Bat Strikes in the Australian Aviation Industry

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Management and Conservation Note

Bat Strikes in the Australian Aviation Industry

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ABSTRACT Bat collisions are a threat to commercial and military aircraft in Australia. We examined bat strike records from Australia during 1996–2006 and found that risk of impact from bats is increasing, is greatest in tropical versus temperate regions, and is more likely during early evening and while an aircraft is landing rather than departing. Temporal patterns of bat strikes differ from those of birds, highlighting the need to employ taxon-specific management strategies to minimize animal impacts on the aviation industry. The use of genetics for identification of strike remains and the implementation of nocturnal survey techniques by wildlife managers at airports will contribute to the mitigation of bat strikes. (JOURNAL OF WILDLIFE MANAGEMENT 73(4):526–529; 2009)

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KEY WORDS aircraft, Australia, aviation, bat strike, flying-fox, human safety, *Pteropus* spp., risk mitigation, wildlife damage management, wildlife strike.

Wildlife strikes to aircraft have been responsible for loss of human lives and damage to aircraft worldwide resulting in a loss of billions of dollars annually. As a result, the aviation industry dedicates substantial time and energy to minimize this risk (Transport Canada 2001). Most risk minimization strategies involve modifying the airport environment to reduce its attractiveness to hazardous species or instigation of disturbance regimes to frighten wildlife from airport environs (Brown et al. 2001, Australian Transport Safety Bureau [ATSB] 2002).

Airports throughout the South Pacific and Paleotropics region are faced with an additional threat of bat strikes from large flying foxes (*Pteropus* spp.). Flying foxes are large bats with a dense body mass up to 1 kg and, unlike birds, do not have light pneumatized bones. This results in a greater and more concentrated impact force from bat strike and a greater capacity to perforate an aircraft's exterior than bird strikes (Transport Canada 2001). Ecological factors influencing bat strikes are also distinct from those of most birds. Australian flying foxes roost gregariously and emerge from roosts in flocks, which may include thousands of flying foxes, thus increasing risk of multiple simultaneous strikes (Ratcliffe 1931). Whereas birds are often attracted specifically to airports because of grass, lights, water, feeding trees, or roosts (ATSB 2002, Barras and Seamans 2002), it is most likely that flying foxes come in contact with aircraft while transiting between food and roosting sites. To date, no one has quantified occurrence of bat strikes in Australia, therefore, we analyzed 10 years of data compiled by the ATSB to better understand this phenomenon.

METHODS

Data were collected from registered airports located throughout Australia. Australia had an extremely variable weather pattern and encompassed a wide variety of vegetation associations. Most urban centers and therefore airports were located in coastal regions.

In Australia, reporting of wildlife strikes by aircraft involved in air transport operations or using licensed aerodromes was mandatory under the Transport Safety Investigation Act and Regulations 2003 (Attorney-General's Department 2003). We examined 10 years of strike data (1996–2006) collected from Australian airports, which we obtained from the ATSB.

According to the Australian Aviation Wildlife Hazard Group (AAWHG) a reported bird or animal strike is deemed to have occurred when 1) a pilot reports a strike to the ATSB, 2) aircraft maintenance personnel find evidence of a bird or animal strike on an aircraft, 3) personnel on the ground report seeing an aircraft strike $\geq$1 birds or animals, or 4) bird or animal remains are found on the airside pavement area or within the runway strip, unless another reason for the bird or animal's death can be found (AAWHG 2007). The ATSB database contains detailed records of all wildlife strikes regardless of taxonomic grouping. We based our analysis on all records that included the words "bat," "fruit bat," or "flying-fox." We obtained data on aircraft movements at individual airports from the Bureau of Infrastructure, Transport, Regional Development and Regional Economics. We classified airports as either tropical or temperate, with reference to the Tropic of Capricorn (23°23′59.94″S).

We analyzed bat strike data using a mixed model approach with restricted maximum likelihood within SAS V9.1 (SAS Institute Inc., Research Triangle Park, NC). We treated each observed bat strike as a dependent variable. We treated geographical region in which each airport was located as a fixed factor, individual airports as a random factor (nested within region), and year as a repeated measure. We standardized number of bat strikes per airport per year by dividing number of strikes by number of aircraft movements at each airport over the relevant time period and square-root transformed these values to resolve normality issues. We

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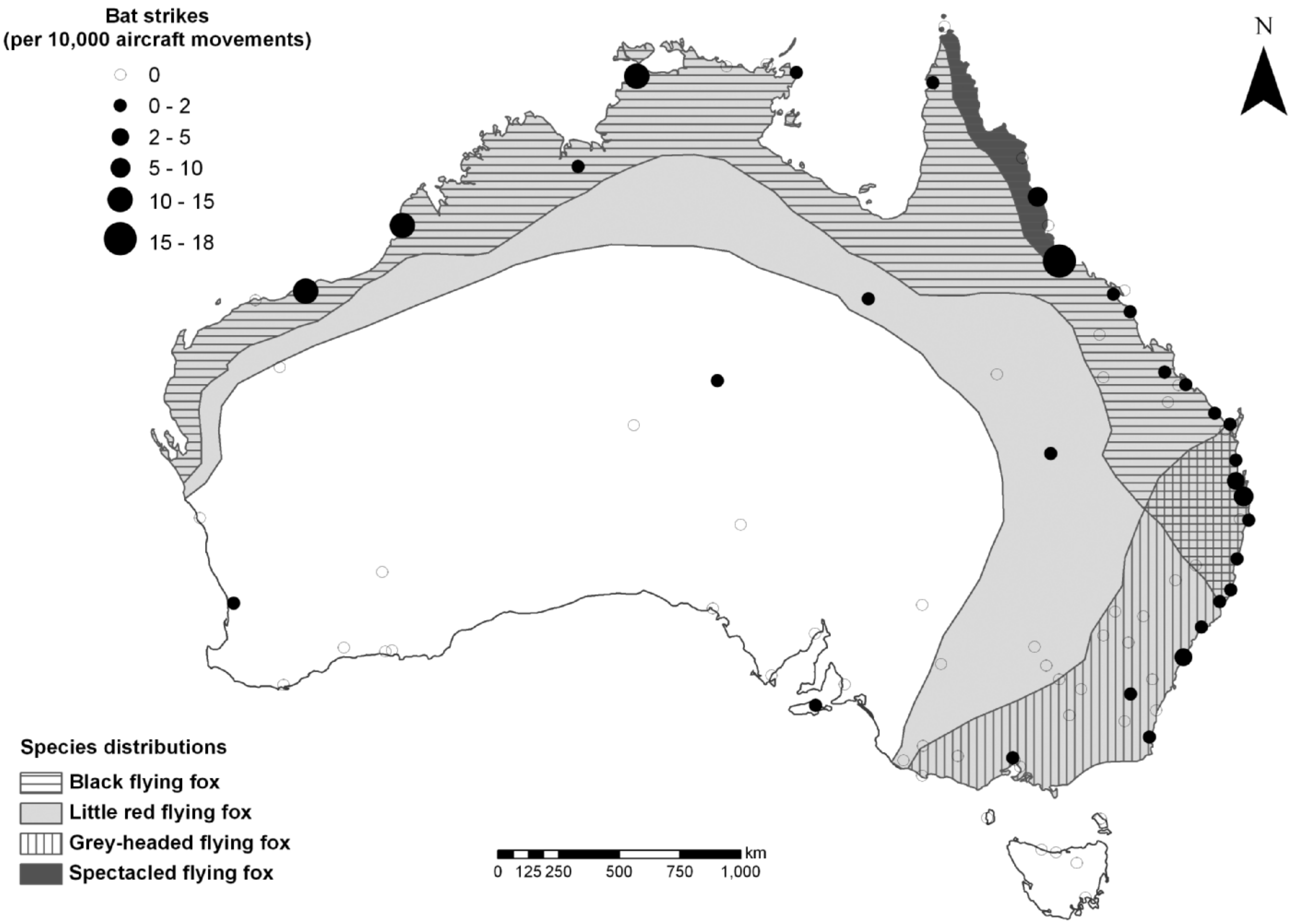

Figure 1. Distribution map of major airports in Australia with an index of bat strike occurrence (from 1996 to 2006) overlain with the range of flying foxes in Australia (Hall and Richards 2000).

therefore report strike rate as number of strikes per 10,000 aircraft movements. We selected an autoregressive covariance structure [AR(1)] in the mixed model to minimize the Akaike's Information Criteria (Littell et al. 1996) and used chi-square goodness-of-fit to test effect of moon and flight phase on bat strike occurrences. A priori alpha levels were $P < 0.05$. We present results as means ± standard errors.

RESULTS

The ATSB database included 327 records of bat strikes from 91 airports during 1996–2006. Bat strikes were identified by presence of an identifiable carcass ($n = 198$; 60%), presence of hair and blood ($n = 8$; 2.5%), visual identification ($n = 94$; 29%), and "guessing" ($n = 1$; 0.5%). No reason for identification was stated for 26 records (8%). Of the 327 bat strikes 62 (19%) caused major damage to aircraft including smashed windscreens, perforated aircraft skin, and engine ingestion.

The highest rate of bat strikes occurred at the Townsville Airport, located in northeastern Queensland (Fig. 1). There was no interaction between region and year on strike ($F_{10,839} = 1.32$, $P = 0.22$). Bat strike rates were influenced by year ($F_{10,839} = 4.63$, $P < 0.001$), which explained 38% of variance in bat strike rates. Strike rates increased from a mean of 0.003 ± 0.002 in 1996 to 0.164 ± 0.11 in 2006 (Fig. 2).

Strike rates differed in airports located in tropical versus temperate regions (0.221 ± 0.054 and 0.030 ± 0.006, respectively, $F_{1,85} = 5.83$, $P < 0.05$) with the 5 highest ranking airports for strikes all located in tropical regions (Fig. 1). All bat strikes occurred within the known flying-fox range in Australia with 3 exceptions: one strike each in Alice Springs, Perth, and Kingscote (Fig. 1). Two of these records were based on bat remains on the runway that may have been transported from elsewhere, but the Perth record was a confirmed flying-fox strike.

The largest proportion of bat strikes occurred between March and May (39%, $n = 105$) and in the year 2003 (23.6%, $n = 77$), with most strikes occurring around sunset, between 1700 hours and 2000 hours (57.2%, $n = 283$). There was no effect of moon phase on occurrence of bat strikes ($\chi^2 = 0.82$, df = 7, $P = 1.00$). Proportion of strikes differed between landing, takeoff, circuiting, and cruising phases ($\chi^2 = 301.60$, df = 3, $P < 0.001$). More strikes occurred during landing (74%, $n = 173$) than takeoff (24.8%, $n = 58$). Few strikes occurred during circuiting and cruising phases (1.28%, $n = 3$).

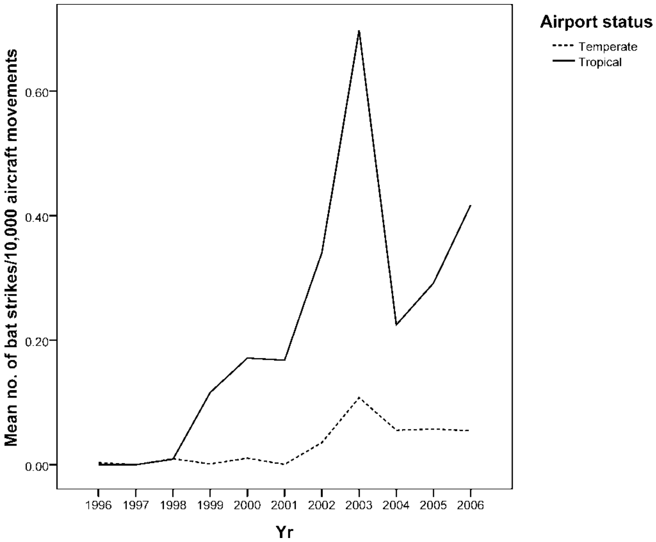

Figure 2. Mean number of bat strikes per 10,000 aircraft movements at Australian airports from 1996 to 2006 ($n = 327$) located in either tropical or temperate regions.

DISCUSSION

Most bat strike identifications were based on detection of identifiable bat remains after a collision. Given the damage aircraft inflict on bats, it is highly likely that these results are an underestimate of the true rate of impact. Genetic techniques can be used to identify species of birds involved in strikes based on blood and tissue smears only (Christidis et al. 2006) and should be applicable to bats.

Rate of bat strikes was greater in tropical than temperate regions, has increased over a 10-year period, and closely matches the range map of flying foxes in Australia (Figs. 1, 2). An increase in recorded strikes may reflect changes in bat distributions as a function of changing food resources. The increase in suitable urban food plants (Markus and Hall 2004) could increase bat densities around urban airports. The high rate of bat strikes occurring in 2003 (Fig. 2) may reflect the El Niño event of 2002–2003 (Bureau of Meteorology 2008), which reduced agricultural (Australian Bureau of Statistics 2008) and natural food production and may have increased movement of bats throughout Australia. The increase may also reflect improvements in accuracy with which airline industry staff record animal strikes, though reporting rates for animal strikes are considered to under-estimate true strike rate (Barras and Dolbeer 2000).

On a yearly basis, peak of bat strikes occurred during April–May, possibly reflecting high plant productivity that occurs at the end of the wet season in the tropics. With increased food resources, there may also be an increase in flying foxes moving from inland areas to tropical coastal regions. The little red flying-fox (*Pteropus scapulatus*) is known to migrate in response to flower availability (Sinclair et al. 1996, Vardon and Tidemann 1999), and favored flowers such as those from paperbarks (*Melaleauca* spp.) would be readily available at this time in coastal areas.

Grey-headed flying foxes (*P. poliocephalus*) typically leave their day roost and fly to foraging sites within 30 minutes after sunset (Parry-Jones and Augee 1992, Welbergen 2006), and it may be presence of concentrated streams of commuting bats that makes them most at risk to aircraft. There was no effect of moon phase on bat strikes, suggesting that activity patterns of flying foxes are independent of the lunar cycle. This was surprising because activity patterns of the Australian blossom bat (*Syconycteris australis*; Law 1997) and the Jamaican fruit bat (*Artibeus jamaicensis*; Morrison 1978) are reduced during periods of higher lunar light.

The pattern of bat strikes we observed is different from that observed for birds. Most bat strikes occur around sunset, whereas most bird strikes occur in the morning (Chilvers et al. 1997, ATSB 2002). Bat strikes are also more likely to occur during the landing phase, whereas most bird strikes occur during the takeoff phase. This pattern in birds has been considered due, in part, to increased fan forces in modern engines during takeoff (Dolbeer 2007). Why a similar pattern is not found in bats is unknown.

Management Implications

Our study increased understanding of risks associated with bat strike in Australia. Determining the stage at which bats and birds typically collide with aircraft strongly supports the need for taxon-specific studies and management strategies. Regional differences in rate of bat strikes indicate that airports may require location-specific management plans. Development of molecular techniques to positively identify species of bats involved in strikes would be valuable, as would the implementation of nocturnal monitoring of the airport environment.

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