Studying mobile species in spatially complex ecosystems: Australian flying-foxes as a case study

by

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ABSTRACT

The high degree of environmental heterogeneity present in Australia has resulted in species possessing specific traits that ensure their survival, one such trait is a high degree of mobility. Some species will migrate or travel long distances in order to track seasonally available resources. This makes the monitoring of mobile species difficult and as climate change continues to affect the timing and availability of these resources, understanding the response of these species is more important than ever. Here I use flying-foxes (*Pteropus* spp.) as a study group as they are highly mobile, the influence of climate change on their distribution is yet to be investigated, they have complex management issues and they are widely distributed across coastal Australia. I identify methods of monitoring highly mobile flying-foxes on a variety of spatial and temporal scales. I then apply the ecological information collected to a specific management issue: bat strikes in the aviation industry.

I develop a new method of monitoring flying-foxes at camps that are difficult to access: aerial photography. This technique produces results comparable to traditional census methods, and the remote capture allows access to information on camps that were impossible to access before. My results from North Queensland show that camp use is highly variable and that patterns shown at a regional level are not necessarily reflected at all camps. This technique can be applied across large areas and could be the key to a national monitoring strategy for Australian flying-foxes.

I then develop climate models for all four Australian mainland flying-foxes on a national scale and find that parameters associated with precipitation are the single most important climatic factor contributing to flying-fox camp location. This could be due to the importance of precipitation for the fruiting and flowering phenology of flying-fox food trees. When modeling the changes in climatic space for these four species with global climate data from 2030, 2050 and 2070. I find that three species (*Pteropus alecto, P. conspicillatus* and *P. scapulatus*) should experience an increase in mean area and abundance at

each time slice and that one species shows a decrease (*P. poliocephalus*). With variable future projections for precipitation in future global climate models and the absence of finer scale data, this should be interpreted with caution. Changes in distribution have been identified for all four species already and a camp has been located that now contains all four species, when previously only two were known to co-roost at this location. The climate at this location is suitable for the two newly recorded species but marginally so for one (*P. conspicillatus*). Evidence suggests that *P. poliocephalus* has historically occurred at this location but that *P. conspicillatus* has more recently occurred in this region, possibly as a result of climate change.

To explore the ecological factors influencing behaviour at a local scale, emergence timing at a flying-fox camp in tropical North Queensland was investigated. This also allowed me to determine if the factors influencing emergence timing in the tropics differed from other areas. I found that a linear relationship with the time of civil twilight explains most of the variation in emergence time, but that significant effects of weather, month and year also exist. Many of these factors also related to light levels, with cloud cover and heavy rainfall, delaying emergence. There was also a possible influence from increased anthropogenic lighting over the seven years of the study as I found that yearly variation in emergence time is correlated with increased activity from a nearby port, possibly reflecting increased light pollution. On a monthly basis, emergence timing was influenced by seasonal variation in roost occupancy, suggesting that foraging competition may also influence this behaviour. At a finer scale again, I investigated roost tree usage within camps and found high variability on a variety of time scales with seasonal changes in abundance overlain on highly variable day-to-day patterns of roost use.

To apply this information to a current management problem, I next investigate flying-fox movements and strikes at a local airport and on a national scale. To identify movement patterns at an airport, I develop motion-detecting infra-red camera technology to detect nocturnal wildlife movements. I found that flying-foxes dominate the nocturnal wildlife activity at this airport and that there are seasonal peaks of activity in the periods preceding and following the wet

season. These peaks of activity correspond with flowering peaks of food trees in the region and a nightly peak of activity after sunset corresponded with the emergence time of flying-foxes in the region. Flying-foxes and birds had opposing directional movements with flying-foxes moving toward the urban centre in the evening whilst diurnally active birds were leaving the area. The pattern reversed in the morning when flying-foxes returned to the camp. This can be explained by the different activity patterns of these groups with both going to forage at different times. Infra-red cameras can provide an efficient and inexpensive monitoring tool for aviation managers and the similarity of local studies to national patterns provides evidence that nocturnal monitoring of wildlife can provide an excellent mitigation strategy. Data on a national scale showed that flying-fox strikes are increasing, are greatest in tropical regions, and are more likely during early evening and while an aircraft is landing rather than departing. These studies show that movements and patterns of aircraft strike differ for flying-foxes and birds and highlight the importance of taxon-specific studies.

I have shown that good baseline ecological data from a variety of spatial and temporal scales can provide important information for the management of flying-foxes at a local airport. I have also provided an overview of many monitoring methods that can be translated to other regions and to other highly mobile species.

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2	Writing	Parsons.
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2. **Parsons, J.G**., Blair, D., Luly, J. and Robson, S.K.A. (2009). Bat strikes in the Australian aviation industry. *Journal of Wildlife Management*: **73(4):** 526 - 529.

3. **Parsons, J.G.**, Blair, D., Luly, J. and Robson, S.K.A. (2008). Flying-fox (Megachiroptera: Pteropodidae) flight altitudes determined via an unusual sampling method: aircraft strikes in Australia. *Acta Chiropterologica* **10(2)**: 377-379.

Peer Reviewed Book Chapters

4. Luly, J.G., Blair, D., **Parsons, J.G.**, Fox, S. and VanDerWal, J. (2010). Chapter 6: Last Glacial Maximum habitat change and its effects on the grey headed flying- fox (*Pteropus poliocephalus* Temminck 1825). In Simon G. Haberle, Janelle Stevenson & Matthew Prebble (editors), *Altered Ecologies: Fire, Climate and Human Influence on Terrestrial Landscapes,* Terra Australis 32. ANU E-Press, Canberra, The Australian National University.

5. **Parsons, J.G**., Robson, S.K.A. and Shilton, L.A. (2010). Roost fidelity in spectacled flying-foxes (*Pteropus conspicillatus*): Implications for conservation and management. *Proceedings of the Symposium on the Biology and Conservation of Australasian Bats.* in press

Reports to Industry

6. Robson, S.K.A., Blair, D. Luly, J. and **Parsons, J.G.** Annual Report for Townsville Airport (August 2007 – July 2008). Minimising the risk of flying-fox strikes to Australian aircraft.

7. Robson, S.K.A., Blair, D. Luly, J. and **Parsons, J.G.** Annual Report for Townsville Airport (August 2006 – July 2007). Minimising the risk of flying-fox strikes to Australian aircraft.

8. Robson, S.K.A. and **Parsons, J.G.** Towards a National Aviation Policy Statement: Issues Paper April 2008. Minimising the risk of bat strikes in the airline industry: a new threat to Australian aircraft.

Conference/Workshop Presentations

9. **Parsons, J.G.** *Studying mobile species in spatially complex ecosystems: flying-foxes as a case study.* James Cook University. 14th July 2009.

10. **Parsons, J.G.**, VanDerWal, J., Robson, S.K.A. and Shilton, L.A. *Micro and macro scale sensing of flying-fox camps in Australia*. 1st International Symposium on Bat Migration. Berlin, Germany. 16-18 January, 2009.

11. **Parsons, J.G.**, Blair, D., Luly, J. and Robson, S.K.A. *Bat strikes in the Australian aviation industry*. 1st International Symposium on Bat Migration, Berlin, Germany, 16-18 January 2009.

12. **Parsons, J.G.**, Robson, S.K.A., Blair, D., Shilton, L.A. and Luly, J. Australian Aviation Wildlife Hazard Group – Education and Information Sharing Forum. Sydney International Airport, Sydney. *Understanding bat strikes in the Australian Aviation Industry*. 11th August, 2008. ***Invited speaker****.*

13. **Parsons, J.G**., Robson, S.K.A., Blair, D. and Luly, J. *Flying-fox strikes in the Australian aviation industry*. International Bird Strike Conference, Kingston, Canada. 10 – 13 September 2007.

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17. **Parsons, J.G.**, Robson, S.K.A., Blair, D., Shilton, L.A. and Luly, J. *The foraging ecology, diet and movement of Australian Pteropodids: Implications for aircraft strike.* Botanists and Zoologists of North Queensland Conference, Cairns. 18-19th November 2006.

18. **Parsons, J.G.**, Robson, S.K.A., Blair, D., Shilton, L.A. and Luly, J. *When bats and planes meet: Minimising the risk of bat strike to the Australian Aviation Industry.* Australian Aviation Bird and Animal Hazard Working Group – Education and Information Sharing Forum. Sydney Airport,

Sydney. 27th September, 2006. ***Invited speaker****.*

19. Robson, S.K.A., **Parsons, J.G.**, Blair, D. and Luly, J. *When bats and planes meet: Minimising the risk of bat strike to the Australian Aviation Industry.* 12th Australasian Bat Society Conference, Auckland, New Zealand. 19 -21st April, 2006.