ASSESSMENT OF CORRECTION FACTORS USED FOR ESTIMATING GOAT POPULATIONS IN THE WESTERN AUSTRALIAN RANGELANDS

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Introduction

Aerial surveys are routinely used to count feral goat populations in the rangelands of Western Australia. As a general rule, the number of goats estimated from an uncorrected aerial survey is an underestimate of the true population size (Caughley 1974, Southwell 1996). In aerial surveys of animal populations the generic reasons for the observed underestimates, or biases, include climatic variables (season and weather), time of day, observer experience, animal characteristics (behaviour and/or physical appearance) and habitat variability (Linklater and Cameron 2002). These biases are particularly relevant to feral goats in the rangelands of Western Australia.

To improve the accuracy of broad-scale aerial surveys, biases need to be quantified and then corrected by using correction factors (CF's). A CF, a form of multiplier, is commonly used to provide the best possible estimate of goat numbers from aerial surveys. These CF's aim to account for goats that are not seen during the survey because of one or a combination of possible biases.

Methods

We conducted a number of aerial surveys, using methods described by Southwell and Pickles (1993) and Southwell (1996), counting goats on four pastoral stations with commercial goat operations in the Gascoyne, Murchison and Goldfields regions of Western Australia. Survey areas ranged from 4,110 ha to 32,830 ha. Following the aerial surveys, goats were trapped or mustered so that a known population could be compared with a population estimate from the aerial survey. Uncorrected population estimates were calculated using the strip-transect methods of Caughley and Grigg (1981), with the CF's applied to these estimates.

We examined a number of CF's, derived from the literature and developed our own, specific to feral goats. The CF's we examined were as follows:

1) A vegetation CF, from Southwell (1996).
2) A colour CF developed specifically for feral goats in the rangelands of Western Australia.
3) A sightability probability CF using line-transect methodology and the DISTANCE software.
4) A double-count CF, following the methods of Marsh and Sinclair (1989).

Results & Discussion

All population estimates of feral goats, using standard broad-scale aerial survey techniques without correction factors (Caughley and Grigg 1981, Southwell and Pickles 1993), grossly underestimated the real population of goats. Even with the correction factors, population estimates were generally under the known population.

The first CF used Southwell's (1996) values for three different vegetation covers that are found in the rangelands of Western Australia (Low = 1.0, Medium = 1.78, High = 1.96). However, we found that the majority of the vegetation scores were in the category of medium (56% of all observations), so this correction factor was limited to the medium value of 1.78. This CF was the largest multiplier of the four CF's and also the best performing. It is uncertain if the performance of this CF was because of its applicability to the rangelands and/or aerial surveys of feral goats or if it just happened to be the largest multiplier of the uncorrected population estimates.

The colour CF was derived on the premise that coloured goats were harder to see than white goats. This CF used the assumption that the probability of seeing a white goat was one ($p = 1.0$) whereas the probability of seeing a coloured goat was less than one ($p < 1.0$). Bias was attributed to the ‘unobserved’ coloured goats. The colour CF was the second best performing CF and it clearly identifies the problem of goat colour as a visibility bias. However the underlying assumption that $p = 1.0$ for white goats is unlikely. In reality, $p < 1.0$ for both white goats and coloured goats. To complicate the colour CF further, colour ratios of white to coloured goats are not equal from one region to the next. For example, ratio of white to coloured goats is higher in the Gascoyne than the Goldfields. Regional specific CF’s are required for any correction factor based on colour.

The sightability CF was derived in an identical manner to Southwell (1996). Its effectiveness increases as population size increases making it well suited to broad-scale aerial surveys. However, the value of the multipliers for the sightability CF was less than the vegetation and colour CF’s. This suggests that other factors (additional biases) were influencing the sightability of feral goats, rather than just the modelled decline in sightability associated with increased distance from the transect-line, as line-transect theory predicts.

The final CF examined was the perception correction factor of Marsh and Sinclair (1989). In this CF, two observers on the same side of the aircraft simultaneously but independently count goats. Analysis follows a variation of the Petersen mark-recapture model (Caughley and Grice 1982) to derive the perception correction factor. The perception CF was the most variable of the four CF’s (for regression analysis of observed versus predicted $p>0.05$ for perception CF *cf* $p<0.05$ for the other CF’s) and its performance was similar to the sightability CF. This suggests that observer bias has had important consequences for population estimations in this study, but as a correction factor the perception CF is not as effective as the other CF’s.

Conclusions

Two main conclusions can be made from this study. The first is that broad-scale aerial surveys generally underestimate the ‘real’ populations and therefore require correction factors. The second conclusion is that the correction factors used in this study attempt to categorise bias to one or two causes (e.g. vegetation, colour, observer, colour & region). However, it is more likely that multiple combinations of both perception and availability biases (as defined by Marsh and Sinclair 1989), such as those outlined in the introduction are working together. More work is required to derive more robust correction factors to apply to aerial surveys of goats in the rangelands of Western Australia.

References

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