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Movement re-established but not restored: Inferring the effectiveness of road-crossing mitigation for a gliding mammal by monitoring use

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ABSTRACT

Wildlife crossing structures are commonly used to mitigate the barrier and mortality impacts of roads on wildlife. For arboreal mammals, canopy bridges, glider poles and vegetated medians are used to provide safe passage across roads. However, the effectiveness of these measures is unknown. We investigate the effect of canopy bridges, glider poles and vegetated medians on squirrel glider movement across a freeway in south-east Australia. We monitored structures directly using motion-triggered cameras and passive integrated transponder (PIT) scanners. Further, post-mitigation radio-tracking was compared to a pre-mitigation study. Squirrel gliders used all structure types to cross the freeway, while the unmitigated freeway remained a barrier to movement. However, movement was not restored to the levels observed at non-freeway sites. Nevertheless, based on the number and frequency of individuals crossing, mitigation is likely to provide some level of functional connectivity. The rate of crossing increased over several years as animals habituated to the structure. We also found that crossing rate can be a misleading indicator of effectiveness if the number of individuals crossing is not identified. Therefore, studies should employ long-term monitoring and identify individuals crossing if inferences about population connectivity are to be made from movement data alone.

1. Introduction

Roads and traffic threaten the persistence of wildlife populations by fragmenting habitat, reducing gene flow and increasing mortality rates through roadkill (Bennett, 1991; Fahrig and Rytwinski, 2009; Forman and Alexander, 1998; Holderegger and Di Giulio, 2010). Wildlife crossing structures aim to mitigate these impacts by providing safe passage for wildlife across roads, yet in most cases their effectiveness has not been evaluated (Clevenger, 2005; Forman et al., 2003; van der Ree et al., 2007, 2009). The first step in evaluating the effectiveness of crossing structures is to determine the frequency of crossing by target species and the number of individuals that use the structure (van der Ree et al., 2007).

The monitoring method employed and survey duration are critical as they are likely to affect the number of crossings detected and thus the perceived success of crossing structures (Hardy et al., 2003; Mateus et al., 2011). Thorough evaluation of the effectiveness of wildlife crossing structures is essential to ensure that successful measure are widely adopted, and unsuccessful ones are not repeated. Short-term studies which monitor the use of structures by wildlife without quantifying impacts of the road prior to mitigation, provide only a limited assessment of the extent to which wildlife crossing structures can restore, or maintain, connectivity (Hardy et al., 2003; van der Ree et al., 2007).

Arboreal mammals are highly susceptible to the mortality and barrier impacts created by large roads as they are often unable, or unwilling, to cross large gaps in tree cover (e.g. Asari et al., 2010; Goldingay and Taylor, 2009; Laurance, 1990; van der Ree et al., 2003). Road agencies increasingly rely on mitigation such as canopy bridges, glider poles or vegetated medians (retaining tall trees in the road median) to reduce the impacts on arboreal mammals, particularly on threatened species. However research on the use of these measures by wildlife is limited to a few studies, including canopy bridges over rainforest roads (Weston et al., 2011), canopy bridges across a major freeway (Goldingay et al., 2012) and glider poles on landbridges which cross major roads (Goldingay et al., 2011).

Radio-tracking of individuals has demonstrated that the Hume Freeway in south-east Australia is a barrier to squirrel glider (*Petaurus norfolcensis*) movement, while vegetated medians

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retained during construction facilitated road crossing (van der Ree et al., 2010). Canopy bridges and glider poles have been built to mitigate the impacts on squirrel glider movement, although the effectiveness of these measures is unknown. Here, we investigate the effect of canopy bridges, glider poles and vegetated medians on squirrel glider movement using remotely-triggered cameras, passive integrated transponder (PIT) scanners and post-mitigation radio-tracking of individuals. We also explore the effects of survey duration and monitoring method on detected crossing rates and how these factors influence the perceived effectiveness of crossing structures.

2. Methods

2.1. Site and study species

We studied a 70 km section of the Hume Freeway between the rural towns of Avenel (33° 42′S, 148° 176′E) and Benalla (36° 55′S, 145° 98′E) in south-east Australia (Fig. 1). This section was upgraded to a four-lane divided freeway during the 1970–80s with an average width of 53 m (44–76 m) including a centre median (21–38 m wide). The average traffic volume is 10,000 vehicles per day (speed limit 110 km/h) 25% of which occurs between 10 pm and 5 am (VicRoads, unpub. data), when native mammal species are most active. The surrounding landscape is predominantly cleared agricultural land with less than 5% of the original (pre-European) tree cover remaining (Fig. 1). The majority (83%) of remnant box–gum wood land (*Eucalyptus* spp.) exists as a network of linear strips along roadsides and waterways (van der Ree, 2002). Where linear strips are bisected by the freeway mature trees occur 5–20 m from the road edge. During the freeway upgrade, vegetated medians containing trees 20–30 m tall were retained at some sites reducing the gap in tree cover across the road to <15 m. Sites without vegetated medians where the treeless gap exceeds 50 m are referred to as ‘unmitigated’. Linear remnants in this region contain a high density of large, hollow-bearing trees providing critical habitat for the squirrel glider, a small (~250 g), nocturnal gliding marsupial (family Petauridae) which is threatened in south-east Australia (van der Ree, 2002). A gliding membrane that extends from each wrist to each hind leg allows individuals to glide from tree to tree. The average glide length is 20–35 m with a maximum of approximately 70 m, depending on launch height (Goldingay and Taylor, 2009; van der Ree et al., 2003). Squirrel gliders very rarely move along the ground (Fleay, 1947).

2.2. Crossing structures

In July 2007, approximately 20–30 years after the highway was upgraded, crossing structures were installed at five sites where the treeless gap across the road exceeded 50 m: Longwood (canopy bridge), Violet Town (canopy bridge), Balmattum (glider poles), Baddaginnie (glider pole) and Warrenbayne (glider pole). Prior to mitigation, radio-tracking at these sites detected no road crossings by squirrel gliders (van der Ree et al., 2010). Structures were placed where a linear strip of remnant woodland (usually along a single-lane rural road) intersected the freeway (Fig. 1).

Each canopy bridge is approximately 70 m long and 0.5 m wide, constructed of UV stabilised marine-grade rope in a flat lattice-work configuration (i.e. analogous to a rope ladder laid horizontally). The canopy bridges are suspended between two timber poles

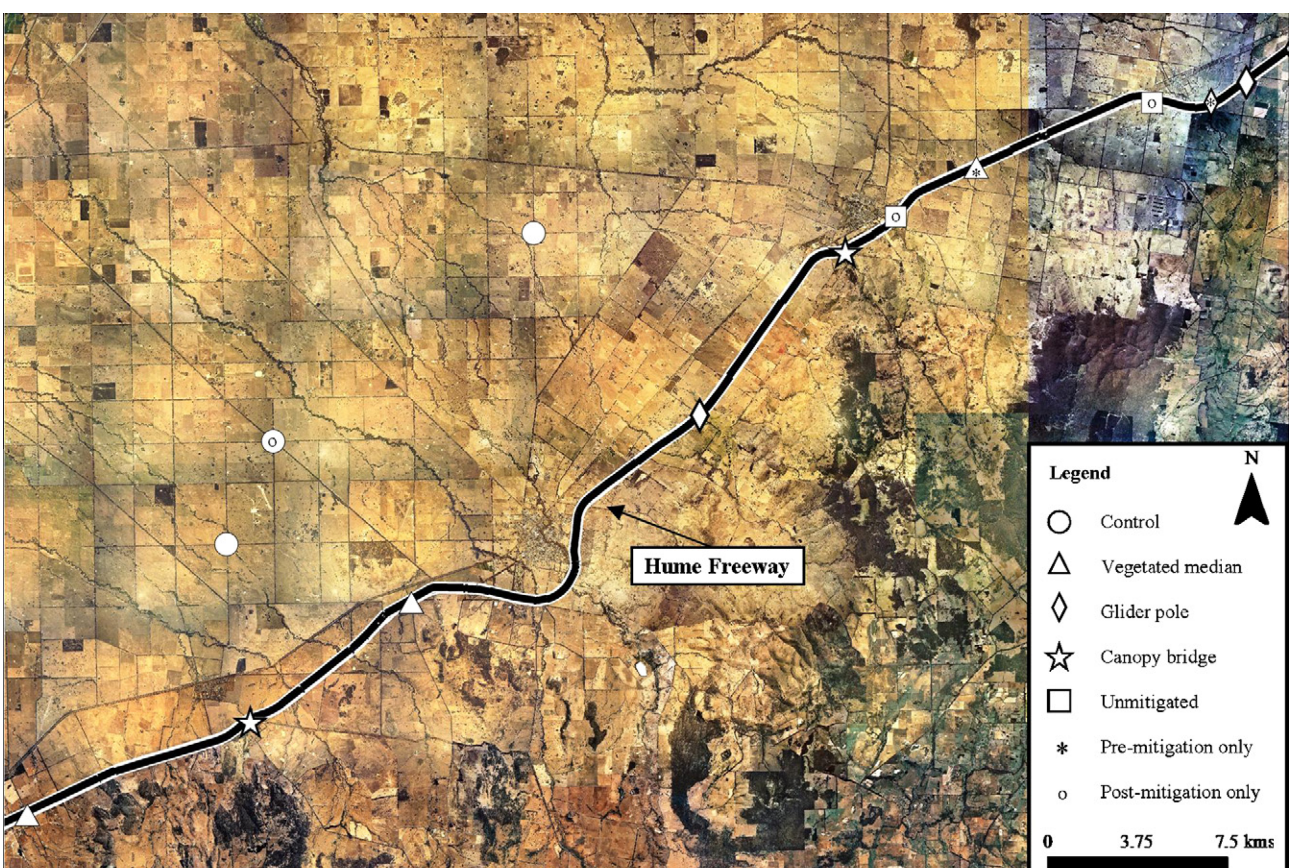

Fig. 1. Map of the study area surrounding the Hume Freeway in south-east Australia showing the location of crossing structures and pre- and post-mitigation radio-tracking sites (DSE, 2011).