Bird and Bat Adaptive Management Plan

BOCO ROCK WIND FARM

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ACRONYMS AND GLOSSARY

BBMP	Bird and Bat Adaptive Management Plan; this plan.
Blade strike	Blade strike refers collectively to mortality of birds and bats through collision with the turbine blades and through pulmonary barotraumas. Pulmonary barotraumas appear to be the main cause of wind-farm related mortality for microbats, where sudden changes in barometric pressure around turbine blades cause fatal organ injuries (Baerwald *et al.* 2008).
BRWF	Boco Rock Wind Farm; the project.
CWP Renewables	The Operator, previously Wind Prospect CWP Pty Ltd
DPE	NSW Department of Planning & Environment (formerly Department of Planning and Infrastructure)
D-G	Director-General of DPE
CoA	Conditions of Approval for the project (provided by NSW Department of Planning on the 9th of August 2010 under Section 75 J of the *Environment Planning and Assessment Act 1979*).
Local population	As defined in OEH's Threatened Species Assessment Guidelines 2007: "*the population that occurs in the study area... the local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to utilise habitats in the study area. The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the study area from time to time*"
Mortality	When a known mortality of any species has occurred, evidenced by carcass findings within the turbine sweep area.
Monitoring event	A site visit to undertake a range of monitoring surveys.
OEH	NSW Office of Environment and Heritage
Recording rate	The number of surveys in which a species is recorded. Recording rate provides a measure of how common or abundant a species is.
SoC	Statement of Commitment; commitments made by the Proponent as a part of the project submission for approval.
The Ecologist	The suitably qualified company contracted by the Operator to implement the BBMP, including managing surveys and data collection.
The Expert	The suitably qualified expert (the 'nominated expert') who has been approved by the D-G of DPE and who has an ongoing role in the implementation of the BBMP.
The Operator	A party nominated by Boco Rock Wind Farm P/L, otherwise the responsibility of Boco Rock Wind Farm P/L.
Wind Prospect	Wind Prospect CWP Pty Ltd; the previous project owner.

PART A – BACKGROUND

1 INTRODUCTION

1.1 HOW TO READ THE PLAN

This management plan for Boco Rock Wind Farm is intended to provide background information to the project and the ecological and landscape values of the site, while prescribing an adaptive management plan for bird and microbat species. The plan has been divided into three sections for practical use:

Part A – Background: The intent of Part A is to provide background on the site and conditions for monitoring, with regard to legislative requirements and ecological values of the site.

This section provides information on the size and location of the project; the scope of the plan detailing the objectives for monitoring; the legislative requirements for monitoring; the roles and responsibilities of personnel fundamental to implementation and auditing of the plan; and a collision risk assessment for birds and microbats.

Part B – Monitoring program methodology and important considerations: The intent of Part B is to detail the methods to be utilised during the monitoring program.

This section prescribes the survey design and intensity for each method prescribed; the duration and timing of the program; and how data will be collected and analysed. To provide clarification on the choice of design for particular methods, or their function, further justification has been provided under the heading 'considerations'; this information was considered important to note as it was influential in the final design of the program, and any deviations in the methodology may render the data less useful for analysis.

Part C – Adaptive management, reporting and compliance: The intent of Part C is to detail how the program will review and report on results of the monitoring program, to manage risk in an adaptive manner.

This section provides information on the triggers that inform potential or real risk and how the risk will be managed according to adaptive principles; the timing, type and scope of reporting requirements; and the compliance requisites to ensure the program remains specific and robust.

Changes that have been made since version 1.2 are indicated in blue text, either within a paragraph or for the paragraph heading where numerous minor edits have been made.

1.2 PROJECT BACKGROUND

The Boco Rock Wind Farm (BRWF) was approved by the NSW Department of Planning on the 9th of August 2010 under Section 75 J of the *Environment Planning and Assessment Act 1979* (EP&A Act). The project, as described in the approval, will involve the construction and operation of up to 122 wind turbines and associated infrastructure, approximately 6 km west of Nimmitabel, in the Bombala and Cooma-Monaro Local Government Areas (LGAs).

Monitoring and management of the operational wind farm on birds and bats is required under the project's approval. The scope of this Bird and Bat Management Plan (BBMP) is limited to Stage 1 only, 67 of the 122 turbines (Turbines T01– T67).

The current version of this BBMP is v1.3. As the plan is intended to be updated as required, references to this plan in other documents should include the version number (e.g. BBMP v1.3).

1.3 SCOPE OF THIS PLAN

This BBMP provides the background and rationale for the development and design of the monitoring program relevant to BRWF and how the program will be implemented and managed. This BBMP was tailored to address: 1) the consent conditions issued by Department of Planning and Infrastructure (DPI, now Department of Planning and Environment); 2) requirements of Office of Environment and Heritage (OEH); and 3) the perceived risks and severity of impact of the wind farm on birds and microbats specific to BRWF.

Broadly, the aim of this plan is to detail the monitoring program appropriate to assess the direct (collision) and indirect (avoidance) impacts of the project on bird and microbat species. Additionally, it includes a range of management measures that would be considered in response to unacceptable levels of direct impact. Specifically, the primary and secondary objectives of the monitoring program are to:

Primary Objective

1. Detect collisions of bird and microbat species with turbines during the operational phase of the project using the following methods:
    a. Mortality surveys (measuring direct impact) to monitor collision rates of bird and microbats.
    b. Supporting surveys (scavenger and detectability trials) to compare and validate results from mortality surveys. These surveys will assist in interpreting the results of the mortality surveys and ensure the mortality survey intensity is sufficient to obtain meaningful information.

Secondary Objective

2. Detect population changes in birds and microbats using the following methods:
    a. Utilisation surveys (measuring indirect impact) to monitor bird activity and movements to ascertain trends in activity incline or decline.

b. Passive Anabat surveys (measuring indirect impact) to monitor microbat species diversity and general activity levels to comment on potential trends in activity incline or decline.[1]
c. *Note that activity levels will be used as a surrogate for measuring population changes, when addressing the secondary objective.*

The conditions of consent specify that the monitoring program is to be of five years duration; however as this is an adaptive management plan, the survey design and intensity has been detailed for the first year only. The first year's data will be used to review the monitoring program to ensure the program remains relevant to capture the 'real impact' of the operating wind farm in subsequent years.

Adaptive management is inherent to the implementation of this monitoring program on account of the uncertainty surrounding current monitoring and management of wind farms, as well as the ambiguity specific to the environmental variables of the BRWF site. Adaptive management will be applied as a structured, iterative process to inform robust decision making in the face of uncertainty, aiming to reduce uncertainty over time via field surveys (monitoring) and statistical analysis. The results of the monitoring program will be progressively integrated into this BBMP during the life of the program. In this way, information is accrued and analysed to improve future management. Thus, monitoring and evaluating the efficacy of management actions is a key step of this BBMP.

[1] It is acknowledged that microbat activity data will be more difficult to collect and the results may therefore be less conclusive.

2 LEGISLATION AND GUIDANCE DOCUMENTS

2.1 LEGISLATIVE REQUIREMENTS

The approval for the project includes a number of consent conditions required to be implemented as part of the project's construction and operation. Specific to the management of bird and microbat impacts, this includes the following:

Condition 3.3 of the Project Approval
*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 account of bird/ bat monitoring methods identified in the current editions of AusWEA Best Practice Guidelines for the Implementation of Wind Energy Projects in Australia 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 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 survey locations, parameters to be measured, frequency of surveys 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, that is, data may be required to be collected prior to the commencement of **construction;***
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 (such as wet seasons where bird species may be attracted to nearby wetlands) 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 monitoring, the 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 on an annual basis for the first five years of **operation** and every two years thereafter from the commencement of operation (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, vary the reporting requirement or period by notice in writing to the Proponent. The Proponent may request the Director-General to consider a variation to the reporting requirements at anytime.*

> *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.*

Additionally, Statements of Commitment made by the proponent as part of the project submission are also required to be implemented. Specific to the management of bird and bat impacts, this includes the following:

> ***Statement of commitment 15***
>
> *h) Bird and bat strike monitoring will be undertaken in accordance with the monitoring guidelines provided by the Australian Wind Energy Association (Brett Lane & Associates 2005). If results show that longer term monitoring is required then a monitoring programme will be developed in consultation with DECCW and other departments/agencies as required. Such a programme could include adaptive management whereby significant impacts are dealt with by using an adaptive approach;*
>
> *i) Should WTG's require lighting, select lighting that minimises the likelihood of attracting insects and hence foraging bats, subject to CASA requirements;*

This plan sets out a framework that allows these conditions to be satisfied. A specific cross reference table is provided in Appendix A, for ease of reference.

2.2 GUIDANCE DOCUMENTS

The approach and methods in the BBMP are based on the following guidelines:

- AusWEA *Wind Farms and Birds: Interim Standards for Risk Assessment* (Lane 2005)
- Auswind *Best Practice Guidelines for the implementation of Wind Energy Projects in Australia* (AusWEA 2006)
- Environment Protection and Heritage Council *National Wind Farm Development Guidelines – Public Consultation Draft – October 2009*
- Standard bird and bat survey methodology, such as methods used by Birdlife Australia and methods outlined in *Survey Guidelines for Australia's threatened Bats* (DEWHA 2009) and *Survey Guidelines for Australia's Threatened Birds* (DEWHA 2008)
- NSW Planning Guidelines: Wind Farms (DPI 2011)

2.3 AGENCY CONSULTATION

The Office of Environment and Heritage (OEH) has provided comments on draft versions of this plan and endorsed the final plan prior to implementation (v1.2).

Consultation with OEH is intended to be ongoing throughout the implementation of the BBMP, triggered by specific events such as a threatened species mortality.

The agency is provided with the Annual Report and are consulted when management actions for threatened species are required.

3 ROLES AND RESPONSIBILITIES

Five key stakeholders are relevant to the implementation of this BBMP. Specific roles and responsibilities of these stakeholders are set out below.

1. The Operator of BRWF.
2. The Landholders on whose land BRWF is located.
3. The Ecologist engaged to implement the BBMP, including undertaking surveys and providing advice to the Operator
4. The Expert engaged to provide interpretation and advice on the implementation of the BBMP.
5. The Statistician engaged to develop the survey design and analyse data.

Additionally,

- The Environmental Representative (ER) nominated for the project has a role in monitoring the overall environmental management of the project, which includes the effective management of bird and bat impacts.

3.1 THE OPERATOR

The primary role of the Operator is to engage an Expert to implement the BBMP. Additionally, the Operator's responsibilities include:

- Engage with the landholder as necessary to monitor or manage identified bird and microbat impacts. The Operator would ensure access to all required survey sites and liaise with the landholder regarding specific management actions, such as lambing near high risk turbines.
- Oversee the implementation of the management actions recommended by the Expert where reasonable and feasible. These will sometimes be carried out by the Operator and sometimes by the Expert, depending on the action but their implementation remains the responsibility of the Operator, not the Expert.
- Submit reports prepared in accordance with CoAs to the Director-General of the Department of Planning & Infrastructure on an annual basis. Again, reporting may be delegated to the Expert but the submission of reports remains the responsibility of the Operator, not the Expert.

3.2 THE LANDHOLDERS

The role of the Landholder is to:

- Work with the Operator to manage bird and microbat impacts, following advice from the Expert. This may include facilitating access for monitoring or management actions. It may also include undertaking specific management actions, such as altering livestock management or cropping activities, if these are identified as likely to increase bird or microbat impacts.

3.3 THE ECOLOGIST

The role of the Ecologist is to implement the BBMP in accordance with this plan. This includes:

- Ensure surveys are undertaken as required.
- Keep the Operator informed about the results of monitoring outcomes.
- Track results each month and identify any triggers for action.
- Provide advice and recommendations to the Operator, based on the ecological significance of monitoring outcomes.
- Carry out specific management actions required to reduce bird and microbat impacts, if engaged by the Operator.
- Adapt the plan as required to meet the objectives of the plan.
- Engage with OEH as required, and as directed by the Operator.

3.4 THE EXPERT

The role of the Expert is to oversee the implementation the BBMP in accordance with the CoAs. This includes the following responsibilities:

- Ensure surveys are conducted to best practice standards.
- Provide advice to the Ecologist and Operator as required.
- Assess the ecological significance of monitoring outcomes based on quarterly reports, or in the intervening period as required.
- Assess the effectiveness of management actions.
- Ensure reports are adequate (*i.e.* meet the requirements of the CoAs).

3.5 THE STATISTICIAN

The role of the Statistician is to work with the Expert to develop the survey design, analyse data and provide advice during the program to ensure that the data being collected is adequate to address the objectives of the plan.

The primary role of the Statistician is to provide advice when requested by the Expert which is likely to relate to the following:

- Provide advice on statistical modelling to define the survey design and intensity of the monitoring program.
- Provide analysis and advice to the Expert about the results of data analyses. Specifically, analyse data for trends and triggers and recommend further investigation (field surveys or desktop) where required to address:
    - Insufficient or inadequate field data to address the objectives of the plan
    - Potential triggers which may indicate an impact and require further investigation
- Provide advice and recommendations to the Expert, where relevant.
- Provide statistical reports to be used by the Expert in technical reports, or when requested by the Expert.

3.6 ENVIRONMENTAL REPRESENTATIVE (ER)

The ER has a role in project auditing and compliance, which includes overseeing the effective implementation of the Bird and Bat Adaptive Management Plan. This is discussed further in Section 9.

4 REGIONAL SETTING AND LANDSCAPE VALUES

One of the main factors contributing to high bird and bat mortality are the landscape features in close proximity to wind turbines (Kingsley and Whittam 2003). This includes the regional position of the site as well as local topography and resources (foraging and roosting resources such as the nectar or specific trees and tree hollows). The flora and fauna assessment prepared by Ecological (Ecological 2009), literature on bird and bat impacts in relation to wind farms and information gained during a site visit by the author of this plan were considered in identifying higher risk locations at the BRWF site.

The identification of regional and local features relevant to bird and bat risks is in keeping with developing a site-specific, risk-based approach to the management of bird and bat impacts. The review below has identified features that will be paid particular attention when analysing data and considering changes to aspects of the survey design. Specifically:

- The representation of migratory and nomadic bird and bat species in survey results
- The influence of wetlands on survey results
- The representation of 'higher risk' turbines within the survey design

4.1 REGIONAL SETTING

The plateau of the Monaro Tablelands is located between two geographic areas, renowned for their high biodiversity: the Australian Alps Range and the Great Escarpment of Eastern Australia (Pulsford *et al.* 2003). The grasslands of the Monaro plateau are bound on their eastern side by the low altitude coastal forests and wetlands of the South-East New South Wales, then the rainforests of the Great Escarpment and on their western side by the alpine forests and lakes of the Alps.

Due to their particular location and orientation (North-South), the Monaro Tablelands are on the pathway of birds and bats undertaking migratory and/or nomadic movements North-South bound (and vice versa) and/or East-West bound from the Murray-Darling catchment to the South-East Coast of the country (and vice versa).

4.2 LANDSCAPE FEATURES

Ridges, steep slopes and valleys

These are landforms that appear to increase the degree of interaction between the turbines and birds using or moving through the area, such as migrants and raptors. During the night-time migration and nomadic movements, birds tend to fly in broad fronts over water and land, and large topographical features (*e.g.* mountains and high ridges) can concentrate birds along relatively narrow pathways.

Swifts, swallows, martins, gulls and raptors utilise thermals forming over ridgelines for foraging and can intercept turbines located along ridge tops. During windy conditions, difficulty in controlling flight behaviour can result in collision with turbines.

Wetlands

Birds and bats may interact with wind turbines when facilities are located near water bodies (*i.e.* river, lake, marsh, swamp, etc.) that are staging areas (areas where waterbirds gather to feed before or during migration).

Waterbodies are known nearby the wind farm including Copper Lake and Avon Lake. These lakes are 1.5 km and 10 km from the defined impact zone (> 500 m) of the wind farm respectively. These lakes are part of the Monaro Lakes complex, declared as Wetlands of National Importance and are important for numerous species of waterbirds for breeding and/or staging during spring and autumn migration (Environment Australia 2001).

The McLaughlin River on the southern boundary of the site acts as a corridor for migrating and/or nomadic bird and bat species that use river systems and permanent water bodies as stepping stones for their inland movements. Species like the White-bellied Sea-Eagle (*Haliaeetus leucogaster*), observed in the area (Ecological 2009), waterbirds, and some bats which forage over water bodies, are particularly at risk of collision, where turbines are located close to waterbodies.

Cultivated areas, forests or woodlands

The site is located in an extensive grassland landscape on the Monaro Tablelands. These landscape features attract resident and migrating species for roosting, foraging and breeding. Like wetlands, patches of vegetation within the Monaro grasslands mosaic act as refuges and food supply stepping stones for some birds and bats. Clusters of Snow Gums are patchily distributed in the project area; those in close proximity to the turbine sweep area will increase the risk of birds and bats collision.

4.3 DEFINING HIGHER RISK TURBINES

The BBMP v1.2, identified higher risk turbines as those in areas where bird and bat collisions were considered more likely to occur on the basis of proximity to:

- Wetlands: marsh, pond, lake, stream, and/or river
- Dense vegetation areas: wood, forest, tree line, tree cluster
- Steep topography: ridge lines, slope, valley

(Thelander 2004, Kunz *et al.* 2007)

However, results of two years monitoring indicate that this delineation has not predicted sites where collision impacts are more likely to occur. A review of high risk turbines is due to be undertaken.

5 BIRD AND MICROBAT COLLISION RISK IDENTIFICATION

Similar to defining influential landscape factors (Section 4), species considered to have a higher collision risk have been defined for the BRWF. Understanding the different risk factors relating to birds and microbats is important in interpreting survey data and determining whether management actions are required. For example, a low number of raptor collisions may be as significant as a high number of passerine collisions, in terms of the potential to generate a population level impact. In the context of managing impacts, collisions with common species are considered to have less importance than species of conservation significance, which are assumed to have lower ability to withstand further loss.

Higher risk species identification has been guided by the following:

- AusWind Best Practice Guidelines (Bird and Bat Surveys; Risk Assessment) (2006).
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft (DEC 2004) and existing DGRs for nearby wind farm proposals (flora and fauna surveys).
- Australian Standards for Risk Assessment (AS/NZS ISO 31000:2009). Risk Management Principles and Guidelines.
- EPBC National Wind Farm Development Guidelines (consultation draft) 2009.

Ecological and morphological characteristics as well as conservation status have been considered in this assessment.

5.1 GENERAL BACKGROUND

Birds

Considering the risk of collision with wind turbines, certain groups of birds may be more affected than others (Kingsley and Whittam 2003, Kunz *et al.* 2007).

Generally, the identified groups at risk are:

- **Passerines:** By far the most abundant flying vertebrates in most terrestrial ecosystems. Until recently passerines have been among the most frequently reported fatalities at utility-scale wind facilities in Europe and America. Breeding birds in the vicinity of wind farms may be at greater collision risk if displaying aerial courtship behaviours (at the BRWF this may include Australian Magpies). Migrating and nomadic passerines at night, typically fly at altitudes of 150m or higher; above the maximum height of most wind turbines. However, passerines may be at risk of colliding with wind farm structures when their flight altitude is lowered by inclement weather conditions (such as fog or driving rain) and at dawn and dusk.
- **Parrots:** Parrots do not appear to have suffered high rates of collision in Australian wind farm literature. This may be because the majority of flights are below Rotor Swept Area (RSA) and most parrots are highly agile and manoeuvrable fliers. However, particular parrot species that are migratory, such as the Swift Parrot, or flocking species are more likely to be at risk. Parrots are considered to be a less of a risk of collision compared to

other bird groups as they typically fly below the RSA and their movement patterns generally follow vegetative corridors; however it is possible they may be at risk of colliding with wind farm structures when their flight altitude is impaired by inclement weather conditions (such as fog or driving rain) and at dawn and dusk. However, risk of collision during adverse weather also seems unlikely as parrots generally stay grounded and reduce movements during such times.

- **Raptors:** Soaring birds are generally of greatest concern as they use landform features such as elevation, ridges and slopes to cruise and take ascendance. Further, they are generally higher order species, meaning they are less abundant and therefore more susceptible to population level impacts. In the USA, migrant raptors account for up to 65% of the total bird mortality due to collision with wind turbines. Fledging raptors are particularly at risk (Wedge-tailed Eagle, for example).
- **Owls and nocturnal birds:** Owls typically fly within wind turbine height or lower, which may put them at risk of collision. Owls are included in the lists of collision victims at a number of sites around the world. The numbers of owls killed at each site varies, representing a proportion at some sites of up to 10-15% of the total numbers of birds killed. Nightjars exhibit the same nocturnal behaviour as microbats, and are often seen hunting insects attracted by street lights. Most owls rely on forest vegetation for roosting, but many forage in open areas, including the Barking and Masked Owls.
- **Waterbirds:** waterbird (*i.e.* grebes, cormorants, ducks, waders, cranes, rails, crakes, gulls, shorebirds) fatalities have been reported worldwide at wind sites close to their staging, breeding and wintering areas. In the USA, sites reporting the most fatalities are those with year-round waterfowl (ducks and geese) which makes up to 10% or more of the total number of fatalities. Shorebirds (snipes, plovers, sandpipers, stints, etc.) and gulls tend to fly in flocks and descend or ascend rapidly when approaching or leaving feeding areas. Therefore, shorebirds are likely to collide with turbines when these are placed in close proximity to wetlands.

In addition, wind farm sites may be frequented by scavenger species (*e.g.* crows, raptors), attracted by crops, livestock or injured birds and bats and/or their carrions, resulting of collisions with turbines.

Microbats

Bats are the second largest group of vertebrates that suffer casualty from collision at wind farms worldwide (Cryan and Brown 2007, Kunz *et al.* 2007). In terms of blade-strike, Australian species that appear to be most at risk are those that forage above canopy (i.e. in open areas) and move through their environment at high speeds, such as the White-striped Freetail Bat. These species are more likely to travel at blade-sweep height and either fails to detect the moving blades, or are less able to quickly manoeuvre around them.

Two groups of bats have therefore been assessed as higher risk from blade-strike impacts:

- Non-migrating, high-flying microbats
- Threatened, migrating, high-flying microbats

5.2 RISK ASSESSMENT SPECIFIC TO BOCO ROCK WIND FARM

The risk assessment presented in this plan has adopted the interim standards of current best practice in environmental risk management in Australia, as documented by Standards Australia (AS/NZS ISO

31000:2009). This standard approach considers potential environmental consequences and their likelihood, to arrive at a measure of environmental risk (low, medium, high) and is based on:

- The likelihood of a perceived impact occurring (i.e. collision risk resulting in mortality); and
- The severity of environmental consequence of the impact if it occurs (i.e. possible negative long-term population affects).

The risk of a wind farm to bird and bat species is largely evaluated within the pre-approval assessment process for the project, while operational monitoring tests the pre-operational predictions by providing factual real-time information on wind farm impacts (AusWEA 2006).

In the case of the BRWF, a preliminary risk assessment was developed post project approval (but prior to monitoring) to build upon ELA's initial flora and fauna assessment (2009) to: 1) provide a more transparent risk assessment; and 2) to incorporate several additional ('other') species of concern raised by OEH. The preliminary risk assessment is presented in Appendix C. Subsequent to this, risk assessments have been undertaken on a species by species basis in response to trigger events. Subsequent risk assessments have been undertaken using the risk matrix presented in Table 7-1 and Table 7-2.

Preliminary risk assessment method

Specifically, the risk assessment reviews the potential for blade-strike risk or threat of flying within the rotor swept area (RSA). Species were ranked against species impact factors with each factor scored as either zero (0) (no impact or risk, or not relevant) or one (1) (risk of impact possible). For birds, a species could accrue a maximum of seven points and species with totals of four or more were considered to be 'at higher risk'. For microbats, a species could accrue a maximum of four points and species with totals of three or more were considered to be 'at higher risk'. Appendix C details the impact factors applied to the risk assessment for birds and microbats. While some of the threatened higher risk species and their habitats are not common to BRWF, many of these species occur in low densities and therefore the consequence to the species' local population from one fatality due to collision is considered high, and adaptive management in this instance should be applied without delay. However, some bird species that were delineated as a higher risk species were later omitted; after further review these species were considered highly unlikely to be at risk from the wind farm, for example the Sooty Owl.

Among the species considered to be potentially at risk of collision with turbines, 16 threatened and/or migrating species, under the *TSC Act* and *EPBC Act*, have been identified as higher risk. Another five species are identified as 'other species' of concern, as detailed by OEH, but have not directly resulted in a high risk score in the risk assessment process (Table 5-1).

Table 5-1. Bird and microbat species with potential for a higher risk of collision with operating turbines.

At Risk Bird Species	At Risk Microbat Species	Other Species[2]
Barking Owl	Eastern Bentwing Bat[3]	The group robins, particularly: • Flame Robin
Powerful Owl	White-striped Freetail Bat	
Masked Owl	Yellow-bellied Sheathtail Bat	The group Raptors, particularly: • Nankeen Kestrel • Brown Falcon • Black-shoulder Kite • Brown Goshawk • Spotted Harrier
Blue-billed Duck		
Glossy Black-cockatoo		
Glossy Ibis		
Great Egret		
Latham's Snipe		Yellow-faced Honeyeater
Little Eagle		White-naped Honeyeater
Square-tailed Kite		Yellow-faced Fuscous
Swift Parrot		Dusky Woodswallow
Wedge-tailed Eagle		Silvereye
White-bellied Sea-eagle		

The monitoring program does not solely focus on, or isolate statistical analyses to higher risk species. The program is designed to monitor impact to any bird or microbat species recorded, and if analysis infers an impact to any species, the cause will be investigated further and managed, if required.

Revision of risk

As with any 'perceived' risk assessment, the process is imprecise as it was based on several assumptions and not on site-specific monitoring data. To reflect 'real' risk and inform risk identification and management further the table will be revised and updated during each annual reporting phase to portray current monitoring results. The monitoring data will be specifically reviewed to determine if collision rates increase, or if trends in bird or microbat activity levels are different over time for these species. If results indicate no risk the 'high risk' status will be downgraded. If results confirm a 'high risk' the management actions documented in Table 7-3 will be considered.

A revision of risk has been undertaken for Eastern Bentwing Bat. This was documented in *Risk Analysis: Eastern Bentwing Bat* (NGH Environmental 2016b). This report found that despite ecological characteristics suggesting the species is generally at higher risk of turbine collision (and barotrauma) than other bats, at BRWF the risk to Eastern Bentwing Bat is moderate. This is due to:

- A clear migratory path not being evident at BRWF, based on Anabat surveys at BRWF during the migratory seasons.

[2] Other Species: species suggested by OEH as being at risk, but not designated as 'higher risk' during the risk assessment documented in Appendix C.

[3] 2015 and 2016 monitoring indicates this species is not high risk. However, this issue continues to be investigated as of March 2017.

- A low number of Eastern Bentwing Bat call files obtained despite a high survey effort during appropriate seasonal timing, across two years.
- No Eastern Bentwing Bat calls obtained during Anabat surveys at nacelle height, suggesting that despite evidence that the bat does fly within the rotor-swept (i.e. that is carcasses at the foot of turbines), it does not do this regularly at BRWF.

At the time of writing (August 2017) the EBB risk analysis (NGH Environmental 2016b) is undergoing a further series of edits in response to OEH comments.

PART B – MONITORING PROGRAM METHODOLOGY AND IMPORTANT CONSIDERATIONS

6 MONITORING METHODS AND CONSIDERATIONS

It is important that survey design and field investigations are designed for particular sites with a clear idea of the statistical analysis to be used (AusWEA 2006). The methods employed for the monitoring program have been developed with regard to statistical sampling design requirements. Symbolix, a data management and analysis services company, were engaged to develop a survey design appropriate to BRWF, that would achieve statistically robust data that could be used to answer the primary and secondary objectives of the plan. The following section sets out the purpose, methods and factors that were considered for monitoring at the BRWF. Symbolix have provided further technical advice and justification for the monitoring methods employed (refer to version 1.2), and survey protocols detailing survey design and schedule (refer Appendix D).

Section 1 defines the aim of the monitoring program as to assess two overarching objectives of the operating wind farm on birds and microbats:

1. Primary Objective: Monitor direct mortality of birds and microbats as a result of collision with blades (direct impact); and
2. Secondary Objective: Monitor changes or trends in activity levels and movements of birds and microbats that may be linked to avoidance of operating turbines (indirect impact).

Four categories of surveys are required to measure the potential direct and indirect impacts of the BRWF. These are listed below and are described in more detail in the following sections.

1. Mortality surveys to monitor collision rates of bird and microbats.
2. Supporting surveys (scavenger and detectability trials) to interpret the results from mortality surveys.
3. Utilisation surveys (indirect impact) to monitor bird activity and movements to ascertain trends in activity incline or decline.
4. Passive microbat survey using Anabat units to monitor species diversity and general activity levels to comment on potential trends in activity incline or decline.

6.1 METHODS

All mortality and bird utilisation surveys are undertaken by two staff working together; one as a lead ecologist and the other a technical assistant. For safety and quality purposes, the team of two stays together during surveys. Observations of both team members are recorded on a single data sheet for each survey. The aim is for field trips to be 28 days apart however this is not always possible due to short months (i.e. February) and logistical reasons.

Detectability and Scavenger Trials

Detectability Trials

Purpose: To determine the rate at which human observers are able to detect carcasses within the natural environment of BRWF and establish a searcher efficiency estimate.

- Detectability trials were conducted in March and July 2015. The July survey was timed for winter during lower biomass conditions (i.e. tussock grasses expected to be lower) and the March survey reflected summer in higher biomass conditions (i.e. tussock grasses expected to be higher).
- The detectability trials were conducted within each zone (high detectability and extended zone).
- Methods for the detectability trial are documented in the BRWF BBMP v1.2 (NGH Environmental 2013) and the Annual Report 2015 (NGH Environmental 2016)..
- Trial results were analysed by Symbolix Pty Ltd and a detectability rate was calculated for different carcass size classes and search zones. This rate is used to calculate estimated annual mortality rates for the project.

Scavenger Trials

Purpose: To determine the rate at which natural scavengers remove carcasses from the BRWF to inform, if possible, the interpretation of mortality results for the potential to lose carcasses to local scavenging activity.

- A scavenger trials was conducted over 28 days in August and September 2015. Timing of the trial was spring as it is expected scavengers may be most active at this time.
- Trial results were analysed by Symbolix Pty Ltd and a scavenge rate was calculated for BRWF. This rate is used to calculate estimated annual mortality rates for the project.
- Methods are documented in BBMP v1.2 (NGH Environmental 2013) and the Annual Report 2015 (NGH Environmental 2016).

Mortality Surveys

Purpose: To detect the rate of fatalities of birds and microbats as a result of collision with wind turbines.

The most common and widespread method of monitoring bird and bat mortalities in regards to wind farm developments is the carcass search. The known method is to conduct regular searches under the operating wind turbines (up to 100 m from the tower) for bird and bat carcasses and remains. For this method, there are a number of difficulties with the use of observers to determine the rate of collision of birds and bats under turbines within a large search area. These difficulties include the need to account for scavenging rates of carcasses and the ability to detect carcasses.

BRWF is characterised by steep and rocky terrain and dense tussock grass which makes searching a 100 m area around turbines difficult in terms of searcher fatigue and affects detectability, which varies dependant on grass height and density and presence of rocks. These factors reduce the accuracy of the data collected. To compensate, a mortality survey has been designed that will increase the ability of field surveyors to detect carcasses on the ground with more reliability. This methodology relies predominantly on searching hardstand and access roads around turbines, which eliminates issues relating to uneven ground and ground cover. The reduced search area is addressed by increasing the number of times this area is surveyed. This design is currently being used in the Casslemann Wind Project in Pennsylvania (US) (Arnett *et al*. 2009).

The mortality survey design for BRWF includes searches for dead bats and birds, remains and feather scatters within the high detectability zone (hardstand and access road) as well as within an extended zone beyond the tower (80m x 80m area) where the reduced detectability factors still apply. The latter area is monitored for a randomly selected sub-sample of turbines each survey.

High Detectability Zone

The high detectability zone is defined as the hardstand of the turbine (~ 20m x 20m area) plus the access road to the turbine (~ 4m by 120m) resulting in an approximate search area per turbine of 880 m^2.

- Searches are conducted at 100 % of turbines[4] for each survey event (including all higher risk turbines, as defined in Section 4).
- This zone is surveyed twice per survey cycle in quick succession. For example, one survey is conducted at all turbines and another survey is again undertaken after a two-day interval at all turbines. This 'pulsed' survey is to account for faster scavenger losses for smaller carcasses and provides greater certainty on searcher efficiency estimates in the long-term (i.e. by accounting for scavenger potential).
- Searches are conducted along transects at four metre spacing over the entire 880 m^2 search area (i.e. 2 m either side of the walked line will be actively scanned for carcasses). Therefore a total of five, 20 m long transects and the access road will be surveyed per turbine.
- Searches are undertaken at a moderate walking pace and are expected to take approximately 8-10 minutes.
- It is anticipated the boundaries of the hardstand areas will be easy to find each survey event and will not need to be marked to ensure consistent search areas are searched. However, if this is not the case, these areas will be marked as required to achieve good replication of the search area.

Extended Zone

Given the high levels of detectability able to be achieved in the high detectability zone, with sufficient search intensity it is expected that 880 m^2 will be adequate to detect and estimate mortality for small to medium size bats and birds.

However, the size and location of this search area may be too small and too close to the tower to adequately detect larger avifauna expected to fall or be thrown further from the tower. To compensate for this, an extended area is searched at 20 turbines to detect larger birds and any other carcasses.. This survey will serve an additional purpose; allowing a comparison between the two levels of detectability (high detectability versus extended zone), informing ongoing survey design.

- Extended zone searches apply to ten (10) randomly selected higher risk turbines (refer to Section 4), and ten (10) additional (non-higher risk) turbines.

[4] This compares to the standard 20-30% of turbines in most wind farm monitoring programs (refer to Version 1.2, Appendix D). The survey design was originally based on surveying a minimum of 50 turbines as this effort would generate enough data for a viable analysis. However, searches have been undertaken at 100% of turbines as an 'insurance program' requested by OEH until the completion of the scavenger and detectability trials.

- The extended zone consists of an offset area of 80 m x 80 m (6400 m^2, or 0.64 ha) and will be additional to the high detectability zone, however its furthest point will be no more than 120 m from the turbine tower.
- The extended zone is not circumferential with the turbine at the centre – it is a square area offset from one side of the turbine.
- Searches are conducted along transects at 12 m spacing over the extended zone search area.
- Searches are undertaken at a moderate walking pace and take approximately 15 minutes.
- The extended search areas have been permanently marked (i.e. with a star dropper, white stones, or paint depending on what is most practical) to ensure the same area is surveyed each time.
- This extended zone will be surveyed once per survey cycle (monthly).

Data Recording for Both Zones

- For every carcass found the following is noted: Turbine ID, date, the survey zone, distance and bearing from the turbine (or GPS location of carcass), distance from the observer to the carcass at the instant of detection, species (if identifiable), condition of carcass (complete, partially scavenged, feather spot), and other notes.
    - Note: if nothing is found during a search, the search effort should still be noted by entering the Turbine ID on the datasheet and striking through the row.
- Meta-data to record includes: weather conditions, observer identification, start and end time of the survey, presence of ephemeral wetlands, ground search conditions. The time information can be used at a later date to determine if the surveys are at risk of scavenger bias interactions. The field observer will also make comment on anything they deem unusual. It might include unusual weather, or something that made searching difficult, or land management issues.

Considerations

- The survey intensity is designed to balance the OEH requirement to sample all turbines, the need to ensure adequate coverage of the turbine area, and to account for faster scavenger losses for smaller species of concern. Current techniques for estimating site mortality are shown to be unbiased under regular survey timing and turbine selection, as employed here.
- For the high detectability zone, the survey design was originally based on surveying a minimum of 50 turbines, with preference given to searching higher risk turbines. OEH have requested increased search effort be employed (searches of 100% of turbines) until such time as results indicate that the search effort is justified in being reduced. The results of mortality surveys, as well as scavenger and detectability trials will be queried to determine if less search effort is justified and if so the program may be altered, in consultation with OEH.

Utilisation Surveys

Purpose: To quantify which bird species are present, their numbers and activity levels and how they use the site. Data from utilisation surveys will be used to assess whether use of the site by birds changes once turbines have been installed and are functioning and to therefore gauge changes in populations.

Habitat stratification

- An early stratification design was for two layers based on habitat available in the BRWF site: grassland/pasture impact sites and grassland/pasture control sites.
- During consultation with OEH prior to finalisation of the BBMP v1.2 (NGH Environmental 2013), an adjunct layer was added in response to agency requests: woodland habitat, which occurs mostly outside of the BRWF site.
- As a result, from the commencement of the program there have been three stratification layers in the design:
    1. grassland/pasture control (> 500 m from turbines)
    2. grassland/pasture impact (< 500 m from turbines)
    3. woodland impact (but by definition a control site as generally occur > 500 m from turbines)
- The three stratification layers are independent of each other[5].
- Impact zones (grassland/pasture habitat) were defined as:
    - Grassland/pasture habitat within 500 m radius of a turbine.
    - Woodland habitat where woodland is available to survey, which is mostly more than 500 m distant from a turbine. In many cases, it is more than 1000 m distant [6].
- The control zone was defined as:
    - Grassland/pasture habitat more than 500 m from a turbine.

Site selection

- During the first year of operation (2015) the utilisation survey design was a stratified random point survey, where the selection of sites was based on randomly generated points by GIS for each stratification layer
- The stratified random points were refined in the field in 2015 and 2016 based on site access and ground truthing.
- In 2017, a longitudinal study proper has commenced with already established sites being revisited throughout the year.

Field method

- Surveys are undertaken monthly (every calendar month). One monthly survey event results in surveying 10 established sites; with a minimum of three sites within each stratification layer. Therefore, after one year the survey intensity will comprise a total of 120 survey sites over 12 survey events.
- The pool of survey sites is greater than 120 in order to allow for flexibility (e.g. if site inaccessible for some reason). The total number of sites is distributed as follows:

Stratum Name	Number of sites
Grassland / Pasture	42

[5] Independence of survey site selection is not between the individual survey points, but between the three stratification layers. All woodland survey points are considered potentially impacted under this design, with no control sites. This maximises the analysis that can be performed; it allows for separate analyses of woodland data, or a control-impact analysis, or a control impact (woodland) – impact (pasture) analysis to be performed.

[6] During the preparation of this plan, OEH (28/3/2013 Allison Treweek and Matt Cameron pers. comm) raised the concern that woodland sites / species may be impacted by the presence of turbines, even if they were located over 500 m from a turbine. To address this, a third stratum 'woodland' was introduced to allow this to be explicitly tested for.

Woodland	42
Control	45

- The surveyors have a list of repeat (longitudinal) sites that they are to visit each calendar month
- Surveys are un-truncated point counts.
    - Un-truncated point counts are not limited to a defined search area[7] and the observer records all observations.
    - Point counts will be 20 minutes in duration in which bird movements are recorded by continually scanning, noting the numbers of each species and approximate distance to each unit. A unit can consist of an individual, or a flock. In the case of a flock, the approximate number in the flock should be estimated.
    - Each individual is noted when first sighted; should an individual disappear and a second (or potentially the same) individual appear later, this is noted as a separate sighting.
    - Surveys will be completed between dawn and dusk. The potential for collision can occur at any time a turbine is operating (i.e. 24 hrs / day), therefore bird movements require monitoring throughout the day to determine bird activity across this entire period.
- For each sighting, the following is recorded: time at first sighting, distance to first sighting (in metres), height above ground, species, number, cue type (observed, heard). Metadata will also be recorded including weather conditions, wind speed and direction.

Considerations

Many of the early considerations about the pre-selected locations within each stratum, access, landholder logistics, and operating constraints and replacement sites have been addressed during the first two years of monitoring and resulted in updates to this plan.

Passive Microbat Survey

Purpose: To determine change in microbat species diversity and activity levels at the BRWF over time and compare activity data to mortality survey results (i.e. activity levels to number of individual bat deaths for each species).

- Microbats will be monitored using four Anabat detectors placed in the same location each survey cycle (i.e. quarterly).
- The monitors will be placed for four consecutive nights in each three-month quarter, ensuring coverage of each relevant season for microbats (March – April and October-November).
- Site selection for surveys will be stratified (two detectors each) according to the habitats available (grassland/pasture and woodland).

[7] Point counts are un-truncated and not defined to a given radius to prevent bias in observer recordings at the edge of the search area. For example, there is tendency for bias to result as a surveyor is inclined to include 'observations' to increase the data-set, even if the species is outside the specified search area. The absence of a search area is overcome by recording distance to first sighting, as this data can be used during analysis to review any questions relating to distribution or location.

- This will allow a comparison of species diversity and relative activity levels of bats utilising the study area over time and will be analysed when the quarterly technical reports are prepared and for the annual reports.

6.2 SEASONALITY AND SITE VARIABLES

Changes in the local environment will be recorded during each site visit on the prescribed datasheets (Appendix E). Documenting such changes will provide a basis upon which to judge whether any observed changes in bird and/or microbat activity or presence can be reasonably attributable to factors other than the operation of the wind farm, including seasonal factors. When appropriate, observations will be recorded for:

- Seasonal changes, including evidence of nesting activity by key species
- Changes in land use practices
- Significant changes in water levels in nearby water bodies
- Significant weather events (e.g. strong winds, persistent rain)
- Anecdotal information from land owners, land managers, wind farm staff and the local community
- Any notable increase in bird or bat food resource abundance

Ephemeral wetlands occur on the site and will hold water after prolonged rainfall events, but appear to be absent the majority of the time; these wetlands were present during the biodiversity assessment (ELA 2009). Given their ephemeral nature the survey design does not specifically target these areas. However, the coverage of survey sites is designed to capture their presence if they appear and any waterbodies will be noted during bird utilisation surveys, as well as their location in relation to the nearest turbine, if present.

Currently, nine ephemeral waterbodies are visited during each survey event. Information is recorded about water levels and opportunistic observations of birds. The following waterbodies are regularly visited:

Waterbody 1: Boundary Lake, 600 m west of Turbine 49.

Waterbody 2: Small unnamed lake, 600 m north of Turbine 49.

Waterbody 3: Large ephemeral wetland, 150 m south-east of Turbine 30.

Waterbody 4: Large ephemeral expansive lake with emergent vegetation on Avon Lake Road, approximately 1.6 km from Turbine 41.

Waterbody 5: Coopers Lake, approximately 700 m north of Turbine 53.

Waterbody 6: Large ephemeral shallow wetland adjacent to Turbine 52.

Waterbody 7: Ephemeral wetland near on Brechnoch Road/Cow Bum Road.

Waterbody 8: Ephemeral wetland near main entry gate to BRWF.

Waterbody 9: Ephemeral wetland near Turbine 29/30.

In order to gain an understanding of the impact of the wind farm upon local bird and microbat populations, surveys must be undertaken across a range of seasons. As surveys are conducted every month, the monitoring program captures data throughout the year in every season but is not influenced by annual deviations (late spring, longer summer etc.) nor the bias of trying to capture 'representative'

seasonal data by adjusting survey timing (i.e. surveying mid-season). This also ensures the survey timing and intensity addresses species-specific seasonal issues such as migrating species.

This monthly survey intensity is considered most appropriate for the BRWF as it will promote consideration of the following factors:

- The Swift Parrot usually arrives between February and March in their south-eastern mainland wintering grounds, and leave early August to return to breed in Tasmania from mid-September to late January.
- Northern Hemisphere waterbird migrants arrive in August-September and stay until February-March when they start their home-bound migration.
- The Eastern Bentwing-Bat congregates in maternity caves from October to November and young start to fly in March.
- The White-striped Freetail Bat may execute long migrations from south to north in response to intensive period of cold in June-August;
- Additionally, waterbirds and raptors winter on the Monaro Tablelands, when conditions are favourable.
- The Monaro Tablelands area is known to be used by migrating birds during:
    - Spring migration (*i.e.* species *en route* to their breeding grounds) with a peak in September-October.
    - Autumn migration (*i.e.* species leaving their breeding areas *en route* to their wintering grounds) with a peak in April-May.

6.3 DATA RECORDS

It is imperative that data be gathered and recorded in a standardised way to facilitate comparison of results between survey events, and in order to identify any trends in the data. All data must be recorded on project-specific data sheets to facilitate this. These sheets will be configured to enable digitisation and electronic record keeping of all data. Data sheets will be updated periodically to reflect recommendations that come out of discussions with the expert and the preparation of the quarterly and annual reports.

Appendix E details the datasheets that will be used to collect information at the BRWF. Datasheets are provided for: 1) mortality surveys; 2) utilisation surveys; and 3) scavenger and detectability surveys.

These datasheets have been developed with advice from Symbolix to ensure the data collected is appropriate for statistical analysis and will allow the aims of the monitoring program to be achieved.

6.4 DATA ANALYSIS

The overall aims of the data analysis will be to:

1. Determine the type of species and to what extent they are colliding with turbines to determine if collision impacts will result in an adverse impact on its population.
2. Detect changes within activity levels or species diversity of birds or microbats and investigate further possible drivers of the change.
3. Determine if changes in activity levels can reasonably be attributed to the operation of the wind farm.

The results of this analysis will be both qualitative and quantitative and used to inform two decisions:

1. Are management actions required in response to the results and trends observed?
2. Should monitoring (including type, location, timing or intensity) be altered in response to the results and trends observed?

Mortality Surveys and Scavenger and Detectability Surveys

Reporting of mortality data requires information on the results of the carcass detection surveys, as well as the scavenger trials and detectability surveys. To ascertain effects of any turbine collisions on the functioning and maintenance of key species' populations the number of recorded mortalities has been used in other wind farm monitoring programs to determine an estimate of overall mortality rate, by factoring in search frequency and intensity, scavenging rates and searcher efficiency. The detectability and scavenger efficiency trials allow the projection of a 'true' mortality count from the detected carcass count.

For BRWF, the average (and standard error) has been determined for the 'time to scavenge' and the detectability. The average time to loss from scavenge was determined using standard survival analysis techniques (see Kaplan & Meier 1958). Refer to Annual Report 2015 (NGH Environmental 2016) for the full results of these surveys.

On an annual basis, scavenge time and detectability calculations are combined with the annual mortality counts to estimate the total mortality. This estimation will be done according to the current best practice, using a published methodology (e.g. Huso 2010, Korner-Nievergelt *et al.* 2011). If an unusually high number of carcasses is detected over a quarter an interim mortality estimate may be calculated, although generally there is insufficient data collected per quarter to warrant interim estimates. The surveys are designed to facilitate any of the current published mortality estimates (e.g. number of birds/turbine/year), and are statistically robust enough to be used in future analysis. This allows the plan to utilise the most appropriate tool, in consultation with the Ecologist, the Expert, the Statistician and, where necessary, OEH.

Utilisation Surveys

The analysis of the utilisation data will test for differences in activity levels at impact sites from those seen at control sites. This will be done using appropriate statistical tools such as Generalised Linear Modelling (GLM). A GLM is an approach in which you can quantify responses (e.g. population indicators such as species diversity) in terms of specific predictors (e.g. impact or control site, seasonality etc.).

In particular, to satisfy consent conditions and detect changes in 'all populations' (activity) of birds, a staged, adaptive approach will be used. At the first level, the analysis will test for changes in species richness and diversity (Shannon diversity[8]). Where possible, changes in abundance of species groups/ guilds will also be investigated (though it is likely that not all groups/guilds will have sufficient counts for the changes to be detected).

These population level indicators provide an initial benchmark test for indirect impacts. Should there be a decline in the on-site abundance of a particular guild, this will manifest as a decline in the number of sightings at impact sites (compared to control sites). The timing and placement of surveys has been designed to have sufficient power and confidence to detect changes in the overall species richness, diversity and abundance.

[8] Shannon diversity is widely used for comparing diversity between various habitats (Clarke and Warwick, 2001).

If a decline in species richness, diversity or abundance of key groups is detected, then this would trigger further investigation or survey by either the Statistician or Ecologist. Such further investigation may include separating the measures into species or guild information to inform hypotheses about possible drivers of the change (refer to Table 6-1). Changes in activity levels may be a result of change in environmental and location variables rather than operational effects of the wind farm, however the Ecologist will investigate possible impacts for that particular species or group.

The survey design and data collection regime for BRWF has been carefully constructed to facilitate and support as many questions and analyses of the data set as possible, should further investigation be required. The current collection regime allows testing for several responses including, but not limited to: species richness, diversity and evenness; counts of individuals or movements; and presence / absence. Testing these responses can be done at several levels (i.e. population, guild, species). Any of these responses can be regressed into a model appropriate to the question being asked to facilitate interpretation of any 'change' in the measured response (data). For example, species richness data (response) can be regressed onto weather metadata (model) as a predictor to test if any changes observed in species richness are linked to weather.

The preceding list is not prescriptive, but it is provided in this instance to highlight the diverse nature of questions and configurations that the survey design can support and the comprehensive data collection that is being undertaken. Analysis and interpretation of the BRWF data will be based upon transparent, and appropriate techniques sourced from peer reviewed and published reference texts which are relevant at the time of analysis, and are specific to address the questions posed in this BBMP. Consultation with the Statistician is ongoing throughout the program.

Passive Microbat Surveys

Analysis of microbat data will be largely qualitative and include the following:

- Record general activity levels, and monitor these for change
- Collate species lists from Anabat data and review species presence/absence every three months (quarter).
- Anabat data does not allow for the abundance of individuals to be measured. However, the results of Anabat data will be compared to mortality survey results and if bat deaths occur, the data can be analysed further for species of interest (Refer Table 6-1).

Considerations

As analyses of bat data (i.e. identification of Anabat files) is costly and time consuming, it may be appropriate from time to time to target particular species during analysis that are shown to be at risk, or to which the wind farm appears to be impacting, rather than identifying all species. All Anabat data will be stored on digital archive system and if mortality results reveal bat deaths of individual species the Anabat data can be analysed further. Further analysis will be targeted and focused particularly on relevant management and mitigation options (refer to Table 6-1).

Qualitative Analysis

For species detected on wind farms site infrequently, particularly if a small number of observations are involved and the species of principal interest are rare, reliance may need to be placed on behavioural and descriptive information. In this instance, qualitative analysis will be undertaken by the Ecologist.

Qualitative analysis will also be undertaken to document, where possible, natural and human changes in the surrounding environment that might influence bird and/or bat behaviour or presence in the BRWF.

This type of analysis will be complementary to the statistical analysis. Factors that may be considered include:

- Graphs or tables of raw numbers for bat analyses or mortality data which can be plotted by turbine, month, or season.
- Effects of weather and lunar cycle on bird behaviour around turbines.
- Effects of landscape features on bird behaviour around turbines.
- Effects of landuse practices on bird behaviour around turbines.

Summary of analysis and response triggers for further investigation of data

The survey design and intensity has been developed so that sufficient data can be gathered to detect a trend or change (impact) to bird and bat populations. If survey results or subsequent data analysis alludes to an 'impact', specific data analysis and further reporting can be undertaken to explore the data further, under a hypothesis, to determine likely or potential drivers for the impact. Table 6-1 summarises the data analysis for each monitoring method described above and the key triggers that will initiate a response for further investigation.

A response action is required when data analysis indicates a potential impact beyond acceptable levels. In the event of any trigger (refer Table 7-3), the Ecologist in consultation with the Expert will assess the risk and invoke targeted management, if required. A response will be formulated in the form of further desktop investigation, survey work and reporting, or immediate management depending on the severity of the risk.

Table 6-1. Summary of analysis and key triggers for response (further investigation) for each objective of the monitoring program.

Objective	Target Species	Method	Data Analysis	Key Role	Timing	Trigger for Action and Response
Mortality Surveys						
Detect deaths of birds and microbats as a result of collision with turbines	Small to medium sized birds and bats	Carcass searches of hardstand and access track areas (1000 m^2 search area) within 50 turbines.	Determine an estimate of overall mortality rate, by factoring in search frequency and intensity, scavenging rates and search efficiency.	Ecologist - survey Statistician - mortality estimate	Monthly - Ecologist Annually – Statistician	Trigger – required under BBMP. Response - Ecologist to investigate possible reasoning behind why species colliding with turbines may be occurring. Knowledge of site, site observations, and current environmental factors will be reviewed. The Ecologist, in consultation with the Expert, will formulate a response in the form of a management action, if required.
Detect deaths of birds and microbats as a result of collision with turbines	Larger birds	As above but combined with an extended search area for 20 turbines.				
Scavenger and Detectability Surveys						
Determine the rate at which natural scavengers remove carcasses from the BRWF.	Small, medium and large size birds and bats.	Carcass searches of hardstand and access track areas (1000 m^2 search area) and extended search area for larger	Results to be used to determine overall mortality rate relevant to the BRWF.	Statistician	Year 1 – rates determined. Ongoing incorporation of this data into mortality projections for annual reporting.	N/A

Objective	Target Species	Method	Data Analysis	Key Role	Timing	Trigger for Action and Response
		species.				
Determine the efficacy at which human observers are able to detect carcasses at BRWF.	Small, medium and large size birds and bats.	Carcass searches of hardstand and access track areas (1000 m^2 search area) and extended search area for larger species.	Results to be used to establish a searcher efficiency estimate to factor into mortality survey results.			
Utilisation Surveys						
Detect change in populations (activity levels)	All birds	Use tally of point counts from utilisation surveys to arrive at an overall species diversity index for BRWF (i.e. aggregated dataset)	Test for changes in species richness, Shannon diversity and species/guild abundance (where possible). These indicators are used to detect whether there is a change in bird activity levels or species composition at impact sites, compared to the background variation measured at the control sites.	Statistician	Annual	Trigger - a (statistically) significant decline in one or more indicators at the impact sites relative to control sites Response - investigate the data further on an individual species or guild level – see below).
Investigate the data to understand any detected change	Specific bird species	Query aggregate data to explore which guilds or	Review aggregate data model.	Statistician to identify what species / guild triggering data and discuss	As soon as trigger is known.	Trigger - (Stage 2 adaptive management – response to trigger outlined above) Response - Ecologist to investigate possible impacts for

Objective	Target Species	Method	Data Analysis	Key Role	Timing	Trigger for Action and Response
		species are causing the trigger and what the possible impact may relate to.		with Ecologist. Review and discussion with Expert.		that particular species. Knowledge of site, site observations, and current environmental factors will be reviewed. Additional survey to investigate the trigger may be required.
Detect change in species recorded.	Bats	Anabat survey	Collate species lists (diversity) and compare results between technical reporting phases (quarterly) and in annual report.	Ecologist in consultation with Expert	Quarterly and annually	Trigger – quarterly and annual report phase Response - Review results in conjunction with mortality results. If deaths for particular species are occurring investigate further (see below).
Use Explorative Data Analysis (EDA) to investigate Anabat data further for only those microbat species that have collided with turbines	Higher risk bats colliding with turbines (determined from mortality surveys)	Further analysis of Anabat data of bats colliding with turbines	Apply exploratory data analysis. Review Anabat records to determine which species are occurring in high numbers and when each species is moving, what environmental events may be linked to bat deaths (i.e. migratory seasons, lunar cycle).	Ecologist in consultation with Expert Statistician where required.	As soon as impact is known and ongoing if mortality continues. .	Trigger - mortality searches reveal threatened species or high numbers of bat deaths. Response - the Ecologist in consultation with the Expert will formulate a response in the form of further survey or a management action, if required.
Observe water level and duration in known	Water birds	Make observations of the level and duration	To be decided if event occurs.	Ecologist	Observational data is collected monthly. As soon as trigger is	Trigger - waterbird mortality. Response - may include: review observational wetland data to

Objective	Target Species	Method	Data Analysis	Key Role	Timing	Trigger for Action and Response
ephemeral wetlands within impact zone (< 500 m of wind turbine)		of water retention in ephemeral wetlands.			known.	identify conditions (e.g. high numbers of waterbirds present), adjust survey effort (i.e. monitoring intensity) in areas of identified wetlands if they hold water for prolonged periods, formulate management action if warranted.

6.5 MONITORING PROGRAM DURATION AND REVIEW

The conditions of consent specify that the monitoring program is of five years duration and monitoring will continue throughout this period. However, the initial survey design and intensity of the monitoring program was specific to the first 12 months of data collection. The program was reviewed after this time in the Annual Report 2015 and Annual Report 2016. Several recommendations were made but no changes to the program have yet been adopted. It is considered highly likely that sufficient statistical power will be maintained with a lower survey intensity in subsequent years.

Every 12 months, the survey design and intensity will be reviewed and revised if required, on the basis of:

- Trends or risks identified in relation to species or turbines.
- Information gaps or uncertainties affecting interpretation of data / confidence in results obtained (including the statistical rigour able to be obtained).
- Usefulness of data being collected in addressing BBMP questions

An adaptive approach to the survey design and intensity of the monitoring program after the first 12 months is fundamental to responding to the monitoring results and keeping the program relevant. It is possible the monitoring data may indicate different or unexpected impacts or different higher risk species, to those forecast in the original risk assessment. The Draft National Wind Farm Development Guidelines (EPHC 2010) specify the uncertainty of impact surrounding wind farms and state:

- Despite pre-construction assessment, some uncertainties about behavioural responses of birds or bats to a wind farm will be inevitable and may prove to contribute to a greater or lesser impact than anticipated.
- Due to the relatively long life of a wind farm, environmental changes may occur over time so that utilisation of the site by various bird or bat species alters in ways that were not able to be forecast prior to commissioning of the facility.

After the first 12 months, the survey intensity will either decrease or increase in light of the results from the first year of monitoring. The principles of adaptive management will be applied at this time to ensure:

- The higher risk species and turbines are correctly identified and managed appropriately
- Monitoring is appropriate to the strata layers (grassland/pasture, woodland, control) of the current design.
- Monitoring is linked to appropriate temporal and spatial scales of the BRWF
- Monitoring retains a focus on statistical power and controls that are relevant to the objectives of the plan.
- Use of computer models applied to the monitoring data are relevant to the BRWF
- Monitoring data are appropriate to inform management and mitigation measures.

6.6 USE OF BASELINE DATA

Surveys were undertaken prior to construction and include surveys undertaken by ELA (2009) in their flora and fauna assessment, as well as unpublished baseline data gathered in Winter and Spring 2012 and Summer 2014 by nghenvironmental (2012), and subsequent unpublished data gathered by OEH in Autumn 2013.

Both general and targeted field surveys were undertaken by ELA (2009) for the original pre-approval assessment and information on species diversity, abundance and threatened species locations was

documented. Pre-construction baseline surveys undertaken by **ngh**environmental involved gathering data on presence and relative abundance of bird and microbat species at the site prior to the construction of the wind farm through bird utilisation surveys and passive microbat surveys. OEH gathered baseline data in April 2013, focusing on bird census surveys and specific raptor surveys, with regard to impact and control sites.

The data collected from the flora and fauna assessment and pre-construction baseline surveys will contribute to knowledge of the site and will aid in understanding site variables and species diversity of birds and microbats before operational monitoring commenced. Where it is considered necessary, the pre-construction data will be compared to operational monitoring results and included in statistical analysis. However, if data collection methods are too dissimilar between the pre-construction and operation monitoring phases so as to unduly reduce statistical power, qualitative analysis only will be employed.

PART C – ADAPTIVE MANAGEMENT, REPORTING AND COMPLIANCE

7 RISK TRIGGERS AND ADAPTIVE MANAGEMENT

7.1 DECISION MATRIX

The decision matrix is made up of a risk assessment matrix and triggers for action table. It has two key purposes:

1. To assist the Ecologist, in consultation with the Expert, in determining the ecological significance of an event detected by the monitoring program (risk assessment matrix).
2. To assist the Ecologist, in consultation with the Expert in developing an appropriate response to the event (triggers for action).

Furthermore however, and equally important, it provides the Operator and Landholders with a clear idea of the type of rapid management responses which they may be required to implement or assist in the management of.

The decision matrix must be seen as a guide and not a predictive tool. Bird and bat behaviours are a function of a number of parameters from weather conditions, landscape features, to distribution and abundance of food resources. An event requiring management is likely to be a result of interaction between several factors and require case-specific consideration; all eventualities cannot be covered by the decision matrix. Specific events will require specific consideration, if and when they arise, to execute the appropriate management response.

Risk Assessment Matrix

The Ecologist would use the risk assessment matrix to determine the ecological significance of an event in a standard manner. The AusWind Best Practice Guidelines (2006) recommend using a qualitative risk analysis based on likelihood and consequence of impact. A qualitative risk assessment matrix is given in Table 7-1 while descriptors of likelihood and consequence ratings are given in Table 7-2. The risk matrix can be used in an iterative manner, for example to evaluate an issue on site in the first instance and then again once more information is known (AusWind 2006). Where events trigger moderate or high risk, further consideration must be given as to whether a response is required (refer to next section).

Table 7-1. Risk matrix with three risk levels: Low, Moderate and High, assigned based on the likelihood and consequence factors.

Likelihood	Consequence			
	Insignificant	Minor	Moderate	Significant
Rare	Low	Low	Moderate	High
Unlikely	Low	Low	Moderate	High
Possible	Low	Moderate	High	High
Probable	Moderate	High	High	High

Table 7-2. Descriptions of likelihood and consequence ratings.

Likelihood	Description	Consequence	Description
Rare	An impact may occur only in unusual circumstances	Insignificant	Impact on species not detectable in the short term
Unlikely	An impact might occur at some time	Minor	Impact may cause non-significant changes to local abundance of species
Possible	An impact could occur during most circumstances	Moderate	Impacts may cause significant changes to local abundance of species
Probable	An impact is expected to occur in most circumstances	Significant	Impacts may be significant at a population scale

Triggers for Action

Certain events may negate the need to undertake a risk assessment: they would be considered to automatically qualify as a moderate to high risk. Such events are 'triggers for action'.

Triggers for action are outlined in Table 7-3. The triggers include events involving key species. Key species have been identified as part of the background to the BBMP and are listed in Section 5. The effectiveness of triggers would be evaluated as part of the BBMP and modified as deemed appropriate by the Ecologist, in consultation with the Expert. A range of potential management responses are listed as examples; this is not intended to be an exhaustive list of actions nor suggest a prescriptive response. Actual management actions will depend on the specific circumstances of a trigger and will be undertaken with consultation between relevant stakeholders (usually the Expert and Operator). Descriptions of management actions are given below.

Management actions below are identified as being short-term (i.e. requiring immediate action) or long-term (due consideration and investigations should be undertaken in the short-term, but management may need to be considered over a longer time period).

Table 7-3. Triggers for action: these events would automatically be considered as moderate to high risk, and would require a management response. Potential management actions linked to these triggers are listed.

Conditions / Species	Triggers for Action	Potential Management Actions
Changes in utilisation and activity trends associated with proximity to wind farm infrastructure	Substantial change in recording rate of the species at impact sites that is not evident at control sites	Disaggregate the data and analyse why the trigger has occurred. Undertake EDA to determine which species the change relates to. Undertake an ecological desktop review of potential drivers, or initiate targeted survey. If required, initiate response management, pending results. Review monitoring program. If appropriate, review and adjust the benchmark impact levels devised under statistical modelling (short-term).
Threatened Birds listed on the TSC Act and/or EPBC ACT	Substantial change in recording rate of the species	As above, however if risk confirmed: Ecologist to notify the Operator that management may be required.
Microbats, those particularly listed in the TSC Act and/or EPBC ACT	Substantial change in recording rate of the bat calls from Anabat surveys in areas near turbines.	Undertake EDA and review Anabat data to determine which species the change relates to. Alter monitoring program (e.g. increase passive bat survey frequency) (short-term). If required, initiate management response, pending results. If appropriate, the installation of detection devices may be a long-term management action (long-term).
Threatened species mortality	Carcass of any threatened species detected.	Expert to notify OEH, and revise risk assessment (short-term). Revise survey monitoring program. If fatality of threatened species occurs, conduct specific analysis for the species in question. Review utilisation at the site and determine if there has been an increase or decline in activity levels for this species. If required, initiate response management, pending results. Apply adaptive management. Expert to notify the Operator that actions such as habitat modification, altered land management regimes and others may be required if further mortality is suspected (short- or long-term).
Raptor mortality	Two mortalities in any three month period.	Employ EDA. If necessary, conduct further surveys, with focus on areas of collisions. Ecologist to revise risk assessment (short-term).

Conditions / Species	Triggers for Action	Potential Management Actions
		Ensure cows/sheep/rabbit carcasses are being removed promptly (short-term).
Other species mortality	Multiple mortalities of native species.	Ecologist to notify the Operator that management may be required if further mortality is suspected (short-term). Ecologist to assess reasons for increase and review risk assessment for the species (short-term).
Other species, particularly waterbirds and raptors	Breeding birds: Detected breeding close to turbines where there is a high risk of adult or juvenile mortality. Migrating/wintering birds: Detected nesting close to turbines where there is a high risk of mortality	Review monitoring program. If appropriate, the installation of deterrents may be a long-term management action (long-term).
Livestock	Wet and cold weather coinciding with lambing period onsite (high lamb mortality is common during inclement weather). This may attract more scavenging raptors toward the turbine envelope.	Ecologist may recommend that lambing occur well away from turbines or lamb carcasses be removed more frequently (short-term). Management may be an option if mortality detected above background rates (short-term).
Wetlands	Prolonged rain which may lead to improved conditions in wetlands adjacent to turbines and thereby increases in water bird numbers in close proximity to turbines.	Further analyse utilisation data looking for potential additional risk. Undertake additional bird utilisation surveys if potential risk identified by ecologist to capitalise on unexpected wetter environmental conditions.
Weather Inclement weather (drizzle and fog) during migration periods, which may lead to reduced visibility for migrants, thereby lowering flights patterns and increasing the risk of collision **Lunar Cycle** Dark and full moon which may lead to improved conditions for some species, thereby increasing collision risks.	Mortalities detected as per those rates documented above.	Employ EDA specifically for weather and lunar patterns. Determine if there is a potential causal relationship of inclement weather or lunar cycles with increased mortality rates. Revise monitoring program if potential risk identified. If required, increase survey intensity during dark and full moon phase or migration periods. Ecologist to notify the Operator that management may be required if mortality trends can be predicted and linked to weather or lunar cycle (short-term).

7.2 MITIGATION STRATEGIES

Mitigation measures and implementation strategies in order to reduce impacts on birds and microbats that are predicted to, or have had an unacceptable impact on bird/ bat mortality at certain times have been detailed as scenarios, in the table above and are summarised below:

- Increase of survey efforts (generally undertaken to better understand the issue). Depending on the issue, this may entail expanded search area, greater intensity of surveys, changed timing of survey or specific targeted surveys for a particular species, either onsite or in the locality.
- Investigate ecological or environmental parameters in more detail (also, undertaken to better understand the issue).
- Investigation of known deterrents *e.g.* bird scanners (as a way of reducing the risk)
- On site habitat modification *e.g.* controlling livestock carcass to reduce site utilisation (as a way of reducing the risk).
- Off site habitat protection and / or enhancement, particularly of breeding areas, to offset the increased mortality caused by the wind farm
- Periodic turbine shutdown (as a way of reducing the risk, but considered to be a last resort).

Any mitigation measure involving management of a threatened species would be implemented in consultation with OEH.

Reporting on mitigation measures and implementation strategies is referred under Section 8 below.

7.3 ADAPTIVE MANAGEMENT

After each monitoring event, the Expert would liaise with the Statistician and Operator regarding survey results, triggers and any potentially ecologically significant outcomes. The outcomes of surveys would be discussed and a brief summary prepared by the Consultant for the Operator. This may take the form of an email or letter. If any management recommendations or actions are prescribed, including changes to the monitoring program, they would be documented in accordance with Section 8.

It is expected that, with increased information collected during monitoring, there will be revisions to the identification of:

- Higher risk species
- Higher risk turbine locations
- Higher risk seasonal / environmental conditions
- Survey intensity

These would require adaptation of the monitoring program, to increase or decrease survey effort or make better use of available resources in addressing the aims of this plan.

If at any time during the implementation of the plan, results indicate that the data obtained are not effectively addressing the primary and secondary objectives of the plan, changes to the plan will be investigated. All changes proposed (which may include data collection methods, survey intensity or survey design) would be justified in a letter to the consent authority prior to implementation. Changes would consider ways to maximise the use of existing data (baseline and operational).

8 REPORTING

8.1 AIMS

There are several aims of the reporting component of the program. Reporting is undertaken to ensure:

- The Operator is kept informed about bird and bat impacts onsite, specific to the primary and secondary objectives of the plan (refer to Section 1.1).
- The reason for any mitigation strategy adopted is fully documented.
- The effectiveness of any mitigation strategy adopted is fully documented.

8.2 MODES OF REPORTING

Modes of reporting can include monthly informal progress reports by email but would also include formal reports to the Operator. Reports would include:

1. Once-off reporting
2. Informal reporting (monthly)
3. Technical reports, after each season (i.e. 3-monthly)
4. Threatened species impact report, in response to the detection of any threatened species mortality
5. Annual reports, summarising annual trends and recommendations for changes to survey program and BBMP

8.3 ONCE-OFF REPORTING

Once-off reporting may arise in response to a trigger or other once-off event. For example, an Eastern Bentwing Bat Risk Analysis was undertaken in 2016 in response to carcasses of that species found in 2015 (NGH Environmental 2016b).

8.4 INFORMAL REPORTING

After each monitoring event (i.e. monthly), the Ecologist would liaise with the Operator and Expert to briefly report on survey results, trigger points and any potentially ecologically significant outcomes. Any management recommendations or actions, including potential changes to the monitoring program, would be documented.

8.5 MATTERS TO BE ADDRESSED IN FORMAL REPORTS

The reports will provide expert technical advice regarding fauna sampling, monitoring and impact assessment to the operator.

Quarterly Technical Reports

After every season (3 monthly), a technical (Quarterly) report will be prepared and present:

- Methodology and survey effort employed.

- Summary of all results for that quarter (including raw datasheets).
- Comparisons between results from that quarter for the current and previous years
- Any issues with monitoring efficacy.
- Discuss and evaluate the application of decision making framework (Section 7.1) in particular:
    - Are any changes to the identification of high risk species or locations required?
    - Have any high risks been identified, requiring management actions?
    - Where an action is required, state clearly its objective, ways that it could be achieved and ways to monitor its success
- Comment on the success or otherwise of other management actions employed to date.

Threatened Species Collision Reporting

Upon detection of evidence of a collision of a bird or bat listed as threatened under the *Environmental Protection and Biodiversity Conservation Act* (1999) or the *Threatened Species Conservation Act* (1995), the following procedure will apply:

- Any dead or injured birds or bats found will be reported to the Responsible Authority (OEH or EPBC) within 24 hours of their identification by telephone or email.
- Injured birds or bats will be taken to a suitable veterinary service for examination.
- The decision to euthanize an injured bird or bat will be made on animal welfare grounds and the final decision to be made by the treating Veterinary Surgeon.
- A Bird/bat Strike Report Form will be submitted to the Responsible Authority (OEH) within three days of discovery of any dead or injured threatened bird or bat. This report will include identification reference, description of evidence, species identification, sex and age (if known), location, photography of evidence and any other relevant information.

Annual Report

The annual report will summarise the results of the previous 12 months of data and provide a synthesised summary of the key results, their significance and the effectiveness of mitigation measures employed. The annual report would consider all monitoring data gathered to date to identify trends and highlight any species at risk. Both the monitoring program (this document) and risk assessment would be revised and updated, if required. Adaptive management considerations would be applied at this time and potential changes to the program documented in the annual report.

Annual Reports would be prepared by the Ecologist and reviewed by the Expert at 12 month intervals from the commencement of operational monitoring (whether full or part). The reporting period is for the preceding 12 months. The report shall be submitted to the Director-General of DPE by the operator within three months of the end of the reporting period.

Annual reports are required for the first five years of operation. Subsequent to this, a two year report will be submitted, unless otherwise agreed with the Director-General.

The Director-General may, at the request of the Proponent, vary the reporting requirement or period by notice in writing to the Proponent. The Proponent may request the Director-General to consider a variation to the reporting requirements at any time.

9 COMPLIANCE

The approval for the project states that:

> ***Condition 6.1 of the Project Approval***
>
> *Environmental Representative(s) shall be the Proponent's principal point of advice in relation to the environmental performance of the project and shall have responsibility for:*
>
> *a) overseeing the implementation of all environmental management plans and monitoring programs required under this approval, and advise the Proponent upon the achievement of these plans/programs;*
>
> *b) considering and advising the Proponent on its compliance obligations against all matters specified in the conditions of this approval, the Statement of Commitments, permits and licences; and*
>
> *c) having the authority and independence to recommend to the Proponent reasonable steps to be taken to avoid or minimise unintended or adverse environmental impacts, and, failing the effectiveness of such steps, to recommend to the Proponent that relevant activities are to be ceased as soon as reasonably practicable if there is a significant risk that an adverse impact on the environment will be likely to occur.*

As such, the ER nominated for the project has a role in monitoring the overall environmental management of the project, which includes the effective management of bird and bat impacts. The level to which the project complies with all CoA, including the management of bird and bat impacts, is evaluated through project auditing, compliance tracking and annual reporting.

9.1 PROJECT AUDITING

This BBMP is one of several required environmental management plans. The broader project will be subject to ongoing auditing during the construction and operational phase. It will be audited against the conditions of approval. The auditing will involve both internal and external audits, undertaken over regular intervals throughout construction. Audits will be conducted in accordance with ISO 19011:2003 - Guidelines for Quality and/ or Environmental Management Systems. Environmental Auditors must be suitably qualified with at least a 3-year university degree in environmental science or related disciplines, and RABQSA certified.

Environmental Actions Register

Actions raised on the Environmental Actions Register must be corrected by the nominated due date. Where this has not occurred, the action is elevated to Level 1 status. At this point, the nominated Environmental Representative (ER) and Wind Farm Project Manager must issue a Corrective Action Required (CAR). The ER or Project Manager may issue a Stop Work Notice if the issue is deemed to potentially impact on the environment.

Non-conformance Control

Non-conformance control will be managed in accordance with the Quality Management System for the project. In general environmental non-conformances may be raised when:

- There is a breach of agreed plans, procedures and work instructions.
- There is a breach of legislation, agreed commitments and community relations.

- A substantial risk of serious environmental impact is present.

9.2 PROJECT COMPLIANCE TRACKING

Compliance tracking will be undertaken during construction and operation, as required by the conditions of approval.

Compliance will be formally reported to DPE as per the conditions of approval. An Annual Environmental Management Report (AEMR) reviewing the performance of the project against the Operational Environmental Management Plan, the conditions of this approval and other licences and approvals relating to the project is required to be prepared to the satisfaction of the ER.

9.3 RELEVANCE TO THIS PLAN

Ultimately, the ER has responsibility for overseeing the implementation of all management plans and monitoring programs required under the project approval and advising the proponent upon the achievement of these plans and programs. This includes the implementation of this Bird and Bat Management Plan.

The incidents reported and actions undertaken as part of the BBMP will be subject to this auditing and compliance tracking regime. The conclusions and recommendations of the BBMP reporting (discussed in Section 8 of this report) will be summarised within the project's overall Annual Environmental Report.

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APPENDIX A CONDITION OF APPROVAL CROSS REFERENCE TABLE

Condition of approval	*Addressed in this BBMP:*
Condition 3.3 of the Project Approval *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 account of bird/ bat monitoring methods identified in the current editions of AusWEA Best Practice Guidelines for the Implementation of Wind Energy Projects in Australia 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 Monitoring, and a Decision Matrix that clearly sets out how the Proponent will respond to the outcomes of monitoring. It shall:*	Risk assessment has been used to identify at risk species and turbine location sites (Appendix B and C). The plan has been prepared by and reviewed by ecologists with doctorates in bird ecology (refer to Appendix F authors' qualifications). A decision matrix is provided in Section 7.
a) incorporate an ongoing role for the suitably qualified expert;	Dr. Jacqui Couglan has provided input into the structure and content of this plan (refer to Appendix F for qualifications of authors of this plan). Further this plan sets out the role for the expert in Section 3. The expert has specific responsibilities in this plan.
b) set out monitoring requirements in order to assess the impact of the project on bird and bat populations, including details on survey locations, parameters to be measured, frequency of surveys 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, that is, data may be required to be collected prior to the commencement of* ***construction;***	Survey requirements and methods are set out in Section 6. They are required to be adaptive such that enough information is gathered to detect changes in populations. Reporting requirements are set out in Section 8. Data analysis requirements are set out in Section 6.4.

Condition of approval	***Addressed in this BBMP:***
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;	A decision matrix is provided in Section 7.1. Its aim is to provide a way to identify high risk situations requiring action and provide sample scenarios to inform all stakeholders of potential management actions that will be rapidly required in response to an event.
d) identify 'at risk' bird and bat groups, seasons (such as wet seasons where bird species may be attracted to nearby wetlands) 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;	Risk assessment has been used to identify at risk species and turbine location sites (Appendix B and C). Seasonality is addressed in Section 6.2. Monthly mortality assessments are proposed for the first 12 months at all turbines.
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	The range of mitigation strategies are provided in Section 7.2 and specific actions set out in Triggers for Action table, Table 7-3.
f) identify matters to be addressed in periodic reports in relation to the outcomes of monitoring, the application of the decision making framework, the mitigation measures identified, progress with the implementation of such measures, and their success.	Reporting requirements, including matters to be addressed in reports, are set out in Section 8. The frequency of reporting is provided in Section 8.2
The Reports referred to under part f) shall be submitted to the Director-General on an annual basis for the first five years of ***operation*** *and every two years thereafter from the commencement of operation (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, vary the reporting requirement or period by notice in writing to the Proponent. The Proponent may request the Director-General to consider a variation to the reporting requirements at anytime.*	

Condition of approval	***Addressed in this BBMP:***
*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.*	The role of the proponent (operator) is set out in Section 3. Each management action would be considered by the Expert and Operator, in terms of what is reasonable and feasible.

Statement of commitment	***Addressed in this BBMP:***
Statement of commitment 15 *h) Bird and bat strike monitoring will be undertaken in accordance with the monitoring guidelines provided by the Australian Wind Energy Association (Brett Lane & Associates 2005). If results show that longer term monitoring is required then a monitoring programme will be developed in consultation with DECCW and other departments/agencies as required. Such a programme could include adaptive management whereby significant impacts are dealt with by using an adaptive approach;*	This plan sets out a monitoring strategy for the first 12 months and a requirement to adapt monitoring as required to assess impacts over the 5-year duration of the program. It stipulates that continued monitoring would be subject to the results of the data obtained in the first year (Section 6.5). A recommendation to forward the first annual report to OEH has been made in Section 8.5.
i) Should WTG's require lighting, select lighting that minimises the likelihood of attracting insects and hence foraging bats, subject to CASA requirements;	Provision of ongoing advice relevant to management of bird and bat impacts is set out in the role of the expert, Section 3. This would include any effects of lighting on bird and bat impacts.

APPENDIX B HIGHER RISK TURBINES

Risk matrix anticipating the likelihood of bird and bat collision with turbines according to their location (i.e. proximity to a wetland, trees cluster/wood, ridge and valley). Note: grid references given for turbines are for their proposed location prior to construction.

WTG Number	Old WTG Number	E	N	Wetland	Trees	Ridge	Valley
T01	75	685651	5940690			■	
T2A	0	685387	5941027		■		■
T18	68	685950	5945309				■
T25	88	687282	5946971		■		
T26	60	687062	5947430	■			
T27	65	687305	5947553	■			
T29	92	685799	5947060	■			
T35	77	686725	5949239	■			
T36	76	686437	5949679	■	■		
T37	82	687710	5949418		■	■	
T41	69	688569	5950519	■			
T42	73	687965	5949062		■	■	
T43	79	688370	5949329		■	■	
T45	48	689060	5948990		■	■	
T46	64	689264	5949903		■	■	
T47	27	690021	5952945		■	■	
T49	28	690269	5953865	■			
T50	29	690378	5954117	■			
T52	30	691064	5953898	■			
T54	39	691168	5951077		■		
T55	38	691452	5951277			■	■
T56	37	691417	5951635			■	■
T57	40	691437	5952042			■	■
T58	45	691890	5952113			■	■
T64	41	692295	5954209	■			
T65	35	692760	5952311			■	■
T66	34	692762	5952598			■	■

APPENDIX C BIRD AND BAT RISK ASSESSMENT

C.1 RISK ASSESSMENT ANTICIPATING THE LIKELIHOOD OF BIRD COLLISION WITH TURBINES FOR KNOWN SPECIES RECORDED AT BRWF

The risk assessment has been applied to bird species recorded at Boco Rock during the biodiversity assessment or identified within database searches and has been undertaken prior to commencement of the monitoring program. Survey results and subsequent analysis may supersede assumptions arising from this risk assessment. The risk assessment reviews the potential for blade-strike risk or threat of flying within the rotor swept area (RSA). Species were ranked against species impact factors with each factor scored as either 0 (no impact or risk, or not relevant) or 1 (risk of impact possible). A species could accrue a maximum of 7 points under this system and species with totals of four or more were considered to be 'at risk'. These factors are detailed in the box below.

Fauna impact factors

1. **Habitat present and site distribution.** Marginal or movement corridors occur; suitable habitat occurs. Core breeding habitat present.
2. **Conservation status.** Threatened or declining (non-threatened migratory may also be rare or declining).
3. **Flight height**. Height of flying or foraging in the air column; likely to fly within rotor swept area at some point (does not discriminate between proportion of time spent in RSA)..
4. **Flight character.** Awkward flight characteristics; large or heavy bodied, or known to have low agility. Raptors hunting for prey.
5. **Movement behaviours.** Migratory, nomadic, very large home range, or flocking species (groups > than 4).
6. **Poor dispersal capability**. Based on known ecology, whether they have an ability to colonise new areas of habitat following disturbance.
7. **Low Density**. Whether a species is naturally distributed at low densities.

AT RISK BIRD SPECIES

Barking Owl
Powerful Owl
Masked Owl
Sooty Owl (later omitted)
Blue-billed Duck
Glossy Black-cockatoo
Glossy Ibis
Great Egret
Latham's Snipe
Little Eagle
Square-tailed Kite
Wedge-tailed Eagle
White-bellied Sea-eagle
Swift Parrot

CODE	COMMON NAME	SPECIES NAME	ID	DB	STATUS		HABITAT (within Development Envelope)		FLIGHT HEIGHT		FLIGHT CHARACTER		MOVEMENT BEHAVIOURS		DISPERSAL CAPABILITY		LOW DENSITY		RISK SCORE
					0 = None; 1 = Threatened		0 = Unlikely; 0.5 = Possible; 1 = Suitable		0 = Below RSA; 1 = within RSA		0 = not at risk; 1 = awkward flight (large, low agility)		0 = Resident; 1 = Migratory, Nomadic or Lge homerange		0 = Good dispersal; 1 = poor dispersal		0 = common; 1 = naturally occur at low densities		> 4 = at risk
WB	Australasian Bittern	*Botaurus poiciloptilus*		o	E TSC & EPBC	1	Freshwater wetlands, usually densely vegetated. Flooded shrubbery or reedbeds.	0.5	Can rise to height if startled, but most likely below RSA.	0	Known to fly at night	0	N - outside breeding season	1		0		0	**2.5**
WB	Australasian Grebe	*Tachybaptus novaehollandiae*	*		N	0	Diverse lakes, swamps, and dams, usually wetlands with abundant vegetation	1	Can fly at night	0		0	R - territorial	0		0		0	**1**
WB	Australasian Shoveler	*Anas rhynchotis*	*		N	0	Wetlands, permanent lakes, or swamps with abundant cover.	1	Flight swift and direct	0		0	N - Highly dispersive	1		0		0	**2**
R	Australian Hobby	*Falco longipennis*	*		N	0	Woodland and open forest, surrounds of lakes and swamp.	1	Usually hunts from perches or from 5-20m in open country.	1	Flight swift and direct.	0	R, N	1		0		0	**3**
P	Australian Magpie	*Gymnorhina tibicen*	*		N	0	Where there is treed areas and open areas in combination. Absent from very dense forests / woodlands.	1	Forage on the ground in open fields. Glide to foraging sites. May fly to great heights in aggressive pursuit of potential predators.	1		0	R	0		0		0	**2**
N	Australian Owlet Nightjar	*Aegotheles cristatus*	*		N	0	Any tree-studded area where there are suitable hollows, although open areas are also visited. During the day it roosts in hollow branches and tree trunks. The birds form permanent bonds, and pairs occupy the same territory throughout the year.	0.5		1		0	R, N, M, W	1	Dispersive and migrate after breeding	0		0	**2.5**
M	Australian Painted Snipe	*Rostratula australis*		o	V, M EPBC	1	Wetlands, swamps, lakes, waterlogged grassland, dams.	0.5	Below Canopy - usually cryptic species staying concealed in vegetation.	1		0	M, W - Highly dispersive	0	Movements governed by presence of water	0		0	**2.5**
P	Australian Raven	*Corvus coronoides*	*		N	0	Woodlands, Grasslands	1	Below Canopy	0		0	R	0		0		0	**1**
WB	Australian Wood Duck	*Chenonetta jubata*	*		N	0	Dams, lakes, estuaries, damp pasture	1	Flight low below trees	0		0	R, N	1		0		0	**2**
N	Barking Owl	*Ninox connivens*		o	V TSC	1	It occurs in dry box-dominated forest and woodlands and roosts in dense foliage of Acacia, Casuarina or Eucalyptus species. It nests in large hollows (20-46 cm diameter) of large, old eucalypts including River Red Gum, White Box, Red Box and Blakely's Red Gum (NPWS 2003a). Nest and roost sites are usually near watercourses or wetlands (NPWS, 2003a). The species have also been recorded in remnants of forest and woodland and in clumps of trees at farms, towns and golf courses (NPWS, 2003a).	0.5		1		0	R, N	1	Have large territories of 30 to more than 200 hectares	0		1	**4.5**
P	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	*		N	0	Woodlands	1	Below Canopy	0		0		0		0		0	**1**
R	Black-shouldered Kite	*Elanus axillaris*			N	0	Hunts over natural grasslands and or low farmland stubble.		Direct flight with quick wing beats. Will hover over prey, usually small prey (house mouse).	1	Will hover while hunting and drops suddenly to take prey. Soars on currents.	0	R, N	1	Small and agile.	0		0	**2**
WB	Blue-billed Duck	*Oxyura australis*		o	V TSC	1	Deep, densely vegetated freshwater wetlands	0.5	Most likely above canopy when dispersing during the breeding seasons to other swamps (up to 300 km away). Juveniles disperse in April-May from breeding swamps.	1		1	R, N	1	Movements governed by presence of water	0		0	**4.5**

CODE	COMMON NAME	SPECIES NAME	ID	DB	STATUS		HABITAT (within Development Envelope)		FLIGHT HEIGHT		FLIGHT CHARACTER		MOVEMENT BEHAVIOURS		DISPERSAL CAPABILITY		LOW DENSITY		RISK SCORE
					0 = None; 1 = Threatened		0 = Unlikely; 0.5 = Possible; 1 = Suitable		0 = Below RSA; 1 = within RSA		0 = not at risk; 1 = awkward flight (large, low agility)		0 = Resident; 1 = Migratory, Nomadic or Lge homerange		0 = Good dispersal; 1 = poor dispersal		0 = common; 1 = naturally occur at low densities		> 4 = at risk
R	Brown Falcon	*Falco berigora*	*		N	0	Widespread in most habitats. Woodland, lightly treed farmland, watercourse tree lines, heath.	1	Usually hunts from perches or from 5-20m in open country.	1		0	R, N	1		0		0	**3**
R	Brown Goshawk	*Accipiter fasciatus*		o	N	0	Forest, woodland, dry scrub and farms.	0	Usually hunts from perch, waiting to ambush prey. Takes more prey from ground than in flight.	0	Fast, agile.	0	R, part M	1	Dispersive outside the breeding season	0		1	**2**
GD	Brown Quail	*Coturnix ypsilophora*	*		N	0	Prefers dense grasslands, often on the edges of open forests, and bracken. May sometimes be seen alongside roads.	1		0		0	R	0		0		0	**1**
P	Brown Songlark	*Cincloramphus cruralis*	*		N	0	Open country, including pastures, short crops, and grassy scrub	1	Below Canopy			0	N, moving from drought affected areas	1		0		0	**2**
P	Brown Treecreeper	*Climacteris picumnus victoriae*		o	V TSC Act	1	Euc woodlands, mallee and drier open forest, preferring woodlands lacking dense understorey. Requires relatively intact woodland areas.	0.5	Below Canopy	0		0	R	0		1		0	**2.5**
M	Cattle Egret	*Ardea ibis*		o	M EPBC	1	Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands, dams or ploughed fields and temporary water.	0.5	Above Canopy	1		0	N, M	1	Movements governed by presence of water	0		0	**3.5**
P	Common Bronzewing	*Phaps chalcoptera*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
P	Common Koel	*Eudynamys scolopacea*	*		N	0	Tall forests and are common in suburban areas.	1	Below Canopy	0		0	M	1		0		0	**2**
P	Common Myna	*Acridotheres tristis*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
P	Common Starling	*Sturrns vulgaris*	*		N	0	Woodlands, Grasslands	1	Below Canopy	0		0	R	0		0		0	**1**
P	Crested Pigeon	*Ocyphaps lophotes*	*		N	0	Woodlands, Grasslands	1	Below Canopy	0		0	R	0		0		0	**1**
Pt	Crimson Rosella	*Platycercus elegans*	*		N	0	Sclerophyll forests, woodlands and timbered farmlands.	1	Forage on ground or branches, but fly at height when travelling between sites but prefer forested areas.	0		0	R	0		0		0	**1**
P	Diamond Firetail	*Stagonopleura guttata*	*	o	V TSC Act	1	Woodlands, Grasslands	1	Below Canopy	0		0	R	0		1		0	**3**
WB	Dusky Moorhen	*Gabinula tenebrosa*	*		N	0	Wetlands (fresh and estuaries). Inhabits large open areas of permanent of temporary water.	1	Below Canopy	1		0	R	1		0		0	**3**
Pt	Eastern Rosella	*Platycercus eximius*	*		N	0	Sclerophyll forests, woodlands and timbered farmlands.	1	Forage on ground or branches, but fly at height when travelling between sites but prefer forested areas.	0		0	R	0		0		0	**1**
P	Eastern Spinebill	*Acanthorhynchus tenuirostris*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
WB	Eurasian Coot	*Fulica atra*	*		N	0	Occurs widely on wetlands, rivers, lakes, swamps, dams.	1	Below Canopy	0		0	R	0		0		0	**1**
P	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	*		N	0	Inhabits most open forests and woodlands, as well as cleared and cultivated open country.	1	Below Canopy	0		0	M	1		0		0	**2**
Ro	Flame Robin	*Petroica phoenicea*	*	o	V TSC Act	1	Forests and woodlands of native vegetation with an open understorey. Breeds in upland forests.	1	Below Canopy	0		0	N, W	1	Breeds in area during breeding season. Disperses to more open lowland habitats in winter (usually sth western slopes)	0		0	**3**

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M	Fork-tailed Swift	*Apus pacificus*		o	M EPBC	1	It spends most of its time in the air feeding on insects, occasionally roosting on cliffs or in large trees (Pizzey *et al.*, 2006).	0	Above Canopy	1		0	M, W	1	This species breeds from central Siberia eastwards through Asia and winters south to Australia.	0		0	**3**
Pt	Galah	*Cacatua roseicapilla*	*		N	0	Occur in a variety of habitat types including open country with scattered suitable trees or woodland areas	1	Forgae on ground, but fly at height when travelling between sites	0		0	R	0		0		0	**1**
Pt	Gang-gang Cockatoo	*Callocephalon fimbriatum*		o	V TSC	1	Woodland - Flowering Eucs or Acacias important	0.5	Forage on mid- upper-stratums on seeds and Eucs. May fly at heights when travelling between sites, but prefers to fly in cover of forest.	0		0	N - Highly dispersive	1		0		0	**2.5**
Pt	Glossy Black-cockatoo	*Calyptorhynchus lathami*		o	V TSC	1	Woodland - Feed trees (*Allocasuarina*) important	0.5	Forage on mid- upper-stratums on feed trees. Fly at height when travelling between sites.	1		0	N - Highly dispersive	1		0		1	**4.5**
M	Glossy Ibis	*Plegadis falcinellus*		o	M EPBC	1	Fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation.	0.5	Above Canopy	1		1	M, W	1	Movements governed by presence of water	0		0	**4.5**
M	Great Egret	*Ardea alba*		o	M EPBC	1	Wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial). These include swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs.	0.5	Above Canopy	1		1	N, M	1	Movements governed by presence of water	0		0	**4.5**
P	Grey Currawong	*Strepera versicolor*	*		N	0	Range of habitats from the coast to the semi-desert, including forests, woodlands, mallee, coastal and other heaths. Also found in remnant vegetation on roadsides and farms, in orchards, and in suburban areas.	1	Below Canopy	0		0	R	0		0		0	**1**
P	Grey Fantail	*Rhipidura albiscapa*	*		N	0	Forests and woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
P	Grey Shrikethrush	*Coffuricincla harmonica*	*		N	0	Forests and woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
WB	Grey Teal	*Anas gracilis*	*		N	0	Permanent or temporary wetlands, dams.	1	Flight swift and direct	0		0	R, N	1		0		0	**2**
WB	Hoary-headed Grebe	*Poliocephalus poliocephalus*	*		N	0	Wetlands (fresh and estuaries). Inhabits large open areas of permanent of temporary water.	1	Can fly at night	0		0	N	1		0		0	**2**
Ro	Hooded Robin	*Melanodryas cucullata cucullata*		o	V TSC Act	1	Open eucalypt woodland and scrub, often in or near cleared areas. Woodland remnants with high habitat complexity. Uses stumps, posts of fallen timber for nesting and foraging.	0.5	Below Canopy	0		0	R	0	Territories range form 10 - 30 ha.	0		0	**1.5**

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M	Latham's Snipe	*Gallinago hardwickii*		o	M EPBC	1	Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity.	0.5	Below Canopy	1		1	M, W	1	Movements governed by presence of water	0		0	**4.5**
P	Laughing Kookaburra	*Dacelo novaeguineae*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
Pt	Little Corella	*Cacatua sanguinea*	*		N	0	Little Corellas often form large flocks, especially along watercourses and where seeding grasses are found.	1	Below Canopy	1		0	N	1		0		0	**3**
R	Little Eagle	*Hieraaetus morphnoides*		o	V TSC	1	Wide variety of habitats. Woodland, open scrub, tree-lined watercourses. Most abundant where open country mixes with wooded or forested hills. Not in densely forested areas.	0.5	Soars to dive at height from about 100m	1	Soars on the updrafts generated by wind deflected up the slope.	1	Usually R, possible N	1	Young dispersive	0		1	**5.5**
P	Little Raven	*Corvus mellori*	*	o	N	0	Woodlands, Grasslands	1		0		0	R	0		0		0	**1**
P	Magpie-lark	*Grallina cyanoleuca*	*		N	0	Woodlands, Grasslands	1	Below Canopy	0		0	R	0		0		0	**1**
WB	Masked Lapwing	*Vanellus miles*	*		N	0	Swamps and lakes, shallows, dams, lakes	1	Usually below canopy	0		1	N	1		0		0	**3**
N	Masked Owl	*Tyto novaehollandiae*		o	V TSC	1	Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides	0.5		1		0	R, N	1	Pairs have a large home-range of 500 to 1000 hectares.	0		1	**4.5**
P	Masked Woodswallow	*Artamus personatus*	*		N	0	Found in open country, often far from water, as well as in open woodlands, around lakes and wetlands and in irrigated areas.	1	Can soar high above canopy	1		0	R, sometimes N	0		0		0	**2**
R	Nankeen Kestrel	*Falco cenchroides*	*		N	0	Open habitats, woodlands, grassland, sparse scrub, farms, roadsides.	1	Can use uplift from wind to drop suddenly. Usually hunting from canopy level on a perch or close to ground.	1	Erratic changes in direction, stopping to hover and glide. Agile and fast.	0	R, N	1		0		0	**3**
HE	Noisy Minor	*Manorina melanocephala*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
P	Olive Whistler	*Pachycephala olivacea*		o	V TSC	1	Woodlands	0.5		0		0	R	0		0		0	**1.5**
WB	Pacific Black Duck	*Anas superciliosa*	*		N	0	All wetland habitats, permanent or temporary water	1	Flight low below trees	0		1	N	1		0		0	**3**
GD	Painted Buttonquail	*Turnix varia*	*		N	0	Temperate and eastern tropical forests and woodlands form the habitats of this species. They appear to prefer closed canopies with some understory and deep leaf litter on the ground.	1		0		0	R	0		0		0	**1**
P	Pallid Cuckoo	*Cuculus palllidus*	*		N	0	Inhabits most open forests and woodlands, as well as cleared and cultivated open country.	1		0		0	R	0		0		0	**1**
R	Peregrine Falcon	*Falco peregrinus*	*		N	0	Diverse habitat, from rainforest to arid scrub to coastal heath to alpine.	1	Hunts from above and can soar high, circling.	1	Powerful, fast.	0	R	1		0		0	**3**
P	Pied Butcherbird	*Cracticus nigrogularis*	*		N	0	Woodlands	1		0		0	R	0		0		0	**1**
P	Pied Currawong	*Strepera graclina*	*		N	0	Woodlands	1		0		0	R	0		0		0	**1**

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Ro	Pink Robin	*Petroica rodinogaster*		o	V TSC Act	1	Open forests and woodlands. Breed in dry eucalypt forests and temperate woodland. Fallen timber is important for nesting and foraging.			0		0	R, N	0	Disperses north and west into more open habitats for winter.	0		0	**1**
N	Powerful Owl	*Ninox strenua*		o	V TSC	1	This species occurs primarily in tall, moist productive eucalypt forests of the eastern tableland edge and the mosaic of wet and dry sclerophyll forests occurring on undulating, gentle terrain nearer the coast (DEC NSW, 2006b). Only scattered, mainly historical records are from the western slopes and plains (DECCW 2010). The species requires old hollow eucalypts in unlogged, unburnt forests for nesting, and roosts in dense mid-canopy trees or tall shrubs (She-oaks, wattles or rainforest species). Nesting and roosting habitat occurs in sheltered gullies, or within 100m of streams, creekflats or minor drainage lines (DEC NSW, 2006b). Hollows greater than 45 cm diameter and greater than 100 cm deep are required.	0.5		1		0	R, N	1	Breeding pairs of this species defend large (300-1500 hectare), permanent territories.	0		1	**4.5**
M	Rainbow Bee-eater	*Merops ornatus*		o	M EPBC	1	Woodlands with sandy, loamy soil. It builds a burrow in sandy ground or bank cuttings such as roads or creeks.	0.5		1		0	N, M	1		0		0	**3.5**
P	Red Wattlebird	*Anthochaera carunculata*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
Pt	Red-rumped Parrot	*Psephotus haematonotus*	*		N	0	Woodlands, Grasslands	1	Forages mostly on ground	0		0	R, N	1		0		0	**2**
M	Regent Honeyeater	*Anthochaera phrygia*		o	E TSC & EPBC Act, M	1	Woodland - Flowering Eucs important	0.5		1		0	N - Highly dispersive	1	Wintering Sites on SE Coast	0		0	**3.5**
P	Richard's Pipit	*Anthus novaeseelandiae*	*	o	N	0	Woodlands, Grasslands	1	Below Canopy	0		0	R	0		0		0	**1**
P	Rufous Songlark	*Cincforamphus mathewsi*	*		N	0	Favours open grassland, grassy open woodland, farmed land and mulga.	1	Below Canopy	0		0	R, M	1		0		0	**2**
P	Rufous Whistler	*Pachycephala rufiventris*	*		N	0	Forests, woodlands and shrublands, with a shrubby understorey. Is also found in gardens and farmland with some trees, and in remnant bushland patches.	1	Below Canopy	0		0	R	0		0		0	**1**
M	Satin Flycatcher	*Myiagra cyanoleuca*		o	M EPBC	1	Heavily vegetated gullies in forests, usually above a shrub layer. During migration it is often found in coastal forests.			0			N, M			0		0	**1**
Ro	Scarlet Robin	*Petroica boodang*		o	V TSC Act	1	Open forests and woodlands. Breed in dry eucalypt forests and temperate woodland. Fallen timber is important for nesting and foraging.	0.5		0		0	R	0		0		0	**1.5**
M	Silver Gull	*Chroicocephalus novaehollandiae*		o	Ma EPBC	0	Any watered habitat and is rarely seen far from land.	1		1		0	N, W	0	Movements governed by presence of water	0		0	**2**
P	Silvereye	*Zosterops lateralis*		o	N	0	Most vegetation types, preferring dense coastal shrubs, commercial orchards and urban parks and gardens. Partially migratory (Schodde and Tidemann 2007).	0.5	Forage below canopy on shrubs, but fly high when migrating	0		0	M, F	1		0		0	**1.5**
N	Sooty Owl	*Tyto tenebricosa*		o	V TSC	1	Wet eucalypt forest and rainforest. Frequently found in tall old growth forests with a dense understorey. Roosts by day in the hollow of a tall forest tree or in heavy vegetation.	0		1		0	R, N	1		0		1	**4**

CODE	COMMON NAME	SPECIES NAME	ID	DB	STATUS		HABITAT (within Development Envelope)		FLIGHT HEIGHT		FLIGHT CHARACTER		MOVEMENT BEHAVIOURS		DISPERSAL CAPABILITY		LOW DENSITY		RISK SCORE
					0 = None; 1 = Threatened		0 = Unlikely; 0.5 = Possible; 1 = Suitable		0 = Below RSA; 1 = within RSA		0 = not at risk; 1 = awkward flight (large, low agility)		0 = Resident; 1 = Migratory, Nomadic or Lge homerange		0 = Good dispersal; 1 = poor dispersal		0 = common; 1 = naturally occur at low densities		> 4 = at risk
N	Southern Boobook	*Ninox novaeseelandiae*	*		N	0	Seen in a variety of habitats from dense forest to open desert.	1		1		0	R	0		0		0	**2**
P	Southern Whiteface	*Aphelocephala leucopsis*	*		N	0	Open woodlands through to wetter grassy woodlands	1		0		0		0		0			**1**
P	Speckled Warbler	*Chthonicola sagittata*		o	V TSC	1	Dry sclerophyll forests and woodlands, typically structurally diverse with a grassy understorey.	0.5	Forages on ground	0		0	R	0		0		0	**1.5**
R	Spotted Harrier	*Circus assimilis*		o	V TSC	1	Open country with dense goundcover, very open woodland	0	Glides low over grassland, farmland, will sometimes soar higher, but usually when dispersing	1	Will travel fast on downward glide, when reached enough speed	0	R, N	1	Dispersive - movements depend on food resources	0		0	**3**
P	Spotted Pardalote	*Pardalotus punctatus*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
R	Square-tailed Kite	*Lophoictinia isura*		o	V TSC	1	Euc woodland, open forest and heathlands.	0.5	Often at tree top level or low over heath or grassland	1	Glides and derives lift from updrafts.	0	S, Partly N	1		0		1	**4.5**
P	Striated Pardalote	*Pardalotus striatus*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
Pt	Sulpher-crested Cockatoo	*Cacatua galerita*	*		N	0	Variety of timbered habitats and are common around human settlements.	1		1		0	R	0		0		0	**2**
P	Superb Fairy-wren	*Malurus cyaneus*	*		N	0	Woodlands, Grasslands	1		0		0	R	0		0		0	**1**
R	Swamp Harrier	*Circus approximans*		o	N	0	Glides over reedbeds, swamps, open water	0.5	Usually hunting over water	1	Flight buoyant, languid soaring and gliding	0	N, M	1		0		1	**3.5**
Pt	Swift Parrot	*Lathamus discolour*		o	E1 TSC, E EPBC	1	Euc forests and woodlands (particularly Box Ironbox) - Flowering Eucs important	0	Forage on mid- upper-stratums on feed trees. Fly at height when travelling between sites.	1		0	N - Highly dispersive	1	Breeds in Tas, migrates to NSW. Wintering Sites on SE Coast	0		1	**4**
P	Torresian Crow	*Corvus orru*	*		N	0	Found on rainforest fringes, in open forests and woodlands, taller scrublands, beaches and in dry areas, along watercourses with tall timber. It is also found around farms and in croplands. It requires tall trees for nesting.	1		0		0	R	0		0		0	**1**
P	Tree Martin	*Hirundo nigricans*	*		N	0	Open woodland, preferrably with tall trees for nesting.	1		1		0	R, M, W	1		0		0	**3**
P	Varied Sittella	*Daphoenositta chiysoptera*	*	o	V TSC	1	Woodlands with native understorey.	1		0		0	R	0		0		0	**2**
R	Wedge-tailed Eagle	*Aquila audax*	*		N	0	Woodlands, Forest, Plain habitats across Australia	1	Above RSA over open country and on steep hills	1	Soars on air currents and swooping on prey. Territorial displays.	1	R. Takes flight heavily, with slow, deep, powerful wing beats.	0	Transient juveniles known to rapidly fill empty territories.	0		1	**4**
P	Weebill	*Smicromis brevirostris*	*		N	0	Woodlands	1		0		0		0		0		0	**1**
P	Welcome Swallow	*Hirundo neoxena*	*		N	0	Wide variety of habitats with the exception of the more heavily forested regions and drier inland areas.	1		1		0	R, partially M	1		0		0	**3**
R	Whistling Kite	*Haliastur sphenurus*	*		N	0	Often over wetlands, but open woodlands and scrub	1	Often glides low around tree tops	1	Flight buoyant, languid soaring and gliding	0	R, N	1		0		0	**3**
M	White-bellied Sea-eagle	*Haliaeetus leucogaster*		o	M EPBC	1	Reefs, headlands, beaches, estuaries, mangroves, swamps, floodplains, major rivers.	0.5	Above Canopy		Soars to height, circling rising on air columns.	1	N, M	1		0		1	**4.5**
P	White-browed Scrubwren	*Sericornis frontalis*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
P	White-browed Woodswallow	*Artamus superciliosus*	*		N	0	Wide range of inland habitats, from eucalypt forests and woodlands to dry heaths and spinifex. It can also be found in farmlands, orchards and towns.	1	Below Canopy	0		0	N	1		0		0	**2**

CODE	COMMON NAME	SPECIES NAME	ID	DB	STATUS		HABITAT (within Development Envelope)		FLIGHT HEIGHT		FLIGHT CHARACTER		MOVEMENT BEHAVIOURS		DISPERSAL CAPABILITY		LOW DENSITY		RISK SCORE
					0 = None; 1 = Threatened		0 = Unlikely; 0.5 = Possible; 1 = Suitable		0 = Below RSA; 1 = within RSA		0 = not at risk; 1 = awkward flight (large, low agility)		0 = Resident; 1 = Migratory, Nomadic or Lge homerange		0 = Good dispersal; 1 = poor dispersal		0 = common; 1 = naturally occur at low densities		> 4 = at risk
WB	White-faced Heron	*Egretta novaehollandiae*	*		N	0	Swamps and lakes, shallows, dams, lakes	1	Usually below canopy	0		1	N	1		0		0	**3**
HE	White-naped Honeyeater	*Melithreptus lunatus*	*		N	0	Open forests and woodlands	1	Forage in canopy, but may fly at height when migrates.	1		0	M	1		0		0	**3**
M	White-throated Needletail	*Hirndapus caudacutus*		o	M EPBC	1	Woodland and Grassland, but usually forage in closed wooded areas. Recorded in airspace above woodlands, forests, farmlands.	0.5	Aerial - 1m up to 'cloud level'.	1	Seen 'patrolling' favoured feeding grounds above ridges and hilltops	0	M, N, W - Highly dispersive	1	Non-breeding season in Australia (Oct - Feb). Move between south and north Australia.	0		0	**3.5**
P	White-throated Treecreeper	*Cormobates leucophaea*	*		N	0	Prefers forests, including rainforests, woodlands and timbered river areas. Rarely seen on the ground, it lives in permanent territories.	1	Below Canopy	0		0	R	0		0		0	**1**
P	White-winged Chough	*Corcorax melanorhamphos*	*		N	0	Woodlands	1		0		0	R	0		0		0	**1**
P	White-winged Triller	*Lalage tricolor*	*		N	0	Woodlands and dry open forest, with shrub and grassy understorey	1	May forage during flight	1	Circling, climbing, gliding flight displays	0	M, N	1		0		0	**3**
P	Willie Wagtail	*Rhipidura leucophyrs*	*		N	0	Woodlands, Grasslands	1	Below Canopy	0		0	R	0		0		0	**1**
HE	Yellow-faced Honeyeater	*Lichenostomus chrysops*	*		N	0	Open forests and woodlands	1	Forage in canopy, but may fly at height when migrates.	1		0	M	1		0		0	**3**
P	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	*		N	0	Woodlands	1	Below Canopy	0		0	R	0		0		0	**1**
Pt	Yellow-tailed Black-cockatoo	*Calyptorhynchus funereus*	*		N	0	Woodland over heathlands with feed trees (i.e. banksias)	1	Forage on mid- upper-stratums on seeds and Eucs. Will fly at heights when travelling between sites.	1		0	N, F	0		0		0	**2**

KEY:

ID: Identified during the biodiversity assessment field work

DB: Identified from database searches (Atlas Wildlife Search of EPBC Protected Matters Search)

CODE: GD – Ground-dwelling; He – Honeyeater; WB – Waterbird; N – Nocturnal; M – Migratory (most relevant attribute); P – Passerine; Pt – Parrot or Cockatoo; Ro – Robin; R - Raptor

MOVEMENT BEHAVIOURS: R – Resident species; N – Nomadic species; M – Migratory species; W – Wintering species

D.1 RISK ASSESSMENT ANTICIPATING THE LIKELIHOOD OF BAT COLLISION WITH TURBINES FOR KNOWN SPECIES RECORDED AT BOCO ROCK WIND FARM

The risk assessment has been applied to bat species recorded at Boco Rock during the biodiversity assessment or identified within database searches and has been undertaken prior to commencement of the monitoring program. Survey results and subsequent analysis may supersede assumptions arising from this risk assessment.

The risk assessment reviews the potential for blade-strike risk or threat of flying within the rotor swept area (RSA). Species were ranked against species impact factors with each factor scored as either 0 (no impact or risk, or not relevant) or 1 (risk of impact possible). A species could accrue a maximum of 4 points under this system and species with totals of 3 or more were considered to be 'at risk'. These factors are detailed in the box below.

Fauna impact factors

1. **Conservation status.** Threatened species.
2. **Seasonal Risk.** Risk from migrational movements.
3. **Flight character**. Height of flying or foraging in the air column; likely to fly within rotor swept area at some point (does not discriminate between proportion of time spent in RSA).
4. **Foraging dispersal**. Based on known ecology, whether bat species forage high and over large distances (need to forage widely increases the species ability to cover more distance and therefore be more susceptible to blade-strike / barotrauma).

AT RISK BAT SPECIES

Eastern Bentwing Bat

White-stripted Freetail Bat

Yellow-bellied Sheathtail Bat

Scientific name	Common name	Conservation status		Seasonal Risk (eg. Migration)		Flight character		Roosting	Foraging dispersal		Breeding season	Likelihood of species behaviour resulting in collisions	Risk score
		0 = None; 1 = Threatened		0 = doesn't migrate; 1 = migrates		0 = below canopy; 1 = above canopy			0 = small foraging range, or forage low not in open areas; 1 = forage high in open areas or over large distances				
Chalinolobus gouldii	Gould's Wattled Bat		0	No	0	Above canopy & sub canopy	1	Tree hollows, buildings	Forages up to 11 km from roost sites. Will pass through open paddocks	1	Mating in late autumn / winter Juveniles fly December or January	Mod	2
Chalinolobus morio	Chocolate Wattled Bat		0	No - individuals in southern Australia do not migrate	0	Mid canopy to below canopy	0	Tree hollows, buildings and caves	Range of habitats including treeless regions	0	Birth in November	Low	0
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	1	No	0	Below or near the canopy and along tracks	0	Tree hollows and sometimes buildings	Highly mobile, with large foraging range; uncommon on ridgetop forests where soil fertility is low.	1	Females pregnant late spring to early summer Lactation December to mid-January	Moderate	2
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	V	1	Yes - travel up to several hundred kilometres to over-wintering roosts	1	Above canopy and open areas	1	Caves, disused mines	Fast and direct flight Forested areas, open areas, waterways, street lights and tracks	1	Mating in early winter Birth in spring / Summer Juveniles leave cave in march	**High**	4
Nyctophilus spp.	A Long-eared Bat		0	No	0	Below canopy and often fly close to the ground	0	Dead trees, exfoliating bark or hollows	Slow, manoeuvrable, undulating flight through dense canopy Can forage in open areas but most is in dense areas Capable of foraging up to 12 km from their roost - when commuting flight is rapid and direct	0	Birth October - November Young fly in December or January	Low	0

Scientific name	Common name	Conservation status		Seasonal Risk (eg. Migration)		Flight character		Roosting	Foraging dispersal		Breeding season	Likelihood of species behaviour resulting in collisions	Risk score
		0 = None; 1 = Threatened		0 = doesn't migrate; 1 = migrates		0 = below canopy; 1 = above canopy			0 = small foraging range, or forage low not in open areas; 1 = forage high in open areas or over large distances				
Tadarida australis	White-striped Freetail Bat		0	Y - migrate to northern regions during winter (non- hibernating species)	1	Above canopy	1	Large eucalypts (often in their hollows) Roosts in trees in a range of habitats from forest to open parklands	Fast and direct path High altitude feeding Can commute 50 km between roost and feeding	1	Birth mid- December to end of January Juveniles weaned by mid- February	Moderate - High	3
Vespadelus darlingtoni	Large Forest Bat		0	N	0	Below canopy, within canopy and forest floor	0	Tree hollows	Cluttered vegetation avoided. Foraging and commuting focused along trails and streams	0	Birth November – December Juveniles fly from mid- January.	Low	0
Vespadelus regulus	Southern Forest Bat		0	N	0	Below canopy & within canopy	0	Tree hollows and roof cavities	Agile, fluttery flight	0	Birth early summer	Low	0
Vespadelus vulturnus	Little Forest Bat		0	N	0	Below canopy	0	Roof cavities and hollows in dead timber	Agile, fluttery flight	0	Birth early summer	Low	0
Saccolaimus flaviventris	Yellow-bellied sheathtail- bat**	V	1	Unlikely	0	Above canopy but lower in open area	1	Tree hollows and buildings	High and fast over forest canopy	1	December to mid-March	Moderate - High	3

NOTE:

Flight characters sources from Strahan (2008) or DECC (2009)

** = not recorded in the study area but predicted to occur

APPENDIX D SURVEY PROTOCOLS

D.1 MORTALITY SURVEY

symbolix

To: Deb Frazer
NGHenvironmental
Via EMAIL

Ref #: NGHBOCOL20130423b
Date: 23rd April, 2013
CC: Nil

Re: **Boco Rock Mortality Monitoring Specification and Field Notes**

Dear Deb,

Please find following a complete specification for the mortality monitoring, detailing the selection, analysis and field practices required to attain the outcomes outlined in the Boco Rock Bird and Bat Adaptive Management Plan. (BBAMP)

Background:

This design specifies 50 turbines to be included in the carcass monitoring. Greater sampling numbers may be used if desired, but included here is a complete monitoring protocol with selected turbines according to specified sampling fractions.

The turbine search area includes two zones: a high detectability zone ('core zone') that is monitored for all turbines, and an extended region that is monitored for a randomly selected subsample. The high detectability area is surveyed twice per survey cycle (with approximately a 28 day followed by a three-day interval between) and the extended area is surveyed once per month. This is designed to balance the requirement to sample all turbines, the need to ensure adequate coverage of the turbine area and the need to account for faster scavenging of smaller carcasses.

Selection of turbines with extended survey area

The selection of turbines is a stratified, random sample with unequal selection probabilities. Those with extended areas are chosen via a secondary random selection from the initial stage. The BBAMP is limited in its scope to only 67 (T01-T67) turbines.

The site uses two stratification layers, as identified in Appendix B of the BBAMP. There are the potentially higher risk turbines ; T01, T18, T25, T26, T27, T29, T35, T36, T37, T41, T42, T43, T45, T46, T47, T49, T50, T52, T54, T55, T56, T57, T58, T64, T65, T66 and T2A. Of this stratum, 100% are selected for core monitoring. Of these, ten (38%) are chosen to have an extended search area (Table 1).

The remainder of the farm consists of 40 turbines. Those selected for core monitoring are: T02, T03, T04, T05, T07, T11, T12, T13, T15, T16, T20, T23, T24, T30, T31, T34, T39, T40, T44, T51, T59, T60, T62. Of this stratum, the first stage of selection involves 23 of 40, making a selection probability of 57.5%. Of these 10 (43%) are selected randomly to have an extended search area (Table 1).

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Higher Risk Stratum		**Remainder**	
Turbine	**Extended survey area**	**Turbine**	**Extended survey area**
T01	**Yes**	T02	No
T18	No	T03	No
T25	No	T04	**Yes**
T26	No	T05	**Yes**
T27	No	T07	**Yes**
T29	**Yes**	T11	**Yes**
T35	**Yes**	T12	No
T36	No	T13	No
T37	No	T15	No
T41	**Yes**	T16	No
T42	No	T20	No
T43	No	T23	**Yes**
T45	No	T24	No
T46	No	T30	No
T47	**Yes**	T31	**Yes**
T49	No	T34	No
T50	**Yes**	T39	No
T52	No	T40	**Yes**
T54	No	T44	**Yes**
T55	**Yes**	T51	**Yes**
T56	No	T59	**Yes**
T57	**Yes**	T60	No
T58	**Yes**	T62	No
T64	No		
T65	No		
T66	**Yes**		
T2A	No		

Table 1: Turbine stratification and survey area.

The Zones

There are two zones to be surveyed.

1. The first, 'core zone' is the hardstand area and the contiguous access road within a 60 metre radius of the turbine tower. This is surveyed twice per survey cycle (month), in close succession. This will be surveyed at 4 metre transect spacings (i.e. 2 metres either side of the walked line will be actively scanned for carcasses).
2. The second zone is the 'extended zone'. This is an 80 metre square (assuming OHS & E restrictions and logistics allow access), such that its furthest point is no more than 120 metres from the turbine tower. The extended zone will be surveyed with 12 metre spacings. Interest in all potential strikes is maintained, with care to be taken to look for even small carcasses in this zone.

Preparation of these zones:

The hardstand and access road should clearly define the core zone, so there is no reason to mark out the core zone boundary nor the transect lines. For particularly complicated core zones, markers may be placed. Note that there is no requirement to repeat the transect placing precisely from survey to survey. It is the zone that should be surveyed and the transects are only a tool to achieve this. If one month the zone is surveyed North-South, and the next time East-West there is no negative effect. The survey is robust provided the zone is surveyed in its entirety.

In the extended zone, however, permanent markers should be placed in the field and left. These should mark, at the minimum, the corners of the extended zone. In undulating, or complex terrain, it may be necessary to mark out the 12 metre transect spacings. The transect markings may be permanent or placed each month. The corner markings, however, should not be altered for the initial twelve months of the survey.

Survey Protocol

The task of surveying the ground for carcasses involves the search itself and the accurate recording of both data and meta-data. Data on the record sheet may be directly used in mortality analysis or to validate and advise evolution of the BBAMP, so it is important that detailed and consistent records are kept.

Survey duration

Upon arrival at a selected turbine, the core zone should be surveyed. Surveying one core zone requires five, 20m long transects plus the road. At a steady walking pace, the access roads, and the core zone should be actively scanned for carcasses.

The expected duration is eight minutes per turbine's core zone. If the zone is scanned within 5 minutes, then the walker is too fast.

After all of the core zones are completed the extended zones may be surveyed. Alternatively each turbine may be surveyed completely, one at a time. The extended zone should take 15-20 minutes, depending on terrain.

The core zones only should be repeated 2-3 days after they were initially surveyed.

Example Survey timings

- Day one: All Core Zones (~6 hours)
- Day two: All Extended Zones (~7 hours)
- Day three: All Core Zones
- Repeat after 4 weeks

Data Recording

An important aspect to note is that finding nothing is of equal importance to finding carcasses. As such, a record will be made of every search, not just those that result in a find. In the interest of conserving resources, the sheet meta data will cover an entire morning/afternoon, with one row per find or one row per turbine searched (if no finds are made).

Survey data

For each survey day note the date, weather conditions, observer id, start and end time of the survey. The time information can be used at a later date to determine if the surveys are at risk of scavenger bias interactions.

There is also a notes section for the field observer's comments on anything they deem unusual. It might include unusual weather, or something that made searching difficult. If they detect unusual land management issues, such as grain feeding on the ground, then this is where it is noted. This section might be used to aid in adaptive management decisions, if unusual data patterns are detected.

Every turbine searched will have a row, with the Turbine ID entered, and a strike through if nothing is found.

Recording carcasses

For each carcass found note the following:

- The turbine ID (if nothing is found still record the ID and strike through the other data columns)
- The survey zone (core or extended)
- The distance, and bearing from the turbine. This will be used to understand coverage and guide the future changes to monitoring. Alternatively, the GPS location (easting and northing) of the carcass may be recorded.
- The distance from the observer to the carcass at the instant of detection. This aids the adjustment of transect spacings in the future. Note that if a carcass is spotted from the car, on approach, this is the detection distance to be used.

- Species, if identifiable. Otherwise unknown bird or unknown bat.
- Condition of carcass (complete, partially scavenged, featherspot)
- Any other notes.

Summary

The mortality surveys are designed to serve a dual purpose. Primarily, they provided a robust estimate of the direct impact of the development. Secondly, they are collected with enough meta-data that they can be used to inform adaptive management options should the need arise.

It is for the second reason that care should be taken to record carefully events on the ground. Of particular import is the recording of a survey with null results. Just because nothing was found, the record keeping of the survey effort is important and should be maintained with as much discipline as recording all the positive detections.

Regards,

Stuart Muir
Symbolix Pty Ltd

D.2 BIRD UTILISATION SURVEY

symbolix

To: Deb Frazer
NGHenvironmental
Via EMAIL

Ref #: NGHBOCOL20130418d
Date: 18th April, 2013
CC: Nil

Re: **Boco Rock Utilisation Monitoring Specification and Field Notes**

Dear Deb,

Please find following a complete specification for the utilisation monitoring, detailing the selection, analysis and field practices required to attain the outcomes outlined in the Boco Rock Bird and Bat Adaptive Management Plan (BBAMP).

Background

The protocol arrived at in the BBAMP is designed to monitor the impact of the development as per the OEH requirements and to facilitate adaptive management. Because of the multiplicity of the requirements for the data collected, the survey is a relatively simple design, balancing site coverage with the quantity of data required to support the analysis outlined in the BBAMP framework document.

The design is a stratified random point survey, where the stratifications are based on the relevant habitats on the farm, with disproportionate selection weights (see 'Selection of point count locations' below). This must be kept in mind when interpreting the data from the utilisation study. The data itself is a hierarchical collection designed for reporting in aggregate form and drilled if necessary.

Selection of point count locations

The point count locations within each stratum are aliased to a GIS polygon set. As the focus is the windfarm, these polygons represent the given stratum, conditional upon access and windfarm relationship constraints.

As an example, the "Grassland/Pasture" Stratum is aliased to be "Pasture within 500 metres of a turbine where access to the land can be reasonably expected." Similarly, the "control" features polygons where "There is a reasonable expectation of access, a potential to place a wind turbine in the vicinity, but no wind turbines locally".

From these polygon sets, a random selection of coordinates is selected. These in turn are allocated to survey dates randomly. To obtain enough sites in each stratum for meaningful analysis, the number of points within strata is not chosen proportional to area. That is, some strata are oversampled. This is a necessary consequence of the imbalance of habitat types. For example, representative sampling would have too few woodland sites to be meaningfully interpreted. This imbalance will need to be considered in analyses.

The random selection of points is done to ensure maximum coverage, with maximum ease of utility of the data for future applications.

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The following table outlines the strata and number of points in each.

Table 1: Point transect stratification

Stratum name	Number of sites
Grassland/Pasture	52
Control	39
Woodland	39

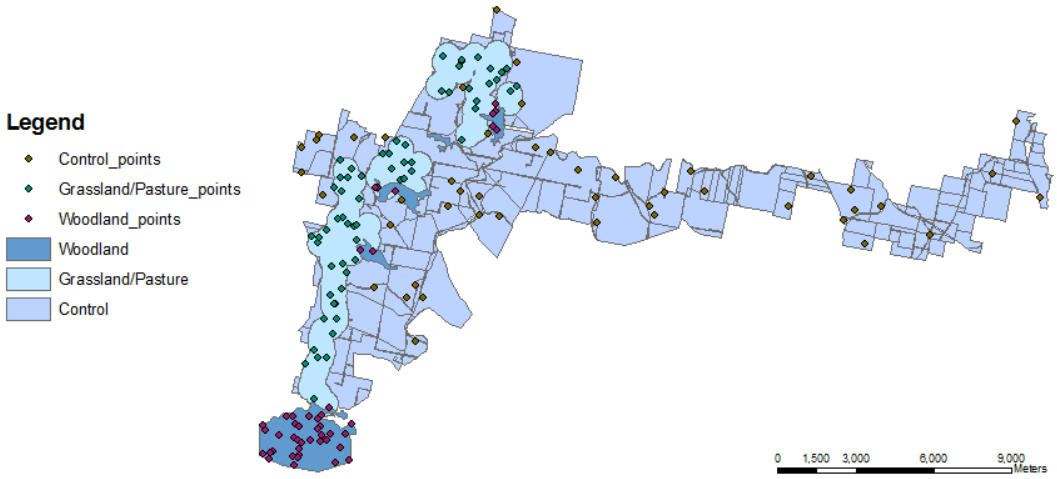

Figure 1: Selected transect point distribution

Field protocol

The observer will have a list of sites preselected that they are to visit. They will also have a list of secondary, or back-up, sites. Should access be lost to a selected site, or ground-truthing reveals the GIS stratum type is in error, the observer is to select the nearest geographical point to the failed selection from this secondary list. The secondary list is only to be referred to when the primary list has a failure point.

The data collection is from un-truncated point counts. This means that the observer should not limit their records only to observations within a given radius of their position. This differs to the Birds Australia guidelines and is designed so. The observer will go to the pre-determined location, and wait for any flushing effect to diminish (usually 3-5 minutes). This time can be used to fill in the very important survey data associated with each point.

Survey timing

The surveys are monthly.

Data Collection

For each point count survey the following survey data should be recorded:

- Point location ID
- Point count date and start/end time
- Weather conditions
- Temperature
- Wind speed and direction

The species data collected is in the form of detection cues. These are loosely movements, or call cues identified to a species (or subspecies level). Each individual is noted when first sighted. Should an individual disappear and a second (or potentially the same) individual appear later this is noted as a separate sighting.

The point transect is covered via a continually scanning, noting the numbers of species, and approximate distance to each unit. A unit can consist of an individual, or a flock. In the case of a flock, the approximate membership should be estimated.

For each sighting, record the following:

- Time at first sighting
- Approximate distance to unit at first sighting (in metres)
- Species
- Approximate numbers (if more than one)
- Cue type (seen/heard only)

Note: under no circumstances should the observer truncate, or excise, observations in the field. The observer is to record everything they see/hear, at all ranges. In some sites, the distance will be naturally limited by foliage and natural factors. This is understood and expected. Truncating the observations in the field introduces an irreparable and irretrievable bias to the data set, greatly reducing the future application and utility of the set.

Summary

The bird utilisation surveys are designed to serve a multiple masters. Primarily, they provided a robust estimate of the indirect impact of the development. Secondly, they are collected with enough meta-data that they can be used to inform adaptive management options should the need arise.

It is for the second reason that care should be taken to record carefully events on the ground. Of particular import is the recording of a survey with null results. If no birds are seen (or heard), the survey data should still be recorded and a note made that nothing was observed.

Additional Information

The data collection is specifically chosen to facilitate as many queries and analyses of the resulting data set as is possible. Ultimately the design has been pushed beyond the original intent through the course of negotiation and compromise. However, it remains configured to facilitate the following analyses:

- Woodland versus control : balanced T-test
- Woodland vs control vs impacted grassland : unbalanced ANOVA

- Recombination of any strata : standard weighted stratification as above
- Trend Analysis (general linear models, (GLM)): individual strata over time
- Trend Analysis (GLM): recombined Strata over time
- Trend Analysis : Differenced pairs
- Gradient studies (GLM)

The preceding list is by no means exhaustive. It is provided to highlight the diverse nature of questions, and configurations, that the data collection can support.

The selected sites attached are provided for a 14 cycle survey. The monitoring at Boco Rock is conditioned to run for five years. However, the design as attached can be adjusted during this time. It is established such that, after the twelve months established in this document, one may (presented in order of utility):

- Select new, random points to visit, continuing the current design
- Repeat visit to the current selection, building a longitudinal study
- Redefine Strata, and select accordingly
- Completely redesign the approach, based upon the findings of the study outlined within this document.

Discussions within an adaptive management construct will decide the most appropriate and applicable course.

Evidence-based adaptive management

In the course of the management of the Boco Rock site, the data set collection specified above will serve as a foundation to launch adaptive and pre-emptive management from. It is important not to prescribe analyses and techniques, as these inevitably progress. The most appropriate analysis should always be employed.

That being said, one would envisage the following approach, performed in partnership between numerical analyst and an ecologist with relevant site and domain knowledge.

- EDA (Exploratory Data Analysis):
    - Identify potential trends or movement in the data over time (most likely as a paired or controlled, Generalised Linear Model),
    - Compare Pre-construction data with Post construction (most likely as a block comparison)
- If a trend or change is alluded to:
    - Drill the data, under a hypothesis, to determine likely or potential drivers. Refine the site knowledge accordingly.
- Assess the Risk (being the likelihood and the consequence) of the potential drivers.
- Invoke Targeted management, within a MERI (Monitor, Evaluate, Report, Improve) cycle.

- This may include modifying the emphasis of any monitoring strategy, or active site management. Any of which, should have an accompanying Program Logic.

Under such an approach, one can see why the data collection is so regimented. Bias needs to be controlled as one does not know how an ecologist may need the data cut to understand the site issues better. One does not know what the best technique to support the ecological monitoring and reporting will be, so all have to be supported as best they can. This does not mean "monitor everything," rather note everything, preclude nothing, and proceed with a clear statement of intent whilst monitoring progress towards that goal.

Regards,

Stuart Muir
Symbolix Pty Ltd

APPENDIX E DATA SHEETS

E.1 MORTALITY SURVEY

Date:	
Weather Conditions	
Temperature	
Wind	

MORTALITY SURVEYS

Observer:

Notes:

Turbine ID[1]	Survey Type[2]	Species[3]	Condition[4]	Easting	Northing	Notes	Ground vis[5]	Search diff[6]

Codes

[1] **Strike line if NULL**

[2] **CORE or EXT (extended)**

[3] **if species is unknown: UNK (unknown bird) or BAT (unknown bat)**

[4] **one of Complete/ Scavenged/ Featherspot/ Wing (if bat)**

[5] **Ground visibility scale:** poor (densely vegetated), average, good, excellent (clear, see to ground)

[6] **Search difficulty:** difficult, average, easy

E.2 BIRD UTILISATION SURVEY

Date:	
Weather Conditions:	
Temperature:	
Wind Direction:	
Wind Speed:	
Site ID:	

Observer:

General Description:

GPS Location:

Time started:

Species	Count (#), or (-) if a call only	Time	Approximate distance from observer	Notes

APPENDIX F AUTHOR QUALIFICATIONS

Dr Christophe Tourenq **Primary author original draft** [9] *University Dissertation in Organisms and Populations Biology, options: Ecology and Animal Biology* *Master in Sciences in Behavioural Ecology and Neurosciences* *PhD in Ecology: values and functions of agro-ecosystems (rice paddies) for waterbirds communities within the mosaic of natural habitats, in one of the most important wetland of Europe.*	Christophe has over 20 years wildlife on biodiversity assessments experience in coastal marine, wetland, mountain, steppe and desert habitats with private, governmental and non-governmental organisations. This includes working at high level with WWF UAE and five years as senior ecologist, and subsequently as co-head of a monitoring and terrestrial survey team for a governmental agency in the United Arab Emirates. From 1997 to 2001, Christophe worked on waterbirds in the rice fields in France to find practical solutions to prevent the damage to culture by wildlife, but also to mitigate the impact of intensive agriculture to wildlife.
Bianca Heinze **Subsequent author v1.1, v1.3** *Bachelor of Applied Science (Natural Resource Management), Southern Cross University*	Bianca has been an ecologist with NGH Environmental since 2008. During this time, she has specialised in wind farm ecological assessments, particularly focusing on bird and bat risk assessment. She has been involved with around 13 wind farm projects mainly in NSW but also in WA, including two operational wind farm monitoring programs.
Dr Jacqui Coughlan **Expert review of drafts** *Bachelor of Science (Hons Freshwater Ecology) (James Cook University, 1989).* *PhD Bird Ecology (James Cook University, 2000).* *Graduate Diploma Environmental Law (Sydney University 2009).*	Jacqui has conducted and managed numerous fauna and flora surveys in New South Wales, Queensland and Western Australia and has a thorough working knowledge of State and Commonwealth legislation related to flora and fauna. Her practical ecological skills in terrestrial ecology have been developed over 25 years. Her expertise in bird ecology and large scale biodiversity investigations are central to the development of bird and bat monitoring programs developed at nghenvironmental. She was the primary author of the Cullerin Range Wind Farm Bird and Bat Management Plan and nominated expert at the Gullen Range Wind Farm.
Deb Frazer **Primary author of final v1.2** *Bachelor of Applied Science - Biodiversity Management (University of South Australia 2005) with First Class Honours*	Deb has over 8 years' experience as an Ecologist and within biodiversity assessment. Deb's positions have included management and senior roles, as well as educational and research assistant positions. Deb has experience in impact assessment and fauna survey projects throughout NSW and South Australia. Deb has expertise in terrestrial fauna and large scale biodiversity and monitoring projects, including mining and wind farms. Deb has 3 years' experience in designing and providing advice on monitoring programs for industry sectors.

[9] The survey design was redesigned after consultation with OEH. It is noted that while much of the background information and management response information remains the same, the final plan is substantially different from the original draft authored by Dr. Torenq and reviewed by Dr. Coughlan.

Dr Stuart Muir (Symbolix) **Statistical Advice on final report (v1.2)** *Bachelor of Science (Hons) Astrophysics and Applied and Computational Mathematics* *PhD Computational Mathematics (Monash University)*	Stuart has ten years' experience on forecasting, modelling and analysing windfarms and their potential impacts in Australia. He has presented material at international (both Asia-Pacific and Europe) conferences on the interactions between windfarms and wildlife. He has written a number of journal articles and conference proceedings on Mortality estimation, utilisation modelling and Collision Risk modelling.