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The assemblage of birds struck by aircraft differs among nearby airports in the same bioregion

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Abstract

Context. Bird–aircraft collisions impose an economic cost and safety risk, yet ecological studies that inform bird hazard management are few, and to date no study has formally compared species' strike profiles across airports. In response to strike risks, airports have implemented customised management on an airport-by-airport basis, based on the assumption that strike risk stems from prevailing local circumstances. We tested this assumption by comparing a decade of wildlife–aircraft strikes at three airports situated in the same bioregion (likely to have similar fauna) of Victoria, Australia.

Aim. To compare the assemblage of wildlife struck by aircraft at three major airports in the same bioregion.

Method. Standardised wildlife strike data were analysed from three airports (Avalon, Melbourne and Essendon Airports), in the Victorian Volcanic Plains bioregion, central Victoria, Australia. Ten discrete 1-year sampling periods from each airport were compared, spanning the period 2009–19. Bird data were comparable, and data on mammals were considered less reliable, so emphasis was placed on birds in the present study.

Results. In total, 580 bird strikes were analysed, with the most commonly struck species being Australian magpie (*Cracticus tibicen*; 16.7%), Eurasian skylark (*Alauda arvensis*; 12.2%), Australian pipit (*Anthus australis*; 12.1%), masked lapwing (*Vanellus miles*; 5.9%), nankeen kestrel (*Falco cenchroides*; 5.0%), house sparrow (*Passer domesticus*; 4.8%), welcome swallow (*Hirundo neoxena*; 4.3%) and tree martin (*Petrochelidon nigricans*; 4.0%). The assemblage of birds struck by aircraft over the decade of study differed between airports. The most commonly struck species drove the assemblage differences between airports.

Conclusions and implications. In the present study system, airports experienced discrete strike risk profiles, even though they are in the same bioregion. The airports examined differed in terms of air traffic movement rates, aircraft types, landscape context and bird hazard management effort. Given that strike risks profiles differ among airports, customised management at each airport, as is currently the case, is supported.

Keywords: aerodrome, aircraft, airfield, collision, community, mammals.

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Introduction

Although aircraft strikes on wildlife are not common events, they present a real hazard to aircraft and exact a significant cost in terms of both human lives and money (Cleary and Dolbeer 2005; El-Sayed 2019). The problem of mammal– and bird–aircraft collisions is likely to become greater in the future as the volume of air traffic increases (DeVault *et al.* 2013). Continued exacerbation of the problem seems likely – it has been suggested that modern commercial aircraft, which are quieter and have larger engine air intakes than older models, are involved in proportionately more bird strikes than older aircraft because birds are less able to detect them in time to avoid collisions (Chilvers *et al.* 1997; Ministerie van Verkeer en Waterstaat 1999). Furthermore, there are concerns, particularly in North America, that populations of high strike-risk species of wetland bird are increasing (North American Bird Conservation Initiative, US Committee 2014).

Although commercial aircraft generally fly too high to be at risk of colliding with birds, many military and light aircraft utilise the same air space as birds, and all aircraft are exposed to the risk of a bird strike when landing or taking off at airports. The threat of bird strikes in the vicinity of an airport is increased because some bird species congregate at these sites (Burger 1983; E&SS 1994; Ministerie van Verkeer en Waterstaat 1999; Transport Canada 2004; DeVault *et al.* 2013; El-Sayed 2019). Thus, the management of wildlife at airports – particularly bird populations – to reduce the risk of wildlife strikes is becoming increasingly important to airport operators, including those in

Australia (ATSB 2012, 2019*a*, 2019*b*). Such efforts generally occur on an aerodrome-by-aerodrome basis, with management plans and management implementation occurring usually by aerodrome-specific operational staff, or by consultants contracted by specific aerodromes (Bunker and Jones 2008). An underlying assumption of this is that aerodromes differ in their circumstances and risks, and therefore require customised management responses. The Australian Transport Safety Bureau (and its predecessor, the Bureau of Air Safety Investigation) has maintained records of bird–aircraft collisions for Australia aerodromes and seeks to share best-practice wildlife management practices (BASI 1996; ATSB 2003, 2008, 2010, 2012, 2014, 2017, 2019*a*, 2019*b*).

Australia has 10 aerodromes classified as 'major class C aerodromes' and 12 classified as 'regional towered' (ATSB 2019*a*, 2019*b*). Three of these 22 larger aerodromes are located to the north and west of Melbourne, Victoria: (1) Melbourne International Airport is a major aerodrome; and (2) Essendon Fields Airport and (3) Avalon Airport are both regional towered aerodromes. All three aerodromes lie within the Victorian Volcanic Plain Bioregion of Victoria (DELWP 2021), but support different numbers and types of aircraft. The local pool of species can influence wildlife species occurring near airports (Alquezar *et al.* 2020). Assuming the wildlife communities at these three aerodromes were similar by virtue of being in the same bioregion, we investigated whether the bird species struck by aircraft at each aerodrome were also similar. We therefore explore how generalisable bird–aircraft strikes are in a biogeographically matched set of airports, and examine the assumption that bird hazard mitigation is best implemented at the scale of the aerodrome.

Methods

Three large aerodromes lying within the Victorian Volcanic Plains Bioregion of Australia were included in this study. Melbourne Airport (IATA code: MEL; 37°40′24″S, 144°50′36″E) is the second busiest in Australia; most aircraft movements are regular passenger transport (RPT) flights, or large passenger jet aircraft. Essendon Fields Airport (IATA code: MEB; 37°43′41″S, 144°54′07″E) lies less than 10 km from the Melbourne Airport runway intersection. This aerodrome supports emergency services' flights, private and corporate aircraft, and flying schools, so has fewer Air Traffic Movements (ATMs; take-offs, landings and touch-and-go) than Melbourne Airport, and does not see the large jets. Avalon Airport (IATA code: AVV; 38°02′26″S, 144°28′15″E) is situated near Little River, and operates some RPT flights, with maintenance and training facilities for large jets. Every second year (odd-numbered years), this aerodrome hosts the Avalon International Airshow, which sees a huge increase in air traffic for one week.

Data on bird strikes were obtained from the Australian Transport Safety Bureau's National Aviation Occurrence Database (ATSB 2019*a*, 2019*b*). All records for the 10-year period between 1 July 2009 and 30 June 2019 for occurrence types 'Bird strike' and 'Wildlife – other' within 25 km of the three airports were obtained and attributed to the appropriate aerodrome. WKS was the wildlife hazards management consultant at two of the three aerodromes and vetted all reports. Any bias in detectability of species struck (a hypothetical effect, which has not been demonstrated), would likely exist among aerodromes and so not confound our comparisons.

Monthly ATM figures for the three aerodromes, Melbourne, Essendon Field and Avalon, were obtained from the Air Services Australia website (Airservices Australia 2019) and summed to show the total number of ATMs per financial year: 2009–10 to 2018–19. All three airports had substantive aircraft movements, although the number of movements differed among airports (repeated-measures generalised linear model on logged data, $F_{1.181,\ 10.630} = 1934.295$, $P < 0.001$; means $\pm$ s.e. number of movements annually: MEB 225 643 $\pm$ 5523; MEL 53 692 $\pm$ 351; AVV, 7504 $\pm$ 523).

Statistical analyses

We analysed the assemblages of birds struck by aircraft using multivariate analyses implemented in PRIMER (*v.* 7). Airport was specified as a factor, and 10 replicate 12-month sampling periods, from July to June inclusive, were available for each airport; these periods were the same across all airports and spanned 2009–19. We present analyses of the frequency of strikes of each species (number of strikes within the given period), but analyses of the presence or absence of a species being struck in a given period revealed qualitatively identical results and are therefore not presented. Analyses of strike rate (species strike rate per ATM) also revealed differences between airports, but rates were extremely low and interpretation proved difficult. Resemblance matrices were based on zero-inflated Bray–Curtis similarity measures, and these were visualised using non-metric Multidimensional Scaling (MDS). Differences were tested using Analysis of Similarities (ANOSIM), and where differences existed these were explored using the test of homogeneity in Permutational Dispersions (PERMDISP) and Similarity Percentages Analysis (SIMPER; contributions to dissimilarities of $\geq$10% are presented).

Results

Unidentified birds were removed from the dataset, leaving 580 bird strikes (54 avian taxa). The most commonly struck species were Australian magpie (*Cracticus tibicen*; 16.7%), Eurasian skylark (*Alauda arvensis*; 12.2%), Australian pipit (*Anthus australis*; 12.1%), masked lapwing (*Vanellus miles*; 5.9%), nankeen kestrel (*Falco cenchroides*; 5.0%), house sparrow (*Passer domesticus*; 4.8%), welcome swallow (*Hirundo neoxena*; 4.3%) and tree martin (*Petrochelidon nigricans*; 4.0%). The assemblage of birds struck by aircraft differed among airports (ANOSIM, $r = 0.801$, $P = 0.001$), with pairwise tests revealing each airport had a different assemblage being struck (MEL *v.* AVV, $r = 0.865$, $P = 0.001$; MEL *v.* MEB, $r = 0.988$, $P = 0.001$; AVV *v.* MEB, $r = 0.530$, $P = 0.001$) (Fig. 1). Differences in multivariate dispersions were not evident (PERMDISP, $F_{1,27} = 1.539$, $P = 0.307$), indicating that differences lay only in the location of assemblage compositions in multivariate space. We used SIMPER to explore these differences, and identified which species drove pairwise differences among airports, i.e. contributed $\geq$10% of the observed dissimilarity (also, see the vectors plotted on Fig. 1). More Eurasian skylark, Australian magpie and Australian pipit were struck at

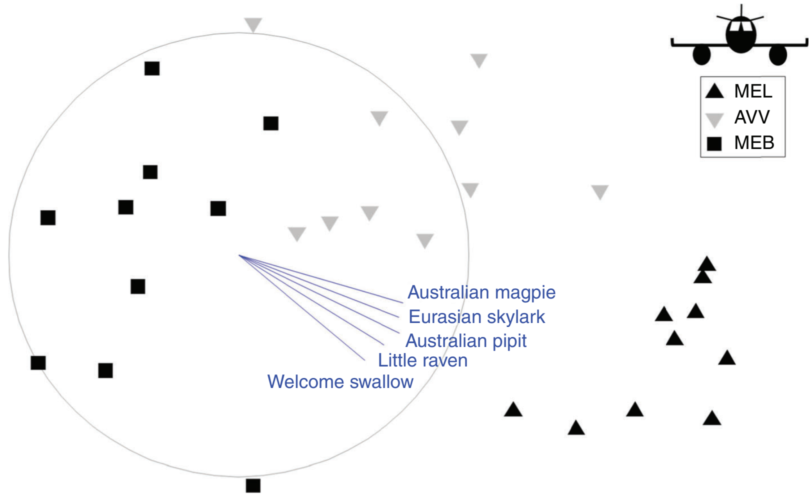

Fig. 1. Non-metric multidimensional scaling plot of birds struck at each airport (two-dimensional stress, 0.13). Vectors indicate correlations ≥0.7. MEL, Melbourne Airport; AVV, Avalon Airport; MEB, Essendon Fields Airport.

MEL than at AVV or MEB. Australian magpie, masked lapwing and house sparrow were struck more frequently at MEB than at AVV. Nankeen kestrel, tree martin and welcome swallow (but no other species) all contributed 5–10% of the observed dissimilarity among airports.

Our data on mammal strikes included three bats (grey-headed flying fox, *Pteropus poliocephalus*; Gould's wattled bat, *Chalinolobus gouldii*; and white-striped freetail bat, *Tadarida australis*) and four terrestrial species (short-beaked echidna, *Tachyglossus aculeatus*; European rabbit, *Oryctolagus cuniculus*; European hare, *Lepus capensis*; and red fox, *Vulpes vulpes*) – 85 strikes of identified species in total. Mammal strikes were less comparable than bird strikes among airports (airport operations staff focus on bird hazards) but we note the assemblage differed among airports (excluding echidna, which were infrequently struck; ANOSIM, $r = 0.548$, $P = 0.001$), although pairwise tests revealed that the assemblage struck did not differ between MEB and AVV ($r = 0.067$, $P = 0.230$). All of the airports are fenced but the areas enclosed vary markedly, with Melbourne Airport covering a substantially greater area than the other two and able to support intractable populations of some mammal species.

Discussion

With one exception (Pfeiffer *et al.* 2018), formal multi-aerodrome comparisons of species struck by aircraft have not previously been performed, although Soldatini *et al.* (2011) consider different animal guilds struck by aircraft at eight Italian airports in deriving their risk assessment model. In the USA, positive correlations in strike rates of species among distant airports were evident (Fernández-Juricic *et al.* 2018), and an analysis of 98 civil airports revealed that higher surrounding landscape heterogeneity (especially the proximity of farmland and water) was associated with higher strike rates with aircraft (Pfeiffer *et al.* 2018). Here we showed that three Australian aerodromes in the same bioregion experience different assemblages of birds struck. This reinforces the current approaches to bird hazard management for aircraft, which are implemented on an aerodrome-by-aerodrome basis (Dolbeer *et al.* 1993). However, some similarities among airports within the studied bioregion are evident. The main species struck were insectivorous or generalist, aerial or ground foragers; this contrasts with airports in northern and Western Australia, where raptors and waterfowl are commonly struck (ATSB 2019*a*, 2019*b*).

The underlying causes of the variation in the assemblage of birds struck between airports are unknown, but could involve factors associated with species and/or those associated with airports. Species distributions and associations with habitat have led to bioregions being the basis of large-scale study of bird occurrence (Barrett *et al.* 2003), but finer-scale variation in species and habitat distributions also occur. Thus, within bioregions, birds may respond to landscape- and local-scale factors (Callaghan *et al.* 2018) such that some are present near or transit through particular aerodromes, whereas others are not. For coastal biomes, the influence of adjacent waters also likely influences the occurrence of some species (Alquezar *et al.* 2020; but see Callaghan *et al.* 2018). Although Avalon airport is near-coastal, differences persisted between the other two landlocked aerodromes we examined. Airports themselves, with their associated light and noise, may effectively 'filter' the local pool of species that venture onto the aerodromes, with some species being 'airport adapters' and some being 'airport avoiders' (Alquezar *et al.* 2020). For example, Australian magpies on airfields appear to habituate to aircraft (Linley *et al.* 2018). Other airport factors involve aircraft type and movement rates, local management of bird hazards (including local habitat management), size and seasonal and temporal patterns in air traffic (Cleary and Dolbeer 2005).

Conclusion

The biogeography of bird hazards to aircraft warrants attention, and would usefully distinguish species, local, landscape and airport factors from any large-scale biogeographical influences (Fernández-Juricic *et al.* 2018; Alquezar *et al.* 2020). Broader-scale comparisons may provide useful patterns at higher spatial scales (Alquezar *et al.* 2020), but given the degree of within-bioregion variation we describe here, such comparisons may be unlikely to usefully inform anything other than generalised management directions. Thus, currently the airport remains the ideal scale at which to plan and deliver bird hazard management. However, we suggest that an understanding of how spatial and biogeographical factors influence strikes would usefully inform planning for new aerodromes, or modifications to existing ones or their surrounding landscape context.

Conflicts of interest

WKS was contracted to provide wildlife hazards management advice at all three study sites, although only briefly at two of these. MAW declares no conflict of interest; he was not involved in design or data collection but in analysis and drafting.

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This work analysed publicly available data; WKS collected data and assisted writing up. MAW did not collect data or design the project. MAW was supported during write up by the Beach Ecology and Conservation Hub (Venus Bay).

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