The use of the first or last distance to cetacean sightings from line transect surveys for abundance estimation.

THORVALDUR GUNNLAUGSSON (thg@hafro.is)
Marine Research Institute, P.O. Box 1390, IS-121 Reykjavík, Iceland

ABSTRACT

The last detection distance recorded for each sighting has been used consistently in abundance analyses of the Iceland/Faroese NASS shipboard data for baleen whales. The common practice is to use the first detection distance, which will be at a smaller angle to the trackline and smaller inclination angle to the horizon and therefore less precise. Significant random movement will introduce a positive bias when the first distance is used. It may also introduce a positive bias when the last distance is used if the last surfacing of animals moving away from the track is more likely missed. As these surveys have not tracked animals upp to abeam (stopped when duplicated and primary sightings not tracked) there has been a potential for bias. The T-NASS sightings first and last detection distances were compared and these sets showed little difference, so if there is a bias it is of similar magnitude with either method. Tracking all sightings up to abeam is suggested for future surveys to avoid this uncertainty.

INTRODUCTION

At its last meeting the NAMMCO Scientific Committee Working Group on Abundance Estimates (March 7-9, 2011, Copenhagen) discussed the use of the last distance estimation for each sighting instead of the first, which is not standard practice for line transect surveys of baleen whales, although it has been used consistently in analyses of the Iceland/Faroese NASS shipboard data. Gunnlaugsson noted that in theory this approach eliminates a possible positive bias due to random movement of the animals detected far ahead on the track line, but may introduce other biases if later surfacings are missed or due to responsive movement. The last measurement should also generally be more accurate because it is done when the animal is closer to the vessel. Others disagreed with this practice because of the other biases that may be introduced because animals moving towards the trackline will have a greater chance of being resighted, and thus having later distance measurements, than those moving away from the trackline. For some species responsive movement might also be an issue (Palka and Hammond 2001). The Group agreed that the issue must be investigated further to determine if this practice introduces a bias into recent abundance estimates that have used these data. Gunnlaugsson agreed to do a comparative analysis of first and last sighting distances to the same sighting, although differences might have other sources and this would not resolve the issue of which method was more biased. However, if difference was small, the method used would not matter.

The possible biases due to random movement depend on the speed of the animals relative to the survey vessel, the forward detection distances, and in particular on the searching behaviour. Using the distance to the first detection has an inherent potential bias, while using the last detection has a potential bias only if this is not the last surfacing. If searching is equal in all directions (up to 90°) there is little room for bias with either method. The more the search is concentrated on the track there is a greater potential for bias. Hiby (1986) concluded that the bias in using first detection would be minor if the animals moved at less than half the speed of the vessel in a particular example. Some telemetry data do exist for large baleen whales but generally not on a fine enough scale to inform on random movement.

The first NASS surveys used closing and later delayed closing to identify species and confirm number, thereby also getting better information on the distance and the behaviour of the animals. The estimates entered on the form were a consensus based on all available information. Effort was then not as focused ahead on the trackline. Binoculars were used for identification and later distance estimation, but not for systematic searching until double platform (BT) mode (Buckland and Turnock 1992) started on the Faroese vessel in 1995 and Icelandic vessels in 2001, and were then used on the higher tracker platform. The BT protocol called for the trackers to concentrate their search close to the trackline ahead. In 2007 high-powered binoculars were introduced and partly used. The potential for bias is therefore greatest in the most recent survey in 2007 (T-NASS).

MATERIAL

Sightings by trackers of large baleen whales in the 2007 Icelandic and Faroese survey vessels where the timing to the first and last recorded distance differed by more than 2.5 minutes were extracted. A few sightings lack a

distance in the first record (no reticule) and a few have no distance or angle in the last record (probably meant only for species or pod size information). In such cases the first/last available distance was used. On the Faroese vessel there are only two instances of such records and showed movement in opposite directions. On the Iclandic vessels 73 instances were identified.

RESULTS

The results of comparing first and last distance from the Icelandic vessels in 2007 are given in table 1.

DISCUSSION

There is little indication of a greater bias either way in the table. Using the first recorded distance in these data would apparently lead to slightly higher estimates, but results from duplicate analysis might then also differ slightly. Frequently the sightings that seem to move away from the track appear to have had initial distance underestimated when compared to the change in the position of the vessel in the meantime (unless the whales also moved fast forward). All vessels jaw several degrees even in flat seas (due to autopilot steering onto pre-set track line). When the whales appear to move towards the track line this noise is the most likely reason for initial overestimation of a small angle. Later estimates at greater angles are less sensitive to such noise.

The practice has been to use the distance to the first sighting even when the species identification came later. Of the 23 humpback sightings 2 had initially been unidentified, but 9 of the 31 fin whale sightings. It would be more logical to use the distance to the first resighting where the species was identified, since unidentified whales would not be included in estimates unless they were resighted and identified. Testing such an approach with these data is doubtful since although tracker sighting information was entered on computer on the spot during this last (TNASS 2007) survey, entering the species into the form may have been delayed when the sighting was far ahead in anticipation of a better resighting. The data may also have been modified (validated) after discussions on-board. This may have biased the duplicate data, as whales missed by the primary observers remain unidentified and are not included in analyses, but initially unidentified whales that were duplicated then received species identification and are included as duplicates.

CONCLUSION

In the large whale species mix in the North Atlantic around Iceland monitoring/tracking of sightings is needed to get good species identification and pod size estimates. There are many examples of sightings not far from the track line that had been identified to one species while on track which turned out to be of another, or mixed species (fin+sei, fin+blue) when resighted later, which may be behind abeam or after slowing down on the track or delayed closing, The pod size also generally increases when the animals are monitored at closer range. There is therefore a need to track/monitor the large baleen sightings up to abeam and therefore the last resighting distance before abeam can be reliably recorded. Sightings by the lower (primary) platform should also be monitored by the higher (tracker) platform for more accurate distances, species and pod size estimates. This may provide an additional correction when group size is underestimated by the lower platform. When sightings are tracked/monitored and the last distance abeam is reliably recorded there is a definite advantage to using it in analysis, for at least the large baleen whales where responsive movement is certainly not an issue.

Firstly there will be greater accuracy in distance and relative accuracy in the angle to the track line. The inaccuracy in the angle due to the jawing of vessels is a great problem with initial sightings at great distance ahead that could only be overcome with precise absolute angle measurements, which have not been an option.

Secondly, there will be no positive bias in the estimates due to random movement on to the trackline.

Thirdly, the duplicate analysis will be comparing sightings closer in time. In addition sightings of in particular humpback whales can show up to be of several smaller groups and then assigning initial distances of several miles to one small group while recording another later detected, at close range, is arbitrary and much more logical to do as they come closer.

If responsive movement occurs only over a relatively short distance the abeam line can be replaced with a preferred reference line that is at such a distance ahead of the abeam line. Occasional sightings first seen within that line could still be included if the responsive movement is believed to be avoidance.

To facilitate any comparison of analysis methods the sighting process must be accurately recorded, such as where the sighting is identified to species and if and where this changes, and as well for the pod size. This is also important for unbiased duplicate analysis. The final verdict, possibly after slowing down or delayed closing, must be recorded separately.

In the BT method, what is a trial, for what and when does it start, has to be well defined and made clear to survey participants.

REFERENCES

Buckland, S.T. and Turnock, B.J. 1992. A robust line transect method. Biometrics 48:901-909.

Hiby, A.R: 1986. Results of a hazard rate model relevant to experiments on the 1984/85 IDCR Minke whale assessment cruise. Rep.Int.Iwc, 36 497-8.

Palka, D.L., Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of Abundance. Can J Fish Aquat Sci 58: 777-787.

Table 1. Number of sightings by 400 meter intervals perpendicular (Pd) using first and last record of distance for fin whales (BP), humpback whales (MN) and all large baleen whales combined.

Pd	BP		MN		all	
Record:	first	last	first	last	first	last
0- 400	6	5	3	3	13	11
400- 800	6	7	4	5	12	13
800-1200	3	3	4	5	7	9
1200-1800	6	7	8	3	15	11