DRONES VS HELICOPTERS FOR BROAD-SCALE ANIMAL SURVEYS – CONSIDERATIONS FOR FUTURE USE

Matthew Gentle[1], Neal Finch[2], James Speed[1] and Anthony Pople[3]
[1]Invasive Plants and Animals, Biosecurity Queensland, Department of Agriculture and Fisheries, Toowoomba, Queensland.
[2]Macropod Management Unit, Environmental Services and Regulation, Environment and Science, Toowoomba, Queensland.
[3]Invasive Plants and Animals, Biosecurity Queensland, Department of Agriculture and Fisheries, Dutton Park, Queensland.

ABSTRACT

Effective monitoring is key for effective wildlife management. Aerial surveys are a proven method for monitoring medium/large-sized mammals (e.g. macropods, feral pigs) in Australia's rangelands. However, conventional aircraft are noisy, expensive, and considered an occupational safety risk for biologists. UAS (unmanned aerial systems, or drones) may offer potential safety and efficiency gains, but need to be assessed against the current best-practice techniques.

We tested the ability of a long-range, fixed-wing drone (300m agl, 65-93 km h^{-1}, thermal and colour imaging) to survey macropod populations and validated the results against those from conventional helicopter surveys (61m agl, 93 km h^{-1}, human observers). Four, 80-km long transects at Roma in south-western Queensland were surveyed and the outputs analysed using line-transect distance sampling methods. The drone was able to survey over half (56%) of the 320 km transects, and over 448 km of survey flights in total. However, the drone technique was unable to distinguish between macropod species, recorded <13% of the macropod density observed during the helicopter survey, and required more flight and data processing time.

Long-range drones clearly have potential for landscape-scale wildlife monitoring but results must match or exceed the conventional techniques. Future UAS applications to wildlife monitoring require a proven ability to identify animals, a similar or greater detection probability than conventional techniques, an efficient means of data collation/analysis, and comparable costs to current-best practice survey methods. We discuss the issues for potential users to consider to ensure that new survey technologies can be used to optimal benefit.

Keywords: UAS (unmanned aerial systems), macropod, kangaroo, densities, landscape.

INTRODUCTION

Monitoring animal populations is key to effective wildlife management. Quite simply, wildlife managers need data on population size, trends or impacts to make informed decisions. Monitoring can be expensive or resource intensive, particularly where large-scale assessments of wildlife populations are required. Broad-scale monitoring of medium-large sized mammals is often performed using manned helicopters or small aircraft. These conventional aerial survey techniques are well-proven, but can be resource-intensive (expensive) and are increasingly considered an occupational-risk for aircrew. Additionally, the typically noisy conventional aircraft may also alter wildlife behaviour, making the detection and census of animals, or analysis of survey data problematic.

New technologies like unmanned aerial vehicles (UAS) or drones, offer several advantages over manned aircraft, and are increasingly being seen as potential viable alternatives for monitoring fauna populations. Improved remote sensing technologies (e.g. optical, thermal, multispectral cameras) offer an increasing ability to detect, identify and count animal species. UAS can have a low acoustic signature, particularly at survey heights, reducing any disturbance to wildlife. An increasing operating range broadens the scope of potential UAS applications for landscape-scale survey. Emerging, affordable UAS technology offers potential safety and efficiency gains, but needs to be assessed against the current best-practice techniques. Here we examine a case study of UAS vs helicopter surveys on macropods (Gentle, Finch, Speed, & Pople, 2018) to highlight considerations for using drone technology to monitor wildlife at the landscape-scale.

MATERIALS AND METHODS

Helicopter surveys are conducted each year by the Queensland government to survey commercially-harvested macropod populations (DEHP, 2015). Helicopter surveys were undertaken on the Roma survey block in south-western Queensland on 26 and 27 May 2017 within 2.5 hours of sunrise and sunset (respectively). A Robinson R44 helicopter, with rear doors removed, was flown (height 61m agl, speed 93 km h^{-1}) along each of four, 80 km long transects placed at 20km intervals across the study site. Two observers counted clusters of animals and recorded these into distances classes perpendicular to the transect line.

The UAS survey was completed on 1–2 June 2017, within 7 days of the helicopter survey to minimise any potential population changes. Survey methods were designed to allow for comparable data collection to the helicopter surveys. The electric-powered UAS ‘Spylite’ (Bluebird Aero Systems Ltd, Israel; http://www.bluebird-uav.com/spylite) was flown at 300 m agl to meet regulatory approvals and assist line-of-sight visuals and communications. Speed was 65-93 km h^{-1}.

Detection probabilities, encounter rates and densities for each species (or species group) were calculated for the helicopter survey and UAS survey by conventional distance sampling methods using DISTANCE 6.0. The mean group size of macropods and the distribution of the group sizes counted by each method were also compared. The efficiency and cost effectiveness of each survey technique were also assessed by comparing the flight and data processing times, and costs, for each technique respectively. The UAS surveys were completed under commercial contract and included all costs associated with completing the UAS surveys, including primary data processing. To be comparable, costs for undertaking the helicopter surveys included helicopter charter, labour and all travel costs, including car hire, accommodation and staff allowances. For more detailed methods, please see (Gentle et al., 2018).

RESULTS

The helicopter completed surveys of all four transect lines (totalling 290km) in 5 h, including ferry. The UAS completed ~8 h of flights over 449km, including ferry, to survey 248 km of transect (including repeated sections). UAS regulatory operating restrictions and technical issues reduced the transect sections that could be surveyed. Analyses were restricted to the transect sections surveyed by both methods.

The encounter rates (macropod groups per km of transect) recorded during the UAS surveys were low (0.18) compared to the helicopter surveys (3.68). Five species of macropods were recorded during the helicopter surveys. Macropod densities (pooled) were 53.8 animals km^{-2}, consisting mostly of the eastern grey (46.4), red (3.6) and common wallaroo (3.0). Individual macropod species could not be distinguished on the UAS surveys and observations were thus pooled. Macropod density derived from the UAS data were estimated as 3.2 animals km^{-2}, well less than one-tenth of the estimate from the helicopter surveys. On each of the four transects, the UAS recorded an average of 8.0% of the macropod density observed during the helicopter surveys (SD = 5.1, range 2.9-12.7%, Figure 1). There was no significant differences in the distribution of group size observed nor the mean group size recorded during each survey type. Surprisingly, there was no decline in detection probability away from the transect line for the UAS data in contrast to the helicopter survey data (Gentle et al., 2018).

The comparative efficiency and costs of each technique are shown in Table 1. Including the time for data processing, the UAS required 9.7 min to survey each km, while the helicopter required less than a third of this time (2.7 min km^{-1}). Similarly, the cost per kilometre surveyed was greater for the UAS (~\$89 km^{-1}) compared with the helicopter (~\$31 km^{-1}).

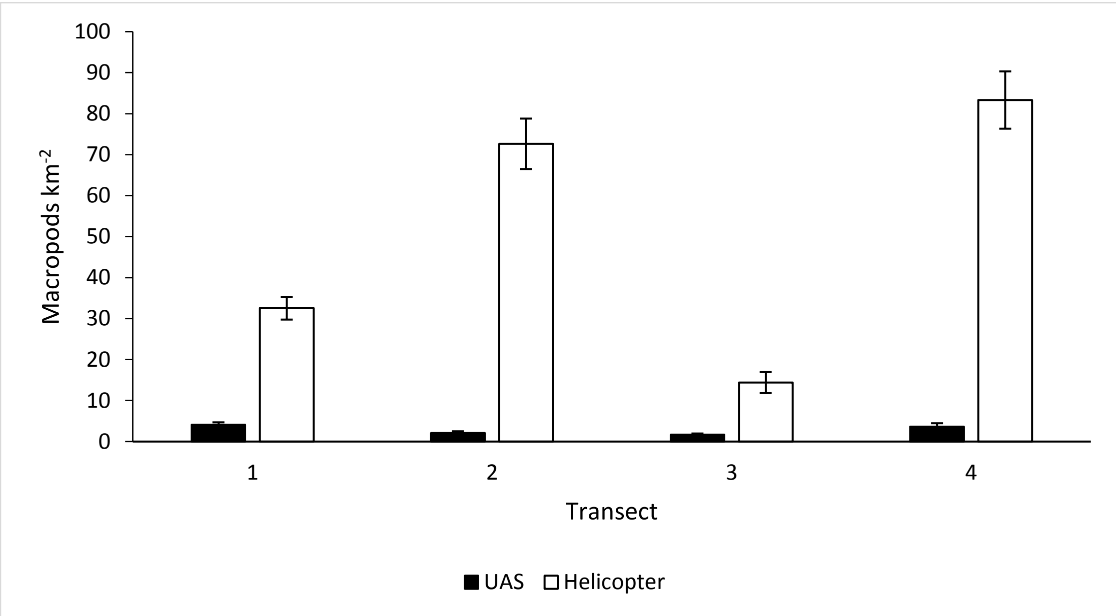

Figure 1. Density of macropods observed on each shared section of transect during the UAS or helicopter surveys. Error bars represent estimated standard error. Source: Gentle et al. (2018).

Table 1. Cost efficiency (including time) of each survey method at Roma. Time and costs are associated with undertaking the survey and primary data processing (in 2017 AUD). Adapted from Gentle et al. (2018).

Survey method	Flight and processing time (h)	Total transects surveyed (km)	Time per survey km (min)	Survey cost (AUD km^{-1})
UAS	40	248.4	9.7	\$88.6
Helicopter	13	290.2	2.7	\$31.3

DISCUSSION

Until recently the use of UAS for broadscale wildlife monitoring has been technically or logistically unfeasible. The ability of UAS to complete wildlife surveys at the landscape scale are therefore encouraging. However, the resulting captured data indicate that UAS are currently an inefficient, expensive and inaccurate alternative to manned helicopter surveys of macropods. Further improvements in a number of key factors are needed before the UAS could replace or supplement helicopter surveys. The following key criteria should be met to for UAS to offer a valid alternative to conventional aerial surveys:

Effective target recognition
The UAS technique were unable to distinguish between macropod species, largely due to the increased flight height relative to the helicopter surveys and an insufficient resolution of imagery. Obviously, the target animal species or group needs to be accurately identified and classified for effective surveys. UAS methods including survey height, swathe width, speed, payload sensor and resolution need to be appropriately balanced and tailored to fit the targeted species and situation (ie habitat) [see Chrétien, Théau, and Ménard (2016),].

Comparatively high probability of detection
The UAS had a limited ability to detect animals of any group size, and the rate of detection was variable. Conventional surveys also suffer from imperfect detection, but their consistency allows for correction. Improvements in sensor technology and/or a reduction in the height flown by the UAS is required before an adjustment for incomplete detection by a human eye. UAS require a consistent, and equal or greater detection probability than existing survey techniques to offer any practical advantages.

Efficient primary data processing
The time taken for primary data processing was four times greater for the UAS (32 h) than the helicopter survey (8 h). Manual data processing of UAS imagery is onerous and can effectively limit many of the potential benefits of the technique. Significant advances in automated processing of imagery, through deep learning and other computer applications [e.g. Norouzzadeh et al. (2017)], are likely required to improve UAS survey efficiency.

High cost-effectiveness and efficiency
The average survey and data processing time, and survey costs for the UAS were approximately three-times greater than required to complete the helicopter surveys. Costs associated with any new technique are likely to decline into the future as technology develops and uptake of such techniques becomes more widespread. Nevertheless, UAS should be considered only where cost-effectiveness or efficiency are comparable to current-best practice survey methods.

Meets regulatory conditions
All transect sections were counted during the helicopter surveys, while Civil Aviation Safety Authority (CASA) regulations limited the UAS to areas >10 nautical miles from Roma airport. Comparable regulatory and logistical operating conditions are required if UAS are to be competitive to manned aircraft for broad-scale wildlife survey.

Pilot trials support more detailed assessments
Pilot trials are essential to understand actual and potential issues with undertaking wildlife survey, and for determining the adequacy of the technique for the species and situation.

Ideally, future developments in UAS should be compared on the aforementioned criteria, to ensure that new techniques offer improvements to current best-practice techniques. This is an essential step before the UAS can be considered to be a suitable benchmark for wildlife survey.

ACKNOWLEDGEMENTS

A commercial operator completed the UAS flights and provided the raw data for analyses. Funding was provided under the Queensland Feral Pest Initiative. This paper is based on recently published work by the authors, Gentle et al. (2018).

REFERENCES

DEHP (2015). 2016 quota submissions for commerically harvested macropods in Queensland. Macropod Management Program, Southern Region, Environmental Services and Regulation, Department of Environment and Heritage Protection, Queensland.

Chrétien, L. P., Théau, J., & Ménard, P. (2016). Visible and thermal infrared remote sensing for the detection of white-tailed deer using an unmanned aerial system. *Wildlife Society Bulletin, 40*(1), 181-191. doi:10.1002/wsb.629

Gentle, M., Finch, N., Speed, J., & Pople, A. (2018). A comparison of unmanned aerial vehicles (drones) and manned helicopters for monitoring macropod populations. *Wildlife Research, 45*(7), 586-594. doi:https://doi.org/10.1071/WR18034

Norouzzadeh, M. S., Nguyen, A., Kosmala, M., Swanson, A., Packer, C., & Clune, J. (2017). Automatically identifying, counting, and describing wild animals in camera-trap images with deep learning. *Proceedings of the National Academy of Sciences*. doi:doi:10.1073/pnas.1719367115