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*

[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.

application of the decision making framework, the mitigation measures 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.

[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.

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

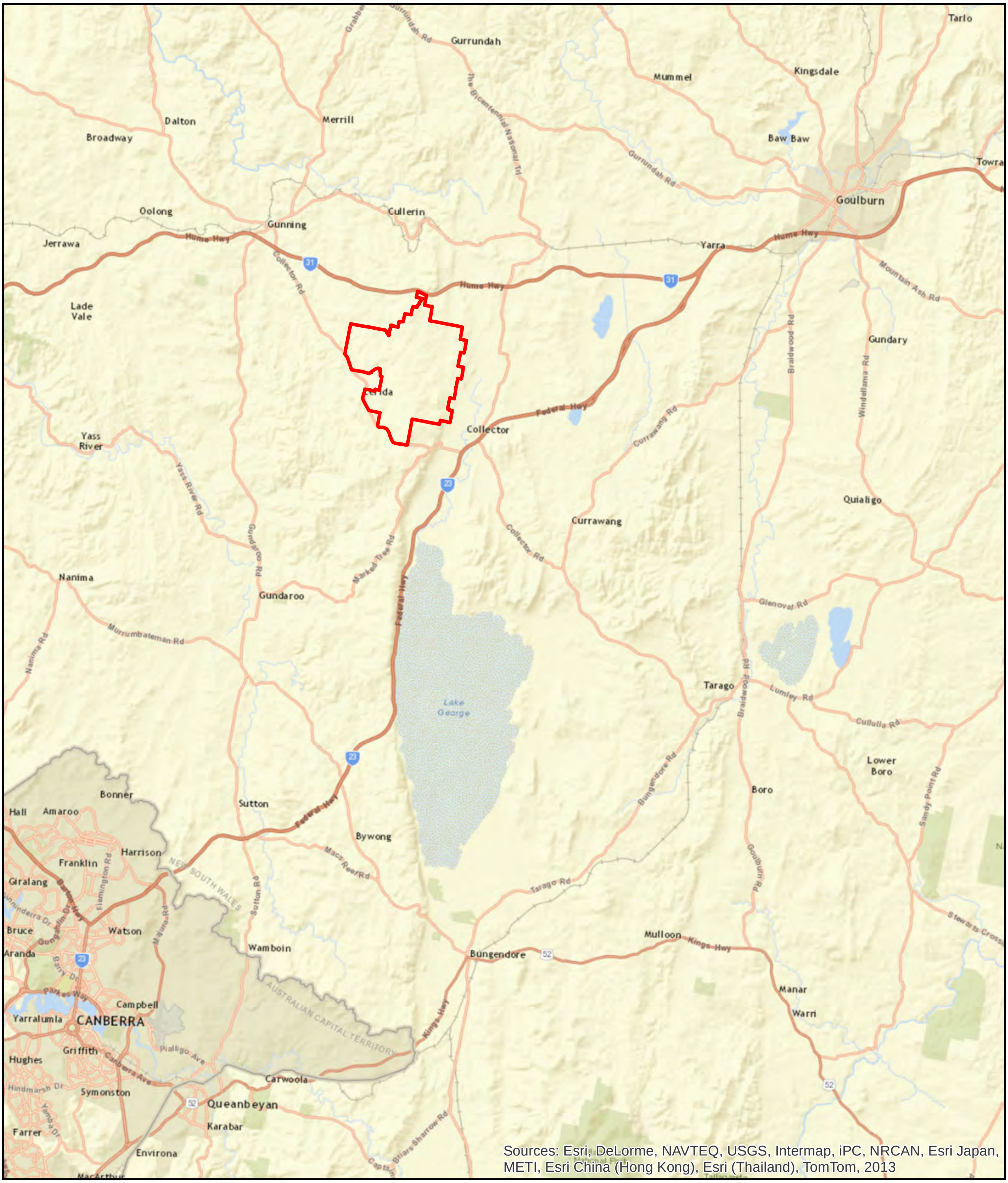
- Pre-construction monitoring surveys
- Post-construction monitoring surveys, including carcass searches under turbines
- Statistical analysis of the results from monitoring
- Reporting

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 and in February and March 2015, 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

Kilometers: 0, 5, 10, 20

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 stag watches, 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.

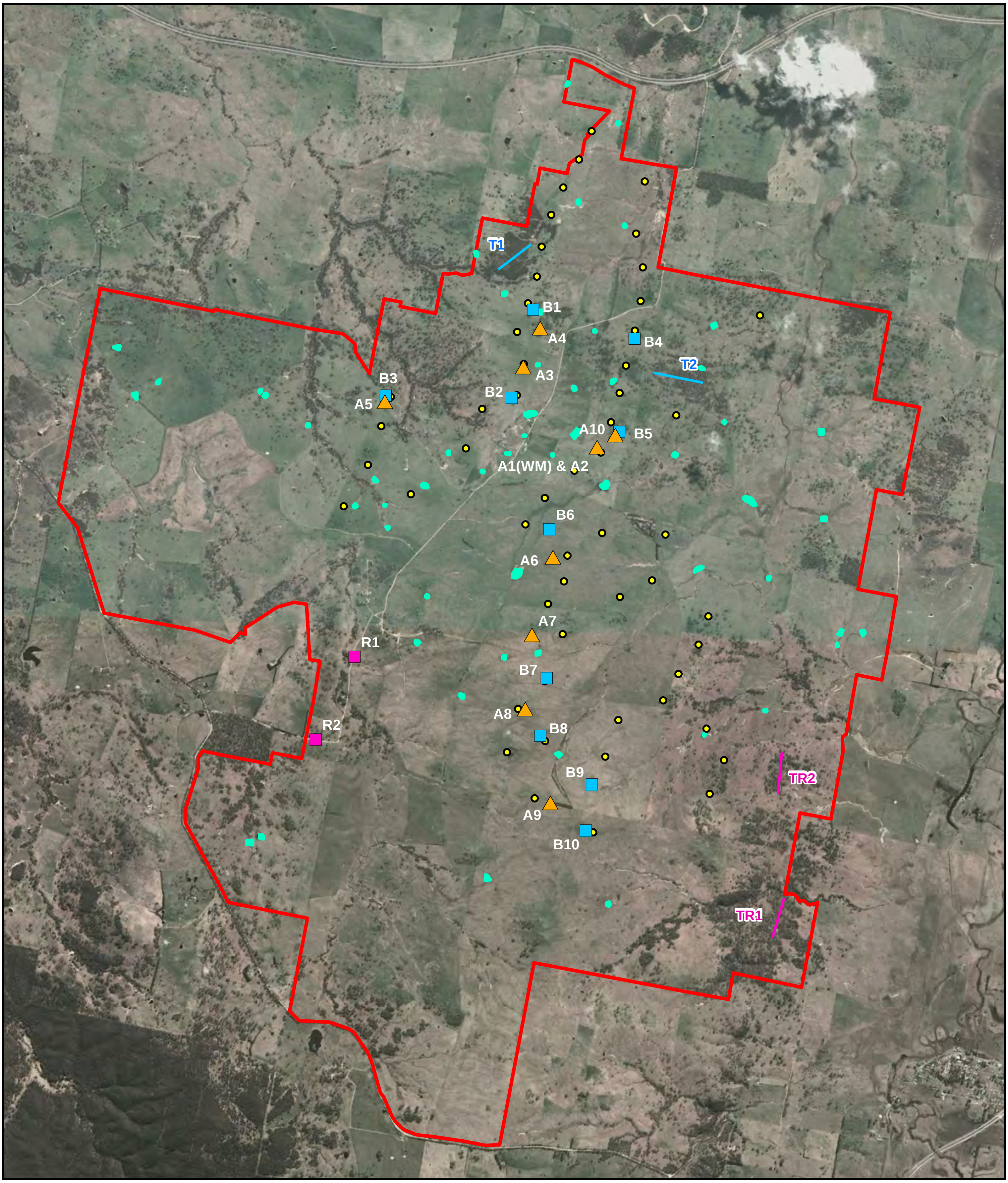
The point count survey method is described below.

- 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 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 when the pre-construction bird survey data was analysed. Rotor swept area has now been confirmed as 33 – 150 metres above ground level.



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		
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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 and 2015, 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 sets of seasonal surveys were carried out:

- The first set in late spring/early summer (November/December 2013) and late summer/early autumn (February/March 2014).
- The second set of surveys October / December 2014 and February / April 2015.

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.

The pre-construction monitoring surveys carried out during mid spring/early summer 2014 and late summer/early autumn 2015 to capture the migration of Eastern Bentwing Bat were conducted in close collaboration with OEH to ensure appropriate timing with the migration to and from their maternity caves. The results are detailed in the following section.

2.3. Preparation of Pre-construction Report

A full 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 bat utilisation surveys are provided as follows:

- Bat utilization surveys were carried out over four survey periods including spring 2013, summer-autumn 2014, spring 2014 and summer-autumn 2015. These were completed using bat echolocation recorders located in ten survey sites (nine in spring 2013), which represented the typical habitats across the site. The majority of turbines across the site are proposed to be located in cleared open pasture or in areas of widely scattered Eucalypt trees.
- Surveys in spring were timed to coincide with the EBB migration to the maternity cave at Wee Jasper (Church Cave), located roughly 65km west of the Collector Wind Farm. Surveys in summer-autumn coincided with EBB migration from the maternity cave to their 'wintering' sites in the Great Dividing Range, southern coastal NSW or other areas.
- During the spring 2013 survey, ten bat species and one species complex were recorded. One threatened species, the EBB, was recorded in very low numbers. However, 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 EBB presence across the site at this time.
- 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 settings in the Goulburn region (BL&A unpubl. data).
- All bat species were recorded from various sections of the wind farm 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.
- Three species were recorded flying at rotor swept area height during spring 2013 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.
- During the summer-autumn 2014 survey, high numbers of EBB were recorded on two nights. On the 8th March 2014, a total of 617 and 331 EBB calls were recorded at sites A7 and A8 respectively. High numbers of EBB calls (2,463) were also recorded at site A5 on 13th March 2014. The results suggest that on two occasions EBB migrated across the site in two distinct movements.
- The summer-autumn migration of EBB was not gradual over many nights but rather was recorded to take place as two major waves with mass movements on two nights in 2014.
- 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 located close to a wide scatter of mature eucalyptus trees, while Site A8 was located in a cleared grazing paddock. Site A5 was located on a hill top supporting scattered trees.
- Migration movements tend to occur as one long mass stream of bats moving from one place to another. Given this, it is highly likely that the bats passed through the Collector wind farm site en route towards the over-wintering sites within a narrow flight path that traversed the site within a single night.
- Further surveys were undertaken the following year to see if migrations were regular or not, or whether they only occur in specific areas of the site. Migration of the concentrated type recorded in 2014 was not recorded across the site in summer-autumn 2015.

- In combining the data from the summer-autumn migration 2014 and 2015 surveys which recorded at least 15 days of information for each period (2 years x 15 days = total 30 days) of which only 2 days in 2014 recorded migrating EBB.
- Excluding the two migration events from the data, EBB activity was similar between the same seasons. EBB activity during spring 2013 and spring 2014 was 0.2 and 2.1 calls per night respectively. In comparison, EBB activity during summer-autumn 2014 and summer-autumn 2015 was 22.7 and 17.8 calls per night respectively.
- The EBB was not recorded flying at rotor swept area during the spring 2013, summer-autumn 2014 or spring 2014 surveys. However eight EBB calls were recorded at 50 meter height over five nights during the summer-autumn 2015 survey. These calls represented 1% of the 801 calls recorded that season. The EBB was recorded on 5 nights out of a total of 147 nights recording at height, or 3% of the time.
- The EBB did not show a particular preference for habitat during summer-autumn surveys. During this time, it was recorded at all sites, with the exception of A1 (50m height) during 2014. However, it showed a preference for habitats near woodland remnants or scattered trees during spring surveys, and in 2013 it was recorded at only A4 and A5 and in spring 2014 it was recorded at A3, A4, A5 and A10.
- The findings from the four surveys suggest that migration of EBB through the wind farm site in large groups was not recorded each survey period.
- The March 2014 migration was recorded in a small section of the wind farm.
- Any migration of the EBB following flight paths through the wind farm site seems to take place within a period limited to a maximum of two weeks following exodus from the maternity cave.

The bat surveys outlined in this report have fulfilled the requirements of pre-construction bat utilisation surveys outlined by the Collector Wind Farm BBAMP (BL&A 2014a). As outlined in the BBAMP, further bat surveys and mortality monitoring will be carried out post-construction, which will continue to track the migration patterns of EBB and inform the development of any possible mitigation measures required.

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. Post-construction monitoring surveys are expected to be carried out for three years following construction, with a review of all monitoring data following the second year to indicate if any changes to the monitoring regime are required. A further review will be carried out three years post-construction.

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 three years following construction: one during spring and one during late summer/autumn.

At the end of the second 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 three years. Any change in survey effort in the third year will be guided by the results of the first two years 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 three years 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 second 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. In addition to the survey points outlined in section 2.2, an additional five bat detectors will be located in turbine nacelles to provide further monitoring of at-risk bat species flying at rotor swept area. The location of the additional bat detectors at turbine nacelles will be identified in conjunction with OEH.

Two surveys will be carried out in the first three 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 three years after operations commence, with a pulse search regime (see below) to be implemented in each 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 three years. After two years of mortality monitoring, 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). The specific turbines to be installed will have a hub height of 91.5 metres, a rotor diameter of 117 metres and a rotor swept area of 33 to 150 metres above ground level. 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.

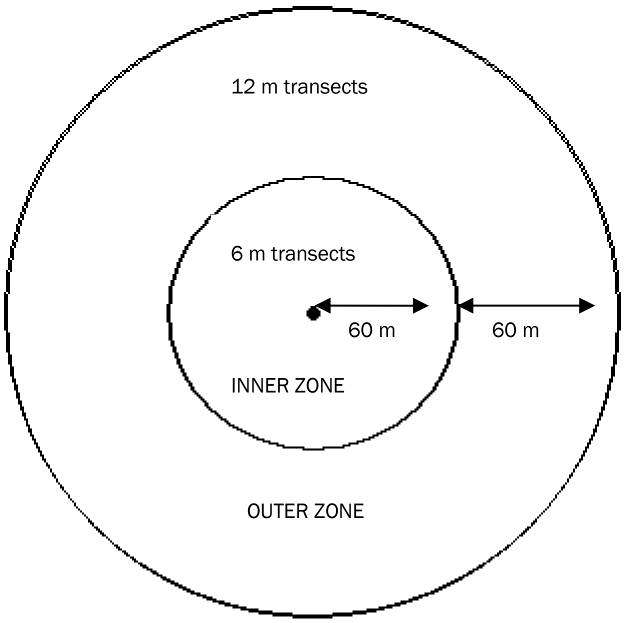


Figure 3: Carcass search zone underneath turbines.

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 prior to any survey work being undertaken, and will be based on advice from OEH bat specialists monitoring bat migration. A protocol will be developed that outlines the communication process between OEH, RATCH and RATCH's chosen consultant. The protocol will outline the steps to followed and will include (but not be limited to) monitoring of the Church Cave maternity site followed by intense carcass searches once the number of migrating bats reaches a total amount. The protocol will be developed in conjunction with OEH.

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 surveys. 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.
    - Bird risk reduction measures.
    - Any further recommendations for reducing mortality, if necessary.
    - Whether the level of mortality was unacceptable for affected listed ('at risk') species of birds or bats.
    - Usage of the wind farm area by 'at risk' species and factors influencing this (ie. climatic, geographical and infrastructure).
    - Analysis of the effectiveness of the decision-making framework.
    - 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 in the third year of 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 the Summer/Autumn 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. Additional surveys were completed in Spring 2014 and Summer/Autumn 2015. A similar migration to the Summer/Autumn migration of 2014 was not recorded in Summer/Autumn 2015.

The results of the surveys are outlined in the report *Collector Wind farm, Pre-construction Bird and Bat Monitoring Surveys, Report 13100 (5.5).* (Brett Lane & Associates September, 2015) and summarised in Section 2.3.2 above.

As outlined in the BBAMP, further bat surveys and mortality monitoring will be carried out post-construction, which will continue to track the migration patterns of EBB and inform the development of any possible mitigation measures required.

These reports conclude that these migrations do not appear to be regular or occur in only occur in specific areas of the Wind Farm. Given the lack of evidence that a permanent migration occurs across the wind farm, the potential mitigation measure of temporary shutdown of wind turbines in identified high risk areas during the species migration from their maternity caves is currently not justified.

This BBAMP proposes the following measures to understand and mitigate potential risks to EBWB. These include:

- Further post-construction Bat surveys as outlined in Section 3.2 above; and
- Carcass and mortality monitoring as outlined in Section 3.3. above.

The reporting on the post construction bat survey will be incorporated into the annual reporting of BBAMP implementation. Should migrations be identified, these will be highlighted in the annual report and specific measures recommended.

In addition, should a fatal collision be recorded between an EBWB, the specific measures as outlined in Section 5.1 below will be followed. This will trigger additional monitoring and assessment of potential impacts. Mitigation measures will be identified with the potential for the use of turbine curtailment or turbine shutdown considered.

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. 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).

4.4. 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.

4.5. 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. A Wedge-tailed Eagle is to be included under this trigger.

Definition of Unacceptable Impact on Threatened Species:

- Where population numbers are known and reported by OEH for the period concerned, an unacceptable impact is any impact that is likely to reduce the total species' population by more than 1% over a five year period; OR
- Where population numbers are not known, an unacceptable impact is more than three carcasses found of one threatened species over a two month period.

5.1.2. Decision Making Framework

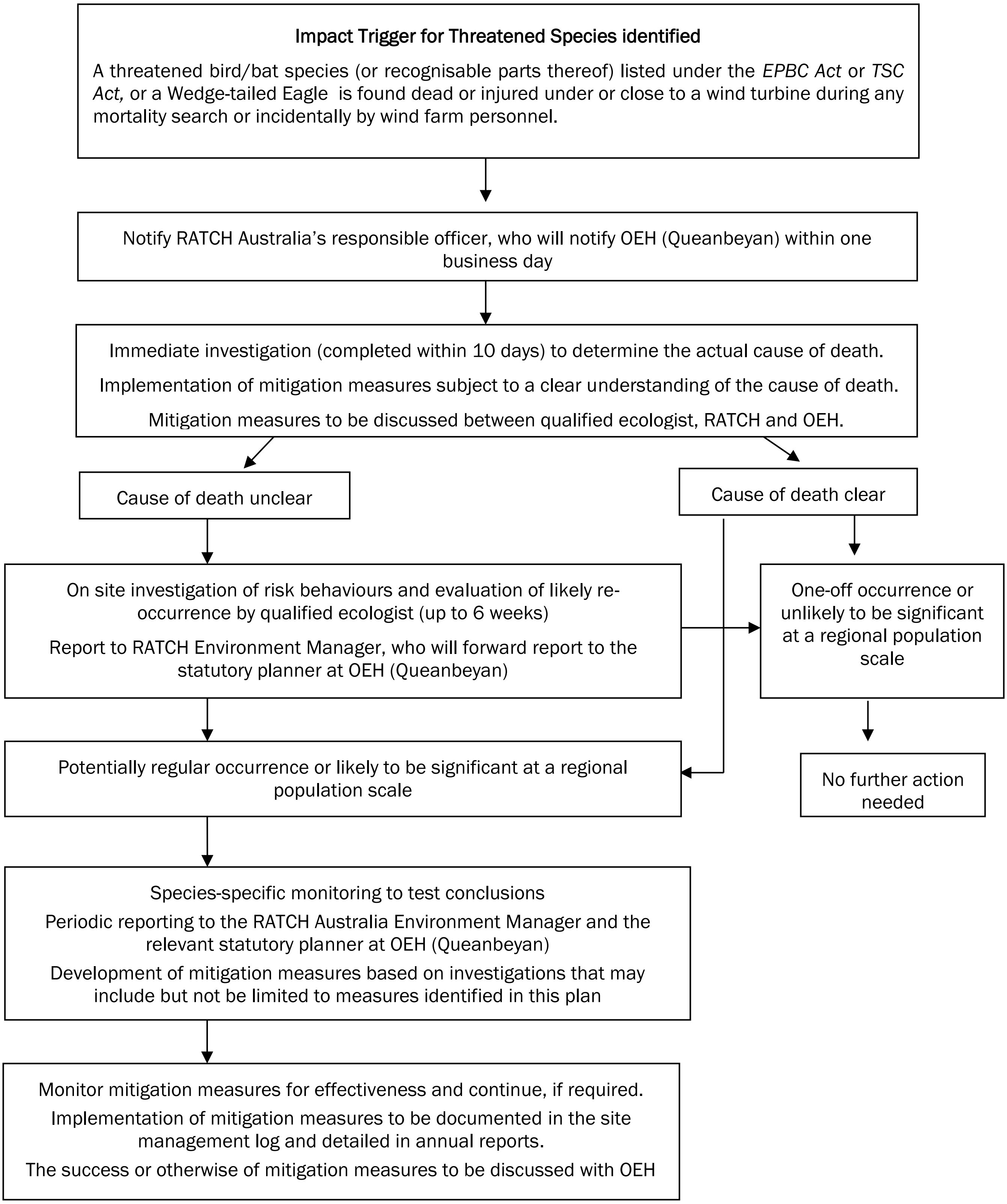
If a threatened species impact trigger occurs, further investigation will immediately be triggered and the decision making framework outlined below and in Figure 4 will be followed. This section complies with Condition B6 (c) of the conditions of approval.

- 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 one business day 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, White Cockatoos, corellas, 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).

Where population numbers are known and reported by OEH for the period concerned, the definition of an unacceptable impact on non-threatened species is any impact that is likely to:

- lead to a greater than 50% reduction in the immediate population (i.e. local population, where known) that utilises the wind farm over a five year period; AND
- act in an ongoing way to reduce the wider, regional population (where known) by more than 30% over a five year period; OR
- reduce the total species' population (where known) by more than 10% over a five year period.

Where population numbers are not known, the definition of an unacceptable impact on non-threatened species is

- More than three carcasses of one non-threatened species (including raptor species) are found during both formal and incidental carcass searches in a two month period.

Note that although the impact trigger does not include ravens, magpies, White Cockatoos, corellas, 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

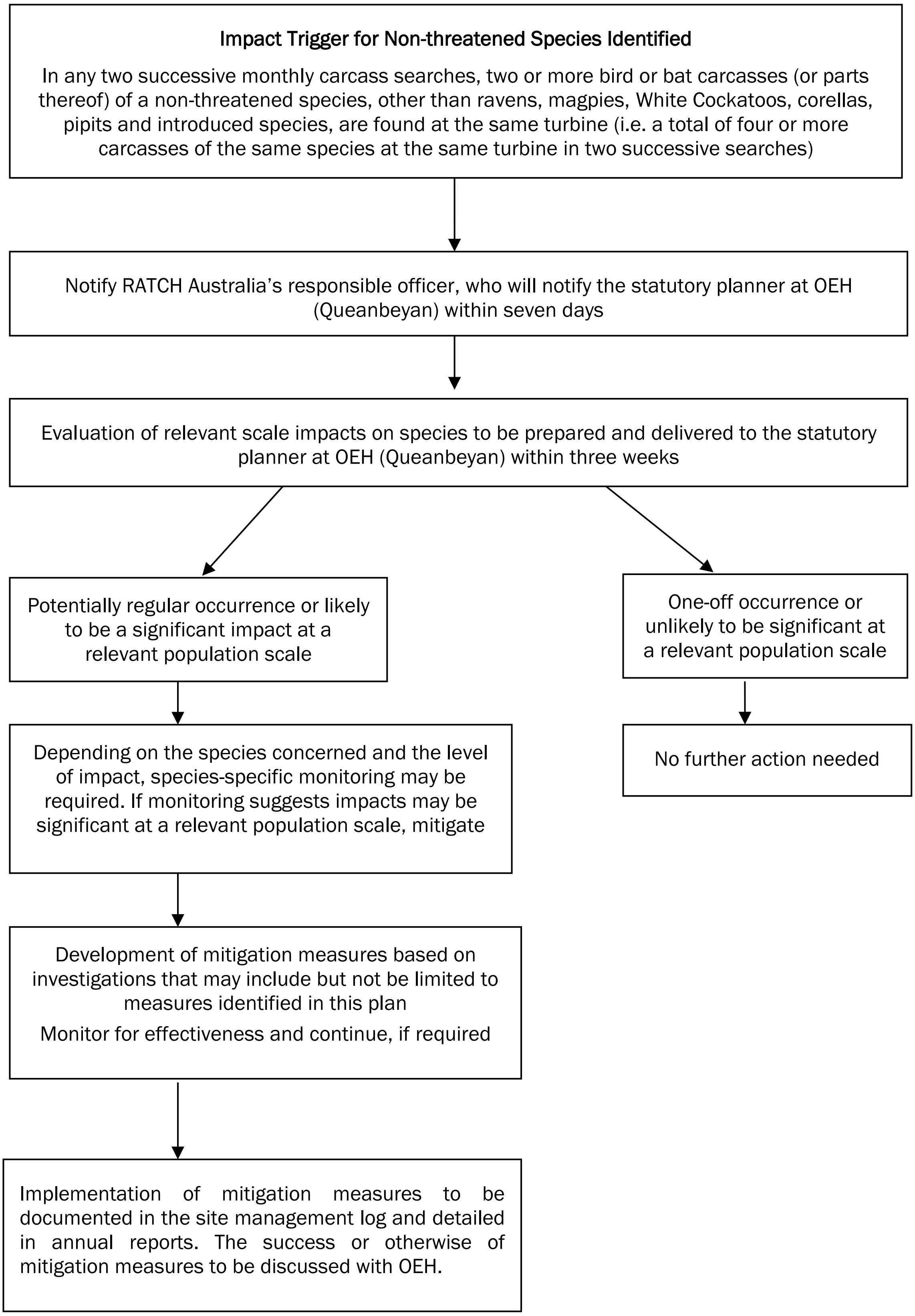
In the event that an impact trigger for non-threatened species is detected, an evaluation of impacts to the non-threatened species will be undertaken. OEH (Quenbeyan) will be notified of the impact trigger within seven days of recording the event. An appropriate scale to consider population effects of 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 possible 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 would need to be implemented, depending on the circumstances.

The purpose of investigations will clearly be to identify the most relevant and effective mitigation measures that are 'fit for purpose'.

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

Hypothetical cause of impact	Mitigation Measure[4]	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.
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	Where low visibility is identified as an issue, carcass searches will be repeated during periods of low visibility to measure mortality rates. Temporary shutdown of those turbines found to cause the problem may be necessary during periods of extreme low visibility – to be implemented only in the event that threatened species are experiencing unacceptable impacts.	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.

[4] Note that the mitigation measures in this table are examples of what may be possible. Ultimately, the chosen mitigation measure will be identified as part of the impact-trigger investigations shown in Figures 4 and 5 and may not include any of these examples if they are not relevant.

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 three years. • Bat utilisation surveys undertaken during spring and summer for three years.	
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 three years	• Post-construction mortality surveys undertaken monthly at 18 turbines for at least three years, with a review after two years to determine if any changes to the methodology are required.	
	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 three years	• Pulse searches undertaken at all 18 turbines from October to April for at least three years, with a review after two years to determine if any changes to the methodology are required.	
	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	
	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 symbolix

To: Annabelle Stewart
Brett Lane & Assoc. PL
via Email

Ref #: BLAMERCL20120913
Date: 13th September, 2012
CC: Nil

Re: **Review of Two Scavenger Trial Timings**

Dear Dr. Stewart,

In light of recent discussion with regulators on the issue of examination intervals on scavenger trial, I hope you find the attached helpful.

Although we have spoken on the phone about the complexity of such designs, and the competing factors required to be considered to make them function properly, I have performed the following work attempting to avoid many of these complex concepts and jargon, and highlight a simple case. Further complexities are alluded to at the end of this document.

Context

Brett Lane And Associates proposed a statistically designed scavenger trial that used an evolving inspection interval (hereafter the BLA trial). From the revised BAM plan *"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 six days, then every 3 days until the carcasses have disappeared or the end of the 30 days"*. As outlined previously (via email 6/9/12), this approach is based on recent overseas studies, and the work of Regina Bispo and colleagues on carcass loss and mortality estimation.

Questions have been forwarded as to its performance relative to an alternate design (daily checks for 30 days) proposed by Mr Stewart Dekker of the DSE (hereafter the DSE trial).

To provide further details, and to ensure that data collected has the greatest application, the following work has been performed:

- Available scavenge data, including data from Waubra WF, has been re-analysed (*pers. comm.* J McGilp Acciona) to estimate the likely time to scavenge.
- A simulation has been run, to compare the BLA design against the DSE design. This simulates 1000 scavenge trials (10 carcasses each, with random loss times based on the average calculated in the previous point).

The findings

- Estimation of the average time to scavenge loss: The BLA design generated no additional bias over the DSE design.

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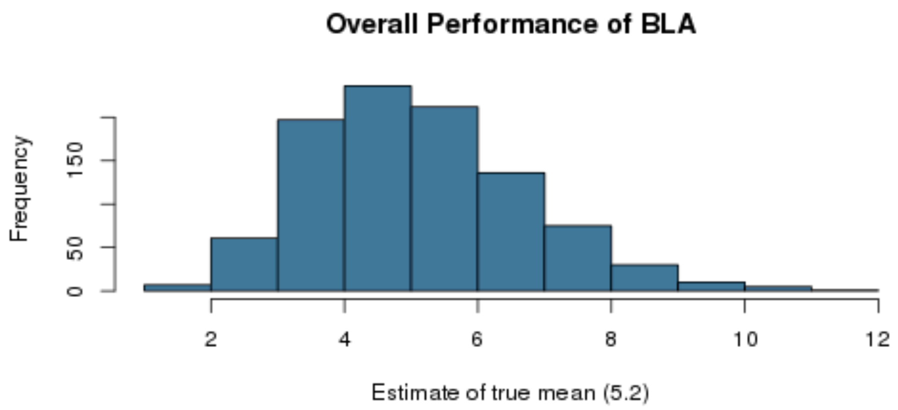
ABN: 62 997 546 845

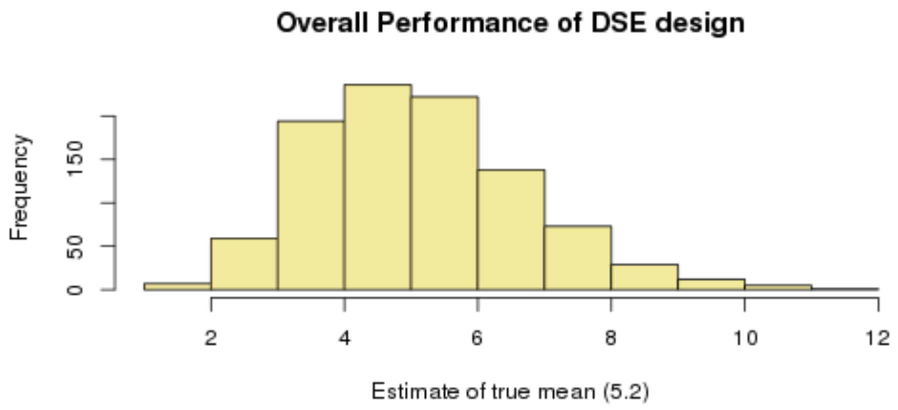
- Standard errors of the average time to scavenge loss: The standard errors returned from the BLA design were no larger than that of the DSE design.
- These points imply that a mortality estimation using these methods would have the same bias and standard error/confidence interval.
- The DSE design is more expensive (+65% more expensive) to run, with no performance benefit.
- The BLA design has additional performance features (e.g. in focusing effort at the start of the survey) that make it the preferred approach

Detailed results

Data from Australian scavenge trials was analysed using modern survival analysis technical, particularly interval and right-censored data techniques. Input data included December and August trials (courtesy Acciona Pty Ltd). This found that, on average, persistence time is around 5.2 days.

This value was used to select 1000 replicate sets of potential carcass trials that were analysed according to the two designs. Each simulation run returned an estimated persistence time. The histograms of the values returned from simulations of both survey methods are shown below.



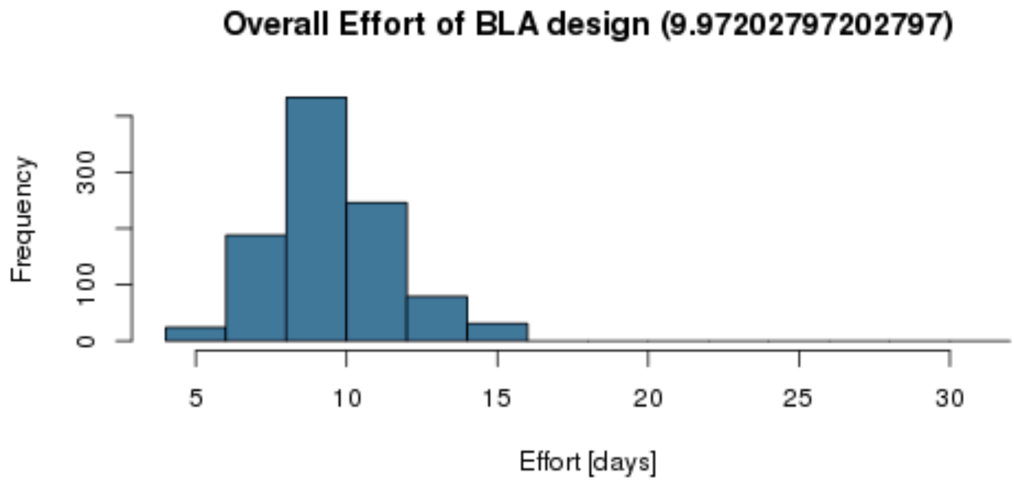


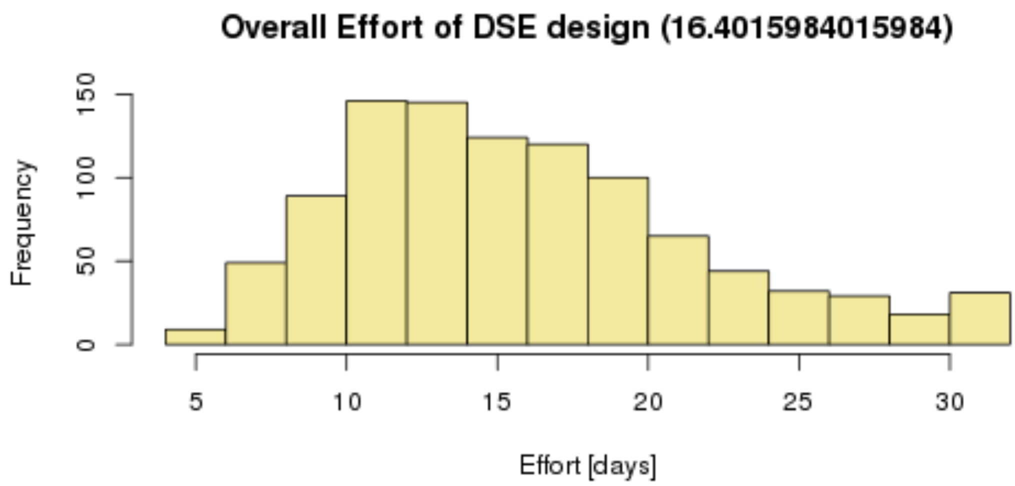
Visually, there is little to separate the two performances, which both return the correct average. There is no additional dispersion, or noise induced by the BLA design.

This can be seen in the following table:

	Average of all simulations	Estimate of average using BLA Design	Estimate of average using DSE Design
Average Persistence Time	5.13	5.09	5.07
Average S.E.	--	1.374	1.372

In terms of performance the two designs are the same. However, in terms of efficiency, the DSE design is relatively poor. It is over-sampling at times much past the average persistence time, providing no performance benefit.





The survey effort is defined as the number of days that a field worker must examine the plot, assuming that once all the carcasses are lost the site can be cleaned up and left permanently.

On average, the BLA design required 10 field days to generate its estimate. The DSE design required an average of 16.4 days, and occasionally made it to 30 field days.

Conclusions

The BLA design is the more efficient at generating the required estimate for the mortality effects. However, the example shown here is a simple case of exponential ("perfect") scavengers using the combined data available to us. There are additional factors that we urge you to consider, as follows:

- There is some evidence that Winter scavengers are more efficient (3.2 days) than those in Summer. The BLA design is better equipped to determine this difference, given that it is an even shorter persistence time than the one used here.
- If scavengers are "visual" or "olfactory" rather than "perfect", then this biases modern mortality estimators. The BLA design is configured to identify these differences whereas the DSE design is not.

In conclusion there is no performance metric that would select the DSE proffered design over that of the BLA approach.

Regards,

Stuart Muir
Director Analysis and Design
Symbolix Pty Ltd

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.

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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 (modeled using an "medium" archetype based around the Little Eagle) :
  - Gang Gang Cockatoo (33-36cm)
  - Superb Parrot (36-42 cm)
  - Little Eagle (45-55cm; 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. There was little difference (less than a few metres) between the predicted fall zones between the smaller and larger options so 'average' turbine values of 90.5m hub height and 116m rotor diameter were used.

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 near complete coverage of the bat fall zone, and about half the fall zone of the key bird species (Table 1**).**

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

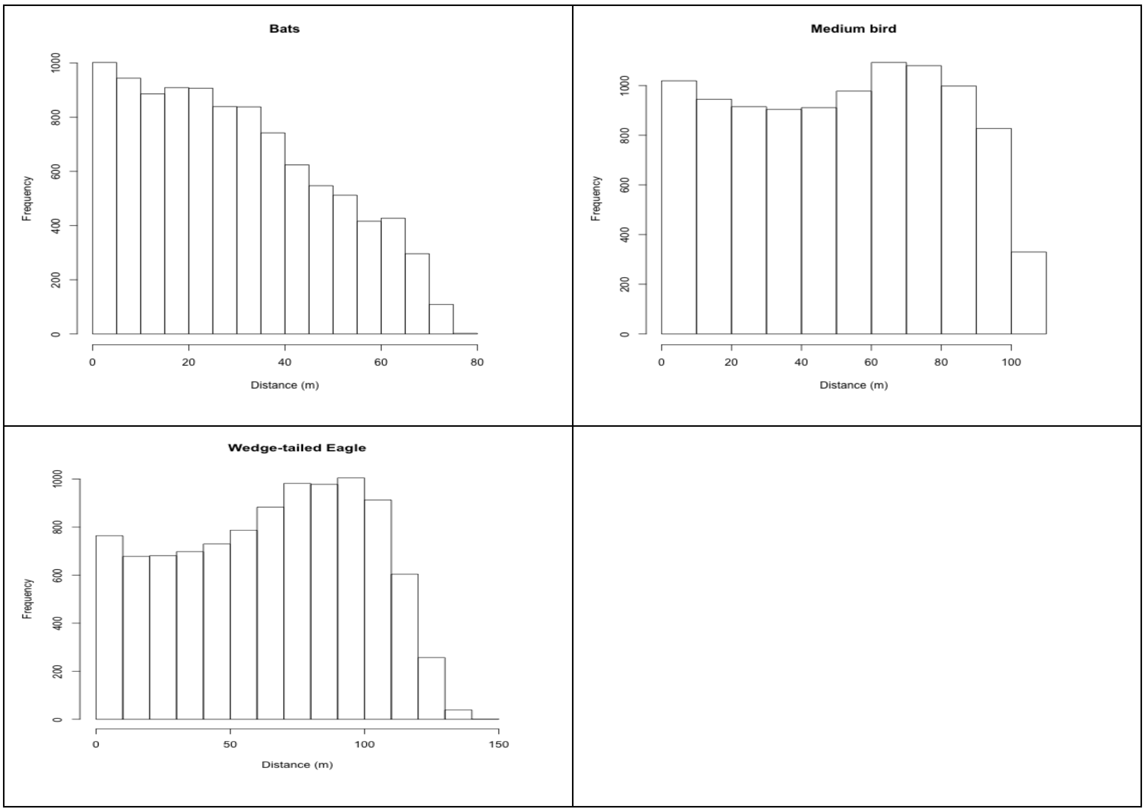

Figure 1: Distribution of finds for bats, medium birds (e.g. superb parrot and Little Eagle) and Wedge-tailed Eagles based on Hull & Muir 2010.

Percentage of fall zone covered by search area radius	**Bat**	**Medium Bird**	**Large/ Wedge-tailed Eagle**
60m (assume visibility to 63-65m)	95%	63%	48%
120m (assume visibility to 123-125m)	100%	100%	98%

Table 1: Predicted proportion of fall zone distribution within proposed search radii.

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.

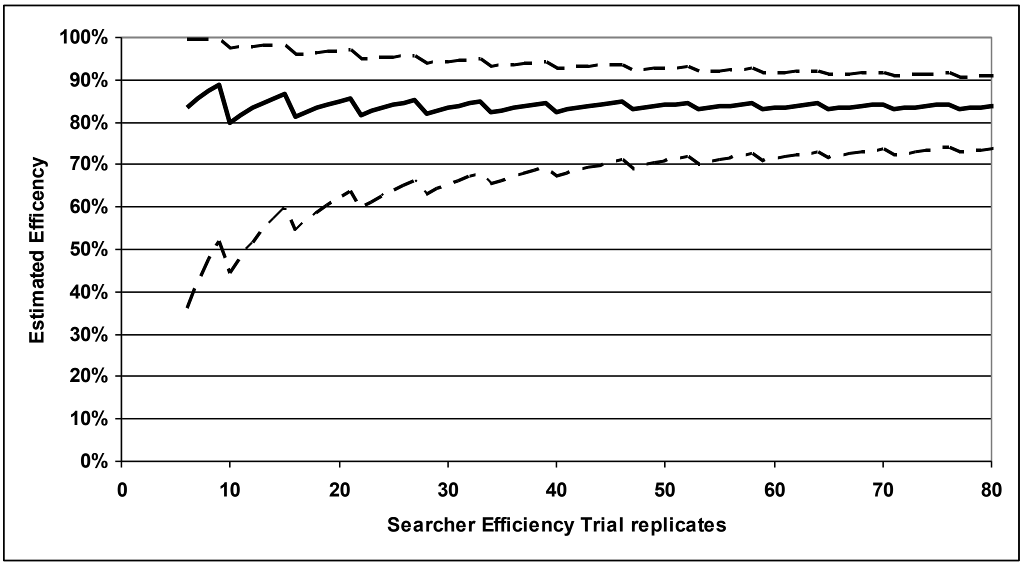

Figure 2 : Estimated searcher efficiency and 95% confidence bounds for N replicates.

[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.

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).

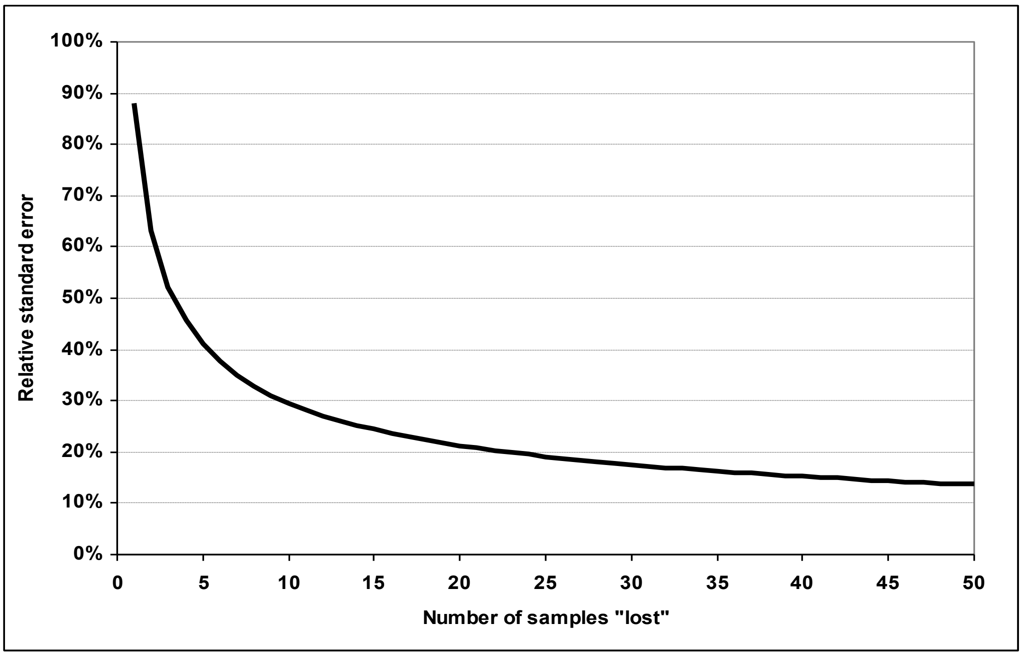

Figure 3 : Simple RSE of average loss time, assuming N losses in the trial period

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
Managing Director; Symbolix Pty Ltd

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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				