eye screen on the bridge had merged with the echo from the bottom. This point was easy to define and recognise, and was repeatable to within a few seconds. To estimate the end effect from these 'bobbin chain' hauls, 1.5 minutes—the approximate average time between the bobbin-chain reaching the bottom and the normal start point—was added to the nominal duration of the regular trawl station.

In the other kind of zero-length haul, the trawl was hauled at the point when a normal haul would have been considered as starting, which is when the head-rope had settled to about its final position. This point was easy to define when fishing on good bottom, but was occasionally uncertain and might have had a margin of error of as much as 15 seconds.

Zero-length hauls were fished at the start, end, or midpoint of survey stations, the catch from which provided a local estimate of the shrimp density. The catch from the zero-length hauls was converted to an estimated fishing time based on the density recorded from the survey station.

The third fishing method was a chain of short hauls of alternating durations, fished in such a way that the next haul started where the previous one ended (Fig. 1). This required recording the distance steamed while the net was sinking, and circling back that far before dropping the net for the next haul. Initially, 10-minute hauls were alternated with 20-minute, but later in the day 5- and 10-minute hauls were alternated. An estimate of the end effect was calculated, by assuming that each pair of consecutive hauls was estimating a common density and maximising the likelihood of the observed catches under that assumption.

As well as these experimental fishing methods that were designed specifically to measure the end effect, the main survey in 2001, like those of the two previous years, used a mixture of trawl durations. In 2001, about 2/3 of the tows lasted about 30 minutes, and 1/3 lasted about 15 minutes. The analysis of that data gave another, separate, estimate of the end effect of the trawl.

Results and Discussion

'Head-rope'-type zero-length hauls were executed at the start point, mid-point, and end point of two 30-minute regular stations and at the start point of one 15-minute station. 'Bobbin-chain'-type zero-length hauls were executed

at the start point, mid-point, and end point of one 30-minute regular station and at the end of the same 15-minute station (Fig. 2). All stations had shrimp biomass densities over 6 tons/sq. km.

The catches in zero-length hauls made in association with survey tows that lasted about 30 minutes were significantly large (Table 1): 'head-rope' hauls made catches that averaged 20% of the catch from a 30-minute tow, and the three 'bobbin chain' hauls made catches of the order of 10% of the 30-minute catch. These zero-length tows estimated that trawling effectively started about 2.7 minutes before the bobbin chain reached the bottom and about 7 minutes before the haul would usually be considered to start. These estimates were much larger than those obtained from the analyses of the mixed tow durations used in the 1999 and 2000 surveys (Kingsley *et al*., in press), and were also inconsistent with usual observations of trawl behaviour, in that a haul is usually considered as starting—i.e. the head-rope appears to have settled to nearly its final position—only 1 or 2 minutes after the bobbin chain reaches the bottom. However, the catches made were not only large, but also consistent at each station.

Catches in zero-length hauls made in association with a single 15-minute survey tow were much smaller. In this case the trawl appeared to start fishing only about 1.3 minutes before the usual start point, and consistently with this it appeared hardly to have fished at all before the bobbin chain reached the bottom. The regular survey tow at this station estimated densities of shrimp over 12 t/sq. km, at the high end of the range of densities usually recorded.

The fitted end effect for the chain of alternating length stations was 1.17 minutes, smaller than found in 1999 and 2000.

In the main survey, which had 221 stations, a general model was fitted to the data on catch and swept area. The estimate of end effect which resulted was, surprisingly, negative and large: -5.5 minutes. Plotting stratum mean density for different tow lengths showed that for several strata, 30-minute tows had given densities several hundred times those obtained with 15-minute tows, resulting in the overall negative estimate of end effect (Fig. 3). The plot was very scattered and did not show a consistent relationship between nominal estimated densities for tows of different lengths.

In the data for 2001, within-stratum variability was often high, possibly because smaller shrimp might have been unusually significant in the stock this year and as indicated in Kingsley *et al*. (in press), the smaller shrimp may occasionally cluster into high-density aggregations and increase variability in the survey results. This might be a partial explanation for the results of the end-effect analyses in 2001, which were all anomalous.

Conclusion

It is clear that an end effect exists. Its size remains in doubt. The previous estimates made from the main surveys in 1999 and 2000 were consistently just under 3 minutes and still seem plausible from the observed behaviour of the net. However, that *series* of zero-length hauls should consistently have made catches indicating that the trawl was fishing as much as 10 minutes before the tow would normally be considered as starting is a cause for concern and indicates that the results of this kind of experimental fishing can be variable. Further work with the Skjervøy trawl is indicated, and it would also be of interest to encourage other research surveys to undertake similar studies with a view to furnishing comparable estimates of the end effect for other gear and other species.

References

Carlsson, D.M., O. Folmer, P. Kanneworff, M.C.S. Kingsley and M. Pennington. 2000. Improving the West Greenland trawl survey for *Pandalus borealis*. J. Northwest Atl. Fish. Sci. 27: 151–160.

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Table 1. Catches from zero-duration tows in the West Greenland shrimp survey in 2001, and estimated end effect.

Zero-duration tow type[1]	Tow location	Distance from station centre (km)	Catch (kg)	Station density (t/sq. km)	Estimated end effect (min.)
Head-rope	Start of 30-min station	1.19	122.5	9.21	9.53
	Mid-point	0.09	83.5		5.90
	End of station	0.53	62.1		4.18
Bobbin chain	Start of 25-min station	1.10	31.3	7.24	3.45
	Mid-point	0.38	20.6		2.18
	End of station	1.17			2.55
Head-rope	Start of 30-min station	0.68	86.3	7.96	8.04
	Mid-point	0.25	81.9		7.53
	End of station	0.84	76.4		6.91
Head-rope	Start of 15-min station	0.70	21.1	12.35	1.35
Bobbin chain	End of station	0.66	1.7		0.11

[1] 'Head-rope' tows were hauled when the head-rope had settled and a normal trawl would have been considered as starting; 'bobbin chain' tows were hauled as soon as the centre of the bobbin chain was on the bottom.

Table 2. Catches in chained tows (see Fig. 1) and end effect estimates from pairs of tows.

Tow duration (min)	Nominal swept area ('000 sq. m)	Catch (kg)	Nominal density (t/sq. km)	Corrected density (t/sq. km)	Fitted joint density with next tow (t/sq. km)
10	14.73	130.8	8.9	7.9	8.32
20	34.33	317.3	9.2	8.7	9.39
10	17.66	198.5	11.2	10.1	9.78
19	33.52	341.6	10.2	9.6	10.67
10	15.94	207.5	13.0	11.6	10.74
5	8.59	103.8	12.1	9.8	9.09
10	16.93	158.2	9.3	8.4	7.81
5	8.26	74.0	9.0	7.3	
Estimated end effect (min)				1.17	

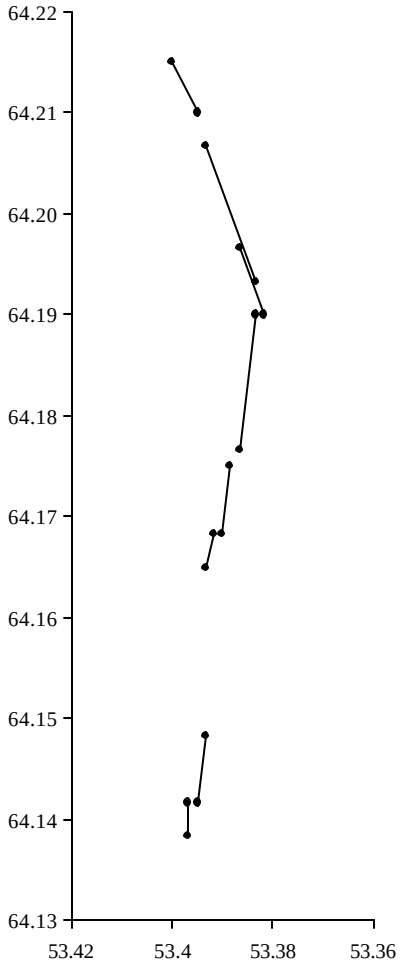

Fig. 1. Layout of a chain of alternating-length tows designed to estimate the end effect of the Skjervoy 3000 trawl in the West Greenland shrimp survey.

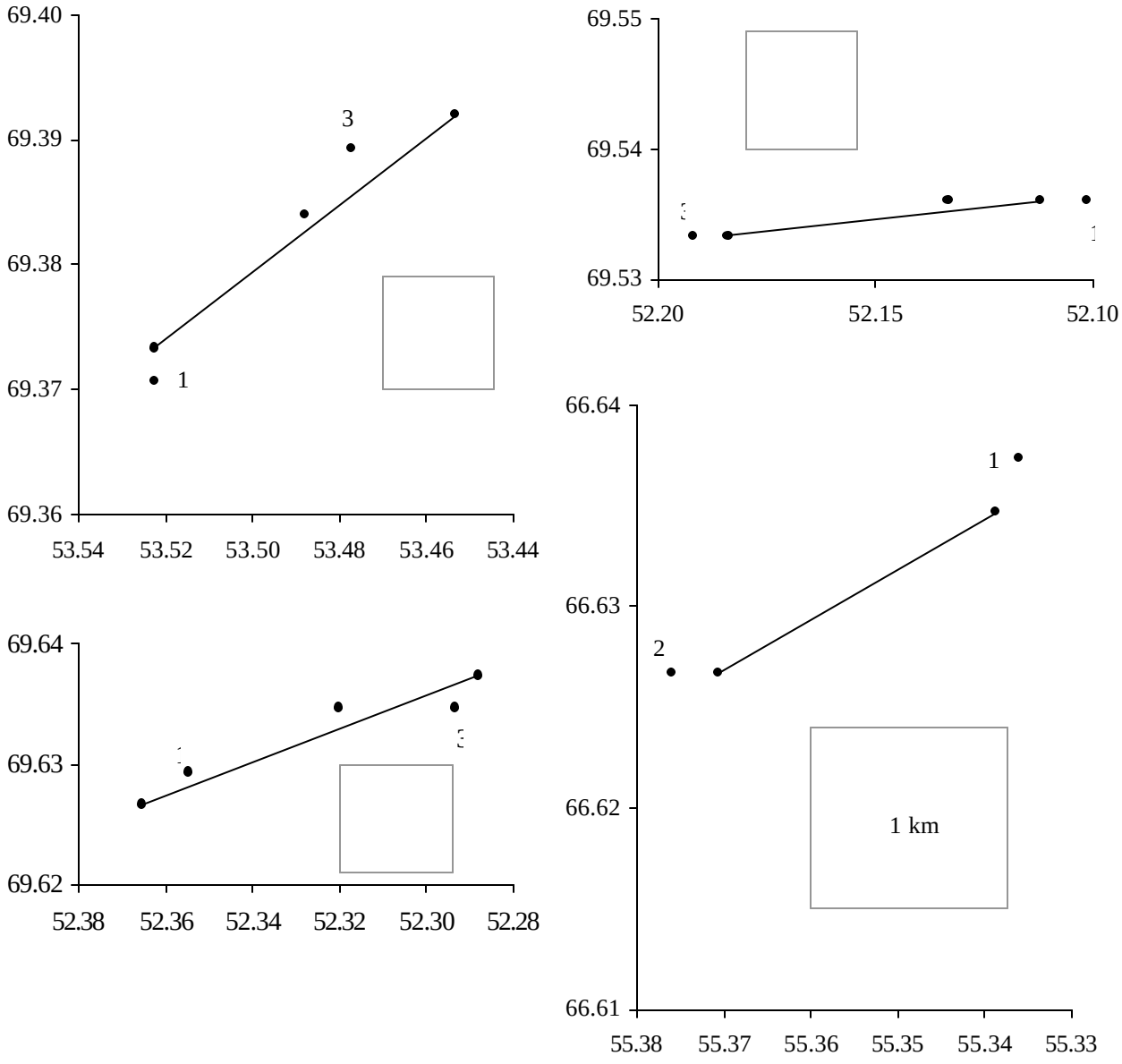

Fig. 2. Layout of zero-length tows executed in connection with regular survey stations in the West Greenland shrimp survey in 2001.

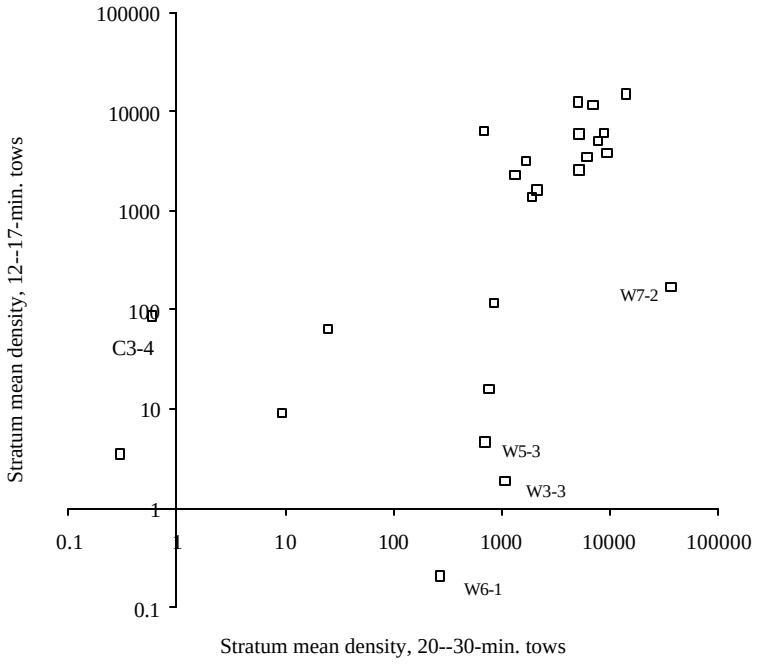

Fig. 3. Stratum mean densities (kg/sq. km) from long and short tows in the West Greenland shrimp survey, 2001.