COLLECTOR WIND FARM

BIRD AND BAT ADAPTIVE MANAGEMENT PROGRAM

RATCH Australia Pty Ltd

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1. INTRODUCTION

RATCH Australia Corporation Limited has obtained planning permission to construct a wind energy facility comprising up to 55 wind turbines. The southern end of the wind farm is more than five kilometers west of the town of Collector in southern New South Wales (Figure 1). Hume Hwy forms the northern boundary of the wind farm and Collector Road lies to the west.

As a condition of approval by the Minister for Planning and Infrastructure (Application MP10_0156), RATCH Australia has to prepare a 'Bird and Bat Adaptive Management Program' (BBAMP) for the wind farm, consistent with the requirements of condition of approval B6, presented below.

> *"B6. Prior to the commencement of construction, the Proponent shall prepare and submit for the Approval of the Director-General a **Bird and Bat Adaptive Management Program**, which takes into account bird/ bat monitoring methods identified in the current editions of AusWEA Best Practice Guidelines for the Implementation of Wind Energy Projects in Australia*[1] *and Wind Farm and Birds: Interim Standards for Risk Assessment. The Program shall be prepared and implemented by a suitably qualified expert, approved by the Director-General. The Program shall incorporate spring – summer pre-construction baseline surveys, post construction and operational monitoring, and a Decision Matrix that clearly sets out how the Proponent will respond to the outcomes of monitoring. It shall:*
>
> *(a) incorporate an ongoing role for the suitably qualified expert;*
>
> *(b) set out monitoring requirements in order to assess the impact of the Project on bird and bat populations, including details on spring-summer baseline survey and post-construction monitoring locations, parameters to be measured, frequency, timing and methods of monitoring and analyses and reporting. The monitoring program shall be capable of detecting any changes to the population of birds and/ or bats that can reasonably be attributed to the operation of the Project, and includes spring-summer pre-construction baseline survey data;*
>
> *(c) incorporate a decision making framework that sets out specific actions and when they may be required to be implemented to reduce any impacts on bird and bat populations that have been identified as a result of the monitoring;*
>
> *(d) identify 'at risk' bird and bat groups, seasons and/or areas within the Project site which may attract high levels of mortality and include monthly mortality assessments and periodic local population census' and bird utilisation surveys;*
>
> *(e) identify potential mitigation measures and implementation strategies in order to reduce impacts on birds and bats such as minimising the availability of raptor perches, swift carcass removal, pest control including rabbits, use of deterrents, and sector management including switching off turbines that are predicted to or have had an unacceptable impact on bird/bat mortality at certain times; and*
>
> *(f) identify matters to be addressed in periodic reports in relation to the outcomes of baseline surveys and post-construction and operational monitoring, the application of the decision making framework, the mitigation measures*

[1] The latest version of these is the 2013 edition, prepared by the Clean Energy Council, the successor to AusWEA. BL&A prepared the bird risk assessment standards for AusWEA in 2005.

identified, progress with the implementation of such measures, and their success.

The Reports referred to under part (f) shall be submitted to the Director-General and OEH on an annual basis for the first five years of operation and every two years thereafter (unless otherwise agreed to by the Director-General), and shall be prepared within two months of the end of the reporting period. The Director-General may, at the request of the Proponent at anytime, vary the reporting requirement or period by notice in writing to the Proponent.

The Proponent is required to implement reasonable and feasible mitigation measures as identified under part (e) where the need for further action is identified through the Bird and Bat Adaptive Management Program, or as otherwise agreed with the Director-General."

This Bird and Bat Adaptive Management Program fulfils the requirements of this condition of approval.

1.1. BBAMP Objectives

The overall aim of this Bird and Bat Adaptive Management Plan is to provide *an overall strategy for managing and mitigating any significant bird and bat strikes arising from operations of the wind energy facility.*

This is achieved by establishing monitoring and management procedures consistent with the methods outlined by the Australian Wind Energy Association (AusWEA 2005) and endorsed in the Clean Energy Council's Best Practice Guidelines (CEC 2013).

The specific objectives of this plan, derived from the conditions of approval, are detailed as follows:

- To monitor the pre- and post-construction presence and behaviour of bird and bats on the wind farm site, and any changes to their populations that are the result of wind farm operations.
- To detail a decision-making framework that outlines the actions to be taken and possible mitigation measures implemented, in the event that an impact trigger[2] is detected.
- To monitor the mortality of birds and bats around or near wind turbines.
- To detect any unacceptable impacts[2] to species to be considered 'at risk', which includes threatened species with the potential to occur onsite and those more likely to fly at rotor swept area (ie. Eastern Bent-wing Bat, Gang Gang Cockatoo, Superb Parrot, Little Eagle and Wedge-tailed Eagle).
- To identify potential mitigation measures that may be appropriate (subject to investigation) to reduce the risk of bird and bat collision with operating wind turbines.
- To detail matters to be addressed in periodic reports and the timing of such reports to the Director-General.

The strategy employed to ensure that any impact triggers and/or unacceptable impacts are detected includes:

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[2] Definition of 'impact trigger' and 'unacceptable impact' is detailed for threatened species in section 5.1.1 and for non-threatened species in section 5.2.1.

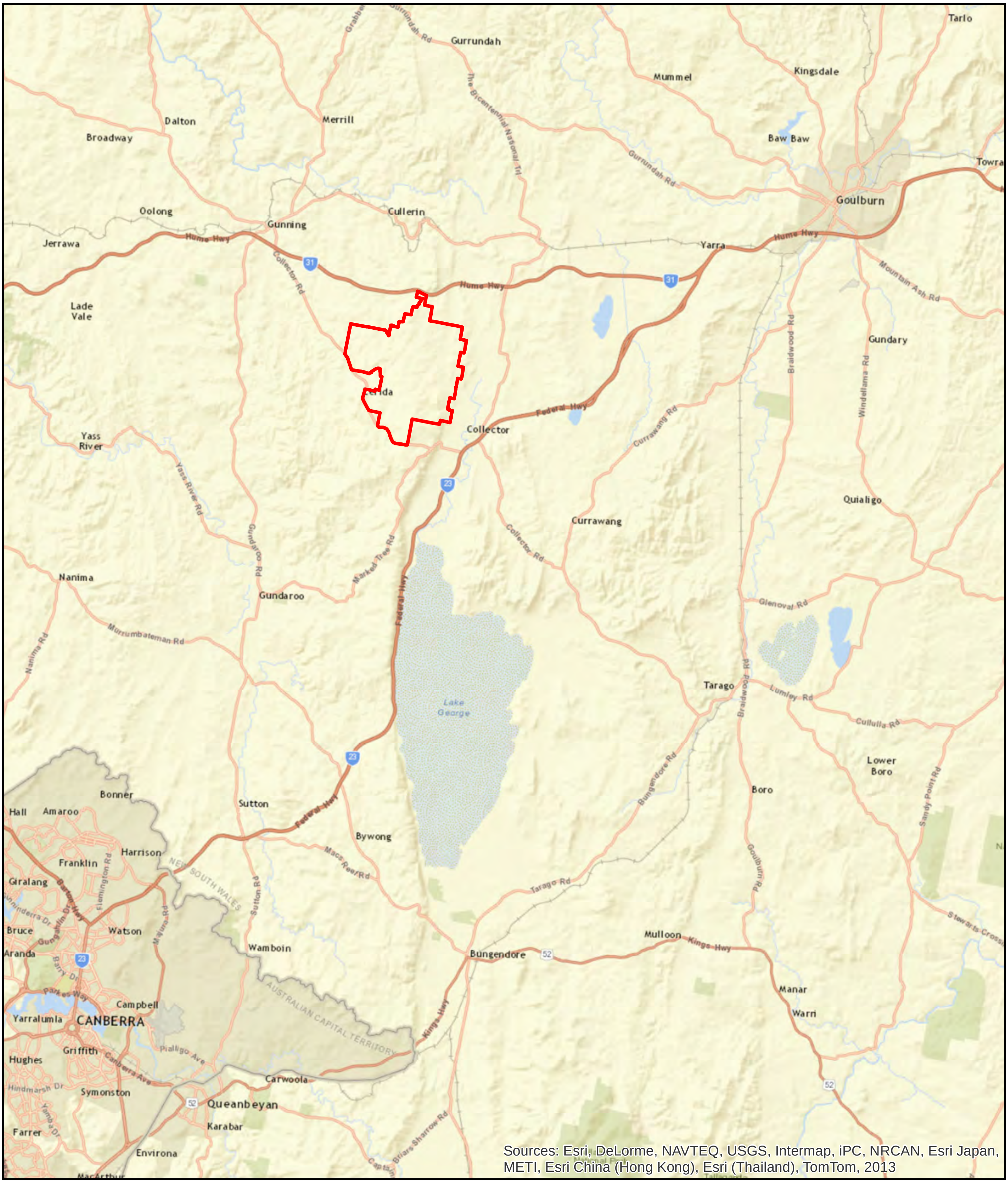
- Pre-construction monitoring surveys
- Post-construction monitoring surveys, including carcass searches under turbines
- Statistical analysis of the results from monitoring
- Reporting

This management plan is adaptive. Therefore, management measures can be amended based on monitoring results to ensure more effective management and mitigation are implemented in response to the findings of monitoring. In order to ensure the efficacy of this adaptive management program, all activities will be undertaken subject to the regular review and reporting by the suitably qualified expert with relevant experience who is approved by the Director-General of the Department of Planning and Infrastructure (DPI). Personnel undertaking the carcass searches will be adequately trained to undertake the assessments. The expert will also be in charge of data analysis, interpretation and reporting.

Note that the technical advice guidance in this plan and development of the decision making framework is based on the preparation and implementation of approved management plans to monitor and mitigate the impacts of wind farm operation on birds and bats at numerous wind farms in New South Wales and Victoria. At the time of writing, BL&A have prepared approved management plans for Capital, Taralga & Woodlawn wind farms in NSW (BL&A 2011b &c, 2014), and Bald Hills, Berrybank, Crowlands, Hawkesdale, Lal Lal, Mt Gellibrand, Mt Mercer, Mortlake South and Ryans Corner wind farms in Victoria (BL&A 2009, 2011a, 2012a-d, 2013a-c).

The approach developed for monitoring impacts to birds and bats has been refined as these plans have been prepared and feedback received from regulators and approval authorities. This Bird and Bat Adaptive Management Program has incorporated learning and experience from these plans, and as a result incorporates the latest approaches to monitoring wind farm impacts.

The methods used for pre-construction bird and bat surveys were developed in consultation with the Office of Environment and Heritage (OEH). OEH attended a site visit to Collector Wind Farm on the 16th September 2013, during which the location of survey points for fixed point bird utilisation surveys and transect surveys was discussed with BL&A and RATCH. In addition, OEH were monitoring numbers of Eastern Bentwing Bat in the Church Cave maternity site during the migration of the bats to and from this cave. Greg Richards & Associates and BL&A were in close contact with Doug Mills (OEH Queanbeyan), particularly during February and March 2014, to ensure that bat surveys were aligned with the migration period. BL&A is grateful to Allison Treweek, Damon Oliver and Doug Mills for their assistance and input to the design of this monitoring program.



Legend

Collector Wind Farm Site

0 5 10 20 Kilometers

Figure 1: Location of Collector Wind Farm

Project: Collector Wind Farm

Client: RATCH Australia

Project No.: 13100	Date: 8/07/2014	Created By: M. Ghasemi / A. Stewart

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1.2. Compliance Summary

The following table details which sections of the Bird and Bat Adaptive Management Plan comply with each of the specific conditions outlined in the Conditions of Approval for the project. The conditions of approval have been abbreviated but their full and correct wording can be found in the introduction.

This BBAMP has been informed by AusWEA (2005), the Australian interim bird risk assessment standards for wind farms. Condition B6 of the consent for the Collector Wind Farm requires that the program be informed by these standards and the methods and reporting standards in this document have been adopted, with adaptation to reflect more recent technical development and regulatory input

Table 1: Sections within the BBAMP that comply with Condition of Approval B6 for Collector Wind Farm.

Condition number	Abbreviated condition details	BBAMP Section/s
B6 (a)	*Incorporate an ongoing role for the suitably qualified expert*	1.1
B6 (b)	*Set out requirements for spring-summer pre-construction baseline monitoring and post-construction monitoring methodology, analysis and reporting.*	2, 3
B6 (c)	*Incorporate a decision making framework that sets out specific actions to reduce any impacts on bird and bat populations*	5.1.2, 5.2.2
B6 (d)	*Identify 'at risk' bird and bat groups… and include monthly mortality assessments and periodic local population census' and bird utilisation surveys*	1.4, 2, 3
B6 (e)	*Identify potential mitigation measures and implementation strategies in order to reduce impacts on birds and bats*	4, 5.3
B6 (f)	*Identify matters to be addressed in periodic reports*	3.6
B6	*Submit reports to the Director-General and OEH on an annual basis for the first five years of operation and every two years thereafter*	3.6, 6

1.3. Site Description

The site consists of 13 involved properties, currently managed for sheep and cattle grazing with some areas sown to exotic pasture for feed, and comprises pasture (exotic and native) and remnant woodlands.

The geology of the site consists of an undulating granitic plains and occasionally plains and ridges supporting sedimentary and metamorphic rock that typically carries woodland assemblages. The site, particularly the northern section is covered by small remnant areas of eucalypt woodland dominated by Yellow Box, Blakely's Red Gum, Apple Box and occasionally Broad-leaved Peppermint. Metamorphic ridges carry dry forest types dominated by Brittle Gum, White or Scribbly Gum or Broad-leaved Peppermint (NGH Environmental 2012). The site's woodlands have been extensively cleared and modified for sheep and cattle grazing. The proposed turbine locations are in the cleared sections of the site or among widely scattered eucalypt trees.

The Collector Wind Farm is within the Upper Lachlan Local Government Area (LGA), and the Monaro subregion of the Murrumbidgee Catchment Management Authority (CMA) region.

1.4. Pre-approval investigations on birds and bats

As part of pre-approval investigations on the wind farm, NGH Environmental (2012) prepared a biodiversity assessment to assess the potential impacts to flora and fauna associated with the Collector Wind Farm. Field surveys undertaken to investigate the bird and bat species found onsite included habitat assessments, bird utilisation surveys and recording of incidental bird observations, hollow-bearing tree surveys and nocturnal surveys including stagwatches, call playback, spotlighting and Anabat surveys.

The investigation identified a number of threatened and migratory bird and bat species that were considered to be at risk from wind farm development and operation, based on recent records and/or habitat availability at the study area. These species included:

Table 2: Threatened and migratory birds and bats considered to be 'at risk'

Birds	Bats
*Brown Treecreeper	*East Coast Freetail Bat
*Diamond Firetail	*Eastern Bentwing Bat
*Varied Sittella	*Large-footed Myotis
*White-fronted Chat	*Yellow-bellied Sheathtail Bat
*Gang-gang Cockatoo	
*Superb Parrot	
Powerful Owl	
Little Eagle	
Spotted Harrier	
Square-tailed Kite	
White-bellied Sea-eagle	

* Recorded in the study area

Assessments of Significance (seven part tests) under the *Environmental Planning and Assessment Act (EP&A Act) 1979* were undertaken for all species listed as threatened under the *Threatened Species Conservation (TSC) Act 1995.* This includes all species in the table above, with the exception of the White-bellied Sea-eagle which is listed as Migratory under the *Environment Protection and Biodiversity Conservation (EPBC) Act.*

The conclusions from the seven part tests found that impacts from the wind farm were unlikely to be significant for each species, provided that the mitigation measures recommended by NGH Environmental (2012) were adhered to.

Further monitoring was recommended for the following species, as part of this bird and bat adaptive monitoring program.

- Little Eagle – Although this species was not recorded within the wind farm boundary, they are known to breed along an escarpment area west of the Lake George basin (approximately ten kilometres south of the project area). Further monitoring of this species was recommended to inform any further mitigation measures required.
- Eastern Bentwing Bat – although this species was recorded across the site, the results from NGH Environmental (2012) investigations suggested that the species did not use the wind farm site as a main migration route from nearby maternity caves. Further monitoring was recommended to verify any unanticipated impacts and develop further mitigation measures if necessary.

2. PRE-CONSTRUCTION MONITORING

Pre-construction monitoring of the wind farm site aimed to establish a baseline of bird and bat activity. The methodology for pre-construction monitoring activities was discussed with and agreed upon with the OEH and is described in this section.

As construction is proposed to occur in late 2014, pre-construction monitoring was undertaken at key times in 2013 and 2014 to ensure that key seasonal periods were monitored.

In accordance with accepted practice, as undertaken at other NSW wind farms (eg Capital & Woodlawn wind farms), carcass search results undertaken as part of the post-construction monitoring program (see Section 3) will be assumed to represent existing baseline carcass presence in the landscape for comparison with potential wind farm-related carcass numbers. Given that approach, pre-construction monitoring has been designed to generate a picture of baseline bird and bat activity against which post-construction observations can be compared, thereby clearly illustrating potential impacts of the project on their activity.

2.1. Bird Utilisation Surveys

Baseline data was collected from the bird utilisation surveys, carried out in late summer/autumn 2013 and spring 2014 (as agreed with OEH). The objective of the surveys was to quantify bird activity by species at representative locations within the wind farm site. The data generated provided a statistically robust baseline of bird activity. The surveys will be replicated after operations commence to ensure that any changes in bird activity will be assessed within an acceptable level of statistical power.

The pre-construction survey also helped to identify what birds are flying at rotor swept area (RSA) height, and equally importantly identify what birds are flying above or below RSA. In this case, a negative record can indicate that threatened species are not flying at rotor swept area.

2.1.1. Point Count Surveys

The bird utilisation surveys, consistent with the guidance in AusWEA's interim bird risk assessment standards, involved fixed point censuses of birds at 10 monitoring points near to wind turbine locations ('impact points') within the wind farm, and two reference monitoring points nearby (>500m from the nearest turbine) within similar landscape and habitat settings. The survey sites were grouped by habitat (a stratified, random sampling design) to account for any obvious habitat differences between areas of the wind farm site, as required by clause (d) of the consent condition.

The point count survey method is described below.

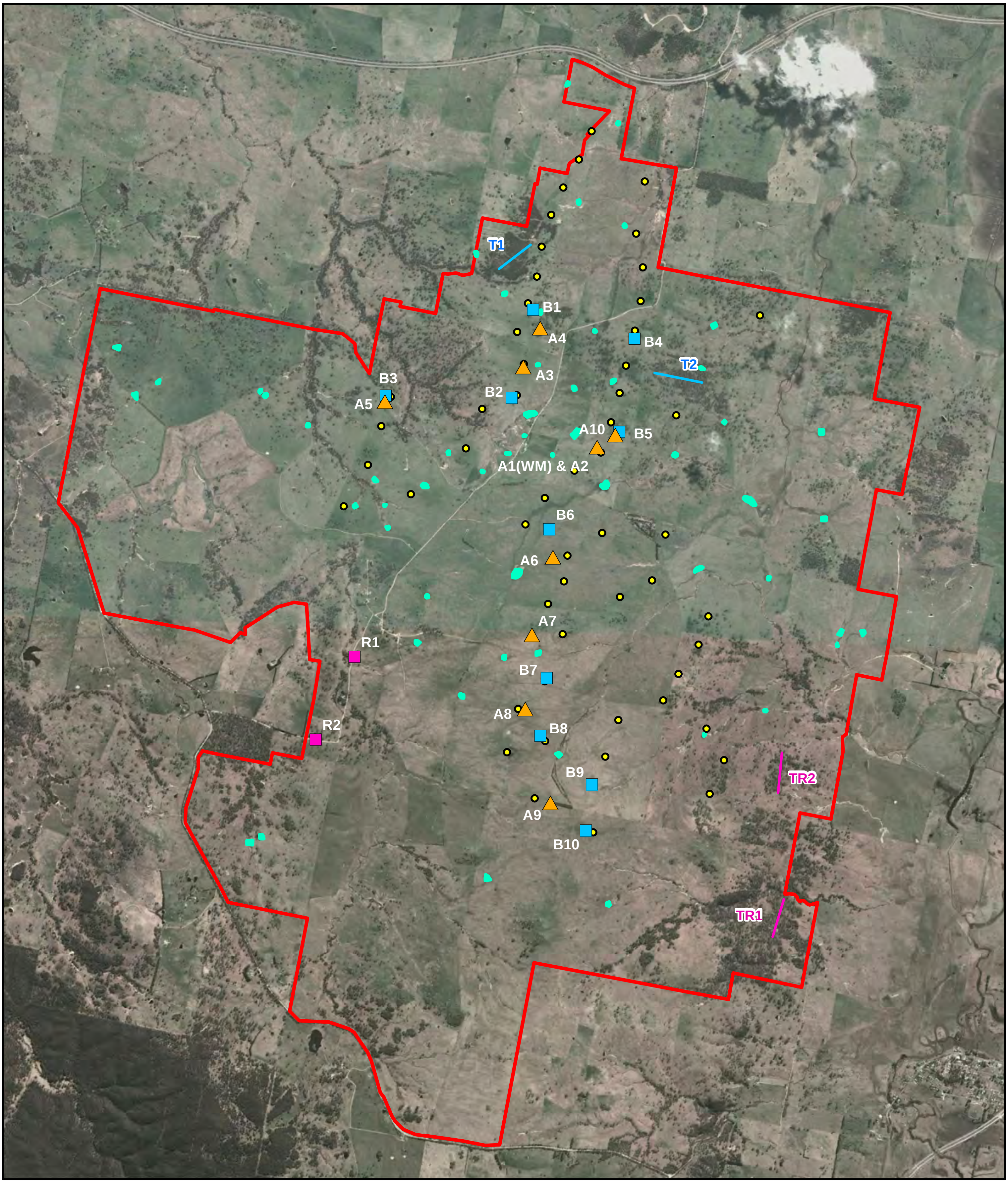
- Observer stationed at a survey point for 15 minutes, during which time all birds observed within a 200 metre radius were recorded. This represents an area of over 12.5 hectares and is considered sufficient to generate bird data representative of the likely 1.17 hectares maximum area occupied by the RSA, based on a maximum rotor diameter of 122 metres.
- Species, number and flight height of individual birds was documented, with flight height recorded in 20 metre intervals and later classified as below, at or above rotor

swept area height (RSA height), based on a worse case scenario of maximum rotor swept area of 30 to 150 metres[3].

- Each point was surveyed at least eight times, a number of surveys considered sufficient to generate bird utilisation data with an acceptable level of statistical power to inform the post-operational impact assessment (BL&A unpublished data).
- Surveys were undertaken during four periods of the day to account for time-of-day differences in bird activity (0730-1000, 1000-1200, 1200-1400 and 1400-1700), with two surveys at each point during each time period.
- The location and use of any perching and roosting sites surrounding turbine locations were incidentally recorded, if observed.

From a random selection of 30 points, ten impact points were surveyed based on the surrounding habitat (woodland versus farmland) and ease of access to the survey site. Sites 1, 3 and 10 were chosen in consultation with OEH during the site visit on 16th September 2013, based on the habitat and vantage points surrounding these sites. The location of the survey sites are shown in Figure 2 and the survey timetable is shown in Table 1. The numbers one to ten represent the impact sites located near to proposed turbines, and R1 and R2 represent the two reference sites.

[3] The specific turbine option to be installed was still under consideration at the time of writing this report, however each turbine option has a hub height of around 90 metres (84 to 92.5 metres) and a rotor diameter that ranges from 113 to 122 metres. Rotor swept area ranges from 28 to 36 metres above ground to a maximum height of 140 to 150 metres above ground. Rotor swept area for analysis of the pre-construction surveys was considered to be 30 to 150 metres.



0 750 1,500 3,000 Metres

Legend

- Collector Wind Farm Site
- Dams
- Wind Turbines

Transect Surveys

- Impact Sites
- Reference Sites

- Bat Utilisation Survey Points

Bird Utilisation Surveys

- Reference Points
- Impact Points

Figure 2: Bird and Bat Survey Points		
Project: Collector Wind Farm		
Client: RATCH Australia		
Project No.: 13100	Date: 8/07/2014	Created By: M. Ghasemi / A. Stewart

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Table 3: Survey Timetable for Bird Utilisation Surveys

Day	Time													
	8:00	8:40	9:20	10:00	10:40	11:20	12:00	13:00	13:40	14:20	15:00	15:40	16:20	17:00
1	1	2	3	4	5	6	7	8	9	10	R1	R2	1	2
2	3	4	5	6	7	8	9	10	R1	R2	1	2	3	4
3	5	6	7	8	9	10	R1	R2	1	2	3	4	5	6
4	7	8	9	10	R1	R2	1	2	3	4	5	6	7	8
5	9	10	R1	R2	1	2	3	4	5	6	7	8	9	10
6	R1	R2	1	2	3	4	5	6	7	8	9	10	R1	R2
7	1	2	3	4	5	6	7	8	9	10	R1	R2		

2.1.2. Transect Surveys

In consultation and agreement with OEH, transect surveys were carried out in woodland vegetation to assess the indirect impacts of wind turbines on woodland birds. Transect surveys will be used to determine the density of woodland birds at 'impact points' and reference sites before and after wind farm operations commence. This is known as the Before-After-Control-Impact (BACI) sampling design recommended by AusWEA (2005), the key guidance reference document defined within the consent condition.

The pre-construction method involved an experienced bird observer walking a transect 400 metres long and 50 metres wide at the locations shown in Figure 2. The survey lasted at least 40 minutes (i.e. 10 minutes per 100 metres) and the observer recorded all birds observed (heard or seen) within 25 metres of the central transect track and the distance of the bird from the central track within the transect when first observed. This method enables bird density to be calculated and any observer distance error to be accounted for.

Two woodland bird transect sites were surveyed in woodland areas within 500 metres of turbines (impact sites) and two sites were surveyed in woodland areas greater than 500 metres from turbines (reference sites). One of the reference sites will be within the area proposed to provide the offset for the vegetation removal required for development of the wind farm. Each site was surveyed once in the morning and once in the afternoon during both spring and again in autumn (i.e. two surveys per site per season).

All results were compiled and included in an annual report at the end of pre-construction monitoring (BL&A 2014, attached as Appendix 1).

2.1.3. Monitoring 'at risk' species

During the above surveys, the observer recorded the flight paths (distance from observer, beginning and end locations, as well as start and finish times) of any species considered to be at risk. In addition, any sightings of these species incidental to the surveys were recorded. This approach helps to develop a spatial picture of the activity of such species and an indication of how consistently they occur on the site.

'At risk' species include threatened, migratory or 'high profile' species (see Table 2) that have the potential to occur within the wind farm boundary and are known to fly at heights within the RSA. This includes the species below – those marked with an asterisk have previously been recorded in the study area.

- Gang Gang Cockatoo*
- Superb Parrot*
- Little Eagle
- Spotted Harrier
- Square-tailed Kite
- White-bellied Sea-eagle
- Wedge-tailed Eagle* (not threatened but considered to be a high profile species).

Woodland birds listed from Table 2 are not included here as they are unlikely to leave their woodland habitats and/or fly at rotor swept area. Although considered to be at risk, microbats listed in Table 2 are not included here as they are too small for their flight paths to be observed and alternative methods need to be adopted to monitor bat activity (see Section 2.2).

2.2. Bat Activity Surveys

Bat activity surveys were undertaken at Collector wind farm using two models of bat call ultrasonic detectors: Anabats (Titley Electronics, Ballina, NSW) and SongMeter SM2BAT+ (Wildlife Acoustics Inc., USA). Surveys were undertaken at nine different sites in 2013 and ten different sites in 2014, which are representative of the habitats near wind turbine locations. One site included a paired sampling site located at a wind mast near proposed turbine 28, where one recorder was located at ground level and a second at 50 metres height up a rope and pulley system on the monitoring mast. This enabled a comparison of bat activity levels by species at height versus at ground level.

The detectors were programmed to commence operation approximately 30 minutes before dusk, and to cease approximately 30 minutes after dawn.

Surveys aimed to coincide with the migratory periods for Eastern Bentwing Bat, along with the most active season for bats. Two surveys were carried out: one in late spring/early summer (November/December 2013) and a second in late summer/early autumn (February/March 2014).

The closest known maternity caves of Eastern Bentwing Bats to Collector Wind Farm are located at Bungonia and Wee Jasper, within 50 to 65 kilometres of the wind farm respectively. Previous research has shown that female Eastern Bentwing-bats congregate at their maternity caves in October or November and give depart over a few days in February or March (Churchill 2008, Dwyer 1995, Hall and Richards 2003, Richards and Hall 2012). In the 2013-2014 migration period, Dr Doug Mills (OEH Queanbeyan) was monitoring numbers of Eastern Bentwing Bat in the Church Cave maternity site during the migration of the bats to and from this cave. The findings suggested that the migration of Eastern Bentwing Bat to their maternity caves may have occurred from mid-late November in 2013 and it is therefore possible that the bat monitoring in late November/early December was not undertaken at the most appropriate time to capture the spring migration. Greg Richards & Associates and BL&A stayed in close contact with OEH during February and March 2014, to ensure that late summer/early autumn bat surveys were aligned with the migration period.

Note that further pre-construction monitoring surveys will be carried out during mid spring/early summer 2014 and late summer/early autumn 2015 to capture the migration of Eastern Bentwing Bat to and from their maternity caves, and fill in any gaps from the current pre-construction monitoring. The results will then feed into any updates of this BBAMP (specifically section 4.1).

2.3. Preparation of Pre-construction Report

An annual report was prepared at the end of pre-construction monitoring, compiling the results of bird and bat utilisation surveys and activities undertaken to comply with this BBAMP and the requirements of the consent condition. The pre-construction bird and bat monitoring report for Collector Wind Farm is summarised below, with the full report provided in Appendix 1.

2.3.1. Summary of findings from pre-construction bird surveys

- The study area consists largely of cleared plateaux supporting a low diversity and abundance of common, predominantly farmland birds. The ten most common species recorded at the impact and reference survey points are presented below. These species comprised 83.4% of all birds recorded at the impact survey points and 67.4% at the reference survey points.

Impact survey points	Reference survey points
Common Starling	Noisy Miner
Sulphur-crested Cockatoo	Sulphur-crested Cockatoo
Australian Magpie	Eastern Rosella
Noisy Miner	Yellow-faced Honeyeater
Galah	Australian Magpie
Raven spp.	Superb Fairywren
Eastern Rosella	Crimson Rosella
Crimson Rosella	Galah
Red-rumped parrot	Common Starling
Yellow-rumped Thornbill	Raven spp.

- The study area supports very few raptors or waterbirds, groups considered vulnerable to collision with operating wind turbines. Raptors and waterbirds represented 0.7% and 2.9% respectively of all birds surveyed.
- The diversity of birds was similar across the observation points with common farmland birds dominating the species list. However, there was a tendency for points close to remnant woodland to have a more diverse bird species.
- Bird abundance and diversity was higher at observation sites surrounded by remnant woodlands or scattered trees compared to sites set up on top of cleared hills mostly lacking trees.
- Bird abundance and diversity also differed seasonally; while species diversity decreased during summer as most of the spring migratory species left the region, bird numbers were higher in the summer survey. Apart from the natural seasonal increase of bird numbers in summer, some increase was caused by the accumulation of birds on feeding spots laid by farmers to feed their livestock among and sometimes close to the observation points.
- The list of birds recorded flying at RSA heights was similar between the 10 observation points. The five most abundant species accounted for almost 75% of the birds counted at RSA height, and consisted of (in order of abundance): Sulphur-crested Cockatoos (26.6%), Galah (15%), Common Starling, Raven spp. and Red-rumped Parrot. These are all common species that are widespread across the Collector Wind Farm site and the wider region. Raptors were not common with only 0.3% of all records being recorded at RSA heights. No waterbirds were recorded flying at RSA height.
- The utilisation rate of the Wedge-tailed Eagle averaged 0.04 eagles per hectare per hour during the spring survey and increased to 0.16 in summer (overall average for both seasons 0.1 birds per hectare per hour).
- Five species of threatened birds were recorded utilising the study area, the Diamond Firetail, Varied Sittella, Scarlet Robin, Brown Treecreeper and White-fronted Chat. The first four species are woodland birds that rarely venture outside the woodland and were seen during the formal counts or incidentally within or close to woodland areas. The last species is normally found in open paddocks but usually flies at low height (ie. zero to ten

metres off the ground). Therefore the collision risk to threatened species from operating turbines is considered low.

2.3.2. Summary of findings from pre-construction bat surveys

The findings from the spring bat utilisation survey, conducted over the period from 28th November to 11th December 2013, are provided as follows:

- Ten bat species and one species complex were recorded from monitoring at nine sites during spring–summer 2013 survey;
- Three species were recorded flying at rotor swept area height using the bat detector at 50 metre height; White-striped Freetail Bat, Gould's Wattle Bat and the Eastern Freetail Bat, none of which are listed as threatened;
- Bat species were more frequently recorded surrounding a large woodland remnant well away from wind turbines. There was much less activity at open cleared paddocks sampling sites. Open pasture is the most extensive habitat within the wind farm site and the habitat in which most turbines are located;
- A very small number of calls of the Eastern Bentwing Bat, listed in NSW as threatened, were recorded during the survey in spring–summer 2013.

One of the aims of the spring bat survey was to capture the migration period of Eastern Bentwing Bats to their maternity caves. In 2013 OEH was monitoring the staging cave approximately four kilometres from the maternity cave (Church Cave) at Wee Jasper (65 kilometres south west of the wind farm). Monitoring in the first week of December found that approximately 14 000 bats were in the staging cave, compared to only a few hundred a couple of weeks earlier. Based on the findings, OEH suggested that the Eastern Bentwing Bat could have passed through the wind farm site on their migration path around mid to late November. It is therefore possible that the bat monitoring at Collector Wind Farm was not undertaken at the most appropriate time to capture the spring migration. This is discussed further in the pre-construction monitoring report (Appendix 1). Further bat monitoring was undertaken at Collector from the 3rd February to the 24th March 2014, based on the same monitoring approach as before. A summary of the findings is provided below.

- Bat counts at the Wee Jasper breeding cave were 31,000 on 2nd March and 2,700 on 12th March, following which the cave was expected to be empty within a few days.
- On the 8th March, high numbers of Eastern Bentwing Bat/Forest Bat (EBB/FB) complex calls were recorded in the south of the Collector wind farm site, with a total of 948 calls at sites A7 and A8 (Figure 2). High numbers of EBB-FB complex calls (2463) were recorded at site A5 on 13th March. Given it is highly unlikely that high numbers of Forest Bats would be active at the site at this time, the calls are more than likely attributable to Eastern Bentwing Bats.
- It is not known if these migrations are regular across the site or not, but this will be confirmed by further pre-construction and post-construction bat survey work (as detailed in section 2.2 and 3.2). Mitigation measures to avoid impacts to migrating Eastern Bentwing Bats are described in section 4.

3. POST CONSTRUCTION SURVEYS

Post-construction surveys are described in this section. As for pre-construction surveys, post construction surveys will include bird utilisation surveys and bat activity surveys, as described in the preceding section of this report. In addition, a comprehensive carcass search program will be implemented to detect birds and bats that collide fatally with wind turbines and to estimate annually the numbers of birds and bats affected. The final structure and methodology for post-construction surveys will be agreed upon with OEH prior to commencement.

Post construction surveys will commence on commissioning of the last wind turbine. If the turbines commence operation at different times, commencement of post-construction monitoring may need to be staged in parallel.

3.1. Bird Utilisation Surveys

3.1.1. Point Count Surveys

Bird utilisation surveys will be undertaken at the same 10 'impact points' and two reference monitoring points used for the pre-construction surveys, using the methodology outlined in section 2.1.

Two surveys will be carried out in the first year following construction: one during spring and one during late summer/autumn.

At the end of the first year of monitoring, recommendations for further point count surveys will be detailed in the annual report and based on the results to date. It is expected that these surveys will continue at the level of effort described above for at least two years. Any change in survey effort in the second year will be guided by the results of the first year of surveys.

3.1.2. Transect Surveys

Transect surveys will be carried out in woodland vegetation at the same two 'impact points' and two reference sites used for the pre-construction surveys, using the methodology outlined in section 2.1.2. Two surveys will be carried out in the first year following construction: one during spring and one during late summer/autumn.

Recommendations for further transect surveys will be detailed in the annual report at the completion of the first year of surveys.

3.1.3. Monitoring 'at risk' species

The methodology for recording 'at risk' species will be the same as for the pre-construction surveys, detailed in section 2.1.3.

3.2. Bat Activity Surveys

Bat activity surveys will be undertaken at the same monitoring points used for pre-construction surveys, using the methodology outlined in section 2.2. Two surveys will be carried out in the first two years of turbine operation; one in late spring/early summer and one in late summer/early autumn. The surveys will be timed to coincide with the migration period of Eastern Bentwing Bat, and the exact timing of the surveys will be discussed and agreed with OEH (based on specific monitoring of the bat migration).

The timing and frequency of further bat utilisation surveys following the second year of post construction operation will be discussed and recommended in the second year annual report. Recommendations will be based upon the findings of pre-construction and post-construction bat utilisation surveys.

3.3. Mortality Detection

The purpose of detecting mortality is to determine the actual impact of the proposed wind farm on birds and bats by attempting to estimate the number of bird and bat deaths per year. Mortality rates will be estimated for all bird species combined, and all bat species combined. If threatened species are recorded dead underneath a turbine, the mortality rate for that particular threatened species will also be estimated, if possible. Mortality is defined as any dead bird or bat detected under wind turbines and within a distance of the turbines in which carcasses could potentially fall if struck. Detection can be either during the formal carcass searches (designed to generate an estimate) or at other times.

Collision by birds and bats with wind turbines will be monitored through a rigorous carcass-search program for a minimum period of two years after operations commence, with a pulse search regime (see below) to be implemented in the first year. Mortality monitoring will commence as close as practicable to immediately after final turbine commissioning. It is possible that turbines will begin operations at different times. If staged commissioning occurs, commencement of monitoring will also be staged so that it coincides with commencement of turbine operations in each stage.

A pulse search regime is characterised by a series of alternating short and long intervals (days) between searches. These aim over time to provide an estimate of the rate at which carcasses appear, which is necessary for refined mortality rate estimation.

It is assumed that any intact dead bird or bat or bird feather spot (defined as a clump of five feathers or more), detected beneath a turbine has died as a result of collision or interaction with a turbine, unless there are obvious signs of another cause of death (e.g. shot).

Ongoing monitoring of turbine mortality at operating wind farms typically serves to (i) provide data that can inform adaptive management of the collision risk (ie. patterns of mortality related to seasonal changes); and (ii) detect mortality of threatened and non-threatened bird and bat species, which can be used to understand the potential impacts.

Species considered to be at risk from collision include threatened, migratory or high profile species with the potential to occur on the wind farm and to fly at rotor swept area (detailed in Table 2). The size of ‘at risk’ species ranges from the smaller Eastern Bent-wing Bat to medium and large sized birds including Gang Gang Cockatoo, Superb Parrot, Little Eagle and Wedge-tailed Eagle. The search protocol has been designed to optimally detect these species but will also record any other species that have fatally collided with turbines. The consistent application of this protocol will ensure that statistically robust, spatially and temporally consistent data on all bird and bat mortality is collected.

To derive accurate mortality rates it is essential that the program is scientifically and statistically robust. A number of factors, such as scavenging and detectability, can affect mortality rates and must be measured and included in any estimate of overall mortality rates. A scavenged carcass may increase the variability in mortality rate estimates and thus carcasses will be assessed for possible scavenging and rates will be estimated from experimental trials (section 3.3.3). Human detectability of carcasses is also a potential confounding variable and protocols have been developed to control or incorporate this factor.

The interpretation of carcass search results, including the design of the search program, scavenger trials and detectability trials (see Section 3.3.4) are determined by statistical considerations. In developing the methods for this plan, advice has been sought from Symbolix Pty Ltd, who provided a statistical report for this plan (Appendix 2). The practical considerations that have informed the design of the trials below are listed below.

- Very few carcasses are found under wind turbines in Australia compared with Northern Hemisphere wind farms (i.e. less than half the number in the Northern Hemisphere based on BL&A data across a number of wind farms);
- Carcasses of a suitable range of sizes for scavenger and detectability trials are difficult to source and usually involve a combination of carcasses found under turbines and those found along roads. It is illegal to source un-cleaned carcasses from poultry producers.
- For statistical reasons, it is likely to be very difficult to determine more than the grossest of differences in scavenging rate or detectability across the year and there is no evidence in the literature for significant differences across seasons in scavenger activity.
- It is known that detectability will be easier in short grass in the dry time of the years compared to in longer grass in the wet time of the year.

Appendix 2 provides a more detailed discussion of how the methods described herein have been developed. Similar methods have been recommended in a number of other approved bird and bat monitoring programs in New South Wales and Victoria (see section 1.1 for examples). Implementation of bird and bat monitoring programs in Australia is still in its infancy, however the techniques described here are based on the small number of programs already implemented (e.g. Hull *et al*. 2013, BL&A unpubl. data from seven projects) knowledge of experimental design, sound statistical analysis and recent feedback from the regulatory authorities.

Mortality detection is proposed to be carried out for an initial period of two years, at the end of which the first estimate of wind farm impacts will be made and the mortality detection program will be reviewed and, where appropriate, refined, consistent with the adaptive approach of this program.

The following sections outline:

- **Turbine selection:** how the wind turbines will be selected for a search
- **Search protocol:** the size of area beneath turbines to be searched and how this will be done
- **Scavenger rates and trials:** definition of scavenging and how experimental trials will be conducted
- **Detectability and trials:** definition of detectability and the experimental trial methodology
- **Analysis and mortality estimation:** general outline of how the data will be analysed to gain estimates of bird and bat mortality.

3.3.1. Turbine Selection

The turbines will be spatially divided into two experimental treatments (strata): potentially higher collision risk (such as turbines 5, 6 and 13, which are adjacent to woodland areas) and low risk. The perceived risk (high or low) of the turbines will be determined in consultation with OEH, and will be based on proximity to vegetation (where the majority of birds and bats are more likely to occur). There are several conditions that will apply so that the mortality rates from the sample population can be scaled up to the entire site. These are:

- Each turbine within a stratum has an equal chance of being selected for the searches (randomly selected by number generation table);
- No stratum can have less than three turbines;
- Once the turbines have been selected, the selection will not change.

The results from each stratum will be analysed separately to establish if there are differences in estimated mortality between them. They will then be combined for a whole-of-wind-farm mortality estimate using appropriate statistical methods for stratified estimates with constant selection probabilities within strata.

To ensure a valid dataset for statistical analysis, the mortality detection search will be based on 18 turbines split between nine turbines in close proximity (within 100 metres) of woodland habitats and nine turbines in non-treed habitats. Of the nine turbines in each strata, six will be searched out to 60 metres and three will be searched out to 120 metres. Section 3.3.2 below details the rationale behind each search zone.

The number of turbines searched has been determined based on what will provide the most accurate mortality rate given the high variability in detected carcasses shown on other wind farms, and that humans will have search limits (e.g. OH&S) (Appendix 2). Each turbine that is selected for the searches will have the following recorded:

- Location (easting, northing)
- Location in row
- Curvature of row
- Distance to nearest turbine
- Identification number of nearest turbine
- Local vegetation (type, height, and density during each search to document change in vegetation cover over time)
- Distance to key habitat feature, such as woodland vegetation, dam/wetland or waterway.

3.3.2. Search protocol

The search area beneath each turbine has been determined to best detect bats and medium to large bird carcasses, based on the turbine dimensions (Hull & Muir 2010). Although the specific turbine to be installed is still under consideration, each turbine option has a hub height of around 90 metres (range 84 to 92.5 metres) and a rotor diameter that ranges from 113 to 122 metres. Based on the Hull and Muir model (2010) 95% of bat carcasses are found within 65 metres of the turbine, and carcasses of medium to large birds (such as the Superb Parrot, Gang Gang Cockatoo and Little Eagle) are reasonably evenly distributed out to 100 metres. Carcasses of very large birds (Wedge-tailed Eagle) are found a little further out, but 95% are within 115 metres of the turbine.

Given the evidence, two circular search zones have been designated, the inner core zone and the outer zone. The inner core zone targets the detection of carcasses of bats and small to medium and large sized birds. In the inner zone, a circle is formed with a 60 metre radius from the turbine and transects are spaced at six metres across this circle (Figure 3).

Although they are still recorded in the inner zone, the outer zone will ensure the adequate detection of carcasses of medium to larger sized birds, which can fall further away from turbines. Search transects are spaced at 12 metres and carried out from the edge of the inner zone out to a total of 120 metres (Figure 3) radius from the turbine. Given that the defined transect spacing and total search area are based on experience and evidence from previous studies (e.g. Arnett *et al*. 2005, Hull and Muir 2010) they are considered to be ample to detect bats and the bird species of concern

In each stratum (treed vs non-treed), 6 turbines will be searched out to 60 metres and 3 turbines will be searched out to 120 metres. The selected turbines will be searched monthly and the order of turbines searched will be randomized. The distance walked by the searcher in the inner and outer zone is roughly 2.4 kilometres and 2.8 kilometres respectively.

A second 'pulse' search will be undertaken two days later within the inner 60 metres for bats between October and April inclusive. The aim of the pulse search is to detect new bat carcasses at turbines, as experience suggests the smaller carcasses are scavenged more quickly than larger carcasses. This will provide information on how often carcasses appear under turbines, which will assist in interpreting the results of carcass searches.

Given the total distances required to be walked for monthly searches (roughly 60 kilometres during normal searches and 103 kilometres during periods of pulse searches), two searchers may be required particularly between October to April. The searcher will record their survey route tracks on a GPS to ensure they keep their circular transects at six and 12 metres for the inner and outer zone respectively.

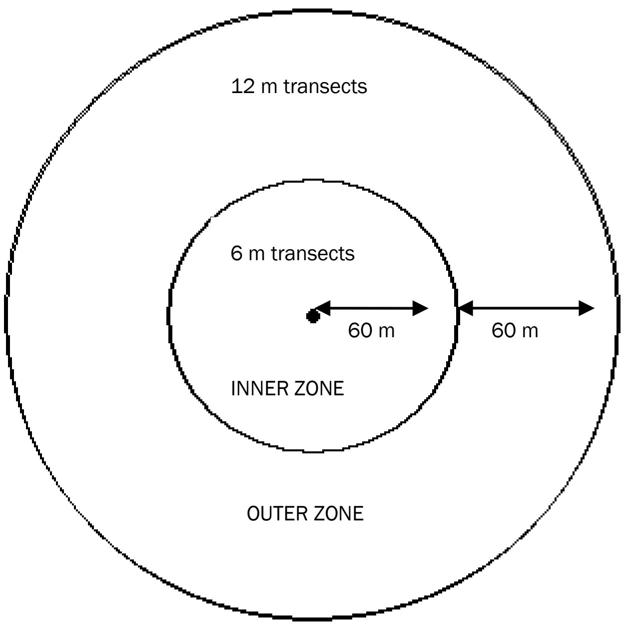


Figure 3: Carcass search zone underneath turbines.

Carcass detection protocol

If a carcass is detected (a 'find') the following variables will be recorded in the carcass search data sheet (see Appendix 3):

- GPS position, distance in metres and compass bearing of the carcass from the wind turbine tower;
- Substrate and vegetation, particularly if it was found on a track or hard-stand area without vegetation as this may assist in quantifying the number of carcasses not found in areas where ground cover makes carcasses less visible;
- Species, age, number, sex (if possible) signs of injury and estimated date of strike; and
- Weather, visibility, maintenance to the turbine and any other factors that may affect carcass discovery.

The carcass will be handled according to standard procedures, as follows:

- The carcass will be removed from the site to avoid re-counting;
- The carcass will be handled by personnel wearing rubber gloves, packed into a plastic bag, wrapped in newspaper, put into a second plastic bag;
- The carcass will be clearly labelled to ensure that its origin can be traced at a later date, if required; and
- The carcass will be transferred to a freezer at the site office for storage so a second opinion on the species identity may be sought, if necessary, and for use in scavenger and/or detectability trials.

It will be necessary for the wind farm operator to obtain a permit from OEH under the *National Parks and Wildlife Act 1974* to handle and keep native wildlife (even dead wildlife) as part of the monitoring program. An application for this permit will be submitted in a timely manner to ensure approval has been obtained prior to commissioning of the turbines.

3.3.3. Intense carcass searches

In response to the findings from the pre-construction bat surveys which indicated that the Eastern Bentwing Bat was migrating through the wind farm during March, two periods of intense carcass searches will be undertaken during the migration period in addition to the monthly carcass searches.

The carcass search methodology detailed in the previous sections will be implemented for two periods of a fortnight each. Each of the 18 turbines chosen for monthly searches will be searched every second day for a fortnight. Searches will be undertaken in the inner and outer zone, and will therefore target both birds and bats.

The two periods will be early summer to represent seasonally maximal bird (e.g. migratory bird) and bat activity on the wind farm, and early to mid autumn to coincide with the March migration of the Eastern Bentwing Bat from their maternity caves in the region. The exact dates will be agreed with OEH at the time of the survey based on advice from OEH bat specialists monitoring bat migration.

The aim of intense carcass searches is to increase survey effort during the period when the Eastern Bentwing Bat is migrating, to ensure that no carcasses are missed. The findings from the intense carcass searches will also be used to validate the survey design of the monthly carcass searches (ie. the results from monthly searches can be compared to the results from intense searches, to investigate any differences in estimated mortality rates between the two methods, and ensure that the statistical theory behind the monthly searches is sound).

Intense carcass searches will be undertaken in the first year of post-construction survey. The need for further intense carcass searches will be discussed with OEH as part of the annual reporting process, and a decision on continuation will be informed by the results of the intense searches.

3.3.4. Scavenger rates and trials

It will be important to ascertain the rate at which carcasses are removed by scavengers. This can be used to develop a 'correction factor' that informs the estimate of wind farm impacts on birds and bats. Scavengers can include ground-based animals, such as foxes and rats (more likely to detect carcasses by scent), as well as aerial scavengers such as birds of prey and ravens (more likely to detect them visually). The scavenger trial described below is designed to ascertain the scavenging rate, usually expressed as an average carcass duration. An intact carcass will be defined as a carcass that does not appear to have been scavenged by a vertebrate scavenger. A partially eaten carcass will be any skeletal or flesh remains found. Feather and fur spots will be defined by their presence (a feather spot being a cluster of five or more feathers) and the absence of any remains. Intact or partial carcasses and feather/fur spots will all be recorded as a find.

Scavenger trials will be undertaken twice per year for the first two years of post-construction monitoring. The objective of having two trials each year is to account for the different vegetation conditions, so one will be held when the grass is long and one when the grass is short. Based on experience, grass is expected to be longest in late spring (most probably November), following rainfall and higher temperatures. Grass is expected to be short during the colder months of winter (July), or when stock have been grazing an area.

After this, the need and frequency of further scavenger trials will be reviewed with OEH.

Scavenger Trials

Scavenger Trials will be undertaken by a trained person (defined in section 3.4) to determine the probability of scavenging loss, and the nature of scavenger removal (e.g. an early peak in scavenging, or scavenging that peaks after carcasses have been in place for a period of time). The search area for scavenger trials will be the same as in the search protocol (above) and will be located under operating turbines, selected based on the methodology outlined in section 3.3.1.

To determine potentially different scavenging rates on birds and bats, two size categories of carcass will be used. Different scavengers are active at different times of day and this will be accounted for by placing carcasses out during the early morning and late afternoon. This will reduce the potential for bias in the search intervals. Based on current mortality estimation software requirements, every endeavor will be made to find ten carcasses of each size category (Table 4). Improvements on this would require an impractical and unlikely availability of required carcass numbers, and do not lead to a commensurate improvement in the statistical power of estimates.

Table 4: Number of replicates for each scavenger trial

Time	Micro-bat	Medium to very large birds
Early Morning	5	5
Late Afternoon	5	5

The trials will be conducted at the same 18 randomly-selected turbine sites used for mortality searches, which includes both low risk and high risk turbines (see section 3.3.1). The first five carcasses of each size category (ten carcasses in total) will be randomly placed under different turbines in the morning (ie. one carcass per turbine). Before placing the evening carcasses, the morning 10 will be checked, then each of the carcasses will be checked every 12 hours for the first three days, then daily for two days, then every 48 hours for the following four days and then every three days until they disappear or at the end of 30 days (Table 5).

Table 5: Scavenger trial search timetable

Day (Time)
Day 1: Early morning
Day 1: Late afternoon
Day 2: Early morning
Day 2: Late afternoon
Day 3: Early morning
Day 3: Late afternoon
Day 4: Anytime
Day 5: Anytime
Day 7: Anytime
Day 9: Anytime
Day 12: Anytime
Day 15: Anytime
Day 18: Anytime
Day 21: Anytime
Day 24: Anytime
Day 27: Anytime
Day 30: Anytime

Additional procedures for scavenger trials are provided below.

- The timing of searches is based on experience and regulatory approval at a number of other wind farms (BL&A unpublished records) where scavenger trials have been undertaken that show almost all carcasses have been scavenged within five to ten days. More frequent monitoring than that proposed herein will not significantly affect consideration of scavenging and its impact on mortality estimates (see Symbolix 2012 for more detailed explanation).
- A mix of small and medium to very large native bird and bat carcasses (if available) will be obtained for use in the scavenger trial. Where carcasses of the species of concern cannot be found, a similar-sized and coloured substitute will be used to reduce bias by visual predators.
- Latex gloves will be worn at all times while handling carcasses to minimise contact with human scent, which may alter predator responses around carrion and to minimise disease risk to the handler.

- At each trial site, one carcass (or more) will be placed randomly within the 60 or 120 metre search area, depending on the search protocol for that turbine. Carcasses will be thrown in the air and allowed to land on the ground to simulate at least some of the fall and allow for ruffling of feathers. Note that bat carcasses will be placed within the inner 60 metre zone.
- Carcasses used in the trial will have their coordinates recorded to ensure that they are not confused with an actual fatality found under a turbine during the trial searches.
- Notes will be taken on evidence remaining at sites where carcasses have been scavenged (e.g. scavenger scats, bones, feathers, animal parts and type of scavenging, if visible, such as tearing, pecking, complete removal of carcass, partial removal of carcass, bird or mammal predator evidence).
- Notes will be taken on the state of remaining carcasses in each search.

Conduct of two scavenger trials at seasonally different times is designed to account for occasional winter/spring increase in carrion use. Previous studies have found that Red Foxes are reliant on rabbits and carrion in agricultural and forested areas (e.g. Brunner *et al*. 1975, Catling 1988, Molsher *et al.* 2000). Feral cats show little but uniform use of carrion throughout the year, whereas fox prey type is dependent on availability (Catling 1988). Catling (1988) found that foxes ate more carrion in winter/spring compared with summer/autumn, when they fed on adult rabbits. However, Molsher *et al*. (2000) found that there was no overall significant difference between seasons for carrion use. Seasonal differences only occurred in other prey types (not carrion), such as lambs, invertebrates and reptiles, as these are only available at certain times of the year.

The number of carcasses per category is based on obtaining a reasonable level of statistical confidence in the estimate of average carcass duration, as reflected in software requirements for current mortality estimation processes, whilst seeking to minimise the number of carcasses used. Large numbers of carcasses (e.g. on-site, road-kill) are difficult to obtain and it may be very complicated to find alternative sources (e.g. farmed and culled animals). It is also possible that large numbers of carcasses, more size categories and more replicates may attract more scavengers to the area. Previous studies (e.g. Molsher *et al*. 2000) have shown that fox prey use is related to availability and therefore more foxes may be attracted to the area if more carcasses are used. In addition, raptors are potentially more susceptible to collision when preying on carrion beneath turbines. However, it is necessary to conduct these trials under turbines as some scavengers may alter their behaviour in response to the turbines. The final scavenger trial design is therefore a necessary compromise between high numbers of trials and practicality whilst ensuring a statistically-valid trial process.

3.3.5. Detectability trials

As in section 3.4, all searchers will be supervised by a qualified ecologist and undertaken by trained ecologists or personnel trained by the ecologist.

These trials aim to assess the probability that a searcher will detect an existing carcass, given the prescribed mortality search protocol detailed for monthly carcass searches in section 3.3.2 (ie. searching along the six metre and 12 metre transects). The most efficient use of time is therefore to conduct the detectability trials concurrently with the monthly searches. As humans are reliant on visual cues to determine carcass location, the two visibility categories of low and high grass cover will be compared (as described in section 3.3.3).

To account for observer variability in detecting carcasses, all personnel who have carried out monthly searchers at Collector (likely maximum two) will be involved in the detectability trials. Detection efficiency (percentage of carcasses detected) will then be incorporated into later analyses that derive mortality estimates. The number of carcasses to be employed in each trial is detailed in Table 6 and explained below. The carcass controller (not involved in monthly carcass searches) will throw each carcass into the air and allow it to land on the ground to simulate at least some of the fall and the potential ruffling of feathers. The carcass controller will note the placement of carcasses (via GPS) and is free to decide how many are deployed under each turbine, however all bats should be located within the inner, 60 metre search zone. Training of searchers and carcass controllers, and who will manage the scavenger and detectability trials is detailed in section 3.4.

Table 6: Number of replicates per season for detectability trials, given two factors of size and visibility

	Micro-bat	Medium to very large bird
Long grass	10	10
Short grass	10	10

The confidence analysis (Appendix 2) highlights that there is a large confidence interval on the estimate of searcher efficiency, even for a high number of trials (plus or minus ten percent even with 50 replicates. This means that only relatively large seasonal changes in detection (~20 - 30% or more) will be resolvable from normal background variation. To produce a distinct average detectability for four seasons could require over 100 carcasses per size class, which is logistically unfeasible and likely to begin to influence the number of scavengers onsite and, therefore, the estimate of wind farm impacts. For this reason, sampling should be undertaken during the two periods that represent the greatest change in vegetation cover (therefore visibility), using a number of carcasses that is logistically manageable and aligned with the number and timing of scavenger trials (Table 4). Statistical confidence analysis (Appendix 2) indicates that this will result in a reasonably precise detectability estimate after one year, and optimal precision after two.

Any substitute carcasses for these trials will be of both similar size, colour and form to the species being represented or species of concern (i.e. brown mice rather than birds should be substituted for bats as birds do not have the same body shape, colour and appearance).

If sufficient carcasses cannot be sought, stuffed, realistic-looking artificial substitutes may be used. As humans are entirely visual searchers, it is not essential to use real carcasses as long as the substitutes appear similar once on the ground. Additionally, the artificial substitutes will not attract scavengers and should not increase the likelihood of raptor collisions and the number of introduced predators on-site. As these trials can be undertaken separately from scavenger trials, artificial substitutes may be ideal (i.e. mice substitutes for bats). Note, however, that it is considered to be more time efficient and cost effective to undertake scavenger and observer trails concurrently.

3.3.6. Incidental Carcass Protocol

Wind farm operators managing the Collector Wind Farm may from time to time find carcasses within the wind farm site during normal day-to-day O&M activities. In this case, the carcass detection protocol outlined in section 3.3.2 will apply. All wind farm personnel will be made aware of this carcass detection protocol as part of their HS& E training and induction. If the find is made within five days prior to a scheduled carcass search, the carcass will be left *in situ* but photographed and its position recorded (GPS). A carcass search data sheet (Appendix 3) will be completed for each incidental carcass found.

3.3.7. Analysis of results and mortality estimation

The results of the mortality monitoring surveys will be analysed in order to provide information on:

- The species, number, age and sex (if possible) of birds and bats being struck by the turbines.
- Any seasonal or yearly variation in the number of bird and bat strikes.

The results will be detailed in annual reports (Section 3.6) and will assess the need for further detailed investigations or mitigation measures.

Modern, statistically robust projections of bird and bat mortality for the entire wind farm site will be presented, based on the data collected from mortality searches. It is acknowledged that this is a current and dynamic aspect of research and that the outcomes from such programs may be equally dynamic. The current program is designed to provide an acceptably accurate and precise estimate of wind farm related bird and bat mortality within two years, so a full analysis and estimate will be provided in the second annual report, together with recommendations on the scope of future monitoring.

All data will be analysed to provide the average, standard error (variability) and range (of the study turbine population). The seasonal and annual mortality (if applicable) of each species and size class detected will be calculated. If possible, the standard error and range of these estimates will be reported. Note that it may not be possible practically to provide this for each factor due to the low number of carcasses detected and available for trials. Where this is an issue, it will be reported. Mortality estimates will also take into consideration the actual operational time of the turbines (obtained from the project operator).

The estimated mortality rate will be generated by modeling the scavenger losses and results of the human detectability trials, and using sampling inference to account for the selection and stratification of turbines. The data from the scavenger and detectability trials will be analysed using relevant techniques based on Generalised Linear Modelling (GLM) and (censored) Survival Analysis. Censored measurements are only partially known, such as the exact time of mortality or the exact time to scavenge loss (see, for example, Kaplan & Meier (1958)). In addition to providing mortality estimates, this analysis will determine if any of the factors (ie. size class or habitat stratification of turbine sites) are significant.

It is difficult to provide the actual format (e.g. fatalities/turbine/year) of the results, in this current BBAM Plan, as it is subject to the results of the experimental trials and the variability of the data. As the results cannot be predicted (no pilot studies are available), results will be reported in a way that gives as much information as possible but with an accurate interpretation of the data. As stated above, it will be possible to provide the number, average (with attendant standard error) and other basic statistics of recorded fatalities per study population for the sampling time/effort, but it is uncertain whether this data can be generalized to a larger population. All species carcass data will be analysed and presented with species-specific information.

3.4. Personnel Involved

This section of the plan outlines the personnel involved and any training required for the field work and report writing required under this BBAMP Plan. All personnel working on this Plan will be trained thoroughly, including background theoretical training, knowledge of policies and other administrative matters (e.g. OH&S) and technical and field training methods. RATCH Australia will undertake a tender process for the engagement of suitably qualified and trained people to supervise and implement the monitoring program.

A suitably experienced and qualified ecologist will oversee in detail and be involved in the implementation of the program, including the carcass searches, searcher efficiency trials, scavenger trials. Any person undertaking searches will be trained and supervised by a qualified ecologist who is familiar with the techniques. The searcher will receive training from the qualified ecologist in the following areas:

- Turbine searches ie. transect spacing in inner and outer zones, number of turbines to search and transect search methods
- Equipment usage ie. GPS
- Data recording
- Species identification

The qualified ecologist will supervise the initial carcass search to ensure that field methods are being undertaken correctly and undertake an audit in the first three months to ensure that methods are being implemented correctly. The qualified ecologist will also be responsible for identifying any recorded carcasses.

The first searcher efficiency trial will be initiated and set up by the ecologist, who will also train a separate person (the 'carcass controller') to run searcher efficiency trials. Training will include:

- Correct preparation and handling of trial carcasses
- Correct methods for the random placement of trial carcasses within a randomly selected sub-set of the search areas, and
- The need to place trial carcasses without the searcher knowing they are being placed,

If for some reason the searcher is unable to undertake the monthly searches as planned (due to illness etc) the field searches will be extended at the end of the nominated search period to make up for the missed searches. If any additional personnel are required to undertake searches, they will also be trained and supervised by a qualified ecologist and will participate in searcher efficiency trials.

The scavenger trials will be set up by the qualified ecologist, with searches being undertaken by the trained searcher.

Analysis of mortality data will be undertaken by a qualified statistician or ecologist. Annual reports and all investigations as a result of an impact trigger being detected will be prepared and carried out by a qualified ecologist.

3.5. Injured Bird and Bat Protocol

All on-site staff and monitoring personnel will be advised of the correct procedure for assisting injured wildlife. Wind farm personnel who find injured wildlife will be required to report the find to the wind farm site manager, who will be required to place the animal immediately into a dark place (e.g. box or cloth bag, if safe to do so) for transfer to the nearest wildlife carer or veterinarian.

Contact details of local veterinary staff and wildlife carers are provided below to ensure that if injured wildlife are found and cannot readily be released back to the wild, they are treated accordingly and in a timely manner.

- Gundaroo South Veterinary Clinic: (02) 6236 8222
- RSPCA ACT: (02) 6287 8113
- Canberra Connect: 13 22 81
- Wildcare Queanbeyan: (02) 6299 1966

This Injured Bird and Bat Protocol is valid for the operational life of the wind farm.

3.6. Routine Reporting and Review Meetings

In accordance with the consent condition, reports will be submitted to the Director-General and OEH on an annual basis for the first five years of operation and every two years thereafter. The first annual report will be prepared within two months of the completion of the first year of post-construction monitoring. The first annual report will not compare pre- and post-operational periods but will focus instead on presenting the results of the bird and bat utilisation surveys, reviewing the monitoring method for mortality searches and recommending refinements, where necessary. This is because two years of carcass search data are required to estimate mortality rates for birds and bats with reasonable levels of accuracy and precision. Matters to be addressed in the first report include, but will not be limited to:

- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices.
- The results of the bird and bat utilisation surveys, and the presence or otherwise of species considered to be at risk.
- Proposed changes to the frequency of searches, based on average carcass duration from the scavenger trial.
- Review of the mortality results to ascertain the likely level of precision in the estimate of bird and bat mortality for the given survey effort.
- Identification of any unacceptable impacts or impact triggers, and application of the decision-making framework.
- Any recommended changes to survey effort based on the results of the surveys.

The second annual report will be prepared within two months of completing two years of post-construction monitoring and will include:

- The survey methods (including list of observers, dates and times of observations).
- The results of the bird and bat utilisation surveys before and after operations commence.
- Estimates of bird and bat mortality rates (animals per turbine per year).
- Seasonal and annual variation in the number and composition of bird and bat strikes.
- Any other mortality recorded on site but not during designated carcass searches i.e. (incidental records by site personnel).
- A summary of livestock carcass removal for the purposes of predator reduction.
- A discussion of the results, including:
    - Whether indirect impacts on bird and bat use of the site are of significance at a regional, state or national level, or if species of concern have been affected.

- o Bird risk reduction measures.
- o Any further recommendations for reducing mortality, if necessary.
- o Whether the level of mortality was unacceptable for affected listed ('at risk') species of birds or bats.
- o Usage of the wind farm area by 'at risk' species and factors influencing this (ie. climatic, geographical and infrastructure).
- o Analysis of the effectiveness of the decision-making framework.
- o Recommendations for further monitoring

At the end of the second year of post-construction monitoring, an overall assessment will be made of all the data obtained during this phase, and details of the management practices implemented, as well as recommended adjustments. The information from this assessment will inform the need for and scope of further detailed monitoring. The results of the review and its implications will be discussed with OEH.

Annual reports prepared for years three to five, and every two years after, will include the results of any monitoring activities undertaken for that year and a discussion regarding any impact triggers or unacceptable impacts identified, mitigation measures implemented and application of the decision making framework. As this management plan is adaptive, further refinements to the program will be included in annual reports following the second year of post-construction monitoring will be based on the outcomes of monitoring surveys and any impacts.

4. MITIGATION MEASURES TO REDUCE RISK

Mitigation involves the prevention, avoidance and/or reduction of the risk of an impact trigger (defined in section 5 as a threshold of impact on birds or bats that triggers an investigation and/or management response) occurring or continuing to occur. This section outlines measures that will be undertaken during operation of the wind farm to prevent or reduce the potential for an impact to occur, and addresses condition of approval B6 (e).

The overall objective of mitigation measures is to ensure that the Collector Wind Farm does not lead to unacceptable impacts on threatened or non-threatened birds and bats. Section 5.3 outlines mitigation measures that are specific to hypothetical impacts, if they were to occur.

4.1. Turbine shutdown during periods of Eastern Bentwing Bat migration

The results from pre-construction bat monitoring indicated that high numbers (up to 2463) of Eastern Bentwing Bat were recorded migrating through parts of the wind farm site during March 2014. It is not known if these migrations are regular or not, or whether they only occur in specific areas of the site, but these uncertainties are expected to be further clarified by further site monitoring work proposed to be undertaken next year (mid spring/early summer 2014 and one in late summer/early autumn 2015). The exact timing of the surveys will be discussed and agreed with OEH based on specific monitoring of the bat migration.

If that further work suggests an increased risk of Eastern Bentwing Bat mortality, a potential mitigation option would be the temporary shutdown of wind turbines in identified high risk areas during the species migration from their maternity caves. There is as yet, insufficient information to develop a detailed turbine shutdown protocol which would define the mechanics of such an approach (eg which turbines, when, how long, etc) – this would be developed in conjunction with OEH and based on further proposed research and field investigations, including but not limited to:

- Further targeted bat surveys, to be carried out during the Eastern Bentwing Bat migration to and from their maternity caves
- Investigations into the correlation between bat numbers and rainfall, wind speed and wind direction.

Key aspects to be considered / incorporated in any such turbine shutdown protocol include:

- Focus on turbines in high risk areas;
- Timing limited to night time periods when bats may be migrating through the wind farm
- Timing process to be agreed with OEH, based on ongoing monitoring of bat numbers / migration at the maternity caves
- Weather conditions that constrain bat flight activities (eg flight activity ceases when wind speed exceeds 8 m/s (Dr Greg Richards, pers.comm 2014)

Outside of these aspects, wind turbines would continue to operate as normal (eg during daylight hours, in weather conditions where wind speed exceeds eight metres per second).

4.2. Carrion removal program

In order to reduce the risk of raptors colliding with turbines, a regular carrion removal program will be implemented during operation, to reduce the attractiveness of the site to raptors and therefore reduce the chances of fatal collisions by this group of birds. Carrion is defined as the dead and decaying flesh of an animal that often serves as a food source for animals.

To provide for the regular removal of carcasses likely to attract raptors to areas near turbines the procedures below will be adopted.

- Designate a suitable person (such as a wind farm employee or landowner) to perform the function of Carrion Removal Coordinator who will undertake the following activities:
  - Monthly inspections of the wind farm site to search for any stock, introduced or native mammal and bird carcasses that may attract raptors (e.g. kangaroos, foxes, rabbits, dead stock). This search is undertaken via vehicle and using binoculars to look for large carcasses within 200 metres of each turbine.
  - Any carcasses and/or remains found that are within 200 metres of turbines, will be collected and disposed of as soon as possible, in a manner that will avoid attracting raptors close to turbines.
  - Consult with landowner or manager in relation to the appropriate disposal of collected carrion, to be located at least 200 metres away from the closest turbine, whilst still leaving the carrion available as a food source so as to not reduce the habitat quality for raptors.
  - Wind energy facility maintenance staff and landowners will be required to notify the Carrion Removal Coordinator immediately following identification of carrion on site in between monthly searches
  - Carcass occurrence and removal will be recorded in a "management log book" maintained by RATCH Australia.
- During lambing season (usually late autumn / early winter) young lambs are susceptible to death. Therefore lambing will be restricted in paddocks at least 200 metres away from turbines.
- In order to reduce collision risks to birds, the practice of feeding stock close to turbines should be discontinued when the wind farm starts operation as it could cause unnecessary impacts. As such, stock will not be fed grain within a 200 metre radius of wind turbines as this may also attract parrots and cockatoos that can then collide with turbines.
- If a large number of rabbit carcasses are incidentally observed during pre- or post-construction monitoring surveys, it may be necessary to conduct an integrated rabbit control program (attractive to Wedge-tailed Eagle) within 200 metres of turbines. Methods to control rabbits include harbour destruction, poisoning and shooting (DPI 2014). Any rabbit control program will require cooperation and agreement from the landowner. Note that high numbers of rabbits have not been incidentally recorded during any of the pre-construction surveys undertaken to date.
- An annual summary of carcass removal, based on the 'management log' will be provided in the annual monitoring reports.

The need for continuation of the carcass removal program will be assessed after one year of operation. In general, the criteria for continuation will be based on the frequency of carcass finds. For example, if carcass frequency is particularly low (e.g. one or two per quarter) outside of turbine search zones (i.e. not beneath turbines) the intense program may be discontinued or reduced considerably subject to agreement from OEH.

4.3. Minimise perching and roosting opportunities

A number of raptor species hunt from perches that can include tall man-made structures or isolated taller trees in farmland, thereby providing them with an ideal vantage point. During pre- construction and post-construction monitoring activities, the location and use of perching and roosting sites surrounding turbine locations will be incidentally recorded. Raptors observed nesting or perching will be recorded in addition to the type of habitats they are located in. Should pre-construction monitoring indicate that regular perching sites within 100 metres of wind turbines create the potential for an impact, perch removal will be considered, in consultation with OEH. Note that no raptor nests were incidentally observed during pre-construction bird and bat utilisation surveys.

4.4. Improving habitats away from wind turbines

Habitat enhancement or protection programs can be implemented to create, improve or protect high quality habitats away from the wind farm site. The aim of improving habitats a safe distance away from turbines is to encourage species to use habitats a safe distance away from turbines. The client has indicated that an area of high quality woodland habitat towards the south east of the wind farm study area is to be set aside as an offset site for the removal of vegetation on the wind farm. This offset site was included as one of the reference sites for pre-construction transect surveys in woodland areas. Protection and any enhancement of this area would help to encourage bird and bat species to use this area, which is located at least one kilometre away from the closest turbine (Figure 2).

4.5. Lighting on turbines and buildings

It has long been known that sources of artificial light attract birds, particularly night-migrating birds in North America and Europe. Lighting is probably the most important factor under human control that affects mortality rates of birds and bats colliding with all structures (Longcore et al. 2008).Most bird mortality at communication towers for example, occurs in poor weather with low cloud in autumn and spring, i.e. during migration periods (Longcore et al. 2008).

It is postulated that bright lights may temporarily blind birds, causing them to fly toward the light source and colliding with the structure (Gauthreaux and Belser 2006). They would appear prone to saturation of their retinas, causing temporary blindness when subjected to bright light (Beier 2006) and mortality of both birds and bats can result from collisions with lit structures. Birds can also become disoriented or 'trapped' in the field of light (Longcore *et al.* 2008).

Bats are also attracted to the increased numbers of insects that may congregate near bright light sources.

Measures to reduce the impact of lighting include using low pressure sodium or mercury lamps with UV filters to reduce brightness. The colour of lighting may also be important. Some studies have found that red lights resulted in a lower mortality than white lights (Longcore *et al*. 2008), but more recent research on oil rigs at sea suggests that blue or green lights may result in lower mortality than red or white lights (American Bird Conservancy 2014).

For the above reasons, building lighting should be baffled and directed to avoid excessive light spillage and security lighting should be baffled to direct it towards the area requiring lighting and not skyward. Should aviation safety lighting be required on turbine nacelles then this should take the form of low intensity, LED red flashing lights with a narrow vertical cross-section directed at aircraft.

4.6. Marking of power lines

There will be no additional above-ground power lines constructed as part of the project – the existing transmission and distribution lines within and around the wind farm site represent pre-existing risks within the existing environment.

Mitigation measures that are specific to hypothetical impacts and the time to implement such measures are detailed in Section 5.3.

5. IMPACT TRIGGERS AND DECISION-MAKING FRAMEWORK

This Section identifies the circumstances that will result in notification, further investigation and additional mitigation for both threatened and non-threatened birds and bats ('impact triggers'). If an impact trigger is met, there must be an investigation into the cause of the impact, and whether the event was likely to be a one-off occurrence or a regular event.

The impact trigger may be an unacceptable impact in itself, or may lead to an unacceptable impact.

Note that the approach developed in this section is based on the preparation of numerous bird and bat monitoring programs in both New South Wales and Victoria and up to date feedback from regulators on the implementation of approved plans (see section 1.1 for details).

5.1. Threatened Species

5.1.1. Definition of Impact Trigger and Unacceptable Impact

Generally, an impact trigger is where there is evidence of death or injury to birds and/or bats by collision or other interaction with turbines. Under this program, the circumstances that define an impact trigger and unacceptable impact for threatened birds and/or bats are detailed below.

Impact Trigger for Threatened Species: A threatened bird/bat species (or recognisable parts thereof) listed under the Commonwealth *EPBC Act* or NSW *Threatened Species Conservation Act 1995*, is found dead or injured under or close to a wind turbine during any mortality search or incidentally by wind farm personnel.

Definition of Unacceptable Impact on Threatened Species: Any impact that leads to a long term significant decrease in the size of the population.

5.1.2. Decision Making Framework

If a threatened species impact trigger occurs, further investigation will immediately be triggered and the decision making framework outlined below and in Figure 4 will be followed. This section complies with Condition B6 (c) of the conditions of approval.

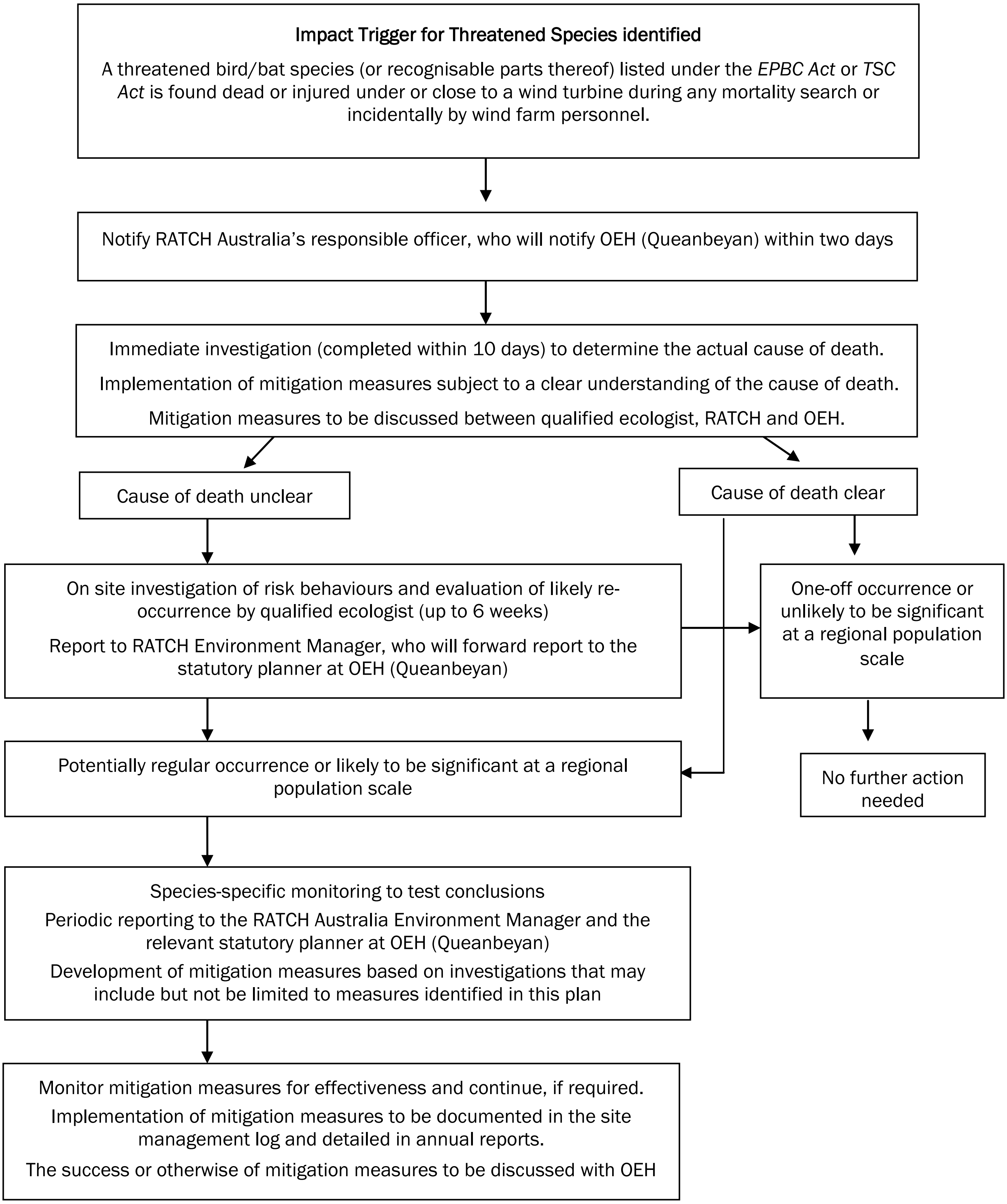
- Immediate reporting of the occurrence of an impact trigger to RATCH Australia's responsible officer, who will report it to the relevant statutory planner at OEH (Queanbeyan) within two business days of it being recorded;
- Immediate investigation (to be completed within 10 days) by an appropriately qualified ecologist to determine the cause of death or injury (in the unlikely event that the animal was, for example, shot). If the cause of death is considered to be due to turbine collision, an investigation will be undertaken to identify any particular risk behaviours that could have led to the collision and an evaluation of the likelihood of further occurrences. The impact trigger may be one-off or cluster events.
- The rapid 10 day investigation will assess the most effective mitigation and will ensure that the mitigation is implemented correctly and quickly, if possible, subject to a clear understanding of the cause of the impact. Table 7 details the time to implementation of specific mitigation measures according to hypothetical causes of death.
- If the cause of the fatality is deemed to be a one-off occurrence or the ongoing risk is unlikely to be significant at a population scale, no further action may be necessary. This

decision will be made in consultation with OEH and will be determined based on available evidence and using a precautionary approach

- If the cause of the impact trigger is not clear, further onsite investigation of risk behaviours and evaluation of likely re-occurrence will be required over the following weeks (up to six weeks). If these investigations suggest that the impact trigger was a one-off event or the ongoing risk is unlikely to be significant at a population scale, no further action may be necessary. This decision will be determined in conjunction with OEH and based on available evidence and using a precautionary approach.
- If the onsite investigation suggests that the impact trigger may be a regular occurrence, species-specific monitoring may be required. During the monitoring period, periodic reports will be provided to RATCH Australia and OEH.
- Responsive mitigation measures will be developed and implemented as needed and in a timely manner. Examples of mitigation measures may include but are not limited to those outlined in sections 4 and 5.3.

Any evaluation of impacts and decisions regarding mitigation measures and further investigations required will be undertaken in consultation with OEH. Any required investigation, and recommended management and supplementary mitigation measures, will be documented in the site management log and detailed in annual reports. This log will be available for inspection by OEH or on the request of the Director-General.

Figure 4: Decision making framework for identifying and mitigating impact triggers for threatened species



5.2. Non-threatened Species

5.2.1. Definition of Impact Trigger and Unacceptable Impact

The circumstances that define an impact trigger and significant impact for non-threatened birds and/or bats under this Management Plan is detailed below.

Impact Trigger for Non-threatened Species: In any two successive monthly carcass searches, two or more bird or bat carcasses (or parts thereof) of a non-threatened species, other than ravens, magpies, pipits and introduced species, are found at the same turbine (i.e. a total of four or more carcasses of the same species in two successive searches at the same turbine)

Definition of Significant Impact for Non-threatened Species: Any impact that leads to a long term significant decrease in the size of a population at a relevant population scale (e.g. regional).

Note that although the impact trigger does not include ravens, magpies, pipits and introduced species, detected mortalities for these species will still be reported as part of the annual reporting process.

5.2.2. Decision Making Framework

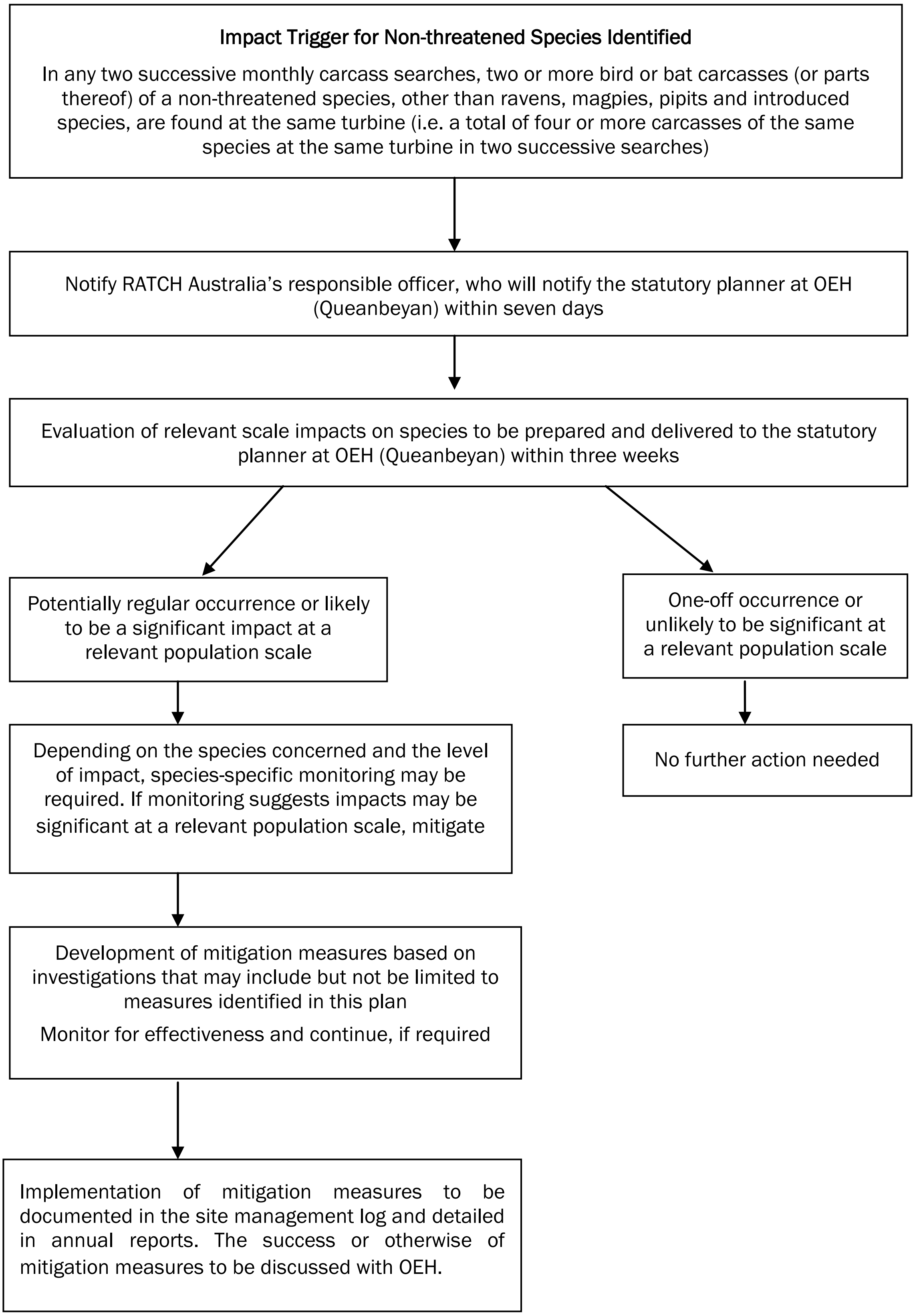
In the event that an impact trigger for non-threatened species is detected, an evaluation of impacts to the non-threatened species will be undertaken. OEH (Quenbeyan) will be notified of the impact trigger within seven days of recording the event. An appropriate scale to consider population effects of the impact trigger will be agreed between OEH and the proponent on a case-by-case basis with consideration given to the species in question.

A report on the investigation will be delivered to the relevant statutory personnel at OEH (Queanbeyan) within three weeks. If the evaluation indicates that the event was a one-off occurrence or is unlikely to be an unacceptable impact at a relevant population scale for the species in question, no further action will be necessary (as outlined in Figure 5).

If the event is deemed to be a potentially regular occurrence or likely to lead to an unacceptable impact to the species in question, species-specific monitoring may be required (Figure 5). If further monitoring confirms that impacts are likely to lead to an unacceptable impact on the species, mitigation measures will be required. Potential mitigation measures are outlined in section 5.3, however specific mitigation measures will be determined based on the species involved and the outcome of investigations.

Any evaluation of impacts and decisions regarding mitigation measures and further investigations required will be undertaken in consultation with and agreement from OEH. Any required investigation, and recommended management and supplementary mitigation measures, will be documented in the site management logs and detailed in annual reports. This log will be available for inspection by OEH or on the request of the Director-General.

Figure 5: Decision making framework for identifying and mitigating impact triggers for non-threatened species



5.3. Supplementary Mitigation Measures

Supplementary mitigation measures will be implemented in consultation with OEH in the event that an unacceptable impact trigger occurs. The purpose of supplementary mitigation measures will be to prevent the impact from continuing to occur. Specific mitigation measures will be implemented depending on the nature, cause and significance of any impact recorded and in response to the results of targeted investigations of the event and of the species concerned on the wind farm site.

It is difficult at this stage to know what the cause of an unacceptable impact trigger will be, therefore examples of impacts and potential mitigation measures specific to the impact trigger, and the time taken to implement these measures, are detailed in Table 7. Note that in implementing mitigation measures, a suite of measures that may or may not include those in Table 7 may need to be implemented, depending on the circumstances.

Table 7 Supplementary mitigation measures in the event of an unacceptable impact trigger occurring

Hypothetical cause of impact	Mitigation Measure	Likelihood of impact continuing following mitigation	Time to implementation
Foraging source identified that attracts threatened species to impact areas	Use acoustics (ie. loud music/irregular noise) to discourage birds from foraging in this location	Low	Implement as soon as possible and no later than two days after recording the impact.
	Encourage species into alternative areas outside of the wind farm boundary, where available, through the use of social attraction techniques offsite (decoys and audio playback systems)		
	Investigate and, if considered appropriate, remove foraging habitat from the wind farm site		Before removal of foraging habitat is undertaken, alternative mitigation measures should prove to be ineffective in reducing collision risk to acceptable levels.
Specific perching opportunity located on wind farm (man-made) that lead to impact	Remove perching opportunity	Low	Implement as soon as possible and no later than ten days after recording the impact.
	Install perch guard		
Farming practice attracts threatened species to risky areas (e.g. grain feeding of stock)	Halt farming practice and remove attraction	Low	Immediately
Wind/rain/fog causing low visibility	Temporary shutdown of turbines during periods of extreme low visibility – to be implemented only in the event that threatened species are experiencing high mortality rates.	Low	Immediately
Attraction to lights on the wind farm site	Avoid high intensity lighting within the wind farm site (e.g. use of light hoods) or switch off lighting temporarily while species is on or near the wind farm site. Alternative measures include: • Synchronise any flashing lights, • Use red rather than white or yellow lights, or • Remove lights	Low	If lights can be switched off, this should occur immediately. Alternative measures should be implemented no later than ten days after recording the impact trigger.
Attraction to small dams on site	Fill in dam and provide alternative stock watering arrangements	Low	Implement within ten days of recording the impact trigger, if possible.

6. MANAGEMENT ACTIONS, TIMING AND PERFORMANCE CRITERIA

The following table outlines the proposed management activities to be implemented for this bird and bat adaptive management program, the timing of activities and performance criteria to measure the success of actions.

Table 8 Management actions and performance criteria for successful implementation of this BBAMP at Collector Wind Farm

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
Baseline surveys	Obtaining pre-construction baseline bird and bat utilisation data	Pre-construction	• Bird utilisation surveys (point count and transect surveys) undertaken during spring and summer. • Bat utilisation surveys undertaken during spring and summer.	
	Obtaining post-construction bird and bat mortality data	Post-construction	• Bird utilisation surveys (point count and transect surveys) undertaken during spring and summer for at least one year. • Bat utilisation surveys undertaken during spring and summer for at least one year.	
Mortality monitoring	Eighteen turbines (separated into treed vs non treed) to be surveyed each month, 12 out to 60 metres and six out to 120 metres. The same turbines will be searched each month for at least two years, following which the need for further surveys will be reviewed based on the results of the first two years.	Post-construction – monthly for at least two years	• Post-construction mortality surveys undertaken monthly at 18 turbines for at least two years.	
	Pulse regime mortality searches – the inner zone (out to 60 metres) of each of the 18 turbines surveyed monthly, to be searched again two to three days later from October to April.	Post-construction – from October to April for at least two years	• Pulse searches undertaken at all 18 turbines from October to April for at least two years	
	Intense carcass searches – each of the 18 turbines chosen for monthly searches, will be searched every second day for a fortnight. This will be undertaken during two times periods – once during early summer and once during the Eastern Bentwing Bat migration period from their maternity caves (most likely March)	Post-construction – once during early summer and once during bat migration, for at least one year	• Intense carcass searches undertaken for two fortnightly periods for at least one year	
	Calculating annual mortality of birds and bats per turbine based on post-operational repetition of monitoring activities. Annual mortality estimates should be made after the second year of monitoring and should include correction factors from scavenger and detector efficiency trials.	Post-construction – at the end of the second year of mortality monitoring	• Scavenger and detector efficiency trials undertaken • Estimates of mortality for birds and bats made after two years of monitoring	
Annual Reports	Preparation of Annual Reports to be submitted to Director-General and OEH for the first five years of operation and every two years thereafter.	Post-construction – every year for the first five years and every two years thereafter.	• Annual reports for the first five years and every two years thereafter delivered within two months of completion of yearly monitoring. • Annual reports to include (but not be limited to) results of monitoring surveys for that year, any impact triggers or unacceptable impacts identified, mitigation measures implemented, application of the decision-making framework and recommendations for the following year.	
Mitigation measures to reduce risk	Carrion removal program - stock and kangaroo carcasses will be removed from within 200 metres of wind turbines on a monthly basis and disposed of.	During operation	• Carcasses removed • Activity recorded in management log book • Increase frequency of stock and kangaroo carcass removal and disposal if required	

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
	Restrict lambing to paddocks at least 200m from turbines.		• No increase in raptor mortality during lambing season	
	Stock will not be fed grain underneath turbines		• No increase in bird mortality due to grain underneath turbines	
Mitigation measures to reduce risk	Pest control program - Implement rabbit control if the carrion removal program suggests rabbit carcasses are an issue	During operation	• Monitor effectiveness of rabbit control and, where bird mortality is clearly related to rabbit numbers, increase the effectiveness of rabbit control	
	Monitor use of perching and nesting sites within 100 metres of proposed turbines. Should these locations be used in a manner that elevates collision risk, turbines should be micro-sited to a greater distance from habitat trees, if feasible.	Pre-construction	• Turbine locations minimised within 100 metres of perching and nesting opportunities, if monitoring shows this is a potential risk. • If necessary, alternative perching, nesting and bat roosting sites will be provided at safe distances from collision risk zone (>500m).	
	Habitat improvement or protection to encourage animals to use habitats away from turbines.	During construction	Protection of offset site located in woodland habitat.	
	Minimising external lighting. If required, aviation safety lighting should use low intensity, LED, red flashing lights on nacelles.		Monitor bat and bird utilisation adjacent to lit and unlit turbines. If mortality at lit turbines significantly exceeds that of activity at unlit turbines, type and duration of lighting will need to be reviewed, subject to other limitations, such as any CASA requirement.	
	Baffle lights on buildings and sub-stations to avoid light spillage and visibility from above.			
	Baffle security lighting to avoid light spillage and visibility from above.			
	Use of deterrents - Overhead powerlines should have marker balls and/or flags where they cross waterways		No incidental records of bird mortality from power line collision around waterways.	

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Appendix 1 BL&A (2014) – Collector Wind Farm Pre-construction Bird and Bat Monitoring Surveys

COLLECTOR WIND FARM

PRE-CONSTRUCTION BIRD & BAT MONITORING SURVEYS

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July 2014

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APPENDICES

1. INTRODUCTION

RATCH Australia Corporation Limited (RATCH) engaged Brett Lane & Associates (BL&A) to carry out the pre-construction surveys outlined in the Bird and Bat Adaptive Management Program (BBAMP) for the Collector Wind Farm (BL&A 2014). This investigation was commissioned to provide baseline data on the pre-construction utilisation by birds and bats of the wind farm site to satisfy the requirements of the BBAMP and help inform the development of any mitigation measures that may be necessary.

The bird utilisation survey (BUS) scope was consistent with the requirements for a "Level One" bird risk assessment in accordance with 'Wind Farms and Birds - Interim Standards for Risk Assessment' issued by the then Australian Wind Energy Association (AusWEA 2005). This approach has been endorsed in the Clean Energy Council's Best Practice Guidelines (2013). The investigations included two bird monitoring methods:

- A BUS at fixed points representing impact and reference sites, undertaken over seven days during late October 2013 and similarly during the second half of February 2014.
- Line transects within woodland vegetation at impact and reference sites to assess the indirect impacts of wind turbines on woodland birds, undertaken over the same time period as the fixed point surveys.

Bat surveys were undertaken in accordance with Clean Energy Councils' Best Practice Guidelines (2013) using bat detection systems to record the echolocation calls of bats. A late spring/early summer (November–December 2013) survey was undertaken by BL&A, and late summer/early autumn bat survey (February – March 2014) was undertaken by Greg Richards and Associates (GR&A) in conjunction with BL&A. Records were made from nine sites during the 2013 survey and ten sites during the 2014 survey. The sites included monitoring with a dual channel recorder at a wind mast with one microphone at 50 metres, and another at ground level (1-2 metres) at the same location. The survey sites represented the various habitat types within the wind farm with a focus on the possible presence of the threatened Eastern Bent-wing Bat.

The survey methods used for these bird and bat surveys, including survey periods, timing and locations, were developed in consultation with the NSW Office of Environment and Heritage (OEH). BL&A is grateful to Allison Treweek and Damon Oliver for their input to the design of this monitoring program.

This report is divided into the following sections:

Section 2 describes the study area

Section 3 provides the methods for the bird and bat surveys

Section 4 provides the results of the bird and bat utilisation surveys

Section 5 details the conclusions from the pre-construction surveys

This investigation was undertaken by a team from BL&A, comprising Khalid Al-Dabbagh (Senior Zoologist), Annabelle Stewart (Senior Ecologist & Project Manager), Brett Lane (Principal Consultant) and Greg Richards (Bat consultant).

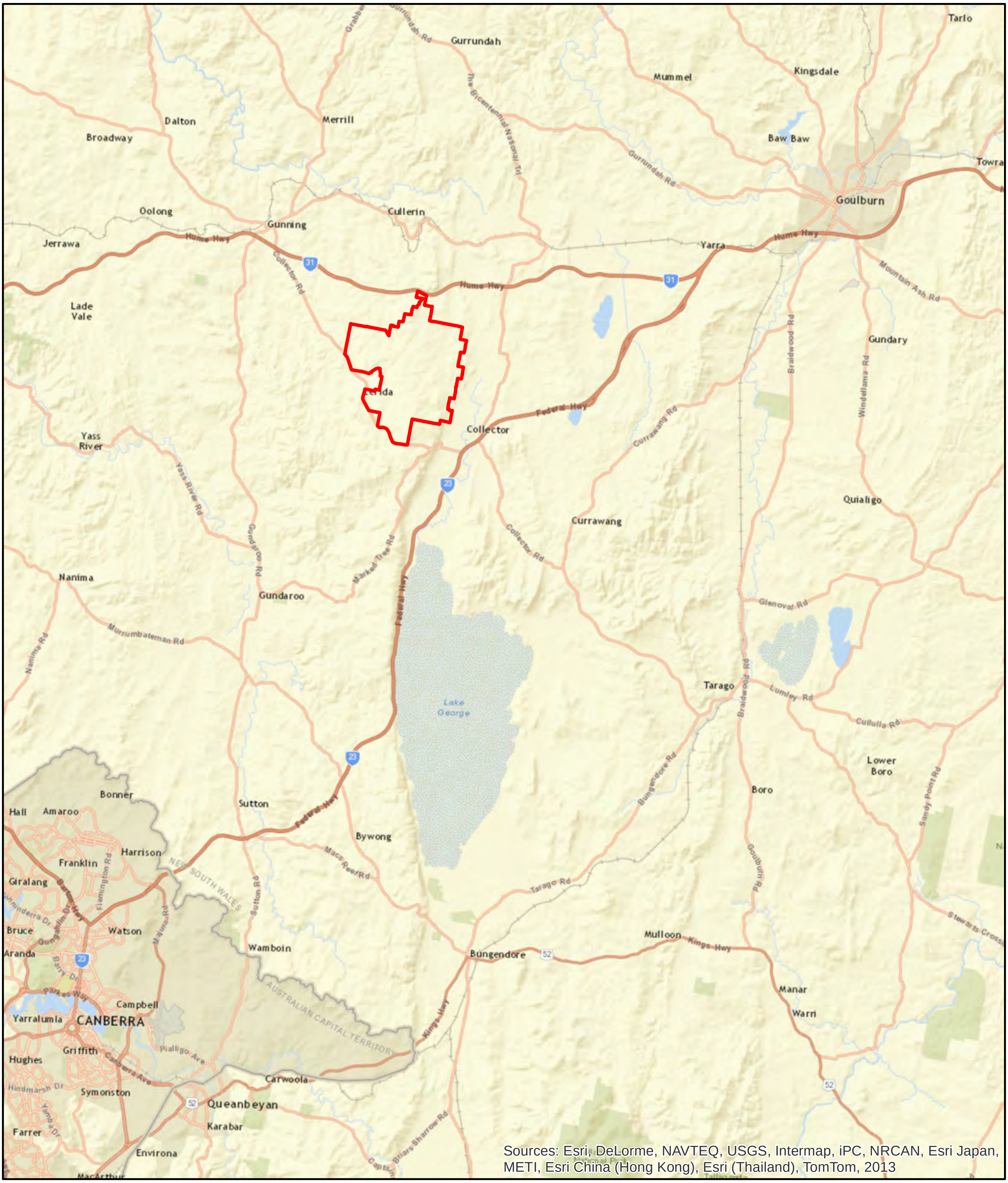
2. STUDY AREA

The Collector Wind Farm is located in the Tablelands region of New South Wales, approximately 30 kilometres south-west of Goulburn and 50 kilometres north-east of Canberra. The site is approximately 6,215 hectares and located less than five kilometers west of the town of Collector, between the Federal Highway (to the south) and the Hume Highway (to the north, see Figure 1).

The site consists of 13 properties, currently managed for sheep and cattle grazing with some areas sown with exotic pasture for feed, and comprises pasture (exotic and native) and remnant woodlands.

The geology of the site consists of undulating granitic plains and occasionally plains and ridges supporting sedimentary and metamorphic rock that typically carries woodland assemblages (NGH Environmental 2012). The site, particularly the northern section, is covered by small remnants of eucalypt woodland dominated by Yellow Box, Blakely's Red Gum, Apple Box and occasionally Broad-leaved Peppermint. Metamorphic ridges carry dry forest types dominated by Brittle Gum, White or Scribbly Gum or Broad-leaved Peppermint. The site's woodlands have been extensively cleared and modified for sheep and cattle grazing. The proposed turbine locations are in the cleared sections of the site or among widely scattered eucalyptus trees.

The Collector Wind Farm is within the Upper Lachlan Local Government Area (LGA), and the Monaro subregion of the Murrumbidgee Catchment Management Authority (CMA) region.



Legend

Collector Wind Farm Site

0 5 10 20 Kilometers

Figure 1: Location of Collector Wind Farm		
Project: Collector Wind Farm		
Client: RATCH Australia		
Project No.: 13100	Date: 8/07/2014	Created By: M. Ghasemi / A. Stewart

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3. METHODS

3.1. Bird surveys

3.1.1. Fixed-point bird count method

The fixed-point bird count method used to collect bird utilisation data involved an observer stationed at a survey point for 15 minutes. The adequacy of using 15 minutes as an interval to record the presence of birds during bird utilisation surveys was investigated in an earlier study at another wind farm site (BL&A unpublished data). This showed that 82 to 100 percent (average 88 percent) of species actually seen in one hour of surveying were seen in the initial 15 minutes of observation. Based on this result, the period of 15 minutes used in the formal bird utilisation surveys was considered adequate to generate representative data on the bird species in the area during the survey.

During this period, all bird species and numbers of individual birds observed within 200 metres were recorded. The species, the number of birds and the height of the bird when first observed were documented. For species of concern (threatened species, waterbirds and raptors), the minimum and maximum heights were recorded.

The specific turbine option to be installed is still under consideration, however each turbine option has a hub height of around 90 metres (84 to 92.5 metres) and a rotor diameter that ranges from 113 to 122 metres. Rotor swept area ranges from 28 to 36 metres above ground to a maximum height of 140 to 150 metres above ground.

For the purpose of this report, flight height relative to RSA height is presented as described below. Note that data have been recorded in 10 metre height intervals during surveys and depending on the final turbine specification, this analysis can be refined.

- **A =** Below RSA (< 30 metres above ground)
- **B =** At RSA (30 – 150 metres above ground)
- **C =** Above RSA (> 150 metres above ground)

The spring bird utilisation surveys were undertaken over seven days across 19-30 Oct 2013 and the late summer surveys were undertaken over seven days across 17-27 February 2014. Table 1 indicates when each point was counted on each survey day. This schedule ensured that all points were visited equally at different times of day to allow for time-of-day differences in bird movements and activity. Every survey point (impact and reference) was visited eight times over the survey period (Figure 2).

Table 1: Times when points were counted for each fixed-point bird count survey day

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
8:00	1	3	5	7	9	R1	2
8:40	2	4	6	8	10	R2	3
9:20	3	5	7	9	R1	1	4
10:00	4	6	8	10	R2	2	5
10:40	5	7	9	R1	1	3	6
11:20	6	8	10	R2	2	4	7

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
12:00	7	9	R1	1	3	5	8
13:00	8	10	R2	2	4	6	9
13:40	9	R1	1	3	5	7	10
14:20	10	R2	2	4	6	8	R1
15:00	R1	1	3	5	7	9	R2
15:40	R2	2	4	6	8	10	1
16:20	1	3	5	7	9	R1	
17:00	2	4	6	8	10	R2	

Note: See Figure 2 for survey point locations. The prefix 'R' refers to reference points

3.1.2. Locations of survey points

Twelve fixed survey points were established; ten impact points and two reference points. Impact points were located near proposed turbine locations and reference points were located at least 500 metres away from impact points in areas of similar habitat.

The survey points were distributed as evenly as possible (subject to access constraints) across the proposed wind farm site to maximise coverage in areas where wind turbines will be located (Figure 2). Impact points were positioned on elevated ground where possible, allowing a clear view in all directions.

Table 2 below provides a description of the habitats associated with each impact and reference point.

Table 2 Habitat associated with each survey point

Survey point	Habitat
B1	Point located on the side of an almost flat top hill surrounded by scattered mature eucalypt trees and within approximately 300 metres of a large woodland remnant. A farm dam is located at the base of the hill, roughly 150 metres away.
B2	On top of a cleared hill (saddle) surrounded by few scattered mature eucalypt trees (within 500 metres). Grass mostly introduced and grazed by sheep.
B3	On the side of a large and almost flat top hill surrounded by scattered large and mature eucalypt trees, almost forming small remnant woodland. Ground is a mixture of native and exotic grazing grasses.
B4	On the top of an open hill top mostly cleared but surrounded by few scattered eucalypt trees.
B5	Close to the flat top of a hill covered with small remnant of eucalypt woodland.
B6	In the middle of a flat grazing paddock; grass mostly exotic and grazed by cattle; no trees in area.
B7	On top of a small hill or undulating ground; with few scattered trees and covered by a mixture of native and exotic grass.

Survey point	Habitat
B8	On the side of a low and cleared hill but with two or three old eucalypt trees; grass is a mixture of native and introduced. Grazed by sheep and cattle.
B9	On the top of a cleared hill with mixed grasses for sheep and cattle grazing; no trees on this hill.
B10	On the top of a hill, cleared of trees and covered by mixed grasses (native and introduced). Large boulders scattered in site. Grazed by sheep and cattle.
R1	On a flat paddock and aside a currently dry creek. Site surrounded by large and mature eucalypts and a thick growth of smaller trees and large shrubs on bank of creek.
R2	On the side of an open hill with scattered large and mature eucalypt trees; ground is mixture of grasses; site also includes a line of exotic pines nearby.

3.1.3. Line transects

Transect surveys were aimed at determining the density of woodland birds at impact and reference sites before wind farm operations commence. This data will later be used for comparison against post-construction monitoring data once operations commence (BACI sampling design). The method involved an experienced bird observer walking a transect 400 metres long and 50 metres wide at the locations shown in Figure 2. The survey lasted 40 minutes (i.e. 10 minutes per 100 metres) and the observer recorded all birds observed (heard or seen) within 25 metres of the central transect track, and the distance of the bird from the central tract when first observed. This method enables bird density to be calculated.

Two woodland bird transect sites were surveyed in woodland areas within 500 metres of turbines (impact sites) and two sites in woodland areas greater than 500 metres from turbines (reference sites) (Figure 2). The impact line transects were both in the northern section of the wind farm site. T1 was within a remnant woodland that consisted of an almost monospecific overstorey of mature eucalypts and very thin or few scattered shrub for the understorey. T2 on the other hand was an open woodland remnant of mixed eucalypt species, some of which were mature with very old trees.

The reference line transects (TR1 and TR2) were located among remnant woodland in the south-western section of the wind farm. Both woodlands consisted of mixed large and mature eucalyptus in the overstorey and a good understorey of shrubs and small trees. The quality and woodland structure was much better at the reference transects compared to the impact transects. Both of the reference sites are proposed to be the offset site for removal of vegetation for construction of the wind farm.

Each site was surveyed once in the morning and once in the afternoon during both the spring and late summer surveys (Table 3).

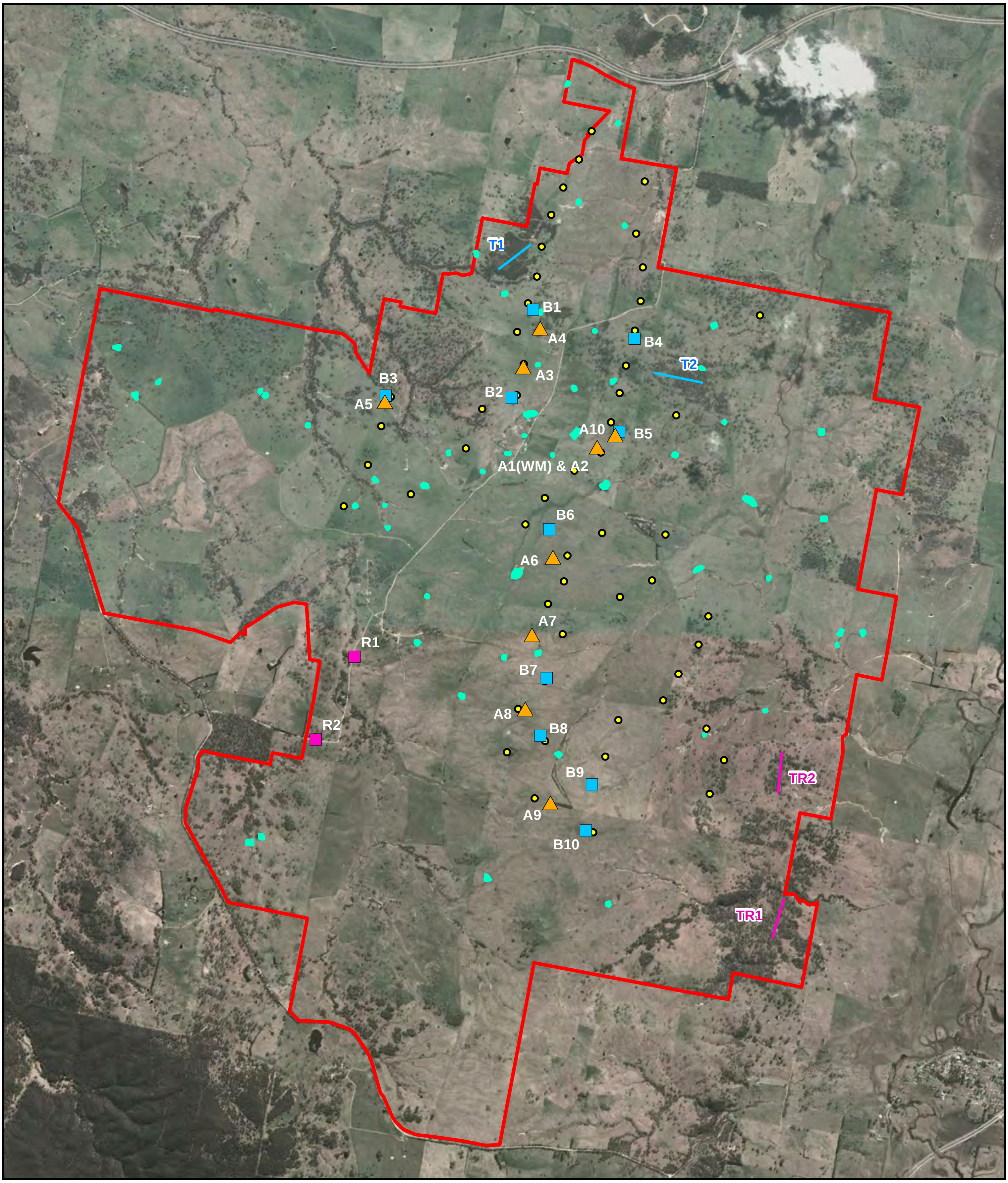
Table 3: Timing of the transect bird surveys

Season	Date	Transect	Time of day
Spring season	23/10/2013	T1,T2	Morning
	23/10/2013	TR1, TR2	Afternoon
	26/10/2013	T1, T2	Afternoon
	26/10/2013	TR1, TR2	Morning
Summer season	19/02/14	T1,T2	Morning

Season	Date	Transect	Time of day
	20/02/2014	TR1, TR2	Afternoon
	21/02/2014	T1, T2	Afternoon
	21/02/2014	TR1, TR2	Morning

3.1.4. Incidental observations

In addition to the observations during formalised, fixed-point or transect counts, incidental observations of birds of concern (threatened species, raptors, and waterbirds) were made whilst travelling throughout the proposed wind farm site. Notes were also made on woodland birds observed in remnant woodlands and any early morning and evening roosting movements. Emphasis was placed on observing birds that were moving through the site at RSA height.



Legend

- Collector Wind Farm Site
- Dams
- Wind Turbines

Transect Surveys

- Impact Sites
- Reference Sites

- Bat Utilisation Survey Points

Bird Utilisation Surveys

- Reference Points
- Impact Points

0 | 750 | 1,500 | 3,000 Metres

Figure 2: Bird and Bat Survey Points

Project: Collector Wind Farm

Client: RATCH Australia

Project No.: 13100	Date: 8/07/2014	Created By: M. Ghasemi / A. Stewart

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3.2. Bat surveys

Automated bat detectors that record the species-specific echolocation calls of free-flying bats were used at nine sampling points that were representative of the habitats near wind turbine locations on the proposed wind farm site (as shown on Figure 2). At one site a dual-channel detectors was used at a meteorological tower, with one microphone at 50 metres and the other at ground level (1-2 metres

The location and characteristics of the recording sites are described below and shown in Figure 2.

Site A1: Installed at 50m height on the wind monitoring mast, which itself is located in the middle of open grazing paddocks without trees

Site A2: Located at the wind monitoring mast (same location as A1), at ground level.

Site A3: Located on top of a flat hill and set up on a dead tree close to remnant eucalypt woodland.

Site A4: Located on side of a large and cleared hill but facing a large eucalypt open woodland remnant. The site represents an interface between open grazing paddocks and remnant woodland.

Site A5: Located on flat hill among scattered large and mature eucalypt trees with hollows and cleared understorey.

Site A6: Located on top of cleared low hill among large rocky boulders (rock knoll), no trees were in the surrounding area.

Site A7: Located close to a wide scatter of mature eucalyptus trees and overlooking cleared grazing hill.

Site A8: Located on top of cleared grazing hill with widely scattered old and mature eucalyptus trees.

Site A9: Located on the flat side of large hill, close to rows of planted trees (mostly blue gum).

Site A10: Located approximately one kilometre east of the wind mast within a small woodland remnant (Feb-Mar survey only).

In general, the recording sites represented the various habitats of the study area, particularly areas where the future wind turbines are to be built. The sites could be grouped into:

- Hill tops in cleared areas (grazing paddocks) with no or little scattered trees. Sites include 1, 2, 6 and 8.
- Hill tops with surrounding scattered trees. Sites include 5 and 9.
- Close to remnant eucalypt remnant woodlands. Sites include 3, 4, 7 and 10.

Two models of the bat call ultrasonic detectors were used in the survey, Anabats (Titley Electronics, Ballina, NSW) and SongMeter SM2BAT+ (Wildlife Acoustics Inc., USA). The detectors were programmed to commence recording bat calls approximately 30 minutes before dusk, and to cease approximately 30 minutes after dawn.

Calls from the units were examined by Greg Richards from Greg Richards & Associates for identification. Call identification was based on a comparison of the characteristics of bat calls with reference calls from known species recorded across Australia.

Identification is largely based on changes to frequency patterns over time, especially as the characteristic frequency changes. Only those recordings that contained at least two definite and discrete calls were classified as bat calls. For most species, a call sequence of at least one second in duration (approximately 20 pulses in the sequence) is required before identification can be made confidently.

3.2.1. December 2013 survey

Spring/summer surveys were carried out from 14 Oct to 11 Nov and 28 Nov to 12 Dec 2013. Due to operator error, no data was recorded from the initial survey between 14 Oct to 11 Nov.

Hence all the discussion below refers only to the results obtained from the work from 28 Nov to 12 Dec, hereafter referred to as the December 2013 survey.

The timing of the bat survey was intended to align with the summer migration of Eastern Bent-wing Bats to their maternity caves at Wee Jasper Cave. Further targeted surveys for Eastern Bentwing Bats were recommended as part of the pre-approval surveys to further investigate the likelihood of the species flying through the wind farm on their migration to and from their maternity caves. Pre-approval surveys did not record any evidence of this occurring.

Bat recordings totalled 1512 hours or 126 recorder-nights from nine different sites.

3.2.2. February–March 2014 survey

The February – March 2014 bat survey was conducted over seven weeks from 3rd February to 24th March 2014. The primary objective of the February – March 2014 survey was to monitor the presence of Eastern Bentwing Bat across the Collector site as they dispersed from their maternity caves to their over-wintering sites in caves and mines on the coast of NSW and in the Great Dividing Range. BL&A and GR&A were in close contact with Doug Mills (OEH Queanbeyan), who was monitoring numbers of Eastern Bentwing Bat within the Church Cave maternity site during February and March. This contact ensured that site bat surveys were underway at the time the bats departed from the maternity caves. BL&A is grateful for the assistance provided by Doug Mills.

Bat recordings totalled 5340 hours or 445 recorder–nights from ten different sites, which included sites A1-A9 detailed above and the additional site A10.

Given that the primary objective of the February – March 2014 survey was to investigate Eastern Bentwing Bat patterns of movement, it was agreed with OEH that only the number of Eastern Bentwing Bat calls nightly at each site over the seven weeks survey period was required to be assessed.

3.3. Limitations

The bird utilisation surveys (fixed point and transect surveys) were undertaken during late October (spring) in 2013 and second half of February (late summer) in 2014.

The purpose of the surveys was to collect a range of data, including usage of the site by migratory birds that may only occur at certain times of the year. During spring, birds such as magpies and ravens would be breeding and holding territories within the study area. Additionally, most migratory bird species, including the summer visitors, would be present in the region.

For these reasons, the utilisation rates and species abundances recorded during the current surveys are considered to be representative of the site during the time of the survey. They are also considered to provide a reasonable basis on which to assess the bird risks associated with the proposed Collector Wind Farm.

For the spring / summer bat surveys, as noted above, only the work undertaken from 28 Nov to 12 Dec 2013 delivered useable results. As also noted, one of the aims of the spring bat survey was to capture the migration period of Eastern Bentwing Bats to their maternity caves, to assess potential migration across the site. At the time, OEH was monitoring a staging cave approximately four kilometres from the maternity cave (Church Cave) at Wee Jasper (65 kilometres south west of the wind farm) – the monitoring in the first week of December found that approximately 14 000 bats were in the staging cave, compared to only a few hundred a couple of weeks earlier. Based on these findings, OEH has suggested that the Eastern Bentwing Bat could have passed through the wind farm site on their migration path around mid to late November, which in turn suggests that the December bat monitoring at the wind farm site was not undertaken at the most appropriate time to capture passage of bats across the site during the spring migration.

In contrast, as detailed above, the surveys undertaken in late summer (across February and March 2014) do seem to have captured the migration of the bats through the wind farm site. This is considered the most important time for survey work as the bats depart in the thousands over a short period of time, compared with the October-November migration where they arrive in smaller groups over a much longer period (G. Richards; pers.comm, 11th November 2013). February to March surveys included a two week period prior to migration (3rd – 17th February), to gather data on background levels of bat activity. Pre-construction bat monitoring surveys will be repeated in late spring/early summer 2014 and late summer/early autumn 2015, to further investigate Eastern Bentwing Bat migratory behaviour through the wind farm and the requirement and scope of any mitigation measures required. In addition, as a requirement of the Bird and Bat Adaptive Management Program (BL&A 2014), bat utilisation surveys will continue post-construction and will be timed to coincide with bat migration to their maternity caves, based on advice from OEH.

The identification of echolocation calls from microbats in south-eastern Australia is facilitated by the fact that many calls are species-specific. However, a limitation of the method is that not all species can be consistently or reliably identified. There is a large overlap in the call characteristics of some species and many calls are attributable only to species “complexes” and not to single species.

A further limitation in the use of this technique is that it is not possible to census bats accurately. That is, the bat recorder unit may record 10 calls of a particular species but it is not known if this represents 10 individuals or one individual flying past 10 times. Therefore, it is not possible to determine utilisation rates as it is for birds.

4. RESULTS

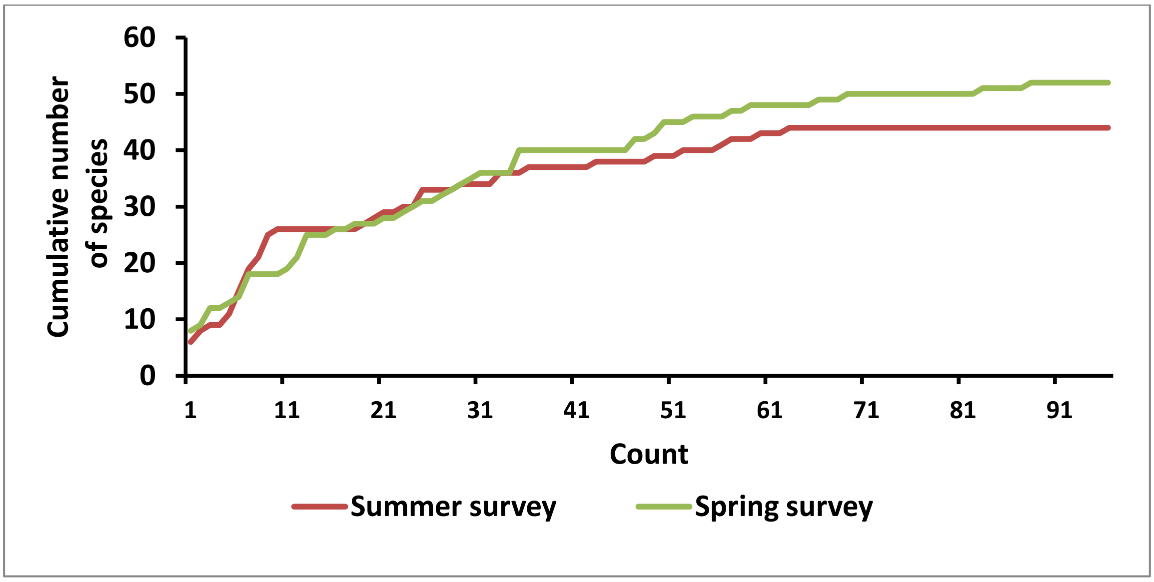
4.1. Bird utilisation surveys

4.1.1. Survey suitability

The cumulative number of species observed from the consecutive fixed-point bird counts conducted at the observation points during the spring and summer survey periods has been plotted as shown in Figure 3. The shape of the curve is fairly consistent between the spring and summer surveys, showing that the number of species recorded largely levelled out after approximately 60 counts for both survey periods. These results suggest that the surveys collectively provide a representative picture of the diversity of bird species flying over the wind farm site during the survey periods.

The adequacy of using a 15 minute survey period to generate representative data on the bird species in the area is based on earlier unpublished research in which 82% to 100% (average 88%) of species actually seen in one hour of surveying were seen in the initial 15 minutes of observation (BL&A; unpublished data).

Figure 3: The cumulative number of species of birds recorded during consecutive counts at the impact points on the Collector Wind Farm.



4.1.2. Species composition

A total of 90 species of birds were recorded within the wind farm site during spring and summer observations (as detailed in Appendix 1). Species recorded were predominantly farmland and bushland species with some records of raptors and waterbirds. The raw data is presented in Appendix 2.

The number of species recorded during the formal bird utilisation survey counts varied depending on the seasonal occurrence of birds in the region. The number of recorded species during each survey is listed in Table 4 below.

Although the number of species was almost similar between seasons, it was slightly higher in spring compared to the summer seasons. This variation in species composition (diversity) is most likely due to the presence of passage migratory birds during the spring months.

Table 4: Number of species recorded at impact and reference sites during spring and summer bird utilisation survey

Season	Impact Sites	Reference Sites	Total number of species across impact and reference sites
Spring BUS 2013	39	34	52
Summer BUS 2014	39	30	44
Combined	47	37	57

The number of species recorded at each impact survey point over the spring survey period ranged between 5 and 22; that of the summer survey ranged between 6 and 18 species. The distribution of the number of species among the various observation points was similar. However, there was a tendency for the number of species to be higher at points closer to vegetation, such as scattered trees or small patches of remnant woodland. Although the majority of the ridges were cleared and covered with exotic grasses, some contained few scattered trees or were covered with remnants of woodlands.

4.1.3. Survey results

The species observed at the impact and reference observation points, and their abundance and height distribution during the spring and summer seasons of surveys are summarised in Table 5 and 6, with full details in Appendix 2.. The total number of birds observed at each point is detailed in Table 7.

The ten most abundant species at the impact and reference survey points are presented below.

Impact survey points

Common Starling (25.9%)
Sulphur-crested Cockatoo (13.3%)
Australian Magpie (12.7%)
Noisy Miner (5.5%)
Galah (5.4%)
Raven spp. (5.3%)
Eastern Rosella (5%)
Crimson Rosella (4.3%)
Red-rumped parrot (3.2%)
Yellow-rumped Thornbill (2.9%)

Reference survey points

Noisy Miner (15%)
Sulphur-crested Cockatoo (12.7)
Eastern Rosella (7%)
Yellow-faced Honeyeater (6.8%)
Australian Magpie (5.4%)
Superb Fairywren (5.3%)
Crimson Rosella (5.1%)
Galah (4.1%)
Common Starling (3.5%)
Raven spp. (3.4%)

These species comprised 83.4% of all birds recorded at the impact survey points and 67.4% at the reference survey points.

Bird diversity was similar between the reference points and the impact points, with almost the same species dominating the list of birds but with variations in their importance due to the varied habitat on the reference sites compared to the impact sites, which included mature eucalypt trees, small regrowth trees and shrubs growing along a small creek.

Table 5: Number and height distribution of bird species at the impact survey points during spring and summer surveys

Species	Spring			Summer			Total	% Imp.
	A	B	C	A	B	C		
Common Starling	411	0	0	495	30	0	936	25.9
Sulphur-crested Cockatoo	263	29	0	162	26	0	480	13.3
Australian Magpie	230	5	0	220	4	0	459	12.7
Noisy Miner	110	0	0	88	0	0	198	5.5
Galah	71	12	0	93	19	0	195	5.4
Raven spp.	75	5	0	90	20	0	190	5.3
Eastern Rosella	59	0	0	111	11	0	181	5.0
Crimson Rosella	78	0	0	76	2	0	156	4.3
Red-rumped Parrot	24	4	0	77	10	0	115	3.2
Yellow-rumped Thornbill	10	0	0	95	0	0	105	2.9
Australasian Pipit	23	0	0	48	0	0	71	2.0
Eurasian Skylark	44	5	0	15	0	0	64	1.8
Australian Wood Duck	0	0	0	56	0	0	56	1.5
Magpie-lark	18	0	0	22	2	0	42	1.2
European Goldfinch	8	0	0	24	0	0	32	0.9
Willie Wagtail	4	0	0	28	0	0	32	0.9
Striated Pardalote	24	0	0	2	0	0	26	0.7
Crested Pigeon	5	0	0	19	0	0	24	0.7
Red-browed Finch	0	0	0	24	0	0	24	0.7
Grey Teal	14	0	0	8	0	0	22	0.6
Pacific Black Duck	11	0	0	10	0	0	21	0.6
Straw-necked Ibis	12	0	0	8	0	0	20	0.6
Black-faced Cuckoo-shrike	12	0	0	7	0	0	19	0.5
Southern Whiteface	7	0	0	12	0	0	19	0.5
Tree Martin	8	4	0	0	0	0	12	0.3
Varied Sittella	0	0	0	12	0	0	12	0.3
Nankeen Kestrel	3	1	0	2	3	0	9	0.2
White-winged Triller	8	0	0	0	0	0	8	0.2
Yellow-faced Honeyeater	0	8	0	0	0	0	8	0.2
Laughing Kookaburra	3	0	0	4	0	0	7	0.2
Superb Fairywren	3	0	0	4	0	0	7	0.2
Grey Butcherbird	1	0	0	5	0	0	6	0.2
Welcome Swallow	0	0	0	6	0	0	6	0.2
Wedge-tailed Eagle	1	0	0	3	1	0	5	0.1
Australian Grebe	4	0	0	0	0	0	4	0.3
Australian Shelduck	0	0	0	4	0	0	4	0.1
Brown Falcon	0	1	0	3	0	0	4	0.1
Brown Songlark	4	0	0	0	0	0	4	0.1
Grey Currawong	4	0	0	0	0	0	4	0.1
Grey Fantail	4	0	0	0	0	0	4	0.1
Peregrine falcon	1	2	0	0	1	0	4	0.1
Striated Thornbill	0	0	0	4	0	0	4	0.1
Brown Goshawk	0	1	0	1	1	0	3	0.1
White-faced Heron	0	0	0	3	0	0	3	0.1
Brown Thornbill	0	0	0	2	0	0	2	0.1
Hardhead	2	0	0	0	0	0	2	0.1
Red Wattlebird	2	0	0	0	0	0	2	0.1
Total	1561	77	0	1849	130	0	3617	100.0

A = below RSA height (<30m); B = at RSA height (30-150m); C = above RSA height (>150m); % Imp., Percentage importance,
Points data is the sum total from 8 counts

Table 6: Number and height distribution of bird species at the reference survey points during spring and summer surveys

Species	Spring			Summer			Grand Total	% Imp.
	A	B	C	A	B	C		
Noisy Miner	84	0	0	80	0	0	164	15.0
Sulphur-crested Cockatoo	11	9	0	51	67	0	138	12.7
Eastern Rosella	16	0	0	54	6	0	76	7.0
Yellow-faced Honeyeater	54	0	0	20	0	0	74	6.8
Australian Magpie	23	2	0	34	0	0	59	5.4
Superb Fairywren	27	0	0	31	0	0	58	5.3
Crimson Rosella	26	0	0	30	0	0	56	5.1
Galah	10	11	0	24	0	0	45	4.1
Common Starling	32	0	0	6	0	0	38	3.5
Raven spp.	26	3	0	8	0	0	37	3.4
Red-rumped Parrot	7	0	0	20	6	0	33	3.0
Australian Wood Duck	14	0	0	18	0	0	32	2.9
White-browed Srubwren	6	0	0	24	0	0	30	2.8
Welcome Swallow	16	2	0	9	0	0	27	2.5
White-eared Honeyeater	26	0	0	0	0	0	26	2.4
Striated Pardalote	20	0	0	4	0	0	24	2.2
Grey Fantail	19	0	0	2	0	0	21	1.9
Magpie-lark	12	0	0	8	0	0	20	1.8
Brown-headed Honeyeater	0	0	0	16	0	0	16	1.5
Striated Thornbill	12	0	0	4	0	0	16	1.5
Brown Thornbill	4	0	0	10	0	0	14	1.3
Yellow-rumped Thornbill	4	0	0	10	0	0	14	1.3
Willie Wagtail	2	0	0	10	0	0	12	1.1
Grey Currawong	2	0	0	8	0	0	10	0.9
White-faced Heron	0	2	0	7	1	0	10	0.9
Grey Shrike-thrush	6	0	0	1	0	0	7	0.6
Laughing Kookaburra	3	0	0	4	0	0	7	0.6
Grey Butcherbird	2	0	0	3	0	0	5	0.5
Dusky Woodswallow	4	0	0	0	0	0	4	0.4
Tree Martin	4	0	0	0	0	0	4	0.4
Rufous Whistler	3	0	0	0	0	0	3	0.3
Black-faced Cuckoo-shrike	0	0	0	2	0	0	2	0.2
Crested Pigeon	2	0	0	0	0	0	2	0.2
Jacky Winter	2	0	0	0	0	0	2	0.2
Red Wattlebird	2	0	0	0	0	0	2	0.2
Spotted Pardalote	2	0	0	0	0	0	2	0.2
	483	29	0	498	80	0	1090	100.0

A = below RSA height (<30m); B = at RSA height (30-150m); C = above RSA height (>150m); % Imp., Percentage importance, Points data is the sum total from 8 counts.

Table 7: Total number of birds counted at each survey points during spring and summer season surveys

Observation points	Spring			Summer			Total	% Imp.	Density
	A	B	C	A	B	C			
Point 1	205	2	0	319	4	0	530	14.7	10.4
Point 2	152	22	0	74	41	0	289	8.0	5.7
Point 3	176	10	0	211	11	0	408	11.3	8.0
Point 4	229	6	0	263	18	0	516	14.3	10.2
Point 5	421	13	0	412	34	0	880	24.3	17.3
Point 6	100	3	0	97	9	0	209	5.8	4.1
Point 7	32	4	0	204	5	0	245	6.8	4.8
Point 8	67	3	0	89	4	0	163	4.5	3.2
Point 9	78	3	0	72	0	0	153	4.2	3.0
Point 10	101	11	0	108	4	0	224	6.2	4.4
Total Impact	1561	77	0	1849	130	0	3617	100.0	7.1*
R1	268	11	0	241	68	0	588	53.9	11.7
R2	215	18	0	257	12	0	502	46.1	10.0
Total Reference	483	29	0	498	80	0	1090	100.0	10.8*

* Density = no. birds/ha/hour

Notes: A = below RSA height (<30m); B = at RSA height (30-150m); C = above RSA height (>150m)
Seasonal data is the sum total from eight impact points, each counted 8 times

On a seasonal basis, bird abundance was highest during summer with a total of 1,979 individual bird movements compared with spring movements of 1,638. The variation in seasonal abundance is mostly related to change in numbers of the dominant species, such as the numbers of starlings, cockatoos, rosellas and Ravens that normally flock following their breeding seasons. However, part of the increase in numbers of the common species during the summer, particularly starlings, cockatoos and rosellas was due to birds congregating where food was laid for sheep and cattle. Farmers at this time of year feed their stock with supplementary food including grain. Such areas were close to future turbine sites and the observation points, therefore causing an increase in numbers of birds counted during the formal BUS counts in summer.

The numbers of remaining species were relatively low and varied seasonally depending on whether the bird was resident, migratory or transient. Their total numbers over the four seasons varied between 1 and 70 birds (total of 16 counts over the two seasons).

The ten most abundant species were almost the same during the two seasons of surveys with slight differences in the rank order of abundance between seasons. These species were mostly typical open farmland species that utilized habitats of mixed remnant woodlands and open grasslands.

The total abundance and height distribution of birds at each survey point for each season are detailed in Appendix 2 and summarised in Table 7.

The combined total number of birds counted at each impact point during the two seasons varied between a minimum total of 153 birds at point 9 to a maximum total of 880 birds at point 5 (total of 16 replicate counts per point over two seasons).

The mix of habitats surrounding the observation points varied. More birds were recorded at points where there were scattered trees or small woodland remnants, than at points where the habitat was cleared hill tops with very few or no trees. Points 1 to 5 were examples of treed habitats while points 6 to 10 were on cleared hill tops. The average number of birds at points 1 to 5 (525 individuals from 16 counts) was two and half times greater than that at points 6 to 10 (199 individuals)

A series of single factor analyses of variance (ANOVA) were undertaken to examine differences in the bird numbers between points during the spring and summer seasons and between the seasons. A summary of the ANOVA results are listed in Table 8.

Table 8: ANOVA Analysis of differences between points and seasons

Note: significant difference exists if $P < 0.05$

Groups	F value	Degrees of freedom	Conclusion
Spring counts	4.58	9, 70	Significant, $P < 0.001$
Summer counts	3.94	9, 70	Significant, $P < 0.001$
Combined data (between seasons)	4.11	19, 14	Significant, $P < 0.001$
Combined points 1–5	2.11	9, 70	Not significant
Combined points 6–10	2.02	9, 70	Not significant

Table 8 shows that the counts from both spring and summer were significantly different between the 10 survey points. When counts were combined, the difference remained significant indicating that the observation points were in fact different both within and between seasons. To further investigate the nature of such difference, counts from the first five observation points (those surrounded by remnant woodlands or scattered trees) of both seasons were compared. The results showed that no significant differences occurred between these counts. Similarly, when counts from the second five observation points (those on cleared paddocks with none or very few scattered trees) from both seasons were compared, the result was similar to that obtained from the first five observation points.

These comparisons indicate that counts of birds were the same regardless of the season at points with similar habitats and differed significantly when habitats were compared (i.e. observations points surrounded by remnant woodlands or scattered trees versus points in the middle of cleared paddocks with no or very few scattered trees).

Bird diversity and numbers at the reference points were generally similar to points 1 to 5 due to the similarity of their surrounding habitats.

4.1.4. Birds at rotor swept area heights (RSA)

Bird flight heights were classified as being *below* RSA height (less than 30 metres), *at* RSA height (30–150 metres) and *above* RSA height (greater than 150 metres). Results (from all impact and reference observation points combined across all seasons) indicated that the majority of birds (approximately 91 percent) were found below RSA heights, with approximately 9.0 percent were found at RSA heights. No birds were recorded flying above RSA height, as shown in Figure 4. The results of the height analysis indicated that the large majority of birds using the wind farm site would not be exposed to a risk of collision with operating turbines.

Figure 4: The distribution of bird heights observed during bird utilisation surveys at Collector Wind Farm

Note: Impact and reference points and seasonal data combined.

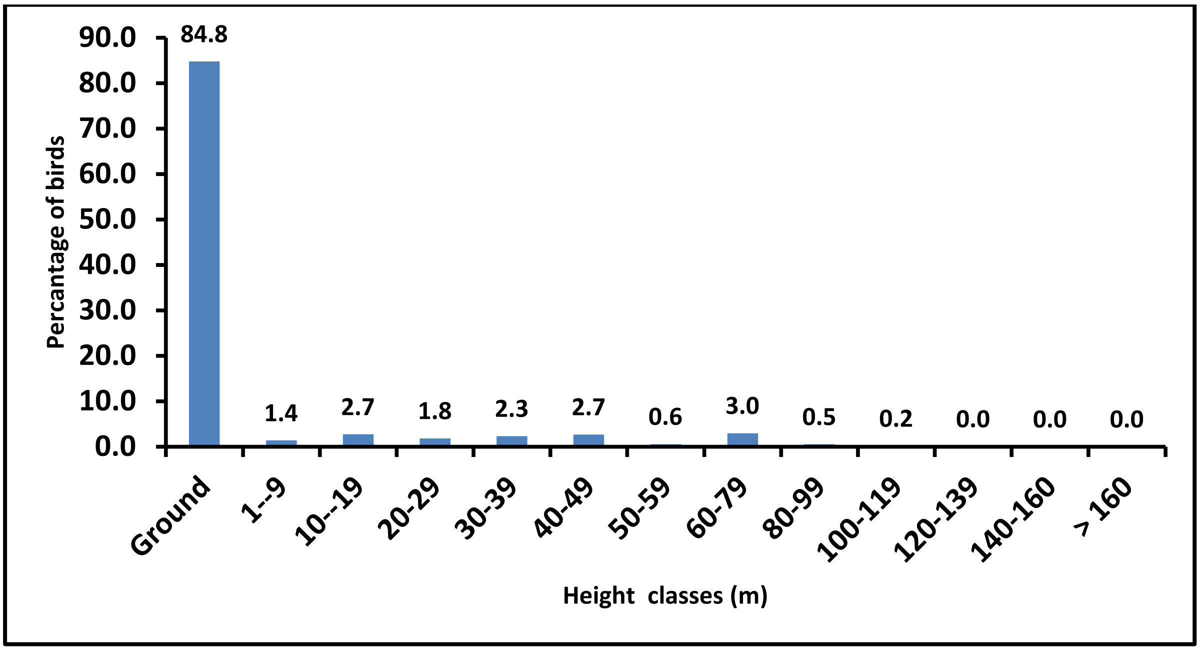


Table 9 shows the total number of individuals from different species observed flying at RSA height at all impact points during each season. Some 207 birds from 17 different species were observed flying at RSA height at the impact points. This equated to approximately 5.7%of the total number of birds counted at the impact points. A large flock of cockatoos that flew at RSA height (Table 9) over the reference sites contributed to the distribution of flights recorded at RSA height (Figure 4).

On a seasonal basis, more birds were observed flying at RSA heights during summer compared with spring. The increase in number of birds at RSA height during summer was mainly due to the presence of more flocks of cockatoos, starlings and ravens over the wind farm site than in spring.

The five most abundant species observed flying at RSA height were:

- Sulphur-crested Cockatoo
- Galah
- Common Starling
- Raven spp.
- Red-rumped Parrot

These five species accounted for almost 75%of the birds counted at RSA height, with Sulphur-crested Cockatoos and Galahs comprising the bulk of these flights (26.6%and 15.0%, respectively). The five most common birds at RSA height were common species that were widespread across the Collector Wind Farm site and the wider region.

The numbers of birds flying at RSA height varied seasonally depending on their numbers at the wind farm site and the phase of their life cycle, but were consistently a small fraction (5.7%) of total bird activity at the wind farm site (Table 9 and Appendix 2).

Galahs, Cockatoos and Starlings are usually more abundant in late summer, when they move and forage in larger flocks. Ravens move in varying sized flocks, particularly during autumn and winter months when they form loose foraging assemblages. They usually fly close to the ground when foraging, but at times fly at RSA height when moving long distances between paddocks or to and from their roost sites. The timing of bird utilisation surveys ensured that all such movements would be represented in the data collected.

Similarly, Red-rumped Parrots move in small flocks between treed areas and fly below tree canopy, but at times when crossing wide open areas fly at RSA heights.

The remaining 12 birds at RSA heights comprised five birds of prey, and the occasional combination of bushbirds and birds of open grassland.

Raptors and waterbirds are bird groups most likely to be observed regularly flying at RSA height and they are discussed in more detail below.

The distribution of birds flying at RSA heights at each of the eight impact points was random during all seasonal surveys. Birds were not recorded flying at RSA heights at any one point more than other survey points, indicating that risk to birds is rather uniformly distributed over the Collector Wind Farm. At the reference points, birds flying at RSA heights were on average less abundant than over the impact points; however one large flock of 60 cockatoos was recorded flying at RSA height over reference site 1 (Appendix 2).

Table 9: Species flying at rotor swept height (RSA) at the impact sites during two seasonal surveys at Collector Wind farm

	Spring		Summer		Total no. of birds at RSA height	Total no. of birds at all heights	% of flights at RSA	% of flights at RSA heights compared with all bird flights at RSA	% of flights recorded at RSA compared with all bird flights observed
Species	No. of flights at RSA*	Total no. of flights at all heights	No. of flights at RSA*	Total no. of flights at all heights					
Sulphur-crested Cockatoo	29	292	26	188	55	480	11.5	26.6	1.5
Galah	12	83	19	112	31	195	15.9	15.0	0.9
Common Starling	0	411	30	525	30	936	3.2	14.5	0.8
Raven spp.	5	80	20	110	25	190	13.2	12.1	0.7
Red-rumped Parrot	4	28	10	87	14	115	12.2	6.8	0.4
Eastern Rosella	0	59	11	122	11	181	6.1	5.3	0.3
Australian Magpie	5	235	4	224	9	459	2.0	4.3	0.2
Yellow-faced Honeyeater	8	8	0	0	8	8	100.0	3.9	0.2
Eurasian Skylark	5	49	0	15	5	64	7.8	2.4	0.1
Tree Martin	4	12	0	0	4	12	33.3	1.9	0.1
Nankeen Kestrel	1	4	3	5	4	9	44.4	1.9	0.1
Peregrine Falcon	2	3	1	1	3	4	75.0	1.4	0.1
Crimson Rosella	0	78	2	78	2	156	1.3	1.0	0.1
Magpie-lark	0	18	2	24	2	42	4.8	1.0	0.1
Brown Goshawk	1	1	1	2	2	3	66.7	1.0	0.1
Wedge-tailed Eagle	0	1	1	4	1	5	20.0	0.5	0.0
Brown Falcon	1	1	0	3	1	4	25.0	0.5	0.0
Totals	77	1638	130	1979	207	3617		100.0	5.7

* RSA height = 30 – 150 metres.

4.1.5. Threatened species

The majority of birds found to utilise the proposed wind farm site were common birds, however five threatened species listed as vulnerable under the *NSW Threatened Species Conservation Act 1995* were recorded within the wind farm boundary during the surveys. These were:

- *Diamond Firetail* - incidentally recorded within the wind farm boundary;
- *Varied Sittella* - recorded at transect line 1 during spring 2013 (7 individuals) and during formal BUS counts at impact site B1 during 2014 summer (12 individuals below RSA height);
- *Scarlet Robin* – recorded at transect line 1 during spring 2013 (6 individuals on one occasion and 10 on another);
- *Brown Treecreeper* - incidentally recorded within the wind farm boundary; and
- *White-fronted Chat* - incidentally recorded within the wind farm boundary.

The first four species are woodland birds that hardly venture outside woodland. During this surveys, these threatened species were recorded in or close to woodland areas.

The White-fronted Chat is normally found in open paddocks. It usually flies at low heights (zero to ten metres above the ground) when moving between feeding patches, although may occasionally fly up to 40 metres above ground particularly when disturbed.

Therefore the collision risk to the above-mentioned threatened species from operating turbines is considered low.

4.1.6. Raptors

Five raptor species were recorded during the surveys (Table 10). None of the raptors observed at Collector Wind Farm were threatened species, either under national or state conservation legislation. The raptors were generally recorded in low numbers (0.7% of all birds and only 0.3% of those flying at RSA heights). The raw data are presented in Appendix 2.

Nankeen Kestrel was the most abundant raptor species at Collector Wind Farm (36% of all raptors recorded during BUS) followed by Wedge-tailed Eagle (20% of all raptors). Peregrine Falcon, Brown Falcon and Brown Goshawk constituted 16%, 16% and 12% of all raptors observed flying during BUS. There was little seasonal variation between the raptors using the wind farm site between spring and summer (Appendix 2 and Table 5 and 6).

The Wedge-tailed Eagle is considered to be a high profile species and one of the most vulnerable species to collision with operating turbines. This species was observed once during formal BUS surveys in spring and on four occasions in summer. One eagle was seen flying at RSA height across open paddock over impact point no. 7 and three eagles were seen at observation point no. 5. The latter observation was of a young bird and a pair found perched on a large tree when first spotted. No evidence was found of eagles nesting within the wind farm boundary. The utilisation rate of the Wedge-tailed Eagle averaged 0.04 eagles per hectare per hour during the spring survey and increased to 0.16 in summer. The combined rate across both surveys was 0.1 birds per hectare per hour which is comparable to eagle utilisation rates at a range of wind farms studies by

BL&A in southern and south-eastern Australia (range 0.001–0.44 eagle per hectare per hour).

Based on above, the wind farm site is likely to be part of the territory of one pair of eagles that reside and probably breed in woodland to the north-east of the wind farm site and occasionally forage over the wind farm site itself.

Based on the low utilisation rate by raptors at the impact points (0.7%), collision risk to this group of birds are considered low.

Table 10: Raptor species recorded at the impact survey points during spring and summer surveys at Collector Wind Farm

Raptors	Total at			Total raptors	% raptors	% of all Birds*	% raptors At RSA	% of all RSA raptors	% RSA raptors of all birds
	A	B	C						
Nankeen Kestrel	5	4	0	9	36.0	0.2	44.4	36.4	0.1
Wedge-tailed Eagle	4	1	0	5	20.0	0.1	20.0	9.1	0.0
Peregrine Falcon	1	3	0	4	16.0	0.1	75.0	27.3	0.1
Brown Falcon	3	1	0	4	16.0	0.1	25.0	9.1	0.0
Brown Goshawk	1	2	0	3	12.0	0.1	66.7	18.2	0.1
Totals	**14**	**11**	**0**	**25**	**100**	**0.7**	**44.0**	**100.0**	**0.3**

All birds = 3617 individuals over spring and summer seasons.

A=below rotor swept area (RSA) height (<30 m); **B=** at RSA height (35-150 m);
C= above RSA height (>150 m) * Total from 16 counts at each impact point.

4.1.7. Waterbirds

The proposed Collector Wind Farm site contained many small farm dams and one large dam (Figure 2). Dams generally lacked aquatic vegetation with bare and trampled edges. A large dam was roughly 250 metres south east of impact point B2 with naturally occurring vegetation forming a semi-natural wetland.

Eight waterbird species were recorded during the surveys, comprising 2.9%of all birds observed during the formal two season BUS counts (Table 11). None of the waterbirds observed were threatened species, either under national or state conservation legislation. Most of the waterbirds were recorded near impact point B1, which was roughly 150 metres away from a farm dam. .

All waterbirds recorded during BUS were flying below RSA heights; this is not unusual since most of these birds fly at low heights when travelling between water dams in the area. The Straw-necked Ibis however, usually flies at RSA heights and may be exposed to collision with operating turbines.

A small flock of the Straw-necked Ibis was once seen in spring (12 individuals at site B5) and twice in summer (2 individuals at site B2 and 6 individuals at site B6) feeding in open grassland. Larger flocks of Straw-necked Ibis might pass across the wind farm site during wet periods, but such flocks were not recorded during the current observations. The Straw-necked Ibis were all below RSA.

Other waterbirds were also recorded utilising the wind farm site. The White-faced Heron was not recorded in spring but a few were seen flying across the site in summer. Those seen flying across the open paddocks flew below RSA height.

The Australian Wood Duck is a very common farmland waterbird that usually roosts along the edges of farm dams and forage in farm dams and open paddocks next to the dams during day and night. They are gregarious birds, known to move and forage in flocks. Flocks of this species were observed at several farm dams throughout the proposed wind farm site. This species tends to fly close to the ground when moving between dams and was not observed flying at RSA heights.

Table 11: Waterbird species recorded at the impact survey points during spring and summer surveys at Collector Wind Farm

Waterbird species	Total birds at			Total waterbirds	% of waterbirds	% waterbirds of all birds
	A	B	C			
Australian Wood Duck	56	0	0	56	42.4	1.2
Grey Teal	22	0	0	22	16.7	0.4
Pacific Black Duck	21	0	0	21	15.9	0.4
Straw-necked Ibis	20	0	0	20	15.2	0.4
Australian Grebe	4	0	0	4	3.0	0.1
Australian Shelduck	4	0	0	4	3.0	0.1
White-faced Heron	3	0	0	3	2.3	0.1
Hardhead	2	0	0	2	1.5	0.0
Totals	132	0	0	132	100	2.8

A=below rotor swept area (RSA) height (<30 m); **B**= at RSA height (30-150 m);
C= above RSA height (>150 m) * Total from 16 counts at each impact point.

4.2. Transect surveys

Weather conditions were suitable to detect bird activity during the surveys, being warm with gentle to fresh wind and clear to partly cloudy.

The number of species and individuals recorded during the transect counts are detailed in Appendix 3 and summarised in Table 12 below.

Table 12: Summary of bird counts from the impact and reference woodland transects

Season	Transect	Time of survey	No species	No. individuals
Spring	T1	Morning	23	89
	T2	Morning	11	84
	TR1	Afternoon	19	164
	TR2	Afternoon	16	57
	T1	Afternoon	5	14
	T2	Afternoon	10	196*
	TR1	Morning	21	126
	TR2	Morning	16	66
Summer	T1	Morning	11	34
	T2	Morning	7	97
	TR1	Afternoon	13	70
	TR2	Afternoon	5	26
	T1	Afternoon	10	26
	T2	Afternoon	6	45
	TR1	Morning	21	88
	TR2	Morning	12	47

* The high number of individuals can be attributed to a large colony of Noisy Miners.

Transect point T2 was colonized by Noisy Miners, a species known to drive away other bushbirds from their area of dominance.

Birds species recorded during the transect counts were dominated by woodland adapted species with few mixed woodland and open grassland species (e.g. magpies, ravens and rosellas). Woodland birds were recorded in greater numbers during the transect surveys in comparison to the fixed point bird utilisation surveys. This was expected due to the transect surveys being carried out in woodland habitat. Apart from rosellas, ravens and magpies, very few birds from the woodland habitats were recorded during the formal counts of BUS.

Woodland species recorded were diverse but none dominated the count; they were almost equally abundant particularly at the TR1 and TR2 transect counts where the woodlands were of much better quality than woodland transects at impact T1 and T2. Most common species collectively were the thornbills (several species) followed by fantails, fairywrens, flycatchers, treecreepers and less abundant honeyeaters, whistlers and robins. Species of mixed habitat usage such as magpies, ravens and rosellas were common at all transects.

Bird counts were higher and more diverse during the morning compared to the afternoon at both the impact and reference transect lines, reflecting the normal known behaviour of birds.

4.2.1. Conclusions

The conclusions from the BUS of the Collector Wind Farm are presented below:

- The study area consists largely of cleared plateaux supporting a low diversity and abundance of common, predominantly farmland birds. The ten most common species recorded at the impact and reference survey points are presented below. These species comprised 83.4% of all birds recorded at the impact survey points and 67.4% at the reference survey points.

Impact survey points	**Reference survey points**
Common Starling	Noisy Miner
Sulphur-crested Cockatoo	Sulphur-crested Cockatoo
Australian Magpie	Eastern Rosella
Noisy Miner	Yellow-faced Honeyeater
Galah	Australian Magpie
Raven spp.	Superb Fairywren
Eastern Rosella	Crimson Rosella
Crimson Rosella	Galah
Red-rumped parrot	Common Starling
Yellow-rumped Thornbill	Raven spp.

- The study area supports very few raptors or waterbirds, groups considered vulnerable to collision with operating wind turbines. Raptors and waterbirds represented 0.7% and 2.9% respectively of all birds surveyed.
- The diversity of birds was similar across the observation points with common farmland birds dominating the species list. However, there was a tendency for points close to remnant woodland to have a more diverse bird species.

- Bird abundance and diversity was higher at observation sites surrounded by remnant woodlands or scattered trees compared to sites set up on top of cleared hills mostly lacking trees.
- Bird abundance and diversity also differed seasonally; while species diversity decreased during summer as most of the spring migratory species left the region, bird numbers were higher in the summer survey. Apart from the natural seasonal increase of bird numbers in summer, some increase was caused by the accumulation of birds on feeding spots laid by farmers to feed their live stock among and sometimes close to the observation points.
- The practice of feeding stock close to turbines should be discontinued when the wind farm starts operation as it could cause unnecessary impacts.
- The list of birds recorded flying at RSA heights was similar between the 10 observation points. The five most abundant species accounted for almost 75% of the birds counted at RSA height, and consisted of (in order of abundance): Sulphur-crested Cockatoos (26.6%), Galah (15%), Common Starling, Raven spp. and Red-rumped Parrot. These are all common species that are widespread across the Collector Wind Farm site and the wider region. Raptors were not common with only 0.3% of all records being recorded at RSA heights. No waterbirds were recorded flying at RSA height.
- The utilisation rate of the Wedge-tailed Eagle averaged 0.03 eagles per hectare per hour during the spring survey and increased to 0.16 in summer (overall average for both seasons 0.1 birds per hectare per hour). The utilisation rate of other raptors and waterbirds was found to be very low when compared to similar rate from other wind farms in the area (BL&A; unpublished data).
- Five species of threatened birds were recorded utilising the study area, the Diamond Firetail, Varied Sittella, Scarlet Robin, Brown Treecreeper and White-fronted Chat. The first four species are woodland birds that rarely venture outside the woodland and were seen during the formal counts or incidentally within or close to woodland areas. The White-fronted Chat is normally found in open paddocks but usually flies at low heights or just above the ground when moving between feeding patches. The collision risk to threatened species from operating turbines is considered low.

The pre-construction fixed point and transect bird utilisation surveys has satisfied the requirement for obtaining pre-construction baseline bird utilisation data.

4.3. December 2013 bat survey

4.3.1. Species recorded

Ten species of bats and one species complex were recorded during the December 2013 survey from nine recording sites. The recorded species are listed in Table 13, including their conservation significance and sites at which they were recorded.

Of the ten species identified at the wind farm site nine are known to be widespread and common. One species, the Eastern Bentwing Bat is considered as a threatened species (vulnerable) on the NSW *Threatened Species Conservation Act 1995*.

In addition to those bats identified to species, one species complex was also recorded; it was a complex of Bentwing Bat/Forest Bat (*Miniopterus/Vespadelus*). This category indicates calls that are indistinguishable between the two species but could most likely be either of the two species.

The common species of bats were recorded from various sections of the wind farm and were not particularly restricted to certain habitats within the wind farm site although there was a tendency for the bats to be more concentrated in sites with more vegetation cover, particularly sites close to mature eucalypts in remnant woodlands.

Long-eared bats are difficult to distinguish to species level, and hence are grouped under their generic name. The species that are likely to occur at the site are *Nyctophilus geoffroyi* and *N. gouldi*.

The Eastern Bentwing Bat was uncommon on the wind farm site and was restricted to only two out of the nine sites, as shown in Table 13.

Table 13: Bat species recorded at the Collector Wind Farm during the spring–summer 2013 survey

Common name	Scientific name	Sites with records	Conservation status
White-striped Freetail Bat	*Austronomus australis*	All sites except 4	Common, secured
Gould's Wattle Bat	*Chalinolobus gouldii*	All sites	Common, secured
Chocolate Wattle Bat	*Chalinolobus morio*	3, 4, 5, 6, 7, 8	Common, secured
Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*[1]	4, 5	Threatened (Vulnerable)
Bentwing Bat/Forest Bat	*Miniopterus/Vespadelus*	3, 4, 5	Common, secured
Eastern Freetail Bat	*Mormopterus ridei*	All sites except 7	Common, secured
Long-eared Bat	*Nyctophilus sp.*	1, 3, 4, 5, 8, 9	Common, secured
Little Broad-nosed Bat	*Scotorepens greyii*	1, 3, 8, 9	Common, secured
Large Forest Bat	*Vespadelus darlingtoni*	All sites except 2	Common, secured
Southern Forest Bat	*Vespadelus regulus*	All sites except 1 & 2	Common, secured
Little Forest Bat	*Vespadelus vulturnus*	3, 4, 5	Common, secured

4.3.2. Bat activity

In terms of presence and abundance of common bat species, bat activity at the proposed Collector Wind Farm is similar to other wind farm sites located in comparable landscape

[1] Australian *Miniopterus* taxonomy is still in a state of flux; this species may also be known as *Miniopterus orianae odceanensis*

settings in the Goulburn region (BL&A unpub. data). Bat activity during the 14 nights of recording varied between the different species, time of recordings and the habitats at the recording sites. Although records of bat calls cannot be taken as a measure of absolute activity or abundance, they can be used in a very general sense as reflecting on bat activity and abundance. A summary of relative activity of the ten bat species expressed as the total number of calls per site and average calls per night for each species from the nine different sites are shown in Table 14. Details of the number of bat calls for each species and from each night of recording are given in Appendix 4.

The Large Forest Bat and Southern Forest Bat were equally the most active with their calls constituting about 26.8% each of all bat calls. This was followed by Eastern Freetail Bat (23.8%) and White-striped Freetail Bat (8.5%). The remaining species were less active and their total calls over the seven nights of recording varied between 0.14% for the Eastern Bentwing Bat to 6.3% for the Gould's Wattle Bat of all calls recorded over the wind farm site during the survey period.

The threatened Eastern Bentwing Bat was uncommon to rare with only four calls recorded from sites A4 and A5 (two calls at each site) or an average of 0.2 calls per night. The overall average over the nine sites was 0.3 calls per night. In addition to the positively identified Eastern Bentwing Bat calls, 21 calls of the Bentwing Bat/Forest Bat complex were also recorded mostly from site A4 (18 calls). A proportion of these were possibly the threatened species. Even so the number of calls recorded remains very low compared to the other bats utilizing the wind farm site.

The Little Broad-nosed Bat was another species recorded in low numbers. The wind farm site is at the edge of the natural range for this species.

The nightly activity of each of the bat species during the 14 nights of recordings varied widely (Appendix 4), without any obvious trends. The activity is probably the product of the site characteristic and the prevailing weather conditions on the day of recording. Weather was mostly fine during most of the recording nights and allowed a moderate activity of bats over the wind farm site.

Table 14: Summary of the average number of call per night recorded for the various bat species at each of the nine recording sites during December 2013

Bat species	Site A1		Site A2		Site A3		Site A4		Site A5		Site A6		Site A7		Site A8		Site A9		Total calls	Av./ night
	Tot. calls	Av./ night	Tot. calls	Av./ Night	Tot. calls	Av./ night	Tot. Calls	Av./ night	Tot. calls	Av./ night	Tot. calls	Av./ night	Tot. calls	Av./ night	Tot. calls	Av./ night	Tot. calls	Av./ night		
White-striped Freetail Bat	2	0.1	11	0.8	175	12.5	0	0.0	7	0.5	4	0.3	7	0.5	23	1.6	11	0.8	240	17.1
Gould's Wattle Bat	1	0.1	3	0.2	8	0.6	14	1.0	117	8.4	5	0.4	13	0.9	5	0.4	13	0.9	179	12.8
Chocolate Wattle Bat	0	0.0	0	0.0	18	1.3	9	0.6	12	0.9	1	0.1	1	0.1	0	0.0	10	0.7	51	3.6
Eastern Bentwing Bat	0	0.0	0	0.0	0	0.0	2	0.1	2	0.1	0	0.0	0	0.0	0	0.0	0	0.0	4	0.3
Bentwing Bat/Forest Bat	0	0.0	0	0.0	1	0.1	18	1.3	2	0.1	0	0.0	0	0.0	0	0.0	0	0.0	21	1.5
Eastern Freetail Bat	1	0.1	1	0.1	579	41.4	3	0.2	57	4.1	2	0.1	0	0.0	12	0.9	17	1.2	672	48.0
Long-eared Bat	0	0.0	1	0.1	71	5.1	14	1.0	16	1.1	0	0.0	0	0.0	1	0.1	2	0.1	105	7.5
Little Broad-nosed Bat	0	0.0	1	0.1	5	0.4	0	0.0	0	0.0	0	0.0	0	0.0	3	0.2	1	0.1	10	0.7
Large Forest Bat	0	0.0	2	0.1	235	16.8	309	22.1	170	12.1	2	0.1	14	1.0	2	0.1	23	1.6	757	54.1
Southern Forest Bat	0	0.0	0	0.0	222	15.9	331	23.6	185	13.2	0	0.0	5	0.4	4	0.3	8	0.6	755	53.9
Little Forest Bat	0	0.0	0	0.0	9	0.6	10	0.7	4	0.3	0	0.0	0	0.0	1	0.1	0	0.0	24	1.7
Average calls/night/site	4	0.3	19	1.4	1323	94.5	710	50.7	572	40.9	14	1.0	40	2.9	51	3.6	85	6.1	2818	201.3

Table 15: Bat activity at three habitat categories at Collector Wind Farm during December 2013.

Bat species	Woodlands remnants (sites 3, 4, 7)		Scattered trees (5, 9)		Cleared paddocks (6, 8, 2)	
	Total calls	Av. / habitat	Total calls	Av. / habitat	Total calls	Av. / habitat
White-striped Freetail Bat	182	60.7	18	9.0	38	12.7
Gould's Wattle Bat	35	11.7	130	65.0	13	4.3
Chocolate Wattle Bat	28	9.3	22	11.0	1	0.3
Eastern Bentwing Bat	2	0.7	2	1.0	0	0.0
Bentwing Bat/Forest Bat	19	6.3	2	1.0	0	0.0
Eastern Freetail Bat	582	194.0	74	37.0	15	5.0
Long-eared Bat	85	28.3	18	9.0	2	0.7
Little Broad-nosed Bat	5	1.7	1	0.5	4	1.3
Large Forest Bat	558	186.0	193	96.5	6	2.0
Southern Forest Bat	558	186.0	193	96.5	4	1.3
Little Forest Bat	19	6.3	4	2.0	1	0.3
Total/Average calls per habitat category	**2073**	**691.0**	**657**	**328.5**	**84**	**28.0**

4.3.3. Bats flying at rotor swept height

Three species of bats were recorded in flight by the recorder installed at 50 metres above ground during December 2013. The actual number of calls recorded was very low (Table 14; site A1). and included two calls from the White-striped Freetail Bat and one call from both the Gould's Wattle Bat and Eastern Freetail Bat. Such level of calls indicated that risk to bats at the Collector Wind Farm is likely to be low.

4.3.4. Bat activity and habitats

During the December 2013 survey, bat activity recorded by the ground-level recorders varied between an average of 1.0 call/night at site 6 to 94 calls/night at site 3 as shown in Table 14. The large variation in recorded bat activity is most probably related to the settings of the recording sites, including the type of vegetation cover, and the availability of sheltering and roosting sites close to each of the recording sites. Habitat structure and availability of water sources have the potential to influence the distribution and presence of bats in a landscape, as they rely on such sites for food sources (invertebrates). Sites varied in such habitat attributes and comprised treed vegetation, open paddocks and scattered paddock trees.

The eight sites as listed above in the methods section were divided into three categories.

- Top of hills in cleared areas (grazing paddocks) with no or little scattered trees, namely sites A2, A6 and A8;
- Top of hills with surrounding scattered trees, sites A5 and A9;
- Close to remnant eucalyptus remnant woodlands, sites A3, A4 and A7.

The results in Table 15 demonstrate that bat activity at the sites close to or on edge of eucalypt remnants was more than double the activity at the cleared areas with scattered mature trees and many folds larger than the activity at the cleared sites or the cleared paddocks that lacked trees. The different activity was mainly due to the common species that found foraging habitat and shelter in areas of mature trees.

4.3.5. Conclusions

The findings from the spring/early summer bat utilisation surveys are provided as follows:

- Ten bat species and one species complex were recorded from monitoring at nine sites during the survey;
- Three species were recorded flying at rotor swept area height using the bat detector microphone receiver at 50 metre height; White-striped Freetail Bat, Gould's Wattle Bat and the Eastern Freetail Bat, none of which are listed as threatened;
- Bat species were more frequently recorded at sites A3 (1323 calls), A4 (710 calls) and A5 (572), which were located within 750 metres of the large woodland remnant and drainage line to the north-east of the site. There was much less activity at open cleared paddocks sampling sites. Open pasture is the most extensive habitat within the wind farm site and the habitat in which most turbines are located;
- A very small number of calls of the Eastern Bentwing Bat, listed in NSW as threatened, were recorded during the survey. However, as noted in Section 3.3 above, it is possible that the surveys missed the main migration of the bats to their

maternity caves, and hence this may not be a full reflection of likely bat presence across the site at this time.

4.4. February - March 2014 survey

This survey was carried out during the period 3rd February to 23rd March 2014, coinciding with the period of Eastern Bentwing Bat dispersal from their breeding colony at Wee Jasper towards their wintering sites. Monitoring of the maternity cave (Church Cave) at Wee Jasper (65 kilometres south west of the wind farm) was undertaken by OEH (Dr Doug Mills) when the bats started dispersing away from their breeding cave towards their wintering roosting caves. Estimated numbers of Eastern Bentwing Bat at Church Cave are shown in Table 16.

Table 16: Estimated numbers of Eastern Bentwing Bat in Church Cave through February and March 2014 (monitored by OEH).

Date	Numbers of Eastern Bentwing Bat in Church Cave
5 February, 2014	21,700
12 February, 2014	36,000
20 February, 2014	41,000
24 February, 2014	40,000
2 March, 2014	31,000
12 March, 2014	2,700

Based on the findings, Dr Mills suggested that the Eastern Bentwing Bat would most likely to have passed through the wind farm site on their migration from their breeding cave at Wee Jasper during the first and second week of March. The February/March monitoring surveys should therefore have captured the migration period of the Eastern Bentwing Bat across the site.

4.4.1. Survey results

Bat counts at the Wee Jasper breeding cave when the migration (post breeding dispersal) started were 31,000 on 2nd March and 2,700 on 12th March. These numbers reflect evidence of a mass dispersal between these times and OEH assumed that the cave would be empty within a few days after that.

Figure 5 shows the total count of Eastern Bentwing Bat calls recorded at each sampling site from the 3rd February to the 24th March (49 nights). On the 8th March, high numbers of Eastern Bentwing Bat/Forest Bat (EBB/FB) complex calls were recorded in the south of the site, with a total of 617 and 331 calls at sites A7 and A8 respectively (Figure 5). High numbers of EBB/FB complex calls (2463) were recorded at site A5 on 13th March (Figure 5).

Activity patterns were examined for site A5, and bat calls were counted for every hour through the night (Figure 6). Numbers peaked at 4:00 AM when 617 calls were recorded, equating to one bat passing through the site every six seconds.

Further information on bat call numbers is detailed in Appendix 5.

The Eastern Bentwing Bat calls recorded were part of the EBB/FB complex. Because there are certain problems in the accurate identification of Eastern Bentwing Bat calls (often there are similarities with Forest Bats), a precautionary approach was adopted and all identified calls from the EBB/FB complex were treated as the Eastern Bentwing Bats. This is reasonable, as it is highly unlikely that high numbers of Forest Bats would be active at the site at this time, and the Forest Bats are unlikely to show the extreme variation in activity that a migrating bat would, therefore the calls are more than likely attributable to migrating Eastern Bentwing Bat.

Apart from a portion of the site in the north that supports remnant woodlands, the wind farm site is primarily very poor bat habitat without trees or water sources that would provide good foraging resources. Background data supports this conclusion, especially in relation to the EBB/FB complex (see Table 14 and section 4.3.4). There does not appear to be any particular aspect of sites A5, A7 or A8 that would attract the EBB to those sites. Site A7 was was located close to a wide scatter of mature eucalyptus trees, while Site A8 was located in a cleared grazing paddock. Site A5 was located out a hill top supporting scattered trees.

Migration movements tend to occur as one long mass stream of bats migrating from one place to another. It does not appear that any particular aspect of the habitat at Collector Wind Farm attracted the bats, it is highly likely that it was on a route towards over-wintering sites, which includes caves and mines in coastal areas of NSW and in the Great Dividing Range. Dwyer (1966) reported that the EBB travelled up to 65 kilometres in one night.

It appears that EBB at Church Cave migrate in groups that perhaps relate to winter destinations. Direct line from Wee Jasper through the wind farm and beyond would predict an arrival point at around the northern Illawarra – Royal National Park area. Known roost sites in this region include railway tunnels and WW2 military installations. There is strong circumstantial evidence for regional groups of EBB to join at their maternity sites, including Riverton Cave, southern Queensland. Banding studies showed that at this maternity cave groups of EBB arrived at different times and occupied different sections of the cave. These groups included some from the major river catchments of far northern NSW and others from central coastal Queensland (G. Richards, unpublished). This information would indicate that if a migration route does exist through the wind farm, then it is highly likely that it is used by one or two groups, and not the entire maternity colony.Excluding the two exceptional nights above (8th and 13th March), the normal activity pattern of Eastern Bentwing Bat varied between zero to 81 calls per night, totalling 1070 calls over the 49 nights of recording (Figure 7). An average of 22 calls were recorded per night, or 2 calls per site per night (Appendix 5).

It is notable that all the Eastern Bentwing Bats were recorded from bat detectors at ground level, and none were recorded 50 metres up the wind monitoring mast. This indicates that the bats were within 20-30 metres from the microphone at ground level, so were recorded well under the turbine RSA.

The results from the autumn monitoring suggest that Eastern Bentwing Bat migrated across the site in two distinct movements. The extent to which the bats are at risk of collision with operating turbines will be assessed in further detailed monitoring work, outlined in the BBAMP (BL&A 2014).

Figure 5: Daily counts of Eastern Bentwing Bat calls recorded at each sampling site from 3rd February to the 23rd March.

Note: Includes high counts at sites A7 (617 calls) and A8 (331 calls) on 8th March and the high counts at site A5 on 13th March (2463 calls).

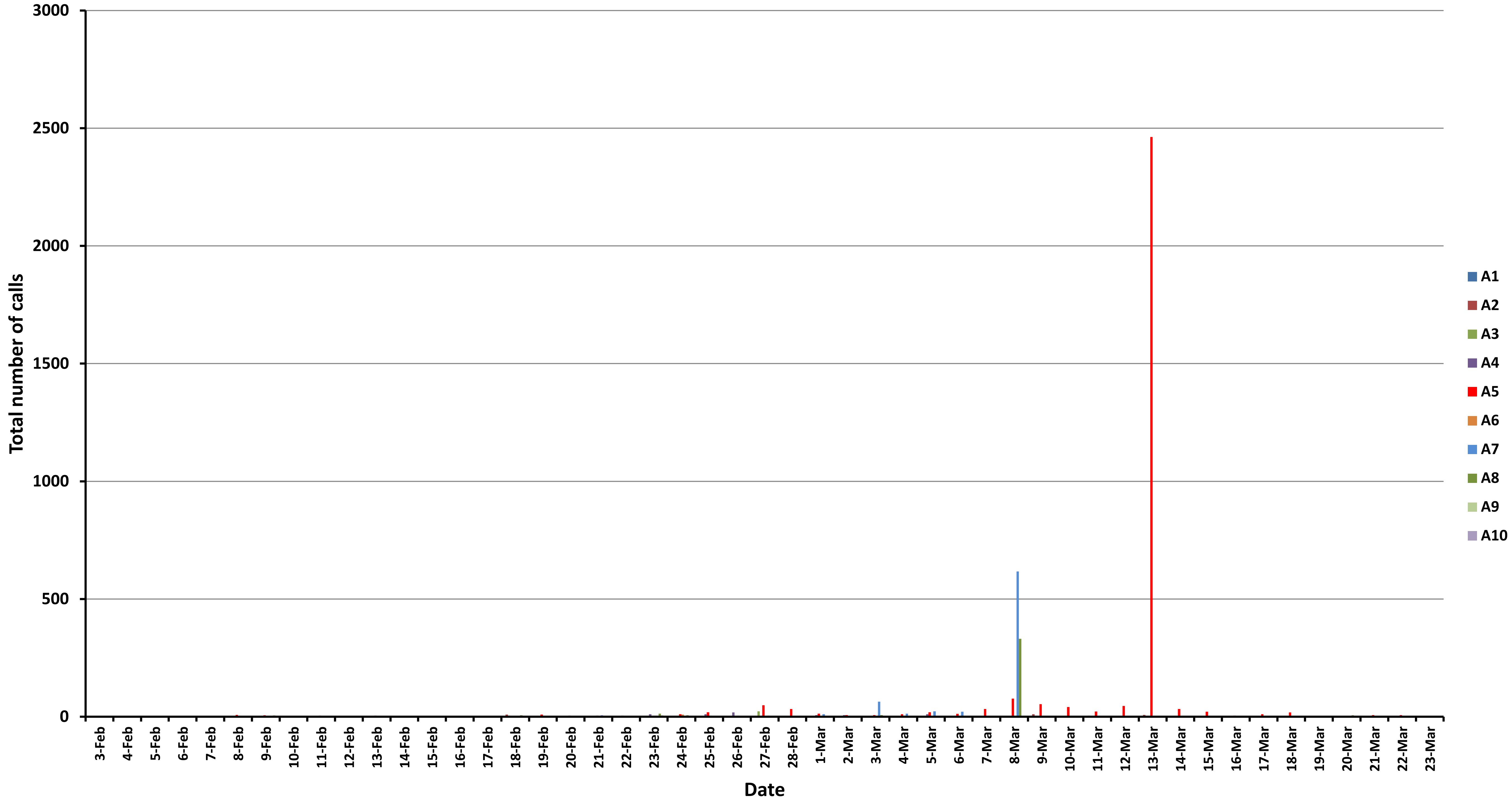


Figure 6: Hourly activity patterns for Eastern Bentwing Bat calls and other bat species at site A5 on the 13th March 2014.

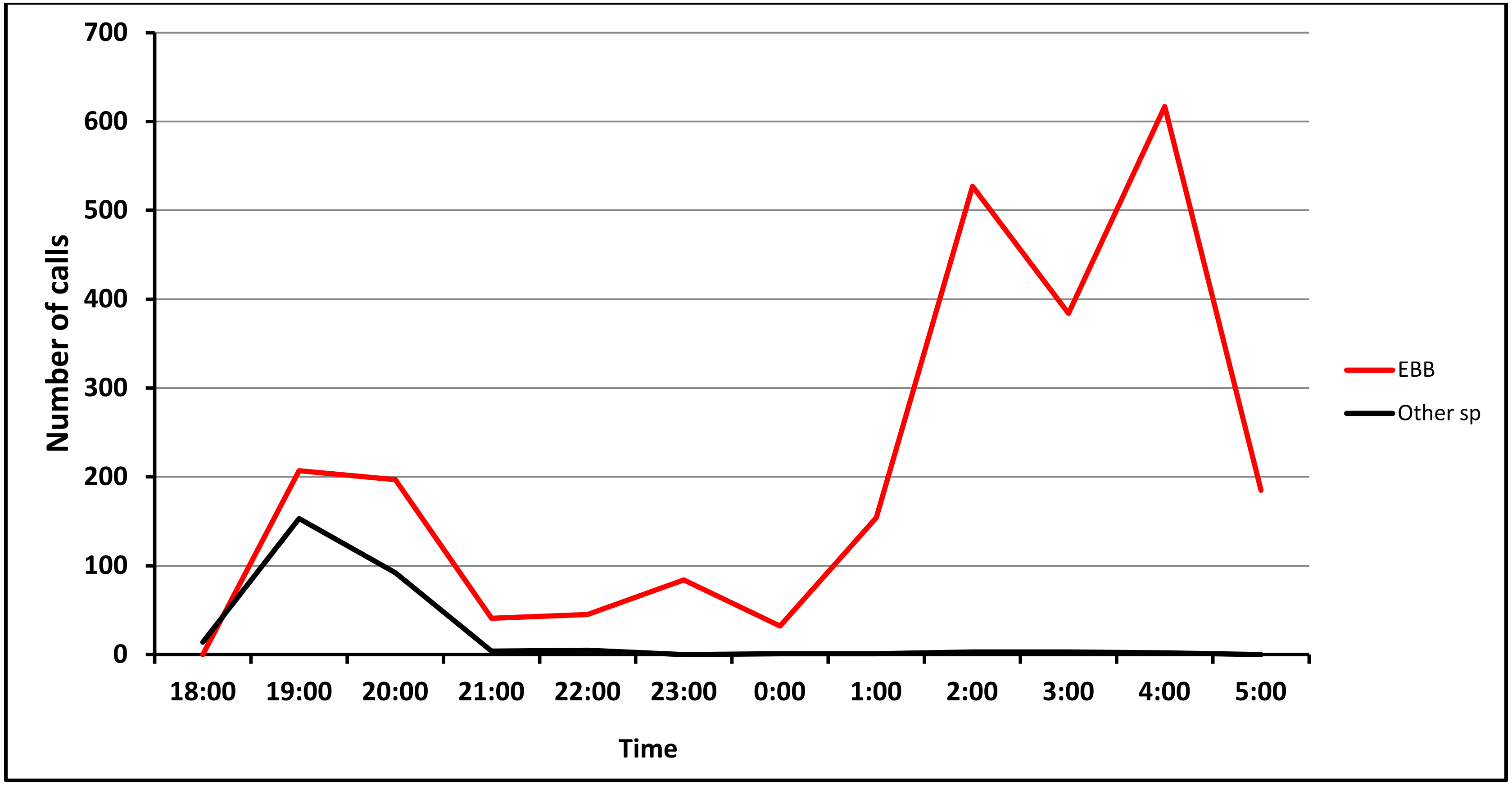
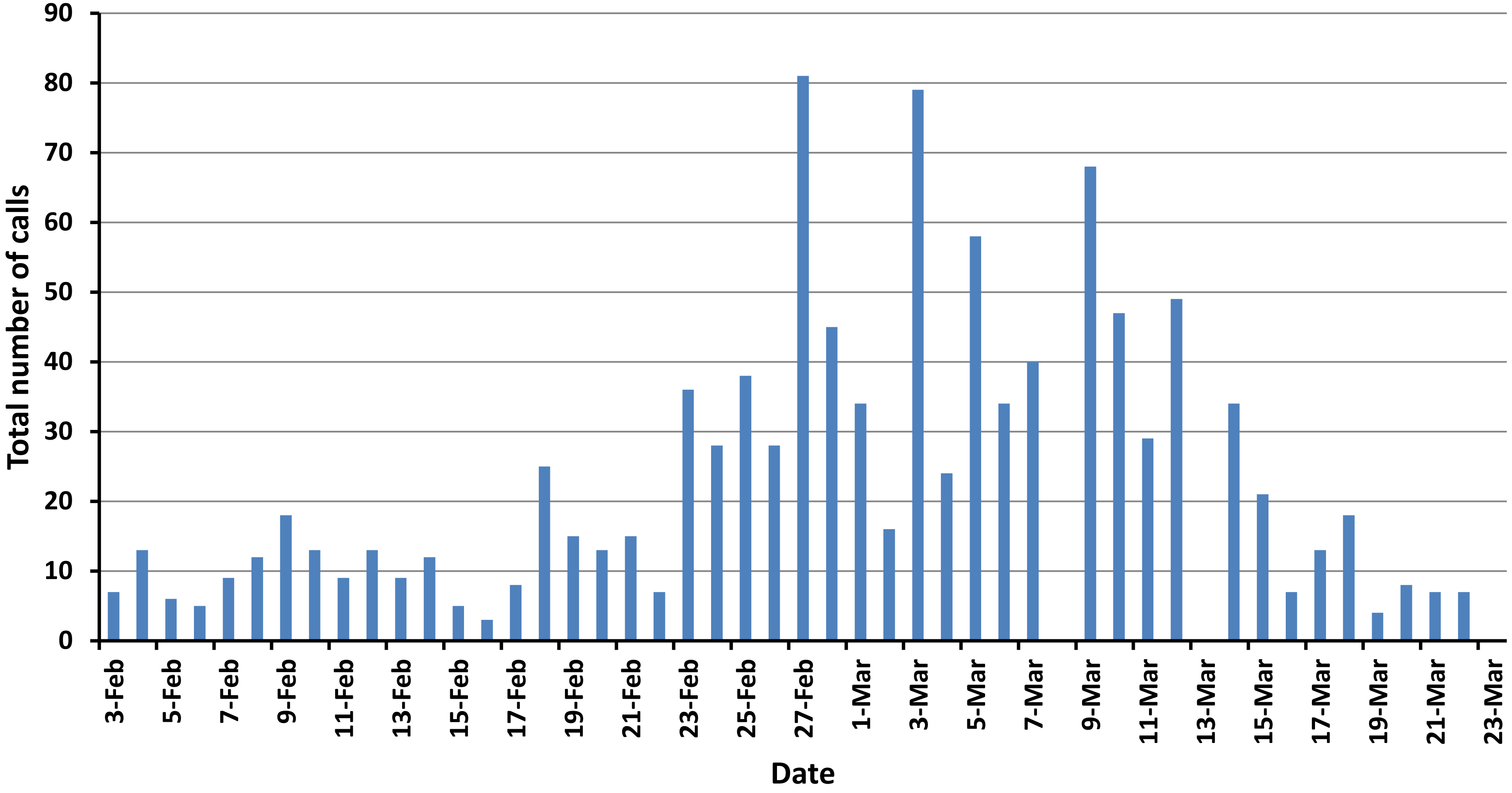


Figure 7: Activity pattern of Eastern Bentwing Bat during the recording period (49 nights), excluding the migration nights on the 8th and 13th March 2014.



4.4.2. Bat activity and environmental factors

Bat activities are known to be influenced by weather conditions and usually become inactive on nights of strong winds, storms, moderate to heavy rain and night of full moon (Arnett *et al*. 2008), especially in open and hilly habitats such as wind farms on the Southern Tablelands (Richards unpublished).

Bat activity in response to weather variables such as air temperature, relative humidity, barometric pressure, wind speed, direction & gusts, rain and moonlight was studied at Capital Wind Farm (Richards 2013) and was found that bats were not active during the following circumstances:

- full moonlight with high elevation;
- wind speeds of greater than seven or eight metres per second;
- wind gusts of over 15 kph; and
- moderate to heavy rainfall.

A similar study of bat activity at a wind farm in Victoria found that bat activity was very low at wind speeds above 8.4 metres per second, and that wind speed increased at greater heights (ie. at rotor swept area) (BL&A unpublished data).

During the period of Eastern Bentwing Bat migration at Collector Wind Farm wind speed seemed suitable at both nights of intense movements, but moon light was only suitable at the 8th March and not suitable on the 13th as it was almost a full moon night. However, such data does not mean much as the comparison sample is very small and no generalization could be made based on the data in Table 17. The client is committed to further pre-construction bat activity surveys (see BBAMP, BL&A 2014). Environmental factors influencing bat activity will be investigated during further studies.

Table 17: Wind speed and direction and moon light during the period of migration. Bolded rows are the two migration days.

Date	Wind speed			Wind direction				Moon light
	Mean	Min	Max	Mean		Min	Max	Illumination (%)
8-Mar	**5.0**	**3.1**	**6.5**	**73**	**ENE**	**24**	**99**	**48**
9-Mar	2.4	0.9	4.1	187	S	59	348	58
10-Mar	2.2	0.6	3.5	157	SSE	59	355	67
11-Mar	5.5	4.1	6.7	281	WNW	270	303	76
12-Mar	6.8	5.3	7.8	89	E	67	115	84
13-Mar	**3.4**	**1.7**	**5.9**	**199**	**SSW**	**6**	**325**	**90**
14-Mar	5.0	2.0	8.9	236	WSW	3	323	95

4.4.3. Conclusions

- The high Eastern Bentwing Bat calls on the two nights of suspected passage of the bats across the wind farm were much higher than normal. As mentioned above, the overall rate of calls of Eastern Bentwing Bat was 2.2 calls per site per night during the 49 nights of surveys in February - March 2014 and this rate was even lower (0.3 for Eastern Bentwing Bat and 1.5 for EBB/FB calls per site per night) during the 14 night of surveys in December 2013. Records of 948 calls and 2463 calls on the 8th and

13th March were a strong indication of the likely migration of the Eastern Bentwing Bat through the wind farm site.

- The migration of Eastern Bentwing Bat was not gradual over many nights but rather took place as two major waves with mass movements on two nights.
- It is not known if these migrations are regular or not, or whether they only occur in specific areas of the site, but these uncertainties are expected to be further clarified by further bat survey work, as detailed in the BBAMP for the Collector Wind Farm (BL&A 2014).

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Appendix 1: Birds observed at the Collector wind farm site during spring 2013 and summer 2014, including birds recorded during BUS, transect surveys and incidentals.

Common name	Scientific name	Common name	Scientific name
Australian Grebe	*Tachybaptus novaehollandiae*	Magpie-lark	*Grallina cyanoleuca*
Australasian Pipit	*Anthus novaeseelandiae*	Masked Lapwing	*Vanellus miles*
Australian Magpie	*Cracticus tibicen*	Mistletoebird	*Dicaeum hirundinaceum*
Australian Raven	*Corvus coronoides*	Nankeen Kestrel	*Falco cenchroides*
Australian Wood Duck	*Chenonetta jubata*	Noisy Miner	*Manorina melanocephala*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Pacific Black Duck	*Anas superciliosa*
Brown Falcon	*Falco berigora*	Peregrine Falcon	*Falco peregrinus*
Brown Goshawk	*Accipiter fasciatus*	Pied Currawong	*Strepera graculina*
Brown Songlark	*Cinclorhamphus cruralis*	Purple Moorhen	*porphyrio porphyrio*
Brown Thornbill	*Acanthiza pusilla*	Red Wattlebird	*Anthochaera carunculata*
Brown Treecreeper#	*Climacteris picumnus*	Red-browed Finch	*Neochmia temporalis*
Brown-headed Honeyeater	*Melithreptus brevirostris*	Red-rumped Parrot	*Psephotus haematonotus*
Buff-rumped Thornbill	*Acanthiza reguloides*	Restless Flycatcher	*Myiagra inquieta*
Common Blackbird*	*Turdus merula*	Rufous Whistler	*Pachycephala rufiventris*
Common Bronzewing	*Phaps chalcoptera*	Rufous Fantail	*Rhipidura rufifrons*
Common Myna*	*Sturnus tristis*	Sacred Kingfisher	*Todiramphus sanctus*
Common Starling*	*Sturnus vulgaris*	Satin Flycatcher	*Myiagra cyanoleuca*
Crested Pigeon	*Ocyphaps lophotes*	Scarlet Honeyeater	*Myzomela sanguinolenta*
Crimson Rosella	*Platycercus elegans*	Scarlet Robin#	*Petroica boodang*
Diamond Firetail#	*Stagonopleura guttata*	Silvereye	*Zosterops lateralis*
Dusky Moorhen	*Gallinula tenebrosa*	Southern Whiteface	*Aphelocephala leucopsis*
Dusky Woodswallow	*Artamus cyanopterus*	Spotted Pardalote	*Pardalotus punctatus*
Eastern Rosella	*Platycercus eximius*	Straw-necked Ibis	*Threskiornis spinicollis*
Eastern Spinebill	*Acanthorhynchus tenuirostris*	Striated Pardalote	*Pardalotus striatus*
Eastern Yellow Robin	*Eopsaltria australis*	Striated Thornbill	*Acanthiza lineata*
Eurasian Coot	*Fulica atra*	Sulphur-crested Cockatoo	*Cacatua galerita*
Eurasian Skylark*	*Alauda arvensis*	Superb Fairywren	*Malurus cyaneus*
European Goldfinch*	*Carduelis carduelis*	Tree Martin	*Petrochelidon nigricans*
Galah	*Eolophus roseicapillus*	Varied Sittella#	*Daphoenositta chrysoptera*
Golden Whistler	*Pachycephala pectoralis*	Wedge-tailed Eagle	*Aquila audax*
Grey Butcherbird	*Cracticus torquatus*	Welcome Swallow	*Hirundo neoxena*
Grey Currawong	*Strepera versicolor*	White-browed Srubwren	*Sericornis frontalis*
Grey Fantail	*Rhipidura albiscapa*	White-browed	*Artamus superciliosus*

Common name	Scientific name	Common name	Scientific name
		Woodswallow	
Grey Shrike-thrush	*Colluricincla harmonica*	White-eared Honeyeater	*Lichenostomus leucotis*
Grey Teal	*Anas gracilis*	White-faced Heron	*Egretta novaehollandiae*
Hardhead	*Aythya australis*	White-fronted Chat#	*Epthianura albifrons*
Horsfield Bronze-Cuckoo	*Chalcites basalis*	White-necked Heron	*Ardea pacifica*
House Sparrow*	*Passer domesticus*	White-throated Treecreeper	*Cormobates leucophaea*
Jacky Winter	*Microeca fascinans*	White-winged Cough	*Corcorax melanorhamphos*
Leaden Flycatcher	*Myiagra rubecula*	White-winged Triller	*Lalage sueurii*
Laughing Kookaburra	*Dacelo novaeguineae*	Willie Wagtail	*Rhipidura leucophrys*
Little Corella	*Cacatua sanguinea*	Yellow Thornbill	*Acanthiza nana*
Little Black Cormorant	*Phalacrocorax sulcirostris*	Yellow-faced Honeyeater	*Lichenostomus chrysops*
Little Pied Cormorant	*Microcarbo melanoleucos*	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Little Raven	*Corvus mellori*	Yellow-tailed Black Cockatoo	*Calyptorhynchus funereus*

threatened species in NSW
* Introduced species

Appendix 2: Details of Bird Utilisation Data collected during the spring and summer surveys.

C1 to C8 indicate the eight replicate counts at each point
A=below rotor swept area (RSA) height (<30 m); B= at RSA height (30-150 m); C= above RSA height (>150 m).

A. Spring Survey

1. Bird counts at impact point B1

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling	5						10						6			20			10						51	0	0	51
Crimson Rosella	2			2			2			2			2			4			2			4			20	0	0	20
Australian Magpie	2			2						2			2			2			3			2			15	0	0	15
Galah	4				2								4			4									12	2	0	14
Grey Teal				7						2			3			2									14	0	0	14
Sulphur-crested Cockatoo	6						2									2			2			2			14	0	0	14
Raven spp.	3												3			2			3			2			13	0	0	13
Magpie-lark				2			2						2			2			2			2			12	0	0	12
Pacific Black Duck							4						4			3									11	0	0	11
Eastern Rosella	3			2															3						8	0	0	8
European Goldfinch				2																		6			8	0	0	8
Australian Grebe				1									1			2									4	0	0	4
Grey Currawong													2						2						4	0	0	4
White-winged Triller																						4			4	0	0	4
Australasian Pipit										2															2	0	0	2
Hardhead																2									2	0	0	2
Nankeen Kestrel							1															1			2	0	0	2
Red-rumped Parrot							2																		2	0	0	2

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Striated Pardalote				2																					2	0	0	2
Willie Wagtail																						2			2	0	0	2
Black-faced Cuckoo-shrike																						1			1	0	0	1
Grey Butcherbird	1																								1	0	0	1
Peregrine falcon																			1						1	0	0	1
Total	26	0	0	20	2	0	23	0	0	8	0	0	29	0	0	45	0	0	28	0	0	26	0	0	205	2	0	207

2. Bird counts at impact point B2

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australian Magpie	4			8			10			6			20	5		10			6			5			69	5	0	74
Common Starling	5			12						4						10			6			6			43	0	0	43
Sulphur-crested Cockatoo					2		2	2		2				5			2						2		4	13	0	17
Raven spp.					2								2						3			4			9	2	0	11
Striated Pardalote	2			2															2						6	0	0	6
Yellow-rumped Thornbill																4						2			6	0	0	6
Red-rumped Parrot																						5			5	0	0	5
Crimson Rosella																2						2			4	0	0	4
Galah								2											2						2	2	0	4
Eastern Rosella	2																								2	0	0	2
Magpie-lark																2									2	0	0	2
Total	13	0	0	22	4	0	12	4	0	12	0	0	22	10	0	28	2	0	19	0	0	24	2	0	152	22	0	174

3. Bird counts at impact point B3

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Noisy Miner	6			6			4						12			4			4			10			46	0	0	46
Sulphur-crested Cockatoo		4		6	2		2			4			2			2			2						18	6	0	24
Australian Magpie				2			3			2			4			4			2			6			23	0	0	23
Crimson Rosella	2			2						5			2			2			4			3			20	0	0	20
Eastern Rosella	4						2			2			2						4						14	0	0	14
Striated Pardalote	4												4									4			12	0	0	12
Black-faced Cuckoo-shrike							1			1			6			1									9	0	0	9
Common Starling										2						6									8	0	0	8
Galah		2					2							2								2			4	4	0	8
Magpie-lark																			2			2			4	0	0	4
Raven spp.																2						2			4	0	0	4
Yellow-rumped Thornbill	4																								4	0	0	4
Red-rumped Parrot																						3			3	0	0	3
Southern Whiteface	3																								3	0	0	3
Laughing Kookaburra																2									2	0	0	2
Red Wattlebird				2																					2	0	0	2
Total	23	6	0	18	2	0	14	0	0	16	0	0	32	2	0	23	0	0	18	0	0	32	0	0	176	10	0	186

4. Bird counts at impact point B4

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Sulphur-crested Cockatoo	2			50			4			16			16						4			2			94	0	0	94
Noisy Miner				12									6			6			4			6			34	0	0	34
Common Starling	6						4												10			12			32	0	0	32
Galah	4			12			4				2											2			22	2	0	24
Australian Magpie	4						2			3			4			2			2			2			19	0	0	19
Crimson Rosella							2			2			2			2			6						14	0	0	14
Eastern Rosella	2						2			2						2			2						10	0	0	10
Red-rumped Parrot											2		2												2	2	0	4
Black-faced Cuckoo-shrike													2												2	0	0	2
Raven spp.																				2					0	2	0	2
Total	18	0	0	74	0	0	18	0	0	23	4	0	32	0	0	12	0	0	28	2	0	24	0	0	229	6	0	235

5. Bird counts at impact point B5

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling	24			6			30			12			50			6			6			10			144	0	0	144
Sulphur-crested Cockatoo	2			12			24	6		9			22			22			20			20			131	6	0	137
Noisy Miner										2			10			4			10			4			30	0	0	30
Galah										2			24												26	0	0	26

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Eastern Rosella	6			4						4			5						3			3			25	0	0	25
Red-rumped Parrot	2	2		4									2						2			2			12	2	0	14
Straw-necked Ibis																						12			12	0	0	12
Australian Magpie				2			3						2						2						9	0	0	9
Crimson Rosella										4						2						2			8	0	0	8
Tree Martin										4	4														4	4	0	8
Crested Pigeon													5												5	0	0	5
Raven spp.							2						2												4	0	0	4
Southern Whiteface																			4						4	0	0	4
Striated Pardalote																2						2			4	0	0	4
Willie Wagtail																2									2	0	0	2
Laughing Kookaburra																						1			1	0	0	1
Nankeen Kestrel														1											0	1	0	1
Total	34	2	0	28	0	0	59	6	0	37	4	0	122	1	0	38	0	0	47	0	0	56	0	0	421	13	0	434

6. Bird counts at impact point B6

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling	30									6															36	0	0	36
Australian Magpie	3			2			2			2			4			3			5						21	0	0	21

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Raven spp.	5						2			4			2			5			2						20	0	0	20
Eurasian Skylark	4			2	2														2			2			10	2	0	12
Australasian Pipit													1						2			2			5	0	0	5
Galah				5																					5	0	0	5
Sulphur-crested Cockatoo													2												2	0	0	2
Nankeen Kestrel				1																					1	0	0	1
Peregrine falcon											1														0	1	0	1
Total	42	0	0	10	2	0	4	0	0	12	1	0	9	0	0	8	0	0	11	0	0	4	0	0	100	3	0	103

7. Bird counts at impact point B7

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling	4			2						2						2									10	0	0	10
Australian Magpie										2			3			2						2			9	0	0	9
Raven spp.													2						2						4	0	0	4
Australasian Pipit				2																					2	0	0	2
Brown Songlark																						2			2	0	0	2
Crimson Rosella	2																								2	0	0	2
Eurasian Skylark				2																					2	0	0	2
Galah					2																				0	2	0	2
Brown Falcon								1																	0	1	0	1
Brown Goshawk														1											0	1	0	1
Wedge-tailed Eagle													1												1	0	0	1
Total	6	0	0	6	2	0	0	1	0	4	0	0	6	1	0	4	0	0	2	0	0	4	0	0	32	4	0	36

8. Bird counts at impact point B8

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling	4			2			2			2						4			2			4			20	0	0	20
Raven spp.	2			2	1											7			2			2			15	1	0	16
Eurasian Skylark	2			2						2			2			2									10	0	0	10
Crimson Rosella	2			2						2						2									8	0	0	8
Australian Magpie																2			2			2			6	0	0	6
Tree Martin										4															4	0	0	4
Australasian Pipit																						2			2	0	0	2
Brown Songlark																2									2	0	0	2
Sulphur-crested Cockatoo														2											0	2	0	2
Total	10	0	0	8	1	0	2	0	0	10	0	0	2	2	0	19	0	0	6	0	0	10	0	0	67	3	0	70

9. Bird counts at impact point B9

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australian Magpie	2			14						4			2			4			6			2			34	0	0	34
Common Starling				12			4						2												18	0	0	18
Eurasian Skylark	2	2		2			2			2	1					4			2						14	3	0	17
Australasian Pipit	2			2												2						2			8	0	0	8
Raven spp.	2															2									4	0	0	4
Total	8	2	0	30	0	0	6	0	0	6	1	0	4	0	0	12	0	0	8	0	0	4	0	0	78	3	0	81

10. Bird counts at impact point B10

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling				10			16			4			5			10			4						49	0	0	49
Australian Magpie	2			2			2			7			3						5			4			25	0	0	25
Eurasian Skylark	2									2						4									8	0	0	8
Yellow-faced Honeyeater																							8		0	8	0	8
Australasian Pipit				2																		2			4	0	0	4
Grey Fantail	4																								4	0	0	4
White-winged Triller																						4			4	0	0	4
Superb Fairywren	3																								3	0	0	3
Crimson Rosella							2																		2	0	0	2
Raven spp.																						2			2	0	0	2
Sulphur-crested Cockatoo																	2								0	2	0	2
Peregrine Falcon																	1								0	1	0	1
Total	11	0	0	14	0	0	20	0	0	13	0	0	8	0	0	14	3	0	9	0	0	12	8	0	101	11	0	112

11. Bird counts at reference point R 1.

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Yellow-faced Honeyeater	6			4			4			4			6			6			6			4			40	0	0	40
Superb Fairywren	4						4						5			4			5			5			27	0	0	27
White-eared Honeyeater	4			4			2			4						4			6			2			26	0	0	26
Grey Fantail	2			2			2			3			2			2			4			2			19	0	0	19
Raven spp.				2			2			3			3			4			2			2			18	0	0	18
Common Starling	4			6			2									4									16	0	0	16

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australian Wood Duck													4			10									14	0	0	14
Striated Pardalote	2			4			2			2			2									2			14	0	0	14
Sulphur-crested Cockatoo	2							2		3	5		2												7	7	0	14
Magpie-lark				2			4									4						2			12	0	0	12
Striated Thornbill	2			2									4						4						12	0	0	12
Australian Magpie								2								2			2			2			6	2	0	8
Crimson Rosella							2									2			2			2			8	0	0	8
Galah				2			2						2			2									8	0	0	8
Red-rumped Parrot				2									3			2									7	0	0	7
White-browed Srubwren										2						4									6	0	0	6
Dusky Woodswallow							4																		4	0	0	4
Grey Shrike-thrush																2			2						4	0	0	4
Yellow-rumped Thornbill	2									2															4	0	0	4
Laughing Kookaburra										1									2						3	0	0	3
Rufous Whistler																			2			1			3	0	0	3
Jacky Winter							2																		2	0	0	2
Red Wattlebird																2									2	0	0	2
Spotted Pardalote	2																								2	0	0	2
Welcome Swallow							2																		2	0	0	2
White-faced Heron								2																	0	2	0	2
Willie Wagtail							2																		2	0	0	2
Total	30	0	0	30	0	0	36	6	0	24	5	0	33	0	0	54	0	0	37	0	0	24	0	0	268	11	0	279

12. Bird counts at reference point R 2.

Spring 2013	C1			C2			C3			C4			C5			C6			C7			C8			Total at			Total
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Noisy Miner				6			4			16			20			10			16			12			84	0	0	84
Crimson Rosella	6									2			4			2			2			2			18	0	0	18
Australian Magpie	2			2			3			2			4						2			2			17	0	0	17
Common Starling										8			6			2									16	0	0	16
Eastern Rosella	3									4						2			4			3			16	0	0	16
Welcome Swallow				4			6			2				2					2						14	2	0	16
Yellow-faced Honeyeater										2			2						6			4			14	0	0	14
Galah		6		2							2									3					2	11	0	13
Raven spp.							2			2	3					2			2						8	3	0	11
Striated Pardalote	2			2									2												6	0	0	6
Sulphur-crested Cockatoo										2	2		2												4	2	0	6
Brown Thornbill																						4			4	0	0	4
Tree Martin										4															4	0	0	4
Crested Pigeon													2												2	0	0	2
Grey Butcherbird																						2			2	0	0	2
Grey Currawong																2									2	0	0	2
Grey Shrike-thrush				1									1												2	0	0	2
Total	13	6	0	17	0	0	15	0	0	44	7	0	43	2	0	20	0	0	34	3	0	29	0	0	215	18	0	233

13. Summary of bird numbers and height distribution at the impact sites (B1-B10) during the spring survey

Spring 2013	B 1			B 2			B 3			B 4			B 5			B 6			B 7			B 8			B 9			B 10			Total			Total	% Imp.
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
Common Starling	51	0	0	43	0	0	8	0	0	32	0	0	144	0	0	36	0	0	10	0	0	20	0	0	18	0	0	49	0	0	411	0	0	411	27.9
Sulphur-crested Cockatoo	14	0	0	4	13	0	18	6	0	94	0	0	131	6	0	2	0	0	0	0	0	0	2	0	0	0	0	0	2	0	263	29	0	292	19.8
Australian Magpie	15	0	0	69	5	0	23	0	0	19	0	0	9	0	0	21	0	0	9	0	0	6	0	0	34	0	0	25	0	0	230	5	0	235	15.9
Noisy Miner	0	0	0	0	0	0	46	0	0	34	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	110	7.5
Galah	12	2	0	2	2	0	4	4	0	22	2	0	26	0	0	5	0	0	0	2	0	0	0	0	0	0	0	0	0	0	71	12	0	83	5.6
Raven spp.	13	0	0	9	2	0	4	0	0	0	2	0	4	0	0	20	0	0	4	0	0	15	1	0	4	0	0	2	0	0	75	5	0	80	5.4
Crimson Rosella	20	0	0	4	0	0	20	0	0	14	0	0	8	0	0	0	0	0	2	0	0	8	0	0	0	0	0	2	0	0	78	0	0	78	5.3
Eastern Rosella	8	0	0	2	0	0	14	0	0	10	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	0	0	59	4.0
Eurasian Skylark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2	0	2	0	0	10	0	0	14	3	0	8	0	0	44	5	0	49	3.3
Red-rumped Parrot	2	0	0	5	0	0	3	0	0	2	2	0	12	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	4	0	28	1.9
Striated Pardalote	2	0	0	6	0	0	12	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	24	1.6
Australasian Pipit	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	2	0	0	2	0	0	8	0	0	4	0	0	23	0	0	23	1.6
Magpie-lark	12	0	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	18	1.2
Grey Teal	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	14	0.9
Black-faced Cuckoo-shrike	1	0	0	0	0	0	9	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	12	0.8
Straw-necked Ibis	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	12	0.8
Tree Martin	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	8	4	0	12	0.8
Pacific Black Duck	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	11	0.7
Yellow-rumped Thornbill	0	0	0	6	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	10	0.7
European Goldfinch	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8	0.5
White-winged Triller	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	8	0	0	8	0.5
Yellow-faced Honeyeater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8	0	8	0.5

Spring 2013	B 1			B 2			B 3			B 4			B 5			B 6			B 7			B 8			B 9			B 10			Total			Total	% Imp.
19 to 31/10/2013	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
Southern Whiteface	0	0	0	0	0	0	3	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	7	0.5
Crested Pigeon	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5	0.3
Australian Grebe	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0.3
Brown Songlark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	4	0	0	4	0.3
Grey Currawong	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0.3
Grey Fantail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	0	4	0.3
Nankeen Kestrel	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	4	0.3
Willie Wagtail	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0.3
Laughing Kookaburra	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0.2
Peregrine falcon	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	3	0.2
Superb Fairywren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	3	0.2
Hardhead	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0.1
Red Wattlebird	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0.1
Brown Falcon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.1
Brown Goshawk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.1
Grey Butcherbird	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.1
Wedge-tailed Eagle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.1
Totals	205	2	0	152	22	0	176	10	0	229	6	0	268	3	0	100	3	0	31	4	0	67	3	0	78	3	0	101	11	0	1407	67	0	1474	100

14. Summary of bird numbers and height distribution at the reference sites during the spring survey

Spring 2013	R 1			R 2			Total			Total	% Imp.
19 to 31/10/2013	A	B	C	A	B	C	A	B	C		
Noisy Miner	0	0	0	84	0	0	84	0	0	84	16.4
Yellow-faced Honeyeater	40	0	0	14	0	0	54	0	0	54	10.5
Common Starling	16	0	0	16	0	0	32	0	0	32	6.3
Raven spp.	18	0	0	8	3	0	26	3	0	29	5.7
Superb Fairywren	27	0	0	0	0	0	27	0	0	27	5.3
Crimson Rosella	8	0	0	18	0	0	26	0	0	26	5.1
White-eared Honeyeater	26	0	0	0	0	0	26	0	0	26	5.1
Australian Magpie	6	2	0	17	0	0	23	2	0	25	4.9
Galah	8	0	0	2	11	0	10	11	0	21	4.1
Striated Pardalote	14	0	0	6	0	0	20	0	0	20	3.9
Sulphur-crested Cockatoo	7	7	0	4	2	0	11	9	0	20	3.9
Grey Fantail	19	0	0	0	0	0	19	0	0	19	3.7
Welcome Swallow	2	0	0	14	2	0	16	2	0	18	3.5
Eastern Rosella	0	0	0	16	0	0	16	0	0	16	3.1
Australian Wood Duck	14	0	0	0	0	0	14	0	0	14	2.7
Magpie-lark	12	0	0	0	0	0	12	0	0	12	2.3
Striated Thornbill	12	0	0	0	0	0	12	0	0	12	2.3
Red-rumped Parrot	7	0	0	0	0	0	7	0	0	7	1.4
Grey Shrike-thrush	4	0	0	2	0	0	6	0	0	6	1.2
White-browed Srubwren	6	0	0	0	0	0	6	0	0	6	1.2
Brown Thornbill	0	0	0	4	0	0	4	0	0	4	0.8
Dusky Woodswallow	4	0	0	0	0	0	4	0	0	4	0.8
Tree Martin	0	0	0	4	0	0	4	0	0	4	0.8
Yellow-rumped Thornbill	4	0	0	0	0	0	4	0	0	4	0.8
Laughing Kookaburra	3	0	0	0	0	0	3	0	0	3	0.6
Rufous Whistler	3	0	0	0	0	0	3	0	0	3	0.6
Crested Pigeon	0	0	0	2	0	0	2	0	0	2	0.4

Spring 2013	R 1			R 2			Total			Total	% Imp.
19 to 31/10/2013	A	B	C	A	B	C	A	B	C		
Grey Butcherbird	0	0	0	2	0	0	2	0	0	2	0.4
Grey Currawong	0	0	0	2	0	0	2	0	0	2	0.4
Jacky Winter	2	0	0	0	0	0	2	0	0	2	0.4
Red Wattlebird	2	0	0	0	0	0	2	0	0	2	0.4
Spotted Pardalote	2	0	0	0	0	0	2	0	0	2	0.4
White-faced Heron	0	2	0	0	0	0	0	2	0	2	0.4
Willie Wagtail	2	0	0	0	0	0	2	0	0	2	0.4
Total	268	11	0	215	18	0	483	29	0	512	100.0

B. Summer Surveys

1. Bird count at impact point B1

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling													12									100			112	0	0	112
Yellow-rumped Thornbill							6			18			10			12									46	0	0	46
Australian Wood Duck				10						16												12			38	0	0	38
Sulphur-crested Cockatoo	5						3			4									6			4	2		22	2	0	24
Australian Magpie	2			2			5			2			2			2			2			2			19	0	0	19
Galah				8									2						4			2			16	0	0	16
Magpie-lark	2			2										2		2			2			2			10	2	0	12
Varied Sittella							12																		12	0	0	12
Willie Wagtail							2						2			2			2			2			10	0	0	10
Pacific Black Duck	4						2															2			8	0	0	8
Grey Teal										2			2			2									6	0	0	6
Southern Whiteface							6																		6	0	0	6
Striated Thornbill										4															4	0	0	4
Raven spp.																3									3	0	0	3

Eastern Rosella							2																		2	0	0	2
Grey Butcherbird																2									2	0	0	2
Striated Pardalote										2															2	0	0	2
White-faced Heron										1															1	0	0	1
Totals	13	0	0	22	0	0	38	0	0	49	0	0	30	2	0	25	0	0	16	0	0	126	2	0	319	4	0	323

2. Bird count at impact point B2.

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling				2	30		3			4			2			4									15	30	0	45
Australian Magpie	4			2	2		4			4			4			3			5			6			32	2	0	34
Galah				7																			5		7	5	0	12
Raven spp.	4			2																			2		6	2	0	8
Welcome Swallow	6																								6	0	0	6
Magpie-lark																						4			4	0	0	4
Sulphur-crested Cockatoo					2								2												2	2	0	4
Straw-necked Ibis																						2			2	0	0	2
Totals	14	0	0	11	4	0	4	0	0	4	0	0	6	0	0	3	0	0	5	0	0	12	7	0	59	11	0	70

3. Bird count at impact point B3

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Eastern Rosella	16									6	6		8			4				3		6			40	9	0	49
Noisy Miner				4			8			12			4									10			38	0	0	38
Australian Magpie	2			2			2			4			2			5			6			4			27	0	0	27
Crimson Rosella	8			2			3			2			4			4			2						25	0	0	25
Sulphur-crested Cockatoo	4			3			2			6			2			2			2			2			23	0	0	23
Red-browed Finch				12																					12	0	0	12

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Yellow-rumped Thornbill																						10			10	0	0	10
Galah										2									2			4			8	0	0	8
Magpie-lark				2			2						2						2						8	0	0	8
Black-faced Cuckoo-shrike				2						2												2			6	0	0	6
Common Starling													6												6	0	0	6
Laughing Kookaburra				2						2															4	0	0	4
Grey Butcherbird							1									1									2	0	0	2
Raven spp.																				2					0	2	0	2
Nankeen Kestrel	1																								1	0	0	1
White-faced Heron																1									1	0	0	1
Totals	31	0	0	29	0	0	18	0	0	36	6	0	28	0	0	17	0	0	14	5	0	38	0	0	211	11	0	222

4. Bird count at impact point B4

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Sulphur-crested Cockatoo		2		12						16						12			16			12	8		68	10	0	78
Common Starling							20						25			25									70	0	0	70
Eastern Rosella				3			4			10			6			4						16			43	0	0	43
Galah	6			6			6				2					4							6		22	8	0	30
Australian Magpie	2			2			2			4			3			2			2			4			21	0	0	21
Raven spp.	4						2						5			3									14	0	0	14
Noisy Miner	4																					6			10	0	0	10
Willie Wagtail	2						2			2												2			8	0	0	8
Red-rumped Parrot																						4			4	0	0	4
Australian Shelduck																						2			2	0	0	2
Grey Butcherbird	1																								1	0	0	1
Totals	19	2	0	23	0	0	36	0	0	32	2	0	39	0	0	50	0	0	18	0	0	46	14	0	263	18	0	281

5. Bird count at impact point B5

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling	100			16						2						20			12						150	0	0	150
Red-rumped Parrot	10			8	4		5			12	6		6			4			4			12			61	10	0	71
Sulphur-crested Cockatoo	10									7				2								30	10		47	12	0	59
Noisy Miner	6			6						4			4			6			4			10			40	0	0	40
Galah				2							6		2						4			15			23	6	0	29
Eastern Rosella	4			4	2		6									2			2			8			26	2	0	28
Raven spp.		2		2			2			7			10			2						3			26	2	0	28
Crested Pigeon	7			2			3									2			3			2			19	0	0	19
Crimson Rosella	3			2	2								2												7	2	0	9
Australian Magpie	2						2			2			2												8	0	0	8
Wedge-tailed Eagle							1						2												3	0	0	3
Black-faced Cuckoo-shrike				1																					1	0	0	1
Brown Goshawk																			1						1	0	0	1
Totals	142	2	0	43	8	0	19	0	0	34	12	0	28	2	0	36	0	0	30	0	0	80	10	0	412	34	0	446

6. Bird count at impact point B6

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Raven spp.				2	2		2			4			5			12			2				6		27	8	0	35
Australian Magpie	2			4			2			2			6			10			2			4			32	0	0	32
Sulphur-crested Cockatoo		20																							0	20	0	20
Common Starling				10																					10	0	0	10
Yellow-rumped Thornbill	10																								10	0	0	10
Southern Whiteface	6																								6	0	0	6
Straw-necked Ibis	6																								6	0	0	6
Australasian Pipit	2			2																					4	0	0	4

Australian Shelduck	2																								2	0	0	2
Peregrine Falcon														1											0	1	0	1
Totals	28	20	0	18	2	0	4	0	0	6	0	0	11	1	0	22	0	0	4	0	0	4	6	0	97	29	0	126

7. Bird count at impact point B7

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling				50						20			12						20						102	0	0	102
Australian Magpie	3			2			2			4			2			2			3			4			22	0	0	22
Crimson Rosella							2			7						2			4			6			21	0	0	21
Australian Wood Duck																6						12			18	0	0	18
Yellow-rumped Thornbill													8						6						14	0	0	14
Raven spp.	2			2									2									2	4		8	4	0	12
Red-rumped Parrot										2									10						12	0	0	12
Sulphur-crested Cockatoo		10																							0	10	0	10
Australasian Pipit				2																					2	0	0	2
Grey Teal	2																								2	0	0	2
Pacific Black Duck																						2			2	0	0	2
Wedge-tailed Eagle								1																	0	1	0	1
White-faced Heron	1																								1	0	0	1
Totals	8	10	0	56	0	0	4	1	0	33	0	0	24	0	0	10	0	0	43	0	0	26	4	0	204	15	0	219

8. Bird count at impact point B8

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling				6			2									6			12						26	0	0	26
Galah																						17			17	0	0	17
Australian Magpie	2			1	2		2			2						2			2			2			13	2	0	15

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australasian Pipit				2			2															4			8	0	0	8
Crimson Rosella				2						4												2			8	0	0	8
Australian Grebe	6																								6	0	0	6
Raven spp.																			2	2		2			4	2	0	6
European Goldfinch	4																								4	0	0	4
Brown Falcon													2			1									3	0	0	3
Totals	12	0	0	11	2	0	6	0	0	6	0	0	2	0	0	9	0	0	16	2	0	27	0	0	89	4	0	93

9. Bird count at impact point B9

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australasian Pipit	4			4						4			2			2						8			24	0	0	24
Australian Magpie	2			2						2			8			2			4						20	0	0	20
European Goldfinch	6									4						6									16	0	0	16
Eurasian Skylark				2			2						2									2			8	0	0	8
Raven spp.	2																								2	0	0	2
Willie Wagtail							2																		2	0	0	2
Totals	14	0	0	8	0	0	4	0	0	10	0	0	12	0	0	10	0	0	4	0	0	10	0	0	72	0	0	72

10. Bird count at impact point B10

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australian Magpie	2			3						2			3			2			4			10			26	0	0	26
Crimson Rosella										3			4						2			6			15	0	0	15
Yellow-rumped Thornbill							5									4						6			15	0	0	15
Red-browed Finch																						12			12	0	0	12

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australasian Pipit				2			4															4			10	0	0	10
Raven spp.																							10		0	10	0	10
Willie Wagtail							2			1			1			2						2			8	0	0	8
Eurasian Skylark	3			2																		2			7	0	0	7
Common Starling																			4						4	0	0	4
European Goldfinch							4																		4	0	0	4
Nankeen Kestrel		1			1					1													1		1	3	0	4
Superb Fairywren																4									4	0	0	4
Brown Thornbill																2									2	0	0	2
Brown Goshawk																	1								0	1	0	1
Totals	5	1	0	7	1	0	15	0	0	7	0	0	8	0	0	14	1	0	10	0	0	42	11	0	108	14	0	122

11. Bird count at reference point R1

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Sulphur-crested Cockatoo	2				3			60		3			2				2		16			4	2		27	67	0	94
Superb Fairywren	10			4			8									4			5						31	0	0	31
Crimson Rosella				3			4			3			2			2			2			7			23	0	0	23
White-browed Srubwren	6						10						2						4						22	0	0	22
Yellow-faced Honeyeater	2						6						4						4			4			20	0	0	20
Galah							4			8						6									18	0	0	18
Australian Magpie	2						4			2			2						4			3			17	0	0	17
Brown-headed Honeyeater							16																		16	0	0	16
Noisy Miner	10																								10	0	0	10
Yellow-rumped Thornbill																			10						10	0	0	10
Raven spp.							4									4									8	0	0	8
White-faced Heron		1											2			1						4			7	1	0	8

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Willie Wagtail							2			2						2						2			8	0	0	8
Common Starling																6									6	0	0	6
Welcome Swallow																						5			5	0	0	5
Striated Pardalote																			4						4	0	0	4
Striated Thornbill							4																		4	0	0	4
Eastern Rosella																2									2	0	0	2
Grey Fantail													2												2	0	0	2
Grey Shrike-thrush																			1						1	0	0	1
Totals	32	1	0	7	3	0	62	60	0	18	0	0	16	0	0	27	2	0	50	0	0	29	2	0	241	68	0	309

12. Bird count at reference point R2

summer 2014	C1			C2			C3			C4			C5			C6			C7			C8			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Noisy Miner	22			6			10			10			10			4			4			4			70	0	0	70
Eastern Rosella	2			4			12			8			4			8			6	6		8			52	6	0	58
Red-rumped Parrot					6																	20			20	6	0	26
Sulphur-crested Cockatoo							4															20			24	0	0	24
Australian Wood Duck																			18						18	0	0	18
Australian Magpie	2			2			2			2			3			4						2			17	0	0	17
Brown Thornbill				4									6												10	0	0	10
Grey Currawong	2						4			2															8	0	0	8
Magpie-lark	2			2						2						2									8	0	0	8
Crimson Rosella				3									2									2			7	0	0	7
Galah							2												4						6	0	0	6
Laughing Kookaburra							2						2												4	0	0	4
Welcome Swallow										4															4	0	0	4
Grey Butcherbird	2						1																		3	0	0	3

Black-faced Cuckoo-shrike																			2												2	0	0	2
White-browed Srubwren													2																		2	0	0	2
Willie Wagtail				2																											2	0	0	2
Totals	32	0	0	23	6	0	37	0	0	28	0	0	29	0	0	18	0	0	34	6	0	56	0	0	257	12	0	269

13. Summary of bird numbers and height distribution at the impact sites (B1 – B10) during the summer survey

summer 2014	B1			B2			B3			B4			B5			B6			B7			B8			B9			B10			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Common Starling	112	0	0	15	30	0	6	0	0	70	0	0	150	0	0	10	0	0	102	0	0	26	0	0	0	0	0	4	0	0	495	30	0	525
Australian Magpie	19	0	0	32	2	0	27	0	0	21	0	0	8	0	0	32	0	0	22	0	0	13	2	0	20	0	0	26	0	0	220	4	0	224
Sulphur-crested Cockatoo	22	2	0	2	2	0	23	0	0	68	10	0	47	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	162	26	0	188
Eastern Rosella	2	0	0	0	0	0	40	9	0	43	0	0	26	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111	11	0	122
Galah	16	0	0	7	5	0	8	0	0	22	8	0	23	6	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	93	19	0	112
Raven spp.	3	0	0	6	2	0	0	2	0	14	0	0	26	2	0	27	8	0	8	4	0	4	2	0	2	0	0	0	0	0	90	20	0	110
Yellow-rumped Thornbill	46	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10	0	0	14	0	0	0	0	0	0	0	0	15	0	0	95	0	0	95
Noisy Miner	0	0	0	0	0	0	38	0	0	10	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88	0	0	88
Red-rumped Parrot	0	0	0	0	0	0	0	0	0	4	0	0	61	10	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	77	10	0	87
Crimson Rosella	0	0	0	0	0	0	25	0	0	0	0	0	7	2	0	0	0	0	21	0	0	8	0	0	0	0	0	15	0	0	76	2	0	78
Australian Wood Duck	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	56	0	0	56
Australasian Pipit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	8	0	0	24	0	0	10	0	0	48	0	0	48
Willie Wagtail	10	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	8	0	0	28	0	0	28
European Goldfinch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	16	0	0	4	0	0	24	0	0	24
Magpie-lark	10	2	0	4	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	2	0	24

summer 2014	B1			B2			B3			B4			B5			B6			B7			B8			B9			B10			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Red-browed Finch	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	24	0	0	24
Crested Pigeon	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	19
Eurasian Skylark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	7	0	0	15	0	0	15
Southern Whiteface	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	12
Varied Sittella	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	12
Pacific Black Duck	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	10	0	0	10
Grey Teal	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8
Straw-necked Ibis	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8
Black-faced Cuckoo-shrike	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	7
Welcome Swallow	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6
Grey Butcherbird	2	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5
Nankeen Kestrel	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	2	3	0	5
Australian Shelduck	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
Laughing Kookaburra	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
Striated Thornbill	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
Superb Fairywren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	0	4
Wedge-tailed Eagle	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	1	0	4
Brown Falcon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	3
White-faced Heron	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
Brown Goshawk	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	2
Brown Thornbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	2
Striated Pardalote	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Peregrine Falcon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Totals	319	4	0	74	41	0	211	11	0	263	18	0	412	34	0	97	9	0	204	5	0	83	4	0	72	0	0	108	4	0	1843	130	0	1973

BL&A

14. Summary of bird numbers and height distribution at the reference sites during the summer survey

Summer 2014	R 1			R 2			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	
Sulphur-crested Cockatoo	27	67	0	24	0	0	51	67	0	118
Noisy Miner	10	0	0	70	0	0	80	0	0	80
Eastern Rosella	2	0	0	52	6	0	54	6	0	60
Australian Magpie	17	0	0	17	0	0	34	0	0	34
Superb Fairywren	31	0	0	0	0	0	31	0	0	31
Crimson Rosella	23	0	0	7	0	0	30	0	0	30
Red-rumped Parrot	0	0	0	20	6	0	20	6	0	26
Galah	18	0	0	6	0	0	24	0	0	24
White-browed Srubwren	22	0	0	2	0	0	24	0	0	24
Yellow-faced Honeyeater	20	0	0	0	0	0	20	0	0	20
Australian Wood Duck	0	0	0	18	0	0	18	0	0	18
Brown-headed Honeyeater	16	0	0	0	0	0	16	0	0	16
Brown Thornbill	0	0	0	10	0	0	10	0	0	10
Willie Wagtail	8	0	0	2	0	0	10	0	0	10
Yellow-rumped Thornbill	10	0	0	0	0	0	10	0	0	10
Welcome Swallow	5	0	0	4	0	0	9	0	0	9
Grey Currawong	0	0	0	8	0	0	8	0	0	8
Magpie-lark	0	0	0	8	0	0	8	0	0	8
Raven spp.	8	0	0	0	0	0	8	0	0	8
White-faced Heron	7	1	0	0	0	0	7	1	0	8
Common Starling	6	0	0	0	0	0	6	0	0	6
Laughing Kookaburra	0	0	0	4	0	0	4	0	0	4
Striated Pardalote	4	0	0	0	0	0	4	0	0	4
Striated Thornbill	4	0	0	0	0	0	4	0	0	4
Grey Butcherbird	0	0	0	3	0	0	3	0	0	3
Black-faced Cuckoo-shrike	0	0	0	2	0	0	2	0	0	2
Grey Fantail	2	0	0	0	0	0	2	0	0	2
Grey Shrike-thrush	1	0	0	0	0	0	1	0	0	1

Summer 2014	R 1			R 2			Total			Total
17 to 27/02/2014	A	B	C	A	B	C	A	B	C	
Totals	241	68	0	257	12	0	498	80	0	578

Appendix 3: Details of Data collected during the spring and summer transects surveys.

A. Transects conducted on 23/10/ 2013

T1- Afternoon	No. seen	Distance (m)	No. heard	Distance (m)
Black-faced Cuckoo-shrike	2	at 25		
Crimson Rosella	2	at 20		
Galah	2	at 25	2	at 25
Golden Whistler	1	at 10		
Striated Thornbill	5	2 at 10, 3 at 15		

T2- Afternoon	No. seen	Distance (m)	No. heard	Distance (m)
Australian Magpie	3	1 at 1o, 2 at 25		
Crimson Rosella	16	5 at 10, 5 at 15, 6 at 25		
Eastern Rosella	4	2 at 5, 2 at 15		
Galah	2	at 15		
Grey Butcherbird	1	at 25	1	at 25
Grey Fantail	2	at 20		
Magpie-lark	2	at 10		
Noisy Miner	150	very large number all over		Av. Dist approx. 15 m
Sulphur-crested Cockatoo	10	4 at 10, 6 at 25		
White-winged Cough	4	as group at 20		

TR1- Morning	No. seen	Distance (m)	No. heard	Distance (m)
Australian Magpie	4	2 at 10, 2 at 25		
Australian Raven	4	at 25		

TR1- Morning	No. seen	Distance (m)	No. heard	Distance (m)
Brown Thornbill	6	small group at 10-15		
Crimson Rosella	2	at 10		
Eastern Spinebill	1	at 20	3	at 25
Grey Currawong	2	at 15	3	at 25
Grey Fantail	7	at 5 to 20		
Horsfield's Bronze-Cuckoo			2	at 25
Leaden Flycatcher	3	at 20		
Mistletoebird	1	at 20	2	at 25
Rufous Whistler	4	at 15	8	at 20-25
Satin Flycatcher	2	at 15		
Scarlet Robin	6	2 at 10, 2 at 15, 2 at 20		
Spotted Pardalote			2	20
Striated Pardalote	2	at 15	6	at 20-25
Striated Thornbill	5	one group at 15		
Superb Fairywren	7	2 groups at 20		
Varied Sittella	7	group at 20-25		
White-throated Treecreeper	2	at 15	5	at 25
White-winged Cough	5	group at 25		
Yellow-faced Honeyeater	10	5 at 15, 5 at 20	15	mostly at 25

TR2- Morning	No. seen	Distance (m)	No. heard	Distance (m)
Australian Magpie	2	at 10-25		
Australian Raven	3	25		
Buff-rumped Thornbill	10	5 at 10, 5 at 15		

TR2- Morning	No. seen	Distance (m)	No. heard	Distance (m)
Crimson Rosella	2	at 20		
Eastern Spinebill			2	at 20
Golden Whistler	2	at 15		
Grey Fantail	6	at 10-25		
Laughing Kookaburra	2	one at 15, one at 20		
Rufous Whistler	1	at 20	3	at 25
Scarlet Honeyeater	2	one at 10, one at 20		
Striated Pardalote	2	at 20		
Striated Thornbill	10	groups of 2-3 at 10-20		
Superb Fairywren	3	groups of 3-7 at 20		
White-winged Cough	7	at 25		
Yellow Thornbill	4	at 15		
Yellow-rumped Thornbill	5	one group at 10		

B. Transects conducted on 23/10/ 2013

T1- Morning- 400 m	No. seen	Distance (m)	No. heard	Distance (m)
Australian Magpie	2	2 at 10		
Black-faced Cuckoo-shrike	2	at 20		
Brown Thornbill	5	a group at 10		
Buff-rumped Thornbill	5	a group at 15		
Common Starling	8	group at 10		
Crimson Rosella	6	2 at 10, 2 at 15, 2 at 20		
Eastern Rosella	4	2 at 10, 2 at 20		
Grey Currawong	2	at 20		

T1- Morning- 400 m	No. seen	Distance (m)	No. heard	Distance (m)
Grey Fantail	2	at 5		
Laughing Kookaburra	2	1 at 10 and 1 at 15		
Noisy Miner	2	2 at 15		
Red Wattlebird	2	at 10	5	at 15
Rufous Whistler			2	at 15
Sacred Kingfisher	1	at 15		
Striated Pardalote			2	at 10
Striated Thornbill	12	7 at 10, 5 at 15		
Sulphur-crested Cockatoo	2	at 15		
Superb Fairywren	4	a group at 5		
White-throated Treecreeper			2	at 10
White-winged Cough	5	at 20		
Willie Wagtail	2	1 at 5 , 1 at 2		
Yellow-faced Honeyeater				at 10
Yellow-rumped Thornbill	10	two groups at 10		

T2- Morning- 400 m	No. seen	Distance (m)	No. heard	Distance (m)
Australian Magpie	8	4 at 5, 4 at 10		
Australian Raven	4	2 at 10, 2 at 25		
Black-faced Cuckoo-shrike	2	at 15		
Crimson Rosella	10	5 at 10, 5 at 15		
Eastern Rosella	2	at 15		
Grey Currawong	2	at 15	2	2 at 20
Magpie-lark	2	at 15 m		

T2- Morning- 400 m	No. seen	Distance (m)	No. heard	Distance (m)
Noisy Miner	10	at 10	25	large groups at 10 - 15
Striated Pardalote			6	2 at 5, 2 at 10, 2 at 15
Sulphur-crested Cockatoo	2	at 20	4	flying at 25
White-winged Cough	5	at 15		

TR1- Afternoon	No. seen	Distance (m)	No. heard	Distance (m)
Australian Magpie	2	at 10		
Brown Thornbill	4	at 5	11	at 10-15
Brown-headed Honeyeater			5	at 15
Crimson Rosella	6	at 15		
Eastern Spinebill	2	at 15	4	at 20
Grey Fantail	5	at 5 - 10		
Grey Shrike-thrush	2	at 10	4	at 25
Horsfield's Bronze-Cuckoo			11	at 20
Leaden Flycatcher	2	at 15		
Rufous Whistler	4	2 at 10 m, 2 at 15	13	at 15 to 25
Sacred Kingfisher	3	at 20, 20, 25		
Scarlet Robin	10	at 10 - 15		
Striated Pardalote	4	at 10 - 15		
Striated Thornbill	4	at 10	6	at 15
Superb Fairywren	13	3 groups at 5, 10 and 10		
White-browed Scrubwren	2	at 15		
White-eared Honeyeater	2	at 20		
White-throated Treecreeper	2	at 10	8	at 15-25

TR1- Afternoon	No. seen	Distance (m)	No. heard	Distance (m)
Yellow-faced Honeyeater	10	at 15	25	at 15-25

TR2- Afternoon	No. seen	Distance (m)	No. heard	Distance (m)
Australian Raven	2	at 20		
Black-faced Cuckoo-shrike	3	1 at 10, 1 at 15, 1 at 25		
Brown Thornbill	5	at 5-10		
Crimson Rosella	4	2 at 10, 2 at 15		
Eastern Spinebill			2	at 15
Grey Fantail	6	at 5 - 15		
Mistletoebird	2	at 10		
Red Wattlebird	2	at 15		
Rufous Whistler	2	at 15	2 at 20	
Striated Thornbill	4	at 10		
Superb Fairywren	7	at 5		
White-eared Honeyeater			3	at 15
White-throated Treecreeper			2	at 10
Yellow Thornbill	4	at 10		
Yellow-faced Honeyeater			4	at 15
Yellow-rumped Thornbill	5	at 5		

C. **Transects conducted on 19/02/ 2014**

T1- Morning- 400 m	No. seen	Distance (m)	No. heard	Distance
Australian Raven	2	25-Jan		
Australian Magpie	4	2 @ 25, 2 @ 40		

T1- Morning- 400 m	No. seen	Distance (m)	No. heard	Distance
Brown Thornbill	2	10		
Crimson Rosella	3	30		
Grey Fantail	2	20		
Red Wattlebird			2	25
Striated Thornbill	8	10		
White-throated Treecreeper	1	1 @ 25	2	1 15, 1@ 25
Yellow-rumped Thornbill	5	20		
Weebill	2	10		
Leaden Flycatcher	1	10		

T2- Morning- 400 m	No. seen	Distance (m)	heard	Distance (m)
Australian Magpie	8	2 @ 30, 2 @ 25, 4 @ 30		
Eastern Rosella	13	3 @ 10, 10 @ 25		
Crimson Rosella	3	20	9	5 at 20, 4 at 15
Noisy miner	20	20	20	10 at 25, 10 at 20
Magpie-lark	2	15		
Sulphur-crested Cockatoo	2	25		
Grey Butcherbirds			2	30

D. Transects conducted on 20/02/2014

TR1- Afternoon	No. seen	Distance (m)	heard	Distance (m)
Laughing Kookaburra	1	10	2	20
White-throated treecreeper	4	2 at 10, 2 at 20	4	25

TR1- Afternoon	No. seen	Distance (m)	heard	Distance (m)
White-browed Scrubwren	3	1 at 10, 2 at 15	4	25
Striated Thornbill	10	10		
Australian Magpie	2	30		
Superb Fairywren	4	20		
Buff-rumped Thornbill	12	6 at 10, 6 at 15		
Weebill	4	2 at 10, 2 at 15		
Black-faced Cuckoo-Shrike	1	25		
White-winged Chough	10	25		
Leaden Flycatcher	2	15		
Yellow-rumped Thornbill	6	10		
Brown Goshawk	1	25		

TR2- Afternoon	N. seen	Distance (m)	heard	Distance (m)
Laughing Kookaburra	2	20		
White-throated treecreeper	2	20		
Grey Fantail	2	20		
Striated Thornbill	4	10		
Buff-rumped Thornbill	16	10		

E. Transects conducted on 21/02/2014

T1- Afternoon	N. seen	Distance (m)	heard	Distance (m)
Yellow-rumped Thornbill	3	5		
White-throated Treecreeper	2	10		

T1- Afternoon	N. seen	Distance (m)	heard	Distance (m)
Rufous Whistler	1	5		
Restless Flycatcher	2	15		
Australian Magpie	2	25		
Buff-rumped Thornbill	6	10		
Brown-headed Honeyeater	4	25		
Striated Thornbill	3	10		
Leaden Flycatcher	1	15		
Grey Fantail	2	25		

T2- Afternoon	No. seen	Distance (m)	heard	Distance (m)
Wedge-tailed Eagle	1	20		
Noisy Miner	10	25	20	10 at 20, 10 at 30
Crimson Rosella	2	15		
Australian Magpie	4	25		
Magpie-lark	2	25		
Striated Thornbill	6	15		

TR1- Morning	No. seen	Distance (m)	heard	Distance (m)
Crimson Rosella	4	2 at 20, 2 at 30		
Australian Magpie	4	2 at 20, 2 at 25		
Striated Thornbill	4	30		
White-throated Treecreeper	3	2 at 5, 1 at 15	4	2 at 10, 2 at 15
Yellow-faced Honeyeater	2	20	4	20

TR1- Morning	No. seen	Distance (m)	heard	Distance (m)
Grey Fantail	4	25		
White-browed Scrubwren	6	20		
Red Wattlebird	2	20		
Buff-rumped Thornbill	9	10		
Brown Thornbill	4	2 at 20, 2 at 25		
Rufous Whistler	1	25	4	25
Sulphur-crested Cockatoo			2	30
Galah			2	20
Yellow-rumped Thornbill	6	20		
Grey Shrike-thrush	2	10	1	25
Superb Fairywren	3	10		
Golden Whistler	3	1 at 15, 1 at 20, 1 at 25		
Leaden Flycatcher	2	15		
Eastern Spinebill			2	10
Spotted pardalote	2	15		
Brown-headed Honeyeater	4	15	4	20

TR2- Morning	No. seen	Distance (m)	heard	Distance (m)
Buff-rumped Thornbill	22	10		
White-throated Treecreeper	2	15		
Grey Shrike-thrush	1	20		
Striated Thornbill	4	15		
Grey Butcherbird			1	25

TR2- Morning	No. seen	Distance (m)	heard	Distance (m)
Superb Fairywren	3	10		
Crimson Rosella	2	25		
Grey Fantail	2	10		
Australian magpie	2	25		
White-eared honeyeater	2	25		
Sulphur-crested Cockatoo			2	30
Brown Thornbill	4	20		

Appendix 4: Bat call records from nine sites during the period 28th November to 11th December, 2013 at Collector Wind Farm

COLLECTOR WF NOV-DEC 2013 BAT FAUNA SURVEY																
Values in cells = number of calls identified																
A 1	Met tower - ground level	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	7	-	-	-	-	3	1	-	-	-	-	-	-	-
		Chalinolobus gouldii	3	-	-	-	-	-	-	-	-	-	-	-	-	-
		Chalinolobus morio	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	1	-	-	-	-	-	-	-	-	-	-	-	-	-
		Nyctophilus sp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-
		Scotorepens greyii	1	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus darlingtoni	-	-	-	-	-	1	1	-	-	-	-	-	-	-
		Vespadelus regulus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus vulturnus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A 2	Met tower - 50 m	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	-	-	-	-	-	-	1	-	-	-	-	1	-	-
		Chalinolobus gouldii	-	-	-	1	-	-	-	-	-	-	-	-	-	-
		Chalinolobus morio	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		Miniopterus/ Vespadelus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	1	-	-	-	-	-	-	-	-	-	-	-	-	-
		Nyctophilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Scotorepens greyii	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus darlingtoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus regulus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus vulturnus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A 3	Remnant	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	56	5	9	2	6	6	1	2	7	3	45	21	4	8
		Chalinolobus gouldii	8	-	-	-	-	-	-	-	-	-	-	-	-	-
		Chalinolobus morio	2	-	1	3	-	1	-	-	1	2	1	3	4	-
		Miniopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	-	-	-	-	1	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	69	54	66	72	54	34	11	76	38	32	19	11	32	11
		Nyctophilus sp.	14	5	9	2	6	6	1	2	7	3	1	8	2	5
		Scotorepens greyii	3	-	-	-	-	-	2	-	-	-	-	-	-	-
		Vespadelus darlingtoni	20	14	18	8	15	19	21	6	16	20	13	21	17	27
		Vespadelus regulus	15	11	16	20	12	8	17	21	13	23	18	14	19	15
		Vespadelus vulturnus	-	2	-	-	2	-	-	-	5	-	-	-	-	-

A 4	Open WL remnant	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Chalinolobus gouldii	3	5	2	-	2	-	-	-	-	2	-	-	-	-
		Chalinolobus morio	2	-	1	3	-	-	-	-	-	3	-	-	-	-
		Miniopterus	-	-	-	2	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	2	5	6	5	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	-	2	-	1	-	-	-	-	-	-	-	-	-	-
		Nyctophilus sp.	3	-	1	6	3	-	-	-	-	1	-	-	-	-
		Scotorepens greyii	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus darlingtoni	72	83	4	96	15	-	-	-	-	39	-	-	-	-
		Vespadelus regulus	56	102	78	71	7	-	-	-	-	17	-	-	-	-
		Vespadelus vulturnus	-	-	-	7	-	-	-	-	-	3	-	-	-	-
A 5	Remnant with dam nearby	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	1	-	1	-	-	1	1	1	-	-	1	-	1	-
		Chalinolobus gouldii	13	9	11	8	9	3	5	1	9	13	6	9	10	11
		Chalinolobus morio	3	-	-	3	2	-	1	-	-	-	2	1	-	-
		Miniopterus	-	-	2	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	-	-	2	-	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	4	2	-	5	11	6	-	3	4	11	1	-	10	-

		Nyctophilus sp.	3	4	-	1	-	3	-	-	-	-	1	-	2	2
		Scotorepens greyii	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus darlingtoni	20	14	11	3	7	15	11	22	21	10	8	5	9	14
		Vespadelus regulus	17	19	12	22	14	32	11	6	9	6	11	7	10	9
		Vespadelus vulturnus	-	2	-	-	-	-	-	2	-	-	-	-	-	-
A 6	Bare rocky knoll	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	-	1	-	2	-	-	1	-	-	-	-	-	-	-
		Chalinolobus gouldii	-	-	1	-	-	-	-	-	1	2	-	-	-	1
		Chalinolobus morio	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Miniopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	1	1	-	-	-	-	-	-	-	-	-	-	-	-
		Nyctophilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Scotorepens greyii	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus darlingtoni	-	-	-	-	-	-	-	1	-	-	-	-	1	-
		Vespadelus regulus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus vulturnus	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A7	Open woodland remnant	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	-	2	-	-	-	1	-	-	2	-	1	1	-	-
		Chalinolobus gouldii	2	1	4	4	-	-	-	1	-	-	-	-	1	-
		Chalinolobus morio	-	-	-	-	-	-	-	-	-	-	-	-	1	-
		Miniopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Nyctophilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Scotorepens greyii	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Vespadelus darlingtoni	3	1	4	-	1	-	1	-	3	-	-	1	-	-
		Vespadelus regulus	1	-	2	-	-	-	2	-	-	-	-	-	-	-
		Vespadelus vulturnus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A8	Bare hill	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	7	-	2	-	-	3	1	-	-	2	-	4	4	-
		Chalinolobus gouldii	3	-	-	-	-	-	-	2	-	-	-	-	-	-
		Chalinolobus morio	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	1	-	-	6	-	-	-	1	-	2	-	-	2	-

		Nyctophilus sp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-
		Scotorepens greyii	1	-	-	-	-	-	-	-	-	-	-	-	2	-
		Vespadelus darlingtoni	-	-	-	-	-	1	1	-	-	-	-	-	-	-
		Vespadelus regulus	-	2	-	-	-	-	-	-	-	2	-	-	-	-
		Vespadelus vulturnus	-	-	-	1	-	-	-	-	-	-	-	-	-	-
A 9	Planted regrowth patch top of hill	Species	28-Nov	29-Nov	30-Nov	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec
		Austronomus australis	-	2	-	-	-	1	-	-	2	-	1	1	-	4
		Chalinolobus gouldii	2	1	4	4	-	-	-	1	-	-	-	-	1	-
		Chalinolobus morio	-	2	-	-	-	4	-	-	-	3	-	-	1	-
		Miniopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Miniopterus/ Vespadelus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Mormopterus ridei	1	3	-	1	-	-	3	-	2	3	-	2	-	2
		Nyctophilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	2	-
		Scotorepens greyii	-	-	-	-	-	-	-	1	-	-	-	-	-	-
		Vespadelus darlingtoni	3	1	5	-	1	-	1	-	3	-	7	1	1	-
		Vespadelus regulus	1	-	2	-	-	-	2	-	-	-	-	-	-	3
		Vespadelus vulturnus	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 5: Eastern Bent-wing Bat call records from nine sites during the period 3rd February to 23rd March 2014 at Collector Wind Farm

Date	Survey Site										Total calls per night
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	
3-Feb	0	1	0	1	3	1	-	0	0	1	7
4-Feb	0	0	1	2	3	2	0	2	3	0	13
5-Feb	0	0	0	1	3	0	0	0	1	1	6
6-Feb	0	0	0	0	3	0	0	1	0	1	5
7-Feb	0	1	0	0	2	2	4	0	0	0	9
8-Feb	0	0	0	0	8	0	0	0	4	0	12
9-Feb	0	1	0	0	6	4	0	0	6	1	18
10-Feb	0	0	4	0	3	0	0	2	3	1	13
11-Feb	0	2	0	2	5	0	0	0	0	0	9
12-Feb	0	0	4	4	0	0	0	3	0	2	13
13-Feb	0	0	0	4	5	0	0	0	0	0	9
14-Feb	0	3	0	2	4	1	0	0	2	0	12
15-Feb	0	0	1	2	2	-	0	-	0	0	5
16-Feb	0	1	1	1	-	-	0	-	0	0	3
17-Feb	0	2	-	3	2	-	-	-	0	1	8
18-Feb	0	9	5	3	0	1	0	6	0	1	25
19-Feb	0	2	1	1	9	0	0	0	1	1	15
20-Feb	0	0	0	4	5	0	0	3	0	1	13
21-Feb	0	0	0	0	5	4	6	0	0	0	15
22-Feb	0	0	0	5	0	2	0	0	0	0	7
23-Feb	0	0	0	11	2	0	3	13	6	1	36
24-Feb	0	0	0	1	11	9	0	6	0	1	28
25-Feb	0	0	0	11	19	5	0	0	3	0	38

Date	Survey Site										Total calls per night
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	
26-Feb	0	0	0	18	2	5	0	3	0	0	28
27-Feb	0	0	23	4	49	0	5	0	0	0	81
28-Feb	0	0	3	2	33	2	0	0	5	0	45
1-Mar	0	0	0	7	13	3	11	0	0	0	34
2-Mar	0	0	0	7	7	-	0	0	0	2	16
3-Mar	0	0	0	0	7	0	64	7	0	1	79
4-Mar	0	0	0	0	11	0	13	0	0	0	24
5-Mar	0	0	0	11	19	2	23	3	0	0	58
6-Mar	0	0	0	0	12	0	21	0	0	1	34
7-Mar	0	0	0	3	33	1	1	1	0	1	40
8-Mar	0	0	1	0	77	0	617	331	0	0	1026
9-Mar	0	11	0	0	53	0	0	4	0	0	68
10-Mar	0	0	0	3	41	0	1	1	0	1	47
11-Mar	0	5	0	0	22	2	0	0	0	0	29
12-Mar	0	0	0	0	46	0	0	3	0	0	49
13-Mar	0	8	0	0	2463	0	0	1	0	1	2473
14-Mar	0	0	0	0	33	0	0	0	0	1	34
15-Mar	0	0	0	0	21	0	0	0	0	0	21
16-Mar	0	0	0	0	5	0	0	2	0	0	7
17-Mar	0	0	0	0	11	0	0	2	0	0	13
18-Mar	0	0	0	0	18	0	0	0	0	0	18
19-Mar	0	0	0	0	4	0	0	0	0	0	4
20-Mar	0	0	0	0	2	0	0	6	0	0	8
21-Mar	0	0	0	0	7	0	0	0	0	0	7
22-Mar	0	0	0	0	7	0	0	0	0	0	7
23-Mar	0	0	0	0	-	0	0	0	0	0	0

Date	Survey Site										Total calls per night
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	
Total calls per site	0	46	44	113	3096	46	769	400	34	21	4569
Range	0	0-11	0-23	0-18	0-2463	0-5	0-617	0-331	0-6	0-2	0-2463
Nights with no EBB calls	49	37	38	24	3	29	35	26	39	30	310

Note: No Eastern Bentwing Bat were recorded at the meteorological tower (site A1 at 50 metres above ground); 0 = nights in which no Eastern Bentwing Bat call was recorded; - = no bat calls recorded, possibly due to battery failure.

Appendix 2: Symbolix (2014) – Generating mortality estimates for wind farms

symbolix

To: Annabelle Stewart
Brett Lane & Associates
Via EMAIL

Ref #: BLACOLL20140122
Date: 22nd Jan 2014
CC:

Re: On generating mortality estimates for wind facilities

Dear Annabelle,

In response to our recent conversations about statistical survey requirements for the Collector Wind Facility BAM plan we have compiled the following overview of mortality estimation for wind farms. This letter outlines the background information that has guided our recent advice and reflects the current state of our ongoing research and work in this field.

We note that mortality searches and estimation is an area of ongoing research worldwide. As such our advice is guided by a combination of statistical tests, current best practice, and practices on-ground at other Australian wind farms (as this increases the ability to compare sites in future).

Estimating mortality

Ongoing monitoring of turbine mortality at operating wind farms typically serve two purposes: to provide data which can inform adaptive management of the collision risk and to provide an estimate of overall mortality that can be used to understand the potential impacts.

In designing a mortality monitoring program, we attempt to make choices that provide the most precise estimate of overall mortality, within the logistic constraints of time, observer fatigue and OH&S.

All current mortality estimation techniques amount to accounting for the area surveyed (as a proportion of possible 'fall zone') and for the probability of detection (which consists of the searcher efficiency confounded with the probability of sample loss through scavenge).

Attesting to the speed of output and effort of exploration in this space, there are multiple approaches to choose from and no clear supreme option. As a starting list, one might use: raw detection count, simple probabilistic scaling, Johnson et al. 2003, Kerns & Kerlinger 2004, Schoenfeld 2004, Jain et al. 2007, Baerwald and Barclay 2009, Huso 2010 through to Korner-Nievergelt et al. 2011.

The amount of effort that has gone into these methods should be acknowledged, and not taken lightly. However, there remain issues, and application to local wind farms should be done with knowledge, care, and an adaptive attitude that allows later techniques to be applied.

Sampling effort – sampling fraction

This is the simple question of how many wind turbine generators (WTGs) to include in the sample.

We do not specify that all turbines be searched, nor suggest a specific set fraction, as there exist standard techniques to account for the fact that a subsample was selected (including modern mortality estimators, back to seminal texts such as Kish 1965). Issues such as stratification, clustering and sampling methods are all well established.

Best here is a logistic choice, being the most WTGs that can be consistently and meaningfully surveyed within a reasonable time. In practice it is usually possible to survey up to 20-30% of a wind farm of this size (63 turbines).

We would usually recommend that the same turbines be visited each time. This allows for any seasonal patterns to emerge, and is a required for accurate mortality estimation for some of the modern estimators.

We understand that this site consists of two distinct land types – pasture and areas adjacent to woodland. We also understand that there is concern that the areas adjacent to woodland may pose a higher collision risk. As such, we support splitting the survey effort into two strata, based on these land types.

In order to determine an overall mortality rate, it is important that the turbines be randomly selected within each stratum. You could choose an equal number, or equal proportion of turbines in each land type, but this is not critical. Statistically, we would require a barest minimum of 3-4 turbines per stratum.

Sampling to optimise mortality estimation

It is common to come across complicated arguments for stratification and large surveying efforts when what is really desired is coverage, i.e. a sample that captures the background variability. Mortality sampling should be unbiased, and have coverage.

We understand that the particular species of concern at this site are:

- Eastern Bent-wing Bat (length about 6cm, weighs up to 20grams)
- Medium-large birds:
    - Gang Gang Cockatoo (33-36cm)
    - Superb Parrot (36-42 cm)
    - Little Eagle (45-55; wing span to 1.30m)
- Very large bird:
    - Wedge-tailed Eagle (90-1.1m; wing span to 2.8m)

The monitoring program should account for potential differences in detectability, scavenge loss and ‘fall zone’ for these different species.

Search area

Our understanding of the potential carcass ‘fall zone’ is simply based on published research of how far a carcass might fall from a given turbine (Hull & Muir 2010). Statistically, it is not necessary to cover the entire ‘fall zone’ in a carcass search, we can survey to a specified radius and account for this later by scaling the number of carcasses by the proportion of the potential fall zone surveyed.

Although there are a number of turbines under consideration, they all have a hub height of around 90m (89-92m) and a rotor diameter that ranges from 113-122m. Using methods in Hull & Muir 2010, we expect to 95% of bats within 65m from the tower. Medium birds (such as the parrot and Little Eagle) are reasonably evenly distributed out to 100m. The range that we expect to find very large birds is a little further out, but with 95% within 115m (Figure 1).

From our experience and discussions with BL&A ecologists, we recommend that it is impractical to cover the entire fall-zone, out to 120m for each turbine (especially considering that observer fatigue can degrade efficiency).

We recommend searching a small number of turbines (e.g. 3 per stratum) out to 120m, to provide assurance that there is no unusual distribution at large distances, but the majority of turbines be searched out to 60-65m. This provides complete coverage of the bat fall zone, and about half the fall zone of the key bird species.

Transect spacing should be decided based on your assessment of visibility and time constraints.

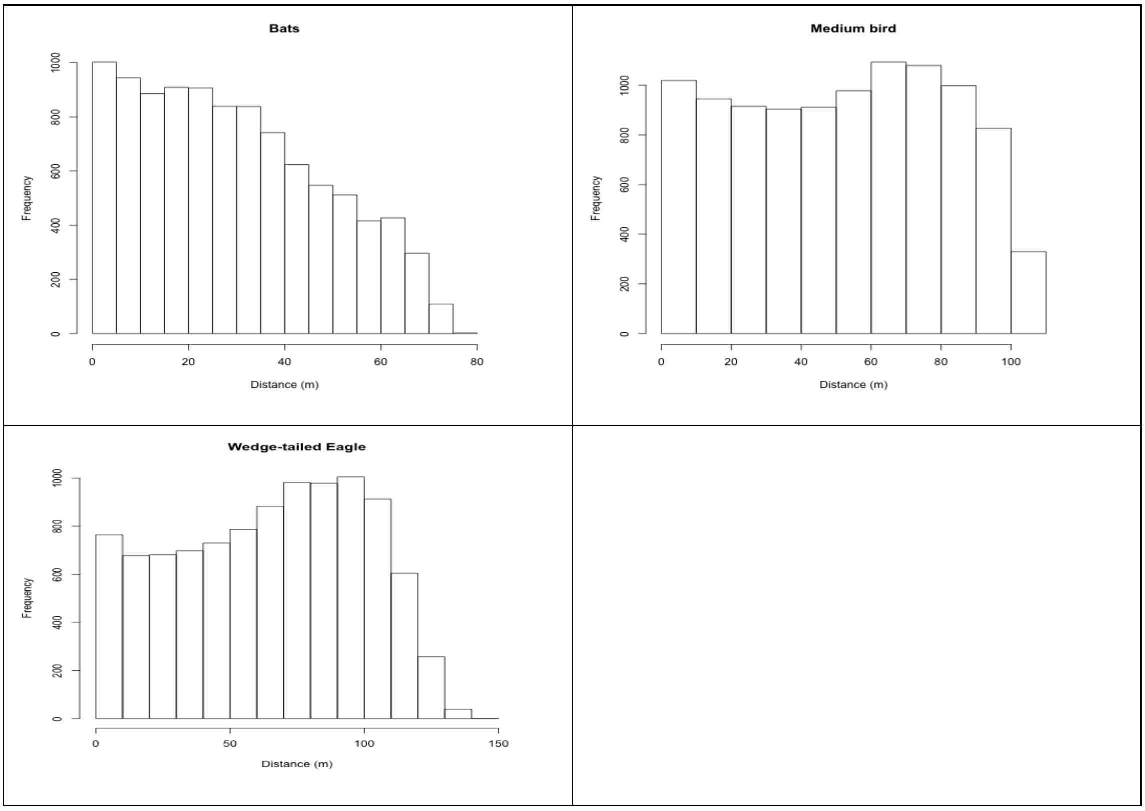

Figure 1: Distribution of finds for bats, medium birds (e.g. superb parrot) and wedge-tailed eagles from Hull & Muir 2010.

Survey timing

For reliable mortality estimates, it is preferable that the survey timing be similar or less than the expected scavenge time (see below). This is ok for larger birds like wedge-tailed eagles (where evidence can remain in place for weeks), but is difficult to achieve for micro-bats and smaller birds, which can be completely scavenged within a few days.

To manage this, we recommend used a pulse survey, where:

- The entire search region for each turbine in the sample is surveyed once per month. They are searched out to 60m or 120m (for those turbines with larger search area).
- Two to three days later a targeted bat/small bird survey is done, where each turbine is revisited and only the inner-most region done (so this is a quicker survey).

This balances the need to obtain coverage of the larger region to ensure that large birds are detected, with the need to 'beat the scavengers' by surveying more frequently surveying for bats.

Detectability and scavenge loss

The two main contributors to a mortality estimate (regardless of the method used) are the detector efficiency and the sample loss rate due to scavengers. To determine these two parameters, one should be aware of the statistical difference between power and confidence.

Power is only necessary if one wishes to "difference" the inputs, i.e. work with the difference between winter and summer parameters. For most instances, stakeholders are more concerned with confidence, or the resulting uncertainty in the measurement of a parameter.

Detector efficiency

As one is unlikely to be trying to determine the difference in detector efficiency between seasons or detectors, it is usually entered as a single parameter in mortality estimation. [1] To determine the optimal number of replicates (a single carcasses of a given size) we consider the confidence level required.

[1] On a technical note, it has been shown that having a non-constant detectability leads to a bias in the current field of estimators (Huso 2010 and Korner-Nievergelt et al. 2011). Consequently, incorporating changeable searcher efficiency will result in less variance in the output, but almost assuredly at the cost of a consistent bias in the projection. In practice a single value (with standard error) is usually used.

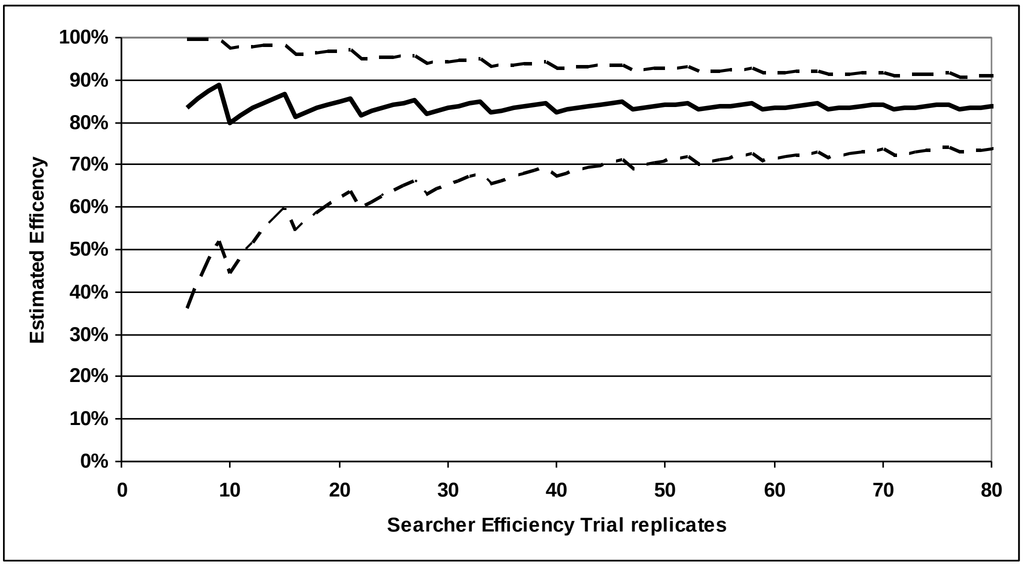

Figure 2 : Estimated searcher efficiency and 95% confidence bounds for N replicates.

The above chart (Figure 2) has been calculated (Cloppers & Pearson 1934) as a scenario to highlight the issues with detectability trials. We have assumed that the “true” observer efficiency is 83.7%.

Notice that 10 replicates is the minimum amount of effort to have a meaningful measure. This indicates why 10 replicates is a commonly used rule of thumb for minimum effort, and is an enforced minimum in recent software estimators (Bispo et al 2010). Note also, that there is very little to be gained in trialling more than 40 samples (in fact you need ~1000 replicates to have a very precise measure).

At this point, it may be worth considering different searcher efficiency per season, such as spring/autumn. The effort required to separate detectability in autumn from spring can be deduced formally from a power analysis. However, the above chart indicates that you will be unlikely to be able to split the two seasons (to 95% confidence) unless the difference between the average detectability is greater than 20-30% (even with 20 replicates in each season).

Given that there is a possibility of a large difference between autumn and spring, and surveying in both also allows coverage of the year, we suggest two detectability surveys timed for maximum detectability difference. Because of the natural variability within a survey, splitting data collection into multiple surveys is unlikely to improve either confidence or power for the additional cost.

We also suggest 20 replicates per carcass size class per year (10 in spring, 10 in autumn), which will provide a reasonable detectability estimate after one year, and optimal after two. This balances statistical confidence with the logistic difficulties in sourcing carcasses.

Scavenge loss rate

A trial is required to determine the rate at which carcasses are lost to scavenge. This should have sufficient replicates to determine an average loss rate and also provide insight into the 'shape' of the scavenge loss.

There are basically three processes through which the sample can be lost, and these interact intimately with the surveying frequency.

1) The loss rate is a constant over time (known as an exponential form)
2) The loss rate is initially very low, then accelerates (can be considered the "olfactory" scavenger's form)
3) The loss rate is highest initially, then diminishes (the "visual" scavenger form)

Whether one is determining the shape or the average, survival analysis techniques would be used. This approach can mathematically account for the fact that you never know the time of loss exactly, only to within a "window". What is often overlooked though, is that interval uncertainty "costs" more at the lower end of the scale than at the upper. For instance, if the time at loss is 6 hours, being uncertain to plus or minus twelve hours is catastrophic to the utility of the datum point. If the loss was at five days, knowing to plus or minus twelve hours amounts to little additional loss of insight. This is the case even for the simplest assumption of constant loss rate (exponential).

So, for scavenger trials, one needs to focus on an uneven time sample, to generate the information. Check the samples early and often (e.g. twice a day for the first few days), then taper off the effort (every few days after a fortnight).

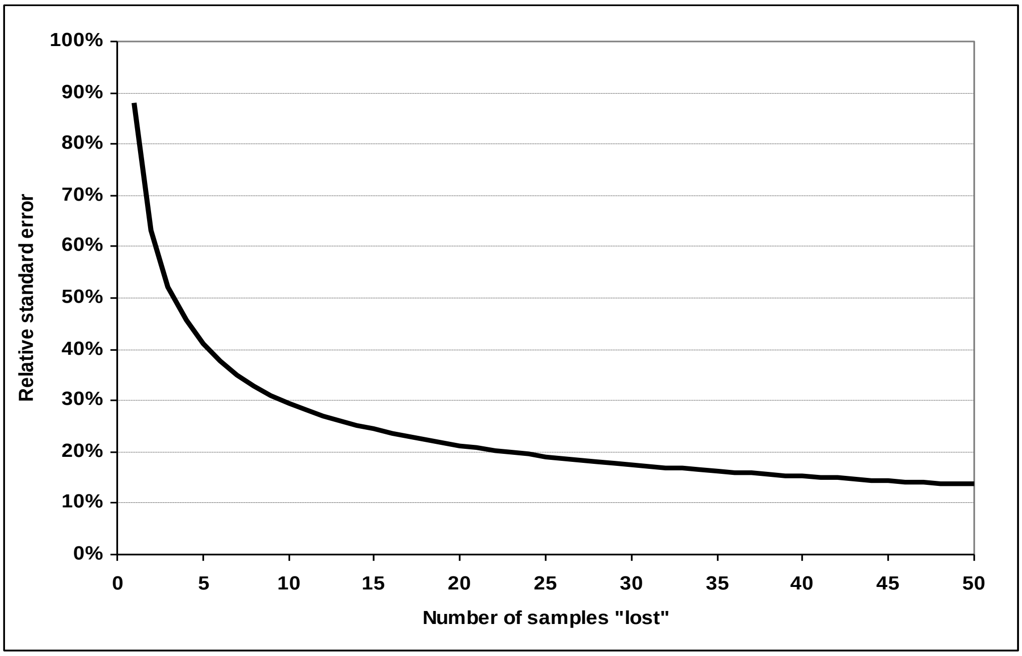

Figure 3 : Simple RSE of average loss time, assuming N losses in the trial period

In terms of confidence in the value, again we can see that 10 replicates is a good start and any more than 40 or 50 trials produces diminishing returns.

As for the searcher efficiency, if we wish to difference the two values, then a power analysis is warranted. However, if the different species of interest are to be treated independently, then we are interested in our resolution confidence (above chart) and not the resolution power.

Considering these points, running scavenge trials concurrently with detectability trials (10 replicates, twice per year) is reasonable to establish the rate and 'shape' of scavenge for the purpose of mortality estimation.

Summary

We hope that the technical information provided here will assist in understanding the statistical considerations that underpinned the management recommendations we have provided as part of the Collector Wind farm BAM plan.

Regards,

Dr Elizabeth Stark
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Appendix 3: Carcass Search Data Sheet

COLLECTOR WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM CARCASS SEARCH DATA-SHEET*				
Please fill out all details above the heavy line for each site searched All details below the line are required if a carcass is found **Do not move a carcass until the details below have been completed**				
Collector:				
Date:				
Start Time:				
Finish Time:				
Turbine Number:				
Wind direction and strength in preceding 24 hours:				
Any unusual weather conditions in last 48 hours?				
Distance of Carcass from Tower(m):				
Bearing of Carcass from Tower (deg):				
Preliminary Species Identification:				
Photo Taken**	Yes / No			
Signs of injury:				
How old is carcass estimated to be (tick category):	<24 hrs	1-3 days	> 3 days	Other
Other Notes (ie. sex/age of bird):				
Post Find Actions: 1. Place carcass in sealable plastic bag then wrap it in newspaper and take to freezer at site office.				
* One form should be completed for each carcass found				
** Please attach photo to this form				