Flyers Creek Wind Farm Pty Ltd

Flyers Creek WIND FARM

Environmental Assessment

APPENDIX E
Avifauna - Bats

AN ASSESSMENT OF THE BAT FAUNA AT THE PROPOSED FLYERS CREEK WIND FARM, NSW

Prepared by Dr G.C. Richards

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Greg Richards and Associates Pty Ltd
Australasian Bat Fauna Specialists
Postal: P.O. Box 9, Gungahlin, ACT 2912
Office: 23 Tanderra Crescent, Ngunnawal, ACT
Phones: 02 6255 0606 0408 221 520
Email: batman3812@bigpond.com
ABN 99 074 890 823

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CONTENTS

[1] This is a requirement of the consultant's insurance company.

EXECUTIVE SUMMARY

The consultant was commissioned by Aurecon Australia Pty Ltd to conduct an assessment of the bat fauna at the proposed Flyers Creek Wind Farm. The project area is located between the township of Carcoar and the Cadia mining operation in the central west of NSW, where the landscape generally consists of extensive areas of open pasture and woodland remnants. The assessment was conducted in two stages: firstly at meteorological towers where bat activity at 50-60 m high was compared with that at ground level, then secondly at a range of woodland remnants that varied in habitat quality.

All ten sampling sites were monitored with Anabat^{TM} echolocation call detection systems where calls were recorded from dusk to dawn, either for 9 consecutive nights (Stage 1) or 11 consecutive nights (Stage 2). The ten monitoring sites were within the project area or very close to the project boundary.

Ten bat species were recorded overall during the bat fauna assessment, including one threatened species, from a total of 280 calls at towers and 7120 calls at woodland remnants. Therefore, bat utilisation for the sites representative of the proposed wind turbine locations (i.e. the wind monitoring masts) was significantly lower than for the remnants woodlands which are predominantly located at lower elevations away from proposed turbine locations. In addition, the bat utilisation recorded ~50 metres above ground level on the masts, representative of the rotor swept area, was lower still. Thus, iIt was shown that open pasture with scattered trees was very poor habitat for bats, and the highest level of activity was recorded in high quality woodland remnants, such as those with a shrubby understorey from which grazing by livestock was excluded.

The Yellow-bellied Sheathtail Bat, listed as Vulnerable in NSW legislation, was recorded at one of the towers in the centre of the project area, and at two high quality woodland remnants. All records were from just a few calls, and only on occasional nights during the survey period. Based on extensive previous studies, it was shown that major populations of this species in the region require much larger tracts of habitat than would be found in the wind farm project area, which was supported by the low level of recording this species.

Impacts that can potentially occur from wind farm developments include habitat loss and collision with turbines.

The habitat utilization patterns indicated that there would be some impact upon bat populations in general if there was major habitat clearance proposed in high quality remnants; that is, those that are large and have an ungrazed understorey. As such, avoidance of clearing of remnant native trees is encouraged, and the proponent has indicated that few parts of the remnant woodland are to be cleared. The turbine sites and routes of tracks and cables will avoid most of the scattered remnant trees and larger stands of woodland. Intervening pasture areas are predominantly exotic pasture and are largely where the wind turbines are proposed to be located.

The closest wind turbine to a high quality woodland remnant, where bat activity is high, is turbine 20 high above Remnant 7 on a cleared hill about 500 metres to the north. At this distance, significant numbers of collisions by bats with turbine blades would not be expected. The other two high quality woodland remnants on the project site are about a kilometre to the nearest proposed turbine. Therefore, the number of collisions by bats with turbines or flight effects from turbulence from blade movement through the air would be

expected to be low for the current turbine layout, including potential impacts involving threatened species.

It has been shown in a previous study that the Yellow-bellied Sheathtail Bat requires large tracts of habitat to maintain high numbers in the regional community. Very large remnants are not present in the project area. Therefore, no significant impact upon the local or regional populations of the Yellow-bellied Sheathtail Bat is expected, due to the small size of woodland remnants within the project area, its occasional occurrence and very low bat activity when present.

Consideration of the potential impacts relevant to EPBC Act matters has been undertaken and with the incorporation of the mitigation measures outlined in this report it is considered that a referral under the Act is not warranted.

INTRODUCTION

The consultant was commissioned by Aurecon Australia Pty Ltd to conduct an assessment of the bat fauna at the proposed Flyers Creek Wind Farm. The project area is located between the township of Carcoar and the Cadia mining operation in the central west of NSW. The landscape consists of extensive areas of open pasture, interspersed with scattered trees and occasional woodland remnants.

Extensive field studies have been conducted elsewhere in the region by the author, particularly in relation to habitat utilisation patterns of threatened bat species known from the area. This background information led to the field assessment being focused on woodland remnants, known to be core areas for bats. Several meteorological towers were also available for the monitoring of activity of high flying species, and these were located in open pasture. When combined, the data was expected to provide a valuable comparison of bat activity between this habitat type and woodland remnants of varying sizes.

BACKGROUND INFORMATION

Background information specific to the region and available to the author included:

- 2001 – Bat fauna monitoring at Wire Gully, Ridgeway Gold Mine (Greg Richards and Associates Pty Ltd 2001)
- 2004 - Bat fauna assessment in infrastructure zones at the Ridgeway mining project (Cadia area) (Greg Richards and Associates Pty Ltd 2005)
- 2006 – Bat fauna assessment of an area extending the southern tailings dam at the Cadia mine (Greg Richards and Associates Pty Ltd 2007)
- 2007 – Assessment of habitat requirements of the Yellow-bellied Sheathtail Bat (within Greg Richards and Associates Pty Ltd 2007) in the south Orange district
- 2007 – Assessment of the bat fauna at a proposed tailings dam to the south of the Cadia gold mine (Richards 2007)

A species list for the region, generated from the background information, is shown in Table 1. This list also includes records from the NSW Wildlife Atlas.

Table 1: Bat species recorded since 2001 in the Cadia – Orange District in close vicinity to the proposed Flyers Creek Wind Farm.
TSC Act = the NSW Threatened Species and Conservation Act, EPBC Act = Environment Protection and Biodiversity Conservation Act, V = listed as Vulnerable, CD = listed as Conservation Dependent. Nomenclature follows Churchill (2008).

Common Name	Taxon	Conservation Status	
		TSC Act	EPBC Act
Sheathtail Bats	**Emballonuridae**		
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	V	-
Freetail Bats	**Molossidae**		
Inland Freetail Bat	*Mormopterus* sp.2	-	-
Southern Freetail Bat	*Mormopterus* sp.4		
White-striped Freetail Bat	*Austronomus australis*	-	-
Ordinary Bats	**Vespertilionidae**		
Gould's Wattled Bat	*Chalinolobus gouldii*	-	-
Chocolate Wattled Bat	*Chalinolobus morio*	-	-
Large Bentwing Bat	*Miniopterus schreibersii*	V	CD
Large-footed Myotis	*Myotis macropus*	V	
Lesser Longeared Bat	*Nyctophilus geoffroyi*	-	-
Gould's Longeared Bat	*Nyctophilus gouldi*	-	-
Little Broadnosed Bat	*Scotorepens greyii*		
Large Forest Bat	*Vespadelus darlingtoni*	-	-
Eastern Forest Bat	*Vespadelus pumilus*		
Southern Forest Bat	*Vespadelus regulus*	-	-
Little Forest Bat	*Vespadelus vulturnus*	-	-

METHODS

Survey Strategy

The bat fauna assessment was designed to obtain baseline data on bat fauna species that were utilising the study area and surrounds, and to target bat fauna species listed in the Schedules of the NSW *Threatened Species Conservation Act, 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*. The surveys closely followed the NSW Department of Environment and Conservation *Threatened Biodiversity Survey and Assessment Guidelines* (working draft dated November 2004). These guidelines require a minimum of four consecutive nights of detection, but experience in open and degraded pastures at other wind farm sites led to longer operating periods (9-11 nights) being used.

The study involved a two-stage process. Detectors were placed at monitoring towers in November 2008 to obtain data on high flying species. Three towers were monitored with detectors at heights in the range 50-70 metres above ground, and at two of them another detector operated at ground level at the same time. In this stage of the assessment, data was obtained from what would be considered poor bat habitat: open pasture with occasional scattered trees.

The second stage involved the monitoring of bat communities in woodland remnants. This habitat had been identified in previous regional studies as being focus areas for the local bat community. Seven large (for the local area) remnants were selected with a different range of habitat quality. One of the many factors that determines bat community structure is the extent and type of understorey present in an ecosystem (Richards 2001), so the remnants for bat monitoring were selected on the basis of understorey type and whether or not it had been grazed.

Targeted Surveys for Threatened Species

The list of threatened bat species listed in the NSW *Threatened Species Conservation Act, 1995* and/or Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* known and/or considered possible occurrences within the wider region was reviewed prior to the study to ensure that appropriate field methods were selected to target threatened species. It was concluded that all of the threatened bat species could be recorded via the electronic detection of echolocation calls, with the exception of the Greater Long-eared Bat and the Grey-headed Flying Fox.

Surveys that target the Greater Longeared Bat are fraught with difficulty and are unreliable. A consensus of ten experts indicated that a wide variety of methods can be used, but these are dependent upon the type of habitat and/or locality that is being assessed (Richards *et al* 2004). Harp trapping is the most reliable method, but these devices do not operate efficiently in open habitats such as the woodland communities within the study area.

To assess the usage of the study area by Grey-headed Flying Foxes (*Pteropus poliocephalus*), observations of flowering trees were made throughout the daytime whilst traversing the study area during both surveys. If any areas were established as possibly providing a food source for these nectarivorous bats, then these areas were to be inspected by spotlight to establish presence/absence of this species. However, because no eucalypts were flowering in the study area, and flying foxes are rarely seen in the region, they were not included in the current study.

Electronic Bat Call Detection

All ten sampling sites were monitored with Anabat^{TM} echolocation call detection systems each linked to a Zcaim which allowed data to be recorded onto a compact flash card for later analysis. Calls were recorded from dusk to dawn, with monitoring

being conducted for nine consecutive nights at meteorological towers, and 11-12 consecutive nights at woodland remnants.

Automated bat detectors (Anabat systems) were used to monitor bat activity at the three meteorological towers in the project area, the locations of which are shown in Table 2 and Figure 1. Detectors were raised by rope and pulley near the top of the tower, and being fitted with lithium batteries operated for 9 consecutive nights

RESULTS AND DISCUSSION

Sampling Sites and Weather Conditions

The location and brief description of the ten sampling sites is shown in Table 2, and the sampling stratification across major habitat types is shown in Table 3. The stratification accordingly allowed a reasonable sample of the way the local bat community selected habitats, information essential to the design and operation of the wind farm facility.

During the tower monitoring period (30 October - 7 November 2008), weather conditions were suitable for generating a reasonable bat survey. Temperatures for the November period, taken from the Bureau of Meteorology website, are shown in Table 4. There were no significant falls of rain.

During the period that woodland remnants were monitored (3 – 13 March 2009), weather conditions were also suitable for generating a reasonable bat survey, apart from a cold period on 6 and 7 March. On these nights, bat activity was less than 20% of the maximal level recorded on other nights.

Table 2: Location and description of ten sampling sites used in the bat fauna assessment at the proposed Flyers Creek Wind Farm.

Sampling site	Latitude (S)	Longitude (E)	Habitat description
Towers			
M-1	33°35.335	149°04.308	Open pasture, large remnant approx. 300 m to the east
M-2	33°32.582	149°04.308	Open pasture with a few scattered trees
M-3	33°30.164	149°04.667	Open pasture with a few scattered trees
Remnants			
R-1	33°35.731	149°05.405	Large remnant, watercourse running through it, grass understorey, lightly grazed
R-2	33°33.857	149°04.275	Very small remnant, grass understorey, heavily grazed
R-3	33°32.082	149°04.252	Small remnant, densely spaced trees, grass understorey, grazed
R-4	33°30.373	149°03.841	Large remnant, widely spaced trees, grass understorey, grazed, dry watercourse running through it, linked to large area of scattered trees
R-5	33°31.297	149°06.094	Very large remnant, shrub and grass understorey, lightly grazed, stock dam in vicinity
R-6	33°33.498	149°05.664	Large remnant, densely spaced trees, shrub and sapling understorey with grass, probably never grazed
R-7	33°34.242	149°05.068	Large remnant with patches of dense regrowth, forms a corridor to other large remnants, stock dam nearby

Figure 1: Proposed layout of the Flyers Creek Wind Farm, showing location of meteorological towers, 44 potential locations for wind turbines and access track routes.

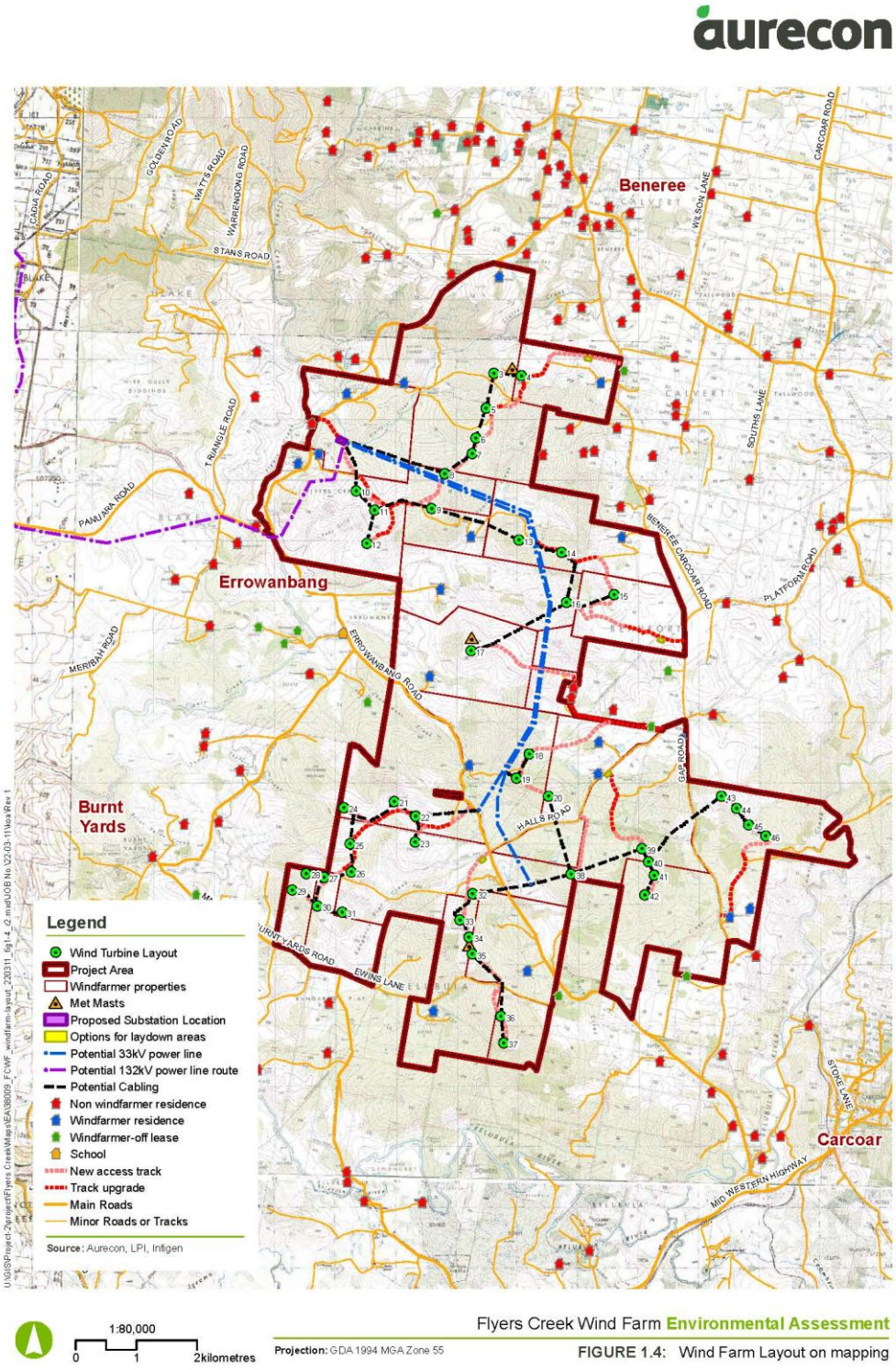


Figure 2: Aerial photograph of the northern portion of the proposed Flyers Creek Wind Farm, showing location of sampling sites.

Figure 3: Aerial photograph of the southern portion of the proposed Flyers Creek Wind Farm, showing location of sampling sites.

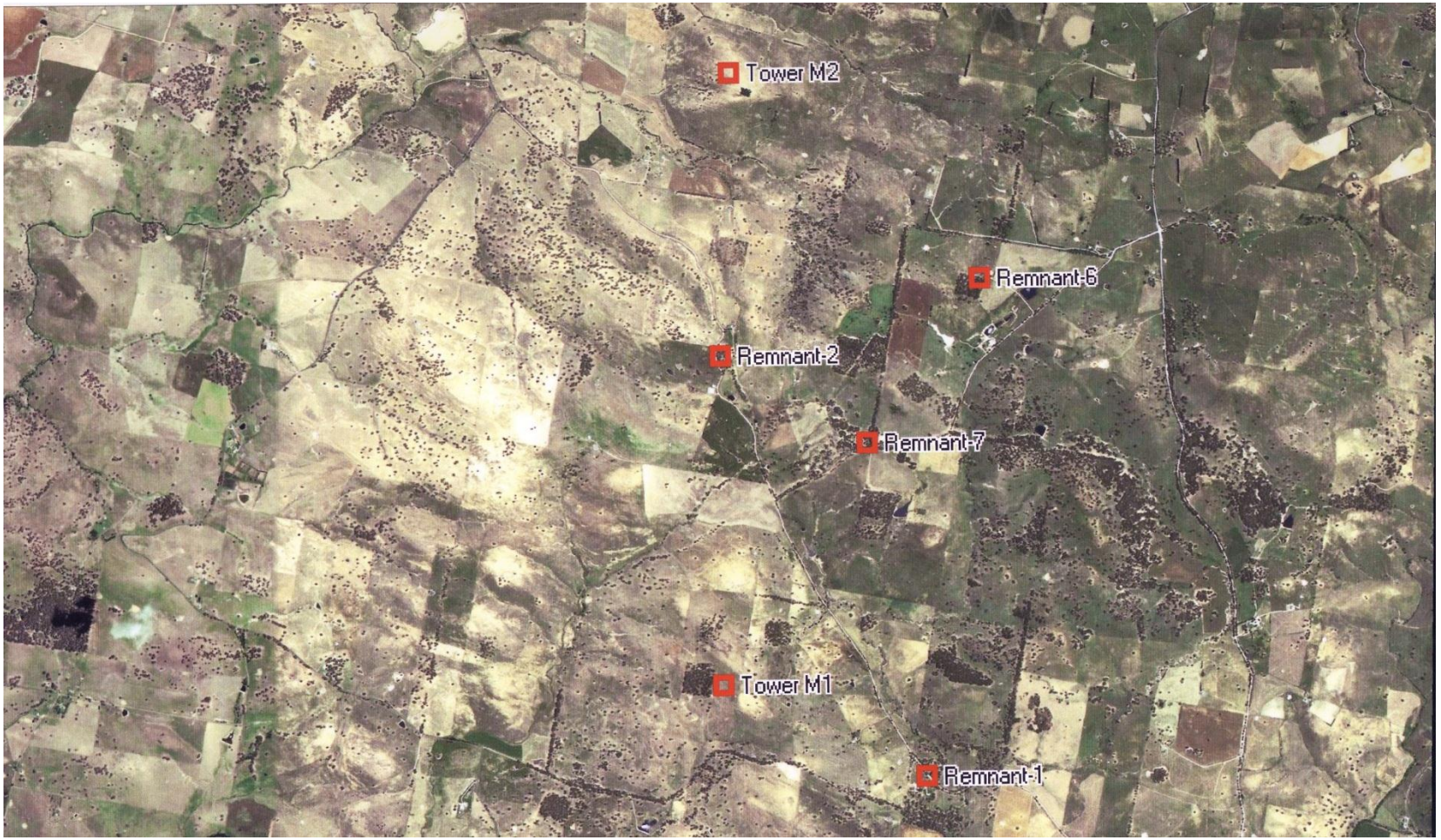


Table 3: Stratification of sampling sites across major habitat types at the proposed Flyers Creek Wind Farm.

Habitat type	Grazed	Light or no grazing	Totals
Open pasture, occasional trees	3		3
Small remnants	2		2
Large remnants	2	3	5
Totals	7	3	10

Table 4: Overnight minimum temperature data recorded by the Bureau of Meteorology at the Orange weather station during the period that bat activity was monitored at the proposed Flyers Creek Wind Farm. The cool period that affected bat activity in woodland remnants is shown in bold. "nd" indicates no data.

Towers		Remnants	
Date	Minimum °C	Date	Minimum °C
30-Oct	nd	3-Mar	13
31-Oct	nd	4-Mar	10
1-Nov	8	5-Mar	7
2-Nov	11	**6-Mar**	**0**
3-Nov	13	**7-Mar**	**2**
4-Nov	5	8-Mar	6
5-Nov	7	9-Mar	12
6-Nov	6	10-Mar	12
7-Nov	6	11-Mar	10
		12-Mar	12
		13-Mar	14

Bat Species Recorded at Meteorological Towers

Ten bat species were recorded overall during the bat fauna assessment, nine of which were recorded at towers in open pasture, the exception being the Chocolate Wattled Bat. At the two towers with paired bat detectors, only a quarter of the calls recorded at ground level (210 calls) were recorded by the detector at a height of 50-60 metres (50), indicating a highly reduced level of activity in the Rotor-Swept-Area (RSA) over the nine nights (Table 5).

Some species such as Longeared Bats were not recorded at all in the RSA, and most others had reduced activity at that height (Table 6). A notable exception was the Yellow-bellied Sheathtail Bat (listed as Vulnerable in the NSW TSC Act), which will be addressed in a section below.

Table 5: Total calls recorded from bat monitoring at three meteorological towers (M-1, M-2, M-3) at the proposed Flyers Creek Wind Farm. Numbers in cells are the total calls recorded over seven nights of study. Species mnemonics are Cgou = *Chalinolobus gouldii*, Mor -2 = *Mormopterus* sp 2, Mor-4 = *Mormopterus* sp 4, Nyct = *Nyctophilus* spp. (not identifiable to species level), Sflv = *Saccolaimus flaviventris*, Aaus = *Austronomus australis*, Vdar = *Vespadelus darlingtoni*, Vreg = *Vespadelus regulus*, Vvul = *V. vulturnus*. No bat detection was conducted on the ground at Tower M1.

Location		Cgou	Mor-4	Mor-2	Nyct	Sflv	Aaus	Vdar	Vreg	Vvul	Totals
M-1	Tower	1	6	-	-	-	10	1	1	1	20
M-2	Ground	10	58	4	1	1	64	6	2	-	146
M-2	Tower	1	4	1	-	3	20	-	-	-	29
M-3	Ground	7	15	-	6	-	21	6	3	6	64
M-3	Tower	2	5	-	-	-	10	2	1	1	21
	Totals	21	88	5	7	4	125	15	7	8	280

Table 6: Differences in bat activity at two sampling sites at ground level compared with simultaneous recordings at 50-60 metres high in the Rotor-Swept-Area (RSA). Bat species mnemonics as shown in Table 5.

Species	Ground detection		RSA detection		% of calls in RSA
	Total calls	Calls/detector	Total calls	Calls/detector	
Cgou	17	8.5	4	1.3	24
Mor.4	73	36.5	15	5.0	21
Mor.2	4	2.0	1	0.3	25
Nyct	7	3.5	0	0	0
Sflv	1	0.5	3	1.0	300
Aaus	85	42.5	40	13.3	47
Vdar	12	6.0	3	1.0	25
Vreg	5	2.5	2	0.7	40
Vvul	6	3.0	2	0.7	33

Effects of Cool Weather

As mentioned above, there appeared to be an effect from several cold nights upon bat activity, as indicated by the low number of calls when air temperature approached freezing when woodland remnants were assessed. The minimum temperature profile is shown In Figure 4 and the relationship with the overnight minima is shown in Figure 5. At most of the remnants, although some species foraged on cold nights, several were not recorded on the two cold nights yet had been recorded on warmer nights; these included the Chocolate Wattled Bat, the Inland Freetail Bat, the Southern Freetail Bat and the Longeared Bat species. This response emphasizes the importance of conducting bat fauna surveys at appropriate

times of the year, but also gives an insight into temperatures when bats will not be interacting with wind turbines.

Figure 4: Minimum overnight temperature profile during the period when woodland remnants were assessed in March 2009, observed to have affected bat activity (see Figure 5).

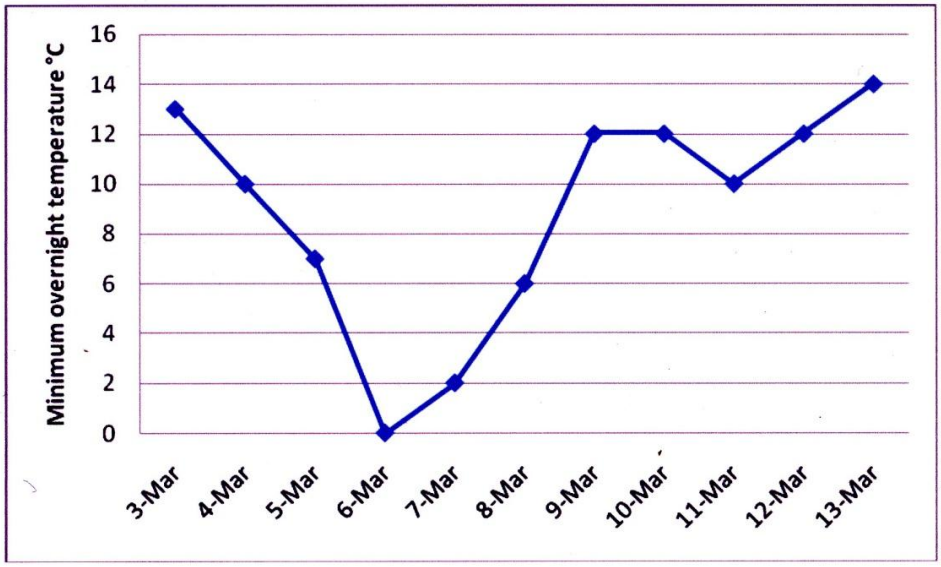
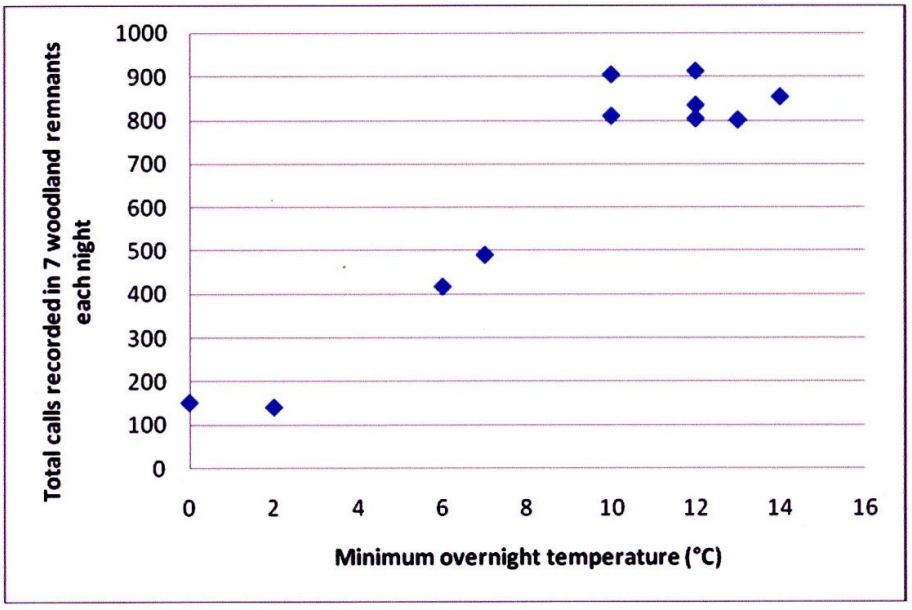


Figure 5: Relationship between overnight minimum temperatures and bat activity in woodland remnants in March 2009, indicating that cold conditions can affect the level of activity and species recorded during surveys.



Bat Species Recorded in Woodland Remnants

Ten of the microbats recorded in the region (Table 1) were detected in remnants during the current assessment, from a total of 7120 identifiable echolocation calls over 11 nights (Table 7). Raw data is provided in Appendix 1. Those species not recorded included the Little Broad-nosed Bat, the Eastern Forest Bat, the Large Bentwing Bat and the Large-footed Myotis. The latter species, listed as Vulnerable in the TSC Act and Conservation Dependent in the EPBC Act, is primarily found in caves south of the Belubula River, and occasionally in extensive tracts of woodland such as Black Rock Ridge to the west. The Belubula River would also provide foraging habitat for the Large-footed Myotis.

Table 7: Total number of calls recorded from bat species present in woodland remnants at the proposed Flyers Creek Wind Farm. Bat species mnemonics as shown in Table 5.

Site	Aaus	Cgou	Cmor	Mor.2	Mor.4	Nyct	Sflv	Vdar	Vreg	Vvul	Totals
R-1	65	130	137	16	119	63	0	92	429	74	1125
R-2	31	47	46	5	38	20	0	36	141	14	378
R-3	43	60	54	0	52	22	0	36	203	18	488
R-4	56	130	153	21	166	60	0	74	299	25	984
R-5	62	154	157	19	144	65	6	94	572	70	1343
R-6	64	186	186	40	150	85	1	126	619	79	1536
R-7	64	162	170	20	162	89	0	112	437	50	1266
Totals	385	869	903	121	831	404	7	570	2700	330	7120

Habitat Value of Woodland Remnants

The stratification of the sampling sites allowed an analysis of the value of woodland remnants of varying quality to the local bat community, and a comparison of remnants with open pasture. Results can have a bearing on the planning of turbine locations and the impact analysis of the wind farm facility.

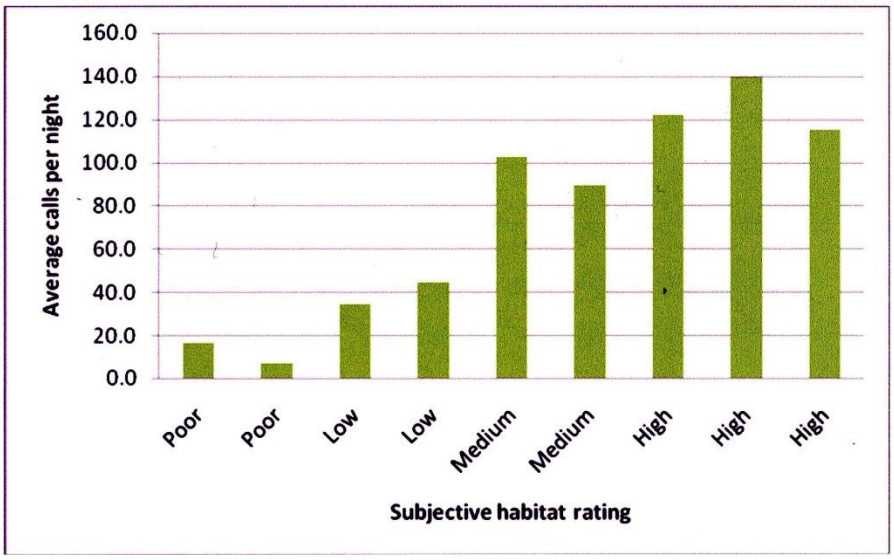
Although ten sites had been sampled, ground level data was not collected for site M-1, a meteorological tower in open pasture that was not monitored at ground level. The remaining nine sites were assessed using a subjective classification that was given to each, based on overstorey type, understorey quality, and the extent of grazing by livestock, as shown in Table 8 and Figure 6.

Because there was a different length of sampling period during the two stages of the assessment, and there were obvious weather effects during the second stage, the data was ordinated to the number of calls recorded per night. Notably, bats used poor habitat such as open pasture very infrequently, with less than 20 calls per night being recorded. In contrast, woodland remnants that were lightly (or never) grazed had the highest levels of bat activity, with as much as 140 calls per night being recorded.

Table 8: A subjective assessment of nine sampling sites in the proposed Flyers Creek Wind Farm, ranked by a "habitat rating".

Site	Habitat type	Understorey	Grazing level	Bat habitat quality rating	Total calls recorded in survey	Number of survey nights	Average calls per night
M-1	Open pasture	Pasture	Medium	Poor	20	7	2.9
M-2	Open pasture with scattered trees	Pasture	Heavy	Poor	146	9	16.2
M-3	Open pasture with scattered trees	Pasture	Heavy	Poor	64	9	7.1
R-2	Small woodland remnant	Grass	Heavy	Poor	378	11	34.4
R-3	Small woodland remnant, dense trees	Grass	Medium	Medium	488	11	44.4
R-1	Large woodland remnant, small watercourse	Grass	Light	Medium	1125	11	102.3
R-4	Large woodland remnant, stock dam in vicinity	Grass	Heavy	Medium	984	11	89.5
R-5	Very large woodland remnant, stock dam in vicinity	Shrubs and grass	Light	High	1343	11	122.1
R-6	Large woodland remnant, densely spaced trees	Saplings, shrubs, grass	None	High	1536	11	139.6
R-7	Large woodland remnant, corridor to other remnants, stock dam in vicinity	Grass	Medium	High	1266	11	115.1

Figure 6: Activity patterns at sampling sites in the proposed Flyers Creek Wind Farm. The two sites in the "Poor" habitat classification were open pasture with nearby scattered trees at meteorological towers, the remainder were woodland remnants of varying quality based on understorey levels and grazing intensity.



Note: The columns in Figure 6 above correspond to Sites M2, M3, R2, R3, R1, R4, R5, R6 and R7 respectively from left to right as per sequence in Table 8. M1 (the poorest site with 2.9 calls per night) is not shown because it would not appear as a y-axis value.

Threatened Species

The Yellow-bellied Sheathtail Bat , which is listed as Vulnerable in the NSW Threatened Species Conservation Act, was recorded at Tower M-2 in the centre of the project area, and at woodland remnants R-5 and R-6. All records were from just a few calls, and only on occasional nights during the survey period (Table 9). Notably, this species was not recorded at any of the other seven sampling sites.

Table 9: Number of calls recorded from Yellow-bellied Sheathtail Bats during the proposed Flyers Creek Wind Farm bat fauna assessment.

	Sampling site		
	M-2	R-5	R-6
31-Oct	3		
3-Mar		2	
8-Mar		1	1
9-Mar		3	
Total calls		6	1
Number of nights present	1	3	1
Total sampling nights	9	11	11
Proportion of nights present	0.11	0.27	0.09

This species was expected in the region (Table 1), and it has been recorded at an average of 3.0 – 3.6 calls per night throughout the adjacent Cadia mining lease over a number of years (Greg Richards and Associates Pty Ltd 2005).

There is extensive information on this species that is available from the Greg Richards and Associates Pty Ltd (2005) study that can provide an initial insight into its expected relative abundance in the project area. The purpose of the aforementioned research was to identify the size of remnants in the Orange District that supported reasonable (and probably viable) populations of this species.

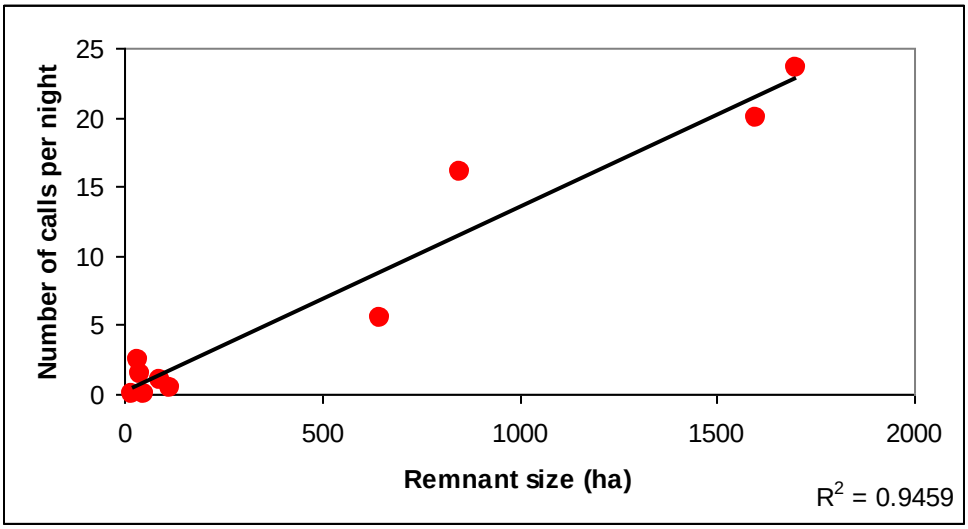
In the Greg Richards and Associates Pty Ltd (2005) study, ten woodland/open forest remnants were surveyed in November 2004, and the number of Yellow-bellied Sheathtail Bat calls recorded are shown in Table 10. Basically, the 2004 survey examined the relative abundance of this species in remnants that ranged in size from 20 – 1700 hectares. Regression analysis showed that the number of calls recorded (which bears some relationship to species relative abundance) was highly correlated (R^2 = 0.9459) with the approximate size of the remnants studied (Figure 7).

It can be seen from Figure 7 that for relative abundance to exceed an average of 5 calls per night, then remnant size would need to exceed 650 ha, but to dramatically increase to an average of 16.0 calls per night then remnant size must be 850 hectares or larger. The size of remnants for Flyers Creek project area is generally less than 50 hectares with most remnant woodland being low density scattered trees with exotic pasture groundcover.

Table 10: Results of a survey of the Yellow-bellied Sheathtail Bat in woodland remnants in the Cadia-Orange District, November 2004.

Remnant location	Approximate remnant size (ha)	Number of Yellow-bellied Sheathtail Bat calls recorded per night
Just east of Cadia East Remnant	50	0
Ashleigh Park	20	0
Ridgeway - side of western ridge	115	0.5
Black Mountain	90	1.0
Ridgeway - Cadialong Dam area	40	1.5
Ashleigh Park	35	2.5
Lapstone Hill	650	5.5
Black Rock Ridge	850	16.0
Lees Mountain	1600	20.0
Mount Canobolas	1700	23.5

Figure 7: Relationship between the size of remnants surveyed in the Cadia Valley region in 2004 and the number of Yellow-bellied Sheathtail Bat calls recorded.



The Eastern Bentwing Bat is known from the region, but was not recorded at the time of survey (March 2009), a time of year when the breeding population at Wee Jasper and Bungonia, NSW, would have been dispersing to wintering caves. This species was recorded infrequently in previous surveys in relation to the gold mining operation at Cadia (approximately 20 km south of Orange). Two surveys (Autumn and Spring 2004) were carried out in a large woodland remnant, totaling 56 survey nights and producing 10,018 calls. Only 30 of these were Eastern Bentwing Bats (Richards unpublished). In another survey nearby, in pastureland with scattered trees and small remnants and totaling 40 survey nights that produced 9212 calls, no Eastern Bentwing Bats were recorded (Richards unpublished).

The Large-footed Myotis was not recorded during the Flyers Creek wind farm survey, and no preferred foraging habitat (open, smooth-flowing water) is found in the project area. No Large-footed Myotis were recorded in the surveys at Cadia cited in the preceding paragraph.

IMPACT ASSESSMENT

Impacts that can potentially occur for bat species from wind farm developments include habitat loss or disturbance during the construction phase and once operational, collision of bats with turbines or air turbulence or pressure effects that result in injury or mortality (barotrauma).

The habitat utilization patterns described above indicate that there could be some impact upon bat populations in general (whether threatened species are present or not) if there was major habitat clearance proposed in high quality remnants; that is, those that are large and have an ungrazed understorey However, such areas are not present in the project area and the proponent has indicated that turbines will generally be located on cleared ridges and avoid significant remnants. In addition, large mature trees will be avoided and retained wherever possible. Therefore, the impact of this project on bat populations would be predicted to be low. Some clearing of isolated trees may be necessary and in these cases should be undertaken in conjunction with an appropriate ecologist.

The closest wind turbine to a high quality woodland remnant, where bat activity is high, is turbine 20 high above Remnant 7 on a cleared hill about 500 metres to the north. At this distance, significant numbers of collisions by bats with turbine blades would not be expected. The other two high quality woodland remnants on the project site are even further away, about a kilometer to the nearest proposed turbine. Therefore, the number of collisions by bats with turbine blades or flight effects from turbulence from the blades movement through the air would be expected to be low for the current turbine layout, including potential impacts involving threatened species.

Due to the low level of activity of the Yellow-bellied Sheathtail Bat, a significant impact upon the local (site) population would not be expected. This conclusion is supported by the fact that this species requires large areas of habitat, and the regional population is focused upon major tracts of habitat that exceed hundreds of hectares in size (no such areas are within the project area).

Consideration of the potential impacts relevant to EPBC Act matters has been undertaken and with the incorporation of the mitigation measures outlined in this report it is considered that a referral under the Act is not warranted.

Barotrauma Issues

Considering that echolocating bats can detect moving objects better than stationary ones, and can especially detect small insects, it is difficult to understand why fatalities occur at turbines. It is highly likely that bats that suffer barotrauma (expansion of air in the lungs in zones of low air pressure) do in fact detect a moving turbine blade and swerve to avoid the tip. However, the zone of low pressure at the tip may extend quite a distance away, due to vortices that occur downwind from the blade.

Baerwald *et al* (2007) examined 87 bat carcasses found beneath turbines, that showed no external injuries. They noted pulmonary haemorrhage and similar lung injuries when the bats were dissected, indicators of decompression. Pressure differences as low a 4 kPa are lethal to Norway rats (Dreyfuss *et al* 1985), and pressure drops at moving turbine blades can be in the range of 5-10 kPa (Baerwald *et al* 2007). Bats have larger lungs and hearts than most other mammals, and have blood-gas barriers that are also much thinner (Maina and King 1984), hence would be more susceptible to barotrauma.

It would seem to be extremely difficult to mitigate for bat barotrauma at any wind turbine, and although currently under development, deterrent devices using ultrasound are not currently commercially available.

MITIGATION MEASURES

It is recommended that the following measures be adopted for the project to mitigate its impact on bat species.

- Targeted monitoring at relevant times would reveal more information about the annual cycle of the Eastern Bentwing bat to confirm whether or not it is present in the project area at any time of the year.
- Clearing of mature trees is to be avoided by the project design
- Where clearing of mature trees cannot be avoided then a suitably qualified specialist should be consulted to assist with selection of the least impact arrangement

- Any clearing of mature trees should be undertaken so as to lower the tree with hollow sections facing up so that any bats roosting within the tree have the chance to escape
- Consideration be given to monitoring of impacts in at least the first year of operation

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APPENDIX 1: Tabulation of raw data obtained from woodland remnants sampled in the proposed Flyers Creek Wind Farm

Remnant R-1	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	Totals	Average
A.australis	6	4	4	6	6	4	7	5	9	8	6	65	5.9
C.gouldii	16	14	13	2	-	9	16	19	14	14	13	130	11.8
C.morio	17	16	12	5	9	11	13	11	15	12	16	137	12.5
Mormopterus sp.2	2	3	1	-	-	-	2	2	2	-	4	16	1.5
Mormopterus sp.4	12	15	7	-	-	5	20	17	11	21	11	119	10.8
Nyctophilus spp.	8	7	6	-	4	5	7	6	5	7	8	63	5.7
S.flaviventris	-	-	-	-	-	-	-	-	-	-	-	0	0.0
V.darlingtoni	11	11	9	1	-	11	11	10	7	8	13	92	8.4
V.regulus	43	55	12	8	5	30	57	56	45	61	57	429	39.0
V.vulturnus	9	5	3	3	-	7	8	9	10	11	9	74	6.7
Totals	124	130	67	25	24	82	141	135	118	142	137	1125	102.3
Remnant R-2	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	Totals	Average
A.australis	4	1	5	3	1	1	7	1	4	2	2	31	2.8
C.gouldii	6	5	4	1	-	3	6	7	5	5	5	47	4.3
C.morio	5	4	5	1	4	4	4	4	5	4	6	46	4.2
Mormopterus sp.2	1	1	-	-	-	-	3	-	-	-	-	5	0.5
Mormopterus sp.4	4	5	3	-	-	2	5	5	4	9	1	38	3.5
Nyctophilus spp.	3	2	2	-	-	2	2	2	2	3	2	20	1.8
S.flaviventris	-	-	-	-	-	-	-	-	-	-	-	0	0.0
V.darlingtoni	4	4	2	-	4	2	5	3	3	4	5	36	3.3

V.regulus	18	23	17	3	2	6	14	11	17	14	16	141	12.8
V.vulturnus	1	2	-	-	-	-	4	2	2	3	-	14	1.3
Totals	46	47	38	8	11	20	50	35	42	44	37	378	34.4
Remnant R-3	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	Totals	Average
A.australis	6	-	3	-	6	3	5	4	7	5	4	43	3.9
C.gouldii	9	9	4	1	-	7	6	7	6	6	5	60	5.5
C.morio	6	7	5	-	4	5	5	4	6	5	7	54	4.9
Mormopterus sp.2	-	-	-	-	-	-	-	-	-	-	-	0	-
Mormopterus sp.4	6	7	3	-	-	2	9	5	6	8	6	52	4.7
Nyctophilus spp.	2	2	2	-	-	3	3	2	2	3	3	22	2.0
S.flaviventris	-	-	-	-	-	-	-	-	-	-	-	0	0.0
V.darlingtoni	4	4	2	1	-	2	4	4	3	7	5	36	3.3
V.regulus	26	19	11	4	6	9	24	31	24	27	22	203	18.5
V.vulturnus	1	1	-	-	-	-	3	2	4	3	4	18	1.6
Totals	60	49	30	6	16	31	59	59	58	64	56	488	44.4
Remnant R-4	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	Totals	Average
A.australis	5	5	4	6	4	2	9	4	5	6	6	56	5.1
C.gouldii	26	22	12	-	-	-	16	21	10	11	12	130	11.8
C.morio	11	16	11	4	7	9	19	15	22	16	23	153	13.9
Mormopterus sp.2	3	2	2	-	-	3	3	4	2	2	-	21	1.9
Mormopterus sp.4	12	27	10	-	5	14	24	19	14	20	21	166	15.1
Nyctophilus spp.	7	9	9	5	-	5	6	5	5	2	7	60	5.5
S.flaviventris	-	-	-	-	-	-	-	-	-	-	-	0	0.0

V.darlingtoni	11	11	5	-	-	2	9	7	9	9	11	74	6.7
V.regulus	22	41	30	11	8	16	34	39	31	27	40	299	27.2
V.vulturnus	-	2	2	-	-	-	4	5	4	6	2	25	2.3
Totals	97	135	85	26	24	51	124	119	102	99	122	984	89.5
Remnant R-5	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	Totals	Average
A.australis	3	5	3	4	7	11	6	5	2	8	8	62	5.6
C.gouldii	23	19	14	2	-	10	20	22	18	13	13	154	14.0
C.morio	15	20	6	4	12	6	19	22	26	14	13	157	14.3
Mormopterus sp.2	4	3	3	-	-	-	5	-	3	1	-	19	1.7
Mormopterus sp.4	15	19	10	1	4	7	23	6	19	24	16	144	13.1
Nyctophilus spp.	9	9	8	-	-	5	9	5	7	5	8	65	5.9
S.flaviventris	2	-	-	-	-	1	3	-	-	-	-	6	0.5
V.darlingtoni	6	14	7	2	-	7	14	16	9	13	6	94	8.5
V.regulus	63	73	32	9	7	21	71	66	76	71	83	572	52.0
V.vulturnus	6	9	5	1	-	-	14	11	9	11	4	70	6.4
Totals	146	171	88	23	30	68	184	153	169	160	151	1343	122.1
Remnant R-6	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	Totals	Average
A.australis	4	6	4	6	4	6	7	5	6	7	9	64	5.8
C.gouldii	26	22	16	3	-	12	23	26	20	19	19	186	16.9
C.morio	17	23	17	5	14	15	19	15	22	16	23	186	16.9
Mormopterus sp.2	7	7	2	-		-	11	3	2	4	4	40	3.6
Mormopterus sp.4	15	18	10	2	-	8	21	16	18	25	17	150	13.6
Nyctophilus spp.	11	9	9	2	-	7	10	9	8	9	11	85	7.7
S.flaviventris	-	-	-	-	-	1	-	-	-	-	-	1	0.1

V.darlingtoni	16	16	8	3	-	8	16	14	11	16	18	126	11.5
V.regulus	72	84	37	11	8	24	81	76	66	80	80	619	56.3
V.vulturnus	8	6	3	1	-	3	11	8	15	11	13	79	7.2
Totals	176	191	106	33	26	84	199	172	168	187	194	1536	139.6
Remnant R-7	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	Totals	Average
A.australis	4	6	4	6	4	6	7	5	6	7	9	64	5.8
C.gouldii	21	22	14	3	-	12	18	22	20	19	11	162	14.7
C.morio	15	31	11	5	3	15	17	15	22	13	23	170	15.5
Mormopterus sp.2	1	2	-	-	-	-	4	4	6	2	1	20	1.8
Mormopterus sp.4	19	24	5	2	-	8	25	17	16	25	21	162	14.7
Nyctophilus spp.	11	9	9	2	-	7	10	9	8	9	15	89	8.1
S.flaviventris	-	-	-	-	-	-	-	-	-	-	-	0	0.0
V.darlingtoni	11	16	8	3	-	8	16	11	11	12	16	112	10.2
V.regulus	62	66	22	8	2	24	54	43	55	49	52	437	39.7
V.vulturnus	8	6	3	1	-	1	5	5	9	3	9	50	4.5
Totals	152	182	76	30	9	81	156	131	153	139	157	1266	115.1