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Quantifying predation attempts on arboreal marsupials using wildlife crossing structures above a major road

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Abstract

We review eight years of monitoring data to quantify the number of predation attempts on
arboreal marsupials using canopy bridges and glider poles across a major road in southeast
Australia. We recorded 13,488 detections of arboreal marsupials on the structures, yet only
a single (and unsuccessful) predation attempt was recorded.

Introduction

Wildlife crossing structures (e.g. underpasses and overpasses) are often used to mitigate
the negative impacts of roads and traffic on wildlife (Forman *et al.* 2003; van der Ree *et al.*
2015). The intent is that these structures provide animals with safe passage across roads,
reducing roadkill and connecting wildlife populations. However, there is concern that
animals using a crossing structure may be exposed to a high risk of predation (Little *et al.*
2002; Mata *et al.* 2015). For example, predators may learn to exploit the crossing structure
as a reliable source of prey, or the lack of cover on structures may increase the ease of
predation (Mata *et al.* 2015). This risk is intensified where crossing structures are narrow
or exposed, with few places to take shelter. High predation rates could negate the
effectiveness of crossing structures, creating ‘prey-traps’ for the species they were
intended to help (Little *et al.* 2002).

Canopy bridges and glider poles are crossing structures for arboreal animals. Canopy
bridges come in a range of designs, from a single wire or rope, to wider, woven-ladder or

lattice styles, to aerial tunnels. Glider poles are usually wooden, with ‘branch-like’ cross beams at the top to mimic trees. In Australia, these structures are predominantly installed for small, nocturnal marsupials such as possums and gliders (e.g. Soanes *et al.* 2013; Taylor and Goldingay 2012; Weston *et al.* 2011; Yokochi and Bencini 2015). Large owls are a natural predator of possums and gliders, presenting a possible predation risk to species as they use canopy bridges or glider poles to cross roads. However, the risk of predation is uncertain and collecting direct observations is difficult.

Here, we review eight years of monitoring data to quantify the number of predation attempts at canopy bridges and glider poles along a major road in southeast Australia.

Methods

Our data were collected as part of a long-term study of the effectiveness of wildlife crossing structures for arboreal marsupials along a 70-km section of the Hume Freeway between the towns of Avenel (32°42’ S, 148°176’ E) and Benalla (36°55’ S, 145°98’ E) in Victoria, southeast Australia. In July 2007, crossing structures were installed at five locations: Longwood (canopy bridge), Violet Town (canopy bridge), Balmattum (glider poles), Baddaginnie (glider poles) and Warrenbayne (glider pole). Each canopy bridge is approximately 70 m long and 0.5 m wide, and consists of multiple ropes woven together to form a flat net (or lattice) design (Fig. 1a). The glider poles consist of 1–2 wooden poles (12–14 m tall) erected in the roadside and centre median, that act as stepping stones to allow gliding species to cross in several glides (Fig. 1b). The structures and methods are described in detail in Soanes *et al.* (2013) and Soanes *et al.* (2015).

We monitored these structures with motion-heat activated cameras from July 2007 to February 2015 to detect use by arboreal and semi-arboreal marsupials, including the squirrel glider (*Petaurus norfolcensis*), sugar glider (*Petaurus breviceps*), common brushtail possum (*Trichosurus vulpecular*), common ringtail possum (*Pseudocheirus peregrinus*), brush-tailed phascogale (*Phascogale tapoatafa*) and yellow-footed antechinus (*Antechinus flavipes*). The cameras recorded either a series of 5–10 images, 3–5 seconds apart (2007–2011; Olympus, Faunatech Austbat, Pty. Ltd) or a 10–20 second video (2011–2015; Buckeye, Orion, USA; 1-second delay between videos). A camera was installed at each end of each canopy bridge, and triggered by the movement of animals past active-infrared sensors. At glider poles, cameras were placed on the cross beam and were triggered by passive-infrared sensors. Based on the camera position, we estimate that we

could detect predation attempts on marsupials while they were within the first 5 m of each end of a canopy bridge, and within the top 1 m of each glider pole. During site visits (conducted once or twice per month), the ground within a 50 m radius of each structure was inspected for signs of predation, such as carcasses, tails or other remains. Potential predators in this landscape included the powerful owl (*Ninox strenua*) and the barking owl (*Ninox connivens*).

Results and Discussion

We recorded 13,488 detections of arboreal marsupials on the crossing structures from 2007 to 2015. Only a single predation attempt was recorded. No carcasses of arboreal marsupials were observed near the structures. A tawny frogmouth (not considered a likely predator of arboreal marsupials) was detected perching on a glider pole in January 2013. A boobook owl was found roadkilled underneath a canopy bridge in May 2012.

In January 2014, an unidentified bird swooped as a squirrel glider crossed the canopy bridge at Longwood (Fig. 2, video provided as Supplementary Material). The squirrel glider paused and turned its head towards the direction of the bird (Fig. 2b) before darting to the opposite side of the bridge (Fig. 2c) in the seconds prior to the attack. As the bird appeared in frame, the squirrel glider ducked to the underside of the bridge (Fig. 2d) and resumed crossing after the bird had passed (Fig. 2e and 2f). Due to the low quality of the video recording (3 frames per second) the bird species cannot be clearly identified (i.e. Fig. 2d). However, as the event occurred during the night (~0500 h) it is most likely a nocturnal raptor. The size suggests a smaller species such as a boobook owl (*Ninox boobook*) or tawny frogmouth (*Podargus strigoides*).

Our study was not a concerted effort to understand predator-prey interactions at crossing structures, and so likely underestimates the actual rate of predation that occurs. For example, predation attempts may have occurred out of range of our cameras, far out into the middle of a canopy bridge or in mid-air at glider poles. Also, the first four years of monitoring recorded images rather than video, which would be less likely to pick up a swift attack (e.g. the predation attempt recorded here lasted < 3 seconds). However, while this study had no formal controls, we can draw on existing studies to compare the ‘natural’ rate of predation. Previous population surveys conducted within the landscape surrounding the Hume Freeway revealed nine out of the 251 tagged squirrel gliders were predated by owls over a two year period (van der Ree 2002). If the crossing structures were modifying

the behaviour of predators or creating prey-traps, we would have expected to observe more than a single predation attempt in ~13,500 animal detections, and more frequent observation of large owl species perching on the structures themselves. We therefore find it unlikely that the arboreal marsupials using canopy bridges and glider poles along the Hume Freeway are subject to high rates of predation by owls.

It may be that the owls are relatively rare in our study landscape. Powerful and barking owls are listed as threatened under Victoria's Flora and Fauna Guarantee Act 1998, with both species requiring relatively large patches of mature forest that contain large hollows for nesting (Clemann and Loyn 2001; Loyn *et al.* 2001; Webster and Lowe 1999). The landscape surrounding the Hume Freeway is predominantly cleared agricultural land with less than 5% of the pre-European tree cover remaining, and therefore may only support a lower densities of these larger owl species. For example, van der Ree (2002) noted that while predation by owls was one of the most common causes of natural mortality for squirrel gliders, the rate was much lower when compared with continuous forest. In landscapes where the owl population is larger, the likelihood of predation at crossing structures may also be greater.

The rope-lattice design of the canopy bridge seemed to allow the squirrel glider to avoid the attack. This suggests that the risk of predation can be reduced by providing species with sufficient places to take shelter on crossing structures, as has been seen for other species and structure types (see Mata *et al.* 2015 for recent review). Simpler bridge designs, such as a single strand of wire or rope, are unlikely to afford crossing animals with the same degree of protection. In contrast, while complex 'tunnel' bridge designs could provide a high degree of cover, studies have shown that many animals simply run over the top of the tunnel, rather than through it (e.g. Bax 2006; Goldingay *et al.* 2013). Adding pipes, nest boxes or other forms of shelter to crossing structures could provide cover sites and reduce the predation risk (Soanes and van der Ree 2015). However, Ball and Goldingay (2008) observed gliders occupying these structures, which may disrupt social processes. Ideally, shelter designs should allow temporary refuge but not provide opportunities for nesting (e.g. open pipes).

The concern about predation at crossing structures is prevalent in road ecology and hinders decision-making by managers, despite scant evidence that the problem is significant (Little *et al.* 2002; Mata *et al.* 2015). Ultimately, crossing structures are installed to provide

connectivity for wildlife and reduce roadkill. While predation at crossing structures may occur, it will only reduce their effectiveness if the mortality rate from predation exceeds that which would have occurred through roadkill, or if it affects the long-term viability of the population. Further research on predator activity and predation rates at crossing structures, when measured relative to control sites, will be important for understanding the effectiveness of wildlife crossing structures and can inform future design.

Supplementary Material

[link to video will be provided]

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208 **Fig. 1.** Canopy bridge (a) and glider pole (b) to allow arboreal marsupials to cross the
209 Hume Freeway, southeast Australia (Images: Kylie Soanes).

Fig. 2. Sequence of screen-captures from video (1–3 seconds apart) showing predation attempt on squirrel glider (*P. norfolcensis*) as it crosses a canopy bridge over the Hume Freeway.