Woolgoolga to Ballina Pacific Highway Upgrade

Threatened Glider Monitoring for Sections 1 & 2: Year 1

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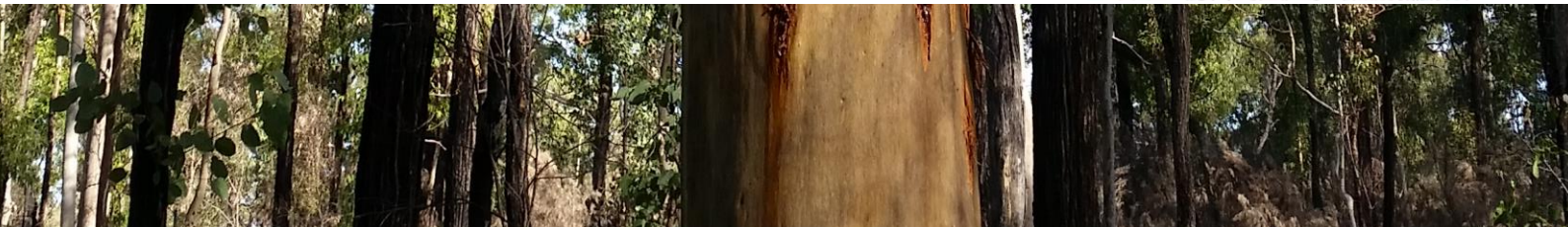
November 2018



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Photography - Lewis Ecological Surveys © else stated

Cover – Small-fruited Grey Gum (*Eucalyptus propinqua*) with numerous recent incisions from a Yellow-bellied Glider at Wells Crossing vegetated median just prior to construction commencing.

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Executive Summary

Year 1 monitoring for threatened gliders was performed in a manner consistent with the Threatened Glider Management Plan (RMS 2015). The 28 monitoring transects selected during baseline sampling surveys (SES 2014) were surveyed in 2016 during late autumn (May), mid winter (July), late spring (November) and mid/late summer (February) in 2017. Each transect was sampled by a single operator (BDL) using a 50-watt spotlight for a set duration of 25 minutes per transect over the 500 m determined by two pre-determined and provided waypoints. No call broadcast was used.

Arboreal mammals were recorded at all sites except one of the impact sites, the vegetated median at Wells Crossing (M2-i). Feather-tail Gliders (*Acrobates pygmaeus*) were the most commonly recorded arboreal mammal being detected at 19 sites, followed by Common Brushtail Possum (*Trichosurus vulpecula*) at 16 sites and Sugar Glider (*Petaurus breviceps*) at 15 sites. Threatened gliders were recorded at 15 (54%) of the 28 sites with Yellow-bellied Gliders (*Petaurus australis*) at seven sites, Squirrel Gliders (*Petaurus norfolcensis*) at seven sites and Greater Glider (*Petauroides volans*) at four sites. The threatened Brush-tailed Phascogale (*Phascogale tapoatafa*) was recorded at one site.

Year 1 sampling recorded more arboreal fauna at sites where the upgrades represents a duplication to the existing carriageway. This was the case for sites associated with the rope bridge and glide pole near Arrawarra Creek (C1-S1), poles in the median at Halfway Creek (C3) and to a lesser extent for sites associated with rope bridge and vegetated median at Wells Crossing (M2-S3). Conversely, far fewer arboreal detections were recorded at the vegetated median and rope bridge associated with Dirty Creek (M1-S2). This latter site being the only area where the Upgrade deviates and creates a new easement through contiguous forest. The overriding pattern of increased detections is discussed in line with higher densities of arboreal fauna seeking to re-establish territories following the mainline clearing.

Year 1 sampling recorded Yellow-bellied Glider (YbG) at 44% of the reference sites compared with 27% at the impact sites. No YbG occupation was recorded at the control sites. In the case of Squirrel Glider (SqG), occupation rate was highest at the control sites (38%) which is close to double that of the impact (18%) and reference sites (22%). For other gliders such as Greater Glider (GG), occupation rate was highest at the reference site (33%), markedly more than 13% occupation recorded at the control sites and more so at impact sites where it was absent, at least within the monitoring transects. The implications of these findings and how these compare with performance measures outlined in the Threatened Glider Management Plan (RMS 2015) are discussed.

1.0 Introduction

1.1 Background

The Woolgoolga to Ballina Pacific Highway Upgrade comprises approximately 155 km of highway to achieve a four-lane divided road extending north of Woolgoolga at the northern extent of Sapphire to Woolgoolga Upgrade to south of Ballina where it ties into the southern extent of the Ballina bypass. The project includes grade separated interchanges, service roads and upgrades to local road connections and has the potential to be staged in 11 sections. The State Minister for Planning and Environment approved the project on 24th June 2014. On 14th August 2014, the Federal Minister for the Environment Greg Hunt approved the project in accordance with Part 9 of the *Environmental Protection and Biodiversity Conservation* Act (1999).

In order to enable commencement of construction in mid-2015, some key preconstruction survey tasks were undertaken as a priority. During preconstruction, baseline and targeted surveys of threatened species enabled the establishment of the monitoring program to be implemented on an ongoing basis to help manage and mitigate any potential impacts of the project on threatened species. Requirements for monitoring and mitigation measures throughout various stages of the project are outlined in a series of threatened species management plans.

The Threatened Glider Management Plan developed for the Upgrade addresses the impacts of the road and proposes mitigation for Squirrel Glider and Yellow-bellied Glider (RMS 2015). One component of this plan was to perform population monitoring of threatened gliders during the construction of the Upgrade. Consequently, the Roads and Maritime Services (RMS) engaged Lewis Ecological Surveys (Contract Identifiers – 13.2544.0919-0020/0023) on the 17th August 2015 and in April 2016 extended this work order to include monitoring of gliders during autumn and winter before extending it on the 16th September 2016 to implement the remainder of Year 1 during construction surveys for spring through to summer 2017.

2.0 STUDY AREA AND SURVEY METHODS

2.1 Monitoring Sites and Sampling Design

The study area extends along sections 1 and 2 of the W2B Pacific Highway upgrade (28.6 km) and includes habitat within 3km of the alignment. The southern end of the upgrade connects to the recently completed Sapphire to Woolgoolga upgrade near Arrawarra Beach Road and to the Glenugie upgrade at the northern end. Monitoring sites were pre determined sites selected by Sandpiper Ecological Surveys as part of the pre-construction baseline survey (SES 2014; 2015). The stratified sampling design is summarised below in Table 2-1.

Spotlight surveys were conducted in accordance with the methods outlined in the Threatened Glider Management Plan (2015). The 28 monitoring transects were surveyed during late autumn (May) 2016, mid winter (July), late spring (November) and mid/late summer (February) in 2017. Access of Site M1-i (Site 22) was not possible due to landholder restrictions. To overcome this, a parallel transect was established to the west (Start – Easting: 516697 N: 6680110 Finish - Easting: 516350 N: 6680543) which samples the same plant community type. Each transect was sampled by a single operator (BDL) using a 50-watt spotlight for a set duration of 25 minutes per transect over the 500 m determined by two pre-determined and provided waypoints. No call broadcast was used. Late autumn surveys (survey 1) were conducted over six nights between the 17th and 30th of May 2016, mid winter surveys (survey 2) over seven nights between 4th and 17th July, late spring surveys (survey 3) over six nights between 23rd and 30th November 2016 and mid/late summer surveys (survey 4) over seven nights spanning 3rd to the 9th February 2017.

Table 2-1. Stratification of BACI impact, control and reference sites associated with the eight aerial crossings in Sections 1/2 of the W2B Upgrade.

Chainage	Site Identification	Structure	Impact Sites	Control Sites	Reference Sites
1860	C1 – S1	Rope Bridge + Glide Pole	2	2	2
5200-6620	M1	Vegetated Median	1	1	1
7110	S2	Rope Bridge	1		
13040	C2	Rope Bridge	2	1	2
16060	C3	Glide Pole in median	2	2	2
16430	C3	Glide Pole in median			
22900-23640	M2	Vegetated Median	1	2	2
24580	S3	Rope Bridge	2		
Total Sites			**11**	**8**	**9**

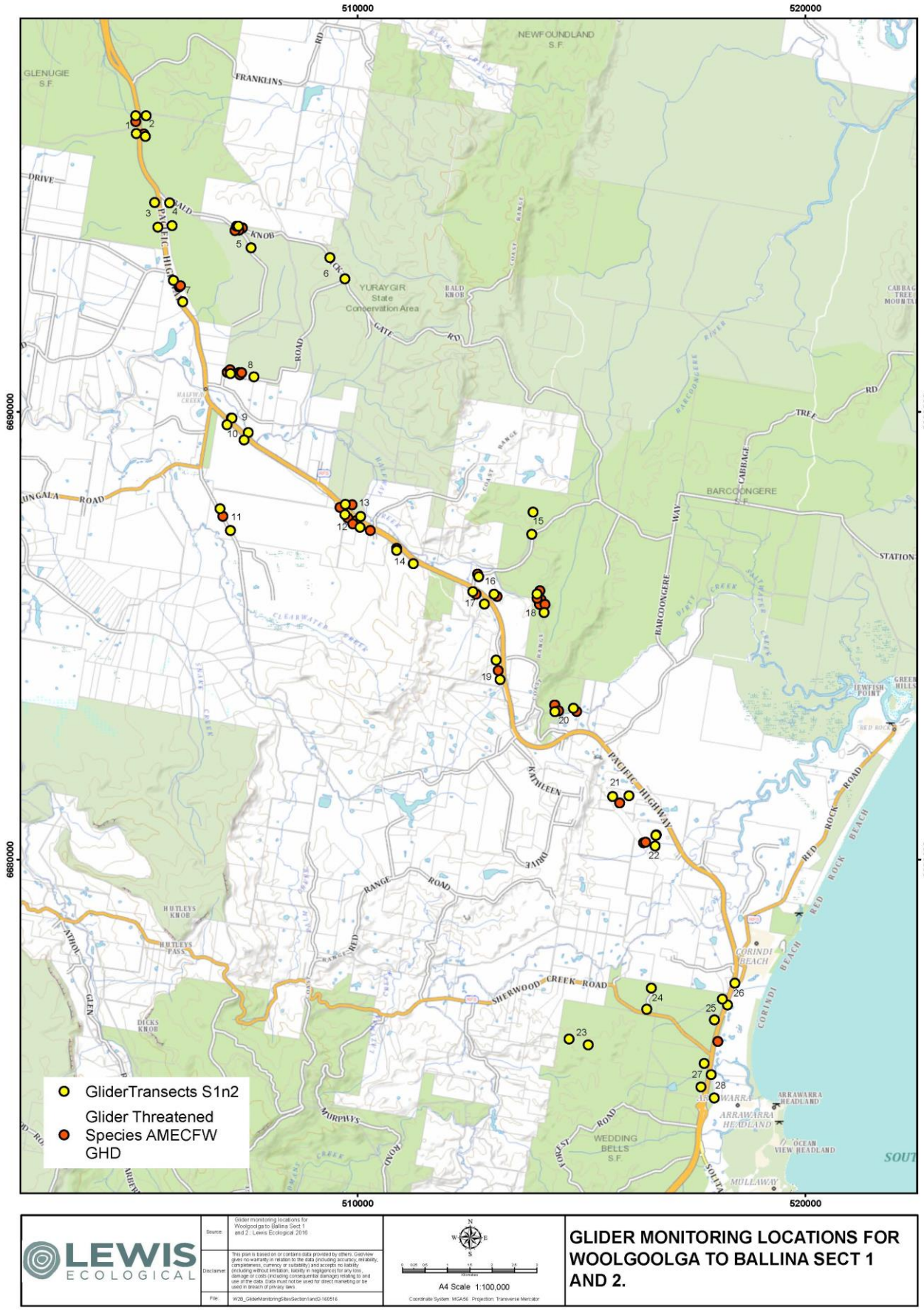

Figure 1-1. Distribution of paired BACI sites in relation to the W2B Upgrade corridor.

2.3 Abiotic Conditions and Flowering Intensity

Weather conditions were generally fine during all four survey periods with wind strength generally still or light whilst rainfall was restricted to one period in late spring when thunderstorm activity on the 29th November. There was however, some variability with the moon phase with surveys occurring from dark phase through to an almost full moon. Full weather details and spotlight effort are provided in Table A1 of Appendix A.

2.4 Flowering Intensity

Flowering intensity was somewhat variable throughout the survey period. During the late autumn survey, moderate flowering of Spotted Gum (*Corymbia maculata*) and occasionally Grey Ironbark (*Eucalyptus siderophloia*) and Coastal Blackbutt (*Eucalyptus pilularis*) were noted. This extended to some of the mid storey and shrub layer species, in particular Coast Banksia (*Banksia integrafolia*), Hairpin Banksia (*Banksia spinulosa*) and occasionally some wattles (*Acacia spp*). Some light flowering was noted more frequently in stands of Coastal Blackbutt (*Eucalyptus pilularis*), Broad-leaved Paperbark (*Melaleuca quinquenervia*), *Acacia spp* and Mistletoe. Most of these species continued to flower during the winter survey, however, some light budding and flowering was recorded at sites which supported stands of Forest Red Gum (*E. tereticornis*) and Swamp Mahogany (*E. robusta*). In late spring, some staggered flowering of the above species was still present at some sites, however, most of the flowering was noted in Bastard Tallowwood (*E. planchoniana*) and other Stringybarks and occasionally Scribbly Gum (*E. signata*). During the mid/late summer surveys, moderate flowering intensity was recorded in Pink Bloodwood (*Corymbia intermedia*) and Bastard Tallowwood (*E. planchoniana*) with light flowering noted in some Spotted Gum, Smooth-barked Apple (*Angophora costata*), Coastal Blackbutt and Wallum Banksia (*Banksia aemula*).

3.0 SURVEY RESULTS

3.1 Arboreal Mammal Detections

Arboreal mammals were recorded at all sites except one of the impact sites, M2-i (7) the vegetated median at Wells Crossing (Table 3-1). Feather-tail Gliders (FtG) were the most commonly recorded arboreal mammal being detected at 19 sites, followed by Common Brushtail Possum (CBP) at 16 sites, Sugar Glider (SuG) at 15 sites, Yellow-bellied Glider (YbG) at seven sites, Squirrel Glider (SqG) at seven sites, Greater Glider (GG) at four sites, Common Ringtail Possum (CRP) at four sites and three scansorial species, Yellow-footed Antechinus (YfA), Fawn-footed Melomys (FfM) and Brush-tailed Phascogale (BtP) at one site each.

Reference and control sites associated with the rope bridge (C2) at Dirty Creek Range (Sites 14,15,18) recorded the most arboreal mammal detections with 12 and 10 individuals respectively, whilst the control site recorded the highest arboreal diversity with five species (Table 3-1). Similarly high arboreal abundance was recorded at the poles in the median at Halfway Creek with 10 individuals comprising four species.

On average, the highest total abundance of arboreal as well as species richness was recorded at the pole treatments in the median at Halfway Creek (C3; 16060 & 16430). Conversely, sites associated with the rope bridge near Arrawarra Creek (C1) and the Well Crossing vegetated median and rope bridge recorded the fewest arboreal mammal detections (Table 3-1).

Full details of spotlight surveys for all four seasons are provided in Table A1.

3.2 Threatened Arboreal Detections

Threatened gliders were recorded at 15 of the 28 sites with YbG at seven sites and SqG at seven sites (Table 3-1). The threatened Brush-tailed Phascogale (BtP) was recorded at one site. Multiple threatened species were recorded at four sites whilst multiple detections occurred at two locations with two SqG recorded at a reference site in Wedding Bells State (S24; C1-r-n) and three SqG at the Dirty Creek Range rope bridge control site (C2-c) currently located in crown and state forest tenure. At this site, three SqG were recorded during both the autumn and winter monitoring events which coincided with peak flowering of Coast Banksia (*Banksia integrafolia*).

Threatened gliders were recorded at all five locations. At the Arrawarra sites, SqG was recorded at the control (C1-c-w) and reference (C1-r-n) site during the autumn monitoring but not for the remainder of the surveys. At the Dirty Creek sites, YbG was recorded at the impact site (M1-i) which had been relocated 150 m further to the west. In fact, this species

was recorded during the winter, spring and summer surveys at this location. YbG was also recorded at the reference site (M1/S2-r), but only during autumn and again in summer.

Table 3-1. Arboreal mammals detected during four seasonal surveys for Year 1.

Location/Crossing (chainage)	Site (No.)	Autumn (May 2016)	Winter (July 2016)	Spring (November 2016)	Summer (February 2017)
Arrawarra Creek/Rope Bridge-C1-S1(1860)	i-e (26)	nil	CmBP	CmBP	CmBP
	i-w (25)	CRP	nil	nil	FtG
	c-e (28)	CmBP		CRP; CmBP	CmBP; FtG
	c-w (27)	SqG	Sug, FtGx2	nil	Sug; FtG
	r-n (24)	SqGx2,Sug	Sugx2	Sugx2	Sugx2
	r-s (23)	Sug		FtG; Sug	FtG; Sug
Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	M1-i (22)	Sugx2,CmBP	YBG	YBG	YBG; CmBP; Sug
	S2-i (21)	CRP	CRP	Nil	FtG; CRP
	c (19)	Sug	Sug	Sug; FtG	FtG
	r (20)	YBG	GG	FtG	YBG; CmBP; GG
Dirty Creek Range/Rope Bridge-C2 (13040)	i-e (16)	Sug,FtG	Sug	FtG; Sug	FtG
	i-w (17)	nil	nil	YBG	Nil
	c (14)	SqGx3	SqGx3,FtG	Mel	SqG; FtG
	r-n (15)	YBG;GG;Sugx2	Nil	YBG; Sug; FtG; GG; CmBP	GG; Sug; CmBP
	r-s (18)		GG;FtG	GG; CmBP	YBG; GG
Halfway Creek/Poles in Median-C3 (16060 & 16430)	i-e (13)	YBG		CmBP x 2; FtG x 2	FtG
	i-w (12)	Sugx2,CRP	SqG;CBPx2	CmBP; CmBP	SqG; CmBP
	c-e (9)	GG,Sug	GG,Sug	GG; CmBP	GG; FtG
	c-w (10)	CBPx2,FtG	CBP	CmBP; FtG	Nil
	r-e (8)	Sug	YBG;FtG	YBG; Sug	Sug; FtG; CmBP
	r-w (11)	Sug	CBP	CmBP	Sug; CmBP
Wells Crossing/Veg Median-M2 (22900-23640) & Rope Br-S3 (24580)	M2-i (7)	nil	nil	nil	nil
	S3-i-e (4)	CBP, Sug		CmBP; FtG	FtG
	S3-i-w (3)		Sug, SqG	CmBP	Yf-Ant
	c-e (2)			FtG	Sug
	c-w (1)	FtG	CBPx2	SqG; CmBP	FtG
	r-e (5)	CBP	SqG, FtG, BTPhas	SqG	Nil
	r-w (6)		Sug	FTG; Sug	FTG; Sug

YbG=yellow-bellied glider; SqG=squirrel glider; GG=greater glider; SuG=sugar glider; FtG=feathertail glider; CmBP=common brushtail possum; CRP=common ringtail possum; BTPas= Brush-tailed Phascogale; YFAnt = Yellow-footed Antechinus; Mel = Fawn-footed Melomys.

Transect: i=impact, c=control, r=reference; Position: e=east, w=west, n=north, s=south.

At Dirty Creek Range (C2) rope bridge sites, YbG were detected on the eastern impact site (C2-i-e) and southern reference site (C2-r-s). They were also detected on C2-r-s during session 1 (Table 3-1). SqG were detected at impact west (C2-i-w) and the control site (C2-c) and present during the summer, autumn and winter sessions but not spring.

At sites associated with Halfway Creek glide poles (C3), YbG were detected on reference east (C3-r-e) and impact east sites (C3-i-e). SqG were also detected on the west side of the highway at an impact site (C3-i-w) with individuals spotlighted during both the winter and summer sessions.

Sites associated with the Wells Crossing vegetated median and rope bridge recorded the threatened Brush-tailed Phascogale from a reference site located several hundred metres east of the installed rope bridge at ch. 24580 (S3-r-e). SqG were recorded across a number of treatments in this area with one individual recorded during winter sampling at an impact site to the west of the existing carriageway (S3-i-w) and during spring sampling from a control site to the west of the existing carriageway (S3-c-w). Multiple records were obtained during winter and spring from a reference site located to the east of the carriageway (S3-r-e).

3.3 Detecting Threatened Glider Population Responses

To accord with previous baseline surveys (SES 2014), site occupancy for threatened gliders (YbG, SqG) has been calculated using "occupied" versus "absent" with the survey data pooled for the four seasonal surveys (*see* Goldingay 2014 and SES 2014). Year 1 sampling recorded YbG at 44% of the reference sites compared with 27% at the impact sites (Figure 3-1; Figure 3-2). No YbG occupation was recorded at the control sites. In the case of SqG, occupation rate was highest at the control sites (38%) which is close to double that of the impact (18%) and reference sites (22%; Figure 3-1; Figure 3-2).

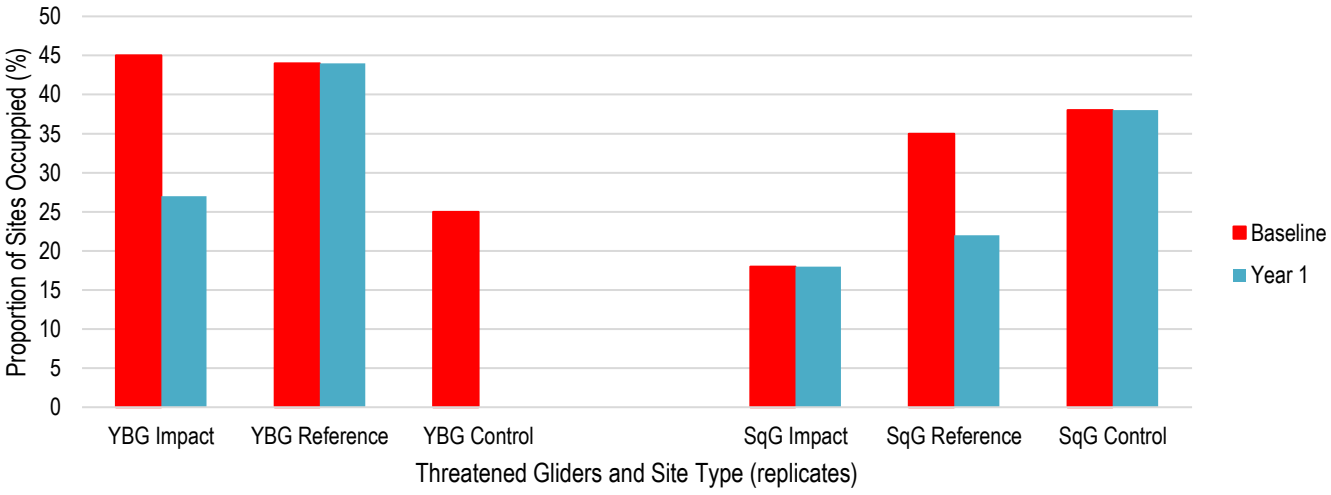

Figure 3-1. Comparison of site occupation rates for threatened gliders between the baseline survey and year 1.

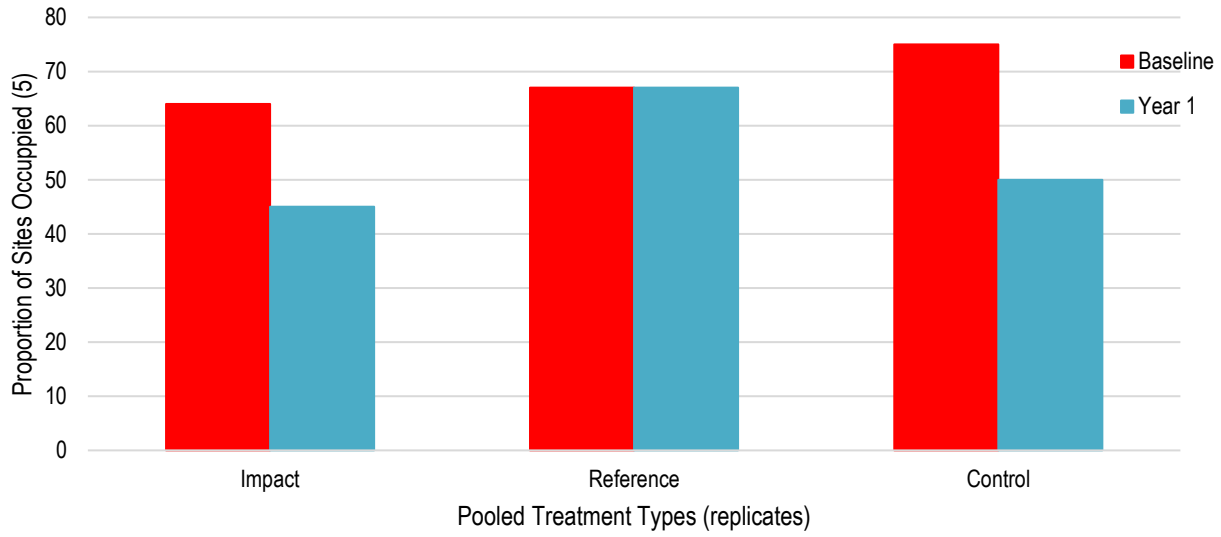

Figure 3-2. Comparison of site occupation rates for pooled threatened gliders between the baseline survey and year 1.

3.4 Road Kill Transects

Road kill surveys performed around the time each seasonal survey found no threatened gliders. Two SuGs were recorded with one individual struck in the north bound lanes adjacent to a control site (C2-c) and another individual found also at the edge of the north bound lanes adjacent to one of the Halfway Creek Poles in the Median (C3-i-w). Flowering Coast Banksia (*Banksia integrafolia*), a key autumn and winter foraging resource was observed in the area.

Road kill sampling performed during the main line clearing operations recorded a SqG adjacent to Wells Crossing vegetated median (M2-i) during clearing in early July 2015 around 9 months before monitoring commenced (EcoSure 2016). Another SqG was recorded as road kill near Boney Creek which occurs adjacent to the rope bridge at Dirty Creek Range (C2-i-e and C2-i-w; SES 2016). Importantly, both sites are located where mitigation has been constructed.

4.0 DISCUSSION OF RESULTS

4.1 Comparison between Year 1 and Baseline Study

Monitoring for Year 1 was performed around 12 months after the initial wave of main line clearing. With that, the initial or immediate effects of habitat loss and fragmentation would be expected among the data. Sites associated with the rope bridge near Arrawarra Creek (C1) recorded markedly more arboreal mammals during Year 1 than the baseline survey (30 versus 13) and included detections of the threatened SqG at a control site (C1-c-w) and one of the reference sites (C1-r-n). Sampling the control and impact treatments in this area is often constrained by dense canopy (C1-i-w) or a very scattered and sparse canopy (C1-i-e) within the designated transects. This is likely to prove problematic when trying to interpret population responses to the Upgrade as observations will be more reliant on individuals being in the lower canopy or scattered trees within the 40 m transect width.

Sites associated with the vegetated median and rope bridge at Dirty Creek responded differently with a marked decline in the number of arboreal detections, down from 36 individuals to just 23, however, species richness was maintained at six species including the threatened YbG. At this location, the Upgrade deviates away from the existing carriageway and bisects some contiguous forest that probably supported a greater density of arboreal fauna which had until recently remained unaffected by road infrastructure. Continued monitoring will prove useful in determining the effectiveness of the mitigation provided.

Sites associated with the rope bridge at Dirty Creek Range reported more arboreal detections during Year 1 than the baseline surveys (35 versus 28) yet species richness was greater during the baseline surveys with seven species versus six species. The impact and control sites in this area are located where the highway is being duplicated, and with this many of the resident arboreal fauna are probably habituated to forest edges and associated effects, unlike the vegetated median and rope bridge treatments at Dirty Creek. The stratification of mitigation treatments and their effectiveness between duplicated sections and green field sites (i.e. newly created easements) may warrant attention as part of the W2B Upgrade. For example, glider groups around the existing highway may be more adaptable at using the provided structures as they have habituated to light and noise disturbances along with increased gaps between tree canopy.

Sites associated with poles installed in the median at Halfway Creek recorded far more arboreal detections during Year 1 monitoring with 43 individuals versus 27 in the baseline surveys. Interestingly, species richness was higher during the baseline surveys with seven species compared with six. This pattern of increased detections may be an artefact of higher densities as arboreal fauna seek to re-establish territories following the mainline clearing. Future monitoring will prove useful in understanding whether these densities are sustainable. Interestingly, both SqG and YbG were captured during the clearing operations adjacent to control treatments (C3-c-e and C3-c-w) at Halfway Creek, however, this first round of

monitoring since the clearing was unable to reconfirm presence. Only the YbG had been previously recorded during the baseline sampling at the eastern control site which borders Halfway Creek (C3-c-e; SES 2014).

Sites associated with the rope bridge and vegetated median at Wells Crossing recorded a similar number of arboreal detections between this round of monitoring (27 individuals) and the baseline survey (25 individuals). Species richness varied a little at these locations, particularly in relation to threatened species with the SqG recorded at fewer sites and the YbG not recorded at all. On a more positive note, the threatened Brush-tailed Phascogale was spotlighted at S3-r-e which is located several hundred metres east of the rope bridge at ch.24580. Based on the monitoring being performed in this area for BtP (*see* Lewis 2016; in prep), occupancy rates of BtP appear sporadic in this area with individuals disappearing then reappearing, however, it does indicate the area provides dispersal habitat.

No arboreal fauna were recorded during this round of monitoring at the Wells Crossing vegetated median (Site 3 at M2-i). Previously, baseline surveys recorded YbG (SES 2014) during summer and early autumn sampling and it was frequently heard calling in this area whilst conducting surveys for other threatened mammals and frogs between 2013-2015 (pers. obs). In early 2015, a Small-fruited Grey Gum was being regularly incised (cover picture) indicating the area provided key habitat values and with that presumably almost constant occupation. SqG was also known to frequent this area with a road kill individual recorded during the mainline clearing in July 2015, around 9 months before Year 1 monitoring commenced (EcoSure 2016). Further monitoring is required to determine if this change in occupancy relates to a short term shift in habitat use, or it does in fact represent a potential decline and loss of these threatened gliders.

4.2 Threatened Glider Occupancy Patterns

Monitoring has revealed the occupancy rates of threatened gliders have declined since the baseline sampling was undertaken in 2014 and 2015. When the data were pooled for threatened gliders (YbG, SqG), this decline was of a comparable magnitude at both the impact and control sites yet remained static at the reference sites. This indicates the initial phase of clearing and the resulting barrier effect and fragmentation may place increased pressures on glider occupancy. The data does suggest each species may respond differently. YbG declined at the impact sites but disappeared from the control sites yet occupancy rates remained static at the reference sites located some distance from the Upgrade. This species does tend to possess a much larger home range then the other two threatened gliders, enabling individuals to disperse away from the clearing, and at times undoubtedly outside of the monitoring transect. The influence of call broadcast which had been used in the baseline survey but not identified in the survey methods in the TGMP is likely to have influenced the reported variation. This species tends to be quite responsive to call broadcast and with that, the baseline surveys are likely to have illicit calls and attracted individuals into the monitoring transect. Interestingly, no change was recorded at either the impact or control sites for SqG, a species which seldom responds to call broadcast. The decline recorded at the reference sites probably reflects natural variation associated with year to year sampling and chances in availability of foraging resources and population fluctuations.

Other factors may explain the reported decline in glider occupancy. Sampling effort during Year 1 appears to be half that of the baseline survey when two surveys per season were performed, not a single season survey as outlined in the TGMP. Importantly, Year 1 sampling is consistent with the sampling requirements outlined in the TGMP (*see* 8.2.3 pg 52 – RMS 2015). This may go a long way to explaining the reported declines above and sampling in Year 2 will need to address this in more detail.

5.0 PERFORMANCE MEASURES ASSOCIATED WITH THE TGMP

The Threatened Glider Management Plan has developed a number of performance measures which focus on the following:

- Population monitoring;
- Arboreal crossing structures and vegetated medians;
- Road mortality monitoring;
- Selection of monitoring locations for gliders, arboreal road crossing and road mortality;
- Nest boxes; and
- Habitat revegetation.

The status and performance of these is summarised in Table 5-1.

5.1 Population Monitoring

Pooled threatened glider data shows a decline of a similar magnitude at the impact and control sites. Sampling in Year 1 found 45% occupancy at the impact sites, down from 64% recorded during the baseline surveys. The control sites also underwent a similar decline, down from 75% in the baseline survey to 50% at Year 1. The reference sites located some distance from the Upgrade, remained static with 67% occupancy during both the baseline survey and Year 1.

At a species level, YbG declined by 18% (45% in baseline; 27% Year 1) at the impact sites whilst the control sites underwent a decline from 25% to zero in Year 1. Similar to the pooled data, YbG remained static at the reference sites with 44% occupancy. The use of call broadcast during the baseline surveys may have assisted detection rates around the road corridor. Interestingly, no change was recorded at either the impact (18%) or control (38%) sites for SqG, a species which seldom responds to call broadcast. There was however, a decline at the reference sites, down from 35% occupancy to 22% at end of Year 1.

The TGMP allows for three monitoring events before a corrective action is required to address declines in the threatened glider population. There is probably a need for some interim considerations focusing on refining and standardising the sampling regime which appears to differ between the baseline survey, what is written in the TGMP (200 m spotlight transect) and what was implemented in Year 1 (relied on provided GPS waypoint and old markers indicating distances of approx. 500-600m). This is outlined further in the recommendations section of this report. The SqG recorded small declines at the reference sites and this indicates some natural variation may be responsible for the declines recorded at the impact and control sites.

5.2 Arboreal Crossing Structures and Widened Median Monitoring

Year 1 monitoring was performed at a time when the arboreal crossing structures were either under construction, nearing completion or were still undergoing a 6 month waiting period before monitoring could commence (*see* RMS 2015).

Although clearing for the widened medians had been completed in Section 1, the works had not been completed at Wells Crossing in Section 2 and with that some additional trees were being assessed due to safety requirements. Consequently, no monitoring was implemented and scheduled to commence during Year 2 of the population monitoring.

5.3 Road Kill Monitoring

No threatened gliders were recorded as road kill during Year 1 and consequently no corrective actions at this point in time. There was however, one Sugar Glider hit at the control site associated with the Dirty Creek Range/Rope Bridge-C2 (13040) treatments and another from an impact site at the Halfway Creek Poles in Median (C3 i-w). Both individuals were recorded during the winter survey period, a time when flowering *Banksia integrafolia* attracts nectivorous fauna close to the carriageway.

5.4 Selection of monitoring locations for gliders, arboreal road crossing and road mortality

The selection of monitoring locations for gliders, arboreal road crossing structures and road mortality was developed as part of the baseline surveys (SES 2014).

5.5 Nest boxes

The installation and monitoring of nest boxes was implemented by the construction contractor with OHL-York in Section 1 and CMC in Section 2. Operational monitoring is currently undertaken by Ecological Australia and addressed separately.

5.6 Habitat revegetation

As Year 1 monitoring was performed during the construction of Sections 1 and 2, the maintenance period for Landscaping had not yet commenced. This is scheduled to occur as part of Year 2 population monitoring whereby plantings will need to be assessed against the performance measured summarised in Table 5-1. For example, greater than 10% of plants have died after first 12 months of maintenance, more than 20% have failed after three years of maintenance and the total weed coverage exceeds 30% in the identified revegetated areas.

Table 5-1. Performance indicators and corrective actions from the Threatened Glider Management Plan (RMS 2015).

Triggers for corrective actions	Corrective actions	Relevance to Year 1 Glider Monitoring	Results of Year 1 Glider Monitoring	Potential Contributing Factors	Corrective Action Required
Population Monitoring					
Decline in the after construction occupancy rates of Squirrel Glider or Yellow-bellied Glider at impact sites over 3 consecutive monitoring sessions.	Review monitoring methods, considering further monitoring and assessment should there be a decline in population abundance. Consider potential for natural variation to be responsible for decline in population numbers/density. Review location of the arboreal crossing structures and consider adding new structures. Investigate habitat adjoining the highway and consider improving habitat condition and connectivity. Post three years of monitoring and implementation of corrective actions, if connectivity measures cannot be demonstrated to be effective at successfully mitigating the barrier and fragmentation impact to glider species, the residual impact to connectivity shall be offset. This is in accordance with MCoA D2.	Relevant	YBG - 18% decline in occupancy at impact sites Reference sites remained unchanged at 44% occupancy. Control sites declined from 25% to absence. SqG – No change at impact or control sites with occupancy remaining at 18% and 38% respectively. Reference sites declined from 35% to 22% in Year 1.	YBG glider has larger maternal home range and the clearing may have caused some shift in habitat use. Call broadcast was used during the baseline survey but not Year 1 sampling. Variability in survey personal between baseline and Year 1. Greater amount of survey effort employed during the baseline survey with multiple surveys performed in each season.	Wait until third monitoring event before determining the requirements for any corrective actions.
Arboreal Crossing Structure and Widened Medians					
No evidence of use of arboreal crossings and widened medians by threatened gliders post- construction.	Review location and type of connectivity structures installed and implement provisional measures in consultation with EPA which may include but not limited to the installation of more glide poles or rope bridges, particularly were known mortality hotspots occur. Consider more strategic planting of habitat or the installation of additional glider poles, informed by the long-term population monitoring data. Post three years of monitoring and implementation of corrective actions, if connectivity measures cannot be demonstrated to be effective at successfully mitigating the barrier and fragmentation impact to glider species, the	Not relevant as all the structures weren't completed and 6 month waiting period.	Not Applicable	Not applicable	Not Applicable

Triggers for corrective actions	Corrective actions	Relevance to Year 1 Glider Monitoring	Results of Year 1 Glider Monitoring	Potential Contributing Factors	Corrective Action Required
	residual impact to connectivity shall be offset. This is in accordance with MCoA D2.				
Road Mortality Monitoring					
Higher mortality rate at impact sites or no significant difference in mortality rates or threatened gliders between impact and control sites.	Review reported usage level of crossing structure by threatened gliders. Corrective actions may include but not limited to the installation of more glide poles or rope bridges to known mortality hotspots. Crossing structures also serve as 'insurance' in the case of stochastic events such as fire or disease which may occur at long time intervals. Further the cost of decommissioning and relocating a rope bridge or glide pole array is likely to be comparable to the cost of installing a new structure. Therefore existing glide poles/rope bridges will be retained.	Relevant	Sugar Glider recorded at Halfway Creek Poles in Median (C3 i-w) adjacent to impact site with poles in median. Another Sugar Glider recorded at Dirty Creek Range/Rope Bridge-C2 (13040) control site.	Flowering *Banksia integrafolia* attracting gliders into the area.	Review crossing structure data and determine the use of additional poles after three successive monitoring years.
High number of incidental records of threatened glider mortality away from crossing structures.	Should road kill data indicate a road-kill hot spot for gliders where there is limited crossing structures RMS will investigate the feasibility of installing additional crossing structures. Post three years of monitoring and implementation of corrective actions, if connectivity measures cannot be demonstrated to be effective at successfully mitigating the barrier and fragmentation impact to glider species, the residual impact to connectivity shall be offset. This is in accordance with MCoA D2. Identify a hot spot. Review options for mitigation, i.e. crossing structure, signage, lowering speed limit. Consider implementation of crossing structure at identified hot-spot or other methods to reduce mortality (e.g. signage, review design of structure in that locality, additional plantings to encourage gliders away from road and to crossing structure).	Relevant	No threatened gliders recorded as road kill	More dedicated road kill monitoring procedure would be required to explore this performance measure. Skilled observers with monitoring sites surveyed within 2 hours of daylight.	Recommended for review.

Triggers for corrective actions	Corrective actions	Relevance to Year 1 Glider Monitoring	Results of Year 1 Glider Monitoring	Potential Contributing Factors	Corrective Action Required
Habitat Revegetation					
Greater than 10% of plants have died after first 12 months of maintenance. Greater than 20% of plants have died after three years of maintenance. Total weed coverage is more than 30% in revegetation areas.	Review maintenance schedule for revegetated areas. Replace dead plants within specified timeframes. Increase weed control if required or review control methods being used.	Not relevant at this point in time.	Not Applicable	Not Applicable	Not Applicable

6.0 CONCLUSION & RECOMMENDATIONS

Year 1 sampling confirmed the continued presence of threatened gliders across all three treatments of impact, control and reference sites. There was however, a notable decline in the occupancy of YbG with an 18% decline at impact sites yet the reference sites remained unchanged at 44%. At the unmitigated control sites, YbG were absent compared to 25% during the baseline survey performed 1-2 years earlier. Different from the YbG, SqG occupancy remained unchanged between the baseline survey and Year 1 yet it occupancy declined at the reference sites unaffected by the Upgrade.

There are a number of reasons that could explain the reported declines including the variability in the survey effort and differing techniques, dispersing individuals occupying areas beyond the monitoring transect (i.e. YbG exhibit home ranges of 30-60 ha), natural seasonal effects such as drought and the 2014 Kremnos Creek wildfire, or the habitat loss and modification associated with the Upgrade. The fact that declines were reported for SqG at the reference sites provides some weight to natural variation and seasonal effects but this alone cannot account for all of the reported decline and further monitoring will be required over the next two years.

Monitoring could not be performed of the arboreal crossing structures and vegetated medians during Year 1. This was due to either the structures not being completed during the monitoring period or they were still undergoing a settling period of 6 months before monitoring could commence. As a consequence, Year 1 monitoring would need to commence as part of Year 2 population monitoring surveys.

Although no threatened gliders were recorded during road kill surveys during this monitoring period, previous mainline clearing reported the loss of two SqG as roadkill, the first of these adjacent to the Wells Crossing vegetated median and the second adjacent to Boneys Creek where Dirty Creek Range rope bridge has been installed. The recording of two SuG as road kill during the monitoring highlights Coast Banksia (*Banksia integrafolia*) growing in the vicinity of median poles installed at Halfway Creek may continue to attract gliders including SqG given the frequency with which it was recorded in this area.

In light of the findings, some recommendations have been proposed in Table 6-1 on page 18.

Table 6-1. Recommendations and RMS responses after Year 1 threatened glider monitoring.

ID No	Recommendation	Roads and Maritime Response/Actions
1.	Ensure the monitoring effort is standardised. That being to: a. Rationalise the difference between the quoted 200 m transects in the TGMP versus reality of 500-600 m transects with the provided GPS coordinates; b. Include or omit call broadcast from the monitoring regime; c. Rationalise the variability between two survey sessions per season versus one survey per season outlined in the TGMP. d. Allow for skewed variations in the transects to compensate for the loss of habitat on one side of the transect so that a standardised amount of habitat is sampled (i.e. 4 ha per transect or 500 x 80 m).	Adopted - The current Glider monitoring program for W2B which is being delivered by Jacobs and Sandpiper includes: • 500 m transects consistent with Lewis 2018 and baseline surveys. • Quarterly monitoring over two non-consecutive nights (8 surveys per year) with YBG call playback and 1 ecologist. This is the same as baseline surveys but they had different ecologists working concurrently on monitoring transects.
2.	Ensure future sampling of Site M1-i (Site 22) occurs along the realigned parallel transect with the following coordinates: Start – Easting: 516697 N: 6680110 Finish - Easting:516350 N:6680543	Adopted
3.	Review the road kill monitoring method so that is can provide more useful data.	Not adopted – The roadkill monitoring is being undertaken in accordance with the approved TGMP This recommendation relates to undertaking the monitoring within 2 hours of daylight. Published research from by Taylor & Goldingay 2004 demonstrated that over 60% of road kill is present after 7 days. Roadkill monitoring will continue in accordance with TGMP.

7.0 REFERENCES

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8.0 APPENDIX 1 – RAW FIELD DATA

Table A1. Results of spotlighting along the 28 transects in Sections 1 & 2 of the W2B Upgrade.

YbG=yellow-bellied glider; SqG=squirrel glider; SuG=sugar glider; GG=greater glider; FtG=Feathertail Glider; CBP=common brushtail possum; CRP=common ringtail possum; PO=powerful owl; AON=owlet nightjar; WtN=white-throated nightjar; TF=tawny frogmouth; GhFF=grey-headed flying fox. LRFF=little red flying fox.

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
1	Wells Crossing	S3-c-w	17/05/2016	2220	2245	15	5/8	0	1	50	FtG x 1 (o)	Gliding into lower canopy of Spotted Gum	2230	1/2 along transect	10% of Spotted Gum	
1	Wells Crossing	S3-c-w	4/07/2016	2241	2306	10.9	0/8	0	0	0	CmBP x 2 (o); FtG x 1 (O)	UC of Ironbark and Grey Box	2300	3/4 transect	<5% IB and buds in Spotted Gum	
1	Wells Crossing	S3-c-w	29/11/2016	2348	0013	18	0	1	0	80	SqG x 1 (o); CmBP x 1 (o)	SqG perched in mc of *Allocasuarina* and CmBP perched in mc of Ironbark	2357; 0004	1/2 transect for both	Nil	Southern Bookbook
1	Wells Crossing	S3-c-w	9/02/2017	2110	2135	22	7/8	1	0	0	FtG x 1 (o)	Observed moving along branch of Spotted gum	2130	1/2 transect	Nil flowering	
2	Wells Crossing	S3-c-e	17/05/2016	2253	2318	14	5/8	0	0	60	nil	-	-	-	5% flowering Spotted Gum	
2	Wells Crossing	S3-c-e	4/07/2016	2317	2342	10.8	0/8	0	0	0	nil	-	-	-	buds only in Spotted Gum	
2	Wells Crossing	S3-c-e	29/11/2016	2314	2339	18	0	1	0	80	FtG x 1 (o)	Observed in the mid canopy moving along branch of Spotted Gum	2330	2/3 along transect	Grey Ironbark 5% flowering	AON; Droplets still remain on branches from thunderstorm earlier in the night
2	Wells Crossing	S3-c-e	9/02/2017	2145	2210	21.5	7/8	1	0	0	Sug x 1 (o)	Observed perched in the mid canopy of Grey Box	2202	2/3 along transect	Nil	
3	Wells Crossing	S3-i-w	17/05/2016	2135	2200	16	5/8	0	0	40	nil	-	-	-	10% Spotted Gum 20% Hairpin Banksia	

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
3	Wells Crossing	S3-i-w	4/07/2016	2153	2218	10.9	0/8	0	0	0	Sug x 1 (o); SqG x 1 (o)	Observed foraging in IB & perched in dead *Allocasuarina*	2200; 2203	1/4 & 1/2 along transect	10% IB bud/flower and 5% Spotted Gum	
3	Wells Crossing	S3-i-w	29/11/2016	2233	2258	18	0	1	0	90	CmBP x 1 (o)	Perched in mid-canopy of *Angophora*	2240	1/2 along transect	Nil	Rain droplets from thunderstorm providing numerous eye shine
3	Wells Crossing	S3-i-w	7/02/2017	2203	2228	25	3/4	0	0	90	Yellow-footed Antechinus x 1 (o)	Moving along horizontal branch in low canopy of Ironbark	2210	1/3 along transect	Nil	
4	Wells Crossing	S3-i-e	17/05/2016	1823	1848	20	5/8	0	0	50	CmBP x 1 (o); Sug x 1 (o)	Perched in low canopy of Ironbark and Sug heard from presumably in a tree	1830; 1841		15% Spotted Gum	
4	Wells Crossing	S3-i-e	4/07/2016	2100	2125	10.7	0/8	0	0	0	Nil	-	-		5% bud early flowering IB	
4	Wells Crossing	S3-i-e	29/11/2016	2045	2110	21	0	1	1	65	CmBP x 1 (o); FtG x 1 (o)	CmBP perched in mc of Ironbark; FtG gliding in canopy of Spotted Gum	2101; 2107	1/2 and 3/4 along transect	Stringybark 10% flowering	Approaching storm.
4	Wells Crossing	S3-i-e	8/02/2017	0010	0035	23	3/4	0	0	95	FtG x 1 (o)	Obs resting in UC of Spotted Gum	17	~1/2 transect	Nil	
5	Wells Crossing	S3-r-e	17/05/2016	1904	1929	18.7	5/8	0	0	50	CmBP x 1 (o)	Perched in mid canopy of Ironbark	1917	St of transect	5% for both Spotted Gum and IB	

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
5	Wells Crossing	S3-r-e	4/07/2016	1936	2001	11.8	0/8	0	0	0	SqG x 1 (o); FtG x 1 (o); BTPhas x 1 (o)	SqG-Observed in mid canopy moving along trunk of IB; FtG-UC still in Bancroft's Red Gum; Brush-tailed Phascogale moving across ground carrying nesting material before accessing a trunk hollow in dead stag	1943; 1949; 2000		15% Ironbark budding and flowering and 5% Spotted Gum	
5	Wells Crossing	S3-r-e	28/11/2016	0139	0204	19	0	1	0	15	SqG x 1 (o)	Perched in *Allocasuarina* in mid canopy	213	1/3 along transect		AON
5	Wells Crossing	S3-r-e	7/02/2017	2330	2355	22.4	3/4	0	0	10	Nil				Nil flowering	
6	Wells Crossing	S3-r-w	17/05/2016	1940	2005	20	5/8	0	0	75	nil				Nil flowering mid + upper canopy whilst Banksia 50%	
6	Wells Crossing	S3-r-w	4/07/2016	1849	1914	11.1	0/8	0	0	0	Sug x 1 (o)	Mid canopy - preening		St of transect	Nil flowering apart from 50% Banksia	YBG heard off in distance but beyond transect recording distance
6	Wells Crossing	S3-r-w	28/11/2016	0102	0127	19	0	1	0	25	FTG x 1 (o); Sug x 1 (o)	FtG moving along branch of Bloodwood; Sug foraging under bark of Blackbutt	0109; 0115	1/4 and 1/2 way along transect	Stringybark flowering <5%; *Banksia oblongifolia*	AON
6	Wells Crossing	S3-r-w	7/02/2017	2250	2315	25	3/4	0	0	35	FtG x 1 (o); Sug x 1 (o)	FtG obs in Stringybark moving along horizontal limb; Sug obs in UC in Bastard TW	2258; 2307	1/3 + 1/2 along transect	Nil	
7	Wells Crossing	M2-i	17/05/2016	2338	0003	13	5/8	0	0	40	nil				Nil	
7	Wells Crossing	M2-i	4/07/2016	2345	0010	13	0/8	0	0	0	nil				2% flowering NGIB	
7	Wells Crossing	M2-i	28/11/2016	0017	0042	20	0	1	0	30	nil				Few *Banksia spinulosa/oblongifolia*, <5% Stringybark	
7	Wells Crossing	M2-i	7/02/2017	2122	2147	25	3/4	0	0	90	Nil				Nil	Site still undergoing post fire recovery

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
8	Halfway Creek/Poles in Median-C3 (16060 & 16430)	S3-r-e	17/05/2016	2015	2040	17	5/8	0	0	90	Sug x 1 (o)	Foraging on branch in mid canopy of Stringybark	2030	3/4 west end	Nil	
8	Halfway Creek/Poles in Median-C3 (16060 & 16430)	S3-r-e	4/07/2016	1805	1830	12.3	0/8	0	0	0	FtG x 1 (o); YBG x 1 (w)	Gliding into lower canopy; heard call at eastern end of transect	1806; 1825	3/4 west end; St of transect	Nil	
8	Halfway Creek/Poles in Median-C3 (16060 & 16430)	S3-r-e	27/11/2016	2324	2349	20	0	1	0	20	YBG x 1(w); Sug x 1(w)	Both heard calling presumably from a nearby tree	2329; 2338	1/3 and 2/3 along transect	<5% Ironbark	GHFF x1; AON
8	Halfway Creek/Poles in Median-C3 (16060 & 16430)	S3-r-e	7/02/2017	2036	2101	26	3/4	0	0	90	Sug x 1 (o); FtG x 1 (o); CmBP x 1 (o)	Sug = LC branch of coastal blackbutt preening; FtG = LC of Angophora perched still; CmBP = Moving along the ground	2040; 2047; 2055	1/4; 1/2 and 3/4 along transect	Nil	
9	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-e	18/05/2016	2112	2132	16	3/4	0	0	90	GG x 1 (o); Sug x 1 (o)	Perched in mid canopy of a Scribbly Gum; Perched on branch in the mid canopy of Blackbutt	2210; 2219	1/3 and 3/4 along transect	*Banksia integrafolia* 90%, *B. spinulosa* 60%	
9	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-e	14/07/2016	2200	2225	6.2	5/8	0	0	50	GG x 1 (o); Sug x 1 (o)	Perched in UC of Scribbly Gum ; Heard in tree	2208; 2220	1/4 and 1/2 along transect	*Banksia integrafolia* 90%, *B. spinulosa* 60%	
9	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-e	27/11/2016	2243	2308	20	0	1	light	35	GG x 1 (o); CmBP x 1 (o)	GG perched in mid canopy of Scribbly Gum; CmBP perched in mc of Blackbutt	2247; 2258	1/4 and 2/3 along transect	Stringybark flowering ~25%	
9	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-e	3/02/2017	2352	0017	21	1/2	1	0	60	GG x 1 (o); FtG x 1 (o)	GG perched in upper canopy of Scribbly Gum; FtG moving/foraging in upper canopy of flowering Pink Bloodwood	2358; 0008	1/3 and near north end of transect	Pink Bloodwood 10%	GHFF x 1

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
10	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-w	18/05/2016	2245	2310	15	3/4	0	0	90	CmBP x 2 (o); FtG x 1 (O)	CmBP perched in MC of Scribbly Gum; FtG foraging in *Banksia integrafolia*	2247; 2249; 2303	Start of transect and near end of transect	Scattered *B. integrafolia* 90%	
10	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-w	14/07/2016	2128	2153	6.5	5/8	0	0	50	CmBP x 1 (o)	Base of young Tallowwood moving up trunk	2150	St of transect	*Banksia integrafolia* 50% flowering but very sparse stems	
10	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-w	27/11/2016	2202	2227	20	0	1	0	90	CmBP x 1 (o); FTG x 1(o)	Perched in low canopy of Scribbly Gum; FtG moving along branch of *Angophora*	2210; 2221	1/4 and 3/4 along transect	Small amount of Scribbly Gum	Southern Boobook
10	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-c-w	3/02/2017	2316	2341	23	1/2	1	Light	70	Nil				Nil	AON
11	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-r-w	18/05/2016	2130	2155	16	3/4	0	0	95	Sug x 1 (w)	Heard in tree	2131		Banksia spinulosa only	
11	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-r-w	7/07/2016	2055	2120	9.6	0/8	0	0	0	CmBP x 1 (o)	Perched in mid canopy of Scribbly Gum	2107	1/2 way along	2% flowering CBB	
11	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-r-w	27/11/2016	2117	2142	19	0	0	0	75	CmBP x 1 (o)	Perched in mid canopy of *Angophora*	2132	1/2 way along	Minor Scribbly Gum	AON
11	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-r-w	3/02/2017	2228	2253	22	1/2	1	0	90	Sug x 1 (o); CmBP x 1 (o)	Sug obs perched in the mc of Scribbly Gum; CmBP perched in low canopy of Scribbly Gum	2237; 2241	1/2 and 2/3 along transect	Wallum Banksia <10%	WTNJ call

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
12	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-w	18/05/2016	2337	0002	16	3/4	0	0	90	Sug x 2 (o); CRP x 1 (o)	Sug 1 perched on branch in upper canopy of Angophora; Sug 2 foraging on *Banksia integrafolia*; Perched in LC in *Allocasuarina*	2342; 2347; 2358	Start of transect; 1/3 and 2/3 along transect	Banksia integrafolia 70% stems flowering	
12	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-w	7/07/2016	2000	2025	11.7	0	0	0	0	SqG x 1 (o); CmBP x 2 (o)	Foraging in *Banksia integrafolia* in LC; Perched in mid canopy of Blackbutt	2010; 2017; 2020	1/4; 1/2 along transect	Banksia integrafolia 40% flowering	
12	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-w	30/11/2016	2310	2335	19	0	1	0	90	CmBP x 1 (o); CmBP x 2 (o)	First CmBP moving along log on ground; Two CmBPs in MC of *Acacia*	2317; 2326	1/5 and 1/2 along transect	Nil	
12	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-w	3/02/2017	2140	2205	23	1/2	1	0	100	SqG x 1 (o); CmBP x 1 (o)	SqG perched in *Acacia* and CmBP on ground log	2147; 2201	1/4 and 3/4 along transect	<5% Coastal Blackbutt	GHFF x 1
13	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-e	19/05/2016	0018	0043	16	3/4	0	0	80	YBG x 1 (w)	Heard calling at eastern edge of transect	0040	Eastern edge transect	Sparse Banksia 70% flowering	
13	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-e	11/07/2016	2253	2318	12.8	1/2	0	0	10	Nil				Sparse Banksia 80% flowering	Habitat tree fall in eastern end of transect
13	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-e	30/11/2016	2342	0007	19	0	1	0	0	CmBP x 2 (o); FtG x 2 (o)	CmBP = 1 in LC resting other in LC of *Angophora flor*; FtG both gliding in mid canopy Blackbutt	2349; 2358	1/3 and 1/2 along transect	Nil	

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
13	Halfway Creek/Poles in Median-C3 (16060 & 16430)	C3-i-e	3/02/2017	2058	2123	24	1/2	1	0	100	FtG x 1 (o)	Moving in upper canopy of Blackbutt	2107	1/3 along transect	Nil	AON; Unconfirmed YBG call further to south of transect
14	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-c	20/05/2016	2323	2348	13	8/8	0	0	0	SqG x 3 (o)	Foraging in LC in *Banksia integ*; Perched in LC in *Allocasuarina*; Perched in the LC in *Banksia integ*.	2328; 2333; 2343	1/2 way along and northern end	Banksia integrafolia 90% flowering	
14	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-c	11/07/2016	2145	2210	12.8	1/2	0	0	25	SqG x 3 (o); FtG x 1 (o)	LC foraging in *Banksia integ*; perched on branch in Blackbutt; foraging in *Banksia integ*; gliding across powerline easement into Tallowwood	2149; 2155; 2159; 2206	1/4; 1/2 and 3/4 along transect	Banksia integrafolia 75% flowering	
14	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-c	30/11/2016	2231	2256	19	0	1	0	100	Melomys *spp* x 1 (o)	Perched in *Banksia integrafolia in low canopy*	2247		<5% Angophora flowering	
14	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-c	5/02/2017	0052	0117	20	1/2	0	0	30	SqG x 1 (o); FtG x 1 (o)	SqG foraging in flowering Blackbutt; FtG moving in same tree	0101; 0103	1/3 along transect	Coastal Blackbutt 5%	GHFF x 2
15	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-n	18/05/2016	1816	1841	20	3/4	0	0	90	YBG x 1 (W); Sug x 1 (O); GG x 1 (O); Sug x 1 (O)	Calling from UC of Blackbutt; Calling from unknown tree; obs perched in mid canopy of Spot Gum; Perched in UC of SFGG	1816; 1820; 1830; 1837	Start, 1/4 and 3/4 along transect	5% buds flowering CBB & Spotted Gum	
15	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-n	7/07/2016	1808	1832	14.8	1/8	0	light	0	Nil - note YBG (w) north east of end transect				5% budding only of Spotted Gum	

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
15	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-n	30/11/2016	2042	2107	20	0	1	0	40	YBG x 1 (W); Sug x 1 (W); FtG x 1 (O); GG x 1 (O); CBP x1 (O)	YBG heard calling from tree, Sug heard calling from tree, FtG obs UC of Spotted Gum moving around foraging, GG sitting in MC of Spotted Gum, CmBP perched in MC of Spotted Gum		YBG - St of transect; Sug 1/4 along; FTG 1/3 along; GG end of transect, CBP 3/4 along	40% flowering Spotted Gum	
15	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-n	4/02/2017	2349	0014	21	1/2	0	light	20	GG x 1 (o); Sug x 2 (w+o); CmBP x 1 (o)	GG perched in Spotted Gum mid canopy; Sugar perched in mc of SFGG and another in perched in *Allocasuarina*; CmBP perched in LC of SFGG	2352; 2357; 0003; 0005	1/4; 1/2 and 3/4 along transect	10% Pink Bloodwood	YBG heard calling from further to the east but off transect; AON; Southern Boobook
16	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-e	18/05/2016	2005	2030	18	3/4	0	0	80	Sug x 1 (o); FtG x 1 (o)	Foraging in *Banksia integ*; MC of Turpentine	2011; 2025	1/4 and south end	Banksia integ 60% flowering; Banksia spinulosa x 90% flowering. No upper canopy species flowering	
16	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-e	14/07/2016	1935	2000	14	1/2	0	0	0	Sug x 1 (o)	Foraging in *Banksia integ* in same manner as 1st survey	1947	1/4 q	Banksia integ 60% flowering; Banksia spinulosa x 90% flowering. No upper canopy species flowering	
16	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-e	28/11/2016	0013	0038	22	0	0	0	25	Sug x 1 (o); FtG x 1 (o)	Sug obs perched in Bastard TW; FtG observed moving along branch of Blackbutt in mid canopy	0017; 0030	1/4 and 3/4 along transect	Bastard Tallowwood 15%; Acacia (minor flowering)	GHFF x 2; AON
16	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-e	4/02/2017	2310	2335	21	1/2	0	0	15	FtG x 1 (o)	Moving in mid canopy of Bastard Tallowwood	2320	1/4 along transect	Nil	AON

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
17	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-w	20/05/2016	1848	1913	17	8/8	0	0	0	Nil				Buds only in 5% of CBB	Southern half of transect has received logging and clearing. Transect vegetation heavily disturbed
17	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-w	14/07/2016	2020	2045	6	5/8	0	0	90	Nil				Nil	YBG's recorded at northern end of transect on 5th June calling in flooded gum
17	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-w	28/11/2016	2333	2358	22	0	1	0	25	YBG x 1 (w)	Heard from gully supporting Flooded Gum	2341	1/4 through transect	Nil	AON
17	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-i-w	4/02/2017	2228	2253	23	1/2	0	0	15	Nil				5% Pink Bloodwood towards southern end	GHFF x 1
18	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-s	18/05/2016	1910	1935	19	3/4	0	0	80	Nil				5% Banksia spinulosa flowering only	
18	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-s	7/07/2016	1856	1921	13.7	0	0	0	0	GG x 1 (o); FtG x 1 (o)	Perched in MC of Blackbutt; Gliding from MC to LC	1903; 1908	GG1 and FT2	10% Spot Gum budding	YBG calling 200 SW of transect
18	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-s	30/11/2016	2135	2200	20	0	1	0	10	GG x 2 (o); CmBP x 1 (o)	GG sitting in mc of Blackbutt; CmBP perched in LC	2139; 2251	Near start and 2/3 along transect	Nil	
18	Dirty Creek Range/Rope Bridge-C2 (13040)	C2-r-s	4/02/2017	2050	2115	22	1/2	1	0	60	YBG x 1 (w); GG x 1 (o)	GG perched in Blackbutt; YBG heard from area of Blackbutt	2102; 2109	1/3 and 3/4 along transect	Pink Bloodwood <5%	AON; GHFF x 1
19	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-c	11/07/2016	2047	2112	15.6	1/2	0	0	70	Sug x 1(o)	Perched in MC/trunk of Ironbark	2101	1/2 along transect	2% flowering CBB	AON

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
19	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-c	20/05/2016	2223	2248	14	8/8	0	0	0	Sug x 1(o)	Foraging on limb in upper canopy of Tallowwood	2239	1/3 along transect	2% flowering CBB	
19	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-c	24/11/2016	0318	0343	18	0	0	0	0	Sug x 1 (o); FtG x 1 (o)	Sug perched in mc of Ironbark; FtG moving along branch of Tallowwood in mid canopy	0323; 0339	1/3 and near north end of transect	Coastal Blackbutt	Noisy site; GHFF x 2; AON
19	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-c	5/02/2017	2144	2209	23	2/3	0	0	20	FtG x 1 (o)	Observed moving in upper canopy of Tallowwood	2159	1/3 through the transect	Nil	AON
20	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-r	25/05/2016	1828	1853	12	0/8	0	0	0	YBG x 1 (w)	Calling from tree	1833	1/3 along transect	5% flowering CBB	Another YBG heard outside transect from further to NE
20	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-r	10/07/2016	1821	1846	16.9	1/2	0	0	0	GG x 1 (o)	Perched UC of Blackbutt	1837	2/3 along transect	<5% flowering of CBB	
20	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-r	24/11/2016	0230	0255	19	0	0	0	0	FtG x 1 (o)	Foraging in MC of Bastard TW	240	1/3 along transect	Bastard Tallowwood - 35% flowering	
20	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/M1-r	5/02/2017	2102	2127	24	2/3	0	0	10	YBG x 1 (w); CmBP x 1 (o); GG x 1 (o)	YBG heard around 1/4 way through transect to north; CmBP perched in mid canopy of CBB; GG x 1 perched in UC of Blackbutt	2109; 2115; 2117	1/4 and 1/2 way through transect	Bastard Tallowwood - 15% flowering; Coastal Blackbutt <5%	GHFF x 3; AON; Southern Boobook

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
21	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/i	20/05/2016	2048	2113	17	8/8	0	0	15	CRP x 1 (o)	Perched in low canopy of Acacia	2105	1/2 along transect	<5% budding flowering in Spotted Gum	Transect measured at 353 m. Recommendation for transect to be extended to standardise
21	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/i	17/07/2016	1916	1941	8	5/8	0	0	90	CRP x 1 (o)	Perched in low canopy of Acacia	1920	1/2 along transect	<5% flowering Spotted Gum and Mahogany	Appears to have been recent clearing on northern side of transect so less vegetation is being sampled over the reduced transect length leading to data sampling inconsistencies
21	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/i	23/11/2016	2127	2152	23	0	0	0	20	Nil				10% Spot Gum; 3% Ironbark; 2% Mahogany flowering	
21	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	S2/i	5/02/2017	2248	2213	22	2/3	0	0	25	FtG x 1 (o); CRP x 1 (o)	FtG moving along limb of Ironbark in UC; CRP perched in mid canopy of Acacia	2207; 2201	1/2 and near western end for FtG	Smooth-barked Apple	AON; GHFF x 1
22	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	M1-i	30/05/2016	1803	1828	15	0/8	0	0	0	Sug x 1 (o); Sug x 1 (o), CmBP x 1 (o)	Foraging in UC of Red Mahogany; Perched in UC of Ironbark, moving along ground	1819; 1827; 1833	1/4; 1/2; 3/4 along transect	20% BLPB and 20% CBB flowering	Transect location amended to address landholder access and still sampling within perceived home range for target gliders
22	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	M1-i	14/07/2016	1812	1837	9.2	5/8	0	0	100	YBG x 1 (w)	Small shrilling call repeating itself in tree	1832	1/4 and east	5% CBB flowering	GG x 1 observed east and outside 40 m transect limit
22	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	M1-i	23/11/2016	2030	2055	24	0	0	0	15	YBG x 1 (w)	Heard calling to east	2048	3/4 along transect	Nil	GHFF x 4 observed along transect
22	Dirty Creek/Veg Median-M1 (5200-6620) & Rope Br-S2 (7110)	M1-i	5/02/2017	2304	2329	22	0	0	1	20	YBG x 1 (w); CmBP x 1 (o); Sug x 1 (o)	YBG heard around 1/3 along transect call to east; CmBP observed mid canopy Ironbark and	2311; 2317; 2322	1/3; 1/2 and 3/4 along transect	Pink Bloodwood @ 15%	GHFF x 3; Southern Boobook

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
												Sug in UC of CBB perched				
23	Arrawarra Creek - Rope Bridge C1 (1860)	C1/r/s	19/05/2016	1858	1923	17	7/8	0	0	0	Sug x 1 (w)	Heard calling 1/2 through transect	1910	1/2 way	<5% Acacia flowering	
23	Arrawarra Creek - Rope Bridge C1 (1860)	C1/r/s	12/07/2016	1943	2008	16.1	1/2	0	0	0	Nil				Nil	
23	Arrawarra Creek - Rope Bridge C1 (1860)	C1/r/s	23/11/2016	2301	2326	21	0	0	0	10	FtG x 1 (o); Sug x 1 (o)	FtG foraging in mc of blackbutt; Sug in low canopy of Blackbutt foraging under bark	2308; 2315	1/4 and 1/2 way along	Nil	GHFF x 1
23	Arrawarra Creek - Rope Bridge C1 (1860)	C1/r/s	7/02/2016	0027	0052	22	2/3	0	0	20	Sug x 1 (o); FtG x 1 (o)	FtG moving along branch of *Acacia* in mid canopy; Sug foraging in LC of Blackbutt	0036; 0043	1/4 and 3/4 along transect	~ 10% Pink Bloodwood	GHFF x 3; AON x 1
24	Arrawarra Creek - Rope Bridge C1 (1860)	C1-r-n	19/05/2016	1811	1836	17	7/8	0	0	0	Sug x 1 (O); SqG x 1 (o); SqG x 1 (o)	Foraging on gum in low canopy of Acacia; Perched in Allocasuarina, Perched in regrowth eucalypt	1818; 1830; 1835	4/5 through transect	<5% CBB and Sp. G	
24	Arrawarra Creek - Rope Bridge C1 (1860)	C1-r-n	12/07/2016	1850	1915	15.5	1/2	0	0	0	Sug x 2 (o)	Perched in low canopy of Tallowwood and other in Mahogany on trunk foraging <5 m away	1853; 1854	1/4 along transect both	5% Sp. Gum and CBB	Productive riparian country in northern end of transect
24	Arrawarra Creek - Rope Bridge C1 (1860)	C1-r-n	23/11/2016	2217	2242	21	0	0	0	35	Sug x 2 (o)	Both foraging in mid canopy of Acacia	2232; 2238	1/2 and near end of transect	5% Mahogany and 2% Spotted Gum flowering	

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
24	Arrawarra Creek - Rope Bridge C1 (1860)	C1-r-n	6/02/2016	2045	2110	24	2/3	0	0	15	Sug x 2 (o)	On trunk of Blackbutt mid canopy foraging under bark; second perched in Acacia in mid canopy	2100; 2107	1/2 and near end of transect	Nil	Productive in northern 1/2 of transect
25	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-w	19/05/2016	2020	2045	16	7/8	0	0	0	CRP x 1 (o)	Observed in mid canopy of Broad-leaved Paperbark	2035	3/4 way through	7% flowering BLPB	Lost northern eastern side of monitoring transect. Dense vegetation making detection difficult
25	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-w	12/07/2016	2300	2325	14.8	1/2	0	0	0	Nil				<5% Mistletoe flowering	
25	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-w	23/11/2016	2358	0023	20	0	0	0	15	Nil				Nil	Difficult site to spotlight with closed forest
25	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-w	6/02/2017	2130	2155	24	2/3	0	0	20	FtG x 1 (o)	Moving along branch of an Ironbark in mid canopy	2142	1/3 along transect	Nil	
26	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-e	19/05/2016	2110	2135	14	7/8	0	0	0	Nil				10% flowering BLPB	
26	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-e	12/07/2016	2347	0012	13.5	1/2	0	0	10	CmBP x 1 (o)	Perched in UC of *Mel quin*	2359	2/3 along transect	Forest Red Gum and Swamp Mahogany very sparse but flowering 60%	
26	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-e	24/11/2016	0032	0057	20	0	0	0	15	CmBP x 1 (o)	Perched in low canopy in *Mel quin*	42	Near Start of transect	Nil	
26	Arrawarra Creek - Rope Bridge C1 (1860)	C1-i-e	6/02/2017	2327	2353	22	2/3	0	0	10	CmBP x 1 (o)	Perched in mc of *Mel quin*	2245	1/2 along transect	Nil	
27	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-w	19/05/2016	2230	2255	14	7/8	0	0	0	SqG x 1 (o)	Perched in LC of Cheese Tree	2243	3/4 along transect	5% BLPB flowering; 20% CBB flowering	

Site	Management Area	Treatment Class	Date	Start Time	Finish Time	Air Temp	Moon	Rainfall	Wind	Cloud Cover	Glider Species Recorded	Behaviour	Time	Location	Presence of Flowering Trees and Shrubs	Comments/Notes
27	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-w	12/07/2016	2132	2157	14.9	1/2	0	0	35	Sug x 1 (o); FtG x 2 (o)	Using nest box (rear entry glider in Pink BW) carrying nesting material in form of green leaves; foraging in mistletoe, moving into a shrub	2139; 2153; 2157	start, 1/4 and 2/3 along transect	60% flowering mistletoe and 10% CBB	
27	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-w	24/11/2016	0140	0205	20	0	0	0	0	Nil				Nil	
27	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-w	6/02/2017	2247	2312	23	2/3	0	0	0	Sug x 1 (o); FtG x 1 (o)	Sug in flowering Pink Bloodwood; FtG moving along branch in *Mel quin*	2256; 2308	1/4 along and 3/4 along transect	Nil	
28	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-e	19/05/2016	2150	2215	14	7/8	0	0	0	CmBP x 1 (o)	Perched in UC of *Mel quin*	2201	1/2 way	5% of CBB and 15% mistletoe; BLPB 30%	
28	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-e	12/07/2016	2215	2240	17	1/2	0	0	30	Nil				Mistletoe 5% and CBB 10%	
28	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-e	24/11/2016	0107	0132	20	0	0	0	0	CRP x 1 (o); CmBP x 1 (o)	CRP perched in low canopy of *Mel quin*; CmBP foraging UC	0111; 0116	St and 1/3 along transect	1% Mahogany flowering	
28	Arrawarra Creek - Rope Bridge C1 (1860)	C1-c-e	6/02/2017	2208	2233	23	2/3	0	0	15	CmBP x 1 (o); FtG x 1(o)	FtG in flowering PBW; CmBP perched in *Mel quin*	2213; 2217	St and first 1/4 of transect	10% Pink Bloodwood	