PHOTOGRAPHIC MEASUREMENTS OF BEARINGS TO SIGHTINGS AND SCANNING PATTERNS OF OBSERVERS ON THE 2008/09 SOWER CRUISE

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ABSTRACT

Downward pointing digital cameras were used to measure bearings to sightings and search patterns of observers on the 2008/09 SOWER survey. Estimated and measured bearings were obtained for a total of 62 sightings, mainly of humpback whales. These suggested little bias in angle estimation and a root mean squared error of 4.9^{o}. These errors are similar to other studies and suggest errors in angle estimation may be almost as important as errors in distance estimation for calculation of perpendicular distances. Observers spent 80% of their time searching within 34° of the trackline and 5% at angles greater than 50°.

INTRODUCTION

Accurate data on distances and angles to sightings are required for line transect surveys. Photogrammetric methods for collecting these data have now been used on a number of surveys. Previous SOWER cruises in 2006/07 and 2007/08 had used video systems to measure distances to sightings and compare these with estimates from observers using reticle binoculars (Leaper *et al*., 2008). On the 2008/09 SOWER cruise experiments were conducted to measure bearings to sightings and to monitor the scanning patterns of observers. This follows similar experiments on the 1983/84 IDCR cruise (Thompson and Hiby, 1985)

METHODS

On IDCR/SOWER cruises, observers in the top barrel search for whales using 7x50 binoculars. Bearings to sightings are estimated relative to the heading of the survey vessel using angle boards. Leaper and Gordon (2001) describe a system for photogrammetric measurement of bearings based on a digital camera attached to the binoculars used by the observer. Mounting the camera on the binoculars has the advantage of moving with the observer and ensuring alignment in a vertical plane because the observer will be holding the binoculars horizontal. The disadvantage is the additional weight for the observer. Observers on the SCANS and CODA surveys used a monopod with the 7x50 binoculars which took the full weight of the system. On SOWER, observers use a shorter binocular support and are sensitive to additional weight. Thus the system used for SOWER involved downward pointing cameras mounted above the observer. Two cameras were used, one with a remote shutter release (infra-red) which was pressed to obtain a bearing to a sighting and a time-lapse camera taking images every 30s to investigate scanning patterns. During similar experiments on the SCANS-II survey, time lapse pictures were taken at random intervals, which is preferable for a truly random sample. However, the 30s interval was considered long enough in relation to the time for the observer to scan across the sector that the sample would effectively be random. This system was very similar to that used on the 1983/84 IDCR cruise (Thompson and Hiby, 1985) except that the cameras were only used to monitor the starboard observer rather than the whole barrel. Two digital cameras, Pentax Optio S10 (for bearings to sightings) and GEC A835 (for time lapse) were mounted in a small, waterproof Lexan case as close to vertically above the observer as possible (Figure 1). A white stripe was attached along the line of the binoculars to allow measurements. The infra-red remote control for the Pentax Optio was also mounted in a small waterproof box with the push button operated by a large waterproof (IP67) switch (RS Components Ltd cat 350276).

It was not possible to position the camera box directly above the observers and so there was some error in bearing measurement due to parallax. This was measured using images of the angle board and found to be less than 1° for all angles within the search area of the starboard observer (the error to the binoculars will be slightly less than this because these were closer to directly beneath the cameras).

RESULTS

The equipment for this experiment was kept as cheap and simple as possible. Initial problems with condensation inside the Lexan waterproof case were solved using silica gel. Otherwise, the cameras and infra-red remote control switch worked reliably.

Measurements of bearings to sightings

There were a total of 62 sightings where bearings were both estimated from angle boards and measured photographically. These are shown in Figure 2. There is evidence of a small systematic bias of around 2° and an overall root mean squared error (RMSE) of 4.9^{o}. Of the 62 sightings, 45 (73%) were humpback whales, 9 (15%) were sperm whales and 5 (8%) were southern bottlenose whales. There were no significant differences in mean squared error between these species (Anova, df=2, p=0.88). There were only four sightings where the cue was not recorded as a blow or blow+body and so it was not possible to investigate the accuracy of bearings with respect to cue type.

Using the estimated distances for the 62 sightings and assuming photographic angles had no error gave a CV_{RMSE} for the perpendicular distances of 0.21.

Observer search patterns

A subset of 1000 images from BT searching effort were randomly selected for analysis of scanning patterns. Of these 948 had useable images where the observer appeared to be actively searching with their eyes to the binoculars. Only the starboard observer was monitored but that observer did spend some time searching to port of the trackline. In order to estimate the combined search pattern for both observers, it was assumed that the behaviour of observers was a mirror image when in each side of the barrel. Thus it was not possible to investigate overall bias to one side of the trackline or the other as had been reported by Thompson and Hiby (1985).

The overall pattern of search effort for all observers combined is shown in Figure 3. The trackline receives the greatest search effort because it falls within the search sector of both observers, although observers actually spent most time in the 15-20° sector. Effort declined steadily with angle at greater angles, with less than 5% at angles greater than 50°.

DISCUSSION

The use of cheap digital still cameras gave good results on this survey, but changing batteries was quite onerous. Future experiments could consider running a power supply to the cameras but this would have the disadvantage of additional cables and needed to run cables through the waterproof housing.

Thompson and Hiby (1985) found from a limited sample size (around 20 observations), that bearings to sightings were usually within 5° on the 1983/84 IDCR cruise. The RMSE from this study of 4.9^{o} with 63% of sightings within 5°, suggests a similar level of accuracy. Thompson and Hiby note surprise at the level of accuracy on the early cruise because the observers relied on marks around the rim of the barrel rather than using angleboards. The RMSE of 4.9^{o} suggests slightly more accurate angle estimation than the SCANS-II survey where the RMSE was 7.1^{o} and 6.0^{o} for 7x50and for Big Eye binoculars respectively. This is what would be expected because the majority of sightings on SCANS-II were transient surfacings of harbour porpoise whereas the majority of sightings in the current analysis were blows from large whales which are visible for longer.

The contribution to the CV of perpendicular distances from angle error was 0.21 from this study. This is only slightly less that the contribution from distance error of 0.26 from the previous SOWER cruise (Leaper *et al*., 2008), suggesting that both angle measurement and distance measurement require a similar level of attention.

Thompson and Hiby (1985) found that over 80% of sighting effort was within 22.5^{o} of the trackline. The equivalent 80-percentile from this study was 34° with only 58% of the effort within 22.5^{o}. This does suggest that observers searched a wider sea area on the 2008/09 cruise than in 1983/84. This is closer to the instructions given to topmen in BT mode to search up to 60° from the trackline, although only 8% of search effort in the current analysis was at angles greater than 45°. The lack of search effort at larger angles may not be a problem for BT mode surveys except for species which show a strong response to the vessel (such as dolphins that rapidly approach vessels to bow-ride).

ACKNOWLEDGEMENTS

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Figure 1. Mounting of digital cameras above observers in the top barrel.

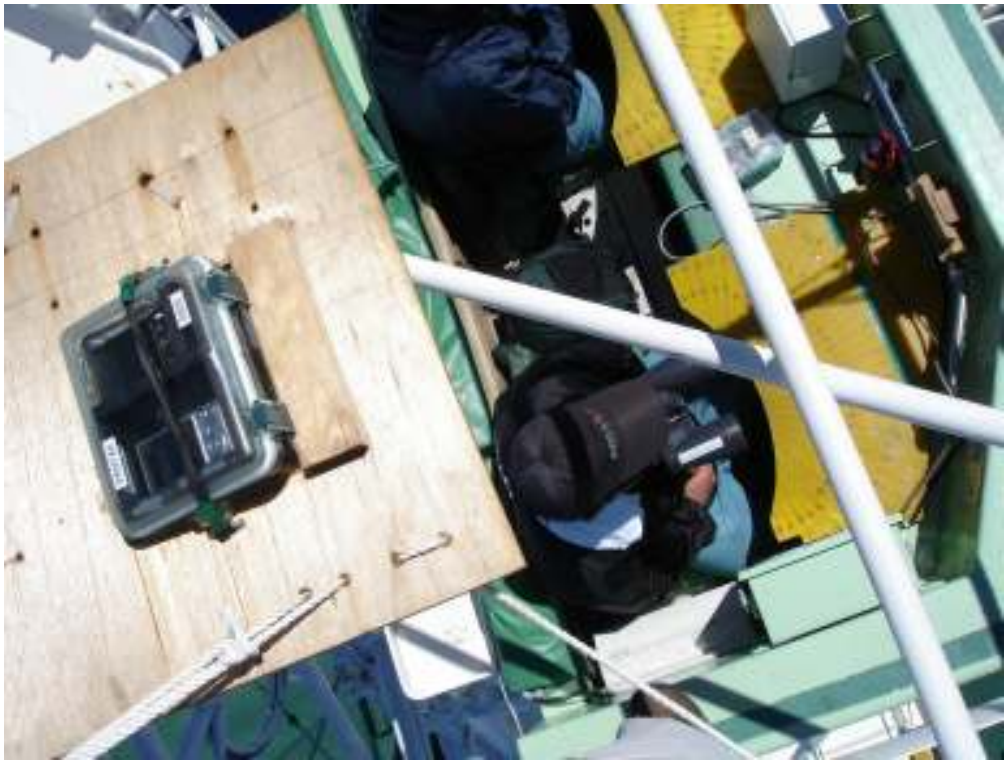

Figure 2. Comparison of estimated and measured bearings to 62 sightings during 2008/09 cruise

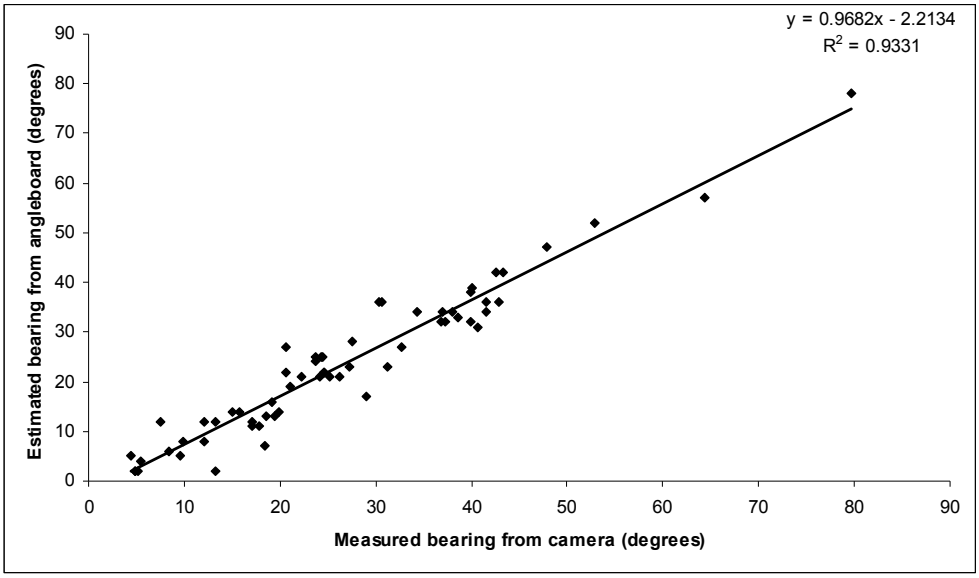
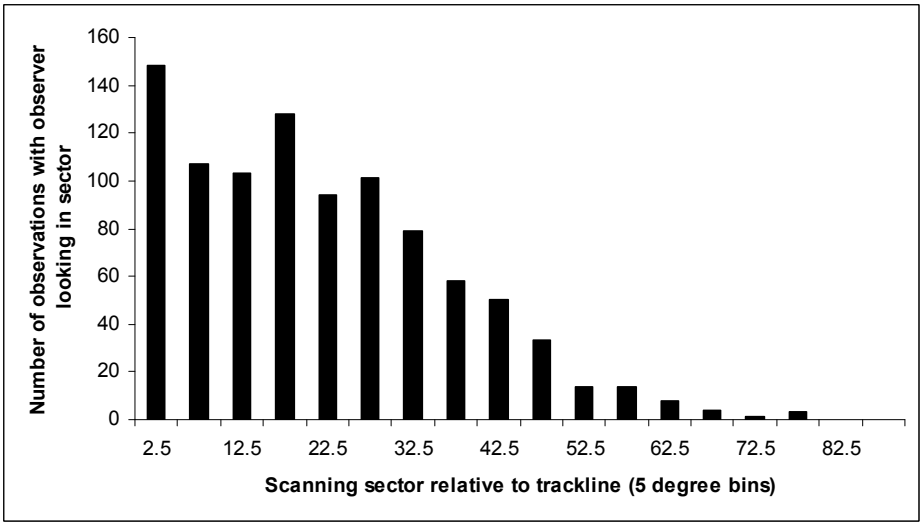
Figure 3. Overall pattern of seach effort with angle from the trackline