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Final report on targeted Squirrel Glider surveys for the Ellerton Drive Extension, Queanbeyan NSW.

Report for the Office of Environment and Heritage, NSW

Report prepared by The Australian Research Centre for Urban Ecology

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Cover photo: Remote-sensor camera image of a Sugar Glider (*Petaurus breviceps)* from the Ellerton Drive Extension surveys, Queanbeyan, 12/1/2016.

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Executive summary

The Australian Research Centre for Urban Ecology was commissioned by the New South Wales Office of Environment and Heritage to undertake targeted Squirrel Glider *(Petaurus norfolcensis)* surveys for the proposed Ellerton Drive Extension (EDE) in Queanbeyan, NSW.

The survey aimed to determine 1) the species' of glider occupying the roof space at 35 Lonergan Drive Greenleigh; 2) the species' of glider found in the backyard of 35 Lonergan Drive; and 3) the occurrence and distribution of gliders within and adjacent to the proposed alignment of the EDE project. This report summarises results of a survey conducted from the 4th to the 19th of January 2016, which included cage trapping (354 trap nights, 4th-11th January), spotlighting (340 person minutes, 7th and 8th January) and camera-trapping (270 camera-trap nights, 4th-19th January). In addition, we discuss the likely impacts of the proposed road project on Squirrel Gliders and provide a suite of recommendations designed to avoid, minimise and mitigate potential impacts of the proposed road development on the species.

A total of eight sites were surveyed, with four focussed on the EDE alignment and the other four on privately owned properties where gliders have recently been sighted. No Squirrel Gliders were detected during the survey by any of the methods. Three Sugar Gliders (*Petaurus breviceps)* were captured, including two females and one male, in cages placed within 35 Ellerton Drive or in habitat contiguous to 35 Ellerton Drive. One Sugar Glider was observed while spotlighting and Sugar Gliders were detected at 17 of 21 remote-sensor cameras. Of those cage-trapped, Sugar Glider body weights were typical for the species, suggesting a healthy population, albeit of low abundance. Common Brushtail (*Trichosurus vulpecula*) and Common Ringtail (*Pseudocheirus peregrinus*) Possums were detected using all three survey techniques, as well as one Antechinus *sp*. detected on a camera.

We also reviewed photographs provided by residents of 35 Lonergan Drive. We determined that most individuals were unable to be identified to species level, some were definitely Sugar Gliders and some individuals showed morphological similarities to both Squirrel Gliders and Sugar Gliders.

Based on the weight of evidence we conclude the following:

1) We cannot confirm the existence of a Squirrel Glider population within the EDE alignment or adjacent surveyed habitat, including at 35 Lonergan Drive.
2) We believe the likelihood of Squirrel Gliders occurring within the EDE area is low, because of (i) our relatively high survey effort using three different survey techniques; (ii) the sub-optimal and low quality habitat for the species and (iii) the lack of historical Squirrel Glider records within the area.
3) We could not conclude that any of the photographs provided by the residents of 35 Lonergan Drive contained Squirrel Gliders. The majority of individuals were either Sugar Gliders or classified as 'Glider *spp*.,' as the photographs did not provide an adequate view of the animal to enable accurate species identification. While some images showed gliders with both Squirrel Glider and Sugar Glider features, there was insufficient evidence to be confident in concluding species identity.
4) The Sugar Glider population within the alignment is of low density but widespread, and appears to be functioning as expected (healthy body weights, even ratios of males and females, lactating females and back-young).
5) Remote-sensor cameras demonstrate that Common Brushtail Possums and Common Ringtail Possums are widespread across the EDE alignment and study area.

The proposed road and bridge structure will impact upon the resident arboreal mammal population, unless mitigation measures are included in the design and construction of the road. The primary impacts on the arboreal mammals would include: i) loss of habitat due to clearing; ii) loss of large and/or hollow-bearing trees used for shelter and denning; iii) barriers to movement; iv) increased wildlife mortality due to collisions with vehicles; v) mortality during clearing, (vi) road noise and lighting and (vii) entanglement with barbed wire fencing.

Introduction

The proposed Ellerton Drive Extension (EDE) development in Queanbeyan, NSW, involves the construction of a new roadway and bridge across the Queanbeyan River. The EDE alignment passes through box-gum woodland and dry forest; habitat that potentially supports several arboreal mammal species.

Squirrel Gliders *(Petaurus norfolcensis)* have not previously been known to reside around Queanbeyan, with the nearest record in the Tallaganda State Forest, approximately 40 km east of the EDE alignment. In 2015 NGH Environmental undertook two surveys, including targeted Squirrel Glider surveys, within the EDE area. NGH did not detect any Squirrel Gliders. However, residents of 35 Lonergan Drive, Greenleigh, provided photo evidence to the Office of Environment (OEH) of what appeared to be Squirrel Glider-like animals residing in habitat adjacent to the EDE, including within the roof cavity of their house. Therefore, in order to confirm the identity of the images, the NSW OEH commissioned the Australian Research Centre for Urban Ecology (ARCUE) to determine 1) the species' of glider occupying the roof space at 35 Lonergan Drive Greenleigh; 2) the species' of glider found in the backyard of 35 Lonergan Drive; and 3) the distribution and abundance of gliders within and adjacent to the proposed alignment of the EDE development.

Methods

Design of proposed EDE

The assessment of significance of impacts on Squirrel Gliders is based on the current proposed design of the EDE undertaken by the Queanbeyan City Council and is summarized below (as detailed in 'Ellerton Drive Extension (EDE) Preliminary Sketch Plan Design Report Part 1-14,' Opus International, 2014).

The proposed extension would connect the eastern side of Queanbeyan, where the existing Ellerton Drive ends, with Karabar at the new Edwin Land Parkway intersection joining to Old Cooma Road. The new sub-arterial road will consist of a two-lane, two-way carriageway up to 3.5 m wide, including a shared 2.5 m wide footpath/cycleway on the western side of the alignment. The extension will be 4.6 km long. A new 180 m long bridge will extend over the Queanbeyan River, at a height of 6 m.

Traffic will be held to 60-80km/h, with new street lighting continuing from the existing Ellerton Drive through to the Edwin Land Parkway intersection with Old Cooma Road. High performance lights and high efficiency high pressure sodium lamps will be used. An upgrade of the existing street lighting at Ellerton Drive will also occur.

Squirrel Glider ecology

Squirrel Gliders *(Petaurus norfolcensis*) (Figure 1) occur across eastern Australia, primarily from north-east Victoria to northern Queensland. Within NSW Squirrel Gliders are listed as Vulnerable, with endangered populations in the Wagga Wagga Local Government Area and on the Barrenjoey Peninsula (NSW Threatened Species Act 1995). Squirrel Gliders are not listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. The species occurs primarily in woodland and open forest with overstorey of *Eucalyptus, Corymbia* or *Angphora* species and a shrubby understorey of *Acacia* and/or *Banksia* species (Quin, 1995; Quin, Smith & Green, 2001). The home range size of Squirrel Gliders in high quality habitat is between 1.5 and 3.5 ha, but can be larger (up to 10-12 ha) in low quality habitat (Quin, 1995; van der Ree & Bennett, 2003). Squirrel Gliders are common in some remnant and roadside patches of *Eucalyptus* woodland within their range, particularly where large, hollow bearing trees (> 80 mm DBH) are abundant. Seasonal home ranges in high quality linear fragments of woodland are small (mean 1.4-2.8 ha) and can range between 320 and 840 m in length (van der Ree & Bennett, 2003). Small patches of trees adjacent to linear habitats can also be extensively used by Squirrel Gliders (van der Ree & Bennett, 2003).

Squirrel Gliders primarily move through their home range by gliding from tree to tree (Figure 2). The average glide length is 30-40 m, with a maximum glide length of approximately 70 m (van der Ree, Bennett & Gilmore, 2003). Squirrel Gliders live in social groups of typically two to seven related individuals and den communally in multiple hollow-bearing trees within their home range. Hollow bearing trees are a critical and limiting resource: without hollows Squirrel Gliders are unable to shelter or raise young (Gibbons & Lindenmayer, 2002; Soanes & van der Ree, 2015). Sparse vegetation cover within fragmented habitats is also a major issue for the persistence of the species as, if the distances between trees is larger than the maximum gliding capability, it can force Squirrel Gliders to move along the ground, leaving them more vulnerable to predation from owls (*Ninox*, *Tyto spp*.), foxes (*Vulpes vulpes*) and cats (*Felis catus*).

Squirrel Gliders are nocturnal and feed mainly on arboreal insects, nectar, pollen and tree sap, but their diet will vary depending on location and time of year. Locations where there is winter and spring flowering of *Eucalyptus* and/or *Banksia* species support higher densities of Squirrel Gliders, whereas lower population densities occur when no winter flowering occurs and flowering species are replaced by a dense understorey of *Acacia* (Quin, Smith & Green, 2001). Female Squirrel Gliders typically give birth to a single litter of one or two young between April and November each year.

Figure 1: A Squirrel Glider (left) and a close-up image of a Squirrel Glider (right). Photos: Lochman Transparencies.

Figure 2: A Squirrel Glider (left) and a Squirrel Glider mid-glide after being released from a cage-trap (right). Photo: Lochman Transparencies (left), Kylie Soanes (right).

Identification of glider species

Squirrel Gliders and Sugar Gliders (*Petaurus breviceps)* (Figure 3) are quite similar in appearance and from a distance may be difficult to distinguish from each other. However, there are a few key distinctive features that help to identify each species (Figures 4-7). When of a similar age, Squirrel Gliders are always larger than Sugar Gliders within the same geographical region (Table 1), with Squirrel Glider skulls on average 25% larger than a Sugar Gliders (Alexander, 1981). Squirrel Glider skulls are much more triangular in shape, whereas Sugar Gliders have a very blunt face, with a high-arching forehead (Figures 4 & 5). Both of these characteristics are also visible on live animals with fur. It is also important to note that the body size of both Sugar and Squirrel Gliders gradually and continuously decreases with increasing latitude according to Bergman's rule (Alexander, 1981; Quin, Smith & Norton, 1996). In other words, Squirrel Gliders in Victoria are larger than Squirrel Gliders of the same age in Queensland.

Squirrel Gliders have a longer, wider and fluffier tail when compared to Sugar Gliders (Figures 6 & 7). Fur width at the base of the tail (i.e. where the tail joins the body) shows the greatest size discrepancy between the two species (Figure 6). The width of a male Squirrel Gliders tail width is 88.7% larger than the width of a male Sugar Gliders tail, and the width of a female's is 67.4% larger than a female Sugar Gliders (Alexander, 1981). The width and fluffiness of a Squirrel Gliders tail means it is hard to distinguish between the end of its rump and where the tail begins, whereas in Sugar Gliders the point at which the tail joins the body is typically quite obvious (Figures 6 & 7). The majority (approximately 2/3^{rds}) of Sugar Gliders also have a white tip at the end of their tail (Alexander, 1981). To our knowledge, there are no records of Squirrel Gliders ever having a white tip at the end of their tail. The patagium and ventral fur of a Squirrel Glider is white to creamy, particularly in juvenile and sub-adult Squirrel Gliders (Figure 1), whereas the ventral fur of Sugar Gliders is creamy/greyish yellow with grey tips on the patagium (Figure 3) (Alexander, 1981). Squirrel Gliders also have longer, narrower ears and more distinct facial markings.

Age and gender enable the ability to distinguish between individuals whose weight and/or body size measurements fall on the upper or lower edge of each species size range. For example, an adult Sugar Glider may weigh more than a juvenile Squirrel Glider, but the age difference is clearly obvious when the animal is in the hand. In both species age is determined by inspecting the level of wear of the upper incisors and noting its reproductive status. In males an active, well-developed frontal gland (located on top of head) indicates adulthood. The reproductive status of females is determined by inspecting the pouch, with reproductively active females (i.e. bred previously, carrying pouch young or lactating) indicating adulthood. Upper incisor wear is measured on a scale of one (long teeth that splice outwards towards the end) to four (teeth worn down to the gums), with one indicating an individual around one year of age and three or four indicating an adult above approximately 3 years of age (van der Ree, Harper & Crane, 2006).

Table 1: The average body measurement and weights of adult Squirrel Gliders and Sugar Gliders found throughout Australia. (Source: Menkorst & Knight, 2011).

Size measurement	Squirrel Glider	Sugar Glider
Head and body length	170-240 mm	160-200 mm
Tail Length	220-300 mm	165-210 mm
Weight	190-300 g	90-150 g

Figure 3: A Sugar Glider (left). Note the white tip on the end of its tail and active head gland. A Sugar Glider with creamy/greyish yellow belly fur and greyer tips on the ends of the patagium (right). Both photographs were taken in NSW. Photo: Ken Stepnell/OEH (left), at http://www.environment.nsw.gov.au/animals/GlidingPossums.htm & David Cook (right), www.flickr.com/photos/kookr/1914343602

Figure 4: The side view of a Squirrel Glider head (left) compared to a Sugar Gliders head (Right). Note also the variation in the definition of the facial markings. Photos: Lee Harrison.

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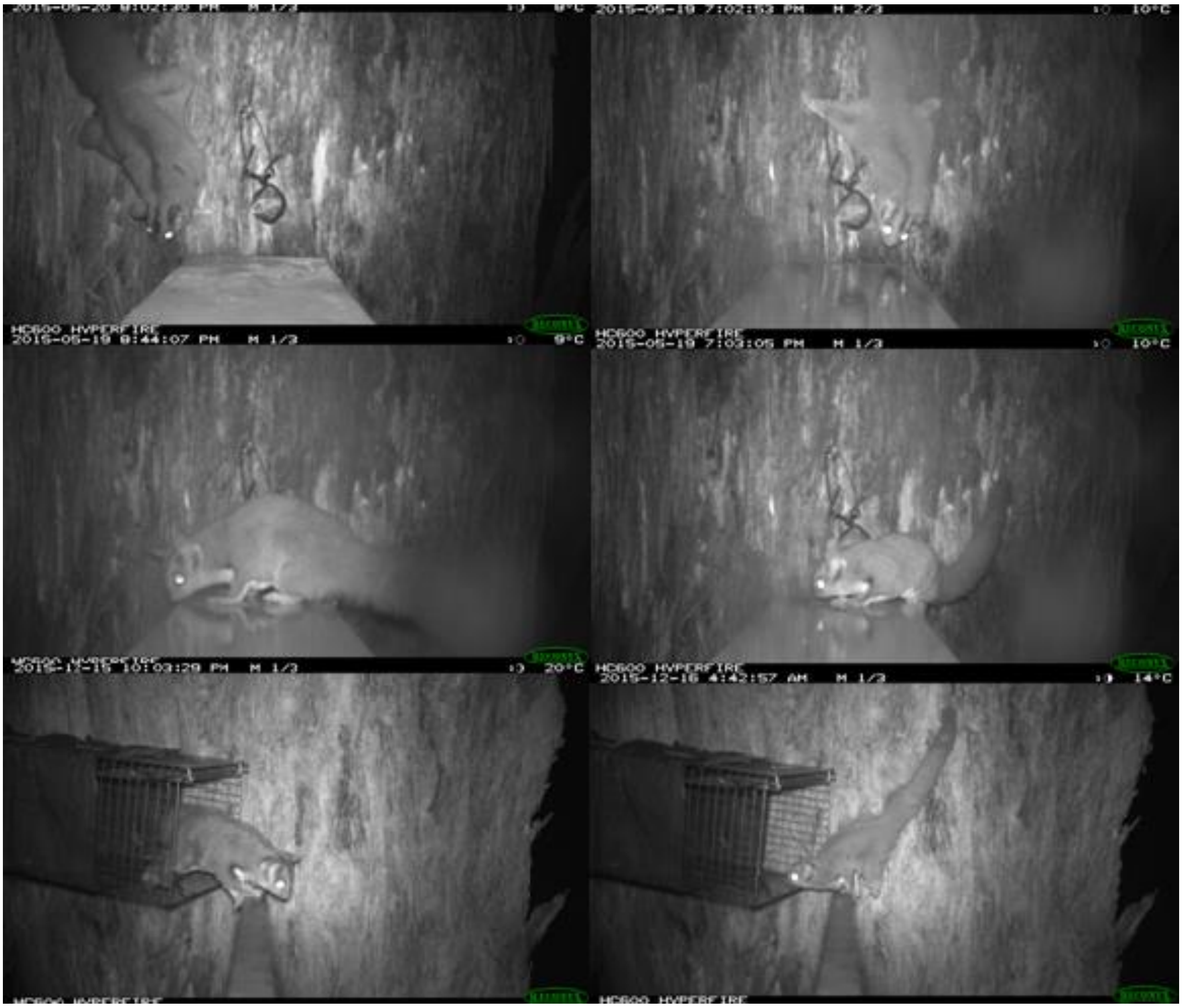

Figure 7: A comparison of Squirrel Gliders (three images at left) and Sugar Gliders (three images at right) captured on the same type of a remote-sensor camera at Blue Metal TSR, on the south-west slopes of NSW. Photos: Briony Mitchell.

Survey effort

Three experienced ecologists conducted the targeted Squirrel Glider surveys from the 4th to the 11th of January, 2016 (Table 2). Remote-sensor cameras were set until the 19th of January, 2016.

Table 2: The three ecologists that undertook the targeted Squirrel Glider Surveys within the Ellerton Drive Extension area, Queanbeyan.

Personnel	Dates	Survey method
Rodney van der Ree	5/1/2016-7/1/2016	Cage-trapping, remote-sensor cameras, animal processing
Alex Kutt	7/1/2016-11/1/2016	Cage-trapping, animal processing, spotlighting
Briony Mitchell	4/1/2016-19/1/2016	Cage-trapping, remote-sensor cameras, animal processing, spotlighting

Site selection and cage trapping survey

Eight sites across the EDE alignment and adjacent trapped habitat (study area) were selected for the Squirrel Glider survey (Figures 8-14, Table 3). Four sites were located within the study area, with the remaining four sites distributed on landholder property where recent glider sightings had occurred.

Trapping surveys were undertaken between the 4th and 11th of January 2016 using wire cage traps (Wiretainers, 20 cm x 20 cm x 50 cm) set on the trunks of trees at approximately 3-5 m above the ground. The number of traps set at each site varied from 3 to 16 and sites were trapped from five to seven consecutive nights. Traps were baited with a mixture of honey, rolled oats and peanut butter and diluted honey was sprayed on the trap-tree to attract animals. The traps at 35 Lonergan Drive were re-sprayed with honey dilution on the 9th January 2016 to increase animal capture rates. Traps were placed approximately 100 m (+/- 20 m) apart, with a preference for placing traps on large and/or hollow-bearing trees. We aimed to set traps in linear transects or in a grid format along the alignment, but the shape and extent of woodland habitat, and a lack of large and/or hollow-bearing trees along the EDE alignment did not always allow this. Many traps were placed within and around 35 Lonergan Drive, where anecdotal Squirrel Glider sightings had occurred, in order to optimise the chance of detecting the gliders. One trap was also placed within the roof cavity of 35 Lonergan Drive and another on the window ledge near the animal's entry-point into the roof space; both locations where gliders had previously been seen. The GPS location of each trap tree (Datum: GDA), its species and diameter at breast height (DBH) were recorded.

All traps were checked from dawn each morning, and any captured gliders were processed (removed from trap, identified, weighed, measured, sexed, aged and reproductive condition noted) and immediately released afterwards. Head to snout length, maximum head width, tail length (base to bone tip & base to fur tip) and fur width at the base of the tail were measured. Reproductive condition and tooth wear were recorded to establish the age of the individual, which assisted with species identification. Each captured glider was marked with a tattoo in the ear and by implanting a microchip beneath the skin between the shoulder blades. Two small (~2 mm diameter) tissue samples were removed from the margins of the ear-flap for DNA testing. Other species captured (Brushtail or Ringtail Possums) were immediately released from the trap and were not processed, as they were not our primary target. If the same individual was captured in the same trap for three consecutive nights (for gliders based on tattoo and microchip numbers, for possums based on size or unique markings/natural ear tears), the trap was closed for the following night. Any other by-catch (e.g. birds) were assessed for injury and released immediately.

Table 3: The eight sites where cage-trapping was undertaken, including the number of remote-sensor cameras located at each site. The location of each site within the Ellerton Drive Extension alignment and study area is shown in Figure 10.

Site number	Site name	Number of traps	Camera numbers (refer to Fig. 17)	Trap Site symbol (refer to Fig. 10)
1	North	7	1, 2	Fluoro green circles
2	Middle	16	3, 4, 5, 6, 7, 8	Blue, open triangles
3	East	10	9, 10, 11, 12, 13	Yellow circles
4	17 Lonergan Drive	3	0	Purple stars
5	20 Lonergan Drive	3	0	Red, open diamonds
6	26 Lonergan Drive	4	0	Dark green, open circles
7	35 Lonergan Drive	12	14, 15, 16, 17	Pink, open squares
8	South	9	18, 19, 20, 21	White, open hexagons

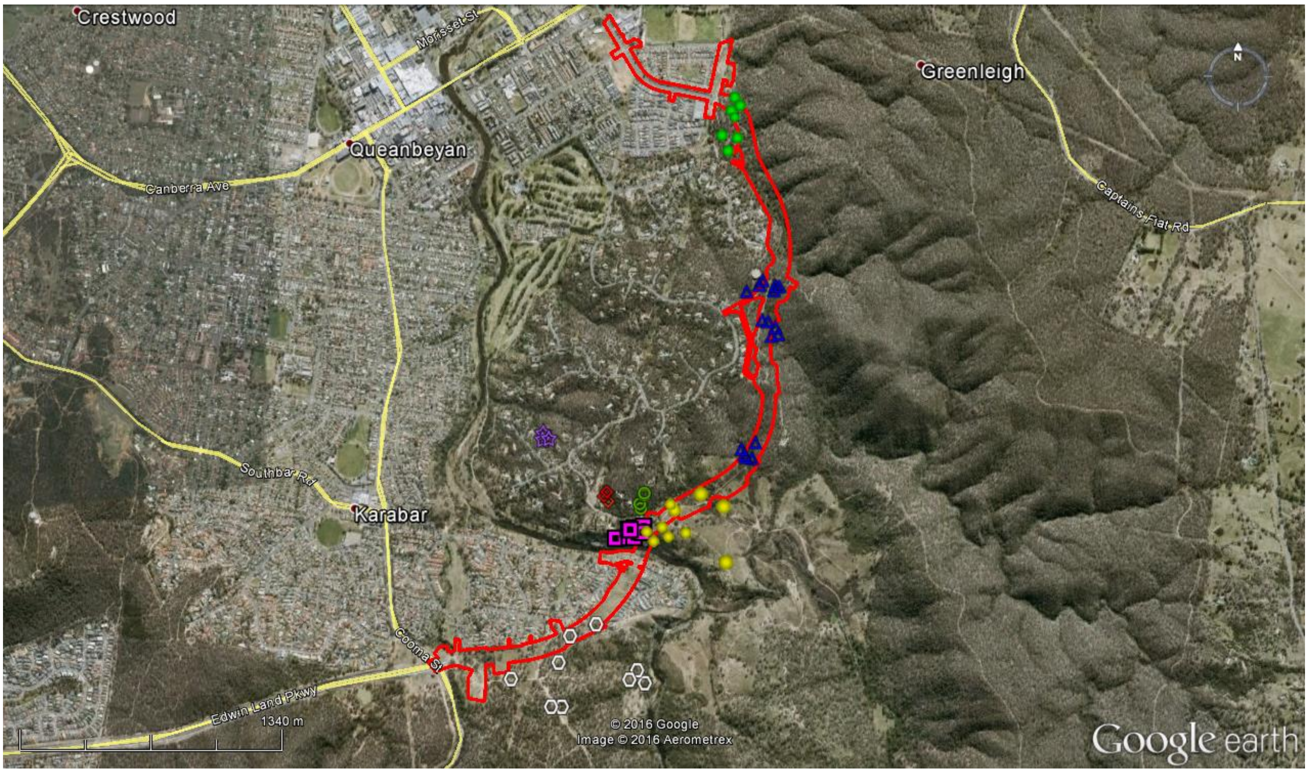

Figure 8: Overview of cage-trap site locations across the Ellerton Drive Extension alignment (red outline) and adjacent surveyed habitat. Refer to Table 3 for site symbol references. Source of background image: Google Earth, 2016.

Figure 9: The seven cage-traps at North site, located towards the northern end of the Ellerton Drive Extension alignment (red outline). Each fluoro green circle represents a single cage-trap. Source of background image: Google Earth, 2016.

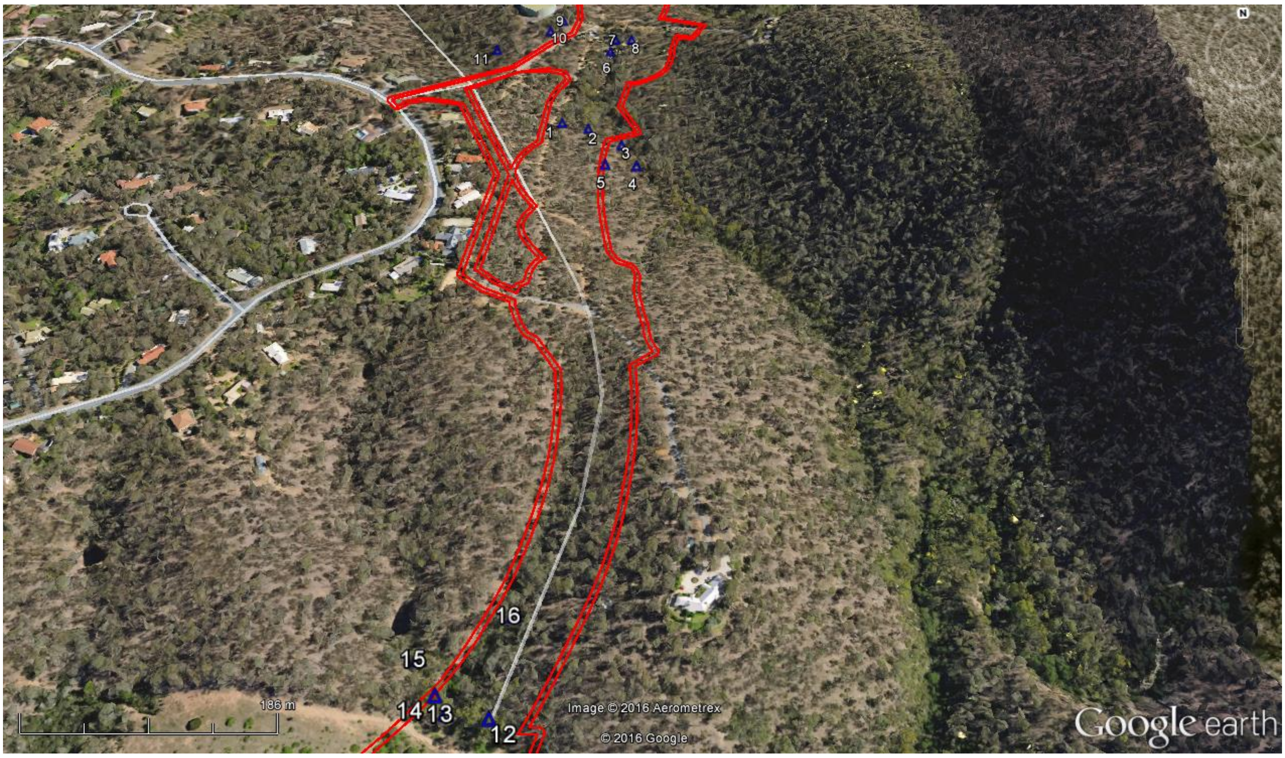

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Figure 14: The nine cage-traps at South site, located along the Ellerton Drive Extension alignment (red outline) and adjacent habitat south of the Queanbeyan River. Each white hexagon represents a single cage-trap. Source of background image: Google Earth, 2016.

Remote-sensor camera survey

Twenty-one Reconyx HC600 Hyperfire remote-sensor cameras were placed across five sites throughout the EDE alignment and Lonergan Drive properties (Figures 15-17, Table 3). Cameras were sequentially deployed from the 4th-7th of January and remained active from the day of deployment until the 19th of January. Twenty cameras were placed on horizontal brackets (1.2 m from the trunk) attached to tree trunks approximately 3-5 m above the ground. One camera was placed within the roof cavity of 35 Lonergan Drive. Baited tea strainers were placed within the field of view of 18 cameras. Three cameras were used in conjunction with a cage trap, where the bait in the trap acted as an attractant. On the 11th January, when cage trapping ceased, any cage traps with cameras were replaced with tea strainers. The sphere-shaped tea strainers were 7 cm long and spoon-shaped tea strainers were 5 cm long. Diluted honey was sprayed on the tree trunk around the cameras on the day on which they were set and again on the 11th of January, 2016.

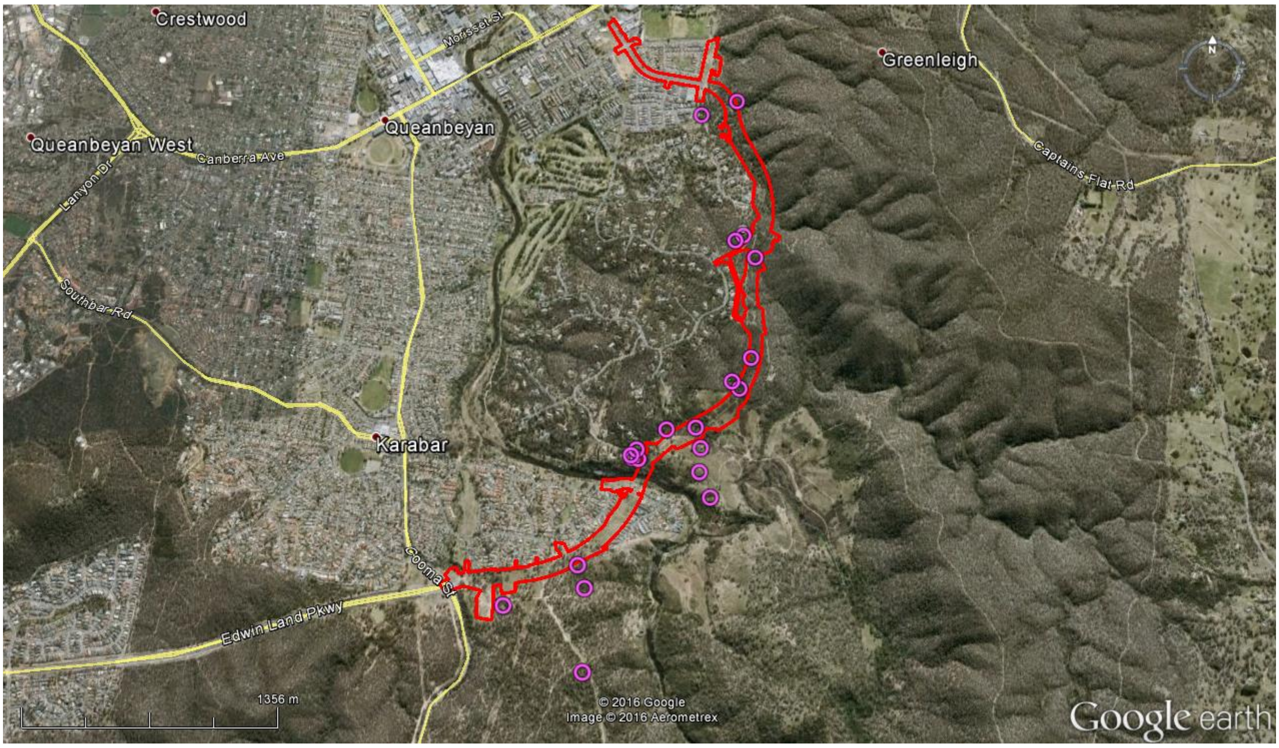

Figure 15: Overview of 21 remote-sensor camera locations (pink open circles) placed across the Ellerton Drive Extension alignment (red outline) and in the adjacent habitat. Refer to Table 3 for camera numbers per site. Source of background image: Google Earth, 2016.

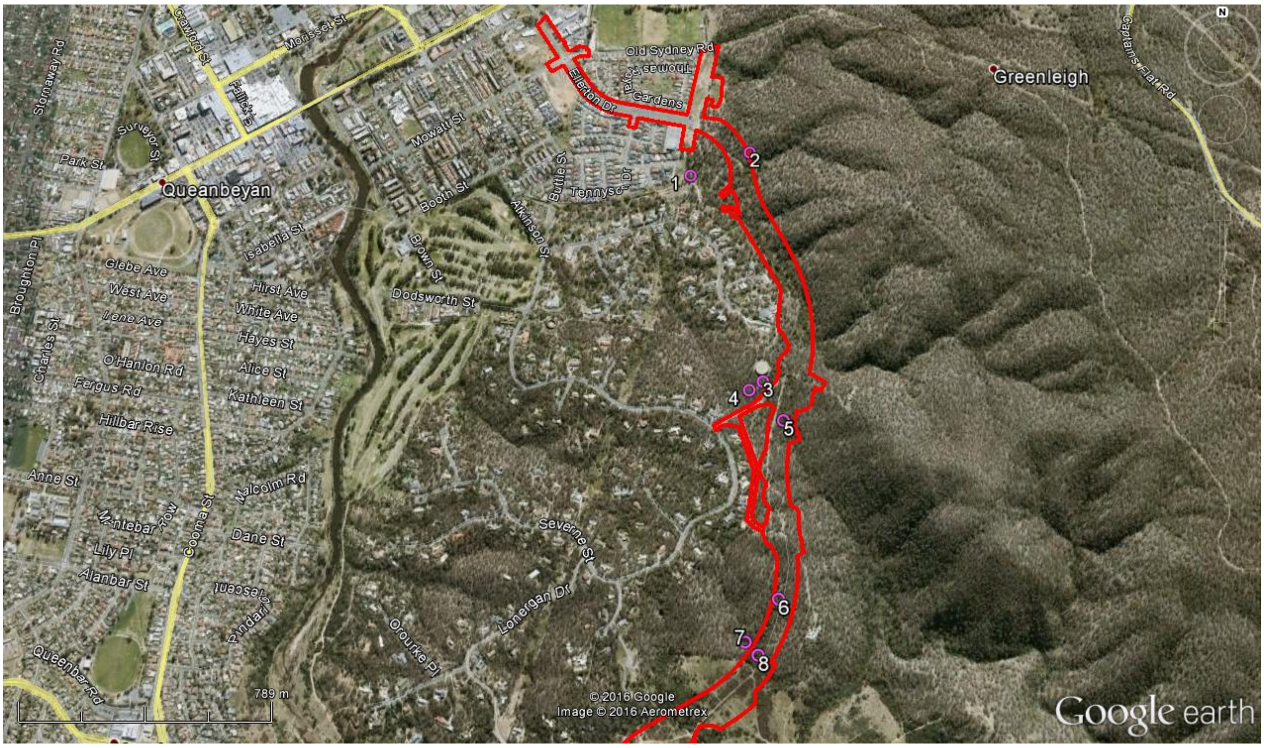

Figure 16: An overview of remote-sensor cameras (pink open circles) at the northern end of the Ellerton Drive Extension alignment (red outline) and adjacent habitat. Refer to Table 3 for camera numbers per site. Source of background image: Google Earth, 2016.

Figure 17: An overview of remote-sensor cameras (pink open circles) towards the southern end of the Ellerton Drive Extension alignment (red outline) and adjacent habitat. Refer to Table 3 for camera numbers per site. Source of background image: Google Earth, 2016.

Remote-sensor camera image analysis

Cameras were set to take two images per trigger with a one second delay between each image. There was then a three minute delay between trigger events. All images were analysed and all animals were identified to species level, with each set of two images per trigger recorded as a single observation. If an image did not display enough of a glider for it to be identified to species level it was recorded as 'Glider *spp.*' If an individual glider within an image displayed attributes of both a Squirrel Glider and a Sugar Glider it was classified as 'Ambiguous Glider.' If we could not identify the animal to genus, but it was definitely a mammal, it was recorded as 'Mammal.' This was usually if the animal's back or rump was directly in front of and in close proximity to the camera. If an animal was not identifiable, but occurred in a set of two images three minutes immediately before or after a previous set of two images, the animal was recorded as the species that was in the previous/next observation. If there were two individuals within a set of two images, this was recorded as one event.

Photographs provided by 35 Lonergan Drive Greenleigh

The residents of 35 Lonergan Drive provided ARCUE with 26 photos of gliders that were either taken in the backyard of the property or on a remote-sensor camera placed within the roof cavity of their house (Figures A1-A23 in Appendix 1). Each individual within the images were viewed and assessed by Rodney van der Ree, Kylie Soanes and Briony Mitchell and classified using the same classification rules as per the 'Remote-sensor camera image analysis' section above.

The timber beams within the roof cavity of 35 Lonergan Drive were marked with a scale (e.g. Figure A7.1) that was used to determine glider size. We measured the 'longer lines' at 6-7 cm long, with a 10 cm distance between each 'longer line.' Each shorter line in between the 'longer lines' was 3-3.5 cm long, with a distance of 5 cm between it and a 'longer line.' The horizontal stick (e.g. Figure A7.1) along the bottom of the images taken in the roof cavity was not observed in the roof at the time of the ARCUE survey. Some of the photos provided also show gliders up against the brick wall of 35 Lonergan Drive. The bricks were 22.9-23.1 cm long, 10.9-11.0 cm wide and 7.6-7.7 cm high. The mortar between the bricks varied between 1.3-1.9 cm per gap. The brick measurements were provided by the residents of 35 Lonergan Drive.

A sound recording of a glider taken at 35 Lonergan Drive was also provided to ARCUE.

Spotlighting

Spotlighting was performed on the 7th and 8th of January, 2016. On both nights two people spotlighted together in an unstructured manner, as we were targeting specific areas where the anecdotal glider sightings had occurred or small areas of higher quality habitat. On the 7th of January spotlighting began at the end of Lonergan Drive at 20:30 hrs and continued onto 35 Lonergan Drive and the front yard of 26 Lonergan Drive, finally ending at East site. This resulted in 240 person minutes of spotlighting. On the 8th of January 120 person minutes of spotlighting occurred at 35 Lonergan Drive, East site (between traps 8 & 9) and Middle site (between traps 12-15).

Results

Cage-trap captures and survey effort

No Squirrel Gliders were captured during 354 cage-trap nights (Table 4). Three Sugar Gliders were trapped within the EDE study area (Figure 18). Two female Sugar Gliders were captured at 35 Lonergan Drive, one in the roof cavity and one in a trap-tree within the backyard. One male was captured at Middle site. All the gliders we detected during trapping were undoubtedly Sugar Gliders.

The Sugar Gliders appeared healthy, with each individual weighing approximately 135 g. They exhibited typical Sugar Glider body size measurements (Table 5). All Sugars Gliders were approximately 3 years old (determined by tooth wear), but accurately aging individuals older than 2-3 years is difficult (van der Ree, Harper & Crane, 2006). The female captured within the roof cavity was lactating and the other female showed no signs of active breeding at the time of the survey, but had previously raised young.

Sugar Gliders were observed within the roof cavity of 35 Lonergan Drive whilst setting and checking the cage- and camera-traps on several occasions. On the 4th of January a Sugar Glider was observed by Briony Mitchell at approximately 16:00 hrs. Then on the 5th of January at 06:00 hrs, Briony Mitchell observed a Sugar Glider with a white tip on the end of its tail. On the 7th of January, Briony Mitchell again observed a Sugar Glider in the roof cavity. The Sugar Gliders were all less than 1-3 m away, so were easily identifiable and we are confident all were Sugar Gliders.

Other trapped mammals included 23 captures of Common Brushtail Possums (*Trichosurus vulpecula*) and one Common Ringtail Possum (*Pseudocheirus peregrinus*) capture. Brushtail Possums were captured at five of the eight sites, including 35 Lonergan Drive, 17 Lonergan Drive and at South, East and Middle sites. Nine Brushtail Possums captures occurred at Middle site, as well as the Ringtail Possum capture. It is unclear how many individuals we trapped, as we did not continue to mark possums after the capture rates sharply increased.

Table 4: Survey effort, including the sex and identity (microchip number) of Sugar Gliders trapped at each site.

Site	Number of traps	Number of trap nights*	Sex (M or F) and microchip code of trapped Sugar Gliders
1	7	35	None trapped
2	16	85	M – 81C57
3	10	60	None trapped
4	3	15	None trapped
5	3	15	None trapped
6	4	20	None trapped
7	12	79	F – 58964, F – 7C5C0
8	9	45	None trapped

***** The number of trap nights is the number of traps multiplied by the number of nights set.

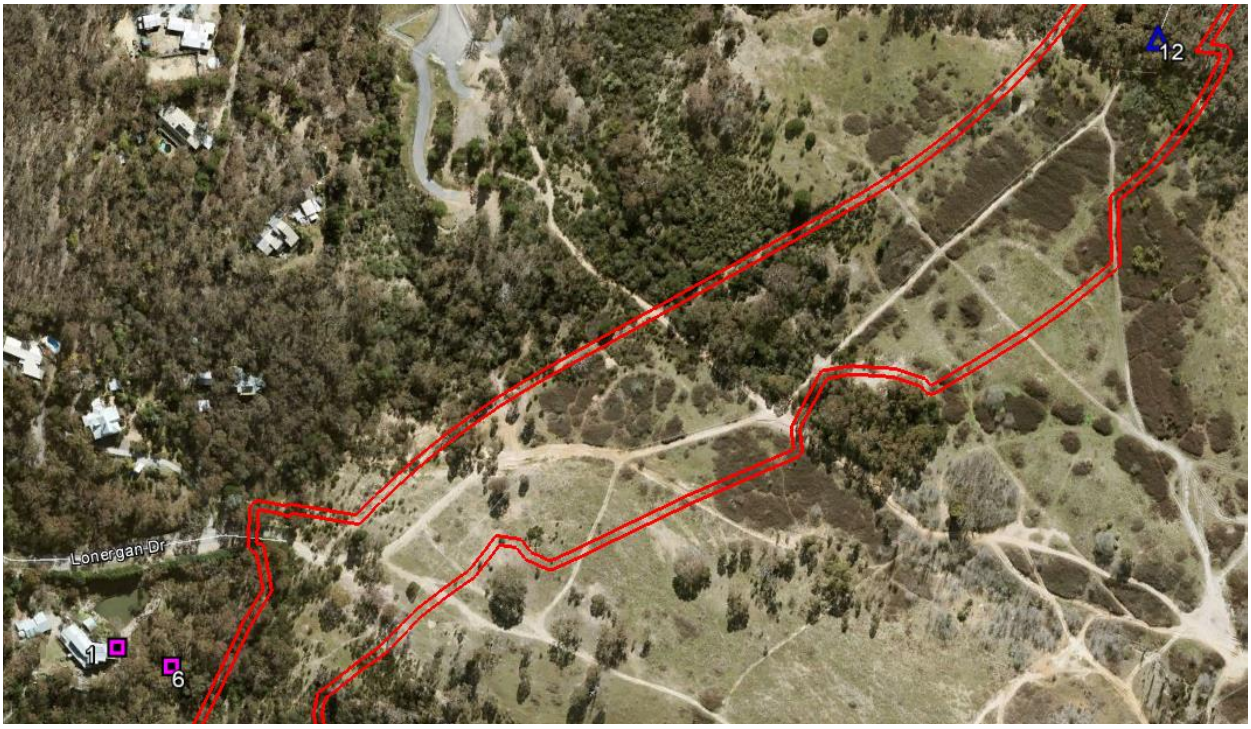

Figure 18: The cage-trap locations where Sugar Gliders were captured. The pink squares represent where the Sugar Gliders were trapped at 35 Lonergan Drive, including trap number one located in the roof cavity and trap number 6 on a tree outside. The blue triangle represents the Sugar Glider trapped at Middle site.

Table 5: The weight, morphological measurements and tail tip colour of the captured Sugar Gliders.

Individual	Gender	Head-snout length (mm)	Max head width (mm)	Tail length to bone (cm)	Tail length to fur (cm)	Tail fur width at base (cm)	Tail tip colour
SGA1^	Female	46	34.2	21	22	3.7	Grey-black
SGA2	Female	37.9	28.4	22	24	5	Grey-black
SGM1	Male	34.9	28.3	19.5	21.3	4.2	White

^Note that a different set of callipers was used to measure SGA1.

Remote-sensor camera detections and survey effort

We detected Common Brushtail Possums, Common Ringtail Possums, *Antechinus* sp. and Sugar Gliders during the 270 camera-trap nights (Table 6). No Squirrel Gliders were observed across all camera-trap sites (Tables 7-11). Sugar Gliders detected at all camera- trap sites across the EDE study area. Sugar Gliders, Brushtail Possums and 'Glider *spp.*' were observed on remote-sensor cameras at 35 Lonergan Drive (Table 7). Brushtail Possums were detected at four sites (Tables 7-10); Ringtail Possums at 2 sites (Tables 7 & 10) and one *Antechinus spp*. was observed at the Middle site (Table 10).

Of the 258 Sugar Glider observations across all camera-trap sites, only 38 were classified as ‘Glider *spp.*’ and none were classified as an ‘Ambiguous Glider’ (Tables 7-11). At 35 Lonergan Drive, 71 Sugar Glider detections occurred, compared to 24 ‘Glider *spp.*’ classifications and four ‘Mammal’ classifications (Table 7). Within the roof cavity 18 Sugar Glider observations occurred, compared to 12 ‘Glider *spp.*’ detections (Table 7). This included the identification of one sub-juvenile Sugar Glider within the roof cavity and backyard area. The sub-juvenile was identified as it was being carried on the back of an adult Sugar Glider (Figure 19). Other Sugar Gliders could also be identified to individual level if they had distinctive natural ear tears. Particularly at Middle site, one male Sugar Glider was evident across many observation events and cameras (Figure 20).

Table 6: Survey effort for the remote-sensor camera survey across each site along the Ellerton Drive Extension.

Site	Number of cameras deployed	Number of camera trap nights*
35 Lonergan Drive	4	54
East	6	65
North	2	24
South	4	52
Middle	6	75

***** The number of trap nights is the number of traps multiplied by the number of nights set.

Table 7: The number of detection events observed for each mammal species per camera-trap at 35 Lonergan Drive. Refer to ‘Remote-sensor camera image analysis’ in the Methods section for ‘species’ categories.

Camera	Sugar Glider	Glider *spp*.	Ambiguous Glider	Brushtail Possum	Ringtail Possum	Mammal
17 (roof cavity)	12	18	0	0	0	3
15	15	2	0	2	0	1
14	13	1	0	16	3	0
16	31	3	0	6	0	0

Table 8: The number of detection events observed for each species per camera-trap at the East site. Note that camera 12 did not record any night images, but the camera was functional for the set period. Refer to 'Remote-sensor camera image analysis' in the Methods section for 'species' categories.

Camera	Sugar Glider	Glider *spp.*	Ambiguous Glider	Brushtail Possum	Ringtail Possum	Mammal
10	8	3	0	0	0	0
9	17	5	0	1	0	0
13	4	0	0	0	0	0
11	12	0	0	0	0	0
12	0	0	0	0	0	0

Table 9: The number of detection events observed for each species per camera-trap at South site. Refer to 'Remote-sensor camera image analysis' in the Methods section for 'species' categories.

Camera	Sugar Glider	Glider *spp.*	Ambiguous Glider	Brushtail Possum	Ringtail Possum	Mammal
19	4	0	0	8	0	0
21	27	1	0	25	0	0
20	27	0	0	0	0	0
18	5	0	0	0	0	0

Table 10: The number of detection events observed for each species per camera-trap at Middle site. Refer to 'Remote-sensor camera image analysis' in the Methods section for 'species' categories.

Camera	Sugar Glider	Glider *spp.*	Ambiguous Glider	Brushtail Possum	Ringtail Possum	Mammal	Antechinus sp.
3	0	0	0	15	6	0	0
4	0	0	0	7	1	0	0
6	3	0	0	0	0	0	1
5	2	2	0	0	0	0	0
8	20	2	0	10	0	0	0
7	7	1	0	1	1	0	0

Table 11: The number of detection events observed for each species per camera-trap at North site. Note that camera 1 did not record any night images, but the camera was functional for the set period. Refer to 'Remote-sensor camera image analysis' in the Methods section for 'species' categories.

Camera	Sugar Glider	Glider *spp.*	Ambiguous Glider	Brushtail Possum	Ringtail Possum	Mammal
1	0	0	0	0	0	0
2	6	0	0	0	0	0

Figure 19: An adult Sugar Glider carrying back-young within the roof cavity of 35 Lonergan Drive (left) and in the backyard of 35 Lonergan Drive (right). Note the white tip on the end of the back-young's tail.

Figure 20: An example of natural ear nicks or tears visible in the remote-sensor camera images. Note the two nicks in the tip of the right ear of the Sugar Glider detected along the Ellerton Drive Extension alignment.

Photographs provided by 35 Lonergan Drive Greenleigh

Here we classify by species each individual from all 26 photographs (Figures A1- A23 in Appendix 1) provided by the residents of 35 Lonergan Drive (Table 12). Please refer to Appendix 1 for the corresponding image numbers and comments on how the decisions on species classification came to be made. In addition, the species of glider in the sound recording could not be identified.

Table 12: Species classification of each glider observed in each image provided by residents of 35 Lonergan Drive, Greenleigh. Each image is shown in Appendix 1.

Image number (as per Appendix 1)	Classification*	Number of individuals
A1	Ambiguous Glider	1
A2	Ambiguous Glider	1
A3	Glider *spp.* & Ambiguous glider	2
A4	Ambiguous Glider	1
A5	Glider *spp.*	1
A6	Sugar Glider	1
A7.1 & A7.2	Sugar Glider	1
A8.1, A8.2 & A8.3	3 Glider *spp.* and 1 Sugar Glider	4
A9	Glider *spp.*	1
A10	Ambiguous Glider	1
A11	Glider *spp.*	1
A12	Glider *spp.*	1
A13	Glider *spp.*	1
A14	Ambiguous Glider	1
A15	Ambiguous Glider	1
A16	Glider *spp.*	1
A17	Glider *spp.*	2
A18	Glider *spp.*	1
A19	Glider *spp.*	1
A20	Glider *spp.*	2
A21	Glider *spp.*	2
A22	Glider *spp.*	1
A23	Glider *spp.*	2

*****Classification: Ambiguous Glider is one where the animal in the photo shows features that are indicative of both a Squirrel Glider and a Sugar Glider. We cannot be confident in species determination, as we would need to view the animal in-hand. Glider *spp*. is where the photo showed insufficient discriminatory features to make a confident determination of species. Further commentary on the determination of each image is given in Appendix 1.

Spotlighting

On the 7th of January two Common Ringtail Possums, one Common Brushtail Possum and two *Antechinus* spp. were observed at 35 and 26 Lonergan Drive. No Squirrel Gliders or Sugar Gliders were observed at any of the searched sites. On the 8th of January two Common Ringtail Possums were observed at 35 Lonergan Drive. No other arboreal mammals were observed at East site. At Middle site a Sugar Glider was observed on the tree that remote-sensor camera 5 was attached to (between cage-traps 12 and 16) (Figure 21). Its body size and attributes were undeniably typical of a Sugar Glider, most notably the white tip on the end of its tail. Also, as the Sugar Glider was on a camera-trap placed on a tree, its body size could be estimated with reference to the known size of the tea strainer bait holder. A head gland was present, as well as a natural chunk out of top of its left ear. No glider-type calls were heard on either night.

Figure 21: The location of the Sugar Glider (pink open circle) at Middle site, observed during spotlighting on the 8th of January, 2016.

Discussion

Presence of Squirrel Gliders in the study area

- **Targeted Squirrel Glider survey**

We could not confirm the existence of a Squirrel Glider population within the EDE alignment or adjacent habitat. While we cannot unequivocally rule out the possibility of Squirrel Gliders being present, we consider it highly unlikely that we would miss them during 354 cage-trap nights, 270 camera-trap nights and two nights of spotlighting. The ability to detect Squirrel Glider abundance and distribution within a particular area can be influenced by extreme weather, lunar cycles and the abundance of natural food sources, such as flowering trees or insects. However, our EDE survey was performed under appropriate weather and lunar conditions and the limited *Acacia* present was not flowering. In addition, at least two survey sessions by experienced ecologists (as detailed in the 'Addendum to the Species Impact Statement,' NGH Environmental, 2015 & in 'Ellerton Drive Extension Squirrel Glider Surveys,' NGH Environmental, NOV 2015) also reported that they failed to detect Squirrel Gliders along the EDE. Cage-traps and remote-sensor cameras were also sprayed with honey dilution several times during the ARCUE survey to increase detection rates. Squirrel Gliders also live in social groups, meaning that if one Squirrel Glider has been sighted in an area more should be present, again increasing the chances of detection. Previously, we have successfully confirmed Squirrel Glider populations during the first cage-trapping event at the majority of sites we have surveyed in southern NSW. Bayesian modelling of data collected from ARCUE's Hume Highway Upgrade Project, that included analysis of detection rates of new and re-trapped individuals, found 72% of first captures occurred during the first four nights of trapping (*n*= 359 Squirrel Glider first captures) (Soanes, 2014), indicating that ARCUE's survey of the EDE provided ample time for a Squirrel Glider population to be detected. Therefore, it is likely that if the observation of a Squirrel Glider at 35 Lonergan Drive was correct, the Squirrel Glider could have simply been dispersing through the area at the time or if it did reside in the area it has either moved on, or the population occurs at very low densities. Further, the abundance of Sugar Gliders in the EDE study area was low, suggesting a lack of critical resources or processes necessary to support multiple species or larger population sizes.

Preliminary observations from this field survey revealed that much of the woodland in the EDE study area showed evidence of historical logging and weed invasion. The majority of the study area lacked an understorey and the soil was generally quite poor and rocky, with invasive weeds, including blackberries (*Rosaceae* family), present throughout much of the alignment. An understorey of *Acacia* species is particularly valuable for Squirrel Gliders as a source of energy-rich nectar and sap, and these were absent from much of the study area. Apart from the box-gum woodland areas where a higher number of Sugar Gliders and Brushtail Possums were detected on camera, large, hollow-bearing trees essential to support populations of arboreal mammals were scattered, limited or absent. Immature and middle-aged stands of eucalypts dominated the EDE study area, and as a result, hollow-bearing trees were relatively lower in abundance. Hence, the roof cavity at 35 Lonergan Drive provided Sugar Gliders with a substitute hollow, in an environment where these were of low availability.

The roof cavity at 35 Lonergan Drive was constantly dark, warm, insulated and large enough to support a single social group. Consequently, two Sugar Gliders were trapped within the vicinity of this "hollow". One sub-juvenile Sugar Glider was also observed within the roof cavity and backyard of the property, which may have suggested a size discrepancy in the gliders observed (i.e. large and small species) in and around the roof cavity, when in fact they were Sugar Gliders of different ages. Males were also viewed on camera within the roof cavity, identifiable by a head gland, adding weight to the size discrepancy issues. At the beginning of the survey the gliders were readily observed moving throughout the roof space when humans were present. However, activity decreased as the survey progressed, most likely due to the frequent disturbance caused by checking the cage- and camera-trap. The addition of another camera set by the residents of 35 Lonergan Drive during our survey would also have increased disturbance caused to the glider group. Therefore the chance of detecting and gliders, including Squirrel Gliders, was likely to have declined. It is also unlikely that both Squirrel Gliders and Sugar Gliders would occupy the same hollow (i.e. roof cavity) at the same time or even over alternating nights. Sugar Gliders and Squirrel Gliders rarely occupy the same site (Menkhorst, Weavers & Alexander, 1988), but when they do co-occur, they exploit different microhabitats and nest sites (Quin, Smith & Green, 2001). Both species can share resources in winter if these are limited, but there is little interaction or overlap between the species during warmer months. Sugar Gliders are also found on less fertile, higher altitude soils up until 1200 m, where as Squirrel Gliders are typically found below an altitude of 250 to 300 m, on more fertile soils and alluvial floodplains, typically with higher rainfall averages. The EDE alignment ranges between 602 m and 665 m above sea level (elevation profile of alignment footprint - red outline in site images, e.g. Figure 8), and much of the area consists of relatively poor and rocky soils.

The two nights of spotlighting confirmed that the EDE alignment area supports relatively low numbers of arboreal species. Brushtail and Ringtail Possums were observed using all methods at 35 Lonergan Drive, but only detected via cage- and camera-trapped across the EDE. We did not observe any gliders at 35 Lonergan Drive while spotlighting, but we did observe one at the Middle site where some large, hollow-bearing trees and *Acacia* were present. Sugar Gliders were also observed on most of the remote-sensor cameras and in all of the sites or “clusters” of cameras, highlighting that cage- and camera-trapping are more likely to detect the presence of arboreal mammals than spotlighting. At the time of spotlighting there was no under- or overstorey flowering observed, weather conditions were appropriate and the personnel were very experienced in spotlighting and the identification of gliders and possums via spotlighting. The surveys also targeted areas where the incidental Squirrel Glider sightings had occurred. Again by utilising all three survey techniques, the likelihood of detecting a Squirrel Glider if present in the area was high.

- **Photographs provided by 35 Lonergan Drive Greenleigh**

Based on the results of the field survey we re-evaluated all of the images that the residents of 35 Lonergan Drive had provided to Rodney van der Ree, Kylie Soanes and Briony Mitchell. The combination of the site visits and observation of habitat, combined with the capture, handling and observation of a number of Sugar Gliders, allowed a more informed assessment of the photographs. We determined that the majority of photographs could not be verified to species level. Out of 31 individuals within the 26 images (Appendix 1), 22 individuals did not display enough of the important morphometric characteristics of a glider that allowed for confident determination of species. For example, in Figures A9 and A11 only a tail was visible. In Figure A15, we observed an ‘Ambiguous Glider’ as it had a Squirrel Glider-like face, but the body size of Sugar Glider. The majority of the tail was also not visible. The same occurred in Figure A16, where the only feature available to identify the glider was its head. Species level confirmation can rarely be made from one feature only as there is always uncertainty in using physical traits to ascertain age, especially from photographs (see van der Ree, Harper, & Crane 2006 about using morphological features to age gliders). We were able to confirm some individuals as Sugar Gliders because they had white tips at the ends of their tails, but with these indviduals we still took size and head shape into account. In photographs that lacked the defining feature of a white tail tip, we could not confidently determine species. We would need to ascertain age (from tooth wear and reproductive status) before a decision could be made with certainty. However, the size of these animals generally indicated Sugar Gliders.

Establishing age and gender enables the ability to distinguish between individuals whose weight and/or body size measurements fall into the upper or lower edge range of a species morphological measurements. Although seven of the 31 individuals were classified as 'ambiguous' (Figures A1-A4, A10, A14 & A15), the majority of the photos in which these individuals were in did not display enough of the distinctive features necessary to accurately identify the individuals to species level. The size of the individual in Figure A1 provided a strong case for it to be classified as a Squirrel Glider. Its body length (max 194 mm, measured from the size of the bricks) put the individual at the upper end of the Sugar Glider size scale, but tail length (max 234 mm) suggested that it would be a Squirrel Glider. Although the tail did appear long, the fur on the tail was not very fluffy. Its facial features appeared to be a mixture of Sugar and Squirrel Glider. Therefore, we classified this individual as ambiguous. The face of the glider in Figure A4 was Squirrel-like and the tail appeared wide at the base. However, the rest of the tail was not fluffy to the extent of a usual Squirrel Glider. The angle of the branch could also be making the tail fur appear wider at the base than it really is. For example, Figure 22 shows a Sugar Glider just after being released from a cage-trap with what appears to be a very fluffy tail. Further, the two images of a single Squirrel Glider from NSW show how head shapes can differ depending on the angle from which a photograph was taken (Figure 23). The image on the left of Figure 23 shows a Sugar Glider-type face, but the photo on the right, taken seconds after the first image, shows a Squirrel Glider-type head shape. The size of the animal was also in between both the average measurements of a Squirrel and a Sugar Glider. Species identity could only be determined once approximate age was known, which was determined from tooth wear and reproductive status. The separation of the tips of the upper incisors and limited tooth wear, in conjunction with a very shallow, white and clean pouch, indicated that this individual was very young, and thus could only be a Squirrel Glider (as juvenile Sugar Gliders would be much smaller in size). In addition, the sub-juvenile Sugar Glider present in the roof cavity of 35 Lonergan Drive could also be giving a false comparison of the size of the adult Sugar Gliders within the roof cavity. The sub-juvenile, whilst not yet independent, is capable of moving on its own within the "hollow" of the roof cavity. Due to its small size and the white tip on the end of its tail, it could easily give the impression that the other Sugar Gliders in the photographs are much larger and therefore could be misidentified as Squirrel Gliders. Ultimately, the ability to accurately and consistently determine a glider species depends on considering all of the aforementioned set of characteristics in combination with age and reproductive status, when possible.

Figure 22: A cage-trapped Sugar Glider in a tree just after release. Note that the tail looks quite fluffy, compared to a usual Sugar Glider tail. Photo: Lee Harrison.

Figure 23: An example of how the angle of an image can impact the appearance of head shape in gliders. This is the same Sugar Glider appearing in consecutive photographs (left & right). It has a Sugar Glider-type head shape on the left and a Squirrel Glider-type head shape on the right. Photo: Lee Harrison.

- **Abundance and distribution of other arboreal mammals in the study area**

The EDE study area and revised subject area currently supports a resident population of Sugar Gliders, Common Brushtail Possums and Common Ringtail Possums. A single Sugar Glider was captured at Middle site, amongst higher quality habitat that included several hollow-bearing trees, whilst two other Sugar Gliders were caught in habitat adjacent to the EDE alignment at 35 Lonergan Drive. Sugar Gliders were detected on remote-sensor cameras at every site, indicating that the entire EDE area is likely used by Sugar Gliders. The mean home-range of Sugar Gliders is 6.2 ha (+/- 0.6 SE), so the area in which they were captured could be used either on a nightly-basis as part of their home range or for longer-distance dispersal movements (Sharpe & Goldingay, 2007). Therefore, the two Sugar Gliders captured outside of the EDE footprint could have home ranges that overlap the actual alignment. The extent of this overlap could be confirmed by radiotracking, which could also be used to determine the rate and location of crossings over the Queanbeyan River.

The low rate of capture and re-capture of Sugar Gliders (i.e. no individuals were re-captured) indicated that the density of the population within the study area was likely low. However, as Sugar Gliders were captured on remote-sensor cameras across all of the EDE study area, we consider the population to be widespread and probably larger than indicated by capture rates via cage-trapping and spotlighting alone; this justifies the extended use of cameras to survey the EDE. The high number of Brushtail Possums caught within the 4.6 km long alignment indicated a relatively widespread and abundant population. While we did not process and individually mark Brushtail Possums, unique features, such as size or natural ear nicks and tears, indicated that we re-captured several individuals.

Summary

Based on the weight of evidence we conclude the following:

1) We cannot confirm the existence of a Squirrel Glider population within the EDE alignment or adjacent surveyed habitat, including at 35 Lonergan Drive.
2) We believe the likelihood of Squirrel Gliders occurring within the EDE area is low, because of (i) our relatively high survey effort using three different survey techniques; (ii) the sub-optimal and low quality habitat for the species, and altitude of the site, and (iii) the lack of historical Squirrel Glider records within the area.
3) We could not conclude that any of the photographs provided by the residents of 35 Lonergan Drive were of Squirrel Gliders. The majority of individuals were either Sugar Gliders or classified as 'Glider *spp*.,' as the photographs did not provide an adequate view of the animal or key morphological characteristics of the species, to enable accurate species identification. While some images showed gliders with both Squirrel Glider and Sugar Glider features, there was insufficient evidence to be confident in concluding species identity.
4) The Sugar Glider population within the alignment is of low density but widespread, and appears to be in typical condition (healthy body weights, even ratios of males and females, lactating females and back-young).
5) Remote-sensor cameras demonstrate that Common Brushtail Possums and Common Ringtail Possums are widespread across the EDE alignment and study area.

Potential impacts of the proposed EDE development on resident arboreal mammal populations and management recommendations

The proposed road and bridge structure will impact upon the resident arboreal mammal population, unless mitigation measures are included in the design and construction of the road. The primary impacts on the arboreal mammals present in the area include: i) loss of habitat due to clearing; ii) loss of large and/or hollow-bearing trees; iii) barriers to movement; iv) increased mortality due collision with vehicles; v) mortality during clearing, (vi) road noise and lighting and (vii) entanglement with barbed wire fencing. Each of these major impacts and potential mitigation measures are described in more detail below (and detailed further in van der Ree, Smith & Grilo, 2015).

- **Loss of habitat due to clearing**

Woodland will be cleared to build the EDE and this will result in a loss of habitat and a concomitant reduction in the abundance of resident arboreal mammals. The likely small size of the resident arboreal mammal populations around the alignment increases its susceptibility to even relatively small impacts of the construction and operation of the road. Smaller populations are less resilient to stochastic events, such as disease, wildfire or drought, which further reduce the size of the population. Habitat loss due to construction may have a disproportionate effect on an already small population, as even small additional population declines could pass the 'tipping point' beyond which populations cannot recover and local extinctions occur. If the local arboreal mammal populations were known to be much larger or occurred at higher densities, it may be better able to cope with the loss of a few individuals through mortality or loss of habitat.

Loss of habitat can only be avoided by constructing the road in already-cleared habitat, which is not entirely possible for the EDE. However, clearing woodland for temporary construction activities (e.g. site offices, car parking, access roads, stock piles) should be avoided (Soanes & van der Ree, 2015), and minor modifications to the alignment to avoid high-quality areas or elements (e.g. tall trees required for connectivity – see below) should be considered. Unavoidable habitat loss should be compensated for by replanting or securing woodland habitat in the nearby area by using strategic revegetation as a form of mitigation. From a gliders perspective, this revegetation should benefit the species by restoring connectivity or improving habitat quality within the alignment or more broadly in the region. For example, creating an isolated patch of woodland in the middle of cleared farmland would be of less value to glider conservation than creating a corridor to connect two isolated populations or improving the carrying capacity of an area of degraded woodland. Specifically, consider undertaking strategic revegetation along the Queanbeyan River or "fill in the gaps" along the edge of the alignment, and creating additional linkages. It is important to connect the East site and 35 Lonergan Drive habitat patches to the box-gum woodland at the end of Woodman Place, which should then be connected to the Middle site, where the larger, hollow-bearing trees occur (between traps 12-15). A crossing over the Queanbeyan River should be made to link the East site with the South site. The linkage between Middle site and Cuumbuen Nature Reserve should be maintained. Additional corridors and linkages around Queanbeyan should also be considered as part of the strategy to mitigate habitat loss.

- **Loss of large and/or hollow-bearing trees**

Sugar Gliders, and indeed many other species of arboreal mammal, birds and reptiles rely on hollows in trees for nesting and denning (Gibbons & Lindenmayer, 2002). Hollows in eucalypts typically take 100 to 150 years to form, and in areas where they occur at low densities, they can be a limiting resource. Gliders typically occupy multiple hollows over time, and some individuals may swap hollows every three to five days (van der Ree, unpub. data). There is already a lack of hollow-bearing trees along the EDE study area, thus any hollow-bearing trees should be retained, especially at the Middle and East site. If not already done, the location of large and hollow-bearing trees within the proposed EDE footprint and adjacent habitat should be surveyed so the development can be aligned to avoid them and minimise the number that need to be cleared.

The loss of hollow-bearing trees will impact arboreal mammal populations through the loss of potential den locations. Fortunately, gliders and other arboreal mammals will readily use artificial hollows (i.e. nest boxes) if appropriately designed and installed. However, it should be realised that nest boxes are a short-term solution to a potentially long-term problem. Nest boxes have a typical lifespan of 10 years or less if poorly built and not maintained. Therefore, nest boxes are a temporary (i.e. ~10 years) solution to a problem that can last 50 years or more, assuming some of the existing stands of trees are 50 years old. Nest boxes with a range of sizes and entrance-hole diameters should be installed to cater for a wide range of species, with at least one glider-specific nest box for every hollow bearing tree removed. Importantly, these nest boxes should be installed on trees and in areas that do not have any (or many) naturally-occurring hollows and occur prior to tree clearing. Due to the potentially short lifespan of the boxes, they should be maintained (e.g. occupation by wildlife monitored, box condition and attachment to tree inspected and repaired where necessary, etc.) until natural tree hollows begin to form in the area. If any nest boxes become degraded they should be replaces immediately. The new nest boxes should be installed in the same area, but on different trees to last an additional 10 years. In addition, consider initiating hollow formation in trees by creating incisions that accelerate the formation of hollows. The implementation of accelerated hollow-formation procedures by qualified, experienced arborists is relatively new in Australia, and some possible experimentation in the field would be required to inform and guide this mitigation. We recommend that this be conducted in an experimental manner in collaboration with scientists to study the effectiveness of this approach. If successful, it could reduce the long-term need for nest boxes to replace the loss of existing natural hollows on other projects.

- **Barriers to movement**

Gaps in canopy cover that exceed the gliding capacity of gliders will be a barrier to the movement of individuals. The type of movement animals undertake include home-range movements (such as on a night-to-night basis to obtain food), dispersal of young from their natal territories and occasional long-distance movements to access new areas. Movement is also important to facilitate the re-colonisation of patches that have undergone local extinction, as well as to allow new individuals to supplement declining or small populations, thereby preventing local extinctions from occurring.

Numerous radiotracking studies have shown that wide (e.g. dual-carriageway) roads are a barrier or filter to the movement of gliders (Soanes *et al.*, 2013; van der Ree, 2006; van der Ree *et al.*, 2010).The overall gap size created by the EDE's two-lane, two-way carriageway and 2.5 m wide footpath will create a large barrier, which gliders may not be able to cross. The ability of gliders to cross such gaps is also dependent on tree height – if tall trees are removed during construction or are absent from the specific location, then the road will be a barrier to movement until trees grow to sufficient height. Furthermore, the risk of collision with vehicles is greater as glide length increases because the height of the landing point gets lower to the ground, placing them in the path of oncoming vehicles. The barrier effect will also be exacerbated where noise walls are installed, which effectively increases the height of a road. In these situations, the remaining trees must be high enough to allow gliders to glide across the road, as well as the noise walls.

Options to mitigate the barrier effect of linear infrastructure on arboreal mammals have been extensively studied and can restore at least some connectivity for the species. The most effective techniques are those where the natural tree canopy remains connected above the road or glide distances are short (<10-20 m), thereby allowing animals natural movement pathways above the road (Soanes & van der Ree, 2015). Where natural canopy connectivity cannot be maintained or restored, gliding poles and canopy rope bridges may be used. Gliding poles and rope bridges are readily used by gliders to cross roads (Soanes, Vesk & van der Ree, 2015). However, only gliders can use gliding poles, while a range of species can use the rope bridges, making the latter mitigation technique a more cost-effective option for a wider suite of species. Furthermore, glider poles may increase the risk of glider collision with vehicles if poles are too short or spaced too widely, as gliders may need to undertake long glides between poles. Long-term monitoring of Squirrel Glider populations along the Hume Highway Duplication Project in southern NSW has demonstrated that even though gliders use poles and rope bridges frequently, the population has still declined significantly since the highway was duplicated (Soanes and van der Ree, unpub. data). While the specific cause of the decline is unknown, one potential explanation is that gliders, potentially young inexperienced individuals, are not successfully using the gliding poles on every occasion, thereby increasing the rate of mortality due to vehicle collision (Soanes, 2014). Other explanations for the population decline include increased emigration or reduced habitat quality since road construction. However, in the context of planning for the EDE, and in the absence of reliable data on the cause of the decline along the Hume Highway, we should assume some increased mortality due to the use of gliding poles. Therefore, we recommend that rope bridges be the preferred form of connectivity mitigation, second to maintaining natural canopy connectivity. This is also the preferred option for the EDE due to the presence of both Brushtail and Ringtail Possums along the alignment. Where natural canopy connectivity and rope bridges are not feasible and gliding poles are required, they should be placed closer together, be taller, and also wider at the base than those used along the Hume Freeway Duplication and Bypasses.

Rope bridges and gliding poles should always be located in close proximity to large and/or hollow bearing trees in an effort to facilitate movement because these types of trees are preferred habitats for arboreal mammals. Radiotracking and surveys of the use of rope bridges combined with microchip scanners suggest that gliders will attempt to cross the road throughout their home range (Soanes, Vesk & van der Ree, 2015; Soanes, 2014). In other words, gliders will not travel one or two km down the road to access a crossing structure. In order to maintain connectivity, crossings should be installed at regular and frequent intervals, such as at every 500 m, along the length of the project. In addition, the structures should be functionally connected to the existing trees to increase rates of use. For example, the first and last pole of rope bridges should be as close as possible to tall and/or hollow-bearing trees and have at least two or three “feeder” ropes at each end of the bridge that connect it to the trees. Each gliding pole and rope bridge installation must take into account the height of any existing trees, the height of the road and noise walls and the width of the gap to be crossed. Gliding poles should be installed to connect with specific tall trees and, while minimum clearances for gliders are not known, a rope bridge should be a couple of metres below the bridge deck and at least 4 to 6 m above the ground. An effective approach adopted on some sections of the Hume Highway Duplications and Bypasses was to conduct site inspections after the alignment was pegged out, but prior to clearing in order to identify strategically important trees that would form part of the connectivity mitigation.

Any area identified as a potentially strategic location for crossing by gliders should be considered as a crossing zone rather than a single crossing point. The crossing zone should be at least 100-200 m in length, with animals able to cross the road at multiple points throughout this zone. If the success of a crossing location is reliant on a single tall tree to achieve a glide across the road, and that tree falls over, then that crossing point is non-functional until a new tree reaches sufficient height. Also, recent evidence from Victoria suggests that single-point crossing structures (rope bridges or poles) can be monopolised by a few individuals who include the structure as part of their territory, thereby potentially limiting access by the rest of the population. Therefore, where possible, the crossing zone should include at least two (and preferably three) crossing options. Where crossing zones consist of two or three options, then the spacing of each crossing zone can be extended beyond the 500 m we recommended in the previous paragraph. In reality, the spacing will depend on the combination and spacing of suitable and optimal locations and the number of crossing structures per zone, and should be determined in the field. This inbuilt resilience will ensure a more robust and reliable crossing option that will remain functional in the long-term. Every rope bridge or gliding pole design should also be approved by an expert in the ecology of the target species to ensure maximum effectiveness. A connectivity management strategy that identifies the key locations across the EDE alignment and Queanbeyan should be developed.

- **Increased mortality of arboreal mammals due collision with vehicles**

Gliders will likely attempt to glide across the road at any location where they perceive that the distance is within their gliding range, especially if there are tall trees within close proximity to the road. If the trees are not at the required height for a glide to clear the road, gliders are likely to be hit my motor vehicles. In some instances, gliders hit by trucks have been taken 500 km from their known home range (Soanes, Carmody Lobo & van der Ree, 2015). Other arboreal mammals, such as Brushtail Possums, will also likely see increased mortality rates due to their attempts to walk across the road at night. Due to the low abundance of Sugar Gliders and other arboreal mammals within the EDE study area, any increased mortality as a result of collision with vehicles could potentially have a substantial impact on the viability of the local population. As there are no fence-designs appropriate to prevent gliders or possums from accessing the roadway, the only viable solution is to provide frequent and regular crossing options like rope bridges and gliding poles, thereby reducing the likelihood of crossing attempts at inappropriate or dangerous locations. The project is unlikely to have a significant impact on the resident arboreal mammal if sufficient crossing structures are installed, and if the majority of crossing options are rope bridges or natural canopy connectivity as mentioned above.

- **Mortality of arboreal mammals during clearing**

Wildlife, including gliders, may be injured or killed during the clearing of vegetation. We recommend the adoption of a two-stage clearing process (as detailed in the ‘RMS Biodiversity Guidelines’), whereby non-hollow-bearing trees are knocked over on day 1, and hollow-bearing trees on day 2, allowing for animals to leave the site on the first night. Alternative denning opportunities (i.e. nest boxes) should be installed in close proximity to the alignment but outside the clearing zone a few months prior to clearing commencing, allowing animals time to locate and use the alternative hollows. Trained and licensed ecologists with experience in fauna handling should be onsite during clearing to check hollows of felled trees and rescue any wildlife.

- **Road noise and lighting**

As discussed earlier, the cause of the decline in the abundance of Squirrel Glider populations along the Hume Freeway in southern NSW is unknown. We have postulated that this may be due to increased mortality, but it may also be because the habitat adjacent to the Hume Freeway is now less suitable for the species to reside in, due to increased noise and light levels created by the road development (Blackwell, DeVault & Seamans, 2015; Parris, 2015). The current plan for the proposed EDE includes the addition and up-grading of street lighting, which may adversely impact gliders and other wildlife in the vicinity. Lighting fixtures and light walls should be incorporated, now and into the future, into the EDE development plan, to avoid light spill into adjacent habitats.

- **Entanglement of gliders with barbed-wire fencing**

Gliders can get entangled with barbed wire fences when gliding, often resulting in death (van der Ree, 1999). This is particularly an issue with new fences (i.e. when barbs are sharp and fence is taught), as gliders are more likely to "bounce-off" a rusty and/or slack barbed wire fence. Most entangled gliders are found in areas that appear to be preferred glide paths, and when the gap between trees is largest (i.e. they land lower down in the tree after a long glide). We recommend that barbed wire is not used along the EDE footprint or study area, and MUST NOT be used within designated crossing zones. The effort and cost involved in providing crossing structures can easily be "undone" if even a small number of gliders get entangled and die.

- **Additional surveys and monitoring**

Comprehensive monitoring of the Squirrel Glider populations along the recently duplicated sections of the Hume Freeway in southern NSW has demonstrated a decline in the population since the construction and operation of the road. Importantly, the decline has not been observed at control sites, strongly suggesting that the impact is due to some aspect of the road duplication or design of mitigation. The cause of the decline is unknown, and we recommend that monitoring of the Sugar Glider population and other potential glider populations around the EDE be undertaken to assess the effectiveness of mitigation. The two aims of monitoring are to determine if the completed road and bridge had an impact on (1) population size and (2) the level of connectivity and glider movement across the alignment. The impacts of the road and effectiveness of the mitigation on the size (and hence viability) of the population can be determined by establishing a reliable baseline estimate before construction and repeating this approximately five years after construction. Depending on the results at 5-years post construction, additional surveys should be considered for 10-years post-construction if the population shows evidence of a decline.

Estimating a reliable population estimate requires more than one trapping episode – we recommend at least three surveys be undertaken prior to construction commencing and another three at 5 years post-construction. Therefore, a further two pre-construction surveys are required, and these should be timed to occur in Autumn and Spring 2016, if the construction schedule allows. In any case, the timing, effort and methods of the before and after surveys should be similar to ensure they truly represent the status of the population. The most cost-effective approach to understand gene flow is to undertake intensive sampling prior to construction to collect sufficient genetic samples to characterise the population, which is then repeated at five and 10 years after opening to traffic. We recommend that DNA samples be collected simultaneously with the population surveys. The samples should be analysed at the conclusion of the "before" surveys and at the conclusion of the "after" surveys, to prevent degradation of the DNA. This monitoring protocol will allow a comparison of the size of the population before and after construction, but is not sufficient to detect a decline during the intervening 5 years and implement recovery. Surveys should also be conducted at a number of control sites in the region to allow a comparison with trends along the project alignment.

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Appendix

Appendix 1: These photographs were provided to ARCUE by the residents of 35 Lonergan Drive Greenleigh, and included images taken within the roof cavity of the house. Here we discuss the various discriminatory features of each glider within each image, which we then used to form our decision on species identity. During this consideration we also took into account information gathered from ARCUE's site visits and observation of habitat, as well as the capture, handling and observation of a number of Sugar Gliders during the survey period, which allowed a more informed assessment of the photographs.

When we were unable to confidently identify an individual glider to species level, we classified it as either an 'Ambiguous Glider' or 'Glider spp'. An 'Ambiguous Glider' was one where the animal in the photo displayed features that were indicative of both a Squirrel Glider and a Sugar Glider. We could not be confident in determining the species of these animals, as we would need to view the animal in-hand to ascertain age and gender. As Squirrel Gliders and Sugar Gliders are relatively similar in appearance, it is important to determine the approximate age of the animal in the hand, in order to accurately and consistently determine species identity. This is particulalrly relevant if an individual's weight and/or body size measurements fall into the upper or lower range of either species morphological measurements, or if there is no white tail tip (noting that only Sugar Gliders have been observed with white tips on their tails). Age is determined by inspecting the level of wear of the upper incisors and if female, by noting reproductive status. Individuals were classified as 'Glider *spp*.' if the photo showed an insufficient amount of discriminatory features necessary to make a confident determination of species.

Figure A1: A photograph of an 'Ambiguous Glider' located on the house at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

This glider has a typically Sugar Glider face shape and tail. However, it does appear larger than the other gliders in the images provided. We used the brick measurements provided by the Kontis' to estimate the maximum size the glider could be. From the nose to the base of the tail the animal appears to be approximately 19.4 cm. However, due to the angle of the image it was hard to ascertain exact body length. The tail is approximately 23.4 cm long. Body size and tail length places it at the low end of the Squirrel Glider morphological scale, and at the higher end of Sugar Glider scale. Taking into account both its Sugar Glider features and inconclusive body size, and as we do not know gender or age, we cannot confirm the species of glider in this image.

Figure A2: An image of an 'Ambiguous Glider.' located on the window ledge of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

The glider in Figure A2 appears to have a typical Sugar Glider head shape, but we cannot see it to its full extent due to the angle of the photo. The base of the tail is quite wide, to the extent that we cannot distinguish between the base of the rump or the beginning of the tail, suggestive of a Squirrel Glider. Although, the glider appears to be quite hunched- up, which possibly forces the tail fur out to appear fluffier than usual. However, the end of the tail is not completely visible in the image, preventing an accurate measurement of its length or ability to see if it has a white tip. The glider is approximately 12 cm long from the head to the base of the tail, making it too small to be an adult Squirrel Glider. Size could indicate that it is a juvenile Squirrel Glider, but we would need to ascertain age to confirm this. Consequently, despite the fact that the majority of features are not completely visible, we have classified it as an 'Ambiguous Glider,' as it has both Squirrel and Sugar Glider attributes.

Figure A3: A ‘Glider *spp.*’ (left) and an ‘Ambiguous Glider’ (right) found on the window ledge of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

We analysed the glider looking at the camera only, as the glider facing away provided too few attributes to begin to distinguish between species. Therefore, it was automatically allocated to the ‘Glider *spp*.’ category. The glider looking at the camera does have a pointy, Squirrel-type face, including distinctive facial markings and somewhat pointy ears. The tail is also quite fluffy underneath, but we can distinguish between the end of the rump and the beginning of the tail. Due to the angle of the glider and only half of the tail being visible and we cannot estimate tail size, although it does appears to be smaller than a typical Squirrel Glider, covering approximately one brick. Also, the scent gland on this animal’s head appears active, suggesting an adult male, which means that it shouldn’t be “smaller than a typical Squirrel Glider” if it is an adult male. Therefore, there are too many variables present to confirm species identity, but from the ones we can see this individual has both Squirrel Glider and Sugar Glider features.

Figure A4: An 'Ambiguous Glider' located around 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

The face and tail of the glider in this photograph appears similar to a Squirrel Glider, although the facial markings are not very distinctive like a Squirrel Gliders. The tail is wide at the base, but again the rest of the tail is not fluffy to the extent of a typical Squirrel Gliders. The branch in which the glider is on also angles away from the camera, which could possibly push the tail fur out at the base making the tail look wider than it really is. There is no definitive scale to this photo (apart from approximate leaf sizes), so we cannot be confident of the size of this animal. Therefore, we classified the glider as ambiguous.

Figure A5: An individual classified as 'Glider *spp.*' in a photograph provided by 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

This image is similar to Figure A4, the only difference being that the head is facing away from the camera and while the tail is fluffy at the base, it shows greater notching than in Figure A4, which is more akin to a Sugar Glider. Again, we cannot comment on the size of the animal as there is no definitive scale. Based on this evidence we cannot verify species, and classify it as 'Glider *spp*.'

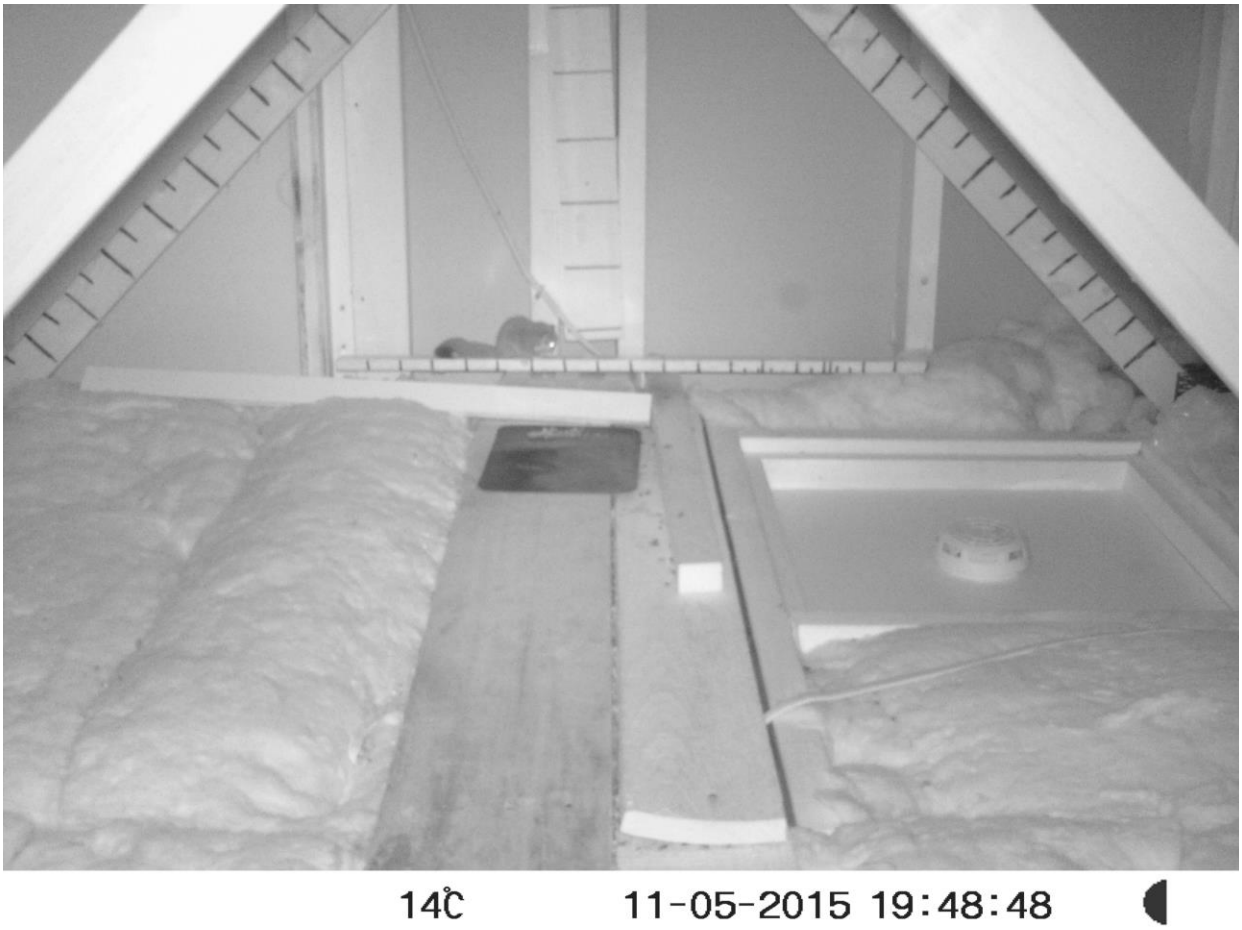

Figure A6: A Sugar Glider located within the roof cavity of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

Even though the glider is hunched in this photo, its size, head shape and tail length indicate that it is a Sugar Glider. Although we do not know the measurements of the pole that it is sitting on, the lines on the wooden beams above indicate the glider is less than 20 cm from its head to the end of its tail (the distance between each line is 5 cm). It also has a white tip at the end of its tail, which is a definitive sign that it is a Sugar Glider.

Figure A7.1: A Sugar Glider located within the roof cavity of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

Figures A7.1 and & A7.2 were taken three seconds apart on the same date, so we can assume that the glider in both images is the same individual. Although we do not know the measurements of the pole that it is sitting on, the lines on the wooden beams above indicate the glider is less than 20 cm from its head to the end of its tail (the distance between each line is 5 cm). Its size, head shape and tail length, as well as the white tip on the end of its tail, show that it is a Sugar Glider.

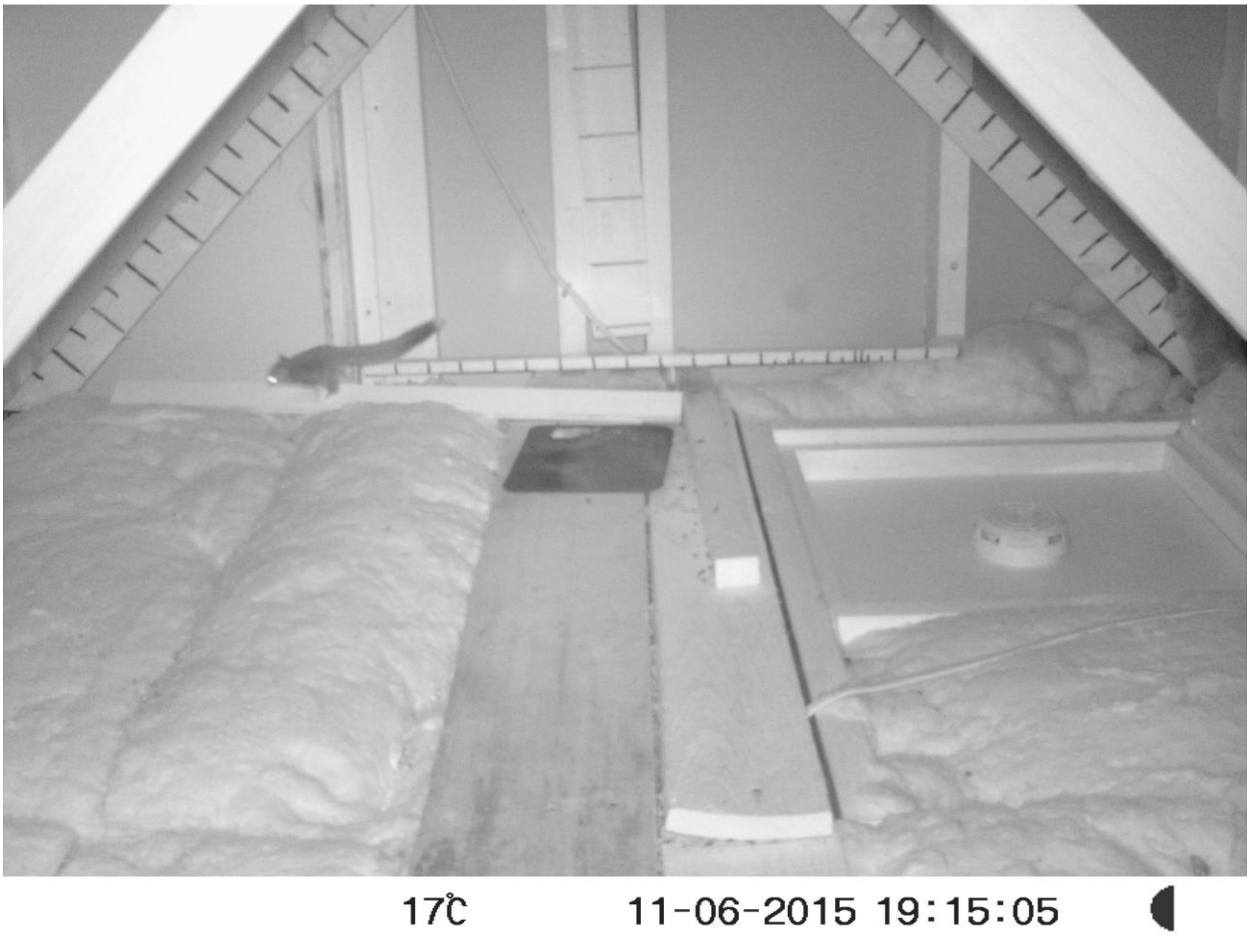

Figure A7.2: A Sugar Glider located within the roof cavity of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

Refer to Figure A7.1 for comments on species classification

Figure A8.1: A Sugar Glider and three ‘Glider *spp.*’ located within the roof cavity of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

Figures A8.1, A8.2 and A8.3 were each been taken two seconds apart on the same date. Therefore we can assume this is a series of images and that each glider is the same individual. The glider on the right at the forefront of the image is a Sugar Glider due to the shape of its head, body size and tail length. It also has a white tip at the end of its tail. The individual towards the left of the image has a sugar-like head, but as it is facing away from the camera it is difficult to comment on any other features. Its tail is very fluffy at the base, which had we seen in isolation we would comment that it is typical of a Squirrel Glider. However, because this glider and the two individuals at the top of the image with only tails visible are in the same photo as an individual that we can confirm to be a Sugar Glider, it is highly likely that these other three individuals are all Sugar Gliders. While not impossible, it would be very unlikely for Sugar and Squirrel Gliders to be sharing the same “hollow” at the same time. This observation also suggests that the tail base of Sugar Gliders at this location may be wider than typical Sugar Glider tails, adding greater weight to the unreliability of using tail-base width as a discriminating feature at this location.

Figure A8.2: A Sugar Glider and three ‘Glider *spp.*’ located within the roof cavity of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

Refer to Figure A8.1 for comments on species classification.

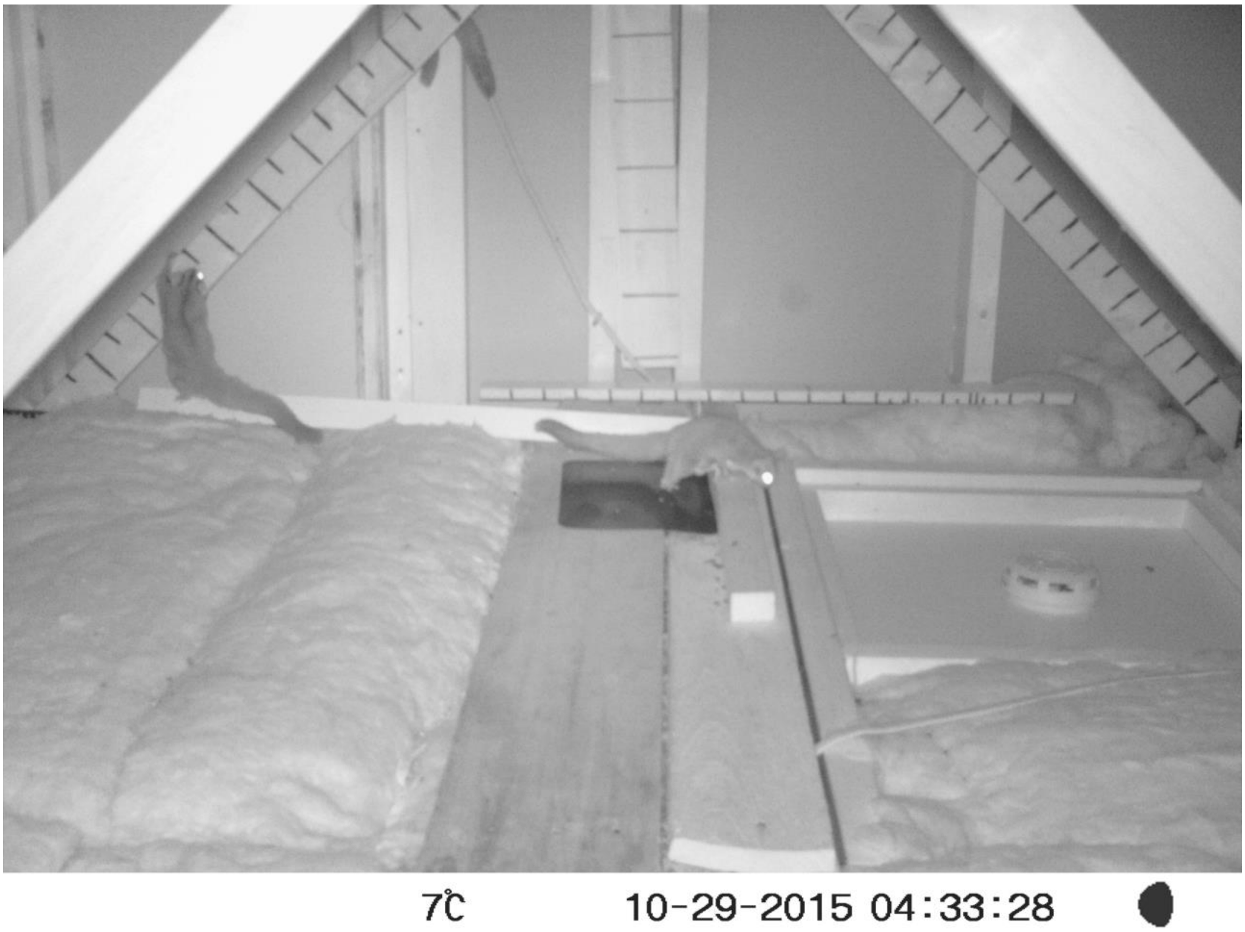

Figure A8.3: A Sugar Glider and three ‘Glider *spp.*’ located within the roof cavity of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

Refer to Figure A8.1 for comments on species classification.

Figure A9: The tail of a 'Glider *spp.*' on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

There is a distinction between the base of that tail and the rump, indicating a Sugar Glider. However, we cannot accurately verify a species from only a tail.

Figure A10: An 'Ambiguous Glider' on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

The glider in this image has a typically Sugar Glider-type face, but it appears to be quite large. Using the brick as a measure, the head and body is approximately 24 cm long at a maximum, meaning it is the size of a Squirrel Glider. However, the photo is looking down onto the individual and it is also on the corner of the bricks, which could be elongating its body size. The beginning of the tail base is obvious and the tail is also not very fluffy. We are unable to comment on tail length, as it is bending outwards and we cannot see where it ends. Consequently, we categorised this individual as ambiguous.

Figure A11: The tail of a 'Glider *spp*.' found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

We cannot accurately verify a species with only a tail visible.

Figure A12: The tail of a 'Glider *spp*.' found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

The tail of the glider appears wide at the base, but as the front of the glider is on a downward angle the tail could appear wider and larger than it actually is. Head shape is Sugar Glider-like, but again the angle in which the head is on does not give us confidence in this decision. No definitive size scale is available either. Therefore, we can only classify this individual as a glider species.

Figure A13: A 'Glider *spp*.' found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

The image is blurry and the head is not visible. The glider is also blocking any view of how many bricks it encompasses; consequently we cannot measure its length. The base of the tail is distinguishable from the rump, but this photograph dies not provide enough evidence to conclude species identity.

Figure A14: An 'Ambiguous Glider' on the outside wall of 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

The tail is wide at the base, appearing as though the fur begins at the back legs, indicating a Squirrel Glider. However, only half of the tail is visible in the image, so we do not know how long it is. The body seems very small, with a maximum estimate of 14 cm's in length, which suggests a Sugar Glider. The angle of the photo and the angle in which the head is on could also be impacting the appearance of the glider. Therefore, as the individual appears to have both Squirrel and Sugar Glider attributes we have classified it as ambiguous.

Figure A15: A 'Glider *spp*.' found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

This glider has a Squirrel-like face, with a pointy nose, although its head and body length would be approximately 10 cm long, making it too small to be a Squirrel Glider. However, the angle of the individual does not allow for an accurate gauge of length. The fur under the chin appears grey in colour, which is indicative of Sugar Gliders. We also cannot see the majority of the tail, resulting in an overall lack of features available to discriminate between glider species. Therefore, we have classified it as a glider species only.

Figure A16: A ‘Glider *spp*.’ found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

We cannot gauge body size or tail length from this image. The gliders face is quite triangular, suggesting Squirrel Glider, but we cannot confirm species identity from this feature only.

Figure A17: Two 'Glider *spp*.' found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

The species of the glider to the left of the image cannot be determined as there aren't enough features visible for accurate species identification. The individual to the right is quite small, approximately 10 cm long from head to the end of its rump. However, the angle of the glider and the fact that the tip of its nose is hidden means that we cannot accurately ascertain size. We also cannot see all of the tail.

Figure A18: A 'Glider *spp*.' found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

Other than the tail appearing wide at the base, with the fur seemingly beginning from the back legs, the rest of the tail appears Sugar Glider-like. The stance of the glider would also be contributing to the tail looking wider at the base. The stance also inhibits us from gauging body and tail size. We also cannot see the head, resulting in too few features available for species determination.

Figure A19: A ‘Glider *spp*.’ found on a window ledge at 35 Lonergan Drive Greenleigh. Photo: Peter and Claire Kontis.

We cannot determine the species of glider in this image, as we cannot see all of the individuals’ body. Some of the head and some of the tail are missing from view. It appears small, at approximately 11 cm long from head and rump, which would indicate a Sugar Glider. The shape of the part of the head that is visible also suggests a Sugar Glider. However, as there are not enough features visible for species identification it was classified as a glider only.

Figure A20: Two individuals classified as 'Glider *spp*.' located on a window ledge at 35 Lonergan Drive, Greenleigh. Photo: Peter and Claire Kontis.

We cannot determine the species for either of the individuals in this image. Apart from the tail of the individual furthest from the camera appearing quite Sugar Glider-like and the tail on the individual closest to the camera appearing fluffy and Squirrel Glider-like, there are no other features available for discrimination. It is also highly unlikely that a Squirrel Glider and a Sugar Glider would be in such close proximity to each other, as mentioned in the body of this report. Consequently, species cannot be determined.

Figure A21: Two individuals classified as 'Glider *spp*.' located on a window ledge at 35 Lonergan Drive, Greenleigh. Photo: Peter and Claire Kontis.

Again, we cannot determine species for either of the gliders in this image. The tail of the individual closest to the camera appears Squirrel-like at the base, but the fluffiness diminishes towards the end of the tail. The tail may also have a white tip, but it is possible that this is a reflection from the window. No other features on either individual are available for us to make an informed decision on species identity.

Figure A22: A 'Glider *spp*.' tail located on a window ledge at 35 Lonergan Drive, Greenleigh. Photo: Peter and Claire Kontis.

We cannot determine the species of a glider from tail alone.

Figure A23: A 'Glider *spp*.' tail located on a window ledge at 35 Lonergan Drive, Greenleigh. Photo: Peter and Claire Kontis.

Again, we cannot determine the species of a glider from tail alone.