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Article *in* Australian Mammalogy · October 2015

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http://dx.doi.org/10.1071/AM15013

Radio-collared squirrel glider (*Petaurus norfolcensis*) struck by vehicle and transported 500 km along freeway

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Abstract. Roadkill (the mortality of animals through wildlife-vehicle collisions) is one of the main impacts of roads on wildlife. Studies quantifying the location and rate of roadkill to identify 'hot spots' are often used to guide the location of mitigation efforts, such as fencing or wildlife crossing structures. However sometimes quantifying rates of roadkill can be challenging, particularly for species that are small and difficult to detect. In our study, a squirrel glider that was trapped and radio-collared in northeast Victoria was found as roadkill more than 500 km away, suggesting that a vehicle struck the animal and carried the carcass away from the site of impact. Our observation is the first evidence that this occurs for squirrel gliders.

Introduction

Roadkill – the mortality of animals through wildlife-vehicle collisions – is one of the main ways that roads affect wildlife populations (Forman *et al*. 2003; van der Ree *et al*. 2015). Quantifying the rates and spatio-temporal patterns of roadkill are common approaches to assessing the impacts of roads and traffic on wildlife and guiding the placement of mitigation (Forman *et al*. 2003; Taylor and Goldingay 2010). However, for some species quantifying the number of animals killed on roads can be complicated. For example, small animals are difficult to identify, particularly after carcasses have been repeatedly run-over by vehicles (e.g. Taylor and Goldingay 2004; Gonzalez-Gallina *et al*. 2013). Smaller carcasses are often more difficult to detect, as they can be removed by scavengers before surveys are conducted, or the impact of the collision may throw the carcass into roadside vegetation (e.g. Santos *et al*. 2011). It is also possible that carcasses may remain lodged on the vehicle itself and transported away from the site of impact; however records of this occurring are anecdotal. All of these factors can influence the accuracy of roadkill counts.

We present evidence that a squirrel glider (*Petaurus norfolcensis*), a threatened gliding marsupial, was killed by a vehicle and its carcass transported approximately

500 km away. This information may help better understand the limitations and uncertainties of roadkill studies for this and similar species.

Method

We have undertaken a series of comprehensive studies to quantify the impacts of roads, traffic and wildlife crossing structures on arboreal mammal populations (McCall *et al*. 2010; Soanes 2014; Soanes *et al*. 2013; Soanes *et al*. 2015; van der Ree *et al*. 2010). Our study area encompassed a 330 km stretch of the Hume Freeway in southeast Australia, between the towns of Avenel in northeast Victoria (36°54'2.54"S, 145°14'0.01"E) and Tarcutta in southeast New South Wales (35°16'34.94"S, 147°44'18.94"E). Within this region the traffic volume averaged 10,000 vehicles per day, approximately 25% of which occurs at night when many native mammals are active. The width of the freeway was approximately 40- 100 m (measured as the distance between woodland habitat on opposite sides of the road) with a centre median up to 40 m wide. The surrounding area was primarily agricultural fields and rural townships. Woodland vegetation (*Eucalyptus* spp, Box-Ironbark and Box-Gum woodland) predominantly occurs as linear strips of remnant vegetation along roadsides and waterways, although some larger reserves are present (Gibbons and Boak 2002; van der Ree 2002).

Our primary study species, the squirrel glider, is a small (~250 g) gliding marsupial in the family Petauridae. Glide distance is largely dependent on launch height and the average glide distance ranges from 20 to 40 m though longer glides of 70–90 m have been recorded (Goldingay and Taylor 2009; van der Ree 2006; van der Ree *et al*. 2003). Squirrel gliders are occasionally observed as roadkill (pers. obs), but the carcasses are likely to be difficult to detect due to their small size and grey colouring.

We captured and radio-collared squirrel gliders along the Hume Freeway in northeast Victoria as part of a project to measure the impacts of the freeway and subsequent mitigation on squirrel glider movement. The trapping and radio-tracking methods for the project are described in detail in Soanes *et al*. (2013). An adult male squirrel glider (SQB1M) was captured at the study site at Longwood (Fig. 1) on 17 November 2010, at which time it was fitted with a VHF radio-collar, tattooed and implanted with a passive integrated transponder (PIT) tag. The site was a linear remnant strip of mature *Eucalyptus* woodland ~20 m wide along a secondary road (~10 m wide, <100 vehicles per day) that intersected the Hume Freeway. A 70 m long canopy bridge connected the woodland habitat on either side of the freeway (described in Soanes *et al*. 2013).

Results and Discussion

We radio-tracked SQB1M over 36 nights from 17 November 2010 to 3 May 2011. Three fixes were obtained, on 23 November, 24 November and 3 December 2010, after which the signal disappeared. We conducted extensive searches on foot and in vehicles within a 5 km radius of the study site, however, SQB1M was not detected

again. Further mark-recapture surveys at the site in December 2010 (41 trap nights) and March 2011 (39 trap nights) also failed to detect this animal, suggesting either that it had left the site or that the radio-collar had stopped working.

In July 2011, we were contacted by an ecologist (D. Engel) who had found a tattooed and collared squirrel glider carcass on the side of the Hume Freeway near the town of Goulburn in New South Wales (34°48'57.08"S, 149°26'19.97"E, accuracy: +/- 13 m). The carcass was described as 'fresh' and in good condition with no signs of decay or scavenging (eyes still present); consistent with an animal being killed by a vehicle the previous night. The carcass was stored in a freezer until we were able to collect and inspect it in July 2012. The radio-collar number, tattoo and PIT tag confirmed that this individual was SQB1M. We could not determine whether the collar had malfunctioned or if the battery had gone flat, as the collection time was beyond the expected battery life (>18 months).

The collection site was approximately 500 km away from the site in Victoria where the glider was originally marked. The roadside vegetation at the collection site consisted of shrubs 2–4 m high with no tall trees. Remote inspection using Google Earth and Google Street View shows that the collection site was within a highly agricultural landscape with only small (< 4 ha) isolated patches of mature woodland apparent within a 2 km radius. More than six months had passed since the carcass was found and the radio-collar signal first disappeared from the study area (Fig. 1).

Given the long distance and extreme level of habitat fragmentation between the site of capture and the site of collection, it is very unlikely that the animal travelled from Longwood to Goulburn unassisted. The journey would have required crossing many large treeless gaps, urban areas and cleared agricultural land. Little is known about the dispersal distances of squirrel gliders, but given the species body size and typical home-range size (3–6 ha, vand der Ree and Bennett 2003; Sharpe and Goldingay 2007) it is likely to be far less than 500 km (Bowman *et al*. 2002).

We believe that the animal was killed by a vehicle while crossing the Hume Freeway, became lodged on the vehicle and was then carried along the freeway. We cannot determine where the animal was killed, except to say that it is extremely unlikely that it was killed at the site it was found. Interestingly, it does not appear that SQB1M used the canopy bridge that was present at the Longwood site to cross the freeway. The canopy bridge was monitored with a PIT tag reader for 46 nights from November 2010 to April 2011 (Soanes *et al*. 2013) and the PIT tag of SQB1M was not detected. Based on the average tree height of 20 m, if the animal attempted to cross the freeway at a location where the distance between trees on opposite sides of the road exceeded 40 m, the glide path would have intersected with the path of traffic (Goldingay and Taylor 2009; Soanes and van der Ree 2015).

Our result illustrates the potential for wildlife carcasses to be transported away from the site of impact. Although our observation represents only a single, and likely

extreme case, the possibility that roadkilled carcasses were killed at locations other than where they were found should be considered in future surveys of small flying and gliding species.

Acknowledgements

Thanks to Deryk Engel for going over and above the call of duty by collecting and storing the squirrel glider carcass that was so critical to this observation. Thanks to Amy Evans for posting the radio-collar back to us, and to the New South Wales Animal Ethics Authority for connecting us all together. All animals were trapped and radio-tracked under The University of Melbourne Animal Ethics Committee Permit 0810924 and the DSE Permit 10004763. We thank the Holsworth Wildlife Research Endowment, VicRoads and the Road and Maritime Service New South Wales for their support of this project.

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190 **Figures**

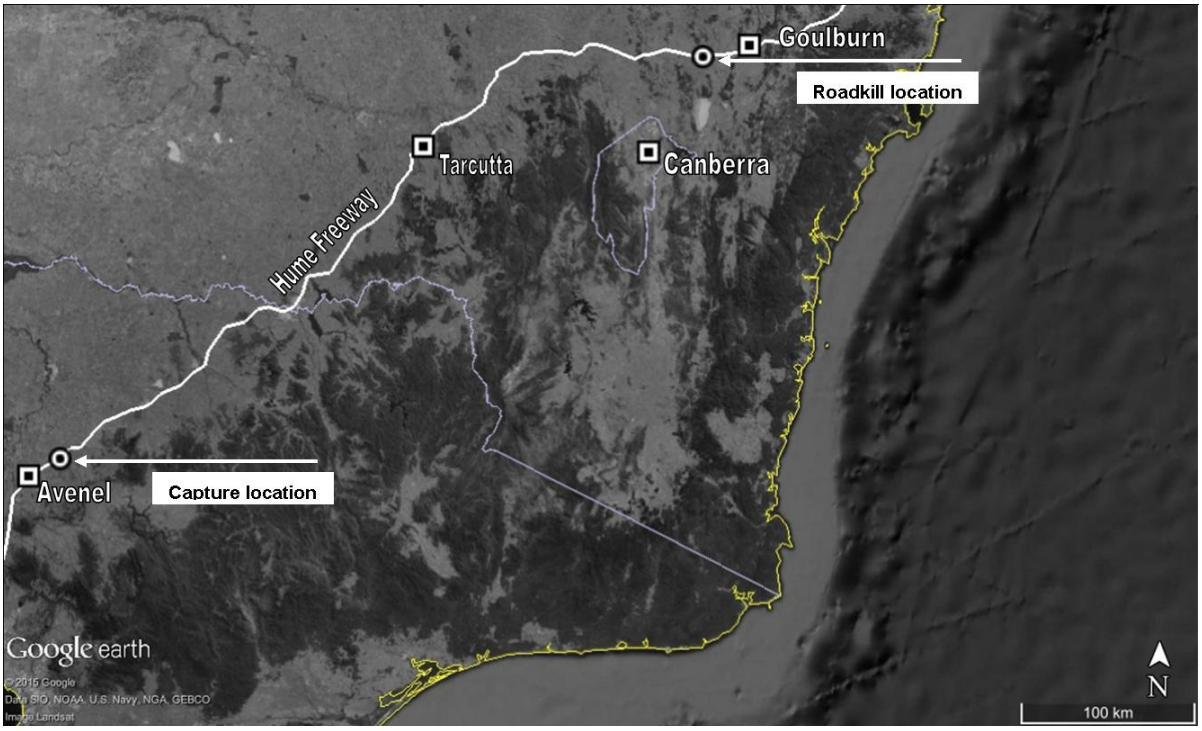

Figure 1. Map showing the capture location and roadkill location of a radio-collared squirrel glider along the Hume Freeway in southeast Australia. Dark shading indicates woodland and lighter areas indicate cleared land.