FAUNA ASSESSMENT

Waddi Wind Farm

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1.0 INTRODUCTION

Waddi Wind Farm Pty Ltd (formerly Wind Prospect WA Pty Ltd) is proposing to establish a wind farm approximately 12 km to the west of the Dandaragan town site within the Shire of Dandaragan, Western Australia. The wind farm has planning approval for up to 57 wind turbines and has a potential output capacity of up to 194 megawatts (MW).

RPS Environment and Planning Pty Ltd (RPS) was commissioned by Waddi Wind Farm Pty Ltd to conduct the ecological studies and assessments to support referrals under the Western Australia *Environmental Protection Act 1986* (EP Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the environmental approvals process for the wind farm project and to support a planning permit application and any associated amendments or approvals required.

1.1 Objectives and Scope of Work

The objectives of the present study were to establish the fauna species likely to be present in the Waddi Wind Farm project area (referred to as the "Study Area" herein), and to discuss the likely impacts of the proposal on these species.

To address these objectives, Bamford Consulting Ecologists undertook a Level 1 reconnaissance fauna survey for the Study Area in November 2008), whilst RPS ecologists conducted a bat survey in October and November 2008 and May 2009. Bamford Consulting Ecologists (BCE) undertook a further site inspection in 2013 to provide specialist technical advice to assist in a revision of the data from the 2008 survey, and to inspect sites outside the original footprint due to minor changes in the footprint of the proposed development which primarily consisted of the Grid Connection route to the existing Cataby Substation and the location of the on-site Waddi Substation and associated access and Distribution Line locations. The minor changes to the footprint and the Study Area are shown in Figure 2. Additionally, the results of a flora and black cockatoo habitat survey undertaken by Outback Ecology in 2013 (Outback Ecology 2013) within the Wind Farm Study Area have been used to inform this report.

The results of these surveys have been used in this report to:

- Review the list of fauna expected to occur on the site based on existing records of fauna in the area and field survey, and place them in context of their ecological significance.
- Identify fragile habitats in the survey area on which fauna may depend.

- Identify any ecological processes in the survey area on which fauna may depend.
- Identify potential impacts on fauna from the proposal and propose recommendations to minimise the impacts.

A Level 1 bird survey (RPS HSO 2010), vegetation survey (Outback Ecology 2010) and follow up flora and vegetation surveys in 2013 (Outback Ecology 2013) were also undertaken for the Study Area and results from these surveys have been incorporated into this report where required.

1.2 Background

The Study Area is located within Dandaragan Shire and lies approximately 42 km north-east of Lancelin at its closest point as shown in Figure 1. The Study Area covers approximately 129 km^2. The area of land that would be directly affected by the wind farm would be significantly less than this due to the small area that the wind turbines and infrastructure occupy. The proposed development would comprise up to 57 turbines of up to 3.4 MW capacity, depending on final market conditions. Infrastructure for the wind farm would consist of a network of service tracks, a network of underground connecting cables, an on-site substation, overhead transmission lines and grid connection to the existing Cataby Substation located west of the wind farm (Figure 2). Three routes were originally considered for the grid connection infrastructure however the focus is currently on Grid Connection 1 Easement route (shown in Figure 2 as Grid Connection 85m Easement (2014)). The original grid connection infrastructure route (shown as Waddi Grid Line Option 1 (2009) in Figure 2) is large because of the original proposal to connect to another proposed wind farm site nearby; the Yandin Wind Farm site. This option is not currently considered feasible which is why the route shown in Figure 2 as Grid Connection 85 m Easement (2014) is now the preferred route.

1.2.1 Regional Description

The Study Area falls within the Swan Coastal Plain Bioregion of the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (EA 2000; McKenzie et al. 2003). The general features of this region are summarised by McKenzie et al. (2003):

> The region is characterised by "a warm Mediterranean climate with rainfall that ranges between 1000 and 600mm annually. It includes urban developments associated with the city of Perth, and is dominated by woodlands of Banksia and Tuart on sandy soils, Sheoak on outwash plains, and paperbark in swampy areas. The colluvial and aeolian sand areas represent three phases of Quaternary marine sand dune development (which provide relief), and include a complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestones and several offshore islands. Younger sandy areas and limestones are dominated by heath and/or Tuart woodlands, while Banksia and

> Jarrah-Banksia woodlands are found on the older dune systems. Fine-textured outwash plains at the foot of the Darling Escarpment are extensive only in the south, and were once dominated by Casuarina obesa-Marri woodlands and Melaleuca shrublands. In the north-east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The Dandaragan Plateau is the region's north-eastern corner, and is composed of cretaceous marine sediments mantled by sands and laterites. The plateau is characterised by Banksia low woodland, Jarrah-Marri woodland, Marri woodland, and by scrub-heaths on laterite pavement and gravelly sandplains. A variety of plants are endemic to the region."

The Swan Coastal Plain Bioregion falls within the Bioregion Group 1 classification of EPA (2004). This grouping is relevant for environmental impact assessment purposes.

1.2.2 Desktop Study

Prior to commencing the ecological surveys, RPS was commissioned to conduct an ecological desktop study, site inspection and preliminary constraints assessment over an area encompassing the Study Area (RPS 2008).

The desktop study acquired data on key environmental features recorded within 15 km of the Study Area boundary. The data was reviewed and a site inspection undertaken to confirm the significant environmental features and the status of ecological habitats at the site. Those findings are provided in Appendix 1. That report provided the basis on which the ecological baseline surveys were established as discussed below. In 2008, consultation with Western Australia's Department of Environment and Conservation (DEC, now the Department of Parks and Wildlife (DPaW)) further refined the survey requirements.

Based on the findings of the desktop study (RPS 2008), RPS recommended further fauna survey work be undertaken to establish the ecological baseline. RPS recommended a Level 1 reconnaissance fauna survey because of the low likelihood of significant impacts on ground fauna. In 2008 consultation with Western Australia's Office of the Environmental Protection Authority (OEPA), confirmed the requirement for this approach. Whilst no data on bats were obtained via the desktop review, it is known that bats are under-recorded due to their nocturnal activities and are difficult to sample. A survey for bats was therefore also recommended.

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2.0 METHODS

2.1 Overview

The baseline studies for terrestrial fauna and bats were conducted in compliance with Western Australian requirements, as set out by the EPA and contained in the following documents:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002)
- *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56* (EPA 2004).

The results of these surveys have been reported by placing each species in the context of its conservation value, specifically with regard to its level of legislative protection. In considering the status of each species, the provisions of the following Commonwealth and state legislation were taken into account:

- the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- the Western Australia *Wildlife Conservation Act 1950* (Wildlife Act)
- the Western Australia *Environmental Protection Act 1986* (EP Act).

This report synthesises the results of a literature review, a site inspection and a field survey (undertaken in 2008), and is classified as a Level 1 reconnaissance survey (desktop study and reconnaissance survey) for terrestrial fauna and a Level 2 survey for bats according to the EPA Position Statement No. 3 (EPA 2002). This was supported by a further site inspection in 2013 to support a revision of the data from the 2008 survey, and to inspect any areas that fall outside the original footprint of the proposed development.

2.1.1 Personnel

The following personnel conducted the work:

- Dr Mike Bamford BSc (Biol), Hons (Biol), PhD (Biol)
- Julie Raines BSc (Biol), Hons (Biol)
- Dr Barry Shepherd BSc Hons (Env Biol), PhD (Ecol).

The Level 1 reconnaissance fauna survey in 2008 was undertaken by Dr Mike Bamford and a field report provided. The second and brief site visit in November 2013 was also undertaken by Dr Mike Bamford. The 2008 bat survey was conducted by Dr Barry Shepherd in consultation with Dr Mike Bamford and Brendan Metcalf. The present report was produced by Julie Raines and Dr Barry Shepherd in consultation with Dr Mike Bamford.

2.1.2 Desktop Review

A desktop review was conducted by RPS in July 2008 when undertaking a constraints assessment of the proposed project. The desktop review was conducted to gather background information and data regarding the ecological values of the proposed wind farm site and the surrounding area. Information on fauna was obtained from the following sources:

- DEC Threatened and Priority Fauna database
- Department of Environment (DoE, formerly Department of the Sustainability, Environment, Water, Population and Communities (SEWPC)) Protected Matters Search Tool (DoE 2008)
- discussions with personnel from wildlife agencies and local experts.

Results of the desktop review are listed in Appendix 1. Further information was sourced from a recent study conducted for Tiwest (now Tronox) Joint Venture (Bamford 2007). Five lists of fauna from that site are provided to supplement the reconnaissance survey for the Waddi site (Appendix 2). This list is reproduced with the permission of Tronox.

2.2 Level 1 Reconnaissance Fauna Survey

A site survey was conducted on 12 and 13 November 2008. The Study Area (as shown on Figure 2) was traversed where possible by tracks and roads mostly by vehicle but partly by foot. Native vegetation in particular was targeted for inspection. Binoculars were used to check on vegetation too far from roads or tracks to inspect by the naked eye. Notes were taken on the habitat and terrain present and opportunistic observations were made on fauna. The main aim was to establish the types of habitat present and the likelihood of the use of these habitats by different fauna, particularly fauna of conservation significance. Fauna was recorded when either detected directly or indirectly by the presence of tracks, scats, diggings, etc. The second site visit took place on 27 November 2013 and areas of new infrastructure in the south-west of the project area were visited to familiarise the consultant with the nature of environments at these locations.

2.3 Bat Survey

The bat survey was designed to be consistent with work previously conducted on similar developments in the area and to take into account the guidelines provided by Lumsden (2007).

It is generally accepted that bat species do not take advantage of open pasturelands to the same extent that they use native vegetation. This is likely due to the exposure to the elements and greatly reduced insect richness and abundance above the pasture. Bats are also known to frequent more sheltered areas rather than exposed high ground, but this may be species specific and larger, stronger flying bats may use higher areas more regularly than smaller bats.

The turbines are proposed to be located on high ground so they are exposed to as much wind as possible. Whilst it is likely that bats use the pasture on higher ground less than they do the woodland and sheltered valleys, a full bat survey was conducted on the proposed wind farm site to establish what species occur in the area and their relative use of the habitats.

AnaBat II bat detectors and AnaBat ZCAIM recording units were placed at six locations across the Study Area (Figure 3) to detect and record passing bats as they echolocate to navigate and find prey. AnaBat detectors were contained within protective cases and microphone extensions were used to locate the microphones approximately two metres off the ground. As bats are most active at night, the detectors were fixed in suitable locations before dark and retrieved either the following morning or several mornings thereafter. Records saved to compact flash cards were then downloaded to computer ready for future analysis. Analysis was conducted on AnalookW v3.3q software, specifically written for Anabat detectors.

The locations of the detectors were selected to represent typical conditions where turbines were proposed and either near or between features known to be used by bats such as linear features (e.g. tree line wind breaks), native vegetation, woodland stands or water bodies. Further sampling was conducted at a lowland wooded site to determine bat species present in optimum conditions in the area. Surveys were conducted over two separate periods between October and November 2008 and in May 2009. Bat detectors were programmed to start recording at 1800 hours and stop recording at 0700 hours.

The records were analysed by Dr Barry Shepherd and validated by Brendan Metcalf of Bamford Consulting Ecologists. To establish bat species, the calls were compared with sonograms from known bats as given by Fullard et al. (1991), Milne (2002) and Pennay et al. (2004). Call sequences were inspected to extract: call type (linear, curvilinear), call duration, minimum frequency, maximum frequency and characteristic frequency. Nomenclature for bat species is as provided by Churchill (2008).

In addition to the passive bat detection, ecologists conducted several ad hoc surveys over two nights in the area to try and establish bat behaviour where conditions allowed. These surveys used ultrasonic bat detectors (BatBox III) which provide real time heterodyne detection of bat echolocation and social calls.

Some bat species emerge from roosting before it gets dark during the evening whilst others emerge only after dusk during darkness. Similarly, some species will return to their daytime roosts in darkness in the morning, whilst others return to roosts in light shortly after dawn. Therefore, it is possible to acquire unaided visual information for some species but not others. Observations that would be noted if bats are seen would be flight height and whether foraging in a normally erratic flight pattern or whether transiting between areas in straight level flight. The ad hoc surveys were located on high open pasture between or near stands of native vegetation or tree lines.

2.3.1 Survey Effort

Passive bat call acquisition was conducted within the Study Area for a total of 20 bat detector nights for 260 hours. Recording was conducted initially in the spring of 2008 but due to detector failure, more sampling was conducted in the autumn of 2009. See Figure 3 for locations of the sampling points at which bat detectors were placed. Sampling points W1 and W2 were located relatively closely together as the nearby habitats and river beds were considered to be key features for bat ecology in the surrounding landscape. Table 1 summarises the bat detection work for the Waddi Wind Farm and conditions in which it was conducted.

Further calls were obtained at Waddi Bush Resort in the spring period to identify what species were present in the low wooded areas. In addition to the passive detection, active transect sampling was conducted to obtain behavioural and flight height information in the autumn of 2009.

Table 1: Summary of Survey Effort, Prevailing Weather Conditions and Time of Dawn and Dusk

Date	Location Ref	No. Anabats	Temp[#]	Sun*	
				Rise	Set
30–31 Oct 2008 (1)	P1, P2	2	9–18 °C	06:23	19:38
31 Oct–27 Nov 2008	Detector failure	1	6–21 °C	06:22	19:39
6–8 May 2009 (2)	W1	1	11–27 °C	06:51	17:36
8–12 May 2009 (4)	W2	1	10–26 °C	06:53	17:34
12–15 May 2009 (3)	W3	1	10–26 °C	06:55	17:32
15–19 May 2009 (4)	W4	1	6–27 °C	06:57	17:30
19–22 May 2009 (3)	W5	1	9–25 °C	06:59	17:28
22–24 May 2009 (3)	W6 (Partial Failure)	1			

Source: BoM (http://www.bom.gov.au/climate/dwo/200905/html/IDCJDW6004.200905.shtml)
* Source: Australian Government – Geoscience Australia (http://www.ga.gov.au/geodesy/)

Further survey work was planned until 30 May, but the Anabat detector malfunctioned due to weather damage.

2.4 Bird (Avifauna) Survey

Methods and detailed results of the bird survey are presented in RPS (2010) (Appendix 3). This survey was designed to develop an understanding of the bird assemblage of the area and to investigate the risk of the wind farm to birds through observation of bird activity. This included documenting the frequency with which different bird species might fly through the Rotor Swept Area (RSA).

2.5 Assessment of Conservation Significance

The preliminary characterisation of conservation significance of fauna and flora within the project site was primarily based on conservation listings under federal and state legislation such as the EPBC Act and the Wildlife Act.

The method used to assess conservation significance is discussed in detail in RPS (2008) and a copy can be found in Appendix 2. Categories used for assessing fauna of conservation significance are discussed further in Section 2.4.2.

2.5.1 State Legislation

In Western Australia, the Wildlife Conservation Act uses a set of schedules but also classifies threatened species using some of the International Union for Conservation of Nature (IUCN) categories. These categories and schedules are described in Appendix 1. In addition, the DPaW has produced a list of Priority Fauna which includes species not considered Threatened under the Wildlife Act, but for which the DPaW identifies cause for concern. Assessments in this report are based on the most recent version of the Wildlife Conservation Act and DPaW priority list (November 2012).

2.5.2 Federal Legislation

The conservation status levels for threatened fauna used in the EPBC Act follow those of the IUCN. The EPBC Act also lists migratory species recognised under the following international treaties:

- China Australia Migratory Bird Agreement (CAMBA)
- Japan Australia Migratory Bird Agreement (JAMBA)
- the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals).

Species listed under the JAMBA are also protected under Schedule 3 of the Wildlife Act.

Reports on the conservation status of most vertebrate fauna species have been produced by the SEWPC in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for the following groups:

- amphibians (Tyler 1997)
- reptiles (Cogger et al. 1993)
- birds (Garnett and Crowley 2000)
- monotremes and marsupials (Maxwell et al. 1996)
- rodents (Lee 1995)
- bats (Duncan et al. 1999).

These publications also use categories similar to those used by the EPBC Act.

On the basis of the above, this report assigns three levels of conservation significance to fauna:

- Conservation Significance 1 (CS1): Species listed under state or Commonwealth Acts

- Conservation Significance 2 (CS2): Species not listed under state or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by DEC

- Conservation Significance 3 (CS3): Species not listed under Acts or publications, but considered of at least local significance because of their pattern of distribution. This level may have links to preserving biodiversity at the genetic level (EPA Position Statement No. 3, EPA 2002). For example, if a population is isolated but a subset of a widespread distribution (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3.

2.5.3 Nomenclature and Taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's Checklist of the Vertebrates of Western Australia. The authorities used for each vertebrate group are: amphibians and reptiles (Aplin and Smith 2001), birds (Christidis and Boles 1994; Johnstone 2001), and mammals (How et al. 2001).

2.6 Risk Assessment

This section outlines the methodology used to assess risks associated with the proposed wind farm. The procedure was developed in accordance with the principles and guidelines contained in:

- *Australian and New Zealand Standard AS/NZS 4360:2004—Risk Management*
- SAA Handbook HB 203:2006, *Environmental Risk Management – Principles and Process*
- SEWPC 2008.

An initial risk assessment has identified the potential for the proposed wind farm to impact fauna species occurring on the site as summarised below. Impacts to fauna, as determined through the risk analysis outlined below are further described in Section 4.

- collision of bats or birds with operating wind turbines while flying through the rotor swept area (RSA) of the wind farm or with overhead lines directly associated with the wind farm

- impacts to fauna habitat through vegetation clearing (including habitat loss and habitat fragmentation)

- impacts to fauna through increased vehicle activity on the site such as death or injury through collisions.

The results of the risk analysis have been used to determine risk likelihood and severity and to evaluate the environmental risks and effects. The risk assessment methodology used in this report is consistent with the standard risk assessment process and practice as outlined in the Australian risk management standard (AS/NZS 4360). The key steps in this process can be summarised as follows:

- Detail the environmental risk context.

- Identify the environmental hazards from the construction and operation of the wind farm.

- Identify the likely environmental effects resulting from the hazards if realised.

- Analyse the risk based on potential likelihood and levels of consequence.

- Identify management measures to prevent, reduce or mitigate undesirable effects.

- Analyse residual risks after the prevention, reduction and mitigation measures have been taken into account.

This process was conducted for each significant ecological receptor likely to be present on site and potentially affected by the proposal. The risks from construction and operation of the proposed wind farm were assessed. Hazards as a result of decommissioning are not considered in this document as it is expected that the use of the development area as a wind farm will continue beyond its design life. If and when decommissioning is carried out, it is expected that it will be conducted in accordance with legislation and best practice at the time.

A qualitative scoring system is applied to the expert judgements of the likelihood of the potential impact on each receptor due to each stressor, and the ecological consequences of the impact.

The definitions used for scoring the likelihood and consequences are described in Tables 2 and 3, respectively. Explanations of the consequence categories are developed by ecological experts for a broad range of receptors (e.g. terrestrial flora and fauna, marine flora and fauna, physical values), and allow criteria to be developed for varying sensitivities (e.g. protected species, restricted flora associations). There are, therefore, a number of separate categories for consequence judgments in Table 4.

Table 2: Likelihood Definitions for Risk-based Environmental Assessment

Likelihood Category	Description
Almost certain	Very likely to occur on an annual basis
Likely	Likely to occur more than once during the life of the project (15 years)
Possible	May occur within the life of the project (30 years)
Unlikely	Not likely to occur within the life of the project (30 years)
Rare	Highly unlikely and unheard of in industry, but theoretically possible

Selection of a consequence level when considering the interaction of a specific stressor/ receptor considers all of the criteria listed in the relevant rows of Table 3. For example, in the case of a protected fauna species the consequences are analysed in terms of all three types of potential impacts: species behaviour, population size and population viability.

Table 3: Consequence Definitions for Risk-based Environmental Assessment

Consequence Category	Insignificant	Minor	Moderate	Major
Terrestrial and Marine Fauna Ecology				
Protected (Listed/ Threatened) Fauna Species	Species Behaviour			
	Local, short-term behavioural impact	Local, long-term or widespread, short term behavioural impact	Widespread, long-term behavioural impact	
	Population Size			
	Local, short term decrease in abundance	Local, long-term or widespread, short-term decrease in abundance	Local, long-term or widespread, short term impact on population	Widespread, long-term impact on population
	Population Viability			
		No reduction in local population viability	Reduced population viability on or surrounding the Waddi site	Extinction on or surrounding the Waddi site reduced viability in the immediate region
General Fauna Communities and Species (not Listed/ Threatened)	Species Behaviour			
	Local, long-term or widespread, short term behavioural impact	Widespread, long-term behavioural impact		
	Population Size			
	Local, long-term or widespread, short term decrease in abundance	Local, long-term or widespread, short term decrease in abundance	Local, long-term or widespread impact on population or assemblage	
	Population Viability			
	No reduction in local population viability	No reduction in population viability on or surrounding the Waddi site	Extinction on or surrounding the Waddi site, or reduced population viability in immediate region	Extinction in the immediate region

Explanation of Terms Used in this Table:

Decrease in abundance	Loss of individual animals.
Impact on population	Decrease in abundance beyond natural variation in population size.
Reduced viability	Reduced ability to taxon or population to persist through time.
Behavioural impact	Disruption of established behavioural patterns affecting reproductive or survival success.
Immediate region	For aspects of the development on the Waddi site. For aspects of the development surrounding the Waddi site.
Local	Area directly affected by development and the surrounding environs.
Widespread	Areas extending to well beyond the area of direct impact from development
Short term	Less than five years.
Long-term	Greater than or equal to five years.

Based on the scoring of likelihood and consequences, risk can be categorised with respect to the regions of high, medium and low risk in the "risk matrix" in Table 4. High and medium risks should be managed such that risk is reduced to a level "as low as reasonably practicable" (ALARP in AS/NZS 4360).

Table 4: Risk Matrix for Determining Risk Category based on Likelihood and Consequence of the Hazard being realised

		Consequence			
		Insignificant	**Minor**	**Moderate**	**Major**
Likelihood	**Almost Certain**	Medium	High	High	High
	Probable	Medium	Medium	High	High
	Possible	Low	Medium	Medium	High
	Unlikely	Low	Low	Medium	Medium
	Rare	Low	Low	Low	Medium

3.0 RESULTS

3.1 Site Description of the Waddi Area

The Study Area is extensively cleared and is gently undulating with few prominent features. The open pasture is sparsely populated with small to moderate sized trees, approximately 5–8 m tall. The Mullering Brook dissects the Study Area from roughly south-west to north-east (Figure 2). This valley is forested with mature woodland and comprises largely native habitat in varying condition depending on whether it has been accessed by livestock or vehicles. Several large stands of heath habitat are present on the higher ground, including a wide buffer strip along Waddi Road and Walyering Road. Several stands of remnant vegetation are also located in open pasture including a significant stand lying just south of Waddi Road (Figure 2).

The largest stand of vegetation proximate to the Study Area is located along the eastern side of the Brand Highway from south of Cataby Road and extends almost continuously to Koonah Road north of the Study Area. This comprises mostly short to shrub-height heathland and is in excellent condition. The stand of vegetation falls partly within the Northern Bassendean Dunes System and listed as an "Indicative Place" on the Register of National Estate (RNE).

Several relatively small plantations of fodder crops and forestry are located in the Study Area.

Badgingarra National Park lies to the west of the Brand Highway and 3.1 km north of Mullering Road (Figure 4).

3.1.1 Habitat Appraisal

The Study Area is characterised by undulating hills with ephemeral to semi-permanent drainage lines in gullies and valleys. Native vegetation has been extensively cleared but has been retained in some remnants, and varies with landscape position. This provides a range of habitats for fauna.

Three key habitat types and a combination of all three occur within the vicinity of the proposed Study Area, namely:

- open pasture/cultivation areas, often with scattered trees
- remnant heathland vegetation
- woodland remnants
- areas where various combinations of heathland and / or woodland are associated with areas dominated by open pasture / cultivated habitats.

Open pasture and cultivated lands occur on hilltops and slopes and largely characterise the areas on which wind turbines would be located. Heathland habitat varies in height and plant species assemblage in relation to elevation on undulating hills. A shorter heathland community characterises the tops and higher slopes of hills while on the lower slopes and flats heathland communities have both a shrubby lower stratum and an upper stratum of large shrubs/small trees. Gullies and valleys have woodland habitats largely associated with drainage lines and these communities merge with heathland on the lower slopes.

3.2 Survey Constraints and Limitations

The Study Area is large and the reconnaissance survey targeted those areas expected to be sensitive and to support a greater diversity of species. These were mostly areas of native vegetation.

3.3 Desktop Study and Reconnaissance Survey Results

The information obtained through the desktop review and lists provided in Appendix 2 (Bamford 2007) were used to supplement the reconnaissance survey for the Study Area. The findings of the reconnaissance survey indicate that the following fauna are likely to be present in the Study Area.

3.3.1 Invertebrates

A number of potential Short Range Endemic (SRE) invertebrate species (as defined by Harvey 2002) have been found at nearby Cooljarloo during fauna investigations for Tronox (Bamford 2010). These include three trapdoor spiders (*Aname* MYG223, *Aganippe* MYG221 and *Aganippe MYG222*), and two millipedes (*Antichiropus* "Cooljarloo" and *Antichiropus* "Cooljarloo 2"*).* They are only considered potential SRE species as collection has been limited in the region, and thus their apparent restricted distribution (known only from type localities at Cooljarloo) may be an artefact of inadequate sampling.

SRE invertebrates are often associated with *mesic refugia* but the species recorded during the Tronox studies have been found in woodland and heath, although their levels of abundance may be greater in sheltered valleys and around wetlands. The species may therefore be present in areas of native vegetation within the project area, but are probably locally widespread. As a precaution, where crossing points over watercourses are required, they have been selected to coincide with existing tracks and areas that are already heavily degraded by grazing and livestock trampling.

3.3.2 Fish

At least two native species of fish, the western minnow (*Galaxias occidentalis*) (CS3) and western pygmy-perch (*Edelia vittata*) (CS3), have been recorded in Mullering Brook which lies to the west of the Study Area (Figure 2), and is close to the northern edge of their distribution range. The western minnow can be found in pools and slow moving water but disperse into tributaries after rainfall to spawn (Pen and Potter 1991). The western pygmy-perch is found in aquatic vegetation around the edges of any permanent freshwater of lakes or streams ponds (Allen et al. 2002). The brooks transecting the Study Area are ephemeral and therefore fish species are only likely to occur near the Study Area after prolonged periods of rain. It is considered that the wind farm is unlikely to affect these two fish species assuming there are no effects upon run-off into drainage systems.

3.3.3 Amphibians

There are likely to be eleven species of frog in the Study Area (Appendix 2) with all but one of these (the terrestrial-breeding turtle frog *Myobatrachus gouldii*) breeding in wetland habitats in the lower landscape. Outside the breeding season several of these species disperse to habitats both high and low in the landscape. None of the frog species is of conservation significance.

3.3.4 Reptiles

Approximately 55 species of reptile may be found in proximity of the Study Area (Bamford 2007). This assemblage includes a number of species of conservation significance.

The woma or Ramsay's python (*Aspidites ramsayi*) (CS1) may be found in sandy areas but is more likely to be locally extinct. If present, it would be largely confined to native vegetation. The CS2 jewelled ctenotus (*Ctenotus gemmula*) and black-striped snake (*Neelaps calonotos*) have both been recorded in the Cooljarloo area, as has the CS1 south-west carpet python *(Morelia spilota imbricata*). The jewelled ctenotus and black-striped snake are also likely to be restricted to native vegetation on sandy soil, but the carpet python may be more widespread across vegetation and soil types. It is as large, non-venomous, easily recognised snake that appears to occur only at low population densities in the region.

3.3.5 Birds

Bamford (2007) has recorded over 120 bird species in the Cooljarloo region, while RPS (2010) recorded 88 species across a range of sites in the region, and 44 species at survey sites within the proposed Study Area. The assemblage includes waterbirds, a range of species associated with farmland as well as species restricted to areas of native vegetation. Potentially 17 species of conservation significance may be present and seven of these were recorded or are considered highly likely to utilise the wind farm area. These conservation significant species are detailed below:

3.3.5.1 Conservation Significance Level 1

Migratory Species

Fork-tailed Swift, Eastern Great Egret, Common Sandpiper, Common Greenshank, Red-necked Stint, Sharp-tailed Sandpiper, Rainbow Bee-eater

With the exception of the swift and the bee-eater, these waterbirds can be expected only as vagrants or otherwise in small numbers on wetlands in the region. The waterbirds could potentially fly through the wind farm project area.

The fork-tailed swift is almost entirely aerial when in Australia and is likely to be an intermittent visitor. Being an aerial species that usually flies at a great height, it is little affected by regionally small areas of ground disturbance.

The rainbow bee-eater is likely to be a regular breeding visitor to the area in spring to early summer. It is actually attracted by ground disturbance, often digging its nest-burrows in low banks around disturbed areas and will nest in paddocks. While of high conservation significance, it is widespread and often favours disturbed environments.

Peregrine Falcon Falco peregrinus

The peregrine falcon is classified as Specially Protected Fauna under Schedule 4 of the WA Wildlife Conservation Act. This species is widespread in a range of environments across Australia but is often associated with cliff-lines or scattered tall trees that provide it with nest sites. It was observed once on site during the surveys and should be considered as a potential occasional visitor to the wind farm project area.

Carnaby's Black-Cockatoo Calyptorhynchus latirostris

Listed as Endangered under the EPBC Act and the WA *Wildlife Conservation Act 1950*, Carnaby's Black-Cockatoo is common in the region with regular counts of 200–300 birds (Bamford 2007) at Cooljarloo during winter. Numbers are lower in spring and summer.

The species is known to breed in the hollows of large trees along Cataby Brook and there is potential breeding habitat (large marri trees) along Mullering Brook just east of the Brand Highway. A large roost (at least 100 birds) is located Mullering Brook (352617E, 6606727N) just west of the Brand Highway. Carnaby's Black-Cockatoo forages largely on the seeds of proteaceae, particularly Banksia spp., but will also feed on seeds of weeds in paddocks. Therefore, they are most likely to occur in areas of Banksia woodland but will readily move across and forage in paddocks in the wind farm project area.

During the flora and vegetation survey undertaken by Outback Ecology in 2013, an assessment for black cockatoo habitat was also undertaken. No current breeding habitat for Carnaby's Black-Cockatoos was recorded in the Study Area; however, significant trees, i.e. trees with potential to develop hollows, were recorded in the central portion of the Study Area. Foraging habitat was recorded in the Study Area in the form of *Eucalyptus spp*., *Banksia spp*. and *Hakea spp*. in the Open Woodland and Proteaceous Heath habitat types. This habitat was found to be of high quality and in good condition (Outback Ecology 2013).

Western Ground Parrot Pezoporus flaviventris

Listed as Critically Endangered under the EPBC Act and as Critically Endangered under the WA Wildlife Conservation Act, the range of the western ground parrot once extended from north of Perth to Esperance, but the species was until recently considered to be restricted to Waychinicup, Fitzgerald River and Cape Arid National Parks where the population is <150 individuals. In the last 10 years however, there have been several unconfirmed sightings in the Jurien–Leeman–Badgingarra–Mt Adams area, including one report near the intersection of Wongonderrah Road and Brand Highway, just north of the wind farm project area. Suitable vegetation (low heath) is present, just east of Brand Highway and adjacent to the Study Area.

3.3.5.2 Conservation Significance Level 2

Australian Bustard Ardeotis australis

The Australian bustard is listed as Priority 4 by the DPaW and Near Threatened by Garnett and Crowley (2000). This species is a large, ground-dwelling bird known to occur in open or lightly wooded country in Australia (extinct in south-eastern Australia) and southern New Guinea. It is nomadic and may range over very large areas, largely dependent on rainfall and hence food availability. It appears to be a summer visitor to the Cooljarloo area, as one or two birds were seen in most years when summer surveys were carried out in the late 1980s and early 1990s (Bamford 2007). It is therefore likely to be an occasional summer visitor in small numbers to the Study Area, and will readily utilise paddocks.

Rufous Fieldwren Calamanthus campestris montanellus

The Wheatbelt sub-species of the rufous fieldwren is listed as Priority 4 by the DPaW because it has lost much of its habitat due to clearing for agriculture. It is common in Low Heaths of Cooljarloo (Bamford 2007) and is likely to occur in this sort of habitat within the Study Area.

Crested Bellbird Oreoica gutturalis gutturalis

The Wheatbelt sub-species of the crested bellbird is listed as Priority 4 by the DPaW because it has lost much of its habitat due to clearing for agriculture. It is common in Banksia Low Woodland of Cooljarloo (Bamford 2007), and is likely to occur in this sort of habitat within the Study Area.

3.3.5.3 Conservation Significance Level 3

The square-tailed kite, southern emu-wren, scarlet robin and white-breasted robin are of local conservation significance and all have declined in areas of clearing and development, such as around Perth (DEP 2000). The square-tailed kite is an uncommon bird of prey that is a winter visitor in small numbers to the Low Heaths of Cooljarloo (Bamford 2007). The southern emu-wren is also an uncommon species and seems to occur in only small numbers in Low Heaths of Cooljarloo (Bamford 2007). The scarlet robin is at the northern extreme of its range at Cooljarloo and was recorded only in the mid-1990s, in an area of rehabilitation that was effectively an open woodland of eucalypts (Bamford 2007). It would appear to be only a vagrant in the area naturally, and that would also apply to the Study Area. In contrast, the white-breasted robin is locally common but restricted to Scrub-Heaths and other dense vegetation around damplands and wetlands. It is likely to occur along Mullering Brook through the Study Area.

The results of site-specific bird surveys consider potential impacts of the proposed wind farm and they are presented in Section 3.5.

3.3.6 Mammals

There is likely to be a depauperate mammal fauna due to habitat degradation and fox predation, which has led to local extinctions. Six mammal species previously recorded are introduced species such as rabbits, cats and foxes. Several rabbits and foxes were recorded during the survey of the Study Area. Bamford (2007) has recorded a suite of small mammals in heath and woodland, including the honey possum (*Tarsipes rostratus*), noodji or ashy-grey mouse (*Pseudomys albocinereus*) and four species of dunnarts (see Appendix 2). All these small mammals are likely to be present in remnant vegetation; none is of conservation significance.

The brush wallaby (*Macropus irma*) (CS2) is potentially present within the Study Area and occasionally ventures onto open areas including roads and tracks. This species is listed as Priority 4 by the DPaW. The various patches of native vegetation across the Study Area could be used by brush wallaby as movement corridors between significant stands of habitat. Maxwell et al. (1996) concluded that the main threat to this species is predation by foxes.

Eight species of bat have been recorded previously in the area and are probably relatively uncommon across the large open expanses of pasture. They are likely to be common in woodlands, along brooks and other stands of vegetation low in the

landscape. These woodlands are mostly long narrow bands of vegetation following the watercourses and roads. Here, bats are likely to fly low and close to the vegetation much of the time. The white-striped freetail-bat (*Tadarida australis*) is common in winter and commonly flies at height and possibly within the RSA. None of those species previously recorded in the area is of conservation significance.

3.4 Bat Survey Results

3.4.1 Species Detected

During the bat survey in the Study Area in October 2008, 28 call recordings were obtained by the Anabat recorders across three detector nights. Of these, six were not clear bat calls and several more were too unclear to identify the species. The remaining call records yielded at least five species (to genus) of bat as shown in Table 5.

Sampling at a lowland site (Waddi Bush Resort) yielded five confirmed species in total and many more calls were detected (see Table 6). The greater number of species and calls for the lowland site confirmed expectations that bats use the closed lowland habitats more readily than the open pasture on higher ground.

A further survey period in autumn 2009 was used to sample bat occurrence in the Study Area. The sampling locations are shown in Figure 3. This occurred between 5 and 27 May 2009 using a single Anabat detector at each location for two to four days. Bat sonograms confidently keyed to species or genus are provided in Appendix 1 and the results of the survey in Table 5. A total of 406 bat sonograms were collected through the autumn survey with most activity at sampling locations W2 and W1 in descending order. These two sites were located adjacent scrub habitat and a pond at the end of a line of trees respectively. Bat activity at the other four sites (all in open pasture) was very low and comprised a small number of detections.

Table 5: Bat Species Detected at Wind Turbine Locations on Waddi Wind Farm, Number of Times They Were Confidently Detected and Date and Time of Detection

Ref	Date	Habitat/Terrain	Notes	Species Recorded	No. Records
W1	6–8 May 09	Close to waterhole and adjacent to line of trees.	Saw bats flying when setting up Anabat.	*Tadarida australis*	3
				Mormopterus sp. (sp 4)	8
				Vespadelus regulus	1
				Nyctophilus major	1
W2	8–12 May 09	Adjacent scattered scrub in open pasture.	Total of 347 records of which ten appear to be background noise.	*Mormopterus* sp. (sp 4)	28
				V. regulus	99
				Chalinolobus gouldii	2
				T. australis	4
				N. major	102
				Unidentified	114
W3	12–15 May 09	Open pasture no trees or scrub.		*Mormopterus* sp. (sp 4)	4
				V. regulus	1

Ref	Date	Habitat/Terrain	Notes	Species Recorded	No. Records
W4	15–19 May 09	Open pasture clumps of remnant or regenerating heath.		*V. regulus*	1
				Mormopterus sp. (sp 4)	4
				N. major	2
				Unidentified	3
W5	19–22 May 09	Open pasture no trees or scrub.	Anabat malfunctioned after 0421 hrs on 21 May. No further records from remaining 2 hrs 39 mins.	*Mormopterus* sp. (sp 4)	4
				V. regulus	2
				N. major	1
				T. australis	1
				Unidentified	1
W6	22–26 May 09	Open pasture no trees or scrub.	Anabat became ultra-sensitive and recorded almost continuous background noise. Although all files were inspected, no bat calls could be deciphered from 16,500 files.		

NOTE: The identification of *Nyctophilus major* is based on data presented in Bullen and McKenzie (2002) and the distribution provided by Churchill (2008). The identification of *Mormopterus* spp 4 is based on distribution.
Note No bat species were detected in the spring on Waddi site, probably as a result of bat detector failure

Table 6: Bat Species Detected at Waddi Reference Site (Waddi Bush Resort)

Species	No. Detections	Date	Time
Southern freetail bat *Mormopterus* spp	17	26–27 Nov	All through night
Southern forest bat *Vespadelus regulus*	6	26–27 Nov	Late night – early morning
Western long-eared bat *Nyctophilus major*	1		
White-striped freetail bat *Tadarida australis*	3	26–27 Nov	Late night
Gould's wattled bat *Chalinolobus gouldii*	2	26–27 Nov	

NOTE: The identification of *Nyctophilus major* is based on data presented in Bullen and McKenzie (2002) and the distribution provided by Churchill (2008).
The identification of *Mormopterus* spp 4 is based on distribution.

Despite the Anabat recording all noise on sampling point 6, it is likely that bats would have been detected if they were active in the area. Given the open pasture at this location and extremely low number of detections in similar habitats, the lack of bats is not a surprise.

All five bat species detected near the proposed turbine locations are fairly common and have been detected during other bat surveys for wind farm developments in the region (ENV 2008). The early detection of three of the bats would indicate they are roosting within the Study Area. None of those species recorded is of conservation significance.

Detectors placed in open pasture detected very few bats and reflected the anticipated pattern of bat activity across such a site (see Plate 1). The largest number of bat records was taken at sampling point W2, which was located amongst scattered scrub (see

Plate 2) but connected to other locations via near-continuous vegetation. Over the four nights of sampling, 347 records of bat call were taken at this point mostly in the evenings with relatively few from the later mornings. Sampling point W1 was located near a waterhole and adjacent to a line of trees and an intermediate level of bat activity (34 records) was recorded at this location. Of note were the records obtained at sampling point W4: this was located approximately 50 m from scattered scrub and low-lying heath and yet acquired only four records (see Plate 3). These results possibly reflect the poor association bats have with open pasture and close association bats have with taller vegetation and the shelter and foraging opportunities it provides.

The most commonly detected of the species was the southern freetail bat (*Mormopterus* spp 4) and was regularly recorded at all sampling locations but in relatively low numbers. The southern forest bat (*Vespadelus regulus*) and western long-eared bat (assumed to be *Nyctophilus major* (previously a sub-species of *N. timoriensis*) based on distribution) were recorded regularly at most sampling locations with a large number at point W2. However, the frequencies of these two species overlap and many of the poor sonograms taken may be of either. The large number of records from this location at dusk indicates that a roost may be close by for one of the species or both. There was an absence of records of either species at dawn indicating that they may have moved to another roost or return to roost in the late evening at this time of year. Low numbers of white-striped freetail bats (*Tadarida australis*) and Gould's wattled bat (*Chalinolobus gouldii*) were taken across the site indicating a low but ubiquitous presence.

The southern freetail bat is a medium-sized bat that has adapted well to changing conditions in Australia and is known to roost in buildings and feed primarily on agricultural pests in the eastern states. It forages normally between or over trees but occasionally near the ground as well. The flight habits of this bat may occasionally put it at risk of collision with turbine blades in the RSA.

The southern forest bat is a small bat species that often uses tree hollows and houses in which to roost. Although it is reported by Churchill (2008) that this species is sensitive to fragmentation and avoids small habitat remnants, corridors and open areas, it would have had to fly over such areas to have been recorded at the majority of locations at which it was detected. Because this bat prefers to fly within vegetation, it is unlikely that it would fly within RSA height.

The western long-eared bat has only been recorded in south Western Australia and near the state border with South Australia. Although generally regarded as preferring woodlands and shrublands (Churchill 2008), they may have been confused with other *Nyctophilus* species in the past and therefore been under recorded. This species does not regularly fly at RSA height so is therefore not expected to be at risk of collision.

The white-striped freetail bat roosts mostly in tree hollows but individuals have been known to roost in caves and lofts of houses. This bat species is known to forage regularly at height as well as at low level and even gleaning from the ground. Its aerial foraging activities may therefore put it at risk of collision with turbine blades.
Other species of bat may be present across the Study Area at certain times of the year.

3.5 Bird Survey Results

3.5.1 Species Detected

RPS undertook a bird survey in 2010 of 43 census points, including Waddi, Yandin and representative points (Figure 5). During survey, RPS (2010) recorded 88 species across a range of sites in the region, and 44 species at the specific survey sites within the proposed Study Area.

Results of this survey are provided in Table 7, which includes the height ranges frequented by the birds to determine potential impacts from the wind farm. The RSA zone heights of the wind farm presented in the table are:

- Zone 1 – Below the RSA
- Zone 2 – Within the RSA
- Zone 3 – Above the RSA.

Those species recorded flying within Zone 2 are most likely to be impacted by the proposed wind farm. These species are summarised in Table 7, those most commonly recorded at this height are discussed below. The only however, conservation significant species recorded occasionally flying at this height is the Carnaby's Black-Cockatoo.

Most species were recorded flying only in Zone 1 (i.e. below RSA). The only species recorded flying in the RSA regularly ($\geq$ 25% of records) were the brown falcon, black-shouldered kite, wedge-tailed eagle, fairy martin and white-backed swallow, although the sample sizes of the brown falcon (seven), black-shouldered kite (three), fairy martin (two) and white-backed swallow (four) were very low. There was a much larger sample size of the wedge-tailed eagle (102 records), which was recorded regularly in both Zones 2 and 3. In general, birds of prey are known to be at risk from wind turbines because they often fly in the RSA, and because they are predators that usually occur at low population densities, and thus small numbers of deaths can be significant (Madders et al. 2006).

Eight other species were recorded flying occasionally (5–25% of records) in the RSA. Of most concern are the Nankeen kestrel (of concern because a bird of prey) and Carnaby's Black-Cockatoo (high conservation significance). Carnaby's Black-Cockatoo also occurs in the Emu Plains Wind Farm area; however, no fauna mortality records for the Emu Plains Wind Farm were available at the time of writing this report. The flight speed of Carnaby's Black-Cockatoo is defined as slow (in flocks) and the slow speed is considered to reduce the risk of birds from turbines.

Table 7: Bird Census Results Showing Habitat over Which the Bird Species Were Recorded, Indication of Their Movement Patterns and Speed Category in Which They Were Recorded Flying

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Australian shelduck	4509	0				Wetlands	Sedentary/Dispersive	Med
Black swan	1633	0				Wetlands	Sedentary/Dispersive	Slow–Medium
Western corella	901	7				Woodland/Grassland	Locally nomadic	Medium Flocks
Galah	458	254				Woodland/Grassland	Locally nomadic	Medium Flocks
Australian raven	427	119				Forest/Woodland/Heath/Grassland	Locally nomadic	Medium
Australian ringneck	374	46				Forest/Woodland	Sedentary	Swift
Straw-necked Ibis	366	65				Wetlands/Grassland	Locally nomadic	Slow
Brown songlark	236	206				Grassland	Aerial Breeding displays	Medium
Tree martin	213	16				Woodland/Aerial	Sedentary	Medium–Swift
Australian magpie	198	62				Forest/Woodland/Grassland	Sedentary	Medium–Swift
Yellow-rumped thornbill	194	60				Woodland/Shrubland/Grassland	Sedentary	Slow
Red-capped plover	179	0				Salt and Freshwater Wetlands	Nomadic/Dispersive	Medium–Swift
Australasian shoveler	154	0				Wetlands	Nomadic/Dispersive	Swift
Grey teal	119	0				Wetlands	Nomadic	Swift
Australian magpie-lark	114	33				Forest/Woodland/Grassland	Sedentary	Slow–Medium
Australian pipit	105	58				Grassland	Aerial Breeding displays	Medium
Red-necked stint	104	0				Intertidal Zone and Saline Wetlands	Migratory/Nomadic	Medium–Swift
Carnaby's Black-Cockatoo	100	36				Forest/Woodland/Heath	Seasonally Nomadic	Slow Flocks
Welcome swallow	99	20				Aerial space above most habitat	Sedentary/Nomadic	Medium–Swift
Black-winged stilt	98	0				Intertidal Zone and Wetlands	Nomadic/Dispersive	Medium

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Black-faced woodswallow	96	55				Forest/Woodland/Grassland/Aerial	Sedentary Migratory	Slow–Swift
Brown honeyeater	85	5				Forest/Woodland/Shrubland/Heath	Sedentary	Slow–Medium
Stubble quail	84	69				Grassland	Nomadic/Irruptive	Swift (but short)
Wedge-tailed eagle	82	20				Forest/Woodland/Grassland	Sedentary (large territory)	Slow–Swift
White-cheeked honeyeater	77	31				Woodland/Heath	Sedentary	Slow–Medium
Nankeen kestrel	70	21				Grassland/ Woodland edges	Sedentary/Dispersive	Slow–Swift
White-winged fairy-wren	59	20				Shrublands/Heath	Sedentary	Slow
Willie wagtail	53	21				Woodland/Grassland	Sedentary	Slow
Silver gull	50	0				Coastal Fringe and Saline Wetlands	Sedentary/Locally nomadic/ Dispersive	Slow–Medium
White-fronted chat	50	34				Shrubland/Grassland/Heath/Flats	Nomadic	Medium
Silvereye	49	13				Forest	Seasonal nomad	Medium Flocks
Splendid fairy-wren	44	19				Woodland/Shrublands/Heath	Sedentary	Slow
Rufous whistler	43	7				Woodland/Shrubland	Sedentary/Breeding Migrant	Slow
Black-faced cuckoo-shrike	41	6				Forest/Woodland/Shrubland	Locally nomadic	Medium
Rainbow bee-eater	38	20				Forest/Woodland/Shrubland	Sedentary/Migratory	Swift
Grey butcherbird	32	9				Forest/Woodland/Shrubland	Sedentary	Slow–Medium
Singing honeyeater	29	9				Forest/Woodland/Shrubland	Sedentary	Medium
Crested pigeon	28	3				Grassland/ Woodland edges	Sedentary	Slow–Swift
Western gerygone	24	0				Forest/Woodland/Shrubland	Sedentary	Slow
Rufous fieldwren	22	19				Heath/Sparse shrubland	Sedentary	Slow

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
White-winged triller	16	4				Woodland/Shrubland/Heath	Breeding Migrant	Slow–Medium
Musk duck	16	0				Deep Water Wetlands	Dispersive	Medium–Swift
Tawny-crowned honeyeater	15	7				Heath	Sedentary	Slow–Medium
Variegated fairy-wren	14	0				Woodland/Shrublands/Heath	Sedentary	Slow
Australian wood duck	13	0				Wetlands	Locally nomadic	Med
Inland thornbill	12	0				Forest/Woodland/Shrubland	Sedentary	Slow
Zebra finch	11	0				Grassland and Open Shrublands	Nomadic/Dispersive	Slow
Yellow-throated miner	10	0				Forest/Woodland/Shrubland	Sedentary	Slow
Black honeyeater	9	4				Shrubland/Heath	Sedentary/Nomadic	Medium–Swift
Laughing kookaburra	8	0				Forest/Woodland	Sedentary	Slow
Rufous songlark	7	4				Grassland	Aerial Breeding displays	Medium
Grey shrike-thrush	7	0				Forest/Woodland/Shrubland	Sedentary	Medium
Horsfield's bronze-cuckoo	6	1				Forest/Woodland	Sedentary/Migratory	Medium–Swift
Australian pelican	6	0				Coastal Fringe and Large Inland Water Bodies	Locally nomadic/Dispersive	Medium–Swift
Banded lapwing	5	5				Grasslands	Dispersive	Slow–Swift
Common bronzewing	5	2				Woodlands/Heaths	Sedentary	Swift
Crimson chat	5	3				Woodland/Shrubland/Heath	Nomadic	Medium
Sacred kingfisher	4	0				Forest/Woodland	Sedentary/Migratory	Swift
White-faced heron	4	0				Grasslands/Wetlands Coastal Fringe	Nomadic	Medium
Western thornbill	4	0				Forest/Woodland/Shrubland	Sedentary	Slow
Varied sittella	4	0				Forest/Woodland/Heath	Sedentary	Slow–Medium

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
White-backed swallow	4	0				Watercourses	Sedentary	Slow–Medium
Brown falcon	4	3				Grassland/ Woodland edges	Sedentary/Dispersive	Slow–Swift
Red-capped parrot	3	0				Marri Woodlands	Sedentary	Swift
Shining bronze-cuckoo	3	0				Forest/Woodland	Migratory/Sedentary	Medium–Swift
Red wattlebird	3	0				Woodland/Heath	Sedentary/Nomadic	Slow
Whistling kite	2	0				Woodlands, Coastal Fringe and Wetlands	Sedentary/Locally Nomadic	Sow–Medium
Collared sparrowhawk	2	1				Forest/Woodland	Sedentary (large territory)	Slow–Swift
Brown goshawk	2	0				Forest/Woodland	Sedentary (large territory)	Slow–Swift
Australian hobby	2	1				Grassland/ Woodland edges	Sedentary/Dispersive	Slow–Swift
Red-necked avocet	2	0				Estuaries and Saline Wetlands	Nomadic/Dispersive	Medium
Striated pardalote	2	0				Forest/Woodland	Sedentary	Swift
White-browed scrubwren	2	2				Forest/Woodland	Sedentary	Slow
Weebill	2	0				Forest/Woodland	Sedentary	Slow
Red-capped robin	2	0				Woodland/Shrubland	Sedentary	Slow
Hooded robin	2	0				Woodland/Shrubland	Sedentary	Slow
Black-shouldered kite	2	1				Grassland/Woodland	Locally nomadic/dispersive	Medium
Pacific black duck	1	0				Wetlands	Dispersive	Swift
Little egret	1	0				Estuaries and Saline Wetlands	Locally Nomadic/Dispersive	Slow
Australian white ibis	1	0				Estuaries, Wetlands and Grasslands	Locally Nomadic/Dispersive	Slow–Medium
White-bellied sea-eagle	1	0				Estuaries, Rivers and Large Inland Water bodies	Locally Nomadic/Dispersive	Slow–Swift

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Gull-billed tern	1	0				Estuaries and Saline Wetlands	Sedentary/Locally Nomadic/Dispersive	Medium–Swift
Brown-headed honeyeater	1	0				Forest/Woodland/Heath	Sedentary	Slow–Medium
Grey fantail	1	0				Forest/Woodland/Shrubland	Sedentary/Seasonal/ Migrant	Slow
Pied butcherbird	1	0				Woodland	Sedentary	Slow–Medium
Mistletoebird	1	0				Forest/Woodland	Sedentary/Nomadic	Medium–Swift
Little grassbird	1	0				Dense Wetland Vegetation	Sedentary	Slow
Fairy martin	1	1				Aerial proximate to nesting sites	Sedentary	Medium–Swift

= Species commonly recorded at this height range during study (25% and >25%)

= Species occasionally recorded at this height range during study (>5% and < 25%)

= Species rarely recorded at this height range during study (> 0% and up to 5%)

= Species not recorded at this height range during study (0%)

3.6 Summary of Fauna

Two EPBC Act listed fauna species have been recorded in the proposed Study Area: Carnaby's Black-Cockatoo and rainbow bee-eater. The only other CS1 species likely to be present is the WA Wildlife Conservation Act listed south-west carpet python. Impacts on these are discussed in the following section.

CS2 fauna with potential presence in the Study Area include the brush wallaby, rufous field wren, crested bellbird, jewelled ctenotus and black-striped snake, and CS3 species include the western minnow, western pygmy perch, white-breasted robin, scarlet robin and southern emu-wren. The brush wallaby could be affected by the proposed development if it is on site and therefore will be considered in the impact assessment. The two fish species will not be considered further, as it is unlikely that the development will have any effect on the habitats in which they are likely to be found. The CS2 and CS3 bird species are all restricted to woodland and heath so are discussed further due to slight risk from habitat alteration.

The survey of birds in relation to their movements through the RSA, found some birds of prey present and potentially at risk and Carnaby's Black-Cockatoo moving through the RSA at least occasionally.

4.0 ECOLOGICAL IMPACT ASSESSMENT

A risk-based ecological impact assessment has been undertaken as described in Section 2.5. Key elements in this assessment are described below.

4.1 Embedded Management Measures

Various management initiatives have been embedded into the design of the proposed wind farm to avoid, reduce or mitigate potential impacts on faunal species. These measures have been taken into account when conducting the risk assessment. The embedded management measures have been developed via an iterative approach between Waddi Wind Farm Pty Ltd and RPS to maintain the ecological integrity of the Study Area wherever possible.

These measures include:

Avoidance Measures

- The Study Area has been selected from numerous site options. The Study Area has fewer ecological interests present that have the potential of being affected than other sites reviewed.
- Turbine locations and infrastructure have been located outside sites designated for wildlife conservation.
- All turbines have been located outside of native vegetation where the majority of fauna would be found.
- Service tracks, underground connecting cable routes, substation, grid connection route and connection to SWIS are located outside of native vegetation wherever practicable.

Reduction Measures

- Where infrastructure cannot avoid native vegetation, the direct and indirect risks to fauna and ecological processes will be minimised by locating activities on the edges of native vegetation or passing through narrow strips of native vegetation that have either been subject to previous disturbance or where weed infestation has reduced the value of the vegetation, rather than impacting on large stands of undisturbed vegetation.
- Turbines have been located a minimum of 30 m from native vegetation to reduce the potential risk of degradation of vegetation and any indirect effects on fauna, for example changes in drainage regimes.

- Turbines have been sited away from native vegetation to reduce the risks of bats and invertebrates colliding with turbine blades in the RSA.
- Tree removal has been minimised to reduce the risks to tree dwelling invertebrates, bat roosts, Carnaby's Black-Cockatoos and arboreal corridors.
- Where service tracks and underground connecting cable routes have passed from existing tracks into pasture fields, the location has been selected to coincide with existing access gates to reduce effects on native vegetation and fauna.
- Where brooks and vegetated valleys are crossed by service tracks, underground connecting cable network and the grid connection route, existing crossings have been selected where practicable to reduce further fragmentation of vegetation or changes in the hydrological regime.

Recommendations for other management and mitigation measures are provided in Section 6.0.

4.2 Identification of Potential Hazards

4.2.1 Potential Hazards during Construction

There are a number of potential hazards associated with the construction of the wind farm that could result in effects on terrestrial fauna receptors. These include:

- loss or fragmentation of native vegetation that provides habitat for fauna
- degradation of native vegetation through clearance and increased fire occurrence
- degradation of native vegetation due to increased drainage of the soil as a result of nearby excavations for turbine bases
- risk of death or injury of fauna during vegetation clearance and ground work
- risk of death or injury of fauna from construction vehicles
- disturbance of fauna from construction vehicles, noise, vibration and lighting
- changes in hydrological regime near rivers as a result of new crossings or vegetation clearance.

4.2.2 Potential Hazards during Operation

There are a number of potential hazards associated with the operation of the wind farm that could result in effects on terrestrial fauna receptors. These include:

- collision risk of aerial fauna (bats and invertebrates) with turbine blades in RSA
- risk of aerial fauna (mainly bats) colliding with new overhead transmission lines
- risk of injury or death from maintenance vehicles
- disturbance due to noise, vibration and movement associated with maintenance activities
- wind turbines acting as a barrier to the movement of fauna
- increases in feral species as a result of increased bird and bat injury.

These hazards were assessed against each of the ecological receptors identified above in line with the risk assessment process detailed in Section 2.

4.3 Risk Evaluation

Table 8 describes the identified key hazards and the respective risk evaluation results for each of the key fauna receptors in the Study Area. Where the hazards identified in Section 4.2 have potentially similar or associated effects (e.g. damage or loss of vegetation) they are grouped together. Not all above hazards will affect all fauna groups and, where hazards are unlikely to affect individual groups, they are omitted from the risk assessment.

Table 8: Summary of Risk Assessment for the Faunal Receptors that are Likely to Occur on the Site of the Proposed Waddi Wind Farm

Receptor	Status/ Importance	Habitat	Hazards	Likelihood	Consequence	Risk	Management Options	Residual
General herpetofauna		Mainly native vegetation, venture into open areas adjacent to native vegetation.	Loss, fragmentation or degradation of habitat (C)	Possible	Incidental	Low	Rehabilitate stand(s) of native vegetation and fence other areas. Encourage landowners to carry out control of feral predators (foxes and cats)	Low
			Risk of injury during vegetation clearance (C)	Possible	Incidental	Low	Clear vegetation to ground level and leave for a few days before earth works begin. Ideally in spring, summer or autumn.	Low
			Risk of Injury on Roads or Construction Areas (C & O)	Likely	Incidental	Low	Restrictions on speed for service vehicles	Low
Jewelled ctenotus and black-striped snake	CS2	Mainly native vegetation, venture into open areas adjacent to native vegetation.	Loss, fragmentation or degradation of habitat (C)	Possible	Incidental	Low	Rehabilitate stand(s) of native vegetation and fence other areas. Encourage landowners to carry out control of feral predators (foxes and cats)	Low
			Risk of injury during vegetation clearance (C)	Possible	Incidental	Low	Clear vegetation to ground level and leave for a few days before earth works begin. Ideally in spring, summer or autumn.	Low
			Risk of Injury on Roads or Construction Areas (C & O)	Likely	Incidental	Low	Restrictions on speed for service vehicles	Low
Carpet python	CS1	Mainly native vegetation, ventures into open areas adjacent to native vegetation.	Loss, fragmentation or degradation of habitat (C)	Possible	Incidental	Low	Encourage landowner to rehabilitate habitat and fence areas, fox and cat control measures	Low
			Risk of injury during vegetation clearance (C)	Unlikely	Minor	Low	Clear vegetation to ground level and leave for a few days before earth works begin. Ideally in spring, summer or autumn.	Low
			Risk of injury on roads or construction areas (C & O)	Unlikely	Major	Medium	Restrictions on speed of service vehicles and on night driving. Driver awareness	Low
General mammals	CS2 (Brush Wallaby)	Mainly native vegetation, ventures into pasture and onto roads.	Loss, fragmentation or degradation of habitat (C)	Possible	Incidental	Low	Rehabilitate habitat and fence areas, fox and cat control measures	Low
			Risk of road injury (C & O)	Likely	Incidental	Low	Restrictions on speed of service vehicles	Low
			Disturbance (C & O)	Possible	Incidental	Low		Low

Receptor	Status/ Importance	Habitat	Hazards	Likelihood	Consequence	Risk	Management Options	Residual
Bats	Landscape ecology processes	Roosting in woodlands, buildings and trees, foraging and commuting over entire site	Loss of habitat and roosting locations (C)	Possible	Incidental	Low	Rehabilitate habitat and fence areas, fox and cat control measures	Low
			Risk of injury or death from vegetation clearance and tree felling (C)	Possible	Incidental	Low	Check trees prior to felling and provide measures to allow bats to move out of roost before felling	Low
			Disturbance from construction activities (C)	Possible	Incidental	Low		Low
			Risk of injury or death from collision with turbine blades (O)	Likely	Incidental	Low	Undertake a collision monitoring program whereby areas searched below turbines for carcasses.	Low
			Avoidance of the wind farm area and loss or fragmentation of habitat. (O)	Unlikely	Incidental	Low	Rehabilitate habitat and fence areas, fox and cat control measures	Low
General birds		Mainly native vegetation, venture into open areas adjacent to native vegetation.	Loss of habitat and roosting locations (C)	Possible	Incidental	Low	Rehabilitate habitat and fence areas, fox and cat control measures	Low
			Risk of injury or death from vegetation clearing (C)	Possible	Incidental	Low	Check trees prior to felling	Low
			Disturbance from construction activities (C)	Possible	Incidental	Low		Low
			Risk of injury or death from collision with turbine blades (O)	Likely	Incidental	Low	Undertake a collision monitoring program whereby areas searched below turbines for carcasses.	Low
			Avoidance of the wind farm area and loss or fragmentation of habitat. (O)	Likely	Incidental	Low	Rehabilitate habitat and fence areas, fox and cat control measures	Low
Black cockatoos	CSI	Breeds in large trees such as Marri and forages in banksia woodland and adjacent paddocks	Loss of habitat and roosting locations (C)	Possible	Incidental	Low	Rehabilitate habitat Foraging habitat occurs at lower elevations away from the proposed turbines, therefore impacts to habitat will be minimal	Low
			Risk of injury or death from vegetation clearing (C)	Possible	Incidental	Low	Check trees prior to felling	Low

Receptor	Status/ Importance	Habitat	Hazards	Likelihood	Consequence	Risk	Management Options	Residual
			Disturbance from construction activities (C)	Possible	Incidental	Low		Low
			Risk of injury or death from collision with turbine blades (O)	possible	Incidental	Low	Carnaby's Black-Cockatoo was occasionally observed flying at RSA height. However, this species was rarely observed flying at this height at the higher elevations where the turbines are located. Undertake a collision monitoring program whereby areas searched below turbines for carcasses.	Low
			Avoidance of the wind farm area and loss or fragmentation of habitat. (O)	Likely	Incidental	Low	Rehabilitate habitat and fence areas, fox and cat control measures	Low
Raptors		Mainly native vegetation, venture into open areas adjacent to native vegetation.	Loss of habitat and roosting locations (C)	Possible	Incidental	Low	Rehabilitate cleared areas where possible	Low
			Risk of injury or death from vegetation clearing (C)	Possible	Incidental	Low	Check trees prior to felling	Low
			Disturbance from construction activities (C)	Possible	Incidental	Low		Low
			Risk of injury or death from collision with turbine blades (O)	possible	Incidental	Low	Undertake a collision monitoring program whereby areas searched below turbines for carcasses.	Low
			Avoidance of the wind farm area and loss or fragmentation of habitat. (O)	Likely	Incidental	Low	Rehabilitate habitat and fence areas, fox and cat control measures	Low

LEGEND: (C): Risks due to construction activities, (O): Risks due to operation activities, (C & O): Risks due to construction and operation activities

4.3.1 General Herpetofauna and CS2 Reptiles

4.3.1.1 Risks Due to Construction

Potential hazards for reptiles and amphibians would be limited to potential injury or death during vegetation clearing, indirect effects from habitat loss, fragmentation or degradation and injury from construction activities if reptiles ventured into working areas.

Risk of Injury during Vegetation Clearing

During removal of vegetation, it is possible that reptiles and amphibians could be injured or killed by mechanical plant undertaking the clearing. Because of the small areas of vegetation involved, numbers of herpetofauna potentially affected would be low. There is potential for some animals to move away from these disturbances, however mortality is inevitable.

Without management practices, the level of likelihood of injury to reptiles or amphibians would be Likely, and the consequences would be Incidental because of the localised and short term drop in abundance of common species that may occur. The level of risk would be Low.

Risk of Injury on Roads or Construction Areas

Except for very wet periods after rainfall, amphibians are not likely to be found in open areas. Reptiles venture into open areas to bask and to hunt. Once warm they are highly active, wary of movement and avoid human activity. They generally do not venture far from cover. The risk of individuals being injured in working areas would therefore be limited to areas close to native vegetation. All of the turbines and most of the infrastructure for the wind farm have been located away from areas of native vegetation to help reduce such effects.

The likelihood of physical harm to any reptile or amphibian is considered Likely as it may occur only occasionally during the construction phase, and the consequence Incidental; any effects would be localised and temporary, and involve low numbers of common species. The risk would therefore be Low.

Loss and Fragmentation of Habitat

Losses and temporary impacts on potential reptile habitat have been reduced by careful design and siting of the wind turbines and infrastructure. The area likely to be affected comprises a very small fraction of the remaining total potential habitat across the proposed Study Area (see Waddi Wind Farm: Targeted Level 1 Vegetation and Flora Assessment (Outback Ecology 2010)). Most locations that are likely to be marginally affected such as at the widening of existing gated access points, are also currently degraded and of low value to reptiles and amphibians.

The fragmentation of habitats has been avoided wherever practicable by locating overhead lines, service tracks and underground connecting cables through existing gaps in vegetation. Where this has not occurred, and the circumstances allow, the vegetation will be allowed to re-establish to a low sward and thus maintain connectivity between stands of vegetation. Impacts on vegetation likely to support any reptiles or amphibians will be limited to the crossing of the road reserve adjacent to the Brand Highway (Outback Ecology 2010).

Overall, the potential indirect risks to general herpetofauna as a result of the wind farm would be insignificant at the population level. The likelihood of herpetofauna being affected by loss of habitat is possible due to the single impact during construction, and the consequences incidental due to the low numbers involved. Therefore, the level of risk would be Low.

Recommendations

To reduce this risk still further, it is recommended that vegetation be carefully removed by brush cutter before any ground works occur. Ideally this should be conducted in the spring or autumn when the reptiles are active but not in peak breeding activity. This will give time for any reptiles (and other fauna) to move away from the impact area before any ground work or vehicle activity occurs. The likelihood would then be Unlikely and the consequence Incidental. The residual risk would be Low.

4.3.1.2 Risks Due to Operations

Risk of Injury on Roads and Operation Areas

Potential hazards for herpetofauna during the operation of the proposed wind farm would be limited to potential injury or death from collision with service vehicles and personnel. It is unlikely that large numbers of reptiles or amphibians would be present in the Study Area in the vicinity of service tracks. Amphibians are only likely to venture out of cover at night and after heavy rainfall and less likely to be at risk. Reptile species that would potentially venture onto tracks and open areas would mostly be common species. The CS2 jewelled ctenotus and black-striped snake are likely to remain under cover of native vegetation.

The likelihood of injury or death of reptiles and amphibians from vehicle traffic across the Study Area would be Likely and the consequence level Incidental as any drop in abundances would be localised. The risk level would therefore be Low.

Recommendations

Restriction of vehicle speed will allow some reptile species time to escape before the vehicle passes. Should vegetation rehabilitation, fencing and feral predator control be carried out in the Study Area, reptiles would benefit. Fencing would allow vegetation to improve and rehabilitation would provide a larger area of native vegetation which could

have a holding capacity for larger reptiles and more species. Predation by feral foxes and cats would drop and thus increase the abundance of reptiles. This would be a net benefit to reptiles across the Study Area. The likelihood would remain Likely and the consequence Incidental with the residual risk Low but with benefits.

4.3.2 Carpet Python

4.3.2.1 Risks Due to Construction

Potential hazards for the carpet python (CS1) would be limited to indirect effects from habitat loss, potential injury or death during vegetation clearance, habitat fragmentation or degradation and potential injury or death during construction if they ventured into working areas. Based on records from Cooljarloo the carpet python is likely to be present, and while it would probably occur only in larger stands of native vegetation, individuals can wander widely.

Loss of Habitat

Losses and temporary impacts on habitat have been reduced by careful design and siting of the wind turbines and infrastructure. The native vegetation likely to be affected comprises a very small fraction of the total across the proposed Study Area (see vegetation survey report by Outback Ecology (2010)). The only area of vegetation that would be affected by the project and that is likely to support any snakes involves the crossing of the road reserve adjacent to the Brand Highway. Most other locations of potential habitat likely to be marginally affected such as, at the widening of existing gated access points, are also degraded and of low value to carpet pythons.

Fragmentation of habitats has been avoided wherever practicable by locating service tracks and network cables through existing gaps in vegetation. Permanent vegetation clearance has been reduced to a very small amount. Where disturbance is unavoidable but temporary, the vegetation will be allowed to subsequently re-establish to a low sward and thus maintain cover and connectivity between stands of vegetation.

With the generally low habitat value across the Study Area for carpet pythons and the management measures proposed, the potential indirect risks to carpet pythons because of vegetation clearing for construction activities would be insignificant at population level. The likelihood of the carpet python being affected by loss of habitat is Possible, and the consequences Incidental. The overall level of risk would be Low.

Risk of Injury during Vegetation Clearance

During the removal of vegetation, it is possible that carpet pythons could be injured or killed by mechanical plant undertaking the clearing. Due to the small areas of vegetation involved with this operation and rarity of the carpet python, it is unlikely any would be present in areas affected. In the unlikely event the species is present in the areas of

native vegetation involved at the time of vegetation clearing, the potential number of individuals affected/present would be small. However, given that the species occurs at a low density in the region, even the loss of one or two animals, especially large adults, could lead to a local population decline.

Without management practices, the level of likelihood of injury of carpet pythons would be Unlikely due to the low likelihood of this species being present in the small areas to be cleared.. The consequences would be Minor because of the potential localised and short-term drop in abundance of a CS1 species. The level of risk would be Low.

Risk of Injury on Roads or Construction Areas

The carpet python is likely to remain close to native vegetation, but individuals can wander. It could therefore venture into work areas, while animals may bask on roads in the early morning, late afternoon and on warm summer nights.

The likelihood of any physical harm to carpet pythons from vehicle activities is Unlikely given the low densities of this species, but the consequence could be Moderate because the species is present in small numbers, and large animals (such as breeding females) are more vulnerable to road kill by virtue of their size.

The level of risk would be Moderate but can be reduced through regulating vehicle speeds, avoiding night driving and driver awareness.

Recommendations

To reduce the risk associated with vegetation clearing, it is recommended that vegetation is first removed by brush cutter to just above ground level before any ground works occur. Ideally this should be conducted in early spring or autumn when pythons are active but not in peak breeding activity. This will give time for individuals to move away from the impact area before any groundwork or vehicle activity occurs. The likelihood level would then be Unlikely and the consequence Incidental. The residual risk would be Low.

The risk associated with animals being struck by vehicles during construction can be reduced through regulating vehicle speeds, avoiding night driving and driver awareness.

4.3.2.2 Risks Due to Operations

Risk of Injury on Roads or Construction Areas

Potential hazards for carpet pythons during the operation of the proposed wind farm would be limited to potential injury or death from movements of service vehicles and personnel. It is unlikely that the species is present in the Study Area in large numbers and proposed tracks have been located predominantly in open pasture and away from native vegetation, but the risk is ongoing and evens the loss of a few animals from a small population, especially if these are adults, is a concern.

The likelihood of injury or death of carpet python from vehicle traffic across the Study Area would be Unlikely and the consequence level Minor as any loss of individuals could adversely affect the already small local population. The level of risk would be Moderate but can be reduced through regulating vehicle speeds, avoiding night driving and driver awareness.

Recommendations

Restriction of vehicle speed will allow carpet pythons time to move off tracks before the vehicle passes. Should vegetation rehabilitation, fencing and feral predator control be carried out in the Study Area, the species would benefit. Fencing would allow vegetation to improve and rehabilitation would provide a larger area of native vegetation which could have an increased carrying capacity for larger reptiles.

Adoption of a feral predator control program would also potentially help this species as predation by foxes and cats can be a concern. This would likely be a net benefit to carpet pythons and most other species of reptiles across the Study Area. The likelihood would remain Possible, the consequence Minor and the residual risk Low.

4.3.3 Birds

4.3.3.1 Risks Due to Construction

The hazards for birds as a result of the construction of the proposed wind farm will be limited to physical injury during vegetation clearing, or as a result of construction vehicle traffic. Effects on native vegetation have been avoided and minimised where possible so that only several small sections will be damaged or disturbed.

Loss of Habitat

Bird species recorded in the Study Area are most likely to occur in the areas of native vegetation, although some species such as the Carnaby's Black-Cockatoo may also forage in adjacent cleared areas and paddocks.

The proposed turbine locations are in areas that have already been cleared for agriculture and clearing of native vegetation, if required, for cables and access roads is expected to be minimal. Further, significant areas of vegetation have been mapped (refer Vegetation reports (Outback Ecology 2013)) to ensure avoidance during any micro-siting work. Therefore, the small loss of habitat as a result of vegetation clearing would be insignificant to birds.

The likelihood of loss of habitat is Possible but would only occur at one time during construction. The effects would also occur in a gradual movement across the Study Area as each area is developed. The consequences of habitat loss would be Incidental as they are common species and adequate foraging and roost resources would remain. The risk

level would therefore be Low. There is also potential for habitat loss through species avoidance of the Study Area after construction, however consequences of this are also considered Low.

Risk of Injury or Death from Vegetation Clearing

The likelihood of injuring birds during clearing activities is Low due to their ability to move away from any disturbances. This risk can be further reduced through checking trees for nests prior to felling.

Recommendations

It would be good practice to inspect trees for nests felling or to undertake vegetation clearing outside of the breeding season of most bird species on site.

4.3.3.2 Risks Due to Operations

The potential risks to birds from the operation of the proposed wind farm are:

1. Collision with the turbine blades or overhead transmission lines.

2. Avoidance of the wind farm, severing lines of movement between foraging, breeding and roosting areas.

Risk of Injury or Death from Collision with Turbine Blades or Overhead Transmission Lines

The most serious hazard because of the operating wind farm is the potential collision with the turbine blades in the RSA. The tips of the turbine blades travel at high speed and can kill or injure birds flying within the RSA. In Australia, collision rates reported have generally been around one to two birds per turbine per year (AusWEA 2004). NZWEA (2005) also refers to rates in Australia generally being between 0.23–2.7 birds per year. The most susceptible Australian birds are likely to include:

- birds of prey, particularly soaring species such as eagles and kites
- nocturnal migrating songbirds
- locally-breeding high-flying songbirds such as Australian magpie-larks
- waterbirds such as straw-necked Ibis, ducks and black swans
- shorebirds, including migratory waders
- Neophema parrots (AusWEA 2002).

Within Australia most wind farm development has been along coastal areas in Western Australia, South Australia and Victoria. In Tasmania, the first two stages of the Woolnorth Wind Farm have been the subject of a bird and bat strike-monitoring program. There has been some evidence for a slightly decreased usage of the Study Area by birds after construction (i.e. displacement) and several species have been reportedly hit by turbines including wedge-tailed eagles, seabirds such as petrels, common skylark, grey fantail, black currawong and banded lapwing (Rae 2005).

Studies conducted at Stanwell's Toora Wind Farm in South Gippsland found no evidence of significant levels of bird mortality, with impacts confined to localised indirect effects on common farmland birds. Species such as wedge-tailed eagles were regularly observed before and after operations began, but they avoided the turbines by flying around or between them (AusWEA 2004).

Risks from turbine operations to all avifauna species that have been recorded within the Study Area and its vicinity during site investigations are summarised in Table 7. Conservation significant species likely to be impacted by the wind turbines are discussed in Table 9.

Table 9: Potential Impacts to Conservation Significant Bird Species

Species	Chance of Occurrence on Site	Potential Impacts	Likely Level of Risk
Calyptorhynchus latirostris Carnaby's Black-Cockatoo (*1*)	**High** Carnaby's Black-Cockatoo was recorded within the Study Area and the wider locality during field surveys. Habitat utilisation within the Study Area and its locality followed what is generally known of the species, i.e. on-site occurrences were largely confined to intact marri (*Corymbia calophylla*) woodland areas, which occur as riparian remnants along valley bottom watercourses and lower slopes, and tall heathland communities and their remnants on sand plains and lower slopes in the wider locality. Local movements were restricted to valley vegetation corridors and rare traversed of more elevated open country were at low elevations. During the survey period a large flock (200+) was noted over a pine plantation east of Cervantes, some 30 km north-west of the Study Area. Outback Ecology undertook a Black Cockatoo Habitat Survey in 2013 (Outback Ecology 2013) and found only potential breeding habitat within the Wind Farm disturbance footprint. No trees with hollows were identified however three trees with potential to develop hollows (Marri trees with DBH over 500mm) were found where the grid connection route crosses Mullering Brook.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision and changed movement paths. However, targeted surveys for this species found that in the locality this species was associated with woodland habitats for roosting, and likely breeding purposes, and tall heathland habitats containing large *Banksia* and proteaceous species for foraging. These communities occur at lower elevations away from turbine locations on the higher ground. All movements within the Study Area and its locality were noted as following lowland valleys. Few movements (12%) across the entire study area were observed to be within the RSA and those areas of high elevation were observed over valley areas. No RSA height movements were observed over elevated areas where the proposed wind turbines would be located. As such, it is considered unlikely that local populations of this species would be at significant risk of collision and/or changed movement patterns as a consequence of the proposed wind farm development. Further discussion on this species is included in Section 4.4, due to records in the vicinity of the Study Area.	**Low**

Species	Chance of Occurrence on Site	Potential Impacts	Likely Level of Risk
Falco peregrinus Peregrine Falcon (*4*)	**Low–Moderate** This species was not detected during targeted field surveys within the Study Area. However, a single bird was observed within the vicinity utilising similar habitat to what was present within the Study Area. Furthermore, due to the widespread utilisation of associated lands for cropping purposes there maybe seasonal periods where influxes of medium sized cockatoos, such as galahs and corellas, may attract predatory species including peregrines, of which these parrots are a favoured prey. It is therefore considered that this species may occur within the Study Area on at least an intermittent basis.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision. Despite the general absence of this species across the site it is considered likely that it may occur within the site intermittently. This species is an aerial specialist and may at times fly at RSA elevation and above. Due to its considerable aerial ability it is considered unlikely that peregrines would collide with turbine blades during normal flight, but it is possible that collision could occur during hunting manoeuvres while the bird might be focussed on its prey. However, the chance of this occurrence is considered remote, due to the low frequency of local observations.	**Low**
Merops ornatus (Rainbow Bee-eater) (*M*)	**High** This species was recorded during field surveys. Its status within the Study Area during the survey period was as a breeding resident. It is possible that seasonal north (Feb–Apr) – south (Sep–Oct) movements of more southerly individuals of this species will traverse the Study Area on migration.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision. There is potential for this species to fly at RSA height if flocks were to move through the area under some seasonal conditions. However this species has considerable aerial ability and is likely to easily avoid collision. Moreover, local occurrences of this species are likely to be intermittent seasonal occurrences.	**Low**

Recommendations

It is recommended that monitoring of bird mortalities due to collisions (species and numbers) be undertaken post construction of the wind farm.

Avoidance of the Wind Farm Area

The turbines can be seen in all but the poorest visibility and produce noise that may visually or audibly deter birds from the area, thus removing potential foraging areas or preventing local movement between features such as stands of vegetation, foraging, roosting and breeding areas.

Potential displacement of raptor foraging has been investigated in several species. In general, most research tends to show that disturbance of raptors at wind farms is negligible (Madders et al. 2006). However as discussed earlier, raptors are more

susceptible to collisions than other species. Studies have not shown whether other species are more likely to be displaced or disturbed by the wind farm, as impacts may depend on a number of different factors including seasonal and diurnal patterns of use by birds, location with respect to important habitats, availability of alternative habitats and perhaps also turbine and wind farm specifications. Behavioural responses are also likely to not only vary between different species, but between individuals of the same species, depending on such factors as stage of life cycle (wintering, moulting, breeding), flock size and degree of habituation (Drewitt et al. 2006).

4.3.4 General Mammals

4.3.4.1 Risks Due to Construction

The hazards for mammals during construction of the proposed wind farm will be limited to physical injury during vegetation clearing, or as a result of collision with construction vehicle traffic.

Loss or Fragmentation of Habitat

Effects on native vegetation have been avoided and minimised to the extent practicable so that only several small areas will be damaged or disturbed. The small areas of vegetation that would be lost as a result of construction works are too minor to have an effect on mammal numbers. With the exception of these few and small areas of native vegetation, locations at which vegetation would be affected are already disturbed by gated entrances or existing tracks through the vegetation. Therefore, the holding capacity of any stands of vegetation is not going to be affected by further fragmentation. The likelihood of mammals being affected by habitat loss by direct removal of vegetation would be Unlikely. The consequences on mammals (including CS2 or CS3 species potentially present), would be incidental. The risk to mammals in this area would therefore be Low.

Risk of Injury during Vegetation Clearing

Large mammal species such as brush wallabies are likely to move significant distances from human disturbance and are not likely to be at risk of injury during vegetation clearing works.

Smaller mammals such as possums are not likely to move significant distances from established territories or home ranges; those that shelter in burrows, such as the noodji or ashy-grey mouse, are likely to remain in their burrow during clearing. Small mammals may move away during or after vegetation clearing but may also suffer direct mortality, with some such mortality unavoidable.

The likelihood of injuring mammals during ground works would be Possible and the consequences Incidental due to the potential of localised reduction in abundance of common species (brush wallaby are unlikely to be affected). The likelihood of injuring mammals would be Unlikely. The consequences would be Minor and the risks would be Low.

Risk of Injury on Access Roads or Operation Areas

There may be an increased risk of mammalian road kill as a result of vehicle traffic across the Study Area. Road kill mainly occurs at night or immediately adjacent to native vegetation where there is fast moving traffic. This is unlikely to occur on the site where construction traffic is most likely to occur during the day, predominantly on open ground and slow moving. Site plant is generally slow moving, noisy and will be confined to cleared land. Site plant will also only be operating during the day when a large number of plant operatives and site staff are present.

Larger, more active mammals such as brush wallabies are likely to move away from construction activities. They are also highly wary of human activity and if disturbed will leave an area. Smaller mammals are only likely to be found within dense vegetation and are less likely to venture onto roads, tracks and other working areas. The disturbance surrounding the operation of site plant is likely to disperse mammals away from any hazards and therefore the hazards to mammals would likely be limited to construction traffic.

The likelihood of physical injury to mammals from site traffic is therefore Possible and the consequences Incidental due to the very low numbers likely to be involved. The risk level is considered to be Low.

Disturbance

Construction vehicle and machinery noise, movements and vibrations have the potential to disturb fauna in the Study Area. Potential disturbance to terrestrial mammals has been reduced by locating the majority of construction work away from native vegetation. Furthermore, construction is likely to be highly localised and involve only small areas at any given time. All mechanical plant and vehicles would also be well maintained and therefore disturbance would be kept to a minimum.

The area is currently under agricultural management and so remaining animals will have been conditioned to small amounts of periodic disturbance. Most animals considered to be affected by vehicle and/or machinery activity are unlikely to be found where most of the disturbance will occur, e.g. on the edges of vegetation or in isolated remnants of vegetation.

The likelihood of disturbing mammals is considered Possible due to the localised construction activity and the consequences Incidental as the disturbance would be short term and localised. The risk level for mammals as a result of disturbance from construction activity would be Low.

Recommendations

Where vegetation has to be removed, it would be good practice to remove it to ground level prior to any ground works. This would give any below ground dwelling mammals (and other fauna) the opportunity to leave the area prior to any destructive ground works or vehicle activity. The risk of road kill can be reduced by imposing speed restrictions on all tracks during construction.

4.3.4.2 Risks Due to Operations

Habitat Avoidance and Barrier Effects

Although the presence of wind turbines on this landscape could potentially act as a barrier to movements or use of the Study Area by terrestrial mammals, there have been no reports suggesting that turbines inhibit terrestrial mammals using an area. Therefore, it is likely that the larger, more mobile mammalian species will continue to use the landscape as before. Smaller mammalian species (excluding bats) are less likely to venture far and use the open pasture on which the turbines would be placed.

The likelihood of mammals being affected by the wind turbines acting as a barrier to movement or use of the Study Area would be Unlikely. The consequences on mammals (including CS2 or CS3 species potentially present), would be incidental. The risk to mammals in this area would therefore be Low.

Increased Risk of Road Kill

Mammals will venture onto roads and tracks and are most at risk of collision with vehicles at night and when native vegetation is located immediately adjacent to fast moving traffic. It is unlikely that service vehicles will operate on the wind farm at night or travel at high speeds when on the site.

Therefore the likelihood of physical injury to mammals from site traffic is Possible and the consequences Incidental due to the very low numbers likely to be involved. The risk level is considered to be Low.

4.3.5 Bats

4.3.5.1 Risks Due to Construction

The hazards for bats as a result of the construction of the proposed wind farm will be limited to physical injury during vegetation clearing, or as a result of construction vehicle traffic. Effects on native vegetation have been avoided and minimised where possible so that only several small sections will be damaged or disturbed.

Loss of Habitat and Roosting Locations

The five species of bats recorded in the Study Area are most likely to forage over and in heavily vegetated areas. The survey results show that they forage for insects across the open pasture in limited numbers, with most records obtained in areas vegetated with shrubs and trees. Construction of the wind farm will not involve the removal of significant areas of dense vegetation. Therefore, the small loss of habitat as a result of vegetation clearing would be insignificant to bats.

Bats will roost during the day in cavities formed in tree hollows, tangled stems, dense vegetation such as that formed by grass trees, rubble piles, buildings and other features commonly found in the area. However, many bat species move between multiple roosts on a regular basis for convenience or comfort depending on their activities and environmental conditions (Churchill 2008).

The five species recorded in the Study Area are all common and widespread. Therefore, the risks to bat roosts in trees that would need to be felled or removal of a small amount of vegetation are unlikely to be significant. There are many trees in the area and bats frequently move between roosts. Any displaced bats would therefore be able to find alternative roosts.

The likelihood of loss of habitat and roosts is Possible but would only occur at one time during construction. The effects would also occur in a gradual movement across the Study Area as each area is developed. The consequences of habitat and roost loss would be Incidental as they are common species and adequate foraging and roost resources would remain. The risk level would therefore be Low.

Risk of Injury or Death from Vegetation Clearing and Tree Felling

It is likely that bats could be present in roosts when vegetation is cleared or trees felled. This work would be conducted during the day when bats are most likely to occupy roosts. If this were the case, it is possible that some bats could be injured. Bat species likely to be present in the area are common and widespread.

The likelihood of injuring bats is Possible and the consequence Incidental as they are common species and occur widely over the Study Area and surrounding area. The losses in abundance would be localised and short term. The risk level is Low. By adopting the precautions as recommended below, the likelihood would be reduced to Unlikely and the residual risk Low.

Disturbance from Construction Activities

Bats are active mainly at night whereas construction will occur only during daylight hours. Bats occasionally emerge during the day to forage but are active mainly from dusk to dawn. Most construction activities are in open pasture and located away from

structures in which bats are most likely to roost, such as buildings and large trees. Bats frequently change roosts depending on conditions and therefore should any disturbance occur at one roost site they may simply move to another. Heavy construction work with greatest potential to disturb bats would be highly localised and conducted at only one or two turbine locations at a time. Potentially disturbing activities would therefore be highly localised.

The likelihood of disturbing bats due to construction activities at any one location is Possible. The consequences of this disturbance would be Incidental due to the low numbers of bats involved and short term of the effect. The risk would be Low.

Recommendations

It would be good practice to inspect trees for potential bat roosts prior to felling. If potential bat roosts are found, either they could be inspected or the tree felled in sections leaving the roost intact and time for the bats to leave. Such activity would best be undertaken in spring, summer or autumn when bats are at their most active. If this were carried out prior to feeling trees, the risk level would remain the same.

4.3.5.2 Risks Due to Operations

The potential risks to bats from the operation of the proposed wind farm are:

1. Collision with the turbine blades or overhead transmission lines.

2. Avoidance by bats of the wind farm severing lines of movement between foraging areas and mating roosts.

Risk of Injury or Death from Collision with Turbine Blades or Overhead Transmission Lines

The most serious hazard for bats because of the operating wind farm is the potential collision with the turbine blades in the RSA. The tips of the turbine blades travel at high speed and can kill or injure bats flying within the RSA. It is unlikely that the towers or nacelles will present any form of risk to the bats.

Most bat fatalities recorded from the USA and Europe are associated with strong migration patterns and proximity to ridgeline woodland (EuroBATS 2003, Horn et al. 2006, Natural England 2009). As a general rule, bats maintain close proximity to native habitat, tree lines and woodland edges. However, they will cross open pasture to move between habitats or when searching for mates or during migration.

There are no known concentrated migration routes for bats in this region and all turbines in the proposed Study Area have been located large distances (minimum 30 m) from remnant woodland to minimise potential effects to flora and fauna including bats.

Only those species of bat that fly at height over high ground are likely to be at risk of collision with turbine blades. Most bats fly at relatively low heights (less than 20 m) when foraging. However, when foraging for high-flying insects or moving over long distances, species such as the southern freetail bat and the white-striped freetail bat may fly within RSA height and be at risk of injury or death.

The small size of the bat species present in the Study Area place them at lower risk of collision than large birds, by virtue of the shorter time it takes their bodies to fly across the RSA for a given speed. High-flying species are also known to fly at high speed.

It is likely that commuting bats reduce their flight altitude when over high ground to conserve energy in a similar way to the birds observed doing this during the bird survey conducted within the Study Area (RPS HSO 2010). Because all the turbines have been located on high ground, the RSA for each turbine is likely to be higher than the flight height of most commuting bats. Furthermore, most medium and small bird species fly at lower heights during high winds to conserve energy, and it is likely that bats do the same (Horn et al. 2006). Therefore, even fewer bats are likely to be flying at RSA height when the wind is strong and the turbine blades travelling fastest.

Whilst bats are at risk of collision with the turbine blades when flying within RSA height, their size and flight habits are likely to reduce the probability of collision to the extent that only a few may collide with the turbine blades in any one year. Monitoring of bat collisions on wind farms in the state of Victoria demonstrated that bat collisions with turbines on pasturelands are infrequent.

There is no evidence to suggest that micro-bats are at risk of new overhead transmission lines. Echolocation abilities of many of the insectivorous bats enable them to identify and avoid objects less than a millimetre across (Grinnell and Griffen 1958). Furthermore, the provision of cable markers intended to warn birds might also help bats detect and avoid the cables.

The likelihood level of bats colliding with turbine blades is considered Likely as it could happen occasionally during the lifetime of the development. It is unlikely that bats would be adversely affected by new overhead transmission lines. The consequence level is Incidental and would potentially only involve a local, short-term decrease in abundance. Numbers of bats are unlikely to be significantly affected over the long term. The risk level is therefore Low.

Recommendations

Little research has been conducted on the interactions of bats with wind farms in Western Australia. It would therefore be prudent to confirm the predicted effects via a monitoring program of bat activity and any bat collisions with turbine blades over the first season the wind farm is operational. Trained dogs and visual searches could be used to search below selected turbines to measure bat mortality due to collision with turbine

blades. Results of the monitoring could be used to establish whether any further management measures are needed. Further monitoring after the first year may be needed depending on the results from the first season.

Vegetation rehabilitation and protection would provide better foraging opportunities for bats in the area. The location of any rehabilitation and revegetated areas should be considered carefully to try and attract bats away from the wind turbines and towards the vegetated areas.

Avoidance of the Wind Farm Area

The turbines can be seen in all but the poorest visibility and produce noise that may visually or audibly deter bats from the area, thus removing potential foraging areas or preventing local movement between features used by bats, such as individual stands of vegetation or when searching for mates.

Bats are known to continue flying and foraging over land on which turbines are placed, and do not deliberately avoid wind turbines (Natural England 2009). Several bat species including the white-striped freetail bat have been shown to continue using wind farm areas as evidenced in the state of Victoria whereby several carcasses of this species were found to have collided with the turbines. Although bats use the airspace above native vegetation more than they do open pasture, they are still likely to fly across open pasture in which the majority of turbines are situated on the proposed Waddi Wind Farm. Therefore, bats are likely to continue moving between large stands of vegetation even if it involves crossing open ground.

Therefore, the issue of fragmentation and barrier effects (i.e. avoidance) is Unlikely and the level of consequence Incidental. The risk is therefore Low.

4.3.6 Cumulative Effects

There is one wind farm (Emu Downs Wind Farm) operating and two other wind farm projects (Badgingarra Wind Farm and Nilgen Wind Farm) planned and approved to be developed in this region of Western Australia. These are located 9.3 km north-west, 12.9 km north-west and 26 km south of the Study Area respectively. Large tracks of land lie between these proposed wind farms and the Study Area offering a large amount of space in which aerial and ground dwelling species can move without being affected by the wind farms.

The Emu Downs Wind Farm is operational and forms part of the existing baseline for flora and fauna that are static or not very mobile. Therefore, only Badgingarra and Nilgen wind farms need to be considered cumulatively with Waddi Wind Farm with reference to potential effects on vegetation and fauna with low mobility, as they have not yet been constructed. All wind farms in the area (including Emu Downs) need to be considered for highly mobile aerial fauna such as bats and birds as the effects on these

may cumulate as a result of all the wind farms being constructed. Both Badgingarra and Nilgen wind farms have avoided native vegetation wherever possible (DA 2008 and ENV 2008 respectively). Therefore, the effects on native vegetation and indirect impacts on fauna as a result of the proposed Waddi Wind Farm would be negligible, either on their own or cumulatively with other wind farms.

With the exception of Yandin Wind Farm, the wind farms are too far from Waddi Wind Farm to affect directly any ground dwelling species of animals. Any cumulative direct effects would be limited to wide ranging and dispersive species such as bats. Because movement patterns around Emu Downs Wind Farm of wide-ranging aerial species such as bats could be affected by Waddi Wind Farm, Emu Downs must also be considered cumulatively in this regard. However, all four wind farms are adequately separated that cumulative effects such as habitat fragmentation and habitat loss would not be an issue. The other two proposed wind farms have reported low levels of bat activity and all of common bat species (DA 2008 and ENV 2008).

It is possible that a planning application will be submitted for the Yandin Wind Farm at the same time as the Waddi Wind Farm (refer to Fauna Assessment, Yandin Wind Farm). Yandin Wind Farm lies approximately 10 km south of Waddi at the closest point. Both wind farms may form part of the same proposal but one or other or both will be pursued depending on the availability of wind turbine components and the capacity of the SWIS to receive the power generated.

Most of the effects on habitat and indirect effects on fauna as a result of the individual wind farms are likely to occur as a result of the grid connection route, which would affect only very small areas of native vegetation. Studies on alternative grid routes have shown that the effects would be ecologically undesirable and therefore omitted from the proposals. Therefore, the combined wind farms will only result in marginally more habitat loss than in isolation. There are few expected impacts on ground dwelling fauna and those that have been identified are limited to injury on roads or during clearance of vegetation. Furthermore, there are fewer stands of native vegetation on the Yandin Wind Farm Study Areas and therefore potential cumulative impacts on ground dwelling fauna are negligible. There is a separation of approximately 10 km between the two wind farms which will allow movement of bats either between the wind farms if they should be displaced as a result of the turbines which, according to the risk assessment is unlikely.

Overall, it is considered highly unlikely that the Waddi, Yandin, Nilgen, Emu Downs and Badgingarra wind farms will have a cumulative effect on fauna that is significantly greater than the Waddi Wind Farm in isolation.

5.0 DISCUSSION

A Level 1 reconnaissance fauna survey was conducted by Bamford Consulting Ecologists and Level 2 bat surveys were conducted by RPS ecologists. The findings of these surveys indicate that the faunal diversity across the Study Area is depauperate, largely because large tracts of land have already been cleared of native vegetation and replaced with pasture.

On consideration of the construction and operational aspects of the proposed wind farm and the avoidance and reduction measures that have been designed into the development project, the potential adverse effects on fauna would be limited to the following hazards:

- death/injury of fauna during clearing
- loss of habitat (clearing)
- fragmentation of habitat
- restrictions to the movements of terrestrial fauna
- collisions of fauna with service vehicles and site plant
- collisions of bats with turbine blades
- disturbance of fauna light, noise and personnel activities.

The general level of risks to fauna associated with these hazards have been identified as Low, principally because most species likely to be present are common species that have been able to colonise open pasture habitat and have low levels of risk from a wind farm development. Risks to mammals including the Brush Wallaby (a CS2 species) and carpet python (CS1) may be elevated as a result of construction and service vehicular traffic. However, it is assumed that site traffic will mainly occur during daylight hours and will be restricted to slow speeds.

The only birds of conservation significance that may be of risk due to the proposed development are the Carnaby's Black-Cockatoo and peregrine falcon. Risks to these birds with respect to collision with wind turbines are considered to be low as the black cockatoos were observed flying through lower lying areas and valleys and were not observed flying at the higher topographies on which the turbines are located. Only one peregrine falcon was observed in the Study Area and consequently risks to this species are considered low.

The Study Area is within the modelled breeding range of the Carnaby's Black Cockatoo, contains potential breeding habitat and contains quality foraging habitat (Outback Ecology 2013). The proposed disturbance footprint will have limited impact on current or future breeding habitat, as only three trees with the potential to form hollows are currently proposed to be cleared as part of the development. Foraging habitat, however, is likely to be impacted by the proposal, through direct habitat loss, degradation and fragmentation.

There is the possibility of a small number of bats colliding with the turbines each year. However, these risks have been identified as Low because the species likely to be present in the Study Area and that may fly at RSA height, are common and widespread.

5.1 Significant Habitats

Native fauna species of the Study Area, including species of conservation significance that may occur such as the carpet python and brush wallaby, are largely confined to the remaining stands of native vegetation. Because the wind farm, including infrastructure, has been largely confined to pasture, potential impacts on significant fauna habitats have been avoided or reduced to low risk levels. The small area of habitat that may require clearing is not considered significant given the large amount of native vegetation that would remain in the area (Outback Ecology 2010).

5.2 Significant Species

Significant fauna species that occur in the Study Area are likely to be limited to brush wallaby, Carnaby's Black-Cockatoo, peregrine falcon, rainbow bee-eater and possibly the carpet python, although the latter is unlikely to occur within close proximity of the wind farm due to the lack of suitable habitat.

Effects of construction and operation will mostly be limited to minor disturbances to these fauna species and are unlikely to affect any populations of significant species. Foraging habitat was recorded in the Study Area in the form of *Eucalyptus spp*., *Banksia spp*. and *Hakea spp*. in the Open Woodland and Proteaceous Heath habitat types (Outback Ecology 2013).

There may be a slight risk to the local population of the carpet python.

6.0 RECOMMENDATIONS

The recommendations provided here are limited to those provisions that relate to fauna, with further specific recommendations related to birds provided as Appendix 3. The recommendations are divided into those that have been agreed in principle with Waddi Wind Farm Pty Ltd and those that could be adopted as good ecological practise, but that would not reduce potential ecological impacts any further than those predicted.

6.1 Agreed Management Measures

The following are recommendations that have been agreed in principle and have been reflected in spirit throughout the design process. They will need to be carried forward into the construction and operation stage by ensuring that the final location of land clearance and ground works comply with the aims:

- The turbine bases be placed to avoid areas that may be used extensively by high flying bats, birds and insects e.g. over native vegetation, water and near woodland.

- The equipment supply routes, cable routes, services and any new tracks are placed to avoid or minimise the removal or fragmentation of native vegetation, particularly with respect to wildlife corridors.

6.2 Recommended Management Measures

The following management measures are recommended for the construction and operation of the wind farm:

- Wherever possible, native vegetation that needs removing should be cleared to ground level initially by mechanical hand held tools to allow ground fauna to move away from the cleared area before destructive ground works begin.

- If any trees need to be felled, they should be inspected for potential bat roosts or bird nests by ecologists prior to felling. Any trees with potential bat roost locations should be removed in stages to permit bats to leave prior to final felling.

- Investigate the potential to undertake vegetation remediation, stock fencing and feral animal control.

- All services be placed underground as far as practicable, but if they must be placed above ground, design the placement so animals can pass under them.

- New overhead transmission lines to be marked with high-visibility markers until such times that bats and birds are familiar with the cables. This should be for a minimum of three seasons.

- Where access routes or cables are to pass across road reserves, they are to pass through existing gaps wherever possible. At these locations, undisturbed reserve vegetation is to be temporarily fenced off with high visibility fencing for protection.

- Wind farm service vehicle speeds to be kept low, to avoid road kills of native fauna.

- Investigate and produce a Construction Management Plan to the satisfaction of the DPaW which will detail among other things
  - general site awareness of site staff and restrictions, e.g. vehicle speed and areas that are out of bounds to site vehicles and plant
  - provision of temporary high visibility fencing around stands of native habitat that may be at risk of damage from site vehicles and plant during construction
  - ecological checks of construction locations prior to soil stripping to ensure no features of significance are present
  - investigate limiting site lighting especially during spring and autumn migration periods
  - wherever possible, investigate and implement seasonal preferences for removal of native vegetation (where permission is provided) to avoid sensitive periods for nesting birds and hibernating reptiles.

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FIGURES

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LEGEND

Study Area

Denison
Yandanooka
Bowgada
Arrino
Perenjori
Three Springs
Caron
Bunjil
Carnamah
YARRA YARRA LAKE
Winchester
Latham
BEEKEEPERS
WOTTO
TATHRA
LAKE LOGUE
Coorow
Moya
CAPAMAURO
ALEXANDER MORRISON
PINJARREGA
Marchagee
Gunyidi
LESUEUR
COOMALLO
WATHEROO
Watheroo
SOUTHERN BEEKEEPERS
BADGINGARRA
Coomberdale
Miling
NAMBUNG
Moora
Bindi Bindi
Dandaragan
WANAGARREN
Koojan
Piawaning
Yericoin
New Norcia
NILGEN
NAMMING
Moore River
Lancelin
Mogumber
MOORE RIVER
Calingiri
Wannamal
Wyening
Beermullah
NARRING
Brockman River
Bolgart
Mooliabeenee
Gingin
Guilderton
Bejoording
Culham
YEAL
Chittering
Yenchep
Lower Chittering
Toodyay
Avon River
Bullsbrook
PEARCE
Clackline
Bakers Hill
Wundowie
Woorolop
Calingiri
Wyening
Bolgart
Bejoording
Culham
Toodyay
Clackline
Wundowie
Woorolop

GREAT SAN DESERT
HAMMERSLEY RANGE
GIBSON DESERT
WESTERN AUSTRALIA
GREAT VICTORIA D
NULLARBO
DARLING RANGE
Perth

Job Number:	11320802
Doc Number:	WF-001
Date:	17.03.14
Scale:	1:750,000 @ A3 Overview Map: NTS
Drafted by:	MA
Source:	Basemap - Esri Online

RPS

Figure 1
Waddi Wind Farm
Regional Map

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BIBBY RD
KOONAH RD
BADDINGARRA RD
Mullering Brook
WONGONDERRAH RD
WADDI RD
STRATHMORE RD
Waddi Substation
WOLBA RD
Existing Cataby Substation
MULLERING RD
COOLJARLOO RD
BRAND HWY
Minyulo Brook

LEGEND

- Study Area

Waddi Windfarm Infrastructure (2009)

- Waddi Turbine Location
- Waddi Substation
- Waddi Grid Line Option 1
- Waddi Cable Layout
- Waddi Access Tracks

Waddi Windfarm Infrastructure (2014)

- Existing Cataby Substation
- Distribution Line Option 1
- Distribution Line Option 2
- Underground Cable to Cataby Substation - Option 1
- Underground Cable to Cataby Substation - Option 2
- Access Ways
- Grid Connection 85m Easement
- Waddi Substation
- Alternate Waddi Substation

RPS

Job Number: 11320802
Doc Number: WF-002
Date: 16.04.14
Scale: 1: 70,000 @ A3
Drafted by: MA
Source: Basemap - Landgate

0 0.375 0.75 1.5 2.25 3 km

Figure 2
Waddi Wind Farm
Study Area

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BIBBY RD
KOONAH RD
BADGINGARRA RD
W3
W2
W1
WONGONDERRAH RD
WADDI RD
W4
W5
STRATHMORE RD
W6
Waddi Substation
WOLBA RD
Existing Cataby Substation
MULLERING RD
COOLJARLOO RD
BRAND HWY
MULLERING RD
MINY

LEGEND

- Bat Survey Location
- Bat Survey Location - No Calls
- Study Area

Waddi Windfarm Infrastructure (2009)

- Waddi Turbine Location
- Waddi Substation
- Waddi Grid Line Option 1
- Waddi Cable Layout
- Waddi Access Tracks

Waddi Windfarm Infrastructure (2014)

- Existing Cataby Substation
- Distribution Line Option 1
- Distribution Line Option 2
- Underground Cable to Cataby Substation - Option 1
- Underground Cable to Cataby Substation - Option 2
- Access Ways
- Grid Connection 85m Easement
- Waddi Substation
- Alternate Waddi Substation

RPS

Job Number: 11320802
Doc Number: WF-003
Date: 16.04.14
Scale: 1: 70,000 @ A3
Drafted by: MA
Source: Basemap - Landgate

0 0.375 0.75 1.5 2.25 3 km

Figure 3
Waddi Wind Farm
Bat Detectors and Activity

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Badgingarra National Park
BIBBY RD
KOONAH RD
MUNGEDAR RD
Badgingarra National Park
BADGINGARRA RD
WONGONDERRAH RD
WADDI RD
STRATHMORE RD
Waddi Substation
WOLBA RD
Minyulo Nature Reserve
Existing Cataby Substation
MULLERING RD
COOLJARLOO RD
BRAND HWY
MALYERING RD
MINYULO

LEGEND

Study Area

Waddi Windfarm Infrastructure (2009)

Waddi Turbine Location
Waddi Substation
Waddi Grid Line Option 1
Waddi Cable Layout
Waddi Access Tracks

Waddi Windfarm Infrastructure (2014)

Existing Cataby Substation
Distribution Line Option 1
Distribution Line Option 2
Underground Cable to Cataby Substation - Option 1
Underground Cable to Cataby Substation - Option 2
Access Ways
Grid Connection 85m Easement
Waddi Substation
Alternate Waddi Substation

DEC Estate (2013)

Conservation Park
National Park
Nature Reserve

RPS

Job Number: 11320802
Doc Number: WF-004
Date: 16.04.14
Scale: 1: 70,000 @ A3
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Source: Basemap - Landgate

0 0.375 0.75 1.5 2.25 3 km

Figure 4
Waddi Wind Farm
Infrastructure Layout and Conservation Mapping

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BIBBY RD
KOONAH RD
MUNGEDAR RD
BADGINGARRA RD
WONGONDERRAH RD
WADDI RD
STRATHMORE RD
WOLBA RD
MULLERING RD
COOLJARLOO RD
BRAND HWY
MINYULO
MULLERING RD

R 1
W 1
W 2
W 3
W 4
W 5
W 6
W 7
W 8
W 9
W 10
W 11
W 12
W 13
W 14
W 15
W 16
R 3

Waddi Substation
Existing Cataby Substation

LEGEND

Study Area

Bird Census Locations

Reference Site

Sampling Location

Waddi Windfarm Infrastructure (2009)

Waddi Turbine Location

Waddi Substation

Waddi Grid Line Option 1

Waddi Cable Layout

Waddi Access Tracks

Waddi Windfarm Infrastructure (2014)

Existing Cataby Substation

Distribution Line Option 1

Distribution Line Option 2

Underground Cable to Cataby Substation - Option 1

Underground Cable to Cataby Substation - Option 2

Access Ways

Grid Connection 85m Easement

Waddi Substation

Alternate Waddi Substation

RPS

Job Number: 11320802
Doc Number: WF-005
Date: 16.04.14
Scale: 1: 70,000 @ A3
Drafted by: MA
Source: Basemap - Landgate

0 0.375 0.75 1.5 2.25 3 km

Figure 5
Waddi Wind Farm
Bird Census Locations

PLATES

PLATES

Plate 1: Bat Detector and Microphone Protector located at Sampling Point W3. Note Cattle Protection Rods

Plate 2: Bat Detector and Microphone Protector located at Sampling Point W1

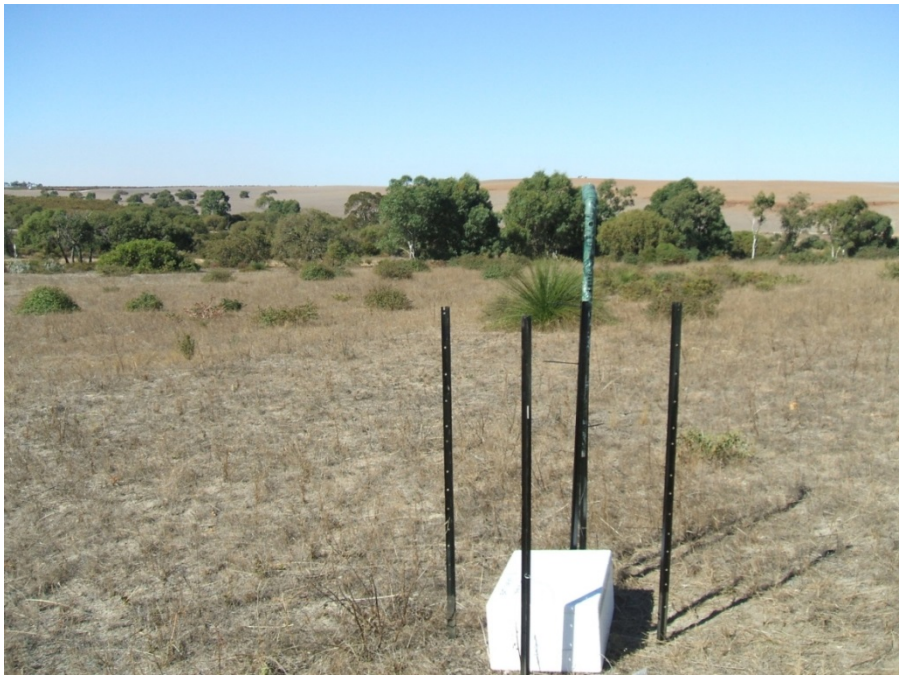


Plate 3: Bat Detector at Sampling Point W4. Note Scrub and Heath in Background

APPENDIX I

Desktop Review: Significant Fauna for the Waddi –Yandin Site

APPENDIX 1: Desktop Review: Significant Fauna for the Waddi – Yandin Site

Fauna species previously identified, in the desktop study, as potentially occurring on the Waddi – Yandin site and their respective conservation listings (RPS 2008). A summary of the categories of conservation significance, described by RPS (2008) are provided in Appendix 2.

Table 1-1: Animal Species Listed on as Threatened and Migratory on the EPBC Act and on Schedule 1 or 2 of the WC Act (RPS 2008)

Binomial Name	Common Name	Conservation Status	Conservation Significance
Reptiles			
Morelia spilota imbricata	Carpet python	Schedule 4 and Priority Four	CS1
Neelaps calonotos	Black-striped snake	Priority Three	CS3
Birds			
Ardea alba	Great egret	Migratory Wetland	CS1
Ardea ibis	Cattle egret	Migratory Wetland	CS1
Botaurus poiciloptilus	Australasian bittern	Schedule 1	CS1
Ardeotis australis	Australian bustard	Priority Four	CS3
Falco peregrinus	Peregrine falcon	Schedule 4	CS3
Haliaeetus leucogaster	White-bellied sea eagle	Migratory	CS1
Leipoa ocellata	Malleefowl	Vulnerable and Schedule 1	CS1
Merops ornatus	Rainbow bee-eater	Migratory	CS1
Oreoica gutturalis gutturalis	Crested bellbird (southern)	Priority Four	CS3
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered and Schedule 1	CS1
Calyptorhynchus sp.	White-tailed black cockatoo	Schedule 1	CS1
Platycercus icterotis xanthogenys	Western rosella (inland ssp)	Schedule 1	CS1
Mammals			
Dasyurus geoffroii	Chuditch, western quoll	Vulnerable	CS1
Phascogale tapoatafa ssp.	Brush-tailed phascogale	Schedule 1	CS1
Potorous platyops	Broad-faced potoroo	Schedule 2 – Presumed extinct	CS2
Macropus irma	Western brush wallaby	Priority Four	CS3
Hydromys chrysogaster	Rakali water-rat	Priority four	CS3

The desktop review (RPS 2008) concluded:

Reptiles

Both CS3 reptiles listed in Table 1-1 could be found on the two sites but are likely to be restricted to large stands of native vegetation. Both are known to occupy *Banksia* woodland and heathlands and the carpet python uses rocky outcrops and tree hollows for basking and shelter.

Birds

The white-bellied sea eagle is a year-round resident of WA and does not migrate. It is also a coastal species and unlikely to be found at this location. The peregrine falcon requires bare rock faces on which to roost and nest and as there are few, if any opportunities, in this location they are not expected to be found at this location on a regular basis. The white-tailed black cockatoo refers to a record of a not fully identified cockatoo that is either Carnaby's or Baudins black cockatoo. Baudin's black cockatoo is generally found south of Perth and is unlikely to have been recorded near Badgingarra in recent years. Carnaby's is likely to occur in this area.

Of those species that may be found on site, those most at risk from collision strike or other aspects of the wind farm proposal are:

- great egret
- cattle egre
- Carnaby's Black-Cockatoo
- western rosella.

The first three of these species are known to fly regularly above 20 m, whereas the western rosella generally flies closer to the ground.

Great egrets are resident and not migratory in WA but disperse after breeding. They inhabit wetlands where they feed on fish, crustaceans and small vertebrates. They are numerous and otherwise not considered Threatened. The cattle egret moves from northern WA where it breeds in the summer months and migrates to southern areas of Australia for the winter where it hunts in open pasture and wetlands often associated with cattle. Both species of egret may therefore be found on the two sites.

Carnaby's Black-Cockatoo is endemic to WA, and defined as Endangered under the EPBC Act and listed on Schedule 1 of the WA Cons. Act. This species breeds in the winter within the Wheatbelt region and moves to the coastal plain for the summer. It is Endangered because of loss of habitat through land clearing and competition with other species such as galahs. They often feed on the ground and can be present in large flocks of many hundreds.

The western rosella is another species endemic to WA and is listed on Schedule 1 of the WC Act. It is mainly sedentary but can move towards the coast in summer. It is generally found in forested areas but also feeds on grassy clearings and pasture.

Mammals

All mammals listed in Table 1 with the exception of the broad-faced potoroo, are likely to be present within the boundaries of the study site. However, most, if not all these species, will only be found in native vegetation and woodland which is found in discrete pockets around the site or river valleys.

The water rat is associated with permanent bodies of water such as rivers, lakes and the shore. This species may be found along the brooks that cross both sites.

The western brush wallaby prefers open woodland and grazes in open areas. It is known to occupy some areas of heath and mallee and therefore may be found on the heaths or the valley woodlands.

The western quoll (*Dasyurus geoffroii)* is largely arboreal and is currently limited to wooded areas such as schlerophyll forests, dry woodland and mallee shrubland. It may therefore be found in the wooded valleys or some of the taller shrub habitats across the site.

The brush-tailed phascogale is found mainly in dry sclerophyll woodland where trees are mature and provide hollows. It spends most of its time in trees in woodlands and therefore is unlikely to be encountered during the development of a wind farm on open pasture.

APPENDIX 2

Categorisation of Conservation Significance of Fauna Extract from RPS (2008)

APPENDIX 2: Categorisation of Conservation Significance of Fauna

1.1 Protected Places or Areas

1.1.1 State Legislation

Conservation and Land Management Act in Western Australia places that have been identified as containing important environmental features are listed on state or federal Heritage Lists and can include national parks, conservation parks and reserves, marine parks and reserves, regional parks and nature reserves. The Register of the National Estate (RNE) is one such list and was frozen in 2007 under the EPBC Act, but is still an active database for land with important environmental features. All areas listed on the RNE for natural heritage purposes are designated Environmentally Sensitive Areas (ESA) under Special Notice No. 55 (WA Government 2005).

Areas listed on the RNE can be categorised under one of several the status of "Registered" does not necessarily imply any legal registration or intrinsic significance. Whilst the status of "Indicative Place" does not offer any legal protection, it may trigger an assessment for inclusion in a register that superseded the Register of the National Estate such as the national or Commonwealth Heritage lists. All areas listed on the RNE for natural heritage purposes are also defined as Environmentally Sensitive Areas (ESAs) under Special Notice No. 55 (WA Government 2005). ESAs are specifically referred to in the EP Act and confer an additional level of protection against the unlawful clearing of native habitat.

1.1.2 Commonwealth Legislation

The EPBC Act defines World Heritage properties, National Heritage places and Ramsar Wetlands as matters of national environmental significance and provides for their protection. Under the EPBC Act, no action can be taken that will have a significant effect on the World or National Heritage values of a matter of national environmental significance without the approval of the Minister for Environment and Heritage.

The Environment and Heritage Legislation Amendment Bill (No. 2) 2000, amended the EPBC Act to list all places of national heritage significance and Commonwealth responsibility on national and Commonwealth Heritage lists respectively.

1.2 Fauna

To facilitate a structured review of the relative conservation values of the various environmental features that occur on the sites, three levels of conservation significance are used for the fauna in this report: Conservation Significance 1, 2 and 3. The preliminary characterisation of conservation significance of fauna and flora within the project site was primarily based on conservation listings under federal and state legislation such as the EPBC Act and the Western Australian *Wildlife Conservation Act 1950* (WA Cons. Act).

1.2.1 State Legislation

In Western Australia, the Department of Environment and Conservation (DEC) has produced a list of Priority Fauna which includes species not considered Threatened under the WA Cons. Act, but for which the DEC identifies cause for concern. Species are listed under several Schedules of the WA Cons. Act. Assessments in this report are based on the most recent version of the DEC priority list (January 2007). The WA Cons. Act uses a set of schedules but also classifies species using some of the International Union for Conservation of Nature (IUCN) categories. These categories and schedules are described in Appendix 1.

1.2.2 Federal legislation

The conservation status levels for fauna used in the EPBC Act are those used by the IUCN,). The EPBC Act also has lists migratory species recognised under the international treaties:

- China Australia Migratory Bird Agreement (CAMBA)
- Japan Australia Migratory Bird Agreement (JAMBA)
- the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals).

Species listed under the JAMBA are also protected under Schedule 3 of the WA Cons. Act.

Reports on the conservation status of most vertebrate fauna species have been produced by the Department of Environment, Water, Heritage and the Arts (DEWHA) in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for the following groups:

- amphibians (Tyler 1997)
- reptiles (Cogger et al. 1993)
- birds (Garnett and Crowley 2000)
- monotremes and marsupials (Maxwell et al. 1996)
- rodents (Lee 1995)
- bats (Duncan et al. 1999).

These publications also use categories similar to those used by the EPBC Act.

On the basis of the above, three levels of conservation significance are assigned in this report for fauna:

- Conservation Significance (CS) 1: Species listed under state or Commonwealth Acts.
- Conservation Significance (CS) 2: Species not listed under state or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by DEC.

- Conservation Significance (CS) 3: Species not listed under Acts or publications, but considered of at least local significance because of their pattern of distribution. This level may have links to preserving biodiversity at the genetic level (EPA Position Statement No. 3, EPA 2002). For example, if a population is isolated but a subset of a widespread distribution (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3.

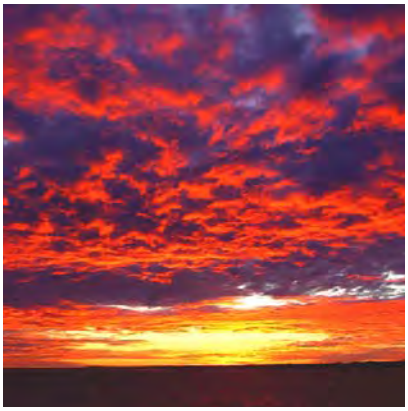
RPS

APPENDIX 3

Avifauna Assessment, Proposed Waddi Wind Farm Development (RPS 2010)

AVIFAUNA ASSESSMENT

Proposed Waddi Wind Farm Development, Dandaragan Shire



AVIFAUNA ASSESSMENT

Proposed Waddi Wind Farm Development, Dandaragan Shire

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Report No: M08038:3
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Document Status

Version	Purpose of Document	Orig	Review	Review Date	Format Review	RPS Release Approval	Issue Date
Draft A	Draft for Client Review	A.Richardson	BarShe	05.02.09			
Draft B	Draft for Client Review	A. Richardson	BarShe	22.04.09			
Draft C	Draft for Client Review	A. Richardson	BarShe	01.06.09			
Draft D	Draft for Client Review	A. Richardson	BarShe	10.06.09	DC 15.06.09		
Draft E	Draft for Client Review	A. Richardson	BarShe/SeaFin	21.07.09	DC 31.07.09		
Draft F	Draft for Client Review	A.Richardson	BarShe	24.04.10			
Draft G	Draft after Client Changes	BarShe	TobLam	14.10.10			
Rev 0	Final for Issue	BroWil	BarShe	25.10.10	SN 29.10.10	S. Finn	02.11.10

Disclaimer

SUMMARY

RPS was commissioned by Wind Prospect WA to undertake avifauna surveys for a proposed wind farm development in the Shire of Dandaragan, Western Australia. As part of the ecological investigations for the site, surveys were undertaken to gain information regarding the movements and habits of locally occurring birds. The surveys recorded all locally occurring birds, with particular consideration of those species that may be listed as Specially Protected or Threatened under the Western Australian *Wildlife Conservation Act 1950* (WC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The methodology for the avifauna surveys (Section 2.0) involved both preliminary desktop studies and a range of field survey methodologies, as guided by discussions with DEC, before survey works were undertaken and reference to relevant guidelines, notably EPA (2004) and Auswind (2005, 2006).

The majority of avifauna observed within the site (Section 3.0) were common bird species. The greatest diversity of birds occurred within structurally diverse native vegetation, including woodland with intact understorey vegetation, which does not characterise the elevated open country locations selected for wind turbine sitings.

Although there are a number of regional wetlands in the wider locality, most wetland habitats within the vicinity of the site were limited to small farm dams. The occasional small creeks in surrounding valleys offer very limited waterbird habitat. Local waterbird movements noted during the study were generally among closely associated wetlands to the west.

Limited numbers of nocturnal birds were observed during the survey period and those were associated with woodland vegetation, which largely occurs within lowland valley topographic contexts.

A number of open country bird species were noted to frequent typical wind turbine locations, although few species were observed to fly at elevations consistent with the Rotor Swept Area (RSA). Those species noted as occurring at RSA elevations on more than a rare occasion included Nankeen Kestrel, Wedge-tailed Eagle, Brown Falcon, White-backed Swallow, Black-shouldered Kite and Fairy Martin.

A general trend in bird movements in ridge-top contexts was relatively low flight elevations, possibly in response to the moderate to strong winds that characterise the Koodiwoodie Range on a daily basis. The Nankeen Kestrel was observed flying at RSA elevations on more than a rare occasion, but as with the majority of bird species observed flying within the RSA height, the greatest proportion of these observations were birds flying over valley areas and not the ridge-top contexts where turbines will be located.

One exception to this general low elevation flight pattern was the Wedge-tailed Eagle, which was most regularly observed soaring above RSA elevation. This is likely due to their dependence upon strong winds to stay aloft. The relatively high number of Wedge-tailed Eagle sightings was due, at least in part, to the obvious flight profile this species offers even at a great distance rather than the importance of the site.

A low number of records for the Brown Falcon, White-backed Swallow, Black-shouldered Kite and Fairy Martin during the survey period suggest that these species are unlikely to be at significant risk of impact due to very low densities within the locality.

Two species listed as Threatened under the WC Act, Carnaby's Black-Cockatoo (Schedule 1) and the Peregrine Falcon (Schedule 4), were observed during the surveys. The Peregrine Falcon was observed once, outside of the proposed wind farm site, near the Brand Highway, and Carnaby's Black-Cockatoo was observed to be associated with woodland and tall heathland, with its movements generally following vegetated valley corridors (i.e. outside the potential turbine locations).

Local flyway orientations were considered unlikely to traverse the proposed wind farm location, due to the general north–south alignment of drainage basins and coastal wetlands.

Based on the results of the avifauna investigations, it was concluded that no bird species potentially occurring within the site is at risk of a significant adverse impact by the proposed Waddi wind farm, either in isolation or in conjunction with other wind farm developments existing or proposed in the region. The other four existing or proposed regional wind farm developments do not align latitudinally, in an east to west sense, with the proposed Waddi wind farm and therefore have limited potential to represent a cumulative impact risk.

Recommendations provided to minimise the potential impact of the proposed wind farm include:

- power lines between turbines should be constructed underground and along road infrastructure where possible to minimise the number of easements through the area and potential for avian collisions (including the creation of perching locations in the vicinity of turbines)

- a post-construction bird monitoring program, such as that described Auswind (2006), should be established to determine the impacts of the project on bird populations

- construction and operational phases of the development should be undertaken in accordance with the Best Practice Guidelines for Wind Energy Projects (Auswind 2006), including the implementation of an Environmental Management Plan (EMP) and a Construction Management Plan (CMP).

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APPENDICES

1.0 INTRODUCTION

1.1 Background

Wind Prospect WA Pty Ltd (Wind Prospect WA) is undertaking baseline surveys and impact assessments in support of the proposed Waddi Wind Farm development in the Shire of Dandaragan in Western Australia. A separate wind farm development (Yandin Wind Farm) is also proposed by Wind Prospect WA to the south of Waddi Wind Farm that may share some of the connection infrastructure to the electricity grid. These two wind farms will undergo separate approvals processes and are therefore being reported on separately.

RPS was commissioned by Wind Prospect WA to undertake avifauna surveys for the Waddi and Yandin Wind Farms and provide an assessment of the likely level of impacts to bird species from the proposed development. Only results for the Waddi Wind Farm are presented in this report.

As part of the ecological investigations for the site, targeted surveys were undertaken to gain information regarding the movements and habits of locally occurring birds. The surveys recorded all locally occurring birds, with particular consideration of those species that may be listed as Specially Protected or Threatened under the Western Australian *Wildlife Conservation Act 1950* (WC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This report outlines the survey methods and findings of the avifauna surveys undertaken over the proposed wind farm development area, including surveys of wider regional bird populations and habitats, to assess potential risks to local bird populations.

1.2 Scope of the Study

In September 2008, RPS conducted a desktop study of the habitats and species that had been previously recorded on or within 15 km of the proposed development site (RPS, 2008).

The desktop study was used to determine what surveys would be required to establish an ecological baseline to support environmental approval processes. Consultation was undertaken with the Western Australian Department of Environment and Conservation (DEC) with regard to the scope of surveys required, these were:

- habitat surveys
- point count surveys
- roaming surveys
- night-time spotlighting surveys
- wetland bird surveys
- targeted survey for Carnaby's Black-Cockatoo.

The objectives of the avifauna surveys were to:

- identify avifauna species occurring within the proposed wind farm site
- identify the habitat usage of locally occurring avifauna species
- gather flight behaviour data for locally occurring bird species and their populations
- identify potential flight movements / corridors of regional and migratory bird populations.

In addition to the formal avian survey work undertaken on the proposed wind farm site, consideration was also afforded to surrounding areas and more distant areas containing wetlands with potential significance to birds. This allows for an appreciation of the environmental context of the site in regard to local species as well as transient and migratory species.

Information provided by the surveys was augmented with desktop review of relevant literature to allow an assessment of likely impact risks to birds from the proposed development.

This report details:

- the methods that were utilised to obtain avian fauna data
- the results of the avifauna surveys
- the 'priority' bird species that occur within the potential development area, which includes species protected under state and Commonwealth legislation and other species requiring particular consideration in relation to wind farm development (Auswind 2006)
- assessment of the likely level of risk to avifauna from a wind farm development at the site
- recommendations to minimise the potential impacts to birds.

2.0 METHODOLOGY

A variety of techniques were employed in this study to record avifauna that may occur across the proposed development site.

Targeted avifauna field surveys were undertaken within the study area by experienced bird ecologists in three separate survey periods, from 29 October – 7 November 2008, 18–26 November 2008 and 15–16 January 2009 inclusive. The avian surveys for this site were conducted in association with the adjoining Yandin Wind Farm proposed by Wind Prospect WA. These surveys were co-ordinated at the same time, used consistent quantitative and qualitative methodology and were on contiguous lands and similar habitats / topography. The surveys and associated research included a significant focus on the regional occurrence of avian species both on and off site, and these species' movements. This regional focus was considered to be important as it allowed the assessment to consider the likely impacts of the proposals in a regional sense, in relation to species occurrence, movements, topography, water-bodies and existing wind farm locations.

To broaden the scope of the assessment, and increase reliability of the information upon which the impact assessment was based, it was also considered advantageous to include the results of surveys from both wind farm sites in this assessment report. The increased reliability comes from increased overall survey effort and identification of numerous additional species for consideration that, if excluded, may underestimate the full range of species actually requiring consideration for either site. The current approach ensures the full complement (as far as possible) of birds, local movements and associated impacts of the wind farm, have been considered for both sites.

In addition, off-site surveys for both proposed wind farms included those areas such as wetlands and lakes in the surrounding region on which locally, regionally and internationally migratory birds might be expected to move between or around.

Guidance Statement 56 – Guidance Statement for Terrestrial Fauna Surveys for Environmental Impact in Western Australia (EPA 2004) was considered in the development of the survey methodology. However, avifauna assessments for wind energy projects, particularly within rural landscapes, require a modified approach to typical survey methods described under this Guidance Statement. Accordingly, while those key principles of avian survey such as habitat assessment, seasonal opportunity/variations and local movements, as required by *Guidance Statement 56* have been appropriately accounted for within survey methodologies and reporting, the survey methodology also incorporated the guidelines provided in the *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (Auswind 2006) and the *Wind Farms and Birds: Interim Standards for Risk Assessment* (Auswind 2005), by ensuring that more detailed data relating to flight behaviour, flight height and species densities relating to each locality were also captured and assessed.

Furthermore, where appropriate, greater levels of assessment detail has been afforded to significant species at the state, national and international levels.

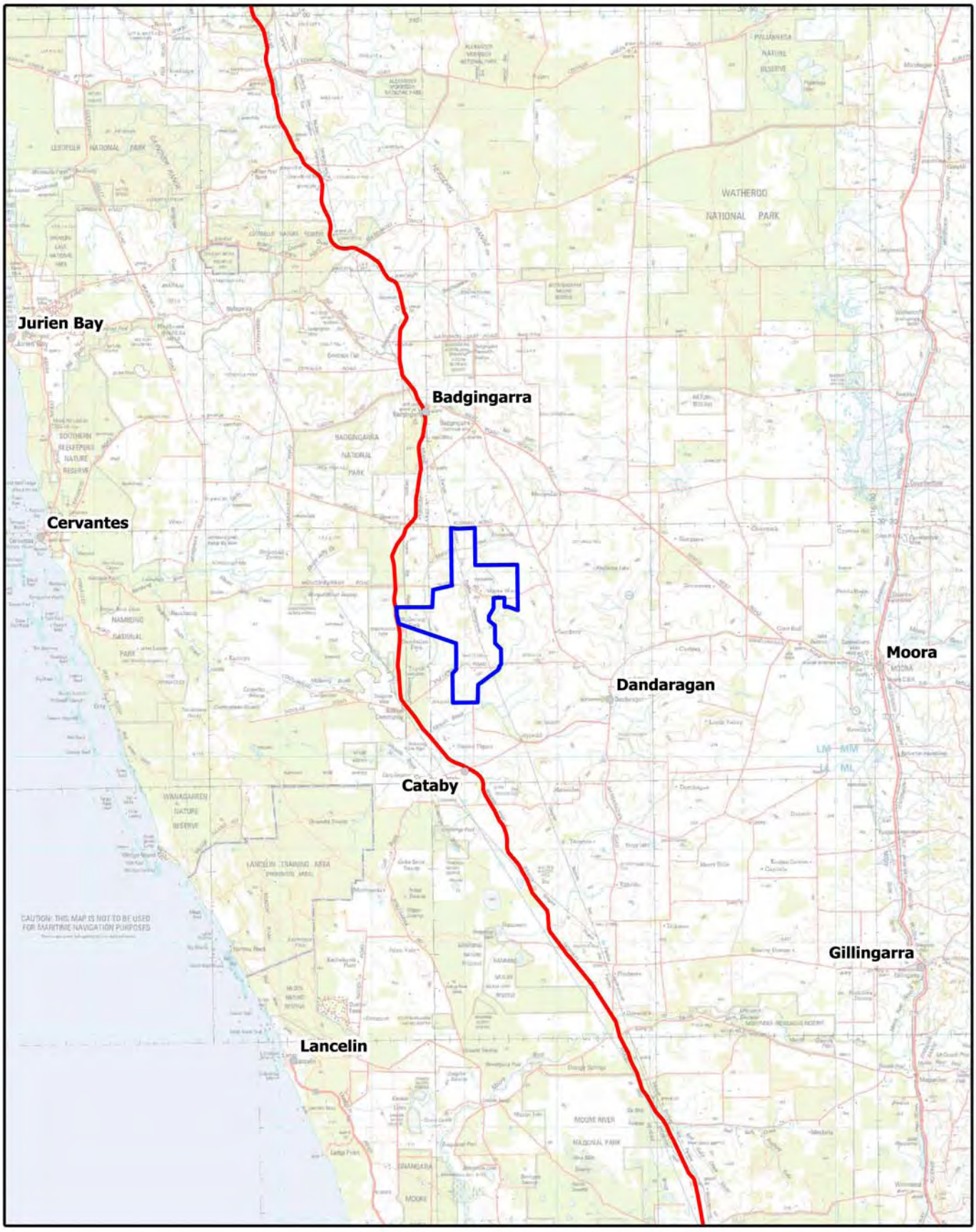
RPS has undertaken a number of avian surveys and impact assessments for wind farms and is familiar with the specific ecological issues associated with wind farm developments. Wind turbines need to be located away from tall remnant vegetation that may create wind turbulence which can be detrimental to the wind turbines and their performance. Therefore, the emphasis is on the identification of species at risk of collision with turbines or alienation from important habitat through an understanding of movement patterns of birds, and key habitat areas and corridors in the vicinity of the turbines.

Surveys focused on bird species present and associated habitat assessment (eg. identification of key habitats, potential movement corridors). Such an approach is consistent with the relevant requirements of DEH (2005), Auswind (2005), DEH (2006) and Auswind (2006).

The avifauna survey methods, as detailed herein, provide sufficient baseline information to detail the known and potential use of the site by locally occurring avifauna and to support an assessment of the potential use of the site by species listed as significant at both state and Commonwealth levels. They also provide baseline data for ongoing monitoring of avifauna during operation of the wind farm, if required.

2.1 Study Area

The study focused on the proposed Waddi wind farm development site (Figure 2-1). However, avifauna survey investigations were conducted across a a wider area of interest, including the Yandin Wind Farm site to the south, and seven representative sites outside the proposed wind farm footprint to gain broader baseline avian movement and distribution data (Figure 2-1). Further to the above surveys a wider regional appreciation of key features, which may influence local avifauna movements was also undertaken, including habitat assessment of lakes and wetlands occurring on the coastal plain and in near coastal areas to the west and drainage line lakes and wetlands associated with the Moore River drainage basin to the east.



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Drafted by: HT
Source: Wind Prospect WA Pty Ltd, 01.09.10.

Figure 2-1

Waddi Windfarm Regional Location

2.2 Data Collation and Literature Review

A review of the biodiversity / Threatened Species data relevant to the site and the wider region was undertaken. Information relating to the potential environmental impacts on birds of wind turbines was also obtained and reviewed. Key information sources included:

- *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (Auswind 2006).
- *Collision fatality of raptors in wind farms does not depend on raptor abundance, Journal of Applied Ecology* (de Lucas et al. 2008).
- *Draft NSW Wind Energy Environmental Impact Assessment Guidelines* (Planning NSW 2002).
- *Ecological Assessment for Waverley Wind Farm, Waverley, New Zealand.* Report prepared for Allco Wind Energy NZ Ltd (RPS HSO 2007).
- EPBC Act Policy Statements, *Supplementary Significant Impact Guidelines 2.1.1 Wind Farm Industry Sector* (DEH 2005).
- EPBC Act 'Protected Matters' Search Tool (Online, DEWHA 2009).
- *Fact Sheet 8: Wind Farms & Bird & Bat Impacts* (AusWEA 2004).
- *Flora and Fauna Assessment box Hill Wind Farm, Ben Lomond Guyra.* Report prepared for Box Hill Wind Farm Pty Ltd (HOS 2004).
- *Flora and Fauna Assessment Highfields Wind Farm, October 2005*, Energreen Wind Pty Ltd (HSO 2005_a).
- *Flora and Fauna Assessment Ben Lomond Wind Farm, August 2005*, Energreen Wind Pty Ltd (HSO 2005_b).
- *Flora and Fauna Assessment Ben Lomond North Wind Farm, August 2005*, Energreen Wind Pty Ltd (HSO 2005_c).
- *Flora and Fauna Assessment for Black Springs Wind Farm*. Report prepared for Wind Corporation Australia Ltd, (ref 23219) (HSO 2006).
- *Guidance Statement 56 – Guidance Statement for Terrestrial Fauna Surveys for Environmental Impact in Western Australia* (EPA 2004).

- *Liverpool Range Wind Farm Nowlands Gap Murrurundi*. Report prepared for Macquarie Generation Pty Ltd, (ref 22555) (HSO 2005$_e$).

- *Preliminary Ecological Results for the Ben Lomond Wind Farm* (PB 2004).

- *Species lists for the 1-degree block encompassing the Dandaragan Postcode locality*. (online, Birdata, October 2008).

- *Wind Farms and Birds: Interim Standards For Risk Assessment* (Auswind 2005).
-
- *Wind farm collision risk for birds – Cumulative risks for threatened and migratory species* (DEH 2006).

A one degree search from within the Birdata (2008) database was used to generate a list of avifauna that have been recorded in the vicinity of the Dandaragan postcode. Coupled with recorded distributions of endemic, migratory and vagrant species occurring in the region, the list formed the basis of an expected bird list for the area.

Local ecologists and DEC were consulted during the scoping process to identify key avian issues, which may apply to the site and the general locality.

In addition, a desk study conducted for this project (RPS 2008) acquired records from local data holdings for an area including the site and 15 kilometres from its boundary. Bird records from this search were also included in the bird list.

2.3 Avifauna Survey Methodology

Avifauna species present on the site were recorded through observation, bird calls and by sighting indirect evidence of species presence such as nests, white-wash and feathers.

2.3.1 Bird Flight Activity and Behaviour

During the bird surveys, bird flight activity and behaviour was observed at sixteen different census sites placed in close proximity to proposed wind turbine locations as shown in Figure 2-2. A further twenty bird census sites were located in close proximity to turbine locations within the Yandin Wind Farm site which adds to the relevant data for the area as a whole. A further seven census sites, representing 20% of the turbine location census sites, were placed in representative habitat areas outside the immediate footprint of both wind farm sites in the wider locality. These seven representative sites were included in the census to act as control sites for ongoing monitoring programs for both the proposed Yandin and Waddi wind farms, if required.

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LEGEND
- Waddi Formal Bird Census Site
- Representative Bird Census Site
- Waddi turbine location V10 04.30.10
- Roads
- Waddi Wind Farm Boundary V2 28.10.09
- Waddi Wind Farm Export Route Boundary

BRAND HWY
COOLJARLOO RD
WOOLKA RD
MULLERING RD
WADDI RD
BADGINGARRA RD
STRATHMORE RD
WOLBA RD
WALYERING RD
CATABY RD
CARO RD
YANDIN RD
WEDGE ISLAND RD
MEADOWS RD
MINGENEW RD
SALT LAKE RD
HINYULO RD
MUTHAWANDERY RD
KAYANABA RD
DANDARAGAN RD
DAMBADJIE RD
MENARDIE RD
BIDGERABBIE RD
STOCKYARD RD
ROWES RD
SCENIC DR
JAM HILL RD
CHELSEA RD
AGATON RD
NORTHWEST RD
KOOLBANN RD
WANDAWALLAH RD
BARBERTON WEST RD
CAPTELLA RD
KOOJAN POOL RD

RPS

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Revision: A
Drafted by: HT
Source: Air photograph (2004). Bird Census Data - RPS Newcastle (2010).

0 625 1,250 2,500 3,750 5,000 metres

Figure 2-2

Bird Sampling Locations and Reference Sites - Waddi Windfarm

RPS' bird census methodology followed the 'sample plot counts' method, where a twenty minute search within each 1.0 ha plot was conducted. All species heard or observed were recorded. Survey locations were selected in elevated areas proximate to proposed wind turbine locations and predominantly encompassed four key habitat types, including:

- open pasture/cultivation dominated areas
- remnant heathland vegetation
- woodland remnants / elements
- areas where various combinations of the above habitats exist.

Apart from these terrestrial habitats the occurrence of wetland habitats within the vicinity of the proposed wind farms were limited to small to moderately sized farm dams. Several small brooks were located within several kilometres of the site's turbine locations.

In addition to those species recorded within the 1.0 ha census plots, all species observed outside census plots were also recorded to ensure (conservatively) that all species that potentially occur within the survey area were identified. Traditional census plot survey procedures usually ignore results outside of discrete plots, due to associated bias toward conspicuous species as distances from the surveyor increase. As a consequence biased results would ensue, particularly if data are to be a measure of species density per area and/or time. However, the premise of this survey was to record all of those species that may potentially be at risk in the wind farm landscape. Limiting survey coverage to 1.0 ha plots would very likely have eliminated records of species that maintain home range territories encompassing many kilometres, such as raptors (birds of prey) and to a lesser extent the corvids (ravens and crows) and similar species such as magpies.

Surveys were also conducted around wetland habitats in the wider locality to determine the status and movements of local waterbird populations and to assess habitat potential for migratory wading bird species. The identification of different wetland habitats in relation to the known habits and habitat requirements of different waterbird and wading bird guilds was undertaken to determine potential movements of these species within the region encompassing the proposed wind farm. Wetland bird surveys were conducted in the late afternoon and evenings to observe any waterbird and wading bird movements that might be taking place on a daily basis. All surveys were conducted in the spring and early summer to coincide with the likely period of migration for most bird species, in particular Carnaby's Black-Cockatoo.

The flight characteristics of individual species throughout all bird surveys were recorded, with flight height ranges split into three zones:

- Zone 1 – 0–40 m (below tip of turbine blade).
- Zone 2 – 40–135 m (rotor swept area - potential collision zone).
- Zone 3 – >135 m (above tip of turbine blade).

After the surveys had been finalised, the wind turbine specifications were changed and altered the height of the RSA. The RSA was increased by the new turbine specification to range from 40 to 152 m above ground level. The assessment in this document has therefore been adjusted by the ornithologists based on their knowledge and professional opinion of those birds recorded flying at the upper limit of Zone 2 and lower limit of Zone 3.

Data were generally collected in accordance with Auswind (2005). The surveys were undertaken in various weather conditions and each 1.0 ha survey plot was surveyed four times. Each site was visited twice in the morning prior to 10.00 am to ensure adequate survey for passerine species, and twice after 10.00 am to ensure adequate survey for soaring species such as waterbirds and birds of prey. Survey teams were rotated between sites to ensure that any potential for observer bias was eliminated from data collected at individual sites.

A targeted survey constituting a component of Level 2 assessment was also undertaken to assess the use of the site and surrounding area by Carnaby's Black-Cockatoo during its migration from the wheat belt region in the east to the coastal plains in the west. This was undertaken during two days in early January 2009. The survey was conducted through the cooler parts of the day from dawn to noon and from later afternoon until dusk, and concentrated on areas between large stands of vegetation and turbine locations. These areas were selected with the expectation that if Carnaby's Black-Cockatoos were flying across the site and at risk of turbine strike they would be flying through such locations.

2.3.2 Call Playback

Nocturnal birds were surveyed using call playback, whereby recordings of the vocalisations of birds are broadcast to elicit a response, either vocal or behavioural. Species calls used included Southern Boobook, and Barn Owl. Calls were broadcast using a portable MP3 player and amplified through a megaphone at woodland sites.

2.3.3 Spotlighting

Spotlighting surveys were undertaken, from a vehicle, along Waddi, Mullering and Yandi Roads, travelling at a speed of 10 km/h using a handheld 100 W spotlight

2.3.4 Survey Dates and Prevailing Conditions

Table 2-1 depicts the dates and prevailing weather during the ecological investigations conducted by RPS ecologists during the October and November 2008 and January 2009 survey periods. The data were derived from a weather station located at Dandaragan to the east of the proposed wind farm site.

Table 2-1: Survey Dates and Prevailing Weather

Date	Weather					
	Temp	Rain (24 hrs to 9.00 am)	Sun		Moon	
			Rise	Set	Rise	Set
28.10.2008	12–18 °C	0 mm	06:25	19:37	04:35	18:08
29.10.2008	12–21 °C	10 mm	06:24	19:38	05:07	19:06
30.10.2008	9–18 °C	1 mm	06:23	19:38	05:42	20:04
31.10.2008	6–21 °C	0 mm	06:22	19:39	06:22	21:01
02.11.2008	9–27 °C	0 mm	06:20	19:41	07:55	22:45
03.11.2008	9–18 °C	0 mm	06:20	19:42	08:48	23:30
04.11.2008	9–18 °C	0 mm	06:19	19:42	09:44	N/A
05.11.2008	9–18 °C	0 mm	06:18	19:43	10:42	00:10
06.11.2008	6–18 °C	5 mm	06:17	19:44	11:39	00:45
07.11.2008	6–18 °C	1 mm	06:17	19:45	12:38	01:18
18.11.2008	12–27 °C	0 mm	06:10	19:54	N/A	9:57
19.11.2008	12–30 °C	0 mm	06:10	19:55	00:03	11:04
20.11.2008	15–24 °C	0 mm	06:09	19:56	00:39	12:08
21.11.2008	9–24 °C	0 mm	06:09	19:57	01:11	13:09
23.11.2008	12–21 °C	5 mm	06:08	19:59	02:08	15:04
24.11.2008	12–21 °C	1 mm	06:08	20:00	02:37	16:02
25.11.2008	12–21 °C	1 mm	06:08	20:00	3:08	16:59
26.11.2008	12–21 °C	1 mm	06:07	20:01	03:42	17:57
15.01.2009	19–41 °C	0 mm	06:32	20:26	00:42	12:49
16.01.2009	24–42 °C	0 mm	06:33	20:26	22:43	10:50

Source:
Australian Government – Geoscience Australia [http://www.ga.gov.au/geodesy/]

2.4 Avifauna Habitat Assessment

The habitat assessment reviewed the potential value of the site (and surrounds) for all avifauna guilds. Particular emphasis was placed on the identification of specific habitat types and resources on the site favoured by known Specially Protected and Threatened Species recorded from the region.

Habitat assessment was based on the specific habitat requirements of each species in regards to home range, feeding, roosting, breeding, movement patterns, corridor requirements and relative value of the habitat(s) present on the proposed development site. Consideration was given to contributing factors including topography, vegetation types and potential foraging, roosting and breeding resources for Specially Protected, Threatened and local avifauna.

The survey concentrated on census points and wetland habitats. More regional and local observations of bird habitat usage trends were also noted where possible, to gain a broader picture of avian ecology for the locality.

2.5 Limitations

Two survey events were undertaken in October and November 2008, and a targeted Carnaby's Black-Cockatoo survey was conducted in January 2009. Survey times were selected because conditions were favourable for studying a wide range of avifauna including sedentary species and summer migrants. The climatic conditions during the surveys were considered to be representative of average conditions for the region such that typical avian communities were recorded during the survey. However, there may be differences in avian species and/or activity in the area in the cooler, wetter months.

Permanent water-bodies were holding sufficient water to support a diversity of waterfowl and waders, providing a relatively high level of confidence in the accuracy of the assessment of recorded and potentially occurring species. However, some more ephemeral regional wetlands had dried beyond the capacity to support moderate or high numbers of waterbird species during the survey period, with higher water levels apparently being restricted to winter months.

The proposed wind farm will occur on undulating hill tops, therefore the majority of formal census points were located on the top or near to the tops of hills. Larger species (e.g. raptors, corvids or cockatoos) observed in these locations tended to keep relatively low over hill top areas compared with their elevation relative to the ground when over valleys. Observations of birds occurring outside of the formal plots were generally of these large species and at significant distances (up to 2 km) from census points. The resulting observed flight elevations of these records were often inflated by their position over the valleys. As a consequence, some of the overall elevation percentages of species recorded during the study may overestimate the actual potential of birds occurring within the RSA.

Of the forty-four species recorded within the sixteen Waddi Wind Farm avian survey plots, thirty-seven species returned less than thirty individual observations, increasing the potential for observed behavioural trends to be skewed by outliers in the low sample numbers. However the number of Waddi species returning less than thirty individual observations is reduced to only seventeen species when taking into account the additional twenty-seven avian survey plots across Yandin and representative sites. To further overcome potential skews in behavioural data, the results were compared with known ecological characteristics of the species observed and, where appropriate, comment is offered on results that appear aberrant in regard known behaviours.

Most bird species avoid people wherever possible, with the proximity at which avoidance occurs varying for different species and generally increasing as bird size increases. Ravens, raptors and in some cases Australian Magpies, may avoid close proximity to people by increasing flight elevation. The presence of the surveyors or other people in the area may have induced this behaviour in some of the individual birds recorded.

Whilst every effort was made to coincide avifauna surveys with migrating bird groups such as waders and black cockatoos, migration periods vary between years and peak events can be missed. However, information on the habitats and landscape was also used to augment and/or validate the data acquired in determining likely distributions across the site.

The conspicuous nature of some bird species at long distances (such as Wedge-tailed Eagles and Ravens) and the relatively close proximity of survey plots are likely to result in some double counting of these species. Therefore, counts of large and high flying species outside of the survey plots is likely to be an unreliable indicator of abundance, probably overestimating true abundance.

2.6 Impact Assessment

Risk assessment for those avian species which were recorded during the survey period from the wider study area, including representative sites, was undertaken by evaluating:

1. The likelihood of impact.
2. The likely severity (consequence) of the impact.

Likelihood was determined through consideration of four aspects of the ecology of each species being:

- Habitat Description (as frequented by the species locally)
- Chance of Occurrence in RSA
- Abundance within the Site Vicinity
- Chance of Occurrence on Site.

This process allows key information about bird ecology within the local context to inform the likelihood each species might be subjected to potential impact given turbine locations and elevation profiles.

A qualitative measure of the likelihood for each species to be impacted was assigned as follows.

- Very Rare – Refers to those species that are considered as having almost no chance of impact, due to either a lack of habitat within the site or its vicinity or flight behaviour that does not approach the RSA.

- Rare – Refers to those species that are considered as having a low chance of impact, due to occasional flight behaviour within the RSA and habitat within the site, or regular RSA flight behaviour but low numbers within the site and its vicinity.

- Possible – Refers to those species that are considered as having a low - moderate chance of impact, with suitable habitat within the site and more regular flight behaviour within the RSA.

- Probable – Refers to those species that are considered as having a moderate - high chance of collision, with suitable habitat within the site, regular flight behaviour within the RSA and potentially high numbers of birds at the site.

A qualitative assessment of the consequences of potential impacts, incorporating the conservation status and local ecological considerations for each species, was undertaken by applying the consequence definitions below.

- Insignificant – Affected species are considered common in regard to distribution and / or abundance. Behavioural and or collision impacts would be highly localised or involve relatively low numbers with no affect at local population levels.

- Minor – Affected species are considered common in regard to distribution but lower in local abundances, including at the site (some raptor species may fall in this category). Behavioural and or collision impacts may impact local populations but no affect at regional levels.

- Moderate – Affected species with restricted distributions or abundance and local numbers likely to be reduced by impacts, possibly affecting regional populations. This category includes species that might only be impacted in low numbers, but due to their legislative status loss of low numbers is considered to be of moderate consequence.

- Significant – Affected species with highly restricted distributions or abundance and impacts could involve a substantial proportion of local numbers with effects to regional or broader populations.

Overall risk level was then analysed in accordance with the risk analysis matrix approach, as described in Auswind (2006).

3.0 RESULTS

3.1 Avifauna Overview

An observed and expected avifauna species list for the site is detailed in **Appendix 1**.

Across all formal avian census plots, including those in the proposed Waddi Wind Farm area, the proposed Yandin Wind Farm area and the seven representative plots, a total count of eighty-eight bird species were recorded. Within this total, forty-four bird species were recorded within formal bird census plots across the proposed Waddi wind farm, including three species that were not recorded in formal plots outside of the Waddi area. A further twenty-five species not observed within the Waddi wind farm area were observed within the proposed Yandin Wind Farm area and another nineteen additional species were recorded at representative plots alone, the majority of which are wetland species associated with the lake to the north-east of Guraga Lake. A further six species were observed in the vicinity of the site during nocturnal movements around the study area. A small number of other species that were noted within the wider locality may have potential to move through the site, on an intermittent basis, due to their nomadic, dispersive or migratory habits, including the Peregrine Falcon, which is listed under Schedule 4 of the *WC Act 1950*. Only two introduced bird species were recorded during the survey period.

Notable results from the October–November 2008 survey period included:

- two bird species listed as Specially Protected under the WC Act, namely, Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and Peregrine Falcon (*Falco peregrinus*) were recorded. *Calyptorhynchus latirostris* is also listed under the EPBC Act as Endangered

- the Rainbow Bee-eater (*Merops ornatus*) and a number of members of the families Accipitridae (Osprey, hawks, eagles and harriers), Anatidae (ducks, swans and geese), Charadriidae (plovers, dotterels and lapwings) and Scolopacidae (snipe, godwits, curlews, sandpipers, stints and phalaropes) were observed within the site all of which are listed as Migratory under the EPBC Act

- birds of prey such as Collared Sparrowhawk (*Accipiter cirrhocephalus*), Brown Falcon (*Falco berigora*), Wedge-tailed Eagle (*Aquila audax*), Australian Hobby (*Falco longipennis*), Black-shouldered Kite (*Elanus axillaris*) and Nankeen Kestrel (*Falco cenchroides*) were observed within the site

- nocturnal bird species such as Southern Boobook (*Ninox boobook*), Barn Owl (*Tyto alba*), Tawny Frogmouth (*Podargus strigoides*) and Australian Owlet-nightjar (*Aegotheles cristatus*) were observed within the vicinity of the site.

The two introduced bird species, Rock Dove (*Columba livia*) and Laughing Turtle-dove (*Streptopelia chinensis*), that were recorded within the vicinity of the site are commensal with humans and were only recorded from urban areas. All avian species recorded within the site were native bird species.

Locations of threatened and other significant (priority) species observations are shown in Figure 3-1.

WARNING
No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from Harper Somers O'Sullivan Pty Ltd.

LEGEND

- 3MW Turbine Location
- Formal Bird Census Site
- Representative Bird Census Site
- Incidental Carnaby's Black-Cockatoo Observation
- Incidental Peregrine Falcon Observation
- Outside Formal Site Carnaby's Black-Cockatoo Observation
- Within Formal Site Carnaby's Black-Cockatoo Observation
- Wedge-tailed Eagle Nest Location

N

0 2.5 5 km

SCALE: 1: 64171.8 AT A3 SIZE

TITLE:	WADDI WIND FARM AVIAN REPORT	LOCATION:	FIG 3-1 THREATENED SPECIES MAP	DATUM: PROJECTION:	DATUM LONGITUDE / LATITUDE (NAD 83)	DATE: PURPOSE:	02/02/2010 PURPOSE

LAYOUT REF: J:\OBS\25K\25342 - DANDARAGAN, WA\DRAFTING\MAPINFO\FAUNA MAPPING
VERSION (PLAN BY): 25342 FIGURE 3-1THREATENED SPECIES MAP A-A4 220509 A. RICHARDSON

CLIENT: WIND PROSPECT
JOB REF: 25342

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3.2 Avifauna Survey Results

Specific information was collated on avian diversity, activity and behaviour. Key results from the 43 bird census points surveyed, including 16 Waddi, 20 Yandin and seven Representative sites are presented in Table 3-1and Table 3-2 (including height ranges frequented).

The survey was conducted using flight height zones that were changed after the survey had been completed. Therefore, data reported in this document has been adjusted using the revised RSA zone heights and is reflected in the Tables. Only those species that were recorded flying in Zones 2 and 3 or just in Zone 3 have been affected by this change.

The data collected in the field did not differentiate birds flying between 135 m (upper limit of the old RSA) and 152 m (upper limit of the new RSA), and therefore actual flight time percentages could not be accurately estimated. Data for birds recorded flying only in Zone 1 or in Zones 1 and 2 would not be affected by the changes, because 40 and 135 m respectively was the upper limits of their flight. Therefore, the percentages of time spent in these two zones would not change.

The flight time percentages of those species flying in Zones 3 and 2 may be under-estimated as a result of the changes in RSA height, and the level of risk will be adjusted using the precautionary principle. The differences between flight times in the original zones and new zones are however, likely to be negligible given that the change is only 17 m.

Those species recorded flying in Zone 3 and not Zone 2, may also be affected by the change in RSA height, and will be dealt with using the professional judgement of the project ornithologists.

Table 3-1 shows elevation height data collected during the census period. Elevation percentages are derived from all records collected from both formal and representative census plots and include those records made inside and outside of all plots.

Table 3-2 shows the spatial distribution of data collected in reference to numbers of each species observed as reported in Table 3-1. Field results are divided into those occurring within and outside of formal census plots.

Raw data upon which results in Table 3-1 and Table 3-2 were derived are presented in full in Appendices 2 and 3.

Notable outcomes of the formal surveys and opportunistic sightings, undertaken during varying weather conditions and diurnal periods, were:

- There was a relatively low diversity of bird species recorded from open pasture areas characterising proposed wind turbine positions.
- There were relatively low numbers of individual birds recorded from open pasture areas characterising proposed wind turbine positions.
- The greatest diversity of bird species recorded in the vicinity of proposed turbine locations were limited to stands of intact native vegetation comprised mostly of heath.
- The majority of movement observations were limited to localised movements.
- Few species were routinely recorded flying within the RSA (40–152 m (as adjusted post-survey)), particularly in ridge top contexts where proposed wind turbines will be located.
- Only five species were recorded flying in the original Zones 2 and/or 3 and therefore in need of consideration for the revised RSA heights. All five of these were common birds and none listed on any lists of conservation concern.
- There were relatively few Threatened bird species recorded within formal survey plots and the majority of those records were outside of the RSA.
- The presence of isolated trees within cleared areas often attracted birds albeit in small numbers and at low diversities.
- No specific areas within the proposed wind farm areas were observed as being significant avian corridors.
- The most prevalent species recorded included Western Corella (Northern), Australian Raven, Galah, Straw-necked Ibis, Australian Ringneck, Yellow-rumped Thornbill, Brown Songlark, and Australian Magpie.
- Threatened avian species recorded regularly in the locality, namely Carnaby's Black-Cockatoo, were found to primarily frequent low-land areas and movements of these species tended to follow valleys with woodland vegetation.
- Raptors including Nankeen Kestrel and Wedge-tailed Eagle, in order of abundance, were observed throughout the study area.
- Other locally abundant species such as waterfowl and waders were observed within specific habitat types not associated with the locations of proposed turbine positions.

Table 3-1: Formal Bird Census Results showing Habitat over which the Bird Species were Recorded, Indication of their Movement Patterns and Speed Category in which they were Recorded Flying

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Australian Shelduck	4509	0				Wetlands	Sedentary/Dispersive	Med
Black Swan	1633	0				Wetlands	Sedentary/Dispersive	Slow–Medium
Western Corella	901	7				Woodland/Grassland	Locally nomadic	Medium Flocks
Galah	458	254				Woodland/Grassland	Locally nomadic	Medium Flocks
Australian Raven	427	119				Forest/Woodland/Heath/ Grassland	Locally nomadic	Medium
Australian Ringneck	374	46				Forest/Woodland	Sedentary	Swift
Straw-necked Ibis	366	65				Wetlands/Grassland	Locally nomadic	Slow
Brown Songlark	236	206				Grassland	Aerial Breeding displays	Medium
Tree Martin	213	16				Woodland/Aerial	Sedentary	Medium–Swift
Australian Magpie	198	62				Forest/Woodland/Grassland	Sedentary	Medium–Swift
Yellow-rumped Thornbill	194	60				Woodland/Shrubland/Grassland	Sedentary	Slow
Red-capped Plover	179	0				Salt and Freshwater Wetlands	Nomadic/Dispersive	Medium–Swift
Australasian Shoveler	154	0				Wetlands	Nomadic/Dispersive	Swift
Grey Teal	119	0				Wetlands	Nomadic	Swift
Australian Magpie-lark	114	33				Forest/Woodland/Grassland	Sedentary	Slow–Medium
Australian Pipit	105	58				Grassland	Aerial Breeding displays	Medium
Red-necked Stint	104	0				Intertidal Zone and Saline Wetlands	Migratory/Nomadic	Medium–Swift

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Carnaby's Black- Cockatoo	100	36				Forest/Woodland/Heath	Seasonally Nomadic	Slow Flocks
Welcome Swallow	99	20				Aerial space above most habitat	Sedentary/Nomadic	Medium–Swift
Black-winged Stilt	98	0				Intertidal Zone and Wetlands	Nomadic/Dispersive	Medium
Black-faced Woodswallow	96	55				Forest/Woodland/Grassland/Aerial	Sedentary Migratory	Slow–Swift
Brown Honeyeater	85	5				Forest/Woodland/Shrubland/Heath	Sedentary	Slow–Medium
Stubble Quail	84	69				Grassland	Nomadic/Irruptive	Swift (but short)
Wedge-tailed Eagle	82	20				Forest/Woodland/Grassland	Sedentary (large territory)	Slow–Swift
White-cheeked Honeyeater	77	31				Woodland/Heath	Sedentary	Slow–Medium
Nankeen Kestrel	70	21				Grassland/ Woodland edges	Sedentary/ Dispersive	Slow–Swift
White-winged Fairy-wren	59	20				Shrublands/Heath	Sedentary	Slow
Willie Wagtail	53	21				Woodland/Grassland	Sedentary	Slow
Silver Gull	50	0				Coastal Fringe and Saline Wetlands	Sedentary/Locally nomadic/Dispersive	Slow–Medium
White-fronted Chat	50	34				Shrubland/Grassland/Heath/Flats	Nomadic	Medium
Silvereye	49	13				Forest	Seasonal nomad	Medium Flocks
Splendid Fairy-wren	44	19				Woodland/Shrublands/Heath	Sedentary	Slow
Rufous Whistler	43	7				Woodland/Shrubland	Sedentary/Breeding Migrant	Slow
Black-faced Cuckoo-shrike	41	6				Forest/Woodland/Shrubland	Locally nomadic	Medium
Rainbow Bee-eater	38	20				Forest/Woodland/Shrubland	Sedentary/Migratory	Swift
Grey Butcherbird	32	9				Forest/Woodland/Shrubland	Sedentary	Slow–Medium

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Singing Honeyeater	29	9				Forest/Woodland/Shrubland	Sedentary	Medium
Crested Pigeon	28	3				Grassland/ Woodland edges	Sedentary	Slow–Swift
Western Gerygone	24	0				Forest/Woodland/Shrubland	Sedentary	Slow
Rufous Fieldwren	22	19				Heath/Sparse shrubland	Sedentary	Slow
White-winged Triller	16	4				Woodland/Shrubland/Heath	Breeding Migrant	Slow–Medium
Musk Duck	16	0				Deep Water Wetlands	Dispersive	Medium–Swift
Tawny-crowned Honeyeater	15	7				Heath	Sedentary	Slow–Medium
Variegated Fairy-wren	14	0				Woodland/Shrublands/Heath	Sedentary	Slow
Australian Wood Duck	13	0				Wetlands	Locally nomadic	Med
Inland Thornbill	12	0				Forest/Woodland/Shrubland	Sedentary	Slow
Zebra Finch	11	0				Grassland and Open Shrublands	Nomadic/Dispersive	Slow
Yellow-throated Miner	10	0				Forest/Woodland/Shrubland	Sedentary	Slow
Black Honeyeater	9	4				Shrubland/Heath	Sedentary/Nomadic	Medium–Swift
Laughing Kookaburra	8	0				Forest/Woodland	Sedentary	Slow
Rufous Songlark	7	4				Grassland	Aerial Breeding displays	Medium
Grey Shrike-thrush	7	0				Forest/Woodland/Shrubland	Sedentary	Medium
Horsfield's Bronze-cuckoo	6	1				Forest/Woodland	Sedentary/Migratory	Medium–Swift
Australian Pelican	6	0				Coastal Fringe and Large Inland Water Bodies	Locally nomadic/ Dispersive	Medium–Swift
Banded Lapwing	5	5				Grasslands	Dispersive	Slow–Swift
Common Bronzewing	5	2				Woodlands/Heaths	Sedentary	Swift
Crimson Chat	5	3				Woodland/Shrubland/Heath	Nomadic	Medium

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Sacred Kingfisher	4	0				Forest/Woodland	Sedentary/Migratory	Swift
White-faced Heron	4	0				Grasslands/Wetlands Coastal Fringe	Nomadic	Medium
Western Thornbill	4	0				Forest/Woodland/Shrubland	Sedentary	Slow
Varied Sittella	4	0				Forest/Woodland/Heath	Sedentary	Slow–Medium
White-backed Swallow	4	0				Watercourses	Sedentary	Slow–Medium
Brown Falcon	4	3				Grassland/ Woodland edges	Sedentary/ Dispersive	Slow–Swift
Red-capped Parrot	3	0				Marri Woodlands	Sedentary	Swift
Shining Bronze-cuckoo	3	0				Forest/Woodland	Migratory/Sedentary	Medium–Swift
Red Wattlebird	3	0				Woodland/Heath	Sedentary/Nomadic	Slow
Whistling Kite	2	0				Woodlands, Coastal Fringe and Wetlands	Sedentary/Locally Nomadic	Sow–Medium
Collared Sparrowhawk	2	1				Forest/Woodland	Sedentary (large territory)	Slow–Swift
Brown Goshawk	2	0				Forest/Woodland	Sedentary (large territory)	Slow–Swift
Australian Hobby	2	1				Grassland/ Woodland edges	Sedentary/ Dispersive	Slow–Swift
Red-necked Avocet	2	0				Estuaries and Saline Wetlands	Nomadic/Dispersive	Medium
Striated Pardalote	2	0				Forest/Woodland	Sedentary	Swift
White-browed Scrubwren	2	2				Forest/Woodland	Sedentary	Slow
Weebill	2	0				Forest/Woodland	Sedentary	Slow
Red-capped Robin	2	0				Woodland/Shrubland	Sedentary	Slow

Species	Total Records Across all Sites	Total Waddi Records	Height Ranges Frequented			Habitat	Movements	Flight Speed
			Zone 1 (below RSA)	Zone 2 (within RSA)	Zone 3 (above RSA)			
Hooded Robin	2	0				Woodland/Shrubland	Sedentary	Slow
Black-shouldered Kite	2	1				Grassland/Woodland	Locally nomadic/ dispersive	Medium
Pacific Black Duck	1	0				Wetlands	Dispersive	Swift
Little Egret	1	0				Estuaries and Saline Wetlands	Locally Nomadic/ Dispersive	Slow
Australian White Ibis	1	0				Estuaries, Wetlands and Grasslands	Locally Nomadic/ Dispersive	Slow–Medium
White-bellied Sea-eagle	1	0				Estuaries, Rivers and Large Inland Water bodies	Locally Nomadic/ Dispersive	Slow–Swift
Gull-billed Tern	1	0				Estuaries and Saline Wetlands	Sedentary/Locally Nomadic/Dispersive	Medium–Swift
Brown-headed Honeyeater	1	0				Forest/Woodland/Heath	Sedentary	Slow–Medium
Grey Fantail	1	0				Forest/Woodland/Shrubland	Sedentary/Seasonal Migrant	Slow
Pied Butcherbird	1	0				Woodland	Sedentary	Slow–Medium
Mistletoebird	1	0				Forest/Woodland	Sedentary/Nomadic	Medium–Swift
Little Grassbird	1	0				Dense Wetland Vegetation	Sedentary	Slow
Fairy Martin	1	1				Aerial proximate to nesting sites	Sedentary	Medium–Swift

= Species commonly recorded at this height range during study (25% and >25%)

= Species occasionally recorded at this height range during study (>5% and < 25%)

= Species rarely recorded at this height range during study (> 0% and up to 5%)

= Species not recorded at this height range during study (0%)

Table 3-2: Bird Species Observation Frequency. NOTE: Data for Waddi, Yandin and Reference Sites have been included to indicate the Bulk of Data Collected in the Combined Survey Approach, which reflects an acute understanding of the Bird Species and Movement Patterns across both Sites

Bird Species (Common Name)	Formal Plots Waddi and Yandin		Representative Plots		Total
	Inside Census	Outside Census	Inside Census	Outside Census	
Australian Shelduck	0	0	5	4504	4509
Black Swan	0	0	0	1633	1633
Western Corella (Northern)	25	154	102	620	901
Australian Raven	19	260	10	138	427
Galah	140	251	21	46	458
Australian Ringneck	197	104	39	34	374
Straw-necked Ibis	26	64	1	275	366
Tree Martin	23	11	1	178	213
Australian Magpie	39	98	4	57	198
Red-Capped Plover	0	0	8	171	179
Australasian Shoveler	0	0	0	154	154
Yellow-rumped Thornbill	107	18	64	5	194
Grey Teal	1	0	0	118	119
Brown Songlark	176	51	3	6	236
Red-Necked Stint	0	0	20	84	104
Australian Magpie-lark	28	50	10	26	114
Black-Winged Stilt	0	0	84	14	98
Brown Honeyeater	47	15	11	12	85
Welcome Swallow	29	11	36	23	99
Wedge-tailed Eagle	4	63	0	15	82
Australian Pipit	61	33	2	9	105
Carnaby's Black-Cockatoo	15	67	2	16	100
White-cheeked Honeyeater	27	19	19	12	77
Nankeen Kestrel	22	42	0	6	70
Stubble Quail	33	45	3	3	84
Black-faced Woodswallow	51	21	13	11	96
White-winged Fairy Wren	28	22	3	6	59
Willie Wagtail	25	9	13	6	53
Silver Gull	0	0	35	15	50
White-fronted Chat	21	18	6	5	50
Silvereye	13	8	19	9	49
Rufous Whistler	14	16	6	7	43
Splendid Fairy-wren	29	13	2	0	44

Bird Species (Common Name)	Formal Plots Waddi and Yandin		Representative Plots		Total
	Inside Census	Outside Census	Inside Census	Outside Census	
Rainbow Bee-eater	23	13	2	0	38
Black-faced Cuckoo-Shrike	25	7	3	6	41
Grey Butcherbird	7	18	1	6	32
Singing Honeyeater	13	10	3	3	29
Crested Pigeon	16	9	0	3	28
Western Gerygone	9	7	7	1	24
Rufous Fieldwren	10	12	0	0	22
Variegated Fairy-Wren	7	7	0	0	14
White-Winged Triller	11	2	1	2	16
Musk Duck	0	0	0	16	16
Tawny-crowned Honeyeater	2	5	4	4	15
Australian Wood Duck	6	0	0	7	13
Inland Thornbill	12	0	0	0	12
Zebra Finch	0	0	4	7	11
Yellow-Throated Miner	5	4	1	0	10
Black Honeyeater	4	0	3	2	9
Horsefields Bronze-Cuckoo	4	0	1	1	6
Laughing Kookabura	1	2	2	3	8
Rufous Songlark	0	7	0	0	7
Australian fPelican	0	0	0	6	6
Grey Shrike-Thrush	2	1	3	1	7
Banded Lapwing	0	5	0	0	5
Common Bronzewing	4	0	0	1	5
Sacred Kingfisher	1	2	0	1	4
Crimson Chat	3	0	0	2	5
White-faced Heron	3	0	0	1	4
Western Thornbill	4	0	0	0	4
Varied Sittella	4	0	0	0	4
White-backed Swallow	0	2	2	0	4
Brown Falcon	0	4	0	0	4
Red-Capped Parrot	1	2	0	0	3
Shining Bronze-Cuckoo	2	1	0	0	3
Red Wattlebird	0	3	0	0	3
Whistling Kite	0	0	0	2	2
Collared Sparrowhawk	0	1	0	1	2
Brown Goshawk	0	2	0	0	2
Australian Hobby	1	0	0	1	2

Bird Species (Common Name)	Formal Plots Waddi and Yandin		Representative Plots		Total
	Inside Census	Outside Census	Inside Census	Outside Census	
Red-Necked Avocet	0	0	0	2	2
Striated Pardalote	1	1	0	0	2
White-Browed Scrubwren	2	0	0	0	2
Weebill	2	0	0	0	2
Red-Capped Robin	1	0	1	0	2
Hooded Robin	2	0	0	0	2
Black-Shouldered Kite	0	2	0	0	2
Pacific Black Duck	0	0	0	1	1
Little Egret	0	0	0	1	1
Australian White Ibis	0	0	0	1	1
White-Bellied Sea-Eagle	0	0	0	1	1
Gull-Billed Tern	0	0	1	0	1
Brown-Headed Honeyeater	1	0	0	0	1
Grey Fantail	1	0	0	0	1
Pied Butcherbird	1	0	0	0	1
Mistletoebird	0	0	1	0	1
Little Grassbird	0	0	0	1	1
Fairy Martin	1	0	0	0	1

3.3 Avifauna Habitat Assessment

3.3.1 Habitats of the Site

The Waddi wind farm site is characterised by a range of different habitats dominated largely by cleared or modified lands with remnant patches/elements of native vegetation. The locality is characterised by undulating hills with ephemeral to semi-permanent drainage lines occurring in the gullies and valleys. This diversity in local topography exhibits general trends in vegetation community assemblages, which in turn provide opportunities for different assemblages and guilds of native bird species.

Four key habitat types occur within the vicinity of the proposed Waddi Wind Farm site, namely:

- Open pasture/cultivation areas.
- Remnant heathland vegetation.
- Woodland remnants/elements.
- Areas where various combinations of heathland and/or woodland are associated with areas dominated by open pasture/cultivation habitats.

Open pasture and cultivated lands occur on hill tops and slopes and largely characterise those lands upon which wind turbine sites are proposed. Heathland habitat varies in height, and plant species assemblage varies in relation to elevation on undulating hills. A shorter heathland community characterises the tops and higher slopes of hills while on the lower slopes and flats, heathland communities have both a shrubby lower stratum and an upper stratum of large shrubs/small trees. Gullies and valleys have woodland habitats largely associated with drainage lines and these communities merge with heathland on the lower slopes. The different habitats provide a mosaic of different habitat opportunities for bird species occurring in the locality.

3.3.2 Habitat Usage

3.3.2.1 Open Pasture/Cultivation Habitats

Where pasture and cultivated habitats are isolated from native plant communities, there are limited habitat opportunities, diversity of native bird species. Species commonly encountered in this habitat type during the study were limited to typical open country species such as Stubble Quail, Brown Songlark, Australian Pipit and Nankeen Kestrel. Straw-necked Ibis were observed foraging in this habitat type intermittently, although usually in lowland locations. Australian Ravens were often observed foraging in this habitat where there were no associated trees.

Fence line windbreaks composed of native or exotic tree species increase shelter and foraging niches when associated with open habitats. Where these linear features occur a number of bird species use the proximity of shelter and open pastures for foraging and nesting opportunities. Such species include Australian Magpie-larks, Australian Magpie, Grey and Pied Butcherbirds, Black-faced Cuckoo-shrike, Australian Ringneck, Black-faced Woodswallow, White-winged Triller, Brown Falcon, Splendid Fairy-wren, Yellow-rumped Thornbill, Western Gerygone, White-fronted Chat, Willie Wagtail and Crested Pigeon. The same species were also found to use open pasture habitat where scattered trees provide the same increased shelter opportunities as windbreak vegetation.

Stands of scattered shrubs and vegetation (shrubs and canola) along fence lines provide sufficient shelter for White-winged Fairy-wrens.

Tagasaste (Tree Lucerne) is planted in some areas to provide fodder for cattle. This man-made shrubland provides shelter and foraging, in particular for the smaller species, such as Splendid, Variegated and White-winged Fairy-wrens, Silvereyes, Red-capped Robin, White-browed Scrubwren, Singing Honeyeater, White-fronted Chat and Willie Wagtail.

Although there is an increase in bird diversity associated with windbreaks, scattered trees and fence line shrubs, this influence is generally limited to the immediate area around these shelter opportunities and does not extend very far into the open pasture. The species using open pasture most widely in this enhanced open habitat context was Australian Magpie.

3.3.2.2 Heathland Habitats

Short heathland habitats on hill tops were characterised by a distinctive assemblage of species, including: Rufous Fieldwren, Tawny-crowned Honeyeater, White-winged Fairy-wren, White-fronted Chat and Black Honeyeater. Taller heathland habitats were frequented by other species, such as: Brown Honeyeater, Brown-headed Honeyeater, White-cheeked Honeyeater, Singing Honeyeater, Red Wattlebird, White-winged Triller, Black-faced Woodswallow, Rainbow Bee-eater, Variegated Fairy-wren, Splendid Fairy-wren, Common Bronzewing, White-browed Scrubwren, Silvereye and Crested Pigeon.

Where heathland vegetation occurs in close proximity to open pasture habitat, and to a lesser extent cultivation, a number of small bird species use the shelter or higher vantage point that the heathland vegetation offers to access open habitat for foraging purposes. These birds include: Yellow-rumped Thornbills, White-fronted Chats, Crimson Chats and Black-faced Woodswallows.

3.3.2.3 Woodland Habitats

Woodland habitats within the study area were found for the most part to occur in lowland areas and on the lower slopes of hillsides. The woodland stands were most often associated with semi-permanent or ephemeral drainage lines where there is some topographical shelter from prevailing winds.

Woodland habitats locally provide the greatest opportunities for bird species due to the diversity of strata and vegetation complexity. Trees provide nesting sites for larger species such as Australian Raven, birds of prey, Australian Magpie, Grey Butcherbird, Australian Ringneck and Red-capped Parrot. The associated foliage provides foraging and nesting opportunities for mid to upper canopy species, such as Rufous Whistler, Western Gerygone, Black-faced Cuckoo-shrike, Spotted and Striated Pardalotes, Sacred Kingfisher and Singing Honeyeater. The understorey is often represented by heathland shrubs and provides shelter and foraging for a range of smaller bird species, including Splendid, Variegated and White-winged Fairy-wrens, White-browed Scrubwrens and Inland Thornbill. Locally, woodland habitats also provide foraging, nesting and roosting opportunities for two cockatoo species, the Western Corella and Carnaby's Black-Cockatoo. Local movements of these species within the study area were noted as being primarily associated with lowland woodland habitats.

3.3.2.4 Wetland Habitats

Apart from those occurring in the wider locality (Section 3.6), wetland habitats in the vicinity of the proposed Waddi wind farm site are few, with water often provided for stock via drinking troughs. The only other sources of water within the Waddi site are the two brooks that run through the bottom of the valleys. These provide very limited waterbird habitat opportunities.

3.3.2.5 Aerial Habitats

In addition to the terrestrial habitats noted above, the sky above these habitats offers foraging opportunities for a number of bird species. Wedge-tailed Eagles were recorded throughout the study area and two nests, one containing a partly fledged eaglet, were found in woodland habitat to the east of Mullering Road. Welcome Swallows and Nankeen Kestrels were recorded over all habitat types, Tree Martins were observed intermittently around suitable nesting trees and Black–faced Woodswallows were noted on heathland shrubs, power lines, remnant trees or associated fence lines where vegetation or other structures afford vantage points for hawking out for insects. The Australian Hobby was observed within the site, although infrequently. The Peregrine Falcon was also observed opportunistically within the locality.

3.3.2.6 Nocturnal Bird Species

Spotlighting surveys were undertaken to identify nocturnal bird species in the area that might occur within the proposed Waddi Wind Farm site.

Southern Boobook was heard calling from riparian woodland habitat on a number of nights at the Waddi Bush resort and one individual was observed in riparian woodland vegetation at the western end of Waddi Road. An Australian Owlet-nightjar was heard in woodland habitat at the Waddi Bush Resort.

A Barn Owl was recorded near the junction of Yandin and Menardie Roads and a Tawny Frogmouth was observed in woodland near Yandin Reserve at the eastern end of Yandin Road during a survey for a wind farm some 15 km south of the Waddi site.

3.4 Bird Movements/Aerial Habits

3.4.1 Species with 0% Records within the RSA

Of the eighty-eight species detected within all survey plots censused in the locality, sixty-nine species were sighted in the formal census sites. Of these sixty-nine species, forty-four were observed within the proposed Waddi Wind Farm site. Fourteen of these species were recorded in the Waddi site in thirty or more individual observations, which provides sufficient data upon which to assume that trends recorded might approximate with some accuracy the behaviours of these species (see Table 3-1). However if results from representative and Yandin sites are included, 28 of those species recorded within the Waddi Wind Farm site returned more than 30 individual records across all surveys. Where results of observed species fall below a number indicating statistical robustness (<30 obs.) the results have been assessed against the known flight behaviours of these species to validate that flight values observed are consistent with the flight habits of the respective species.

Of those twenty-eight Waddi Wind Farm species with more than thirty overall records, 15 species returned 0% of observations within the Rotor Swept Area (RSA). However, only thirteen of those species returned 0% of records in the RSA over total sites surveyed in the locality. Those species with more than thirty records returning percentages above 5% within the RSA on the Waddi site were Galah, Australian Raven, Australian Ringneck, Straw-necked Ibis, Brown Songlark, Australian Magpie, Australian Magpie-lark, Australian Pipit, Carnaby's Black-Cockatoo Wedge-tailed Eagle and Nankeen Kestrel. These results are further discussed below in Section 3.4.3 however, in most cases these records were either from distant observations outside of formal 1ha plot areas or influences by the relatively low numbers of records or both. A large number of which were inflated by the bird's position above valleys and not the ridge-top locations that wind turbines will be located. No changes were required to the list of birds here following review of the RSA height after the survey had been completed.

One species, being the Black-shouldered Kite recorded 100% of records within the RSA, although the number of records for this species within the site was only a single record and is therefore too low to draw any meaningful statistical conclusions from. The single record for the kite was one of only two records made during the course of field investigations in the locality.

Investigation of potential results anomalies noted that two species within the group returning 0% of records in the RSA on the Yandin site, being the Rainbow Bee-eater and White-fronted Chat may under some circumstances fly at elevations within the RSA, largely within long range movements. The Rainbow Bee-eater is an aerial hunter and it may forage at relatively high elevations at times when sufficient prey is available. Another species the Australian Shelduck, which was recorded in high numbers to the west at Guraga Lake North and Namming Lake, also has the potential to fly within the RSA, but all movements noted over the top of undulating hills in the vicinity of the proposed wind farm were at low elevations.

Of the forty-five species encountered within the vicinity of the proposed Waddi Wind Farm, seventeen species returned less than thirty records over all sites surveyed and thirty-one species returned less than thirty records within Waddi surveys alone. Of these seventeen species, fourteen species returned 0% of observations within the RSA. These results are considered to be accurately representative for the majority of these species, due to the low height of native vegetation within the locality and the general premise that the ecology and lifecycle of most of these species is closely tied to the immediate vicinity of native vegetation. However, there are at least three species guilds in this group that are known to sometimes fly at considerable heights, those being birds of prey (Collared Sparrowhawk, and Australian Hobby), Honeyeaters (Singing Honeyeater, Tawny-crowned Honeyeater, and Black Honeyeater) and waterfowl (ducks, geese and waders).

The Collared Sparrowhawk (*n* = 2) is a predominantly bird hunting species which targets passerine birds, particularly in woodland habitats. Foraging activity is usually associated with the habitat of their woodland prey, but this species is known to soar at considerable heights, usually over foraging areas. This species also performs elevated courtship displays. However, these flights are usually made over the breeding territory and usually associated with foraging areas. This species is likely to be primarily associated with lowland woodland areas that are not closely associated with the ridge top locations where the proposed wind turbines would be located.

The Australian Hobby largely forages and performs aerial courtship displays at low elevations. However, there are times when it soars or flies at higher elevations. Other Australian Hobbys (3) observed elsewhere in the region during the same period of the survey were noted as flying at elevations below RSA and one bird was observed targeting young Welcome Swallows, which were flying at low elevations and perching on heathland vegetation near the sea.

Although most heathland honeyeater species are confined to the low vegetation during the majority of their lifecycle, many perform nuptial flights above their breeding territories during the breeding season. There are variations upon the theme, but the general nuptial flight pattern is a slow ascent while calling, sometimes with undulations at the top, and a relatively steep or undulating descent to a prominent perch in the breeding territory. With heathland species these displays take place over heathland territories and do not reach RSA elevations.

Generally, most potentially higher flying bird species observed during the survey period were recorded as flying low over the highest sections of associated undulating hills (i.e. prospective turbine locations).

3.4.2 Species with > 95% but <100% of Records below RSA

Of the forty-five bird species noted within the vicinity of the proposed Waddi Wind Farm, two species recorded 95% or greater but < 100% of records below the RSA. These species were the Black-faced Woodswallow (96%, *n* = 55) and Welcome Swallow (95%, *n* = 20).

The Black-faced Woodswallow, in contrast to some other Woodswallow species, is rather less aerial in its habits and individuals noted during the survey spent most of their time hawking at low elevations from low perches. Welcome swallows are likely to fly at a range of elevations depending upon altitude of prey items, although most birds were seen to hunt insects associated with vegetation, which is of low elevation surrounding the potential wind turbine sites.

3.4.3 Species with > 5% of Records within RSA

Of fourteen species recorded within formal census sites in the wider locality returning > 5% of observations recorded from within the RSA only ten returned >5% of records from within the RSA on the Waddi Wind Farm site. However, two species returning <5% overall, the Australian Ringneck and Australian Magpie-lark, returned >5% of records within the RSA on the Waddi site. Table 3-3 below lists these species, the number of records made, the zone in which they were recorded and the calculated percentages represented in each zone.

Table 3-3: Bird Species with > 5% of Observations within the RSA. NOTE: these values have not been adjusted to account for the revised RSA height.

Species Observed		*n*	Total % in Zone 1	Total % in Zone 2	Total % in Zone 3
Scientific Name	**Common Name**				
Cacatua roseicapilla	Galah	458	78	22	0
Cacatua roseicapilla	Galah	254	59	41	0
Corvus coronoides	Australian Raven	427	85	12	3
Corvus coronoides	Australian Raven	119	58	38	4
Threskiornis spinicollis	Straw-necked Ibis	366	84	8	8
Threskiornis spinicollis	Straw-necked Ibis	65	40	40	20
Cincloramphus cruralis	Brown Songlark	236	81	19	0
Cincloramphus cruralis	Brown Songlark	206	78	22	0
Gymnorhina tibicen	Australian Magpie	198	88	10	2
Gymnorhina tibicen	Australian Magpie	62	61	32	7
Anthus novaeseelandiae	Australian Pipit	105	94	6	0
Anthus novaeseelandiae	Australian Pipit	58	91	9	0
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	100	88	12	0
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	36	67	33	0
Aquila audax	Wedge-tailed Eagle	82	22	27	51
Aquila audax	Wedge-tailed Eagle	20	25	40	35
Falco cenchroides	Nankeen Kestrel	70	79	20	1
Falco cenchroides	Nankeen Kestrel	21	76	24	0
Coracina novaehollandiae	Black-faced Cuckoo-Shrike	41	93	7	0
Coracina novaehollandiae	Black-faced Cuckoo-Shrike	6	100	0	0
Cheramoeca leucosternus	White-backed Swallow	4	50	50	0
Cheramoeca leucosternus	White-backed Swallow	0	0	0	0
Falco berigora	Brown Falcon	4	25	75	0
Falco berigora	Brown Falcon	3	33	67	0
Elanus axillaris	Black-Shouldered Kite	2	0	100	0
Elanus axillaris	Black-Shouldered Kite	1	0	100	0
Banardius zonarius	Australian Ringneck	374	99	1	0

Species Observed		*n*	Total % in Zone 1	Total % in Zone 2	Total % in Zone 3
Scientific Name	**Common Name**				
Banardius zonarius	Australian Ringneck	46	89	11	0
Grallina cyanoleuca	Australian Magpie-lark	114	98	2	0
Grallina cyanoleuca	Australian Magpie-lark	33	94	6	0

Unshaded rows represent total records for locality
Shaded rows represent records from Waddi Wind Farm
n = the number of individual birds observed of each species
Zone 1 – Represents elevations below the RSA (Rotor Swept Area)
Zone 2 – Represents elevations within the RSA
Zone 3 – Represents elevations above the RSA

In respect to some of the figures quoted within Table 3-3 above, there is some inflation of individual Zone 2 (RSA) percentage figures for a number of species due to the inclusion of records outside the formal census plots where a significant number of observations were over lowland areas. Galah, Australian Raven, Straw-necked Ibis Australian Magpie, Carnaby's Black-Cockatoo, Wedge-tailed Eagle, Nankeen Kestrel and Black-shouldered Kite results were inflated in this way as the majority of those records within the RSA for these species were recorded outside of the formal Census plots during surveys. In the majority of cases these species were noted as flying below the RSA when flying across the highest areas of the undulating hills where wind turbines will be located. Observations made of birds such as Ravens in transit over high topography suggested that such species flew low over the tops of hills to avoid stronger winds at higher elevations, particularly in the context of the study area, which is prone to moderate – high wind velocities for much of each day.

Movements of Carnaby's Black-Cockatoo during the survey period were noted as occurring along woodland corridors within valleys. Those observations made within the RSA were largely in down-slope areas outside formal survey plots and there were no records of this species occurring within the RSA in ridge top contexts (see Appendix 2).

Nankeen Kestrel and Black-shouldered Kite hover at a range of altitudes, including elevations occasionally occurring within the RSA, however the Kestrel's RSA percentage during the study is significantly inflated by down-slope observations and the Kite's figures are not indicative of the species' normal habitats due to the very small data set skewing the figures away from normal trends.

Brown Songlark and Australian Pipit are essentially open country species foraging and nesting on the ground, but the males of both these species perform aerial flight displays during territorial and courtship behaviour. As a consequence, the RSA percentages recorded for these species are considered accurate.

Black-faced Cuckoo-shrike figures are considered relatively accurate as this species is known to fly at higher elevations at times, although no RSA records were made within the Waddi site despite the numbers elsewhere in the locality.

White-backed Swallow and Fairy Martin are aerial hunting species that forage at a range of elevations including those occurring within the RSA, but the percentages returned during the study are highly skewed away from what would be expected as normal, due to the low incidence of records during the study.

The Brown Falcon results are also influenced by the low number of records. Observations of this species during the study were made close to the observer, which may have pushed the bird higher to avoid closer proximity to the observer. This species was observed hunting over hilltop heath habitats, which provides abundant niches for its favoured reptile prey. The same individual was observed on a number of occasions perching in tall roadside heath habitat or associated windbreak pines.

A number of species recorded relatively higher percentages in the RSA within the Waddi Wind Farm survey site alone. These species include Galah 41% (*n* = 254), Australian Raven 38% (*n* = 119), Straw-necked Ibis 40% (*n* = 65), Brown Songlark 22% (*n* = 206), Australian Magpie 32% (*n* = 62), Carnaby's Cockatoo 33% (*n* = 36), Wedge-tailed Eagle 40% (*n* = 20), Nankeen Kestrel 24% (*n* = 21) and Brown Falcon 67% (*n* = 3). The majority of these records are exaggerated when compared to overall results from the locality (see table 3-3 above), although it is noted that the greatest majority of higher elevation records came from birds observed outside of the formal census plots, which were in most cases flying over valley areas not closely associated with potential ridge top turbine locations. In the case of Wedge-tailed Eagles, considering the size of these birds, it is possible they may, in contrast to most other species recorded within the study, seek out areas characterised by high wind to stay aloft. The Wedge-tailed Eagle nests to the east of Mullering Road are in valley woodland habitat at a height of no more than 7 m. The nest positions are on a slope that allows the birds to fly down-slope to the east away from the proposed Waddi Wind Farm site to become airborne. Furthermore, access to the nest is from the east so that the birds fly uphill into the prevailing wind to alight on the nest. The nests occur approximately 1.6 km from the nearest turbines to the west of Mullering Road.

3.5 Regional Wetland Habitats and Associated Movements

3.5.1 Habitats

The proposed Waddi wind farm site occurs in undulating hills approximately 50 km from the coast. There are few wetlands apart from farm dams in the vicinity of the site, although a small lake occurs some 10 km to the east of the wind farm at Aggies Cottage on Badgingarra Road (see Section 3.3.2.4). However, there are a number of relatively large water bodies to the south-west (~18 km) of the wind farm site, small to moderate sized water bodies to the east near Dandaragan (~10 km), a considerable number of water bodies in the upper Moore River catchment near Moora (~37 km) and a number of large water bodies further west near Wongan Hills including Lake Hinds (~120 km) and Lake Ninan (~130 km). The location of regional wetlands is shown on Figure 3-2.

3.5.1.1 Lake Guraga and Nearby Lakes

Lake Guraga occurs to the west of the Brand Highway some 18 km to the south-west of the Yandin section of the wind farm. Two other relatively large water bodies occur nearby including the heritage listed Lake Namming to the south of Lake Guraga and a relatively large water body near to the Brand Highway just north-east of Lake Guraga. Aerial photography reveals that there are a number of other water bodies at a similar distance from the coast to the Lake Guraga group.

During November, when wetland surveys were conducted, Lake Guraga was only holding a couple of very shallow crescent shaped ponds and there were approximately 30 Red-capped Plovers foraging on the lake substrate, the majority of which were away from the small ponds. No other bird species were observed at Lake Guraga. Due to the very shallow substrate profile, it is likely that Lake Guraga would support a range of water bird species when filled, including waterfowl and both migratory and resident wading bird species.

Namming Lake to the south of Guraga Lake was full during the November waterbird survey. The lake had no shoreline habitat for waders to forage and no migratory or resident wader species were observed. The lake does appear to be an important permanent water body for waterfowl, with Musk Ducks (approximately 60), Blue-billed Ducks (approximately 80), Australian Shelduck (approximately 500), Australasian Shoveler (approximately 150), Hoary-headed Grebe (40) and a single Black Swan. Little Black (7) and Little Pied Cormorants (1) and a single Yellow-billed Spoonbill were also present. The lake is surrounded by *Melaleuca* sp. trees, which provided roosting and foraging sites for water birds and may represent breeding sites for those species observed on the lake.

The lake to the north-east of Guraga Lake was holding a significant amount of water and due to the shallow substrate profile was found to have significant shoreline habitats at the southern end. Large numbers of water fowl were recorded on this lake, including, Australian Shelduck (> 1200) and Black Swan (> 400). Other smaller waterfowl were also present but observation distances made confident identification difficult. However, numbers of Australasian Shoveler (> 100), Grey Teal (60+) and Pacific Black Duck (2) were observed. Shoreline habitats in the south were supporting both resident and migratory waders including Red-capped Plover (88), Black-winged Stilt (35), Red-necked Avocet (2), Common Greenshank (1) and Red-necked Stint (35). Other species closely associated with the lake included Silver Gull (22), Gull-billed Tern (1), Little Egret (1), Nankeen Night Heron (1), Straw-necked Ibis (70 – roosting), White-bellied Sea-eagle (1) and Whistling Kite (1).

Another lake/dam occurring to the south-east of Namming Lake opposite Nammegarra Road's intersection with the Brand Highway was surveyed on several occasions and found to contain fluctuating numbers of Australian Shelduck, Black-winged Stilt, Black-fronted Dotterel, Australasian Shoveler, Pacific Black Duck and Whistling Kite were also observed.

3.5.1.2 Thetis Lake

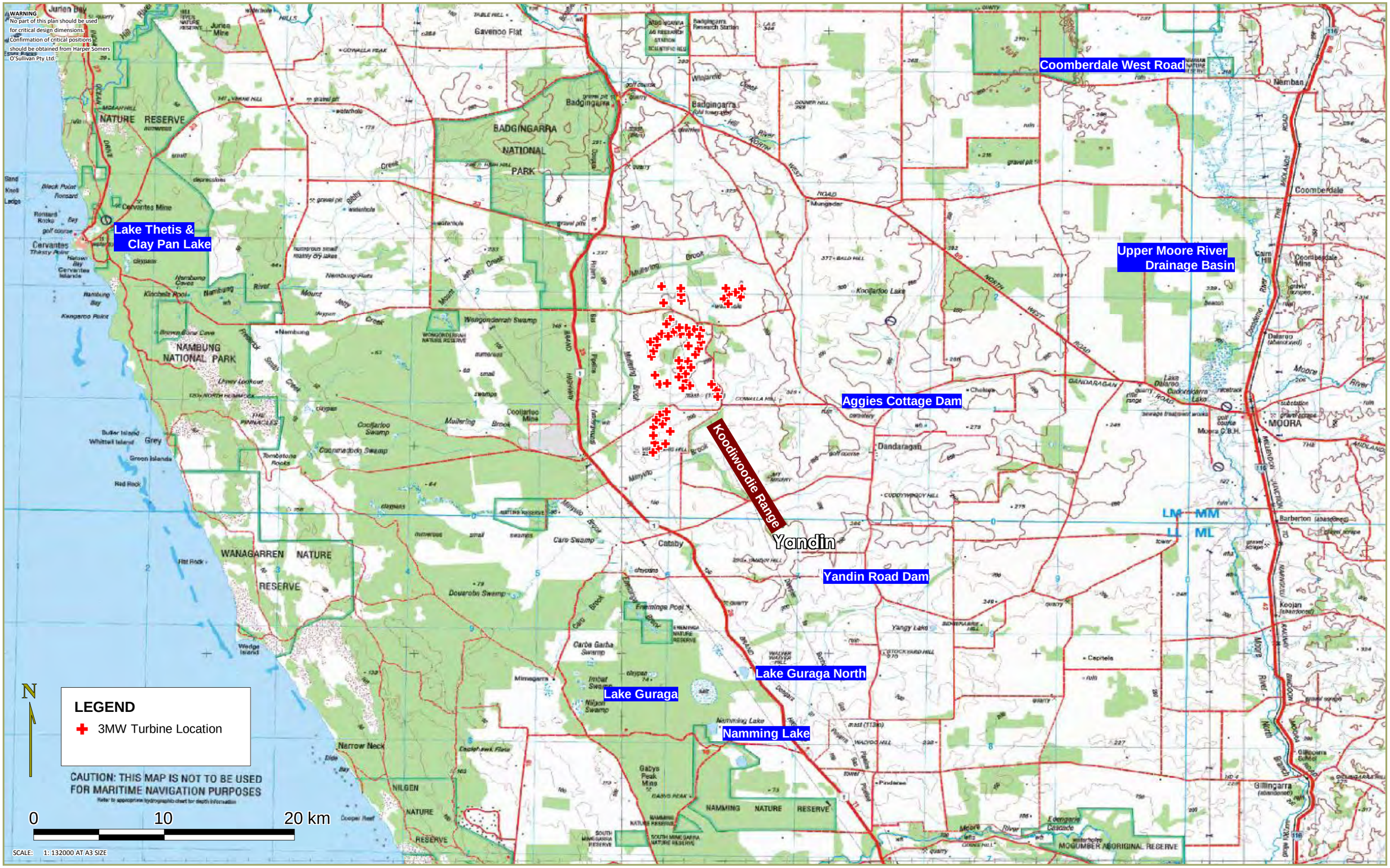
Thetis Lake is a saline lake occurring in near coastal dunes to the south-east of Cervantes approximately 25 km west of the proposed wind farm site. Waterfowl and waders were observed using the lake, including Black Swan (6), Australian Shelduck (> 20), Pacific Black Duck (4), Hoary-headed Grebe (3), Common Greenshank (23), Common Sandpiper (1), Pacific Golden Plover (4) and Red-capped Plover (1). The lake was surveyed as representative of a number of saline lakes occurring in near coastal areas along the coast, particularly to the north of Jurien Bay.

3.5.1.3 Upper Moore River Catchment near Moora

The upper Moore River catchment near Moora, approximately 23 km east of the proposed wind farm site, is represented by broad lowlands traversed by a number of channels and a string of small to large lakes, some saline in water quality. A number of these lakes, particularly those to the west of Moora and north of Dandaragan Road were holding little water during the survey period and hence were limited in the diversity of waterbirds they were attracting. Relatively large numbers (> 100) of Red-capped Plovers were observed foraging over wet substrate within a largely waterless lake just to the north of the Moora Golf Course. Some lakes further to the north on Coomberdale West Road were holding water; one in particular appeared reasonably permanent with short vegetation around the edges. A number of resident and migratory waders were using this lake, including Black-winged Stilt (96), Banded Stilt (1), Sharp-tailed Sandpiper (23) and Pectoral Sandpiper (1). A larger lake to the south of Coomberdale West Road was only holding about a third of its capacity and there were Black-winged Stilt (43), Red-necked Avocet (11) and Banded Stilts (2) present.

3.5.1.4 Aggie's Cottage and Farm Dams

There is a moderately sized dam/lake at Aggie's Cottage to the south-east of the intersection between Wolba Road and Badgingarra Road, which lies approximately 9 km east of the proposed Waddi Wind Farm site. The lake is freshwater and used by a number of waterfowl, including Australian Shelduck (4), Pacific Black Duck (2), Grey Teal (11), Musk Duck (2), Australasian Shoveler (10), Hardhead (6), Black Swan (1) and Hoary-headed Grebe (102). Little Pied (1) and Little Black Cormorant (1) and Black-winged Stilt (11) were also observed. A small farm dam to the west (1.2 km) of Aggies Cottage regularly had a pair of Australian Shelducks and often up to six Grey Teal in attendance during the November survey period.



TITLE: WADDI WIND FARM AVIAN REPORT

LOCATION: FIG 3-2 REGIONAL WETLAND MAP

DATUM: DATUM
PROJECTION: LONGITUDE / LATITUDE (NAD 83)

DATE: 02/02/2010
PURPOSE: PURPOSE

LAYOUT REF: J:\OBS\25K\25342 - DANDARAGAN, WA\DRAFTING\MAPINFO\FAUNA MAPPING 25342 FIGURE 3-2 WADDI REGIONAL WETLAND MAP A-A3 300709
VERSION (PLAN BY): A. RICHARDSON

CLIENT: WIND PROSPECT
JOB REF: 25342

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3.5.2 Waterbird Movement Surveys

A number of the above wetlands were visited in the late afternoon and evenings to determine whether there were any water bird movements to and from these water bodies during this time of day. Movements of birds to and from these water bodies were also noted whenever water bird surveys were conducted at the above wetland areas,

Evening movement surveys were conducted at the lake to the north-east of Guraga Lake, due to the significant number of birds using this site, the lake on Yandin Road due to its proximity to the wind farm and Thetis Lake near Cervantes to note any potential movements of migratory wading birds to or from near coastal habitats.

The surveys revealed a number of limited avian movements from these water bodies during the course of the survey, involving a low diversity of species.

3.5.2.1 Lake North-east of Guraga Lake

The majority of movements observed were to and from the lake to the north-east of Guraga Lake. Small groups (< 10) of Australian Shelducks were noted flying in from the south in the early evening and another couple of small (sounding) groups were heard flying in from the same direction after dark. During morning surveys two small groups (< 10) were observed flying from the lake to the south-east and one group of about 10 individuals were observed flying east over hills to the east of the Brand Highway. Due to the directions of flights, the large number of Australian Shelducks at Namming Lake and the fluctuating numbers of Australian Shelducks at the small lake near the Nammegarra Road turnoff, it is highly likely that these movements were to or from these water bodies.

After dark a Nankeen Night Heron and a Common Greenshank were heard to fly in from the south. It is likely that the Night Heron roosts by day at Namming Lake and nocturnally forages on the shore of north-east lake, due to the roosting opportunities within the surrounding melaleuca trees at Namming Lake, but it is not known where the Greenshank may have flown in from. However, Common Greenshank numbers observed at Thetis Lake suggests that movements to this more inland band of lakes may be from near coastal saline wetlands.

Red-necked Stints, Black-winged Stilts and Red-capped Plovers were observed foraging during the night (spotlighting) at north-east lake and movements observed were limited to accessing different foraging areas of the shoreline.

3.5.2.2 Yandin Road Dam

No movements were observed during late afternoon and evening surveys at Yandin Road Dam. During the November survey period the dam at Yandin Road was used primarily by waterbirds as breeding habitat (see Section 3.3.2.4).

3.5.2.3 Thetis Lake

Most movements observed around Thetis Lake were between different shoreline areas for roosting or foraging purposes. A group of five Common Greenshank and a single Pacific Golden Plover were observed flying off to the south-south-east at sunset on 2 November 2008. There is another shallow saline lake in the south-south-east on the eastern side of Pinnacles Drive in Nambung National Park, which is the most likely destination of this movement. The fluctuating numbers of species and abundances at Thetis Lake suggested that birds moved at least on a local basis between similar habitats, although the presence of a Common Greenshank at the lake to Guraga Lake's north-east indicates that this species moves further inland on occasion.

Movements of observed migratory species to these habitats from the northern hemisphere are likely made along near coastal habitats, although the distributions of Common Sandpiper and Common Greenshank extend inland considerable distances and so there may be some movements between the inland and coast when conditions are favourable.

3.5.2.4 Upper Moore River Catchment

No movements of resident or migratory wading birds were noted at the wetlands along Coomberdale West Road to the north of Moora, or those west of Moora adjacent to Dandaragan Road. However, Red-necked Avocets and Banded Stilts are highly nomadic in response to the fluctuations of ephemeral inland lakes and other water bodies and move between different wetlands to access foraging opportunities when they are at their peak. Sharp-tailed Sandpiper and the Pectoral Sandpiper were flushed when another car stopped close by, but moved elsewhere in the lake. These sandpipers migrate from the northern hemisphere and likely follow similar habitat down the Moore River catchment from the north.

Lakes further west near Wongan Hills reported as containing large flocks of Banded Stilts on 24 October 2008 were dry with no birds on 23 November 2008, evidencing the ephemerality of these species in response to water availability.

There is likely to be some intermittent movement toward Guraga Lake water bodies from these eastern inland water bodies by resident waders, as indicated by the pair of Red-necked Avocets at the lake to Guraga Lake's north-east.

3.6 Threatened Species

3.6.1 Environment Protection and Biodiversity Conservation Act 1999

3.6.1.1 Threatened Species

One bird species listed as Threatened under the EPBC Act was recorded on the proposed Waddi Wind Farm site namely, Carnaby's Black-Cockatoo. Carnaby's Black-Cockatoo is listed under the EPBC Act as Endangered.

Carnaby's Black-Cockatoo was noted as being strongly associated with the woodland habitat which occurs within valleys and gullies on the site, particularly for roosting purposes and likely breeding opportunities. The majority of observed movements by this species, both within formal census plots and incidental records, were in association with lowland corridors. The remaining movements of this species were recorded at low altitude over pasture in the valleys or on hill tops below the RSA, when they appeared to be moving intently between locations rather than milling or foraging.

The Carnaby's Black-Cockatoo uses the woodland and tall heathland vegetation for foraging purposes. A flock in excess of 200 birds was observed some 30 km to the north-west of the site, east of Cervantes, over pine plantations. The cones of *Pinus* sp. may represent a food resource for this species in the region during some season contexts, as reported within Higgins (1999).

3.6.1.2 Migratory Species

A number of species and families observed within the site, its vicinity and more widely within the region are listed under the EPBC Act as Migratory. The families Accipitridae (Osprey, hawks, eagles and harriers), Anatidae (ducks, swans and geese), Charadriidae (plovers, dotterels and lapwings) and Scolopacidae (snipe, godwits, curlews, sandpipers, stints and phalaropes) are listed as Migratory species under the EPBC Act. In the case of the families Accipitridae and Anatidae there are no Australian species which can be considered truly migratory between Australia and other countries, although some make dispersive, nomadic or migratory movements within Australia. Most of these species are common local species, with no particular conservation significance and therefore they are not included in the assessment of migratory species within this report. Such treatment of common species, which have been inadvertently included within Commonwealth Migratory species schedules under the EPBC Act as a component of adopting migratory species agreements with northern hemisphere countries, is standard practice within Ecological Assessments and has been verified with the Department of Sustainability, Environment, Water, Population and Communities (SEWPC, formally Department of Environment, Water, Heritage and the Arts (DEWHA)) personnel by RPS Ecologists in the past and adopted within all assessment documents.

Only some representatives of the plover (Charadriidae) and Sandpiper (Scolopacidae) families, which occur in Australia, are truly migratory and these species are specifically identified under the legislation. No habitat exists for migratory members of these families within the vicinity of the proposed wind farm, although a Greenshank and Red-necked Stints were observed in the wider locality at the lake to the north-east of Lake Guraga to the site's south-west. Greenshank were also observed at Thetis Lake near Cervantes and it is likely that greenshank and some other migratory waders may make intermittent movements between these lakes occurring in the coastal strip west of the Koodiwoodie Range , although movements further east to inland lakes may occur on rare occasions, when conditions are suitable.

The Rainbow Bee-eater is a listed Migratory species under the EPBC Act, but was sighted as a breeding resident within the proposed Waddi Wind Farm during the survey period. No migratory movements of this species were noted during the survey but this species may move through the region during their annual north-south movements.

No Fork-tailed Swift individuals were observed during the survey period from anywhere within the region, but this EPBC Act listed Migratory species may occur locally during dispersive movements particularly in the summer months.

Migratory bird species have been further discussed in Table 3-5 and Section 3.7.

3.6.2 Wildlife Conservation Act 1950

Two bird species listed as Specially Protected under the WC Act, namely, Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and Peregrine Falcon (*Falco peregrinus*) were recorded within the locality of the proposed wind farm site.

The Carnaby's Black-Cockatoo has been further discussed in Section 3.6, Table 3-5 and Section 3.7.3.2.

Over a period of 18 survey days across the site and wider locality the Peregrine Falcon was observed once, which indicates that numbers of this species in the region are relatively low. The Peregrine Falcon has been discussed further in Section 3.6, Table 3-5 and Section 3.7.3.3.

3.7 Impact Assessment

3.7.1 Background Research

3.7.1.1 Overview

Research undertaken internationally (including New Zealand) and in Australia (NWCC 2004; Auswind 2005; Birdlife International 2003) has demonstrated three main types of potential impacts to birds from wind farms:

- Direct mortality from collisions.
- Indirect impacts from avoidance, habitat disruption and displacement.
- Loss of, or damage to, habitat resulting from wind turbines and associated infrastructure.

There are a number of important factors that influence avian mortality (Drewitt and Langston 2006). The location of wind farms is seen as a major factor, with those sited near wetlands, critical habitat areas, or along migratory flight paths having greatest impacts. The rates of collisions can be influenced by adverse weather conditions and poor visibility, flight characteristics of birds (e.g. fast flying, flocking, and nocturnal flyers may be more prone to collisions) and an individual species' ecology (e.g. migratory species may be less familiar with the area (Drewitt and Langston 2006)).

Turbulence created by the rotors (as a specific consideration) is also likely to affect species and result in a low level of mortality (Winkelman 1992). This aspect of wind turbine impacts has been subject to little available research. Such effects are particularly likely for smaller birds and bats, which are considered less able to divert course away from the blades/strong turbulence, once caught in the turbulence zone.

No specific calculations are available to accurately determine the turbulence zone size, although the turbulence zone has been assumed likely to be at least 100 m in either direction of the rotor blades. Turbulence causes a range of effects on flying birds depending on the proximity of the bird to each blade and speed of the blade (Winkelman 1992).

Occasional deaths may be attributable to birds and bats being caught in such a turbulence zone generated by the proposed wind turbines, particularly if it causes significant deviation of flight path or disorientation, however numbers of such potential events are unlikely to be significant. Furthermore, it is unlikely that the number of bird fatalities attributable to blade-strike in general would be significant given the lack of through-site bird movements. This is particularly due to the locations of the turbines being in existing cleared areas.

The probability of adverse bird interactions appears to be both site-specific and species specific. The most important step that can be taken to avoid adverse bird interactions is to locate facilities based on careful siting studies and away from critical habitat (Colson and Associates 1995).

Turbulence in a large part of this zone is likely only to cause small disruptions to flight patterns to a degree that would not affect the individual bird. In a smaller part of this zone the turbulence may be strong enough to entrap individual birds or cause significant changes to the flight patterns that may then put birds at risk of injury. Very close to the blades turbulence may put birds at risk of direct physical harm either by causing collision with the blade or sudden changes in pressure (compression and rarefaction) that could cause barotraumas (physical injury to tissue especially that surrounding air cavities such as lungs and sinuses) (Baerwald et al. 2008).

3.7.1.2 International Examples

Impacts to birds have been shown to vary among sites and are considered likely to depend on several factors including the amount of bird use, vegetation, and biological characteristics of the specific wind farm and surrounding area (NWCC 2004). Studies conducted at a number of other wind farm sites in the USA and Scotland have recorded few to no fatalities, including sites frequented by raptors (Rae 2005).

Based on a review of 12 comprehensive bird-monitoring studies in the USA, fatality rates have averaged 2.3 individuals per turbine per year (NWCC 2004). The impact of wind turbine collisions has been estimated to be less than 0.02 per cent of the 200–500 million collision related deaths in the USA from other structures, such as vehicles (60–80 million), buildings and windows (98–980 million), and communication towers (4–50 million) (AusWEA 2004).

Recent research in North America (Barclay et al. 2007), undertaken over 33 wind farm sites, indicates that the average annual mortality rate for birds was 0.61 per turbine. This included a range of tower heights and rotor swept areas. Heights ranged from 24 to 94 m, while diameter of rotor swept areas ranged from 15 to 80 m. The study also indicated that differences in rotor swept area were not a significant factor in relation to impacts, with no evidence that taller turbines are associated with increased bird fatalities. In fact, the per turbine mortality rate for birds was constant despite variations in tower height. Barclay et al. (2007) indicated that factors influencing fatality rates may include differences in the number of species present within the area, their population sizes, the use of migration corridors, variation from site to site at which birds fly, and variation in numbers of migrants from year to year.

3.7.1.3 New Zealand Examples

New Zealand-based research on bird mortality is limited. NZWEA indicates that as at 2005 there had been no domestic reports of mortalities of any rare, threatened or endangered bird species at domestic wind farms since they started operations and that,

in general existing data from New Zealand wind farms would seem to indicate a lower mortality rate than the global average. Indications are that recorded deaths in New Zealand are predominantly of common species such as Australian Magpies, various gulls and Blackbirds. Specific examples of New Zealand wind farm operations that have been monitored include Brooklyn (near Wellington), Hau Nui and Tararua. Bird mortality at these locations has been identified as being minor, or non-existent, with scientific monitoring at Tararua abandoned, in part due to the lack of data (i.e. bird mortality).

3.7.1.4 Australian Examples

In Australia, collision rates reported have been generally around one to two birds per turbine per year (AusWEA 2004). NZWEA (2005) also refers to rates in Australia being generally between 0.23–2.7 birds per year. The most susceptible Australian birds are likely to include:

- birds of prey and owls, particularly soaring species such as eagles and kites
- nocturnal migrating songbirds
- locally-breeding high-flying songbirds such as Australian Magpie-larks
- waterbirds such as Straw-necked Ibis and Black Swans
- ducks
- shorebirds, including migratory waders
- Neophema Parrots (AusWEA 2002).

Within Australia most wind farm development has been along coastal areas in Western Australia, South Australia and Victoria. In Tasmania, the first two stages of the Woolnorth wind farm have been the subject of a bird and bat strike-monitoring program. There has been some evidence for a slightly decreased usage of the site by birds post-construction (i.e. displacement) and several species have been reportedly hit by turbines including Wedge-tailed Eagles, seabirds such as petrels, Common Skylark, Grey Fantail, Black Currawong and Banded Lapwing (Rae 2005).

Studies conducted at Stanwell's Toora wind farm in South Gippsland found no evidence of significant levels of bird mortality, with impacts confined to localised indirect effects on common farmland birds. Species such as Wedge-tailed Eagles were regularly observed before and after operations began, but they avoided the turbines by flying around or between them (AusWEA 2004).

As the Australian wind farm industry develops, information increasingly suggests that the mortality rates at Australian wind farms are lower than in the northern hemisphere, apparently due primarily to the lack of large numbers of night-migrating songbirds in Australia (AusWEA 2004).

3.7.2 Risks to Avifauna Occurring within the Site

Potential impacts to avifauna from the wind farm primarily relate to turbine operation, ie collision risk and indirect effects from avoidance, habitat disruption and displacement.

The proposed turbine locations are in areas that have already been cleared for agriculture and clearing of native vegetation, if required, for cables and access roads is expected to be minimal (<150 m^2). While the locations of these roads and cables have yet to be finalised, the results of the investigations undertaken indicate that the clearing of this small an area of vegetation is unlikely to have a significant impact on any avifauna species as a result of habitat loss. Further, significant areas of vegetation have been mapped (refer Vegetation reports) to ensure avoidance during any micro-siting work.

Risks from turbine operations to all avifauna species which have been recorded within the site and its vicinity during onsite investigations are summarised in Table 3-4. This Table is structured to include the heads of consideration that informed the assessment process, as follows.

Species – Each species is identified by its recognised common name as adopted in Christidis and Boles (2008).

Habitat Description – A brief broad characterisation of habitat in which each species frequently occurs is given as a comparative reference against the largely open habitats represented by turbine positions.

Chance of Occurrence in RSA – Local movements of those avian species observed to occur within the site during the survey period are given a qualitative (Low, Moderate or High) measure of their likelihood to occur within the RSA in reference to movements observed within the site and its vicinity during onsite investigations. Due to the difficulty in observing the full range of bird flight activity and behaviour within time constraints determined by short (20 minute) census periods, the full range of known behaviours of recorded species was taken into account to establish flight elevation tendencies in the survey area.

Abundance within the Site Vicinity – A qualitative abundance (Low, Moderate or High) measure based on observed species densities within the site is given.

Chance of Occurrence on Site – Depending on habitat requirements the likelihood that different species might occur within the site varies. Based on observed occurrences and known habitat usage of local species a qualitative (Low, Moderate or High) measure of their likelihood to occur within the site is given.

Likelihood of Impact – Based upon the above heads of consideration a qualitative (very rare (VR), rare (R), possible (Po) or probable (Pr)) measure of the likelihood for each species to be considered at risk of impact is given.

Status – The conservation status of each species observed within the site's vicinity is stated as:

- C = Common with no particular conservation status (i.e. not listed)

- M = Listed as a Migratory species under the EPBC Act
- E = Listed as Endangered under the EPBC Act
- R = Listed under Schedule of the WC Act as a species that is rare or likely to become extinct.

Consequence – A qualitative (insignificant (In), minor (Mi), moderate (Mo) or significant (S)) measure of Risk for each avian species is given.

Likely Level of Risk – The resultant (Low, Moderate or High) measure of the likely level of risk for each avian species based on consideration of Consequence and Likelihood of impacts is provided.

Table 3-4: Risk Assessment Table for Avian Species occurring within the Site and its Vicinity

Species	Habitat Description	Chance of Occurrence in RSA	Abundance Within the Site Vicinity	Chance of Occurrence on Site	Likelihood of Impact	Status	Consequence	Likely Level of Risk
Stubble Quail	Grassland	Low	Moderate	High	**Low**	C	**In**	**Low**
Australian Wood Duck	Wetlands/Grassland	Low	Low–Moderate	High	**Low**	M	**In**	**Low**
Musk Duck	Deepwater Wetlands	Low	Low	Low	**Low**	M	**In**	**Low**
Black Swan	Wetlands	Low	Low	Low–Moderate	**Low**	M	**In**	**Low**
Australian Shelduck	Wetlands	Low	Low–Moderate	High	**Low–Moderate**	M	**In**	**Low**
Pacific Black Duck	Wetlands	Low	Low	Low–Moderate	**Low**	M	**In**	**Low**
Australasian Shoveler	Wetlands	Low	Low	Low–Moderate	**Low**	M	**In**	**Low**
Grey Teal	Wetlands	Low	Low	Low–Moderate	**Low**	M	**In**	**Low**
Australian Pelican	Wetlands	Low	Low	Low–Moderate	**Low**	M	**In**	**Low**
White-faced Heron	Wetlands/ Grasslands	Low	Low	Low–Moderate	**Low**	C	**In**	**Low**
Little Egret	Wetlands	Low	Low	Low	**Low**	C	**In**	**Low**
Straw-necked Ibis	Wetlands/Grassland	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**
Australian White Ibis	Wetlands	Low	Low	Low	**Low**	C	**In**	**Low**
Black-Shouldered Kite	Grassland/ Woodland	Moderate	Low	High	**Low**	M	**Mi**	**Low**
Whistling Kite	Woodland/Grassland/ Heath/Wetlands	Low	Low	Low–Moderate	**Low**	M	**In**	**Low**
Collared Sparrowhawk	Forest/Woodland	Low–Moderate	Low	High	**Low**	M	**Mi**	**Low**
Brown Goshawk	Forest/Woodland	Low–Moderate	Low	High	**Low**	M	**Mi**	**Low**
White-Bellied Sea-Eagle	Wetlands/Large Watercourses	Low	Low	Low	**Low**	M	**Mi**	**Low**

Species	Habitat Description	Chance of Occurrence in RSA	Abundance Within the Site Vicinity	Chance of Occurrence on Site	Likelihood of Impact	Status	Consequence	Likely Level of Risk
Wedge-tailed Eagle	Forest/Woodland/ Grassland	Moderate–High	Low	High	**Moderate**	C	**Mi**	**Low–Moderate**
Brown Falcon	Grassland/Woodland edges	Moderate	Low	High	**Low**	C	**Mi**	**Low**
Nankeen Kestrel	Grassland/Woodland edges	Moderate	Low–Moderate	High	**Low–Moderate**	C	**Mi**	**Low**
Australian Hobby	Grassland/Woodland edges	Low	Low	High	**Low**	C	**Mi**	**Low**
Peregrine Falcon	Grassland/Woodland edges	Low	Low	Low–Moderate	**Low**	R	**In**	**Low**
Red-Necked Stint	Wetlands	Low	Low	Low	**Low**	M	**Mi**	**Low**
Black-Winged Stilt	Wetlands	Low	Low	Low	**Low**	C	**Mi**	**Low**
Red-Necked Avocet	Wetlands	Low	Low	Low	**Low**	C	**Mi**	**Low**
Red-Capped Plover	Wetlands	Low	Low	Low	**Low**	M	**Mi**	**Low**
Banded Lapwing	Grasslands	Low	Low	High	**Low**	M	**Mi**	**Low**
Silver Gull	Wetlands	Low	Low	Low	**Low**	C	**Mi**	**Low**
Gull-Billed Tern	Wetlands	Low	Low	Low	**Low**	C	**In**	**Low**
Common Bronzewing	Woodlands/Heaths	Low	Low–Moderate	High	**Low**	C	**Mi**	**Low**
Crested Pigeon	Grassland/Woodland edges	Low	Low–Moderate	High	**Low**	C	**In**	**Low**
Carnaby's Black-Cockatoo	Forest/Woodland/ Heath	Low	Low–Moderate	High	**Low**	R, E	**In**	**Low**
Galah	Woodland/Grassland	Low–Moderate	Moderate	High	**Low**	C	**Mi**	**Low**
Western Corella (Northern)	Woodland/Grassland	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**
Red-Capped Parrot	Woodland	Low	Low	Low–Moderate	**Low–Moderate**	C	**In**	**Low**

Species	Habitat Description	Chance of Occurrence in RSA	Abundance Within the Site Vicinity	Chance of Occurrence on Site	Likelihood of Impact	Status	Consequence	Likely Level of Risk
Australain Ringneck	Woodland	Low	Moderate	High	**Low**	C	**In**	**Low**
Horsefields Bronze-Cuckoo	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Shining Bronze-Cuckoo	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Laughing Kookabura	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Sacred Kingfisher	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Rainbow Bee-eater	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	M	**In**	**Low**
Splendid Fairy-wren	Woodland/ Shrublands/Heath	Low	Low	High	**Low**	C	**Mi**	**Low**
Variegated Fairy-Wren	Woodland/ Shrublands/Heath	Low	Low	High	**Low**	C	**In**	**Low**
White-winged Fairy Wren	Shrublands/Heath	Low	Low	High	**Low**	C	**In**	**Low**
Striated Pardalote	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
White-Browed Scrubwren	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Rufous Fieldwren	Heath/Sparse shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Western Gerygone	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Inland Thornbill	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Western Thornbill	Forest/Woodland/ Shrubland	Low	Low	Low–Moderate	**Low**	C	**In**	**Low**
Yellow-rumped Thornbill	Woodland/Shrubland/ Grassland	Low	Low–Moderate	High	**Low**	C	**In**	**Low**

Species	Habitat Description	Chance of Occurrence in RSA	Abundance Within the Site Vicinity	Chance of Occurrence on Site	Likelihood of Impact	Status	Consequence	Likely Level of Risk
Weebill	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Red Wattlebird	Woodland/Heath	Low	Low	High	**Low**	C	**In**	**Low**
Yellow-Throated Miner	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Singing Honeyeater	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Brown-Headed Honeyeater	Forest/Woodland/ Heath	Low	Low	High	**Low**	C	**In**	**Low**
White-cheeked Honeyeater	Woodland/Heath	Low	Low	High	**Low**	C	**In**	**Low**
Tawny-crowned Honeyeater	Heath	Low	Low	High	**Low**	C	**In**	**Low**
Black Honeyeater	Shrubland/Heath	Low	Low	High	**Low**	C	**In**	**Low**
Brown Honeyeater	Forest/Woodland/ Shrubland/Heath	Low	Low	High	**Low**	C	**In**	**Low**
Crimson Chat	Woodland/Shrubland/ Heath	Low	Low	High	**Low**	C	**In**	**Low**
White-fronted Chat	Shrubland/Grassland/ Heath/Flats	Low	Low	High	**Low**	C	**In**	**Low**
Red-Capped Robin	Woodland/Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Hooded Robin	Woodland/Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Rufous Whistler	Woodland/Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Grey Shrike-Thrush	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Willie Wagtail	Woodland/Grassland	Low	Low	High	**Low**	C	**In**	**Low**
Grey Fantail	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	C	**In**	**Low**

Species	Habitat Description	Chance of Occurrence in RSA	Abundance Within the Site Vicinity	Chance of Occurrence on Site	Likelihood of Impact	Status	Consequence	Likely Level of Risk
Black-faced Cuckoo-Shrike	Forest/Woodland/ Shrubland	Low–Moderate	Low	High	**Low**	C	**In**	**Low**
White-Winged Triller	Woodland/Shrubland/ Heath	Low	Low	High	**Low**	C	**In**	**Low**
Black-faced Woodswallow	Forest/Woodland/ Grassland/Aerial	Low	Low	High	**Low**	C	**In**	**Low**
Grey Butcherbird	Forest/Woodland/ Shrubland	Low	Low	High	**Low**	C	**In**	**Low**
Pied Butcherbird	Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Australian Magpie-lark	Forest/Woodland/ Grassland	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**
Australian Magpie	Forest/Woodland/ Grassland	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**
Australian Raven	Forest/Woodland/ Heath/Grassland	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**
Zebra Finch	Woodland/Tall heath	Low	Low	Low	**Low**	C	**In**	**Low**
Australian Pipit	Grassland	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**
Mistletoebird	Forest/Woodland	Low	Low	High	**Low**	C	**In**	**Low**
Welcome Swallow	Aerial space above most habitat	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**
White-backed Swallow	Woodland/Watercourses	Moderate	Low	High	**Low**	C	**In**	**Low**
Tree Martin	Woodland/Aerial	Low–Moderate	Low	High	**Low**	C	**In**	**Low**
Fairy Martin	Aerial proximate to nesting sites	Moderate	Low	High	**Low**	C	**In**	**Low**
Little Grassbird	Wetlands	Low	Low	High	**Low**	C	**In**	**Low**
Brown Songlark	Grassland	Low–Moderate	Moderate	High	**Low–Moderate**	C	**In**	**Low**

Species	Habitat Description	Chance of Occurrence in RSA	Abundance Within the Site Vicinity	Chance of Occurrence on Site	Likelihood of Impact	Status	Consequence	Likely Level of Risk
Rufous Songlark	Woodland/Grassland	Low	Low	High	**Low**	C	**In**	**Low**
Silvereye	Forest	Low	Low	High	**Low**	C	**In**	**Low**
Varied Sittella	Forest/Woodland/ Heath	Low	Low	Low–Moderate	**Low**	C	**In**	**Low**

C = Common with no conservation status other than as a protected species under Western Australia legislation.
M = Listed as a Migratory species under the EPBC Act.
R = Listed as a Rare species under the WC Act.
E = Listed as an Endangered species under the EPBC Act.

3.7.3 Assessment of Risks to Listed Avifauna Species

3.7.3.1 Summary

Further detail of key elements of the assessment undertaken for avifauna species listed under the WC Act and the EPBC Act that have been gazetted/recorded from within the site or its vicinity is provided in Table 3-5. Explanatory description is provided for each species in regards to consideration of its potential to occur within the study area and the likely impacts as a result of the proposed development. Table 3-5 is structured as follows.

Species – Lists each listed species known from the vicinity of the site. The status of each species under the WC Act and EPBC Act is also provided.

Habitat Description – Provides a brief account of preferred habitat attributes required for the existence/survival of each species.

Chance of Occurrence within Site – Assesses the likelihood of each species to occur within the site in terms of the aforementioned habitat description and taking into account local habitat preferences, results of recent field investigations, data gained from various sources and previously gained knowledge via fieldwork undertaken within other ecological assessments in the locality.

Potential Impacts within Development Site – Assesses the potential and likely impacts to each species that would result from the proposed Wind Farm development, taking into account both short and long-term effects. This assessment considers the probability of occurrence of each species in the area of potential impact, including the RSA, with due recognition to other parameters such as home range, habitat use, connectivity, etc.

For listed species that were observed on the site or its vicinity during the surveys, further textual discussion is provided in Sections 3.7.3.2. to 3.7.3.5.

Table 3-5: Listed Avian Species Assessment Detail

Species/ Community	Habitat Description	Chance of Occurrence On Site	Potential Impacts	Likely Level of Risk
Avifauna (Listed under the *Wildlife Conservation Act 1950*)				
Calyptorhynchus latirostris Carnaby's Black-Cockatoo (*1*)	Occurs in eucalypt forests and heath in SW Western Australia. The division of habitat-use largely follows woodland habitats for roosting and breeding purposes and heathland for foraging where it mainly takes the seeds of Banksias and other proteaceous heathland vegetation. This species is also known to forage in pine plantations under some seasonal contexts and it is also reported as coming to the ground to feed on *Erodium* sp. within pastures and roadside habitats, although it is not known to forage on cereal crops. It requires large Eucalypt tree hollows for nesting, although some tree species are more reliably utilised due to their higher occurrence of hollows.	**High** Carnaby's Black-Cockatoo was recorded within the site and the wider locality during field surveys. Habitat utilisation within the site and its locality followed what is generally known of the species, i.e. onsite occurrences were largely confined to intact Marri (*Corymbia calophylla*) woodland areas, which occur as riparian remnants along valley bottom watercourses and lower slopes, and tall heathland communities and their remnants on sand plains and lower slopes in the wider locality. Local movements were restricted to valley vegetation corridors and rare traversed of more elevated open country were at low elevations. During the survey period a large flock (200+) was noted over a pine plantation east of Cervantes, some 30 km north-west of the site.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision and changed movement paths. However, targeted surveys for this species found that in the locality this species was associated with woodland habitats for roosting, and likely breeding purposes, and tall heathland habitats containing large *Banksia* and proteaceous species for foraging. These communities occur at lower elevations away from turbine locations on the higher ground. All movements within the site and its locality were noted as following lowland valleys. Few movements (12%) across the entire study area were observed to be within the RSA and those areas of high elevation were observed over valley areas. No RSA height movements were observed over elevated areas where the proposed wind turbines would be located. As such, it is considered unlikely that local populations of this species would be at significant risk of collision and/or changed movement patterns as a consequence of the proposed wind farm development. Further discussion on this species is included in Section 4.4, due to records in the vicinity of the site.	**Low**
Leipoa ocellata Malleefowl (*1*)	Occurs in temperate Australia largely limited to the semi-arid zone. Mostly limited to areas of inland semi-arid scrub, this species prefers a dry environment with low-growing eucalypt trees and shrubs, referred to as mallee country. Although their diet exhibits seasonal variation, they mostly feed on ants and the seeds of wattle and other legume plants.	**Low** This species was not recorded within the site during fieldwork. This species is highly unlikely to occur within the site due to the absence of suitable habitat within the site and the wider locality.	Unlikely to be any potential consequences associated with local occurrences of this species, due to the absence of suitable habitat in which this species is mostly found.	**Low**

Species/ Community	Habitat Description	Chance of Occurrence On Site	Potential Impacts	Likely Level of Risk
Falco peregrinus Peregrine Falcon (*4*)	Occurs over most terrestrial habitat types across Australia including coastal shorelines and desert areas where reporting rates are somewhat lower than those in higher rainfall areas. In most of its range territories are often associated with cliffs and rocky outcrops or rocky coastal islands but in the absence of rocky habitat eyrie opportunities Peregrines will nest in trees or tall man-made structures. It is essentially an aerial species and hunts above canopy vegetation where it's favoured prey is medium sized birds such as Galah and Rock Doves.	**Low— Moderate** This species was not detected during targeted field surveys within the site. However, a single bird was observed within the vicinity of the site utilising similar habitat to what was present within the site. Furthermore, due to the widespread utilisation of associated lands for cropping purposes there maybe seasonal periods where influxes of medium sized cockatoos, such as galahs and corellas, may attract predatory species including Peregrines, of which these parrots are a favoured prey. It is therefore considered that this species may occur within the site on at least an intermittent basis.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision. Despite the general absence of this species across the site it is considered likely that it may occur within the site intermittently. This species is an aerial specialist and may at times fly at RSA elevation and above. Due to its considerable aerial ability it is considered unlikely that Peregrines would collide with turbine blades during normal flight, but it is possible that collision could occur during hunting manoeuvres while the bird might be focussed on its prey. However, the chance of this occurrence is considered remote, due to the low frequency of local observations.	**Low**
Avifauna (Listed under the *EPBC Act 1999*)				
Apus pacificus Fork-tailed Swift (*M*)	Essentially an aerial species that occurs widely over a range of habitats at a range of elevations from quite close to the ground to at least 300 m, although likely higher. Although it occurs across a wide range of habitats within Australia it is mostly observed over inland plains and is seen over coastal beaches and cliffs. A non-breeding visitor to Australian skies from the northern hemisphere it is more frequently observed in coastal eastern Australia than elsewhere, due no doubt to a higher density of observers. Flocks in the thousands have been observed during the wet season at Anna Plains in NW Western Australia (RPS ecologist pers. Obs).	**Low – Moderate** The Fork-tailed Swift was not recorded within the site during fieldwork. Although, this species was not recorded within the site or its wider locality during field surveys, due to its wide ranging movements across open areas within Australia, its occurrence within the site on at least an intermittent seasonal basis cannot be discounted.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision. There is potential for this species to fly at RSA height if flocks were to move through the area under some seasonal conditions. However this species has considerable aerial ability and is likely to easily avoid collision. Moreover, local occurrences of this species are likely to be intermittent spasmodic seasonal occurrences.	**Low**

Species/ Community	Habitat Description	Chance of Occurrence On Site	Potential Impacts	Likely Level of Risk
Ardea modesta Eastern Great Egret (*M*)	A large egret common across a wide range of wetland habitats throughout Australia, including inland swamps, rivers and lakes and coastal swamps, watercourses and estuarine systems. Movements are generally of a localised nature although the species is dispersive in response to rainfall conditions and it often breeds in association with other egret/heron species, Ibis, spoonbills and cormorants.	**Low** This species was not detected during field surveys within the site. There are no habitat opportunities for this species within the site. The occurrence of suitable habitat both to the east and west of the site may indicate that east – west movements through the site are possible. However, taking into account the low densities of this species locally to the west and only intermittent habitat opportunities to the east, east-west movements through the site are only considered to occur on rare occasions.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision and changed movement paths. There is potential for this species to fly at RSA height if birds were to disperse between regional wetlands, however birds are likely to fly at lower elevations over high areas to avoid wind as many other species appear to do. Moreover, local occurrences of this species are likely to be intermittent spasmodic occurrences linked to rainfall patterns.	**Low**
Ardea ibis Cattle Egret (*M*)	A small to medium sized egret occurring across most of Australia apart from the arid interior and central western coasts. Often occurring in flocks associated with grazing cattle. General habitat is pasture lands and a range of fresh and estuarine wetlands. A colonial breeder it often returns to the same breeding sites sometimes attended by other waterbird species. It may travel reasonable distances between roosting and communal foraging areas.	**Low** This species was not observed during surveys on site at the time of survey. There are limited habitat opportunities for this species within the site, due to the dominance of cropping lands. The occurrence of suitable habitat both to the east and west of the site may indicate that east – west movements through the site are possible. However, there are few records for this species locally and it was not observed during the survey period, which suggests that local movements through the site are considered unlikely.	Unlikely to be any potential consequences associated with local occurrences of this species, due to the absence of local records.	**Low**

Species/ Community	Habitat Description	Chance of Occurrence On Site	Potential Impacts	Likely Level of Risk
Calyptorhynchus latirostris Carnaby's Black-Cockatoo (*V*)	Occurs in eucalypt forests and heath in SW Western Australia. The division of habitat-use largely follows woodland habitats for roosting and breeding purposes and heathland for foraging where it mainly takes the seeds of Banksias and other proteaceous heathland vegetation. This species is also known to forage in pine plantations under some seasonal contexts and it is also reported as coming to the ground to feed on *Erodium* sp. within pastures and roadside habitats, although it is not known to forage on cereal crops. It requires large Eucalypt tree hollows for nesting, although some tree species are more reliably utilised due to their higher occurrence of hollows.	**High** Carnaby's Black-Cockatoo was recorded within the site and the wider locality during field surveys. Habitat utilisation within the site and its locality followed what is generally known of the species i.e. onsite occurrences were largely confined to intact Marri (*Corymbia calophylla*) woodland areas, which occur as riparian remnants along valley bottom watercourses and lower slopes, and tall heathland communities and their remnants on sand plains and lower slopes in the wider locality. Local movements were restricted to valley vegetation corridors and rare traversed of more elevated open country were at low elevations. During the survey period a large flock (200+) was noted over a pine plantation east of Cervantes, some 30 km north-west of the site.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision and changed movement paths. However, targeted surveys for this species found that in the locality this species was associated with woodland habitats for roosting, and likely breeding purposes, and tall heathland habitats containing large *Banksia* and proteaceous species for foraging. These communities occur at lower elevations away from turbine locations, all of which are on higher ground. All movements within the site and its locality were noted as following lowland valleys. Few movements (12%) across the entire study area were observed to be within the RSA and those areas of high elevation were observed over valley areas. No RSA height movements were observed over elevated areas where the proposed wind turbines would be located. As such it is considered unlikely that local populations of this species would be at significant risk of collision and/or changed movement patterns as a consequence of the proposed wind farm development.	**Low**
Leipoa ocellata Malleefowl (*V*)	Occurs in temperate Australia largely limited to the semi-arid zone. Mostly limited to areas of inland semi-arid scrub, this species prefers a dry environment with low-growing eucalypt trees and shrubs, referred to as mallee country. Although their diet exhibits seasonal variation, they mostly feed on ants and the seeds of wattle and other legume plants.	**Low** This species was not recorded within the site during fieldwork. This species is highly unlikely to occur within the site due to the absence of suitable habitat within the site and the wider locality.	Unlikely to be any potential consequences associated with local occurrences of this species, due to the absence of suitable habitat in which this species is mostly found.	**Low**

Species/ Community	Habitat Description	Chance of Occurrence On Site	Potential Impacts	Likely Level of Risk
Haliaeetus leucogaster (White-bellied Sea-Eagle) (*M*)	Found commonly over a range of fresh and saltwater habitats, including lakes, bays, estuaries, river systems and dams. Largely found near coastal regions but can be found long distances inland along major river systems. Uses large dead/living trees or structures for nesting. Mostly territorially sedentary in habits but dispersive movements to inland water bodies occur by some adults and immature birds.	**Low** This species was not recorded within the site during fieldwork. Habitat for this species within the region occurs within the coastal fringe and lakes occurring to the south-west. Although this species is unlikely to occur within the site due to the absence of suitable habitat it is possible that it may traverse the site on rare occasions during dispersive movements inland.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision. Due to the general absence of this species preferred habitat within the vicinity of the site, it is considered that it may occur within the site only rarely. Therefore it is unlikely that this species would be placed at significant collision risk as a consequence of the proposed wind farm.	**Low**
Merops ornatus (Rainbow Bee-eater) (*M*)	This species occurs widely across the Australian mainland apart from central western arid zone. Frequents open woodland, heathland and riparian habitats characterised by sandy soils and vertical nesting opportunities such as occur on the edges of riverbanks, sand-ridges, watercourses, cuttings and cliffs. It is also known to burrow into flat ground within suitable soil substrates.	**High** This species was recorded during field surveys. Its status within the site during the survey period was as a breeding resident. It is possible that seasonal north (Feb/Apr) – south (Sep/Oct) movements of more southerly individuals of this species may traverse the site on migration.	Potential consequences of the wind farm upon this species would be limited to rotor blade collision. There is potential for this species to fly at RSA height if flocks were to move through the area under some seasonal conditions. However this species has considerable aerial ability and is likely to easily avoid collision. Moreover, local occurrences of this species are likely to be intermittent seasonal occurrences.	**Low**

Key: **(1)** = Schedule 1 – Fauna that is rare or is likely to become extinct, listed under the Wildlife Conservation Act 1950(WC Act1950).
(4) = Schedule 4 – Other specially protected fauna, listed under the Wildlife Conservation Act 1950(WC Act 1950).
(M) = Migratory listed under Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999).
(V) = 'Vulnerable' Species listed under EPBC Act 1999.
(E) = Endangered Species listed under EPBC Act 1999.

3.7.3.2 Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)

This species is widespread in the south-west region of Western Australia. The species migrates domestically, occurring within the Wheatbelt region in Kwongon woodlands nesting in hollow bearing *Eucalyptus. wandoo* and *E. salmonophloia* during the breeding season and migrating to the coast, primarily roosting and foraging in remnant Banksia woodland and pine plantations on the Swan Coastal Plain following breeding.

The range of Carnaby's Black-Cockatoo has contracted with birds being recorded from a third of its original breeding range since the mid 1970s. These contractions are mostly as a result of fragmentation or the destruction of habitat from the effects of agriculture, forestry and mining. Carnaby's Black-Cockatoo is listed under Schedule 1 of the WC Act and listed as Endangered under the EPBC Act. The SEWPC is yet to release a formal policy for the management of species, however current advice indicates that a 10:1 offset will be required if clearing breeding or foraging habitat.

This species is gregarious and is usually seen in small parties, occasionally in large flocks of hundreds. The Carnaby's Black-Cockatoo and the Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*) are almost indistinguishable from a distance, with only slight variations in their calls and a longer upper beak on the Baudin's Black-Cockatoo, both species have a prominent white ear patch and white panels in the tail.

The foraging behaviour and habitat of the Carnaby's Black-Cockatoo is the easiest way to distinguish the two species. In general the Caranaby's Black-Cockatoo feeds on proteaceous shrubs in the Kwongon heathland during the breeding season, and Banksia, Dryandra, Hakea, Grevillea and Marri seeds and a variety of introduced species (pines, cape lilac, wild radish and wild geranium) when foraging on the coast in the non-breeding season. The Baudin's Black-Cockatoo tends to be found in the Jarrah forests although foraging ranges may overlap with Baudin's Black-Cockatoo during the non-breeding season.

Within the proposed wind farm site, Carnaby's Black-Cockatoo was observed to be strongly associated with woodland habitat, which occurs within valleys and gullies between the higher ridges of the Koodiwoodie Range, particularly for roosting purposes and potential breeding opportunities. A flock of some fifty birds were observed to regularly roost in woodland habitats associated with the Waddi Bush Resort to the north of the wind farm development. The majority of observed movements by this species, both from formal census plots and incidental local records were in association with lowland corridors.

In addition to woodland occurrences observed within the locality of the proposed wind farm site, Carnaby's Black-Cockatoo was also observed regularly in tall heathland containing tall *Banksia* sp. on the lower sandy flats to the west of the Koodiwoodie Range along the Brand Highway. A relatively small number of observations of foraging birds were made in remnant heathland components occurring in woodland patches or as

isolated plants within cleared areas, along roads surrounding the wind farm site (see Figure 3-1). A flock in excess of 200 birds was observed some 30 km to the north-west of the site, east of Cervantes, over pine plantations. The cones of *Pinus* sp. may represent a food resource for this species in the region during some season contexts, as reported by Higgins (1999). Although local observations of the species were largely consistent with habits reported within literature (Higgins 1999), no birds within the site were observed to come to the ground for foraging purposes as has been reported in some areas.

Although observed flight elevations of Carnaby's Cockatoos were occasionally at heights consistent with the RSA, as with many other species observed in the locality, RSA height observations tended to be over lowland areas and lower flight patterns were recorded over the higher ridges where wind turbines will be located. This is likely due to avoidance of moderate to high wind velocities that characterise the site on a daily basis and the somewhat laboured flight action of Black-Cockatoos. As a consequence it is considered unlikely that this species will be placed at a level of risk, which might threaten the viability and numbers of local populations, due to the proposed wind farm.

3.7.3.3 Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon occurs across most of the world. In Australia they are widely distributed, but appear to avoid small areas in the arid interior. In Western Australia they are widespread but recorded sporadically. They are rare in the desert regions of WA, although more commonly occur in the western Kimberley region, south coast especially rocky islands, Stirling Ranges and inland ranges that extend into Northern Territory. Records also extend to the Nullarbor, Goldfields and Pilbara regions. The Peregrine Falcon is listed in Schedule 4 of the WC Act.

The Peregrine Falcon is a solitary aggressive falcon occurring across most habitats. It flies and soars strongly at great heights and can dive at high speeds in pursuit of prey. They hunt aerially at a range of elevations from high altitudes down to within 1 m off the ground. Large birds are sometimes taken, although medium sized birds are the primary prey and usually taken from an elevated assault. Despite a predominant focus upon avian prey, prey animals can vary according to the habitat, with other food sources including rabbits and large insects. Peregrines mainly hunt diurnally however they may hunt during the crepuscular period and occasionally nocturnally.

Preferred habitat is over wooded and forested lands, open country and wetlands of tropical and temperate areas. The range encompasses varied elevations from sea level to alpine areas and extends into arid areas, although it does not include treeless and waterless deserts. Peregrines avoid densely forested habitat as they prefer an unhindered line of sight from above, enabling a fast attack and greater manoeuvrability.

Breeding occurs across its range. Nest sites have been known to occur as high as 900 m in Tasmania (Olsen 1985, Mooney and Brothers 1987). The preferred nesting sites are ledges and cavities in sea cliffs of mainland and offshore islands and also rugged inland

ranges. Records have shown that nesting sites also include hollows in trees usually on plains and undulating country, river systems and wetlands. Occasionally stick nests of other birds are used and on rare occasions they nest in caves, sink holes, on the ground or in buildings.

This species is generally accepted to be sedentary, within much of breeding range, but some birds may disperse to inland areas during summer. Most established pairs remain within their nesting territory all year round.

In general, however, widespread clearing of forests has provided open areas for hunting, and has promoted the expansion of Galah (*Cacatua roseicapilla*) and introduced bird populations, which are the favoured prey of falcons, but as a consequence, forest clearing has generally reduced the number of native bird species available as prey. (Olsen and Olsen 1980, White et al. 1981).

Locally Peregrine Falcons were observed to be scarce during field investigations with only a single bird being recorded off site within the vicinity and wider locality of the site, including coastal habitats from Lancelin to Green Head and easterly flats to Moora. The bird was perched in tall heath habitat near the Brand Highway on Mullering Road to the south-west of the site (see Figure 3-1). A pair nesting in a remnant woodland patch at Pithara, some 120 km to the north-east, was recorded during wider excursions within the survey period. The very large stick nest contained a fledgling, located in a tall eucalypt within woodland dominated by mallee eucalypts. The location lies within country dominated by wheat production and the birds are likely to occur in that area in order to target granivorous birds attracted by the wheat.

There are potential Peregrine hunting opportunities within the site and its vicinity due to the occurrence of wheat and pasture lands attracting medium sized cockatoos. Nesting opportunities are generally scarce due to the lack of cliffs and the lack of suitable hollows in local woodland dominated by *Corymbia calophylla* (Marri). As a consequence it is possible that the locality of the site in general may only experience intermittent occurrences of this species. There is a general paucity of records for the locality as evidenced in Birds Australia data (Birdata 2005–2007), which has a single record for the area.

A bird possessing such acute vision, highly honed flying skills and largely diurnal habits, it is unlikely that Peregrines would have a high risk of collision with turbine rotors. As such it is unlikely that this species is likely to be placed at a significantly higher level of risk of local adverse impacts as a consequence of the proposed wind farm development.

3.7.3.4 Migratory Species as Listed under the EPBC Act

As aforementioned in Section 3.6.1.2, the vast majority of listed migratory species recorded within the site (Table 3-4) are not indeed migratory in their habits (being predominantly resident or nomadic/dispersive within Australia). Duck and raptor species in particular (Families Anatidae and Accipitridae respectively) fall into this category.

Only a limited number of the species listed as Migratory within the area of interest can be considered truly migratory, and only a limited number are likely to occur within the site at greater frequencies than occasional rare occurrences, including Fork-tailed Swift and Rainbow Bee-eater, Great Egret and Cattle Egret.

Of these species, only the Rainbow Bee-eater could be considered to utilise the habitats contained within the site on a regular basis as a consequence of their migration to south-western Australia. Such habitat opportunities are not confined to the site, but occur widely throughout the region. The sandy substrates associated with landscapes in the locality are favoured by this species for nesting opportunities. Although there is only a relatively sparse collection of records widely spread within the region, this is likely due to limitations on local survey effort as similar results are returned for locally common species such as the Australian Ringneck.

This species is occasionally observed hunting at moderately high elevations, which might be consistent with the RSA, however, their insectivorous hunting habits, in the locality, were observed to be strongly associated with stunted heathland vegetation, where an abundance of flowering plants is the dominant attractor of the Bee-eater's insect prey. Due to the dominance of low elevation hunting opportunities locally it is unlikely that this species would fly at RSA elevations more than rarely, during its general day to day activities. Therefore it is unlikely that this species would be placed at a significant risk of adverse impact as a consequence of the proposed wind farm.

3.7.3.5 Migratory Wading Bird Species

Certain members of the families Charadriidae (plovers, dotterels and lapwings) and Scolopacidae (snipe, godwits, curlews, sandpipers, stints and phalaropes) are also listed as Migratory species under the EPBC Act. Within these families a number of species are recognised as resident species and although they are somewhat nomadic or dispersive in their movements, they breed within Australia and so they are not considered to be truly migratory in habits. A range of other members of these families migrate annually from temperate and arctic regions in the northern hemisphere to Australia during the onset of the Austral summer period. These species are those that are considered to be true migrants.

The site does not contain habitat for migratory wading bird species, although there are habitats within the region that are frequented by these species.

A number of migratory wading bird species were recorded from wetland habitats around Lake Guraga to the south-west, the near coastal Lake Thetis near Cervantes and from the Upper Moore River area to the north-west and west of Moora. Movements to and from these wetland habitats by migratory wading birds are likely to follow north–south routes, which follow the general landscape arrangement of these habitats in relation to drainage basins in the east and coastal dune topography in the west. As such, it is unlikely that significant movements of migratory wading birds would take place in an east–west direction across the Koodiwoodie Range where the proposed wind farm is to be constructed. As a consequence it is unlikely that migratory wading bird species will be placed at significant risk of adverse impact due to the proposed wind farm.

3.7.4 Risks to Other Priority Species

Auswind (2006) guidelines for bird assessments describe a need to consider species which may not be included on legislative schedules but which are present in significant numbers on or near the site or prone to collisions or other effects from wind farms.

Of those species observed to occur within the site, only one species, the Wedge-tailed Eagle, was observed flying with regularity at RSA elevations and is considered to have a greater than low risk of impact in relation to the proposed wind farm development (Table 3-4).

The Wedge-tailed Eagle is a declared pest of agriculture under the provisions of the Agriculture and Related Resources Protection Act 1976, administered by the Western Australian Department of Agriculture and Food. This declaration allows for the approval and implementation of a management program in various areas of the state including agricultural areas such as those in the locality of the proposed Waddi Wind Farm (DEC 2007).

As a native species, the Wedge-tailed Eagle is protected under the provisions of the WC Act, administered by the DEC. The shooting of Wedge-tailed Eagles is not permitted, but damage licences may be issued by DEC to shoot or scare the eagles away from livestock (DEC 2007).

Wedge-tailed Eagles were widely recorded across the site and the surrounding area, with some 76 individual observations made during the course of the survey period. However, of those 76 records only four were recorded within formal survey plots. The relatively high number of records from the site is largely due to the sedentary nature of local birds and their high visibility from long distances, which has resulted in individuals being repeatedly observed from a number of formal survey plots. This species occupies territories representing large areas, and therefore numbers of individuals noted within the study areas were generally low.

It is likely that the northern portion of the study area is occupied by a single pair and perhaps a young bird or two from previous breeding seasons, although it is possible that the territories of other individuals occurring largely offsite to the east and west may include some areas of the Koodiwoodie Range. The numbers of Wedge-tailed Eagles are likely to fluctuate, with occasional influxes from birds occurring in areas adjacent to the Koodiwoodie Range. Two nests were observed in the wider locality to the north of the proposed wind farm, just east of Mullering Road, one containing a half fledged, half downy eaglet.

Fifty-one per cent of Wedge-tailed Eagle observations within the survey period were from elevations higher than the RSA, 29% were from elevations within the RSA and 20% were from elevations lower than the RSA (Appendix 2). It is likely that the eagles may have been flying for longer periods within the revised RSA height of between 40 and 152 m. However, given the difference is only 17 m, the flying time within RSA height is unlikely to change substantially and affect the overall conclusions.

Apart from those species with observation numbers that are too low to draw valid statistical results, such as Fairy Martin, White-backed Swallow and Black-shouldered Kite, this species was recorded as occurring within RSA elevations more than any other species. This can to some extent be accounted for by observations made of distant birds flying over valley areas outside of the formal census plots as is the case for the Nankeen Kestrel. Nevertheless, in contrast to most species observed over elevated areas, Wedge-tailed Eagles were observed to fly at generally higher altitudes with 51% of observations exceeding the RSA. This is likely due to the eagle's size and therefore dependence upon the prevailing winds to aid its soaring flight habits.

Despite its higher elevation flight patterns local Wedge-tailed Eagles are sedentary individuals, which are likely to have a detailed knowledge of local landscape features and it is considered likely that local birds would easily avoid turbine collisions. Being a diurnal species with no known nocturnal habitats it is unlikely that there would be periods where the turbines might be unsighted by individuals, apart from foggy mornings during which birds are not likely to be active, due to the lack of wind.

There is a possibility, given their generally more elevated flying patterns over the Koodiwoodie Range, that young of this species might collide with turbines on rare occasions. However, based on the generally low densities that occur in the area and probability that local individuals will tend to avoid turbines, combined with the common and secure status of this species in the locality, the level of risk to the species is considered to be greater than low, but not sufficient to be considered of moderate significance.

3.7.5 Potential Cumulative Impacts from other Wind Farm Proposals

In the wider regional context there are four other wind farm projects of relevance. The first is an existing wind farm at Emu Downs, some 12 km to the north-north-west of the

proposed Waddi wind farm development. The other three are proposed wind farm developments. These include the proposed Badgingarra wind farm to the north of the existing Emu Downs wind farm, the Yandin wind farm on the Koodiwoodie Range some 9.5 km to the south-east and another at Nilgen some 30 km to the south-west of the proposed Waddi wind farm.

Three of these other wind projects occur in a more westerly context to the current proposal and are situated upon rises in the coastal strip between the near coastal dune system and the Koodiwoodie Range. The fourth is situated on the Koodiwoodie Range in a similar topographical context to the proposed Waddi wind farm.

Potential impacts within each of these sites are likely to primarily involve local bird populations occurring in the vicinity of each development due to the limited likelihood of significant bird movements through the general area. The proposed Waddi wind farm is unlikely to act together with any of these proposed developments to represent a significant cumulative impact upon regional bird movements. This is due to the Waddi wind farm's eastern location inland of likely migratory wading bird exchanges between western lakes such as Guraga Lake and near coastal lake systems further west.

The respective north to south alignments of both coastal and easterly drainage basin wetland habitats is likely to provide natural movement corridors for truly migratory species due to the continuity of potential stopover opportunities that these north to south habitat linkages represent. As such, there are no known important migratory bird movements that might traverse the proposed Waddi wind farm and any other wind farm proposal in the region. There is the potential for intermittent east to west movements by resident waterbirds in response to inland inundation events, but these are considered to represent rare occurrences and would not require movement across multiple wind farm developments due to their staggered spread in a latitudinal sense.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The avian surveys conducted within the proposed wind farm site and over a large area of the Koodiwoodie range and the surrounding locality in the Dandaragan Shire Council area, indicate that the avifauna of the site are predominantly common bird species. The open country (cleared) locations selected for wind turbine sitings are of relatively low habitat value for birds, with greatest species diversity associated with areas of structurally diverse native vegetation. Surveys observed limited numbers of avian species in habitats associated with ridge-top turbine locations.

Species observed which are listed under state and Commonwealth schedules, including migratory species, were found to primarily frequent or move through/between lowland areas where more suitable habitat for these species occurs. Local flyway orientations were considered unlikely to traverse the proposed wind farm location, due to the general north-south alignment of drainage basins and coastal wetlands, although the potential for some intermittent east to west bird movements may exist, due to the temporary nature of regional wetlands in response to periodic inundations, particularly those in the east.

During the period surveyed, most species appear to fly at lower elevations in relation to the ground over ridge-top areas to avoid the strong westerly winds that characterise the site on a daily basis. In contrast to this general trend in flight behaviour, one species, the Wedge-tailed Eagle, was often observed at elevations much higher than the RSA, which is likely attributable to their dependence upon high winds to stay aloft.

Assessment of all avian species potentially occurring within the site concluded that no bird species is considered to be at risk of a significant adverse impact by the proposed wind farm, either in isolation or through cumulative effects from the existing and currently proposed wind farms in the region. The wind turbines were unlikely to have a significant impact on avifauna in the area of interest, as the majority of species tended to be low flying, or concentrated in lower valleys and heathlands where turbines would not be located. All turbines will be located within cleared paddocks, and the extent of potential clearing of vegetation will be minimal, making it unlikely that loss of habitat will have a significant impact on any of the avifauna species on the site.

Specially Protected and Threatened Species were targeted during the surveys, and the Carnaby's Black-Cockatoo and the Peregrine Falcon were identified, however both of these species were located outside the formal census plots and are unlikely to be significantly impacted by the proposed wind farm development. The Carnaby's Black-Cockatoo is likely to forage and roost in woodlands and tall heathland near to their food sources such as Banksia and Marri seeds. The Peregrine Falcon is a high flying species and unlikely to occur within the RSA.

The following recommendations have been outlined to ensure that the ecological impact of the proposed wind farm is minimised as far as possible:

- Power lines between turbines should be constructed underground and along road infrastructure to minimise number of easements through the area and further incidents of potential avian collisions (including the creation of perching locations in the vicinity of turbines).

- A post-construction bird monitoring program, such as that described by Auswind (2005) should be established to determine the impacts of the project on bird populations. Such data may prove invaluable for assessing the impacts of future wind farms within the Region and elsewhere within Australia.

- Constructional and operational phases of the development should be in line with the Best Practice Guidelines for Wind Energy Projects (Auswind 2005), including the implementation of an Environmental Management Plan (EMP) and a Construction Management Plan (CMP).

- Vegetation and associated habitat loss is kept at a minimum through careful planning of cable and access road alignments.

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APPENDIX I

Avifauna Species List

APPENDIX 1: Avian Species List

Below is a list of avifauna species that could be *reasonably* expected to be found within the study area at some occurrence. Such an approach has been taken given the low probability of recording *all* potentially occurring species within an area during formal fauna surveys (due to seasonality, climatic limitations, crypticism, etc).

Family sequencing and taxonomy follow for each fauna class:

Birds – Christidis and Boles (2009)

Appendix Key: ✓ = Species Detected
* = Introduced species
(E) = Species listed under *EPBC Act 1999* as Endangered.
(R) = Species listed under WA *WC Act 1950* as Rare.
(O) = Species listed under WA *WC Act 1950* as Other Specially Protected Fauna
(M*) = Species listed under the Commonwealth EPBC Act as Migratory
(C) = Species listed under CAMBA
(J) = Species listed under JAMBA

Data Source: **W** = Species recorded within Waddi formal census
Y = Species recorded within Yandin formal census
R = Species recorded within representative plots
✓ = observed

Known and Expected Bird List

Family Name	Scientific Name	Common Name	W	Y	R
Casuariidae (Emu)	*Dromaius novaehollandiae*	Emu			
Phasianidae (True Quails, Pheasants and Fowls)	*Coturnix pectoralis*	Stubble Quail	✓	✓	✓
	Coturnix ypsilophora	Brown Quail			
Anatidae (Swans, Geese and Ducks)	*Oxyura australis*	Blue-billed Duck (M*)			
	Biziura lobata	Musk Duck (M*)			✓
	Cygnus atratus	Black Swan (M*)			✓
	Tadorna tadornoides	Australian Shelduck (M*)			✓
	Chenonetta jubata	Australian Wood Duck (M*)		✓	✓
	Anas platyrhynchos	*Northern Mallard (M*)			
	Anas rhynchotis	Australasian Shoveler (M*)			✓
	Anas superciliosa	Pacific Black Duck (M*)			✓
	Anas gracilis	Grey Teal (M*)		✓	✓

Family Name	Scientific Name	Common Name	W	Y	R
	Anas castanea	Chestnut Teal (M*)			
	Malacorhynchus membranaceus	Pink-eared Duck (M*)			
	Aytha australis	Hardhead (M*)			
Podicipedidae (Grebes)	*Tachybaptus novaehollandiae*	Australasian Grebe			
	Poliocephalus poliocephalus	Hoary-headed Grebe			
	Podiceps cristatus	Great Crested Grebe			
Anhingidae (Darters)	Anhinga novaehollandiae	Australasian Darter			
Phalacrocoracidae (Cormorants)	Phalacrocorax carbo	Great Cormorant			
	Microcarbo melanoleucos	Little Pied Cormorant			
	Phalacrocorax sulcirostris	Little Black Cormorant			
	Phalacrocorax varius	Pied Cormorant			
Pelecanide (Pelicans)	*Pelecanus conspicillatus*	Australian Pelican			✓
Ardeidae (Herons, Bitterns and Egrets)	*Ardea pacifica*	White-necked Heron			
	Egretta novaehollandiae	White-faced Heron		✓	✓
	Egretta garzetta	Little Egret (J)			✓
	Ardea modesta	Great Egret (C,J, M*)			
	Nycticorax caledonicus	Nankeen Night Heron			
Threskiornithidae (Ibises and Spoonbills)	*Plegadis falcinellus*	Glossy Ibis (C, M*)			
	Threskiornis molucca	Australian White Ibis			✓
	Threskiornis spinicollis	Straw-necked Ibis	✓	✓	✓
	Platalea flavipes	Yellow-billed Spoonbill			
Accipitridae (Hawks, Kites and Eagles)	*Pandion cristatus*	Osprey			
	Elanus axillaris	Black-shouldered Kite (M*)	✓	✓	
	Lophoictinia isura	Square-tailed Kite (M*)			
	Haliastur sphenurus	Whistling Kite (M*)			✓
	Haliaeetus leucogaster	White-bellied Sea-Eagle (C, M*)			✓
	Circus assimilis	Spotted Harrier (M*)			
	Circus approximans	Swamp Harrier (M*)			
	Accipiter fasciatus	Brown Goshawk (M*)		✓	
	Accipiter cirrhocephalus	Collared Sparrowhawk (M*)	✓		✓
	Aquila audax	Wedge-tailed Eagle (M*)	✓	✓	✓
	Hieraaetus morphnoides	Little Eagle (M*)			

Family Name	Scientific Name	Common Name	W	Y	R
Falconidae (Falcons)	*Falco berigora*	Brown Falcon (M*)	✓	✓	
	Falco longipennis	Australian Hobby (M*)		✓	✓
	Falco peregrinus	Peregrine Falcon (M* O)			
	Falco cenchroides	Nankeen Kestrel (M*)	✓	✓	✓
Rallidae (Crakes, Rails and Gallinules)	*Fulica atra*	Eurasian Coot			
	Porzana tabuensis	Spotless Crake			
	Porphyrio porphyrio	Purple Swamphen			
	Tribonyx ventralis	Black-tailed Native-hen			
Otididae (Bustards)	*Ardeotis australis*	Australian Bustard			
Turnicidae (Button-Quails)	*Turnix velox*	Little Button-quail			
	Turnix varius	Painted Button-quail			
	Turnix pyrhothorax	Red-chested Button-quail			
Scolopacidae (Snipe, Godwits, Curlews, Sandpipers, Stints & Phalaropes)	*Limosa limosa*	Black-tailed Godwit (M*,C)			
	Limosa lapponica	Bar-tailed Godwit (M*,C)			
	Numenius minutes	Little Curlew (M*)			
	Tringa nebularia	Common Greenshank (M*,C)			
	Tringa glareola	Wood Sandpiper (M*,C)			
	Actitis hypoleucos	Common Sandpiper (M*,C)			
	Tringa brevipes	Grey-tailed Tattler (M*,C)			
	Arenaria interpres	Ruddy Turnstone (M*,C)			
	Calidris tenuirostris	Great Knot (M*,C)			
	Calidris canutus	Red Knot (M*,C)			
	Calidris alba	Sanderling (M*,C)			
	Calidris ruficollis	Red-necked Stint (M*,C)			✓
	Calidris subminuta	Long-toed Stint (M*,C)			
	Calidris acuminata	Sharp-tailed Sandpiper (M*,C)			
	Calidris ferruginea	Curlew Sandpiper (M*,C)			
Haematopodidae (Oystercatchers)	*Haematopus longirostris*	Australian Pied Oystercatcher			
Recurvirostridae (Stilts & Avocets)	*Himantopus himantopus*	Black-winged Stilt (M*)			✓
	Cladorhynchus leucocephalus	Banded Stilt			
	Recurvirostra novaehollandiae	Red-necked Avocet (M*)			✓

Family Name	Scientific Name	Common Name	W	Y	R
Charadriidae (Lapwings, Plovers and Dottrels)	*Pluvialis squatarola*	Grey Plover (M*,C)			
	Charadrius ruficapillus	Red-capped Plover (M*)			✓
	Charadrius mongolus	Lesser Sand Plover (M*,C)			
	Erythrogonys cinctus	Red-kneed Dotterel (M*)			
	Elseyornis melanops	Black-fronted Dotterel (M*)			
	Vanellus tricolor	Banded Lapwing (M*)	✓		
Laridae (Gulls and Terns)	*Chroicoephalus novaehollandiae*	Silver Gull			✓
	Larus pacificus	Pacific Gull			
	Chlidonias hybridus	Whiskered Tern			
	Hydroprogne caspia	Caspian Tern (M*,C)			
	Gelochelidon nilotica	Gull-billed Tern			✓
	Thalasseus bergii	Crested Tern			
		Roseate Tern			
		Fairy Tern			
		Little Tern			
		Bridled Tern			
	Sterna hirundo	Common Tern (M*,C)			
	Sternula albifrons	Little Tern (M*,C)			
Columbidae (Pigeons and Doves)	**Columba livia*	Rock Dove			
	Streptopelia senegalensis	Laughing Turtle Dove			
	Ocyphaps lophotes	Crested Pigeon	✓	✓	✓
	Phaps chalcoptera	Common Bronzewing	✓	✓	✓
	Phaps elegans	Brush Bronzewing			
Cacatuidae (Cockatoos)	*Calyptorhynchus banksii*	Red-tailed Black-Cockatoo			
	Calyptorhynchus latirostris	Carnaby's Black-Cockatoo (R, E)	✓	✓	✓
	Eolophus roseicapillus	Galah	✓	✓	✓
	Cacatua tenuirostris	Long-billed Corella			
	Cacatua pastinator derbyi	Western Corella (Northern)	✓	✓	✓
	Cacatua sanguinea	Little Corella			
Psittacidae (Parrots)	*Glossopsitta porphyrocephala*	Purple-crowned Lorikeet			
	Polytelis anthopeplus	Regent Parrot			
	Platycercus icterotis	Western Rosella			
	Barnardius zonarius	Australia Ringneck	✓	✓	✓
	Melopsittacus undulatus	Budgerigar			
	Neophema petrophila	Rock Parrot			

Family Name	Scientific Name	Common Name	W	Y	R
Cuculidae (Old World Cuckoos)	*Chrysococcyx osculans*	Black-eared Cuckoo			
	Cacomantis flabelliformis	Fan-tailed Cuckoo			
	Chalcites basalis	Horsfield's Bronze-Cuckoo	✓	✓	✓
	Chalcites lucidus	Shining Bronze-Cuckoo		✓	
	Cacomantis pallidus	Pallid Cuckoo			
Strigidae (Hawk Owls)	*Ninox boobook*	Southern Boobook			
Tytonidae (Barn Owls)	*Tyto javanica*	Barn Owl			
Podargidae (Frogmouths)	*Podargus strigoides*	Tawny Frogmouth			
Aegothelidae (Owlet-nightjars)	*Aegotheles cristatus*	Australian Owlet-nightjar			
Apodidae (Typical Swifts)	*Apus pacificus*	Fork-tailed Swift (M*,C)			
Halcyonidae (Kingfishers and Kookaburras)	*Dacelo novaeguineae*	Laughing Kookaburra		✓	✓
	Todiramphus sanctus	Sacred Kingfisher		✓	✓
Meropidae (Bee-eaters)	*Merops ornatus*	Rainbow Bee-eater (M*)	✓	✓	✓
Maluridae (Fairy-Wrens and Emu-Wrens)	*Malurus splendens*	Splendid Fairy-wren	✓	✓	✓
	Malurus lamberti	Variegated Fairy-wren		✓	
	Malurus pulcherrimus	Blue-breasted Fairy-wren			
	Malurus leucopterus	White-winged Fairy-wren	✓	✓	✓
	Stipiturus malachurus	Southern Emu-wren (M*)			
Pardalotidae (Pardalotes, Scrubwrens, Thornbills)	*Pardalotus punctatus*	Spotted Pardalote			
	Paradalotus striatus	Striated Pardalote		✓	
	Sericornis frontalis	White-browed Scrubwren	✓		
	Hylacola cauta	Shy Heathwren			
	Calamanthus campestris	Rufous Fieldwren	✓	✓	
	Pyrrholaemus brunneus	Redthroat			
	Smicrornis brevirostris	Weebill		✓	
	Gerygone fusca	Western Gerygone		✓	✓
	Acanthiza apicalis	Inland Thornbill		✓	
	Acanthiza uropygialis	Chestnut-rumped Thornbill			
	Acanthiza inornata	Western Thornbill		✓	
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	✓	✓	✓

Family Name	Scientific Name	Common Name	W	Y	R
Meliphagidae (Honeyeaters)	*Anthochaera carunculata*	Red Wattlebird		✓	
	Anthochaera lunulata	Western Wattlebird			
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater			
	Manorina flavigula	Yellow-throated Miner		✓	✓
	Lichenostomus virescens	Singing Honeyeater	✓	✓	✓
	Lichenostomus leucotis	White-eared honeyeater			
	Lichenostomus penicillatus	White-plumed Honeyeater			
	Lichenostomus ornatus	Yellow-plumed Honeyeater			
	Melithreptus brevirostris	Brown-headed Honeyeater		✓	
	Melithreptus lunatus	White-naped Honeyeater			
	Lichmera indistincta	Brown Honeyeater	✓	✓	✓
	Phylidonyris novaehollandiae	New Holland Honeyeater			
	Phylidonyris niger	White-cheeked Honeyeater	✓	✓	✓
	Glyciphila melanops	Tawny-Crowned Honeyeater	✓		✓
	Acanthorhynchus superciliosus	Western Spinebill			
	Certhionyx niger	Black Honeyeater	✓		✓
	Epthianura tricolor	Crimson Chat	✓		✓
	Epthianura aurifrons	Orange Chat			
	Epthianura albifrons	White-fronted Chat	✓	✓	✓
Eopsaltriidae (Robins)	*Petroica boodang*	Scarlet Robin			
	Petroica goodenovii	Red-capped Robin		✓	✓
	Melanodryas cucullata	Hooded Robin	✓		
	Eopsaltria griseogularis	Western Yellow Robin			
	Eopsaltria georgiana	White-breasted Robin			
Pomatostomidae (Australo-Papuan Babblers)	*Pomatostomus superciliosus*	White-browed Babbler			
Neosittidae (Sittellas)	*Daphoenositta chrysoptera*	Varied Sittella		✓	
	Oreoica gutturalis	Crested Bellbird			
Pachycephalidae (Whistlers, Shrike-tit, Shrike-thrushes)	*Pachycephala pectoralis*	Golden Whistler			
	Pachycephala rufiventris	Rufous Whistler	✓	✓	✓
	Colluricincla harmonica	Grey Shrike-thrush		✓	✓
Dicruridae (Monarchs, Fantails and Drongo)	*Myiagra inquieta*	Restless Flycatcher			
	Grallina cyanoleuca	Magpie-lark	✓	✓	✓

Family Name	Scientific Name	Common Name	W	Y	R
	Rhipidura albiscarpa	Grey Fantail		✓	
	Rhipidura leucophyrs	Willie Wagtail	✓	✓	✓
Campephagidae (Cuckoo-shrikes and Trillers)	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	✓	✓	✓
	Lalage sueurii	White-winged Triller	✓	✓	✓
Artamidae (Woodswallows, Butcherbirds, Currawongs)	*Artamus*	Masked Woodswallow			
	Artamus cinereus	Black-faced Woodswallow	✓	✓	✓
	Artamus cyanopterus	Dusky Woodswallow			
	Cracticus torquatus	Grey Butcherbird	✓	✓	✓
	Cracticus nigrogularis	Pied Butcherbird		✓	
	Cracticus tibicen	Australian Magpie	✓	✓	✓
	Strepera versicolor	Grey Currawong			
Corvidae (Crows and allies)	*Corvus coronoides*	Australian Raven	✓	✓	✓
	Corvus bennetti	Little Crow			
Motacillidae (Old World Wagtails,Pipits)	*Anthus novaeseelandiae*	Australasian (Richard's) Pipit	✓	✓	✓
Passeridae (Sparrows, Weaverbirds, Waxbills)	*Taeniopygia guttata*	Zebra Finch			✓
Dicaeidae (Flowerpeckers)	*Dicaeum hirundinaceum*	Mistletoebird			✓
Hirundinidae (Swallows and Martins)	*Cheramoeca leucosterna*	White-Backed Swallow		✓	✓
	Hirundo neoxena	Welcome Swallow	✓	✓	✓
	Petrochelidon nigricans	Tree Martin	✓	✓	✓
	Petrochelidon ariel	Fairy Martin	✓		
Sylviidae (Old World Warblers)	*Acrocephalus australis*	Clamorous Reed Warbler			
	Megalurus gramineus	Little Grassbird			✓
	Megalurus timorensis	Tawny Grassbird			
	Cincloramphus cruralis	Brown Songlark	✓	✓	✓
	Cincloramphus mathewsi	Rufous Songlark	✓	✓	
Zosteropidae (White-eyes)	*Zosterops lateralis*	Silvereye	✓	✓	✓

RPS

APPENDIX 2

Waddi Species Elevation Records

APPENDIX 2: Waddi Species Elevation Records

Waddi Species Seen		1 ha Site Survey Plots												1 Ha Reference and Yandin Plots												Totals			
		n Within 1Ha Plots				*n* Outside 1ha Plots				% within Site Survey Plots				*n* Within 1Ha Reference Plots				*n* Outside 1ha Reference Plots				% within Reference Plots							
Scientific Name	**Common Name**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	***N***	**Total % in 1**	**Total % in 2**	**Total % in 3**
Tadorna tadornoides	Australian Shelduck	0	0	0	0	0	0							5	0	0	4503	1	0	100	0	0	100	0	0				
Cygnus atratus	Black Swan	0	0	0	0	0	0							0	0	0	1633	0	0				100	0	0				
Cacatua pastinator	Western Corella	0	0	0	7	0	0				100	0	0	127	0	0	726	41	0	100	0	0	95	5	0	7	100	0	0
Cacatua roseicapilla	Galah	65	2	0	86	101	0	97	3	0	46	54	0	94	0	0	110	0	0	100	0	0	100	0	0	254	59	41	0
Corvus coronoides	Australian Raven	3	0	0	66	45	5	100	0	0	57	39	4	23	3	0	273	3	6	88	12	0	97	1	2	119	58	38	4
Banardius zonarius	Australian Ringneck	22	5	0	19	0	0	81	19	0	100	0	0	209	0	0	119	0	0	100	0	0	100	0	0	46	89	11	0
Threskiornis spinicollis	Straw-necked Ibis	13	13	0	13	13	13	50	50	0	33	33	33	1	0	0	281	4	15	100	0	0	94	1	5	65	40	40	20
Cincloramphus cruralis	Brown Songlark	124	38	0	37	7	0	77	23	0	84	16	0	17	0	0	13	0	0	100	0	0	100	0	0	206	78	22	0
Hirundo nigricans	Tree Martin	16	0	0	0	0	0	100	0	0				8	0	0	189	0	0	100	0	0	100	0	0	16	100	0	0
Gymnorhina tibicen	Australian Magpie	6	0	0	32	20	4	100	0	0	57	36	7	37	0	0	99	0	0	100	0	0	100	0	0	62	61	32	6
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	47	0	0	13	0	0	100	0	0	100	0	0	124	0	0	10	0	0	100	0	0	100	0	0	60	100	0	0
Charadrius ruficapillus	Red-Capped Plover	0	0	0	0	0	0							8	0	0	171	0	0	100	0	0	100	0	0				
Anas rhynchotis	Australasian Shoveler	0	0	0	0	0	0							0	0	0	154	0	0				100	0	0				
Anas gracilis	Grey Teal	0	0	0	0	0	0							1	0	0	118	0	0	100	0	0	100	0	0				
Grallina cyanoleuca	Australian Magpie-lark	13	0	0	18	2	0	100	0	0	90	10	0	25	0	0	56	0	0	100	0	0	100	0	0	33	94	6	0
Anthus novaeseelandiae	Australian Pipit	34	4	0	19	1	0	89	11	0	95	5	0	24	1	0	22	0	0	96	4	0	100	0	0	58	91	9	0
Calidris ruficollis	Red-Necked Stint	0	0	0	0	0	0							20	0	0	84	0	0	100	0	0	100	0	0				
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	2	3	0	22	9	0	40	60	0	71	29	0	12	0	0	52	0	0	100	0	0	100	0	0	36	67	33	0
Hirundo neoxena	Welcome Swallow	15	0	0	4	1	0	100	0	0	80	20	0	50	0	0	29	0	0	100	0	0	100	0	0	20	95	5	0
Himantopus himantopus	Black-Winged Stilt	0	0	0	0	0	0							84	0	0	14	0	0	100	0	0	100	0	0				
Artamus cinerius	Black-faced Woodswallow	42	0	0	11	2	0	100	0	0	85	15	0	22	0	0	19	0	0	100	0	0	100	0	0	55	96	4	0
Lichmera indistincta	Brown Honeyeater	0	0	0	5	0	0				100	0	0	58	0	0	22	0	0	100	0	0	100	0	0	5	100	0	0
Coturnix pectoralis	Stubble Quail	26	0	0	43	0	0	100	0	0	100	0	0	10	0	0	5	0	0	100	0	0	100	0	0	69	100	0	0
Aquila audax	Wedge-tailed Eagle	2	2	0	3	6	7	50	50	0	19	38	44	0	0	0	13	14	35				21	23	56	20	25	40	35
Phylidonyris nigra	White-cheeked Honeyeater	14	0	0	17	0	0	100	0	0	100	0	0	32	0	0	14	0	0	100	0	0	100	0	0	31	100	0	0
Falco cenchroides	Nankeen Kestrel	7	0	0	9	5	0	100	0	0	64	36	0	13	2	0	26	7	1	87	13	0	76	21	3	21	76	24	0
Malurus leucopterus	White-winged Fairy Wren	5	0	0	15	0	0	100	0	0	100	0	0	26	0	0	13	0	0	100	0	0	100	0	0	20	100	0	0
Rhipidua leucophrys	Willie Wagtail	13	0	0	8	0	0	100	0	0	100	0	0	25	0	0	7	0	0	100	0	0	100	0	0	21	100	0	0
Larus novaehollandiae	Silver Gull	0	0	0	0	0	0							35	0	0	15	0	0	100	0	0	100	0	0	0			
Epthianura albifrons	White-fronted Chat	17	0	0	17	0	0	100	0	0	100	0	0	10	0	0	6	0	0	100	0	0	100	0	0	34	100	0	0
Zosterops lateralis	Silvereye	9	0	0	4	0	0	100	0	0	100	0	0	23	0	0	13	0	0	100	0	0	100	0	0	13	100	0	0

Waddi Species Seen		1 ha Site Survey Plots												1 Ha Reference and Yandin Plots												Totals			
		n Within 1Ha Plots				*n* Outside 1ha Plots				% within Site Survey Plots				*n* Within 1Ha Reference Plots				*n* Outside 1ha Reference Plots				% within Reference Plots							
Scientific Name	**Common Name**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	***N***	**Total % in 1**	**Total % in 2**	**Total % in 3**
Malurus leucopterus	Splendid Fairy-wren	13	0	0	6	0	0	100	0	0	100	0	0	18	0	0	7	0	0	100	0	0	100	0	0	19	100	0	0
Pachycephala rufiventris	Rufous Whistler	3	0	0	4	0	0	100	0	0	100	0	0	17	0	0	19	0	0	100	0	0	100	0	0	7	100	0	0
Coracina novaehollandiae	Black-faced Cuckoo-Shrike	4	0	0	2	0	0	100	0	0	100	0	0	21	3	0	11	0	0	88	13	0	100	0	0	6	100	0	0
Merops ornatus	Rainbow Bee-eater	11	0	0	9	0	0	100	0	0	100	0	0	14	0	0	4	0	0	100	0	0	100	0	0	20	100	0	0
Cracticus torquatus	Grey Butcherbird	1	0	0	8	0	0	100	0	0	100	0	0	7	0	0	16	0	0	100	0	0	100	0	0	9	100	0	0
Lichenostomus virescens	Singing Honeyeater	3	0	0	6	0	0	100	0	0	100	0	0	13	0	0	7	0	0	100	0	0	100	0	0	9	100	0	0
Ocyphaps lophotes	Crested Pigeon	2	0	0	1	0	0	100	0	0	100	0	0	14	0	0	11	0	0	100	0	0	100	0	0	3	100	0	0
Gerygone fusca	Western Gerygone	0	0	0	0	0	0							16	0	0	8	0	0	100	0	0	100	0	0	0			
Calamanthus campestris	Rufous Fieldwren	8	0	0	11	0	0	100	0	0	100	0	0	2	0	0	1	0	0	100	0	0	100	0	0	19	100	0	0
Lalage sueurii	White-Winged Triller	3	0	0	1	0	0	100	0	0	100	0	0	9	0	0	3	0	0	100	0	0	100	0	0	4	100	0	0
Biziura lobata	Musk Duck	0	0	0	0	0	0							0	0	0	16	0	0				100	0	0	0			
Phylidonyris melanops	Tawny-crowned Honeyeater	2	0	0	5	0	0	100	0	0	100	0	0	4	0	0	4	0	0	100	0	0	100	0	0	7	100	0	0
Malurus lamberti	Variegated Fairy-Wren	0	0	0	0	0	0							7	0	0	7	0	0	100	0	0	100	0	0	0			
Chenonetta jubata	Australian Wood Duck	0	0	0	0	0	0							6	0	0	7	0	0	100	0	0	100	0	0	0			
Acanthiza apicalis	Inland Thornbill	0	0	0	0	0	0							12	0	0	0	0	0	100	0	0				0			
Taeniopygia guttata	Zebra Finch	0	0	0	0	0	0							4	0	0	7	0	0	100	0	0	100	0	0	0			
Manorina flavigula	Yellow-Throated Miner	0	0	0	0	0	0							6	0	0	4	0	0	100	0	0	100	0	0	0			
Certhionyx niger	Black Honeyeater	4	0	0	0	0	0	100	0	0				3	0	0	2	0	0	100	0	0	100	0	0	4	100	0	0
Dacelo novaeguineae	Laughing Kookaburra	0	0	0	0	0	0							3	0	0	5	0	0	100	0	0	100	0	0	0			
Cincloramphus mathewsi	Rufous Songlark	0	0	0	4	0	0				100	0	0	0	0	0	3	0	0				100	0	0	4	100	0	0
Colluricincla harmonica	Grey Shrike-Thrush	0	0	0	0	0	0							5	0	0	2	0	0	100	0	0	100	0	0	0			
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo	1	0	0	0	0	0	100	0	0				4	0	0	1	0	0	100	0	0	100	0	0	1	100	0	0
Pelecanus conspicillatus	Australian Pelican	0	0	0	0	0	0							0	0	0	6	0	0				100	0	0	0			
Vanellus tricolor	Banded Lapwing	0	0	0	5	0	0				100	0	0	0	0	0	0	0	0							5	100	0	0
Phaps chalcoptera	Common Bronzewing	2	0	0	0	0	0	100	0	0				2	0	0	1	0	0	100	0	0	100	0	0	2	100	0	0
Epthianura tricolor	Crimson Chat	3	0	0	0	0	0	100	0	0				0	0	0	2	0	0				100	0	0	3	100	0	0
Todiramphus sanctus	Sacred Kingfisher	0	0	0	0	0	0							1	0	0	3	0	0	100	0	0	100	0	0	0			
Egretta novaehollandiae	White-faced Heron	0	0	0	0	0	0							3	0	0	1	0	0	100	0	0	100	0	0	0			
Acanthiza inornata	Western Thornbill	0	0	0	0	0	0							4	0	0	0	0	0	100	0	0				0			
Daphoenositta chrysoptera	Varied Sittella	0	0	0	0	0	0							4	0	0	0	0	0	100	0	0				0			
Cheramoeca leucosternus	White-backed Swallow	0	0	0	0	0	0							2	0	0	0	2	0	100	0	0	0	100	0	0			
Falco berigora	Brown Falcon	0	0	0	1	2	0				33	67	0	0	0	0	0	1	0				0	100	0	3	33	67	0
Purpureicephalus spurius	Red-Capped Parrot	0	0	0	0	0	0							1	0	0	2	0	0	100	0	0	100	0	0	0			

Waddi Species Seen		1 ha Site Survey Plots												1 Ha Reference and Yandin Plots												Totals			
		n Within 1Ha Plots				*n* Outside 1ha Plots		% within Site Survey Plots						*n* Within 1Ha Reference Plots				*n* Outside 1ha Reference Plots				% within Reference Plots							
Scientific Name	**Common Name**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	***N***	**Total % in 1**	**Total % in 2**	**Total % in 3**
Chrysococcyx lucidus	Shining Bronze-Cuckoo	0	0	0	0	0	0							2	0	0	1	0	0	100	0	0	100	0	0	0			
Anthochaera carunculata	Red Wattlebird	0	0	0	0	0	0							0	0	0	3	0	0				100	0	0	0			
Haliastur sphenurus	Whistling Kite	0	0	0	0	0	0							0	0	0	2	0	0				100	0	0	0			
Accipiter cirrhocephalus	Collared Sparrowhawk	0	0	0	1	0	0				100	0	0	0	0	0	1	0	0				100	0	0	1	100	0	0
Accipiter fasciatus	Brown Goshawk	0	0	0	0	0	0							0	0	0	2	0	0				100	0	0	0			
Falco lonipennis	Australian Hobby	1	0	0	0	0	0	100	0	0				0	0	0	1	0	0				100	0	0	1	100	0	0
Recurvirostra novaehollandiae	Red-Necked Avocet	0	0	0	0	0	0							0	0	0	2	0	0				100	0	0	0			
Pardalotus striatus	Striated Pardalote	0	0	0	0	0	0							1	0	0	1	0	0	100	0	0	100	0	0	0			
Sericornis frontalis	White-Browed Scrubwren	2	0	0	0	0	0	100	0	0				0	0	0	0	0	0							2	100	0	0
Smicrornis brevirostris	Weebill	0	0	0	0	0	0							2	0	0	0	0	0	100	0	0				0			
Petroica goodenovii	Red-Capped Robin	0	0	0	0	0	0							2	0	0	0	0	0	100	0	0				0			
Melanodryas cucullata	Hooded Robin	0	0	0	0	0	0							2	0	0	0	0	0	100	0	0				0			
Elanus axillaris	Black-Shouldered Kite	0	0	0	0	1	0				0	100	0	0	0	0	0	1	0				0	100	0	1	0	100	0
Anas superciliosa	Pacific Black Duck	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	0			
Egretta garzetta	Little Egret	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	0			
Threskiornis molucca	Australian White Ibis	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	0			
Haliaeetus leucogaster	White-Bellied Sea-Eagle	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	0			
Sterna nilotica	Gull-Billed Tern	0	0	0	0	0	0							1	0	0	0	0	0	100	0	0				0			
Melithriptus brevirostris	Brown-Headed Honeyeater	0	0	0	0	0	0							1	0	0	0	0	0	100	0	0				0			
Rhipidura fuliginosa	Grey Fantail	0	0	0	0	0	0							1	0	0	0	0	0	100	0	0				0			
Cracticus nigrogularis	Pied Butcherbird	0	0	0	0	0	0							1	0	0	0	0	0	100	0	0				0			
Dicaeum hirundinaceum	Mistletoebird	0	0	0	0	0	0							1	0	0	0	0	0	100	0	0				0			
Megalurus gramineus	Little Grassbird	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	0			
Hirundo ariel	Fairy Martin	0	1	0	0	0	0	0	100	0				0	0	0	0	0	0							1	0	100	0

RPS

APPENDIX 3

Total Species Elevation Records

APPENDIX 3: Total Species Elevation Records

Total Species Seen Across All Formal Sites		1 ha Site Survey Plots												1 Ha Reference Plots										Totals			
		n Within 1Ha Plots				*n* Outside 1ha Plots				% within Site Survey Plots				*n* Within 1Ha Reference Plots				*n* Outside 1ha Reference Plots				% within Reference Plots							
Scientific Name	**Common Name**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**N**	**Total % in 1**	**Total % in 2**	**Total % in 3**
Tadorna tadornoides	Australian Shelduck	0	0	0	0	0	0							5	0	0	4503	1	0	100	0	0	100	0	0	4509	100	0	0
Cygnus atratus	Black Swan	0	0	0	0	0	0							0	0	0	1633	0	0							1633	100	0	0
Cacatua pastinator	Western Corella	25	0	0	113	41	0							102	0	0	620	0	0							901	95	5	0
Cacatua roseicapilla	Galah	138	2	0	150	101	0							21	0	0	46	0	0							458	78	22	0
Corvus coronoides	Australian Raven	16	3	0	201	48	11	84	16	0				10	0	0	138	0	0	100	0	0				427	85	12	3
Banardius zonarius	Australian Ringneck	192	5	0	104	0	0							39	0	0	34	0	0							374	99	1	0
Threskiornis spinicollis	Straw-necked Ibis	13	13	0	19	17	28							1	0	0	275	0	0							366	84	8	8
Cincloramphus cruralis	Brown Songlark	138	38	0	44	7	0	78	22	0				3	0	0	6	0	0							236	81	19	0
Hirundo nigricans	Tree Martin	23	0	0	11	0	0							1	0	0	178	0	0							213	100	0	0
Gymnorhina tibicen	Australian Magpie	39	0	0	74	20	4	100	0	0				4	0	0	57	0	0							198	88	10	2
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	107	0	0	18	0	0							64	0	0	5	0	0							194	100	0	0
Charadrius ruficapillus	Red-Capped Plover	0	0	0	0	0	0							8	0	0	171	0	0	100	0	0	100	0	0	179	100	0	0
Anas rhynchotis	Australasian Shoveler	0	0	0	0	0	0							0	0	0	154	0	0							154	100	0	0
Anas gracilis	Grey Teal	1	0	0	0	0	0							0	0	0	118	0	0							119	100	0	0
Grallina cyanoleuca	Australian Magpie-lark	28	0	0	48	2	0							10	0	0	26	0	0							114	98	2	0
Anthus novaeseelandiae	Australian Pipit	56	5	0	32	1	0				97	3	0	2	0	0	9	0	0				100	0	0	105	94	6	0
Calidris ruficollis	Red-Necked Stint	0	0	0	0	0	0							20	0	0	84	0	0							104	100	0	0
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	12	3	0	58	9	0							2	0	0	16	0	0							100	88	12	0
Hirundo neoxena	Welcome Swallow	29	0	0	10	1	0	100	0	0	91	9	0	36	0	0	23	0	0				100	0	0	99	99	1	0
Himantopus himantopus	Black-Winged Stilt	0	0	0	0	0	0							84	0	0	14	0	0							98	100	0	0
Artamus cinerius	Black-faced Woodswallow	51	0	0	19	2	0	100	0	0	90	10	0	13	0	0	11	0	0				100	0	0	96	98	2	0
Lichmera indistincta	Brown Honeyeater	47	0	0	15	0	0	100	0	0				11	0	0	12	0	0							85	100	0	0
Coturnix pectoralis	Stubble Quail	33	0	0	45	0	0	100	0	0	100	0	0	3	0	0	3	0	0	100	0	0	100	0	0	84	100	0	0
Aquila audax	Wedge-tailed Eagle	2	2	0	10	15	38							0	0	0	6	5	4							82	22	27	51
Phylidonyris nigra	White-cheeked Honeyeater	27	0	0	19	0	0							19	0	0	12	0	0							77	100	0	0
Falco cenchroides	Nankeen Kestrel	20	2	0	30	11	1							0	0	0	5	1	0							70	79	20	1
Malurus leucopterus	White-winged Fairy Wren	28	0	0	22	0	0				100	0	0	3	0	0	6	0	0							59	100	0	0
Rhipidua leucophrys	Willie Wagtail	25	0	0	9	0	0							13	0	0	6	0	0							53	100	0	0

Total Species Seen Across All Formal Sites		1 ha Site Survey Plots												1 Ha Reference Plots												Totals			
		n Within 1Ha Plots				*n* Outside 1ha Plots				% within Site Survey Plots				*n* Within 1Ha Reference Plots				*n* Outside 1ha Reference Plots				% within Reference Plots							
Scientific Name	**Common Name**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**N**	**Total % in 1**	**Total % in 2**	**Total % in 3**
Larus novaehollandiae	Silver Gull	0	0	0	0	0	0							35	0	0	15	0	0							50	100	0	0
Epthianura albifrons	White-fronted Chat	21	0	0	18	0	0	100	0	0				6	0	0	5	0	0							50	100	0	0
Zosterops lateralis	Silvereye	13	0	0	8	0	0	100	0	0	100	0	0	19	0	0	9	0	0				100	0	0	49	100	0	0
Malurus leucopterus	Splendid Fairy-wren	29	0	0	13	0	0	100	0	0	100	0	0	2	0	0	0	0	0							44	100	0	0
Pachycephala rufiventris	Rufous Whistler	14	0	0	16	0	0	100	0	0	100	0	0	6	0	0	7	0	0	100	0	0	100	0	0	43	100	0	0
Coracina novaehollandiae	Black-faced Cuckoo-Shrike	22	3	0	7	0	0	88	12	0	100	0	0	3	0	0	6	0	0	100	0	0	100	0	0	41	93	7	0
Merops ornatus	Rainbow Bee-eater	23	0	0	13	0	0	100	0	0	100	0	0	2	0	0	0	0	0							38	100	0	0
Cracticus torquatus	Grey Butcherbird	7	0	0	18	0	0	100	0	0	100	0	0	1	0	0	6	0	0	100	0	0	100	0	0	32	100	0	0
Lichenostomus virescens	Singing Honeyeater	13	0	0	10	0	0	100	0	0				3	0	0	3	0	0	100	0	0				29	100	0	0
Ocyphaps lophotes	Crested Pigeon	16	0	0	9	0	0	100	0	0	100	0	0	0	0	0	3	0	0							28	100	0	0
Gerygone fusca	Western Gerygone	9	0	0	7	0	0				100	0	0	7	0	0	1	0	0				100	0	0	24	100	0	0
Calamanthus campestris	Rufous Fieldwren	10	0	0	12	0	0	100	0	0	100	0	0	0	0	0	0	0	0							22	100	0	0
Lalage sueurii	White-Winged Triller	11	0	0	2	0	0	100	0	0	100	0	0	1	0	0	2	0	0	100	0	0				16	100	0	0
Biziura lobata	Musk Duck	0	0	0	0	0	0							0	0	0	16	0	0							16	100	0	0
Phylidonyris melanops	Tawny-crowned Honeyeater	2	0	0	5	0	0	100	0	0	100	0	0	4	0	0	4	0	0							15	100	0	0
Malurus lamberti	Variegated Fairy-Wren	7	0	0	7	0	0	100	0	0	100	0	0	0	0	0	0	0	0							14	100	0	0
Chenonetta jubata	Australian Wood Duck	6	0	0	0	0	0	100	0	0				0	0	0	7	0	0							13	100	0	0
Acanthiza apicalis	Inland Thornbill	12	0	0	0	0	0	100	0	0				0	0	0	0	0	0							12	100	0	0
Taeniopygia guttata	Zebra Finch	0	0	0	0	0	0							4	0	0	7	0	0							11	100	0	0
Manorina flavigula	Yellow-Throated Miner	5	0	0	4	0	0	100	0	0	100	0	0	1	0	0	0	0	0	100	0	0				10	100	0	0
Certhionyx niger	Black Honeyeater	4	0	0	0	0	0	100	0	0				3	0	0	2	0	0							9	100	0	0
Dacelo novaeguineae	Laughing Kookaburra	1	0	0	2	0	0	100	0	0				2	0	0	3	0	0							8	100	0	0
Cincloramphus mathewsi	Rufous Songlark	0	0	0	7	0	0				100	0	0	0	0	0	0	0	0							7	100	0	0
Colluricincla harmonica	Grey Shrike-Thrush	2	0	0	1	0	0	100	0	0				3	0	0	1	0	0							7	100	0	0
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo	4	0	0	0	0	0							1	0	0	1	0	0							6	100	0	0
Pelecanus conspicillatus	Australian Pelican	0	0	0	0	0	0							0	0	0	6	0	0							6	100	0	0
Vanellus tricolor	Banded Lapwing	0	0	0	5	0	0				100	0	0	0	0	0	0	0	0							5	100	0	0
Phaps chalcoptera	Common Bronzewing	4	0	0	0	0	0							0	0	0	1	0	0							5	100	0	0
Epthianura tricolor	Crimson Chat	3	0	0	0	0	0	100	0	0				0	0	0	2	0	0				100	0	0	5	100	0	0
Todiramphus sanctus	Sacred Kingfisher	1	0	0	2	0	0				100	0	0	0	0	0	1	0	0				100	0	0	4	100	0	0

Total Species Seen Across All Formal Sites		1 ha Site Survey Plots												1 Ha Reference Plots												Totals			
		n Within 1Ha Plots				*n* Outside 1ha Plots				% within Site Survey Plots				*n* Within 1Ha Reference Plots				*n* Outside 1ha Reference Plots				% within Reference Plots							
Scientific Name	**Common Name**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**Elevation 1**	**Elevation 2**	**Elevation 3**	**% inside Plot in 1**	**% inside Plot in 2**	**% inside Plot in 3**	**% Out of Plot in 1**	**% Out of Plot in 2**	**% Out of Plot in 3**	**N**	**Total % in 1**	**Total % in 2**	**Total % in 3**
Egretta novaehollandiae	White-faced Heron	3	0	0	0	0	0	100	0	0				0	0	0	1	0	0							4	100	0	0
Acanthiza inornata	Western Thornbill	4	0	0	0	0	0	100	0	0				0	0	0	0	0	0							4	100	0	0
Daphoenositta chrysoptera	Varied Sittella	4	0	0	0	0	0	100	0	0				0	0	0	0	0	0							4	100	0	0
Cheramoeca leucosternus	White-backed Swallow	0	0	0	0	2	0				0	100	0	2	0	0	0	0	0	100	0	0				4	50	50	0
Falco berigora	Brown Falcon	0	0	0	1	3	0							0	0	0	0	0	0							4	25	75	0
Purpureicephalus spurius	Red-Capped Parrot	1	0	0	2	0	0	100	0	0				0	0	0	0	0	0							3	100	0	0
Chrysococcyx lucidus	Shining Bronze-Cuckoo	2	0	0	1	0	0	100	0	0	100	0	0	0	0	0	0	0	0							3	100	0	0
Anthochaera carunculata	Red Wattlebird	0	0	0	3	0	0							0	0	0	0	0	0							3	100	0	0
Haliastur sphenurus	Whistling Kite	0	0	0	0	0	0							0	0	0	2	0	0				100	0	0	2	100	0	0
Accipiter cirrhocephalus	Collared Sparrowhawk	0	0	0	1	0	0							0	0	0	1	0	0							2	100	0	0
Accipiter fasciatus	Brown Goshawk	0	0	0	2	0	0				100	0	0	0	0	0	0	0	0							2	100	0	0
Falco lonipennis	Australian Hobby	1	0	0	0	0	0	100	0	0				0	0	0	1	0	0				100	0	0	2	100	0	0
Recurvirostra novaehollandiae	Red-Necked Avocet	0	0	0	0	0	0							0	0	0	2	0	0				100	0	0	2	100	0	0
Pardalotus striatus	Striated Pardalote	1	0	0	1	0	0	100	0	0	100	0	0	0	0	0	0	0	0							2	100	0	0
Sericornis frontalis	White-Browed Scrubwren	2	0	0	0	0	0							0	0	0	0	0	0							2	100	0	0
Smicrornis brevirostris	Weebill	2	0	0	0	0	0	100	0	0				0	0	0	0	0	0							2	100	0	0
Petroica goodenovii	Red-Capped Robin	1	0	0	0	0	0	100	0	0				1	0	0	0	0	0	100	0	0				2	100	0	0
Melanodryas cucullata	Hooded Robin	2	0	0	0	0	0	100	0	0				0	0	0	0	0	0							2	100	0	0
Elanus axillaris	Black-Shouldered Kite	0	0	0	0	2	0							0	0	0	0	0	0							2	0	100	0
Anas superciliosa	Pacific Black Duck	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	1	100	0	0
Egretta garzetta	Little Egret	0	0	0	0	0	0							0	0	0	1	0	0							1	100	0	0
Threskiornis molucca	Australian White Ibis	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	1	100	0	0
Haliaeetus leucogaster	White-Bellied Sea-Eagle	0	0	0	0	0	0							0	0	0	1	0	0							1	100	0	0
Sterna nilotica	Gull-Billed Tern	0	0	0	0	0	0							1	0	0	0	0	0	100	0	0				1	100	0	0
Melithriptus brevirostris	Brown-Headed Honeyeater	1	0	0	0	0	0	100	0	0				0	0	0	0	0	0							1	100	0	0
Rhipidura fuliginosa	Grey Fantail	1	0	0	0	0	0							0	0	0	0	0	0							1	100	0	0
Cracticus nigrogularis	Pied Butcherbird	1	0	0	0	0	0	100	0	0				0	0	0	0	0	0							1	100	0	0
Dicaeum hirundinaceum	Mistletoebird	0	0	0	0	0	0							1	0	0	0	0	0							1	100	0	0
Megalurus gramineus	Little Grassbird	0	0	0	0	0	0							0	0	0	1	0	0				100	0	0	1	100	0	0
Hirundo ariel	Fairy Martin	0	1	0	0	0	0	0	100	0				0	0	0	0	0	0							1	0	100	0

RPS

APPENDIX 4

Species Plot Results

APPENDIX 4: Species Plot Results

Waddi Wind Farm Results 1																																									
Species Seen		**W1**					**W2**					**W3**					**W4**					**W5**					**W6**					**W7**					**W8**				
Scientific Name	**Common Name**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**
Coturnix pectoralis	Stubble Quail			H	H		H				H				H	H					H				H			O			H					H					H
Chenonetta jubata	Australian Wood Duck																																								
Biziura lobata	Musk Duck																																								
Cygnus atratus	Black Swan																																								
Tadorna tadornoides	Australian Shelduck																																								
Anas superciliosa	Pacific Black Duck																																								
Anas rhynchotis	Australasian Shoveler																																								
Anas gracilis	Grey Teal																																								
Pelecanus conspicillatus	Australian Pelican																																								
Egretta novaehollandiae	White-faced Heron																																								
Egretta garzetta	Little Egret																																								
Threskiornis spinicollis	Straw-necked Ibis																																								
Threskiornis molucca	Australian White Ibis																																								
Elanus axillaris	Black-Shouldered Kite																																								
Haliastur sphenurus	Whistling Kite																																								
Accipiter cirrhocephalus	Collared Sparrowhawk																																								
Accipiter fasciatus	Brown Goshawk																																								
Haliaeetus leucogaster	White-Bellied Sea-Eagle																																								
Aquila audax	Wedge-tailed Eagle	O	O								O										O															O					
Falco berigora	Brown Falcon																				o		0			O															
Falco cenchroides	Nankeen Kestrel					O										O					O					O					O										
Falco lonipennis	Australian Hobby													O						H																					
Calidris ruficollis	Red-Necked Stint																																								
Himantopus himantopus	Black-Winged Stilt																																								
Recurvirostra novaehollandiae	Red-Necked Avocet																																								
Charadrius ruficapillus	Red-Capped Plover																																								
Vanellus tricolor	Banded Lapwing					O																																			
Larus novaehollandiae	Silver Gull																																								
Sterna nilotica	Gull-Billed Tern																																								
Phaps chalcoptera	Common Bronzewing																																								
Ocyphaps lophotes	Crested Pigeon																																								
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo																																								

Waddi Wind Farm Results 1

Species Seen		W1					W2					W3					W4					W5					W6					W7					W8				
Scientific Name	**Common Name**	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp	29/10/2008	30/10/2008	31/10/2008	2/11/2008	Opp
Cacatua roseicapilla	Galah					O			O					O	O	O		O			O					O					O			O	O	O					
Cacatua pastinator derbyi	Western Corella															O																									
Purpureicephalus spurius	Red-Capped Parrot																																								
Banardius zonarius	Australian Ringneck															H			H	H	O					H								O	O						
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo																																								
Chrysococcyx lucidus	Shining Bronze-Cuckoo																																								
Dacelo novaeguineae	Laughing Kookaburra																																								
Todiramphus sanctus	Sacred Kingfisher																																								
Merops ornatus	Rainbow Bee-eater	O																																							
Malurus leucopterus	Splendid Fairy-wren																										O									O					
Malurus lamberti	Variegated Fairy-Wren																																								
Malurus leucopterus	White-winged Fairy Wren					O/H											H	O								O															
Pardalotus striatus	Striated Pardalote																																								
Sericornis frontalis	White-Browed Scrubwren																																								
Calamanthus campestris	Rufous Fieldwren				H	H																				O											H				
Gerygone fusca	Western Gerygone																																								
Acanthiza apicalis	Inland Thornbill																																								
Acanthiza inornata	Western Thornbill																																								
Acanthiza chrysorrhoa	Yellow-rumped Thornbill										O		H						O								O						O		O						
Smicrornis brevirostris	Weebill																																								
Anthochaera carunculata	Red Wattlebird																																								
Manorina flavigula	Yellow-Throated Miner																																								
Lichenostomus virescens	Singing Honeyeater															H			H																						H
Melithriptus brevirostris	Brown-Headed Honeyeater																																								
Phylidonyris nigra	White-cheeked Honeyeater	H			O	O																H			O	O/H														O	
Phylidonyris melanops	Tawny-crowned Honeyeater																									H															
Certhionyx niger	Black Honeyeater																																								
Lichmera indistincta	Brown Honeyeater					O																H				H															
Epthianura tricolor	Crimson Chat																																								
Epthianura albifrons	White-fronted Chat																																				O				H
Petroica goodenovii	Red-Capped Robin																																								
Melanodryas cucullata	Hooded Robin																																								
Pachycephala rufiventris	Rufous Whistler																							O		H															H
Colluricincla harmonica	Grey Shrike-Thrush																																								

Waddi Wind Farm Results 1																																									
Species Seen		**W1**					**W2**					**W3**					**W4**					**W5**					**W6**					**W7**					**W8**				
Scientific Name	**Common Name**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**	**29/10/2008**	**30/10/2008**	**31/10/2008**	**2/11/2008**	**Opp**
Rhipidura leucophrys	Willie Wagtail	O										O	O		O				O																	H					
Rhipidura fuliginosa	Grey Fantail																																								
Coracina novaehollandiae	Black-faced Cuckoo-Shrike		O									O	O						O																						
Lalage sueurii	White-Winged Triller																																								
Artamus cinerius	Black-faced Woodswallow	O										O	O		O				O							H		O								O					
Cracticus torquatus	Grey Butcherbird										H					O				O	H					H															H
Cracticus nigrogularis	Pied Butcherbird																																								
Grallina cyanoleuca	Australian Magpie-lark													O	H	O		O	O	H	H					H					H										H
Gymnorhina tibicen	Australian Magpie				O						H					O	O			O	H					O				O						H					H
Corvus coronoides	Australian Raven	O				O					O/H		O			O					O					O					H					H					H
Taeniopygia guttata	Zebra Finch																																								
Anthus novaeseelandiae	Australian Pipit		O			H	O		O/H	H	O/H		O		O	O					O		O			O/H		O		O								H			
Dicaeum hirundinaceum	Mistletoebird																																								
Hirundo neoxena	Welcome Swallow					O	O	O	O	O							O																							O	
Cheramoeca leucosternus	White-backed Swallow																																								
Hirundo nigricans	Tree Martin									O	O																														
Hirundo ariel	Fairy Martin																																								
Megalurus gramineus	Little Grassbird																																								
Cincloramphus cruralis	Brown Songlark					H				H	H		O		O	H		O	O	O	H				H				O	O	O	O			H	H	O		O	H	H
Cincloramphus mathewsi	Rufous Songlark															H					H																				
Zosterops lateralis	Silvereye			O																																					
Daphoenositta chrysoptera	Varied Sittella																																								

RPS

APPENDIX 4

Fauna Found in Similar, Nearby Habitat during Survey for Tiwest Joint Venture (Bamford 2007)

APPENDIX 4: Fauna Found in Similar, Nearby Habitat during Survey for Tiwest Joint Venture (Bamford 2007)

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Table 4-1: **Fish that May Occur in the Vicinity of the Falcon Lease**

Species		Status	Recorded
GALAXIIDAE (Gallaxiids)			
Galaxias occidentalis	western minnow	CS3	Cool
NANNOPERCIDAE (Pygmy perches)			
Edelia vittata	western pygmy perch	CS3	Cool
GOBIIDAE (Gobies)			
Pseudogobius olorum	Swan River goby		Cool
POECILIIDAE (Livebearers)			
Gambusia holbrooki	mosquitofish	Int	Cool

Status is assigned as described in Methods. Those recorded in studies conducted at Cooljarloo (Cool) and Falcon (Fal) are indicated.

Table 4-2: Amphibians that may Occur in the Vicinity of the Falcon Lease

Species		Status	Recorded
HYLIDAE (tree frogs)			
Litoria adelaidensis	slender tree frog		Cool
Litoria moorei	motorbike frog		Cool
MYOBATRACHIDAE (ground frogs)			
Heleioporus albopunctatus	western spotted frog		Cool
Heleioporus eyrei	moaning frog		Cool, Fal
Heleioporus psammophilus	sand frog		Cool, Fal
Limnodynastes dorsalis	banjo frog, pobblebonk		Cool
Neobatrachus pelobatoides	humming frog		Cool
Crinia insignifera	squelching froglet		Cool
Crinia pseudinsignifera	bleating froglet		
Myobatrachus gouldii	turtle frog		Cool
Pseudophryne guentheri	Günther`s toadlet		Cool, Fal

Status is assigned as described in Methods. Those recorded in studies conducted at Cooljarloo (Cool) and Falcon (Fal) are indicated.

Table 4-3: Reptiles that may occur in the vicinity of the Falcon Lease

Species		Status	Recorded
CHELUIDAE (Side-necked freshwater turtles)			
Chelodina oblonga	Long-necked tortoise		Cool
AGAMIDAE (Dragons)			
Pogona minor	Western bearded dragon		Cool, Fal
Rankinia adelaidensis	Western heath dragon		Cool, Fal
GEKKONIDAE (Geckos)			
Crenadactylus ocellatus	Clawless gecko		
Diplodactylus alboguttatus	White-spotted ground gecko		Cool
Diplodactylus polyophthalmus			Cool
Strophurus spinigerus	Soft spiny-tailed gecko		Cool
Underwoodisaurus milii	Barking gecko		
Christinus marmoratus	Marbled gecko		Cool, Fal
PYGOPODIDAE (Legless lizards)			
Aclys concinna	Javelin legless lizard		Cool
Aprasia sp. nov. aff. '*fusca*'		CS3	
Aprasia repens	Sand-plain worm-lizard		Cool
Delma fraseri	Fraser's legless lizard		Cool
Delma grayii	Gray's legless lizard		Cool
Lialis burtonis	Burton's legless lizard		Cool
Pletholax gracilis	Keeled legless lizard		Cool
Pygopus lepidopodus	Common scaly-foot		Cool, Fal
SCINCIDAE (Skinks)			
Cryptoblepharus plagiocephalus	Fence skink		Cool, Fal
Ctenotus australis	Western limestone ctenotus		Cool
Ctenotus catenifer			
Ctenotus fallens	West coast ctenotus		Cool, Fal
Ctenotus gemmula	Jewelled ctenotus	CS2	Cool
Ctenotus impar	South-western odd-striped ctenotus		Cool
Ctenotus pantherinus	Leopard ctenotus		Cool
Cyclodomorphus celatus			Fal
Egernia kingii	King's skink		
Egernia multiscutata	Bull skink		Cool
Egernia napoleonis	Salmon-bellied skink		Cool
Hemiergis quadrilineata	Two-toed earless skink		
Lerista christinae	Bold-striped four-toed lerista	CS3	Fal
Lerista elegans	West coast four-toed lerista		Cool, Fal
Lerista lineopunctulata	West coast line-spotted lerista		
Lerista praepedita	Western worm lerista		Cool
Menetia greyii	Common dwarf skink		Cool, Fal
Morethia lineoocellata	Western pale-flecked morethia		Cool
Morethia obscura	Dusky morethia		Cool, Fal
Tiliqua occipitalis	Western blue-tongue		Cool
Tiliqua rugosa	Bobtail		Cool

Species		Status	Recorded
VARANIDAE (Monitors and goannas)			
Varanus gouldii	Sand goanna		Cool
Varanus tristis	Black-headed monitor		
TYPHLOPIDAE (Blind snakes)			
Ramphotyphlops australis	Southern blind snake		Cool
BOIDAE (Pythons)			
Antaresia stimsoni	Stimson`s python		
Morelia spilota	Carpet python	CS1	Cool
ELAPIDAE (Venomous land snakes)			
Brachyurophis fasciolata	Narrow-banded shovel-nosed snake		Cool
Brachyurophis semifasciata	Southern shovel-nosed snake		Cool
Demansia psammophis	Yellow-faced whipsnake		Cool
Echiopsis curta	Bardick		Cool
Neelaps bimaculatus	Black-naped snake		Cool
Neelaps calonotos	Black-striped snake	CS2	Cool
Notechis scutatus	Tiger snake	CS3	
Parasuta gouldii	Gould`s snake		Cool
Pseudechis australis	Mulga snake		Cool
Pseudonaja nuchalis	Gwardar		Cool
Simoselaps bertholdi	Jan`s banded snake		
Simoselaps littoralis	West coast banded snake		

Status is assigned as described in Methods. Those recorded in studies conducted at Cooljarloo (Cool) and Falcon (Fal) are indicated.

Table 4-4: Birds that may Occur in the Vicinity of the Falcon Lease

Species		Status	Recorded
CASUARIIDAE (Cassowaries and emus)			
Dromaius novaehollandiae	Emu		Cool
PHASIANIDAE (Pheasants and allies)			
Coturnix pectoralis	Stubble quail		Cool
ANATIDAE (Ducks and allies)			
Oxyura australis	Blue-billed duck [w]	Vag	Cool
Biziura lobata	Musk duck [w]	Vag	Cool
Cygnus atratus	Black swan [w]	Vag	Cool
Tadorna tadornoides	Australian shelduck [w]		Cool
Chenonetta jubata	Australian wood duck [w]		Cool
Anas superciliosa	Pacific black duck [w]		Cool
Anas gracilis	Grey teal [w]		Cool
Anas castanea	Chestnut teal [w]	Vag	Cool
Anas rhynchotis	Australasian shoveler [w]	Vag	Cool
Aythya australis	Hardhead [w]	Vag	Cool
Malacorhynchus membranaceus	Pink-eared duck		
PODICIPEDIDAE (Grebes)			
Tachybaptus novaehollandiae	Australasian grebe [w]		Cool

Species		Status	Recorded
Poliocephalus poliocephalus	Hoary-headed grebe [w]		Cool
ANHINGIDAE (Darters)			
Anhinga melanogaster	Darter [w]	Vag	Cool
PHALACROCORACIDAE (Cormorants)			
Phalacrocorax melanoleucos	Little pied cormorant [w]	Vag	Cool
Phalacrocorax sulcirostris	Little black cormorant [w]	Vag	Cool
PELECANIDAE (Pelicans)			
Pelecanus conspicillatus	Australian pelican [w]	Vag	Cool
ARDEIDAE (Herons, bitterns and egrets)			
Egretta novaehollandiae	White-faced Heron [w]		Cool
Egretta garzetta	Little egret [w]	Vag	
Ardea pacifica	White-necked heron [w]		Cool
Ardea alba	Great egret [w]	CS1, Vag	
Nycticorax caledonicus	Nankeen night heron [w]		Cool
THRESKIORNITHIDAE (Ibises and spoonbills)			
Threskiornis molucca	Australian white ibis		
Threskiornis spinicollis	Straw-necked ibis		Cool
Platalea flavipes	Yellow-billed spoonbill [w]	Vag	Cool
ACCIPITRIDAE (Osprey, hawks and eagles)			
Elanus axillaris	Black-shouldered kite		Cool
Lophoictinia isura	Square-tailed kite	CS3	Cool
Haliastur sphenurus	Whistling kite		Cool
Haliaeetus leucogaster	White-bellied sea-eagle	CS1, Vag	Cool
Circus assimilis	Spotted harrier		Cool
Circus approximans	Swamp harrier		Cool
Accipiter fasciatus	Brown goshawk		Cool
Accipiter cirrhocephalus	Collared sparrowhawk		Cool
Aquila audax	Wedge-tailed eagle		Cool
Hieraaetus morphnoides	Little eagle		Cool
FALCONIDAE (Falcons)			
Falco berigora	Brown falcon		Cool, Fal
Falco longipennis	Australian hobby		Cool
Falco peregrinus	Peregrine falcon	CS1, Vag	
Falco cenchroides	Nankeen kestrel		Cool, Fal
RALLIDAE (Rails, gallinules and coots)			
Gallirallus philippensis	Buff-banded rail [w]	Vag	
Porzana pusilla	Baillon's crake [w]	Vag	
Porzana fluminea	Australian spotted crake [w]	Vag	
Porzana tabuensis	Spotless crake [w]	Vag	
Porphyrio porphyrio	Purple swamphen [w]		Cool
Gallinula ventralis	Black-tailed native-hen w	Vag	Cool
Fulica atra	Eurasian coot [w]		Cool
OTIDIDAE (Bustards)			
Ardeotis australis	Australian bustard	Vag, CS2	Cool

Species		Status	Recorded
TURNICIDAE (Button-quails)			
Turnix velox	Little button-quail	Vag	Cool
Turnix varia	Painted button-quail		Cool
SCOLOPACIDAE (Curlews, godwits, snipe, sandpipers and allies)			
Tringa nebularia	Common greenshank [w]	Vag, CS1	
Actitis hypoleucos	Common sandpiper [w]	Vag, CS1	Cool
Calidris ruficollis	Red-necked stint [w]	Vag, CS1	
Calidris acuminata	Sharp-tailed sandpiper [w]	Vag, CS1	
RECURVIROSTRIDAE (Stilts and avocets)			
Himantopus himantopus	Black-winged stilt [w]	Vag	Cool
Cladorhynchus leucocephalus	Banded stilt [w]	Vag	
Recurvirostra novaehollandiae	Red-necked avocet [w]	Vag	
CHARADRIIDAE (Lapwings, plovers and dotterels)			
Charadrius ruficapillus	Red-capped plover [w]	Vag	Cool
Elseyornis melanops	Black-fronted dotterel [w]	Vag	Cool
Erythrogonys cinctus	Red-kneed dotterel [w]	Vag	
Vanellus tricolor	Banded lapwing	Vag	Cool
COLUMBIDAE (Pigeons and doves)			
Columba livia	Rock dove/feral pigeon	Int, Vag	
Streptopelia senegalensis	Laughing turtle-dove	Int, Vag	Cool
Phaps chalcoptera	Common bronzewing		Cool
Phaps elegans	Brush bronzewing	CS3	Cool
Ocyphaps lophotes	Crested pigeon		Cool, Fal
CACATUIDAE (Cockatoos)			
Calyptorhynchus latirostris	Carnaby`s Cockatoo	CS1	Cool
Eolophus roseicapilla	Galah		Cool
Cacatua pastinator	Western corella		Cool
Cacatua sanguinea	Little corella	Vag	
Nymphicus hollandicus	Cockatiel	Vag	
PSITTACIDAE (Parrots)			
Glossopsitta porphyrocephala	Purple-crowned lorikeet	Vag	
Polytelis anthopeplus	Regent parrot	Vag,	Cool
Barnardius zonarius	Australian ringneck		Cool
Melopsittacus undulatus	Budgerigar	Vag	Cool
Pezoporus wallicus	Ground parrot	CS1	
CUCULIDAE (Old world cuckoos)			
Cuculus pallidus	Pallid cuckoo		Cool
Cacomantis flabelliformis	Fan-tailed cuckoo		Cool
Chrysococcyx osculans	Black-eared cuckoo	Vag	
Chrysococcyx basalis	Horsfield's bronze-cuckoo		Cool
Chrysococcyx lucidus	Shining bronze-cuckoo		Cool
STRIGIDAE (Hawk owls)			
Ninox novaeseelandiae	Southern Boobook		Cool
TYTONIDAE (Barn owls)			
Tyto alba	Barn owl		

Species		Status	Recorded
PODARGIDAE (Australian frogmouths)			
Podargus strigoides	Tawny frogmouth		Cool
CAPRIMULGIDAE (Nightjars and allies)			
Eurostopodus argus	Spotted nightjar		Cool
AEGOTHELIDAE (Owlet-nightjars)			
Aegotheles cristatus	Australian owlet-nightjar		
APODIDAE (Typical swifts)			
Apus pacificus	Fork-tailed swift [a]	Vag, CS1	
HALCYONIDAE (Kingfishers)			
Dacelo novaeguineae	Laughing kookaburra	Int	Cool
Todiramphus pyrrhopygia	Red-backed kingfisher	Vag	Cool
Todiramphus sanctus	Sacred kingfisher		Cool
MEROPIDAE (Bee-eaters)			
Merops ornatus	Rainbow bee-eater	CS1	Cool
MALURIDAE (Fairy-wrens, emu-wrens and grasswrens)			
Malurus splendens	Splendid fairy-wren		Cool, Fal
Malurus lamberti	Variegated fairy-wren		Cool
Malurus pulcherrimus	Blue-breasted fairy-wren		Cool
Malurus leucopterus	White-winged fairy-wren		Cool
Stipiturus malachurus	Southern emu-wren	CS3	Cool, Fal
PARDALOTIDAE (Pardalotes, bristlebirds, scrubwrens, thornbills and allies)			
Pardalotus punctatus	Spotted pardalote		Cool
Pardalotus striatus	Striated pardalote		Cool
Sericornis frontalis	White-browed scrubwren		Cool
Calamanthus campestris	Rufous fieldwren	CS2	Cool, Fal
Smicrornis brevirostris	Weebill		Cool
Gerygone fusca	Western gerygone		Cool
Acanthiza apicalis	Inland thornbill		Cool
Acanthiza inornata	Western thornbill		Cool
Acanthiza chrysorrhoa	Yellow-rumped thornbill		Cool
MELIPHAGIDAE (Honeyeaters)			
Anthochaera carunculata	Red wattlebird		Cool
Anthochaera lunulata	Western wattlebird		Cool
Manorina flavigula	Yellow-throated miner		Cool
Lichenostomus virescens	Singing honeyeater		Cool
Melithreptus brevirostris	Brown-headed honeyeater		Cool
Lichmera indistincta	Brown honeyeater		Cool, Fal
Phylidonyris novaehollandiae	New holland honeyeater	Vag	Cool
Phylidonyris nigra	White-cheeked honeyeater		Cool, Fal
Phylidonyris melanops	Tawny-crowned honeyeater		Cool
Acanthorhynchus superciliosus	Western spinebill		Cool, Fal
Certhionyx niger	Black honeyeater	Vag	Cool
Certhionyx variegatus	Pied honeyeater	Vag	Cool
Epthianura tricolor	Crimson chat	Vag	Cool
Epthianura albifrons	White-fronted chat		Cool

Species		Status	Recorded
PETROICIDAE (Robins)			
Petroica multicolor	Scarlet robin	CS3	Cool
Petroica goodenovii	Red-capped robin		Cool
Melanodryas cucullata	Hooded robin		Cool, Fal
Eopsaltria georgiana	White-breasted robin	CS3	Cool
NEOSITTIDAE (Sitellas)			
Daphoenositta chrysoptera	Varied sittella		Cool
PACHYCEPHALIDAE (Whistlers, shrike-thrushes and allies)			Cool
Oreoica gutturalis	Crested bellbird	CS2	Cool, Fal
Pachycephala rufiventris	Rufous whistler		Cool, Fal
Colluricincla harmonica	Grey shrike-thrush		Cool, Fal
DICRURIDAE (Monarchs, fantails and drongos)			
Myiagra inquieta	Restless flycatcher	Vag	
Grallina cyanoleuca	Magpie-lark		Cool
Rhipidura fuliginosa	Grey fantail		Cool
Rhipidura leucophrys	Willie wagtail		Cool, Fal
CAMPEPHAGIDAE (Cuckoo-shrikes and trillers)			
Coracina novaehollandiae	Black-faced cuckoo-shrike		Cool, Fal
Coracina maxima	Ground cuckoo-shrike	Vag	Cool
Lalage sueurii	White-winged triller		Cool, Fal
ARTAMIDAE (Woodswallows, butcherbirds and currawongs)			
Artamus personatus	Masked woodswallow	Vag	Cool
Artamus cinereus	Black-faced woodswallow		Cool, Fal
Cracticus torquatus	Grey butcherbird		Cool
Cracticus nigrogularis	Pied butcherbird		Cool
Gymnorhina tibicen	Australian magpie		Cool
CORVIDAE (Crows and allies)			
Corvus coronoides	Australian raven		Cool, Fal
Corvus bennetti	Little crow	Vag	
MOTACILLIDAE (Old world wagtails and pipits)			
Anthus novaeseelandiae	Richard's pipit		Cool
PASSERIDAE (Sparrows, weaverbirds, waxbills and allies)			
Taeniopygia guttata	Zebra finch	Vag	Cool
DICAEIDAE (Flowerpeckers)			
Dicaeum hirundinaceum	Mistletoebird		Cool
HIRUNDINIDAE (Swallows and martins)			
Hirundo neoxena	Welcome swallow		Cool, Fal
Hirundo nigricans	Tree martin		Cool, Fal
Hirundo ariel	Fairy MARTIn		
SYLVIIDAE (Old world warblers)			
Cinclorhamphus mathewsi	Rufous songlark		Cool
Cinclorhamphus cruralis	Brown songlark		Cool
ZOSTEROPIDAE (White-eyes)			
Zosterops lateralis	Silvereye		Cool, Fal

Status is assigned as described in Methods. Species marked with a superscript "w" are generally dependent on wetlands and species marked with a superscript "a" are highly aerial species. Those recorded in studies conducted at Cooljarloo (Cool) and Falcon (Fal) are indicated.

Table 4-5: Mammals that may occur in the Vicinity of the Falcon Lease

Species		Status	Recorded
TACHYGLOSSIDAE (Echidnas)			
Tachyglossus aculeatus	Echidna		Cool, Fal
DASYURIDAE (Dasyurids)			
Sminthopsis crassicaudata	Fat-tailed dunnart		Cool
Sminthopsis granulipes	White-tailed dunnart		Cool
Sminthopsis griseoventer	Grey-bellied dunnart		Cool
PEREMELIDAE (Bandicoots)			
Isoodon obesulus	Southern brown bandicoot, quenda	CS2	
POTOROIDAE (Potoroos and bettongs)			
Bettongia penicillata	Brush-tailed bettong, woylie	CS2	
PHALANGERIDAE (Brushtail possums)			
Trichosurus vulpecula	Brush-tailed possum		Cool
MACROPODIDAE (Kangaroos, wallabies and tree kangaroos)			
Macropus eugenii	Tammar, tammar wallaby	CS2	Cool?
Macropus fuliginosus	Western grey kangaroo		Cool, Fal
Macropus irma	Brush wallaby	CS2	Cool
TARSIPEDIDAE (Honey Possum)			
Tarsipes rostratus	Honey possum, noolbenger		Cool, Fal
VESPERTILIONIDAE (Vespertillionid bats)			
Chalinolobus gouldii	Gould`s wattled bat		Cool
Chalinolobus morio	Chocolate wattled bat		
Nyctophilus geoffroyi	Lesser long-eared bat		Cool
Nyctophilus timoriensis	Greater long-eared bat		Cool?
Vespadelus regulus	Southern forest bat		Cool
MOLOSSIDAE (Freetail bats)			
Tadarida australis	White-striped freetail-bat		Cool
MURIDAE (Rats and mice)			
Mus musculus	House mouse	Int	Cool, Fal
Pseudomys albocinereus	Ashy-grey mouse, noodji		Cool, Fal
Rattus fuscipes	Western bush rat, moodit		Cool, Fal
LEPORIDAE (Rabbits and hares)			
Oryctolagus cuniculus	Rabbit	Int	Cool, Fal
CANIDAE (Dogs and foxes)			
Vulpes vulpes	Red fox	Int	Cool, Fal
FELIDAE (Cats)			
Felis catus	Cat	Int	Cool, Fal

Status is assigned as described in Methods. Those recorded in studies conducted at Cooljarloo (Cool) and Falcon (Fal) are indicated.