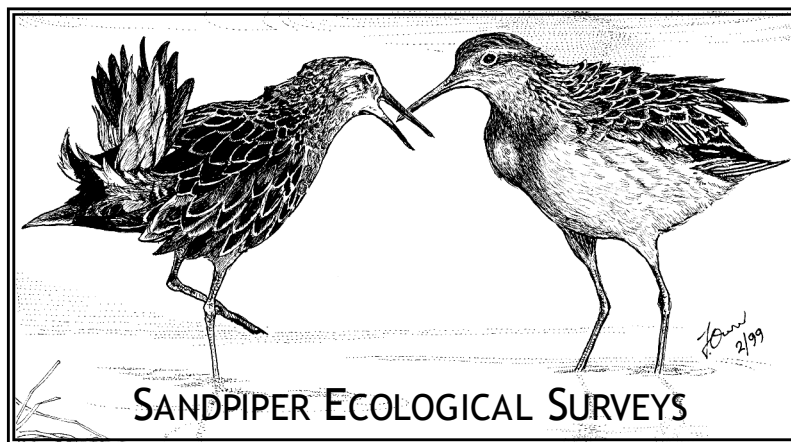


BONVILLE PACIFIC HIGHWAY UPGRADE
~ UNDERPASS, VEGETATED MEDIAN AND ROPE
BRIDGE MONITORING - 2009 ~

30 MARCH 2010



**BONVILLE PACIFIC HIGHWAY UPGRADE
UNDERPASS, VEGETATED MEDIAN AND ROPE BRIDGE
MONITORING**

30 MARCH 2010

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1. INTRODUCTION

Sandpiper Ecological Surveys was contracted by Bilfinger Berger Services Australia (BBSA) to monitor use of selected fauna crossings on the Bonville Pacific Highway Upgrade. The monitoring was intended to target vertebrate fauna other than Koalas (*Phascolarctos cinereus*). Types of fauna crossings monitored and the target groups were:

1. Large bridge fauna underpasses at Reedy Creek, Middle Creek (Infra 8) and Bonville Creek – all vertebrate fauna.
2. Vegetated medians between the northbound and southbound carriageways and southbound carriageway and local service road – gliders.
3. Rope Bridge situated on the landbridge – gliders.

2. METHODS

2.1 SURVEY TIMING

The timing of surveys varied between the different sample methods (Table 1). Sand pad monitoring was undertaken in three one-month sample periods, July/August, October and Nov/Dec. Initial sand pad monitoring in Mar/April 2009 was washed out and further sampling was postponed until after the wet season. Spotlighting was conducted during two sample periods that broadly coincided with dispersal (Mar-May) and breeding (Sept-Nov) of small petaurid gliders. Hair funnel sampling coincided with spotlighting plus some additional sampling at underpasses in Nov/Dec (Table 1). Cameras were installed in mid-July and remained active at the time of writing this report.

Table 1: Timing and duration of monitoring events.

Method	1 st Sample (sample days/ samples)		2 nd Sample (sample days/ samples)		3 rd Sample (sample days/ samples)	
	Start	Finish	Start	Finish	Start	Finish
Sand Pads	17/07/09	18/08/09 (32/4)	30/09/09	30/10/09 (30/4)	11/11/09	11/12/09 (29/4)
Spotlighting	12/03/09	28/05/09 (8/8)	18/9/09	18/11/09 (8/8)	na	na
Hair Funnels	20/03/09	30/04/09 (41/2)	30/09/09	18/11/09 (49/2)	30/10/09*	2/12/09* (32/2)
Cameras	17/07/09	11/11/09 (117/1)	11/11/09**	10/3/10*** (83/1)		

* installed at underpasses

** 2nd (western) camera reinstalled on 18/11/09

*** cameras still active at time of completing this report

2.2 VEGETATED MEDIANS

Vegetated medians were sampled using a combination of spotlighting and hair funnels. The objective of sampling was to detect the presence of gliders within the median. The sampling method was based on the assumption that the two vegetated medians between the northbound and southbound carriageways were too small for gliders to occupy permanently. **Each median has a total area of approximately 0.5ha**, which is substantially smaller than published estimates of home range for sugar and squirrel gliders in northern NSW. Spotlighting and hair tubing was conducted in four medians (Table 2). It was initially intended to sample reference sites in the

adjoining habitat, however, this plan was abandoned in preference for greater survey effort in the medians. Each of four medians was spotlighted on eight occasions during two time periods, March to May and September to November. Spotighting was conducted by two experienced observers using hand-held 50-watt spotlights. Transects were either 500m long or the entire length of the median, whichever was shorter. Each transect was traversed on-foot at a speed of 1km/hr and either followed an existing track through the median, or was situated along the edge of the median. A dusk census was undertaken by two observers on two occasions (10 & 18/11/09). On both occasions the census was undertaken near a suspected glider den tree situated on Transect 4.

All arboreal mammals sighted were identified to species level, their behaviour noted and location plotted using a GPS. Once detected, gliders were observed for brief periods to ascertain their movement patterns. A basic habitat assessment was conducted within each median to describe habitat and determine if denning habitat exists within the median.

Ten hair funnels were set within each median. Hair funnels were set between 6 and 8m high and were baited with peanut butter, honey and oats. Hair funnels were spaced at intervals of 30-40m and were positioned near the centre of retained vegetation. Hair funnel sampling coinciding with spotlight surveys. Funnels were left in place for up to six weeks with the wafers and bait replaced after 2-3 weeks. Hair samples were sent to B. Triggs for identification.

Table 2: The location and size of transects sampled within the Bonville Pacific Highway Upgrade.

Transect No.	Length	Median Type	Notes
One	500m (Ch 93400-93900)	Between service road and southbound carriageway.	Large vegetated median; moist hardwood forest.
Two	500m (Ch 94150-94650)	Between service road and Southbound carriageway.	Large vegetated median; moist hardwood forest.
Three	500m (Ch 94400-94900)	Between carriageways, including underpass on service road.	Narrow median; remnant Coastal Blackbutt forest
Four	450m (Ch 94950-95400)	Between carriageways.	Narrow median; remnant Coastal Blackbutt forest

2.2 UNDERPASSES

Three 'large bridge' underpasses were monitored. The underpasses were Reedy Creek (infra 6), 'Middle' Creek (infra 8) and Bonville Creek (infra 11). Each underpass was divided into a north and south side by a watercourse. Sand pads were installed on either side of the watercourse at all sites except Bonville Creek where sand pads were installed on the north side only. The width from the abutment to the edge of the watercourse varied substantially between sites and sides of a watercourse within a site. The width of the underpasses (i.e. up to 40m) negated the ability to install multiple sand pads on each side. Initially sand pads were installed on each side of the watercourse at each site (Table 3). These pads were washed away in successive floods in March/April 2009. When reinstalled in July 2009 multiple smaller (3-10m) pads, separated by short distances, were used in areas where the distance between the abutment and creek exceeded 20m.

A 3:1 mix of washed river sand and 'brickies' loam was used in the sand pads. The intention was to create a mix that would retain moisture and not develop a hard crust as it dried out. Sand pads were installed by filling 20L sand bags with sand, dropping the bags over the sides of bridges and then depositing the sand on the pad site. Pads were smoothed using the back of a square-nosed shovel at the commencement of monitoring and completion of each sample. Pads were moistened with water using a 4L garden sprayer if they were too dry to capture good quality prints. Pads were sampled on four occasions during each monitoring event (Table 1). The time

period between each sample during a monitoring event ranged from 5 to 10 days. The procedure adopted for all monitoring events included; search sand pads for tracks, identify tracks to species level, if possible, and determine the total number of crossings by each species and the direction of movement and re-smooth sand pads for next sample. Tracks were identified using Triggs (2004).

Table 3: Design of sand pads at three underpasses within the Bonville Pacific Highway Upgrade.

Underpass	Initial Sand Pad Design	Final Sand Pad Design
Bonville Creek	1 pad for entire width of north side	2 * 10m long pads on north side; one extending from abutment and one closer to creek edge
Middle Creek	2 pads for entire width on both sides	1 pad on either side of creek
Reedy Creek	2 pads for entire width on south side and 1 pad for entire width on north side.	1 pad on south side and two 10m long pads on north side; one extending from abutment and one closer to creek edge.

Four hair funnels baited with peanut butter honey and oats were installed at each underpass during the Nov/Dec sample. Hair funnels were re-baited and the wafers changed after two weeks. Hair funnels were set on the ground at all sites except Reedy Creek where they were initially installed on the fauna furniture. Hair samples were sent to Barbara Triggs for identification.

2.3 LANDBRIDGE

Two Digilant Xtern-Cams were installed on the overpass rope bridge. The Xtern-Cams have an inbuilt motion sensor and infra-red spotlight and are powered by an internal high capacity battery. Images are saved onto a 2GB memory card. Cameras were mounted on the top of the rope bridge, two panels from each end. Cameras were aligned parallel to the angle of the rope bridge. Cameras were installed away from the ends of the rope bridge to minimise the incidence of false triggers from leaves and branches and gliders that were using only the ends of the bridge.

To further reduce the incidence of false triggers the Xtern-Cams were configured to arm and disarm at 1830 and 0630 hours respectively. Camera sensitivity was set on 1 (out of 4) during the first sample period and reduced to 0 (most sensitive) for the second sample period.

Pictures were downloaded and batteries replaced on two occasions, 11 November 2009 and 10 March 2010. Cameras were installed and checked by a qualified tree climber. The procedure involved removing the camera from the bridge, replacing the data card and battery and reinstalling the camera. Cameras remained active at the time of this report. Pictures were downloaded onto a laptop computer.

Animals were identified using standard field guides (Menkhorst & Knight 2004; Strahan 1995). All night pictures (pictures taken between 6.30pm and 7.00am) were enlarged and viewed in order to search for evidence of fauna. The following information was collected for active pictures: date, time, species, whether the animal was the same as the previous picture, direction of movement (east to west), location on the rope bridge. Types of movement include: moved east, moved west, moved away but returned and unsure. Assessing movement involved a degree of subjectivity, however, most animal visits resulted in multiple pictures which enabled movement direction to be determined. The time of each picture also assisted in assigning a movement type. Full crossings were assessed by studying the species present, time and date of crossing between the two cameras.

2.4 LIMITATIONS

The timing and duration of surveys was influenced by several factors, including:

1. Height of trees in the vegetated medians and presence of vehicles affected the success of spotlighting. The height of trees affects the ability to detect small gliders foraging in the canopy. Vehicles must be constantly considered whilst spotlighting which in some instances limits the area that can be effectively spotlighted.
2. Underpasses can be accessed on-foot only, which greatly increased the time and effort required to install sand pads. Underpasses were substantially wider than was indicated during initial discussions which reduced the ability to install multiple sand pads. The underpasses are frequently inundated and during storm events experience strong flows. Sand pads were washed away or/covered with silt during the initial monitoring event in autumn 2009 and again (partially) in October 2009.
3. Approval to use cameras was only obtained after the completion of the sample.

3. RESULTS

3.1 WEATHER CONDITIONS

Specific weather data was recorded only during the spotlight surveys (Table A1; Appendix A). Weather conditions were generally ideal for spotlighting. Wind was either absent or light and no rain occurred during the surveys. Cloud cover was typically >50% during the autumn surveys but absent during spring. Overall, above average rainfall was recorded during the first half of 2009 with below average rainfall in the second half of the year. High rainfall caused flooding of the underpasses on several occasions washing away sand pads.

3.2 UNDERPASSES

Twenty-seven species/groups of vertebrate were recorded at three underpasses (Table 4). A similar number of species/groups were recorded at Bonville (20) and Reedy Creek (21), whilst substantially fewer species/groups were recorded at Middle Creek (14). Several species were identified with a medium to high level of confidence ('probable' species in Table 4). Several of these species were sighted in or near the underpasses. Species with the highest level of certainty included Swamp Wallaby (Plate 1), Koala (Plate 2), Common Brushtail Possum (Plate 3), *Crinia signifera*, Lace Monitor (Plate 4), Water Dragon and Pacific Black Duck. There was a high level of certainty for other groups, however, it is impossible to distinguish between the tracks of species within a group. Examples include: bandicoots, rodents and large waterbirds. It is also impossible to distinguish between the tracks of Common and Mountain Brushtail Possums and it is likely that some 'brushtail' tracks belong to Mountain Brushtail Possums.

A further 10 species were identified to a 'possible' level of confidence (Table 4). The record of Eastern Grey Kangaroo is uncertain and the tracks may have belonged to a large Swamp Wallaby. Smaller and finer macropod tracks were also recorded. These were similar to Red-necked Wallaby (*Macropus rufogriseus*) but could have also been a juvenile Swamp Wallaby and were classified as the later species due to its abundance in the study area. Ten species were recorded at all three sites. Nine species/groups were recorded at one site only. These included: Eastern Grey Kangaroo, Common Dunnart, Koala, Human, Striped Marsh Frog, *Crinia signifera*, Striated Heron, White-necked Heron and Galah. The only threatened species recorded was a Koala which moved west through the Middle Creek (infra 8) underpass. Several tracks could not be assigned to a species or group and were classified as Unidentified spp. (Table A2, Appendix A).

Comparison of Frequency of Occurrence, Direction of Movement and Number of Passes between species/groups and sites shows that (Swamp) Wallaby was the most common species (Table 5).

Wallabies were recorded in all samples at all sites and the number of passes was typically 3-4 times that of the next most common species. Species/groups present in more than 50% of samples included Red Fox (all sites), Large Waterbird (Reedy Creek), Dog (Bonville Creek), Water Dragon (Reedy Creek) and Bandicoot (Bonville Creek). Koala, Brushtail Possum, Cat, Human, Striped Marsh Frog, Snake, Small Lizard, Galah, Magpie Lark and Torresian Crow were recorded in less than 10% of observations at one or more sites (Table 5). The only obvious differences in movement direction were large waterbirds at Reedy Creek and wrens at Bonville Creek. Both species/groups moved predominantly in a westerly direction.

Table 4: Species and groups recorded at each underpass sampled on the Bonville Pacific Highway Upgrade.

Confirmed Species/Group	Probable Species	Possible Species	Bonville	Middle	Reedy
Wallaby	Swamp Wallaby		x	x	x
Macropod		Eastern Grey Kangaroo			x
Small Marsupial		Common Dunnart	x		
Bandicoot			x	x	x
Koala				x	
Brushtail Possum	Common Brushtail		x	x	x
Rodent	Bush Rat or Black Rat		x	x	x
House Mouse			x		x
Red Fox			x	x	x
Dog			x	x	x
Cat			x	x	x
Human			x		
Frog sp 1	Myobatrachid	Striped Marsh Frog	x		
Frog sp 2	Crinia signifera				x
Goanna	Lace Monitor		x	x	x
Agamid spp.	Water Dragon			x	x
Large Lizard	Skink spp.		x	x	
Small Lizard			x	x	x
Snake			x		x
Duck	Pacific Black Duck			x	x
Heron (small)		Striated Heron	x		
Heron (large)		White-necked Heron			x
Heron (large)		White-faced Heron	x		x
Parrot		Galah			x
Passerine sp 1		Magpie-lark	x		x
Passerine sp 2		Fairywren	x	x	x
Corvid spp.		Torresian Crow	x		x
			20	14	21

Table 5: Frequency of Occurrence, Number of Passes and Direction of Movement for each species/group recorded at three underpasses on the Bonville Pacific Highway Upgrade.

Possible Species/Group	Bonville				Middle				Reedy			
	% of samples (n=13)	Total Passes	Direction of Movement		% of samples (n=13)	Total Passes	Direction of Movement		% of samples (n=13)	Total Passes	Direction of Movement	
			East	West			East	West			East	West
Wallaby	100	183	21	23	100	91	21	19	100	142	26	28
Common Dunnart	23	7	1	3								
Bandicoot	54	18	5	4	31	9	3	4	23	3	2	1
Koala					8	1		1				
Common Brushtail	38	7	3	2	38	7	3	3	8	1	1	
Bush Rat or Black Rat	46	13	4	2	23	3			15	3		1
House Mouse	23	4		3					15	9	2	2
Red Fox	85	41	11	9	69	24	9	11	62	23	8	9
Dog	62	20	7	5	38	18	6	8	38	25	7	7
Cat	23	4	3		15	2	2		8	1		
Human	8	1										
Striped Marsh Frog	46	11	4	4					8	3	1	1
Crinia signifera												
Lace Monitor	23	4	1	2								
Water Dragon	23	3	1	2	31	13	3	6	54	11	7	4
Skink spp.					8	1						
Small Lizard	8	3			8	1		1				
Snake	31	6	3	2					8	1		1
Pacific Black Duck					23	3	1	1	31	28	1	3
Striated Heron	15	1	1									
Large Waterbird	38	7	1	2	15	3	1	2	62	38	1	10
Galah	8	2	1									
Magpie-lark	15	3	1	1					8	2	1	
Fairywren	46	7		4					38	10	2	4
Torresian Crow	23	5	2	1					8	1	1	

Table 6: Occurrence of species/groups during twelve samples across all sites.

Species/Group	July	July	August	August	October	October	October	October	November	November	November	December
Wallaby												
Small Marsupial												
Bandicoot												
Koala												
Common Brushtail												
Rodent												
House Mouse												
Red Fox												
Dog												
Cat												
Human												
Marsh Frog												
Crinia signifera												
Lace Monitor												
Water Dragon												
Skink spp.	Recorded in initial March 2009 sample											
Small Lizard												
Snake												
Pacific Black Duck												
Striated Heron												
Large Waterbird												
Galah												
Magpie-lark												
Fairywren												
Torresian Crow												



Plate 1: Wallaby track (probable Swamp Wallaby) recorded at the Bonville Creek underpass.



Plate 2: Koala track recorded at the Middle Creek underpass on 25 November 2009.



Plate 3: Brushtail possum tracks recorded at the Middle Creek underpass.



Plate 4: Goanna track recorded at the Reedy Creek underpass.

Wallaby and fox were the only groups that were recorded during all 12 samples (Table 6). Many species occurred sporadically through the sample period, although some subtle trends are evident. Brushtail Possums and Cats were not recorded in the Nov/Dec sample, whilst rodents were more regularly recorded in Nov/Dec. Large Waterbirds were more common in the Oct-Dec samples (Table 6). Positive hair samples were obtained at Bonville Creek only. Confirmed records of House Mouse (*Mus musculus*) and 'probable' records of Bush Rat (*Rattus fuscipes*) were obtained at that site.

3.3 VEGETATED MEDIANS

3.3.1 Spotlighting

In autumn, three species were recorded, whilst in spring six species were recorded in the medians (Table 7). One Koala was recorded on three occasions at Transect 2 in both autumn and spring and one individual was recorded once on Transect 1 in spring. Individual Sugar Gliders were spotlighted on nine occasions, five in autumn and four in spring (Table 7). In autumn, sugar gliders were recorded twice on Transects 1 and 2 and once on Transect 4. In spring sugar gliders were recorded on four occasions on Transect 4. At least two individuals were recorded at Transect 4. Individuals were distinguishable as one had a white tip at the end of its tail. Feathertail Glider was recorded once at Transect 3 in spring and Common Ringtail Possum was recorded twice in spring at Transect 1. One Southern Boobook was recorded at Transect 1 in autumn. The highest species richness was recorded at Transect 1 (5 species), followed by Transects 2 and 4 (2 species each) and Transect 3 (1 species). No evidence of directional movement by Sugar Gliders was obtained during the survey. On all occasions gliders were observed foraging on either mistletoe or eucalypt blossom.

Table 7: Fauna recorded during spotlight surveys of four vegetated medians. A = autumn; S = spring.

Species	Transect, Season and No. Samples Present								Notes	
	1		2		3		4			
	A	S	A	S	A	S	A	S		
Long-nosed Bandicoot		1								
Koala		1	3	3						Red ear tag; possible ♀; recorded in same location; regular visitor to median no. 2.
Common Ringtail Possum			2							
Feathertail Glider							1			
Sugar Glider		2		2			1	4		No directional movement was recorded; gliders were observed foraging on all occasions.
Grey-headed Flying-fox								1		
Southern Boobook		1								

3.3.2 Hair Funnels

Five species/groups were identified from the hair funnel samples (Table 8). Brown Antechinus was the most widespread species with samples obtained from Transects 1, 2 and 3 in spring and Transect 3 in autumn. Cats were recorded at Transect 4 in autumn and spring. It is unclear how cats were accessing the medians. Sugar Gliders were not recorded in autumn but were widely distributed across Transect 4 in spring with records obtained from both the start (positions 1, 2, 3) and end (positioned 7, 8, 9 & 10) of the transect (Table 8).

Table 8: Hair funnel results obtained from four vegetated medians on the Bonville Pacific Highway Upgrade. A = autumn; S = spring; * = probable identification.

Species	Transect, Season and No. Samples Present								Positions	
	1		2		3		4			
	A	S	A	S	A	S	A	S		
Yellow-footed Antechinus					x*		x			
Brown Antechinus		x		x	x*		x			
Dasyurid spp.					x*					
Cat								x	x	
Sugar Glider								x*		<i>Petaurus</i> spp. was confirmed; Recorded at positions 1, 2, 3 and 7, 8, 9 & 10.

3.4 ROPE BRIDGE

Four species of vertebrate were photographed on the rope bridge (Table 9; Plates 5 & 6). Sugar Gliders (Plate 5) were photographed on two occasions at the west camera and Feathertail Gliders were photographed on four occasions at both cameras (Plate 6). Other species included an Australian Magpie (*Cracticus tibicen*) on 7 November 2009 and an unidentified tree frog on 17 November 2009. No confirmed crossings (i.e. pictures by both cameras on the same evening) were recorded. Most individuals were moving in a westerly direction away from the western camera, which is suggestive of directional movement.

Table 9: Species of vertebrate recorded using the Bonville Overpass Rope Bridge. d = definite; pr = probable.

Side	Date	Time	Species	Direction of Movement	No. Images	Image No's
West	19.11.09	2.19.50	Sugar Glider (d)	E	1	612
	19.11.09	2.21.32	Sugar Glider (d)	w	1	613
	14.12.09	00.00.54	Feathertail Glider (pr)	w	2	673-674
	23.12.09	00.49.10	Feathertail Glider (pr)	w	2	695-696
	11.1.10	21.23.26	Feathertail Glider (pr)	w	1	743
	12.1.10	2.12.12	Sugar Glider (d)	w	1	744
East	7.11.09	nr	Australian Magpie	n/a	3	nr
	17.11.09	00.54.21	Tree frog (<i>Litoria</i> spp)	w	15	1178-1192
	21.12.09	19.37.44	Unidentified spp.	unknown	207	4611-4816
	25.12.09	19.20.30	Feathertail Glider (pr)	e	2	4999-5000



Plate 5: Sugar Glider photographed from the western camera.



Plate 6: Probable Feathertail Glider photographed from the western camera.

4. DISCUSSION

4.1 UNDERPASSES

4.1.1 Fauna Use of Underpasses

The three underpasses sampled were used frequently by a diverse range of vertebrates. The variety of species/groups recorded is equivalent to results obtained in other underpass monitoring programs (e.g. AMBS 2002; Fitzgerald 2005). The number of underpasses monitored at Bonville is substantially less than Bulahdelah to Coolongalook (11 underpasses – AMBS 2002) and Yelgun to Chinderah (16 underpasses Fitzgerald 2005). There are several reasons to explain the high diversity at Bonville, including, geographic location, landscape position (riparian zones), habitat type, connectivity and proximity of vegetation to the underpass edge. The latter feature has been identified repeatedly as important in maximising underpass use (AMBS 2002; Donaldson & Bennett 2004). The high vertebrate diversity recorded at a small number of sites is most likely due to a combination of the above factors. Rapid growth of ground vegetation around the edges of the underpasses has contributed to use. Poor response of vegetation has been cited as a possible reason for low use of underpasses (Sandpiper Ecological Surveys 2008).

It is tempting to attribute high diversity to the design and type (large bridge) of underpasses monitored. According to Donaldson and Bennett (2004) 'openness' and the ability to see habitat on the other side of an underpass are important features. Large-bridge underpasses have these characteristics. Fitzgerald (2005) did not record any obvious difference in species occurrence or number of crossings between bridges and culverts. Clevenger *et al.* (2001) found that the response to openness varied between species and they recommended a variety of size classes to cater for a range of species. Fitzgerald (2005) also made the important point that the number of species recorded and frequency of use of underpasses is likely to be correlated with the abundance of those species in the surrounding habitat. The dominance of Swamp Wallaby is most likely because that species is abundant in adjoining habitat and is not deterred by crossing small gaps.

Whilst the high diversity recorded during this study is most likely due to landscape position, connectivity and habitat type it is worth noting that a greater variety of species were recorded at the larger underpasses (i.e. Reedy and Bonville Creeks). Furthermore, the cumulative number of crossings was substantially greater at Bonville Creek (350 passes) and Reedy Creek (301 passes) than Middle Creek (176 passes). Unlike Middle Creek the sand pads at Bonville and Reedy Creek did not cover the entire underpass and the number of passes is not absolute. Bonville Creek links large tracts of vegetation, although Middle Creek appears to have better connectivity than Reedy Creek. If connectivity alone was influencing use it is predicted that Middle Creek should have higher use than Reedy Creek.

The majority of fauna recorded in the underpasses are common and many often exploit degraded habitats and forest edges and may be less affected by noise and lights. One threatened species, Koala, was recorded during the survey. On 25 November 2009 Koala tracks were recorded at Middle Creek. The individual was moving in a westerly direction. The Middle Creek underpass was not established specifically for Koala's, however, its use emphasizes the value in providing a variety of appropriately spaced underpasses. Despite the predominance of common species the underpasses are providing a valuable function by enabling fauna to move beneath the highway. Four, possibly five (black rat), introduced species (excluding humans) were recorded in the underpasses. The presence of these species is not surprising as they are common in forested habitats in northern NSW and will readily utilise fragmented habitats.

It is unlikely that all of the species/groups recorded were using the underpasses to move from one area to another. The majority of birds were most likely recorded incidentally as individuals foraged along the creek banks or vegetation edge. In some instances waterbirds may have used the underpasses to move between foraging areas but such movement is likely to be rare.

Confirming that species/groups used the underpasses to move from one-side to the other is difficult as sand pads did not extend for the entire underpass width. Nonetheless, the frequency of crossings and presence of east and west movement by many species/groups suggests that full passes were likely.

Sand pads provide a simple and cost effective but imprecise means of monitoring fauna use of underpasses. They are cheap to establish and maintain and are simple to use but do not always provide conclusive evidence of use. Tracks of many species are indistinguishable (e.g. Common and Mountain Brushtail Possum) and distinguishing between other species is dependent on sand pad quality (e.g. Fox and Dog). There is often a degree of error associated with sand pads. If used in cautiously sand pads can provide a good indication of the types of fauna using an underpass. Furthermore, they are not subject to mechanical or software problems that can plague camera monitoring.

4.1.2 Future Sampling

Underpass sampling is providing interesting data on the types of species that use underpasses, frequency of use and possible use of different sized underpasses at Bonville. Apart from the Koala record the data are not adding greatly to our knowledge of underpass use by vertebrates. Most of the species identified during this study have been recorded using underpasses elsewhere. To ensure that monitoring is both cost effective and targeted at priority areas it is worthwhile considering if funds for underpass monitoring in the second year of the monitoring program can be channeled to other components such as glider use of the vegetated medians.

4.2 VEGETATED MEDIANS

4.2.1 Use of Vegetated Medians by Gliders

Monitoring confirmed the presence of Sugar Gliders in three of the four medians sampled. Gliders were recorded in both of the (larger) medians situated between the service road and highway and in one of the (smaller) medians situated between the carriageways (Transect 4). At least two individuals (distinguished by tail color) were recorded at Transect 4 in spring, although only one individual was recorded at a single time. At Transect 4 Sugar Gliders were generally spotlighted in the same area, although hair tube data show that they occur throughout the median.

The data do not prove that gliders use the median to move across the highway. However, it is unlikely that gliders reside permanently in the median as the area of habitat is insufficient to support an individual or family group. The Transect 4 median is approximately 0.5ha in size and although it contains a dense midstorey of *Acacia* spp. and a canopy of myrtaceous species, which are important food resources, it is substantially smaller than published estimates of home range. Quinn (1995) recorded home ranges of approximately 2.5ha for Sugar Gliders in northern NSW, whilst Henry and Suckling (1984) recorded home ranges of 0.5 to 0.7ha in Victoria. Sugar Gliders may use up to five hollows within a home range (Gibbons and Lindenmayer 2002). The vegetated median at Transect 4 is substantially smaller than the only home range estimate available for Sugar Gliders in northern NSW. If it is assumed that gliders cannot reside permanently within the median then their presence can be attributed to:

1. Individuals moving across the highway; or
2. Individuals whose home range includes the vegetated median.

Both of the above scenarios require gliders to cross one or both carriageways. If this assumption is correct the data show that gliders are capable of using the vegetated median to cross at least one carriageway. This result addresses many aspects of the monitoring, although it does not prove that gliders are using the medians to make full crossings of the dual carriageway. Furthermore, there is some chance that the gliders observed may have been isolated in Transect

4 by highway construction and are persisting in the median. Radio-tracking may be the only way to confirm that gliders are using the vegetated medians to cross the highway.

Transect 4 is known to include at least one potential Hollow Bearing Tree and gliders were often spotlighted in the vicinity of that tree. As most spotlight surveys commenced shortly after sunset it is likely that gliders would have been recorded near their dens. Van der Ree and Bennett (2003) monitored home range size and movement of Squirrel Gliders in linear road-side remnants in Victoria. They found that most radio-tracked individuals occupied linear home-ranges consistent with the shape of the available habitat. They also found that gliders occupying linear habitats had a greater range length (up to 1km) than those in continuous habitats.

4.2.2 Further Sampling

Spotlighting and hair tubes were proposed as a cost-effective means of gathering information on glider use of the vegetated medians. The limitations associated with using these methods were highlighted in the proposal. The primary limitation of spotlighting and hair tubes is that they do not provide information on animal movement. Whilst the assumption that gliders recorded in the median would be in transit rather than resident is reasonable given the small size of the medians. The possibility that gliders would use the median as part of their home range or could be isolated in the median was overlooked. It appears, based on previous monitoring, that further spotlighting may not add substantially to the existing information. It is therefore recommended that alternative methods be explored in the second year of monitoring, as recommended in the original project proposal.

The alternative method would involve radio-tracking a sample of gliders captured from either side of the alignment and/or within the vegetated medians. Radio-tracking would provide information on movement, home range size and shape (in relation to the highway), den locations and possibly use of the overpass. There are limitations associated with a radio-tracking study, particularly the difficulty capturing gliders in very tall Eucalypt forest. To undertake radio-tracking it would be necessary to either provide additional funding or redirect funding from another component of the monitoring program.

4.3 ROPE BRIDGE

The absence of mammal records on the rope bridge during the initial monitoring is not surprising given the brief period since installation and the length and exposed nature of the rope bridge. Although Squirrel Gliders were recorded on a rope bridge over the Karuah Bypass within 12 months of opening this may be atypical (Thiess 2005). The Karuah Rope bridge is shorter than the Bonville bridge and the ends are situated in mature vegetation. In contrast, the Bonville rope bridge is isolated on the east side by a service road and the bridge is quite wide. It is likely to take gliders some time to become familiar with the rope bridge. Ongoing monitoring throughout 2010 is required to provide further information on mammal use of the rope bridge.

5. RECOMMENDATIONS

5.1 UNDERPASSES

- Discontinue underpass monitoring in 2010 and re-allocate funds to monitoring glider use of vegetated medians.

5.2 VEGETATED MEDIANS

- Discontinue spotlight and hair tube sampling of the vegetated medians.
- Utilise the existing budget to undertake a radio-tracking study to determine if Sugar Gliders are using the vegetated medians to cross the highway. The program should include trapping of sugar gliders on either side of the carriageway and within Transect 4,

attachment of radio-collars, tracking of glider movement and stag watching of the potential den tree on Transect 4.

5.3 ROPE BRIDGE

- Continue monitoring the rope bridge with cameras and hair tubes throughout 2010.

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APPENDIX A

Table A1: Weather data recorded during spotlight surveys of vegetated medians within the Bonville Pacific Highway Upgrade.

Date	Cloud (%)	Cover	Temperature (OC)	Relative Humidity (%)	Dew Point (%)	Wind	Rainfall
12/03/2009	95		22.7	84.2	19.9	nil	nil
16/03/2009	70		21.6	88	19.6	nil	prior
19/03/2009	nr	nr	nr	nr	nr	nr	nr
25/03/2009	50		22.4	83.3	19.7	nil	nil
8/04/2009	95		21.8	80	18.3	nil	nil
24/04/2009	80		20	86.5	18	nil	nil
30/04/2009	80		12.5	82.2	12.2	RL	nil
28/05/2009	35		20.8	85.3	18.6	nil	nil
18/09/2009	85		21	73.6	16.1	RL	nil
24/09/2009	0		18	62.2	11	nil	nil
30/09/2009	0		18.1	72.2	15	nil	nil
8/10/2009	0		17.3	50	6.7	MSB	nil
15/10/2009	0		21.9	61.5	15.1	nil	nil
2/11/2009	0		24.2	68	18.2	nil	nil
10/11/2009	0		21.2	72.7	16.1	nil	nil
18/11/2009	100		22.8	79.5	19.1	nil	nil

Table A2: Results of sand pad monitoring at four underpasses on the Bonville Pacific Highway Upgrade.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes				
26/03/2009	D. Rohweder	Reedy (infra 6)	sth	Goanna	certain	1	W	moderate (hard crust forming)					
				wallaby	certain	1	W						
				kangaroo	possible	6	B	distinguished on front paw size					
				rodent	certain	1	W						
				unid spp.		1	W						
				fox	probable	1	W						
				nth	wallaby	certain	5	W		poor (hard crust)			
		dog	probable	1	E								
26/03/2009	D. Rohweder	Middle (infra 8)	sth	Agamid	probable	1	W	moderate					
				duck	certain	1	along						
				wallaby	certain	2	B						
				lizard	certain	1	along						
				rodent	certain	2	along						
			nth	unid spp.		1	W	good		marsupial bounding tracks			
			Goanna	certain	1	E							
			brushtail possum	certain	1	W							
			water dragon	probable	2	W							
			bandicoot	certain	4	B							
			wallaby	certain	2	W							
			rodent	certain	1	along							
			D. Rohweder	Bonville (infra11)	sth	fox	certain			8	B	good	
						waterbird	probable			1	E		
rodent	certain	3				B							
wallaby	certain	2				B							
house mouse	possible	2				W							
small marsupial	possible	5				B	bounding tracks						
passerine sp 1	probable	1				W							
brushtail possum	certain	2				B							
passerine sp 2	probable	1				W							
unid spp.		1	E										
lizard	certain	1	E										
Goanna	certain	1	E										
amphibian	probable	1	E										

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes		
23/07/2009	D. Rohweder	Reedy	sth	wallaby	certain	7	B	poor (hard crust)			
				canid	certain	1	E				
			central	swamp wallaby	probable	7	B	moderate			
				wallaby	certain	1	W				
				fox	probable	1	along				
				dog	probable	1	W				
			nth	wallaby	certain	1	W	good			
				dog	probable	3	B				
				Crinia signifera	certain					tadpoles	
30/07/2009	D. Rohweder	Reedy	sth	wallaby	certain	9	B	moderate			
				unid spp.		1	W				
				dog	certain	1	W				
				brushtail possum	certain	1	E				
			middle	unid - possible possum	possible	1	E	pictures & description			
				swamp wallaby	probable	4	B				
				fox	certain	1	W				
				bandicoot	certain	2	B				
				sth	bird spp.	certain	1			W	moderate
					bandicoot	certain	2			B	
wallaby	certain	13	B								
human	certain	1	along								
nth	dog	certain	2		along	good					
	fox	certain	2		along						
	wallaby	certain	2		W						
	bandicoot	certain	2	B							
30/07/2009	D. Rohweder	Reedy	sth	unid - possible possum	possible	1	E	good	pictures & description		
				dog	certain	1	E				
				wallaby	certain	5	B				
				duck	certain	2	W				
				small bird	probable	2	W				
				unid spp.		1	W				
				unid bird	possible	3	B				
				bandicoot	probable	1	E				
				middle	dog	certain	3			B	good
					fox	probable	1			E	
wallaby	certain	13	B								

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes
				red-necked wallaby	possible	2	B		
			nth	nil					
	D. Rohweder	Middle	sth	cat	certain	1	E	good	
				dog	certain	3	B		
				dog	probable	1	W		
				wallaby	certain	7	B		
			nth	brushtail possum	certain	1	E	moderate	
				cat	probable	1	E		
				canid	certain	3	B		
				wallaby	certain	6	B		
				unid spp.		1	E		3 dots
	D. Rohweder	Bonville	sth	dog	certain	1	E	good	
				brushtail possum	certain	1	along		
				small marsupial	possible	1	W		3 point pad
				small lizard	probable	1	W		
				house mouse	probable	1	W		
				small waterbird	certain	1	along		
				wallaby	certain	19	B		
			nth	bandicoot	certain	6	B	good	
				dog	certain	2	B		
				fox	probable	1	W		
				wallaby	certain	1	E		
10/08/2009	D. Rohweder	Reedy	sth	duck	certain	1	along	moderate	
				water dragon	probable	2	B		
				fox	probable	2	B		
				dog	probable	3	B		
				wallaby	certain	12	B		
				red-necked wallaby	probable	1	W		
				possum spp	probable	1	E		
				small bird (wren)	probable	1	W		
			middle	small bird (wren)	probable	5	B	moderate	
				wallaby	certain	22	B		
				Goanna	certain	2	B		
				fox	probable	4	B		
				dog	certain	7	B		
			nth	dog	probable	2	E		
				fox	probable	1	E		
				wallaby	certain	2	B		

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes
	D. Rohweder	Middle	sth	canid	certain	3	B	moderate	
				wallaby	certain	7	B		
			nth	dog	probable	2	B	poor (very soft)	
				duck	certain	1	E		
				canid	certain	2	B		
				bandicoot	possible	1	W		
				wallaby	certain	8	B		
	D. Rohweder	Bonville	sth	wallaby	certain	40	B	poor	
				canid	certain	1	along		
				dog	probable	3	B		
				unid spp.		1	W		
			nth	bandicoot	certain	2	B	good	
				fox	certain	3	along		
				dog	certain	8	B		
				wallaby	certain	4	B		
				brushtail possum	probable	1	E		
18/08/2009	D. Rohweder	Reedy	sth	wallaby	certain	9	B	good	
				fox	certain	2	W		
				dog	certain	2	W		
				waterbird	certain	1	E		
				duck	certain	2	W		
			middle	duck	certain	10	B	good	
				wallaby	certain	10	B		
				fox	probable	1	W		
				dog	probable	2	W		
				small lizard	probable	1	W		
				unid spp.		1	W		
			nth	swamp wallaby	probable	1	W	good	
				red-necked wallaby	possible	1	W		
	D. Rohweder	Middle	sth	wallaby	certain	5	B	good	
			nth	brushtail possum	probable	1	W	moderate	
				brushtail possum	possible	1	W		
				bandicoot	probable	2	B		
				canid	probable	1	E		
				wallaby	certain	3	B		
	D. Rohweder	Bonville	sth	dog	probable	1	W		
				wallaby	certain	23	B		
				bandicoot	probable	3	E		

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes			
6/10/2009	D. Rohweder & D. Owner	Reedy	nth	waterbird	certain	1	along	good				
				small passerine	certain	1	along					
				fox	probable	1	W					
				wallaby	certain	3	B					
				dog	probable	4	B					
				corvid	probable	1	E					
				house mouse	probable	1	W					
		sth	waterbird	certain	3	2E; 1W	good					
			fox	certain	2	1W; 1E						
			lace monitor	probable	1	W						
			water dragon	probable	2	1E; 1W						
			sw wallaby	probable	1	E						
			central	waterbird	certain	2			W	good		
fox	certain	1	N									
sw wallaby	probable	2	E									
nth	water dragon	probable	1	W	moderate							
	fox	certain	1	W								
	sw wallaby	probable	5	3W; 2E								
6/10/2009	D. Rohweder & D. Owner	Bonville	sth	waterbird	certain	1	W	poor				
				wren	possible	2	W					
				sw wallaby	probable	7	3E; 4W					
				rat	probable	1	S					
				nth	dog	certain	1			N	poor	
				small skink	possible	3	2N; 1S					
				cat	possible	1	E					
		nth	snake	certain	1	E	poor					
			sw wallaby	probable	5	3W; 2E						
			sw wallaby	probable	5	3W; 2E						
7/10/2009	D. Owner	Middle	sth	water dragon	probable	2	1E; 1W	poor				
				sw wallaby	probable	1	E					
				fox	certain	2	1E; 1W					
				nth	water dragon	probable	4			2E; 2W	moderate	
				sw wallaby	probable	2	1E; 1W					
				fox	certain	2	1E; 1W					

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes		
14/10/2009	D. Owner	Reedy	sth	water dragon	probable	1	E	good			
				sw wallaby	probable	10	9E; 1W				
				fox	certain	2	1E; 1W				
			central	fox	certain	2	1E; 1W	good			
				wren	possible	1	SE				
				sw wallaby	probable	3	2W; 1E				
			nth	sw wallaby	probable	8	1E; 7W	poor			
				fox	certain	1	E				
				water dragon	probable	1	W				
				sw wallaby	probable	9	4E; 5W				
14/10/2009	D. Owner	Bonville	sth	snake	certain	1	W	poor			
				fox	certain	1	W				
				cat	possible	1	E				
				bandicoot	possible	1	E				
			nth	sw wallaby	probable	5	4E; 1W	good			
				fox	certain	1	NE				
				snake	certain	1	E				
				waterbird	probable	1	S				
				water dragon	probable	1	NW		poor		
				fox	certain	1	E				
sw wallaby	probable	8	3W; 5E								
dog	certain	1	E								
nth	water dragon	probable	2	E	moderate						
	sw wallaby	certain	6	3E; 3W							
15/10/2009	D. Owner	Middle	sth	fox	certain	2	W	moderate			
				common brushtail possum	certain	2	E; W				
			nth	WF Heron	probable	2	E		moderate		
				corvid	possible	1	E				
				water dragon	probable	1	E				
				sw wallaby	probable	3	E				
				cat	possible	1	N				
				central	waterbird	certain	1			E	good
					sw wallaby	certain	3			1E; 2W	
				nth	fox	certain	1			N	poor
waterbird	certain	1	W								
fox	certain	1	E								
22/10/2009	D. Owner	Reedy	sth	sw wallaby	probable	3	1W; 2E				

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes	
22/10/2009	D. Owner	Bonville	sth	fox	certain	3	2W; 1E	moderate		
				sw wallaby	probable	5	2E; 3W			
				snake	certain	1	E			
				common brushtail possum	probable	2	W			
			nth	fox	certain	1	N			
				cat	possible	2	E			
				sw wallaby	certain	2	W			
23/10/2009	D. Owner	Middle	sth	sw wallaby	certain	2	1E; 1W	good		
				fox	certain	2	1E; 1W			
				lace monitor	probable	1	E			
			nth	sw wallaby	certain	5	3W; 2E			moderate
				fox	certain	2	1E; 1W			
				lace monitor	certain	2	1E; 1W			
30/10/2009	D. Owner	Reedy	sth					washed away		
			central	fox	certain	2	1E; 1W	poor		
			nth	sw wallaby	certain	2	1E; 1W	poor		
			D. Owner	Bonville	sth	sw wallaby	certain	4	2E; 2W	poor
	fox	certain				1	N			
	nth	lace monitor			probable	2	NW			
		sw wallaby			certain	1	W	moderate		
						fox	certain	4	2W; 2E	
						wren	possible	1	W	
	D. Owner	Middle	sth	waterbird	certain	2	1E; 1W	moderate		
sw wallaby				certain	2	1E; 1W				
nth				fox	certain	2	1E; 1W			
										washed away
20/11/2009	D. Owner	Reedy	central	waterbird	certain	1	SW	good		
				sw wallaby	certain	2	1SE; 1W			
				water dragon	probable	1	NE			
				mouse	possible	7	3W; 4E			
			nth	waterbird	certain	1	E			poor
				frog	probable	3	2E; 1W			

note: wallabies & foxes going around pad due to pooling

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes
20/11/2009	D. Owner	Bonville	sth	dog	certain	3	1E; 1S; 1W	good	
				fox	certain	5	2W; 1E; 1N; 1S		
				sw wallaby	certain	10	1N; 4E; 5W		
				bandicoot	certain	2	1N; 1S		
				rat	probable	2	E		
				galah	possible	2	E		
			nth	sw wallaby	certain	2	E	good	
				waterbird	certain	3	1S; 1W; 1E		
				fox	certain	4	2NE; 2SW 1ESE; 1NE		
				dog	certain	2	NW		
				bandicoot	certain	1	2W; 1E		
20/11/2009	D. Owner	Middle	sth	duck	probable	1	W	good	
				fox	certain	3	2E; 1W		
				sw wallaby	certain	2	1E; 1W		
				water dragon	probable	1	W		
				rat	probable	1	S		
25/11/2009	D. Owner	Reedy	sth	bandicoot	probable	1	W	poor	
				sw wallaby	certain	4	2E; 2W		
				waterbird	certain	1	W		
			central nth	magpie-lark	probable	2	E	good moderate	
				waterbird	probable	9	6E; 3W		
				sw wallaby	certain	1	W		
25/11/2009	D. Owner	Bonville	sth	corvid	possible	1	SE	good	
				bandicoot	certain	1	N		
				rat	probable	2	N		
				waterbird	certain	1	S		
			nth	sw wallaby	certain	7	2W; 5E	good	
				sw wallaby	certain	2	1E; 1W		
				frog	probable	3	2E; 1W		
				lace monitor	probable	1	W		
				fox	certain	3	1E; 2W		

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes
25/11/2009	D. Owner	Middle	sth	fox	certain	1	SW	good	
				sw wallaby	certain	2	E		
				small lizard	probable	1	W		
			nth	sw wallaby	certain	6	5E; 1W	good	
				koala	certain	1	W		
30/11/2009	D. Owner	Reedy	sth	bandicoot	probable	1	E	moderate	
				water dragon	probable	1	E		
				sw wallaby	certain	1	W		
			central	sw wallaby	certain	1	W	poor	
				snake	certain	1	W		
			nth	waterbird	probable	2	1N; 1S	good	
				waterbird	probable	6	3E; 3W 1E; 1W; 1N		
				small lizard	possible	3	1N		
				sw wallaby	certain	1	E		
			1/12/2009	D. Owner	Bonville	sth	corvid	probable	3
wren	possible	1					S		
sw wallaby	certain	7					5W; 2E		
dog	certain	1					E		
fox	certain	1					E		
nth	rat	probable				2	E	moderate	
	frog	probable				1	E		
	fox	certain				2	NE		
	frog	probable				2	W		
	sw wallaby	certain				4	3E; 1W		
30/11/2009	D. Owner	Middle	sth	dog	certain	3	1E; 2W	good	
				sw wallaby	probable	1	W		
			nth	lace monitor	probable	1	W	poor	
				fox	certain	1	E		
				dog	certain	3	1SE; 1E; 1W		
11/12/2009	D. Owner	Reedy	sth	rat	probable	2	1N; 1S 1N; 1W;	moderate	
				waterbird	certain	3	1E		
				wren	possible	1	W		
				sw wallaby	probable	1	E		

Table A2 cont.

Date	Observer	Site	Pad	Species	Accuracy	Number of Passes	Direction	Pad Condition	Notes		
11/12/2009	D. Owner	Bonville	central	duck	probable	2	N	poor			
				waterbird	probable	2	1E; 1W				
				mouse	possible	2	1E; 1W				
			nth	water dragon	probable	1	SW	good			
				waterbird	probable	3	1NE; 2W				
				duck	probable	2	E				
			sth	sw wallaby	certainty	3	2E; 1W	moderate			
				fox	certainty	2	1S; 1E 1SE; 1E; 1W				
				rat	probable	3	3E; 2W				
				sw wallaby	certainty	5	1SW; 1W				
				snake	certainty	2	N				
				wren	probable	1	W				
				common dunnart	possible	1	E				
				nth	water dragon	probable	1			W	good
					maggie-lark	probable	2			NE	
frog	probable	1	1NW; 1SE								
fox	certainty	2	E								
11/12/2009	D. Owner	Middle	sth	fox	certainty	4	2W; 2E	moderate			
				dog	certainty	2	1E; 1W				
			nth	lace monitor	probable	3	2E; 1W	moderate			
				fox	certainty	1	W				
				dog	certainty	3	1E; 2W				
				sw wallaby	certainty	1	E				

Key

Date = date that pads were sampled.
 Sites = Reedy Creek; Middle Creek; Bonville Creek
 Pad = Reedy Ck - Pad 1 sth side, Pad 2 nth side ck, Pad 3 nth side abutment; Middle Creek - Pad 1 sth side, Pad 2 nth side; Bonville Ck - Pad 1 sth pad, Pad 2 Nth (abutment) pad.
 Species = Species or types recorded
 Accuracy = certain (90-100%); probable (70-89%); possible (50-69%); doubtful (<50%)
 No. of Passes = number of times that a species crossed the pad
 Direction = direction the species was moving
 Pad condition = subjective scale of good, moderate or poor. A moist soft pad is generally good; dry sandy or hard crusty pads are generally poor or moderate.

Table A3: Results of spotlight surveys conducted at four sites within the Bonville Pacific Highway Upgrade study area in autumn 2009.

Date	Transect	Start	Finish	Results	Number	Notes
12/03/2009	1	2010	2040	Boobook Owl	1	
	2	2045	2115	nil		
	3	2145	2215	nil		
	4	2230	2300	nil		
16/03/2009	1	2005	2030	Sugar Glider	1	foraging on mistletoe
	2	2035	2100	Sugar Glider	1	
	3	nr	nr	nil		
	4	nr	nr	nil		
19/03/2009	1	1930	2000	nil		
	2	2005	2030	Sugar Glider	1	
	3	2100	2125	nil		
	4	2140	2205	nil		
25/03/2009	1	1930	2000	nil		
	2	2005	2035	nil		
	3	2100	2125	nil		
	4	2150	2220	nil		
8/04/2009	1	1915	1940	nil		
	2	1945	2010	Koala	1	red ear tag (possible female)
	3	2050	2120	nil		
	4	2135	2200	nil		
24/04/2009	1	1918	1945	nil		
	2	1950	2020	Koala	1	red ear tag (possible female)
	3	2050	2120	nil		
	4	2135	2200	nil		
30/04/2009	1	1915	1945	Sugar Glider	1	
	2	1950	2020	Koala	1	red ear tag (possible female)
	3	2050	2120	nil		
	4	2135	2205	Sugar Glider	1	
28/05/2009	1	1915	1940	nil		
	2	1945	2010	nil		
	3	2040	2105	nil		
	4	2120	2150	nil		

Table A4: Results of spotlight surveys conducted at four sites within the Bonville Pacific Highway Upgrade study area in spring 2009.

Date	Transect	Start	Finish	Results	Number	Notes
18/09/2009	1	1905	1930	Common Possum	1	Ringtail
	2	2000	2015	Koala	1	
	3	2050	2120	nil		
	4	2015	2040	Sugar Glider	1	white tip on tail; Foraging on tallowwood blossom
24/09/2009	1	1920	1945	Koala; Common Ringtail Possum; Bandicoot	1	Long-nosed female
	2	1955	2025	Koala	1	
	3	2120	2150	Feathertail Glider	1	
30/09/2009	4	2245	2110	Grey-headed Flying-fox	1	Foraging on tallowwood blossom
	1	2050	2120	nil		
	2	2125	2145	nil		
	3	nr	nr	nil		
8/10/2009	4	2200	2230	nil		
	1	2100	2125	nil		
	2	2130	2200	nil		
	3	2240	nr	nil		
15/10/2009	4	2205	2230	Sugar Glider	1	no white tip on tail
	1	2050	2115	nil		
	2	2120	2145	nil		
	3	2225	2250	nil		
2/11/2009	4	2150	2215	nil		
	1	2000	2025	nil		
	2	2030	2050	nil		
	3	2140	2205	nil		
10/11/2009	4	2050	2115	Sugar Glider	1	on blackbutt in canopy
	1	2040	2100	nil		
	2	2105	2130	Koala	1	female
	3	2145	2215	nil		
18/11/2009	4	2240	2310	nil		
	1	2050	2110	nil		
	2	nr	nr	nil		
	3	nr	nr	nil		
18/11/2009	4	2145	2210	Sugar Glider	1	foraging on blackbutt blossom