Preface

'While efforts will always be made to eliminate as far as possible major sources of inaccuracy in counts of animals taken from the air, errors of one kind or another are inevitable. … To state that there is likely to be one elephant completely hidden in cover for every two seen may be entirely justified, but only if supported by some reliable evidence.' Thus Jolly (1969: p. 50) introduced a paper on the treatment of errors in aerial surveys of wildlife in southern Africa in 1968 and the problem is still relevant.

This special issue presents a collection of papers derived from a symposium on aerial surveying of wildlife populations held at the 2006 annual conference of the Australasian Wildlife Management Society in Auckland, New Zealand, and from the ensuing active debate. It provides a contemporary discussion on theoretical aspects of the collection and analysis of aerial survey data at a time of rapid development in technologies and techniques. These technologies and techniques, including digital voice recorders, audio filtering software, accurate geographic positioning systems (GPS; e.g. Marques *et al.* 2006), geographic information systems (GIS), sighting guns linked to laptop computers (Southwell *et al.* 2002), advanced analysis software such as DISTANCE (Buckland *et al.* 2001; Thomas *et al.* 2006) and MARK (White and Burnham 1999; White 2008), and considerable advances in analysis techniques (this issue), have greatly increased possibilities for accuracy and precision in aerial surveys.

The first seven papers introduce and review theoretical contemplations for those undertaking and analysing aerial surveys. After definition of bias, accuracy and precision, pertinent aspects of surveyors, their aircraft and their targets are considered. Essentially three methods of population estimation are presented within the five papers deliberating on appropriate analyses: distance estimators, tandem-count mark–recapture estimators (equivalent to double counting in some papers) and combination distance/ mark–recapture estimators. All these have their applications and limitations: Borchers *et al.* (2006), among others, have raised shortcomings of tandem-count mark–recapture models, whereas Caughley and Sinclair (1994), Melville and Welsh (2001), and Welsh (2002) questioned the use of distance estimators.

The remaining papers document applications of aerial survey methods and analyses. Subject animals include kangaroos in temperate and arid environments, penguins in Antarctica and ungulates in Kruger National Park, Wyoming, alpine New Zealand and Australia, and in Australian rangelands.

When designing and undertaking aerial surveys, consideration is required for fundamental factors that can cause bias, including human limitations, statistical distribution of group sizes and recounting of animals. Contraventions of the assumptions of estimators will also result in inaccurate estimates. During tandem-counts, correlation between observers (non-independence) may result in negative bias. Negative biases are also likely when natural marks are used in mark–resight estimators because there are some animals that have no obviously discernable differences. For simple line-transect estimators, all animals are unlikely to be observed on the line resulting in negative bias. Positive or negative bias may result from non-adherence to the uniformity assumption of line-transect estimators caused by responsive movement or other reasons. Insufficient sample sizes, especially for highly clustered populations, will create additional problems for modelling covariates in tandem-counting, and with the uniformity assumption in line-transect applications, both resulting in positive or negative biases. Combinations of mark–recapture and distance methods, although attempting to resolve these issues, may contravene some assumptions of both methods. The extent and direction of biases in estimates of abundance can only be resolved by comparison with accurate censuses or by collecting additional information at the time of the survey.

Given the complexity of interactions between animals, aircraft and observers when aerially surveying, it is unsurprising that there are divergent views and conclusions about the appropriateness of different estimators. The debate is healthy and essential for the development of the science of surveying wildlife populations: constructive criticism of the *status quo* is a precursor for scientific advancement. We had a choice: to present only one side of the debate (perhaps the one we favoured at the time of the symposium?), or to present the divergent analyses and discussions and allow the readers to decide which arguments they agree with and which methods best suit their needs. We chose this as the most useful approach because there are lodes of gold to be mined among the theory (with apologies to Caughley and Sinclair 1994: p. 204). Whatever the aerial survey application being considered, the papers in this special issue provide the most up-to-date musings enabling the collection of 'reliable evidence' and minimising the 'inevitable errors' encountered in aerial surveys of wildlife.

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