Bird and Bat Management Plan

DUGALD RIVER WINDFARM

MMG DUGALD RIVER PTY LTD

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WULGURU TECHNICAL SERVICES

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Document Control and History

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WTS acknowledge the work of EcoSmart Ecology for their ongoing commitment to ecological survey and monitoring at MMGs Dugald River Mine and for the preparation of a summary of survey effort since 2013 to support this report.

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1. Introduction

The objective of the Bird and Bat Management Plan (BBMP) is to provide a plan for monitoring potential impacts of the windfarm on bird and bat species and to provide a strategy to manage and mitigate significant impacts.

The BBMP uses an adaptive management approach. Monitoring will indicate compliance or non-compliance under approval conditions and management strategies. It also informs where management strategies are effective and where they need to be reviewed and altered. The proposed conditions also align with the conditioning precedent in EA EPML00731213.

1.1. Background

MMG are seeking to develop a windfarm at the Dugald River Mine (DRM) on the Knapdale Range to provide a sustainable energy source for mine related activities.

The DRM is located approximately 70 km northwest of Cloncurry in western Queensland and situated adjacent to the Knapdale Range. Other infrastructure such as the mine camp are located on the range itself along with the valley fill tailings dam which is situated in the northern one-third of the range.

The rocky habitat of the Knapdale Range supports populations of Purple-necked Rock-wallaby (PNRW) (*Petrogale purpuriecolis*) which is considered a vulnerable species under the *Nature Conservation Act 1992* (NCA). Local populations are currently monitored under the MMG DRM PNRW Monitoring Program and reported annually to the Department of Environment, Science and Innovation (DESI) in accordance with the EA.

Nine locations across the Knapdale Range were selected for geotechnical investigations with the intended purpose of installation of wind turbines. Construction of turbine pads, access tracks, powerlines, and laydown areas requires 75 ha of land clearing within the lease footprint. There will be eight turbines. The Rotor-swept Area (RSA, i.e. referring to the height range within which the blades of operating wind turbines move (Brett Lane & Associates Pty Ltd, 2005) was considered at the largest dimensions possible to allow for design adjustments. The Goldwind GW 165-5.2/5.6/6.0MW (or equivalent) with a 130m hub height and 165m rotor blade diameter calculates to an RSA between 47.5m - 212.5m height above ground level, with blade rotation area of 21,382m^2. This assessment has been based on these criteria in consideration of the Precautionary Principle and in accordance with accepted methodology and conditioning style adopted through Planning guidance State Code 23: Wind farm development.

The project will consist of a clearing phase, a construction phase, an operation phase, and a decommissioning phase following mine closure.

2. Pre-construction Bird and Bat Information

2.1. Desktop analysis

A review of available information was undertaken to provide insight on the potential occurrence of bird and bat species surrounding and within the windfarm area.

A comprehensive desktop analysis was undertaken as part of the Ecological Assessment Report (WTS, 2023) to identify potential environmental values, constraints, and potential impacts within the Project area and to enhance understanding of the ecology of the area and its relationship to and connectivity with the surrounding landscape.

2.2. Survey Effort

Two rounds of Bird and Bat Utilisation surveys (BBUS) were undertaken by EcoSmart Ecology in May and September 2023 at eight survey sites, four of which are proposed turbine locations that will become impact sites upon commencement of construction and operation.

A subsequent BBUS was performed by Wulguru Technical Services (WTS) in April 2024. Four additional survey sites were included during this campaign to provide a more comprehensive coverage of the Project area, bringing the total to 12 survey sites.

Prior to commencement of construction and operation, impact and control sites are to be monitored twice yearly, once in the post-wet season and once in the pre-wet season.

2.3. Bird Survey

2.3.1. Bird Survey Methodology

Level one bird surveys are conducted as per the approved method outlined in *Wind Farms and Birds: Interim Standards For Risk Assessment* by Brett Lane & Associates (Brett Lane & Associates Pty Ltd, 2005). Level one surveys are considered to be a minimum requirement to assess the potential impacts of a wind farm on birds during the pre-construction phase.

BBUS were performed to collect quantitative data on bird use of the potential windfarm site. This can be used to estimate potential collision rates and provide a ranked abundance of species use of the site at varying heights. The BBUS involved a “Fixed-point Count” methodology where an observer is stationed at a fixed survey point for 20 minutes. During the 20 minutes, all bird species and number of birds observed were recorded. Observations of birds (and theoretically diurnally flying bats) during the survey periods were broken into BBUS and incidental observations. BBUS observations are those which include individuals observed to be flying above the predominant canopy. These observations do not include individuals that briefly fly out of the canopy layer at a low height. All other observation not conforming to BBUS records, including positively identified bird calls were recorded as incidental observations. The BBUS method provides the following information:

- Species
- Number of individuals
- Estimated distance from observer

- Estimated height above observer
- Bearing to record
- Direction of flight
- Behaviour
- Any additional notes on the observation

2.3.2. Bird Survey Results

Birds recorded during the BBUS surveys were characterised as either occurring within or outside of the RSA. These records are shown below in Table 1. An additional 76 species of bird have been historically recorded from the site. These are recorded as incidental observations and are shown in Appendix A. Bird species commonly entering RSA height can be broken into two main groups, raptors and aerial insectivores. Raptors include all species within the Accipitriformes and Falconiformes Orders, while aerial insectivores include woodswallows, martins and the rainbow bee-eater. One listed Marine species, the rainbow bee-eater was recorded during BBUS surveys. A single listed Migratory species, the glossy ibis, has historically been recorded from the Dugald River Project Area.

2.3.3. Bird Collision Likelihood Risk

Collision Risk Susceptibility of birds previously identified on site, as well as potentially occurring NCA or EPBC listed species was determined through the results of the surveys and the ecology of each species.

To determine collision risk susceptibility, a number of characteristics of bird behaviours were considered including:

- Foraging, dispersal and territorial behaviours;
- Flight manoeuvrability;
- General flight patterns;
- Size of birds; and
- Distribution, and biology.

A review of approvals issued by the State and Federal Governments informed the development of a Collision Risk Assessment. A BBMP from Base Consulting (2022) formed the basis of the assessment. Of the key collision risk characteristics, flight height pattern was given the larger weighting over distribution and biology. Flight manoeuvrability was given the lowest weighting. Table 2 below outlines the criteria evaluated for each species or group of birds assessed.

For the purposes of this report, flight height is presented as below, at or above RSA height:

A = Below RSA (< 47.5 metres above ground)

B = At RSA (40 – 212.5 metres above ground)

C = Above RSA (> 212.5 metres above ground).

Table 1. Collision Risk Assessment Table

Risk Characteristics	Criteria	Score
Flight height Expected frequency a species enters the RSA.	Never – Species not expected to enter RSA	0 – Negligible
	Occasional – Species is typically present outside of RSA but may enter infrequently.	5 – Low
	Regular – Species enters RSA, but majority of records are outside RSA.	10 – Medium
	Predominant – Species within RSA most of the time while in flight.	15 – High
Movements and biology Annual presence of a species within the Project Area.	Rare – Present once or twice per year	0 – Negligible
	Intermittent – Present <1 month of the year	2 – Low
	Seasonal/migration – Present for 1-5 months of the year	5 – Medium
	Resident – Present throughout most of the year (>5 months)	10 – High
Manoeuvrability Size and relative manoeuvrability of the bird species	Small size, highly manoeuvrable	0 – Negligible
	Small size, constrained manoeuvrability or medium size, highly manoeuvrable	2 – Low
	Medium size, constrained manoeuvrability or large size, highly manoeuvrable	4 – Medium
	Large size, constrained manoeuvrability	6 – High

Scores for each of the criteria in the above table were combined to produce an overall value for the Collision Risk Susceptibility in Table 3. Species expected to never fly in the RSA are all considered to have a low Collision Risk Susceptibility regardless of other criteria.

Threatened birds including migratory species identified from the desktop EPBC, PMST, and WildNet searches with the potential to occur within the Project Area were also considered during the risk assessment process.

Table 2. Collision Risk Susceptibility

Collision Risk Scoring	Overall Collision Risk Susceptibility
Risk score 0-10	Low
Risk score 11-20	Moderate
Risk score 21+	High

2.3.4. Bird Collision Consequence Criteria

Using the collision risk susceptibility assessment and the relative abundance of species within the Project area, potential collision consequences were able to be estimated. An evaluation of the potential collision consequences for birds is outlined in Table 4.

Table 3. Collision Consequence

Collision Consequence	Collision Consequence Criteria
No loss of individuals	• Not previously identified on site or, • Low abundance with low collision risk susceptibility
Rare loss of individuals	• Low abundance with moderate collision risk susceptibility or, • Moderate abundance with low collision risk susceptibility
Occasional loss of individuals	• Low abundance with high collision risk susceptibility or, • Moderate abundance with moderate collision risk susceptibility or, • High abundance with low collision risk susceptibility
Repeated loss of individuals	• Moderate abundance with high collision risk susceptibility or, • High abundance with moderate collision risk susceptibility
Significant loss of individuals	• High abundant with high collision risk susceptibility

2.3.5. Bird Collision Risk Assessment

2.3.5.1. General Order Risk Assessment

General risk assessments have been made at the Order or Family (for some passerine birds) level for all species found on site, this assessment can be found in Appendix B. The most at risk Orders of birds known to occur within the project area are the Accipitriformes, the Coraciiformes (in part), the Falconiformes, and the Families *Artamidae* and *Hirundinidae* of the Passeriformes Order. Many of these species of birds have been recorded within the proposed RSA of the Project area.

2.3.5.2. Listed Species Risk Assessment

NCA/EPBC listed species deemed as having a 'possible' likelihood of occurrence in WTS's Ecological Assessment Report have been assessed at a species level in Appendix C (Wulguru Technical Services, 2023). Only two species of bird listed under the NC or EPBC Acts are considered to have the potential for losses of individuals as a consequence or turbine interaction. The glossy ibis (EPBC: Marine, Migratory) is considered to have the potential for rare loss of individuals, while the rainbow bee-eater (EPBC: Marine) is considered to have the potential for repeated loss of individuals as identified in previous tables.

Species recorded within the RSA have been assessed at a species level; data from the onsite BBUS was used to inform the assessment. Birds recorded within the RSA are assessed separately in Table 5 below.

2.3.5.3. RSA species

Analysis of the collision consequences for bird species within the RSA did not identify any species as having the potential for significant loss of individuals via turbine interaction. However, based on these assessments, four species were considered to have the potential for repeated loss of individuals. These are as follows:

- Black-faced woodswallow (*Artamus cinereus*)
- Little woodswallow (*Artamus minor*)
- Masked woodswallow (*Artamus personatus*)
- Rainbow bee-eater (*Merops ornatus*)

All other species recorded within the RSA are considered to have the potential for rare or occasional loss of individuals via turbine interaction.

Table 4. Collision Risk for Species Recorded Within Rotor Swept Area

Species	Description and behaviour	Total Records	Records within RSA	% within RSA	Collision Risk Susceptibility	Collision Consequence
Raptors						
Black kite (*Milvus migrans*)	A dark-coloured kite with a distinct fish-tailed appearance from below. The black kite is common across much of the country, often appearing in high abundance in response to favourable foraging conditions, such as bushfires, locust, and mouse plagues (Pizzey & Knight, 2012). The black kite is abundant around the mine and camp area, a typical trait of this species. It is likely this species will occur along the Knapdales in higher abundance when conditions are suitable. Recorded soaring within the RSA.	2	2	100	High	Occasional loss of individuals
Black-shouldered kite (*Elanus axillaris*)	A small, predominantly white kite with black shoulders. The black-shouldered kite is present across most of mainland Australia and may be irruptive in areas in response to prey availability (Pizzey & Knight, 2012). Observed foraging within the RSA	2	1	50	High	Occasional loss of individuals
Brown falcon (*Falco berigora*)	The brown falcon is a large species of falcon with distinct dark double teardrop markings descending from either side of the eye. This species is fairly common across most of Australia, often irruptive in response to high prey abundance (Pizzey & Knight, 2012). This species is known to fly within the RSA.	5	3	60	High	Occasional loss of individuals
Nankeen kestrel (*Falco cenchroides*)	A small falcon, light brown to rufous from above with distinct black wing tips. The nankeen kestrel is often seen hovering above grasslands searching for prey to dive on (Pizzey & Knight, 2012). It has been observed foraging within the RSA	3	1	33.3	High	Occasional loss of individuals
Wedge-tailed eagle (*Aquila audax*)	Australia's largest bird of prey with an unmistakeable diamond-shaped tail from below. The wedge-tailed eagle is typically varying shades of brown, with older individuals darker than the light brown immatures. Often scavenges on carrion but also a very proficient predator, capable of taking large prey items including macropods (Pizzey & Knight, 2012). Typically seen flying within the RSA, often soaring on thermal air currents of the Knapdale Range.	6	5	83.3	High	Occasional loss of individuals
Whistling kite (*Haliastur sphenurus*)	A medium-sized raptor typically sandy-brown in colouration. The whistling kite has a rounded tail from below, with a distinct pale band on each underwing. A regular species across most of Australia, the whistling kite feeds on carrion as well as captured prey (Pizzey & Knight, 2012). Typically flies within the RSA, observed soaring on thermal currents over the Knapdales.	4	4	100	High	Occasional loss of individuals
Aerial Insectivores						
Black-faced woodswallow (*Artamus cinereus*)	A common and widespread species, the black-faced woodswallow is regularly seen swooping from powerlines and other vantage points (Pizzey & Knight, 2012). It is abundant around the main mine area, as well as on the Knapdale Range. This species forages at or below RSA height.	35	29	82.9	High	Repeated loss of individuals

Species	Description and behaviour	Total Records	Records within RSA	% within RSA	Collision Risk Susceptibility	Collision Consequence
Little woodswallow (*Artamus minor*)	The smallest species of woodswallow. It is chocolate-brown in colour within a blueish bill (Pizzey & Knight, 2012). It is the most abundant aerial insectivore within the Project area for most of much of the year, though may be outnumbered by the masked woodswallow on seasonal migration. Forages at or below RSA height.	133	63	47.4	Moderate	Repeated loss of individuals
Masked woodswallow (*Artamus personatus*)	A distinct woodswallow with a large black mask extending from above the eye to the top of the breast. Considered a part-migratory species, the masked woodswallow typically arrives in northern Australia from its breeding habitat in the south in Autumn (Pizzey & Knight, 2012). These dispersive events often see the species travelling in expansive flocks which may be at a high risk of collision with turbines. Travels and forages at RSA height.	200	200	100	Moderate	Repeated loss of individuals
Rainbow bee-eater (*Merops ornatus*)	An unmistakable, vibrantly coloured bird with a finely curved bill. The rainbow bee-eater is a proficient predator of bees, wasps, flies, and similar insects which it catches on the wing (Pizzey & Knight, 2012). Large groups may forage at RSA height in periods of high insect activity.	11	9	81.8	High	Repeated loss of individuals
Fairy martin (*Petrochelidon ariel*)	A small martin with a distinct ginger cap. The fairy martin undertakes a regular migration to the north from its breeding habitat in southeastern Australia, typically arriving in the north from March to April before leaving in September to October (Pizzey & Knight, 2012). Recorded foraging at RSA height.	31	12	38.7	Moderate	Occasional loss of individuals
Other Birds						
Australasian Darter (*Anhinga novaehollandiae*)	A unique cormorant-like bird with a distinct long, pointed bill and long neck. The Australasian darter is an proficient semi-aquatic predator of fish and invertebrates (Pizzey & Knight, 2012). This species is probably a regular inhabitant of watercourses in the vicinity of the Project area. Flies at RSA height but likely limited to rare passes from dispersing individuals.	2	2	100	Moderate	Rare loss of individuals
Varied Lorikeet (*Psitteuteles versicolor*)	A small, predominantly green lorikeet with a pinkish cap and upper breast. The varied lorikeet is nomadic in response to the flowering patterns of *Eucalyptus* and *Melaleuca* species (Pizzey & Knight, 2012). It is very abundant across the project area but rarely enters the RSA. Most individuals or flocks fly quickly at around or just above canopy height.	52	1	1.9	Low	Occasional loss of individuals
White-faced Heron (*Egretta novaehollandiae*)	A medium-sized, mostly grey heron with a white face and yellow legs. It is likely a regular inhabitant of watercourses within the greater Project area. Flies at RSA height but likely limited to rare passes from dispersing individuals.	1	1	100	Moderate	Rare loss of individuals
White-necked Heron (*Ardea pacifica*)	A moderately large heron with a predominantly white head and neck and a slatey grey body. This species is probably a regular inhabitant of watercourses in the vicinity of the Project area. Flies at RSA height but likely limited to rare passes from dispersing individuals.	2	2	100	Moderate	Rare loss of individuals

Only two species of bird listed under the NC or EPBC Acts are considered to have the potential for losses of individuals as a consequence or turbine interaction. The glossy ibis (EPBC: Marine, Migratory; NCA: SL) is considered to have the potential for rare loss of individuals, while the rainbow bee-eater (EPBC: Marine) is considered to have the potential for repeated loss of individuals as identified in previous tables.

2.4. Bat Survey

2.4.1. Bat Survey Methodology

Bats are monitored at each BBUS site using Anabat Chorus passive high-frequency sound recorders to capture microbats calls. One Anabat Chorus bat detector was installed at each of the 12 survey sites for two nights. These passive detectors were set to record in full spectrum .wav files from one hour before sunset to one hour after sunrise. Bat call analysis to identify microbat species present was undertaken by Greg Ford of Balance Environmental for EcoSmart Ecology's two initial rounds of surveying. Bat call analysis undertaken in 2024 was undertaken by Professor Simon Robson for WTS. Additionally, the BBUS methodology can be used to record bat species should they be identified during surveys.

2.4.2. Bat Survey Results

The following bat species have been recorded during BBUS surveys of the Project Area, either by EcoSmart Ecology or WTS (Table 6). As bat presence is measured entirely by call monitoring, relative abundance of bats species is not able to be accurately estimated. Many factors influence the detectability of bat calls, including flight height, distance from recorder, weather and other variables. Additionally, repeated recordings of singular or small numbers of individuals flying close to the bat detector can significantly skew abundance data. As such, for this report we consider bat call records as a confirmation of presence only and not a determinant of relative bat abundance.

2.4.3. Bat Collision Risk Assessment

Collision Risk Susceptibility of bat species previously identified on site through call detection was determined through the review of available literature, with particular reference to flight heights. The collision risks for bats are explained in Table 7, and an evaluation of bat flight heights and their relative collision risks is outlined in Table 8. As with the bird collision risk table, these are derived from a report from Base Consulting (2022).

Table 5: Collision Risk Susceptibility for Bats Recorded on Site During BBUS Surveys

Risk Characteristic	Criteria	Collision Risk
Flight height Expected frequency a species enters the RSA.	Never – Species not expected to fly at RSA height	Low
	Occasional – Species may fly at RSA height during some scenarios	Moderate
	Frequent – Species regularly flies at RSA heigh	High

Table 6: Collision Risk for Bat Species Identified During BBUS Surveys

Species	RSA utilisation	General Description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General flight height	Collision Risk Susceptibility	Collision Consequence
Finlayson's Cave Bat (*Vespadelus finlaysoni*)	Not expected	This species forms colonies that occupy caves or cavities within rocky terrain and will take residence in abandoned mining operations. This species forages for prey near water (Menkhorst & Knight, 2011).	Rapid flight with high mobility suited to foraging over water	<15m	Low	No loss of individuals
Gould's Wattled Bat (*Chalinolobus gouldii*)	Foraging	*C. gouldii* is insectivorous; in much of its range, moths are the most common food item. Other known prey includes cockroaches, flies, stoneflies, orthopterans, hemipterans, hymenopterans and other lepidopterans, including caterpillars. Grass seeds and twig fragments are occasionally ingested as well (Chruszcz & Barclay, 2002). In wooded areas, they are mostly arboreal, though they have also been found in the stumps and hollow limbs of trees or in bird nests.	Rapid flight with limited manoeuvrability	May fly to RSA height	Moderate	Occasional loss of individuals
Hoary Wattled Bat (*Chalinolobus nigrogriseus*)	Not expected	These bats prefer to roost in the hollows of eucalypt trees, and occasionally rock crevices. They like to fly fast below the canopy layer and therefore live in areas where the undergrowth is naturally sparse. They can commonly be found in a range of habitats, including Forests, woodlands, vine thickets, coastal scrub and open grasslands, across the coastal hinterland regions of Queensland (Churchill, Australian bats, 2008) (Hall, 2009).	Rapid flight with high mobility suited to foraging below the canopy	<15m	Low	No loss of individuals
Inland Broad-nosed Bat (*Scotorepens balstoni*)	Not expected	Foraging is achieved using echolocation whilst in continuous flight, keeping within 15 metres of the ground, with rapid diversions to pursue prey. Foraging mainly occurs between trees, not going above the tree canopy, as well as at	Rapid flight with high mobility suited to foraging below the canopy	<25m	Low	No loss of individuals

Species	RSA utilisation	General Description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General flight height	Collision Risk Susceptibility	Collision Consequence
		the edges of forests venturing into open areas. Foraging locations in the drier distribution areas appear to depend on nearness to water points and roosting sites (Churchill, Australian bats, 2008).				
Inland Forest Bat (*Vespadelus baverstocki*)	Not expected	The flight of the species is fluttery and rapid, sharply turning as it forages over water.	Rapid flight with high mobility suited to foraging over water	<15m	Low	No loss of individuals
Little Broad-nosed Bat (*Scotorepens greyii*)	Foraging	The Little broad-nosed bat is an insectivore which feed and drink while in flight. They forage for prey close to treetops, over water, open grassland and other open habitat. They are characteristically fast fliers which make abrupt darts and turns to catch prey (Churchill, 2009) (Van Dyck & Strahan, 2008) (Menkhorst & Knight, 2011).	Rapid flight with high mobility suited to foraging over water and canopy	May fly to RSA height	Moderate	Occasional loss of individuals
Northern Freetail Bat (*Chaerophon jobensis*)	Foraging	They will fly and forage in groups of two or more individuals. Its foraging style utilizes fast, direct flight suited for open areas or above canopies. It is insectivorous, consuming beetles, bugs, moths, lacewings, grasshoppers, cockroaches, flies and leafhoppers (Kutt, Milne, & Richards, 2008).	Rapid flight with limited manoeuvrability	May fly to RSA height	Moderate	Occasional loss of individuals
Northern Free-tailed Bat (*Ozimops lumsdenae*)	Not expected	*O. lumsdenae* is associated with permanent water, agricultural dams, and watercourses in semi-arid regions, where it resides and forages in eucalypt woodland (Reardon & Armstrong, 2020). Roosts in tree hollows.	Rapid flight with high mobility suited to foraging below the canopy	<15m	Low	No loss of individuals
White-striped Freetail Bat (*Austronomus australis*)	Foraging	This free-tailed bat is a specialized high altitude, fast flying interceptor insectivore. Their diet consists principally of moths, beetles and bugs. This species can be	Rapid flight with high manoeuvrability	Flies at RSA height	High	Occasional loss of individuals

Species	RSA utilisation	General Description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General flight height	Collision Risk Susceptibility	Collision Consequence
		found in most habitats from closed forest to open flood plain, and occurs in urban areas, in regions across temperate and subtropical Australia.				
Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	Not expected	Yellow-bellied sheath-tailed bats are canopy feeders, meaning that they are capable of fast flight, but inefficient at rapid manoeuvring. They generally feed at heights of 20–25 m, unless feeding in open spaces or at forest edges, where they forage lower (Churchill, Australian bats, 2008) (Rhodes, Hall, & Parish, 1997).	Rapid flight with low manoeuvrability	<25m	Low	Rare loss of individuals
Bristle-faced Free-tailed Bat (*Setirostris eleyri*)		Bristle-faced Free-tailed Bats are locally uncommon across inland Australia, and only known to inhabit riparian zones and floodplains. During the day these bats roost in tree hollows of mature eucalypts, but are noted as squeezing themselves into other tiny crevices. The observations are along drainage lines and open channels, flying with slow fluttering movements below the canopy at a low altitude of 3 to 4 metres (Pennay, 2006).	Rapid flight with high mobility suited to foraging below the canopy	<15m	Low	No loss of individuals
Common Sheathtail Bat (*Taphozous georgeanis*)		Common Sheathtail Bats roost in caves, old mines and cracks in rocks. They often rest on rocks during the night's feeding. They hunt alone, flying slowly in a straight line while following a grid pattern over the feeding ground. They feed over bushes and water catching and eating insects while flying (Australian Museum, 2020).	Slow flight with low manoeuvrability	May fly to RSA height	Moderate	Rare loss of individuals

3. Potential impacts

The potential impacts of the windfarm to birds and bats lie within the construction and operation phases, and have been listed below:

- Loss or degradation of habitat through clearing of turbine pads and tracks.
- Wind turbine structures, primarily rotor blades and associated RSA, causing;
  - Collisions between flying fauna and wind turbine rotor blades or other structures, or barotrauma as a result of flight close to rotor blades, resulting in injury or fatality. The likelihood of a collision is dependent on a range of factors, including:
    - Design characteristics, such as:
      - the type of wind turbine; and
      - the layout of the wind farm;
    - site characteristics, including:
      - the ecosystems on the wind farm site;
      - proximity to bird concentrations;
      - the numbers of birds moving across the wind farm site;
      - the behaviours of birds and bats (e.g. soaring at RSA height); and
      - weather conditions (Brett Lane & Associates Pty Ltd, 2005).
  - Displacement and barrier effects resulting in greater energetic cost to fauna flying through the area;
- Noise pollution, pressure, and vibrations from the operation of the wind turbines;
  - Light confusing/disorientating aerial fauna increasing risk of collision (risk has been nullified by design adjustments – lighting will not be present on the turbines); or
  - Disturbing surrounding habitat making it less preferable for native species or conditioning avoidance and affecting normal distribution patterns.

4. Monitoring and Management

4.1. Ongoing BBUS

BBUS will continue throughout the construction and operation phase with the same methodology, with the potential to increase survey timing from biannually to quarterly as the construction and operation phases begin.

Ongoing BBUS during operation, compared to pre-construction surveys, should also monitor avoidance behaviours defined below:

- Avoidance – involves birds remaining on a wind farm site but flying around, over or under operating wind turbines and it is a commonly observed behaviour at wind farms.
- Diversion – involves birds remaining within the area around a wind farm but avoiding the wind farm site entirely.
- Displacement – involves birds being displaced through disturbance from the area around the wind farm.

4.2. Carrion monitoring

Carrion monitoring involves surveying of the areas immediately under or around the turbines for carcasses of birds and bats.

In the first instance, surveys should cover an area out to a distance equivalent to the height of the wind turbine for dead birds, remains and feather spots. This distance can be altered if carcass locations indicate this.

For each turbine in the windfarm, a 220m radius area will be searched surrounding the turbine once per month, on a random day, until searchers are satisfied they have found what they can/what is present.

Information on each carcass found should be recorded as follows:

- date;
- species;
- signs of injury and likelihood of death due to collision;
- signs of scavenging;
- distance and bearing from turbine tower base;
- ground conditions (e.g. height and density of vegetation, presence of stock, etc.);and
- aerosphere conditions (e.g. visibility conditions such as fog, wind, rain, current and previous 24hr weather conditions).

Carrion monitoring should occur for the first 48 months of the windfarms operation phase. If a significant level of bird or bat mortality to a regional species or species population is measured, then the monitoring should continue (Brett Lane & Associates Pty Ltd, 2005).

The number of carcasses found during surveys is an underestimated measure of the true mortality rate, as it is affected by two major biases: the overlooking of carcasses present in the field; and carcass disappearance before being counted due to removal by scavengers or other means (Barrientos, et al., 2018; Wood, 2017).

A scavenging trial should be undertaken at least twice during the first 48 months of operation during different times of the year. The aim of this trial is to determine the typical rate of removal of carcasses by scavengers, and therefore estimate the likelihood a carcass is detected during carrion monitoring and provide more accurate estimates of bird and bat fatality rate from the wind farm.

Outside of the scavenging trial, carcasses should be removed when located to prevent unnecessary attraction of scavengers to the area potentially resulting in higher bird mortality.

Eight carcasses collected during carrion monitoring, or incidentally from the roads, should be frozen and kept for use in the scavenging trial, with an even ratio of small and large birds if available. One carcass should be placed within the carrion monitoring radius at each turbine, along with an appropriately placed camera trap to capture scavenging birds and monitor the condition of the carcass. Carcasses should be checked weekly until there is no flesh left for scavenging. It is important to note the condition (wholeness) of the carcass upon initial collection, the size (small or large bird), and the time taken for partial (~50%) and complete (~100%) removal or decomposition of the carcass, as well as the species observed scavenging. The removal of carcasses during carrion monitoring will reduce the chance of scavenger swamping, a bias observed in some scavenging trials caused by an abundance of available carcasses reducing the likelihood of scavenging of the monitored ones.

A searcher efficiency trial should be run in the same season as the scavenger trial, up to twice per year, to determine the proportion of bird and bat fatalities that the observer undertaking the searches actually finds. Four to eight additional carcasses collected during carrion monitoring, or incidentally from the roads, should be frozen and kept for use in the searcher trial, with an even ratio of small and large birds if available. Chicken or mice sourced from pet food suppliers may be used as surrogates for bird and bat carcasses if required. Carcasses should be placed within a 50m radius surrounding a random wind turbine by a member of staff not involved in the searcher efficiency trial, ensuring that carcasses are placed in a stratified random manner that reflects a natural carcass resting place, and that they reflect the habitat of the full carrion monitoring area including different vegetation types/densities, crevices, gullies, and flat areas. An approximate 50/50 split should be used of carcasses in cover and in the open, with an even ration of small and large birds in each if available. The searcher efficiency trial search should be performed to the same thoroughness as the carrion monitoring, that is until searchers are satisfied they have found what they can/what is present.

Correction factors for scavenging and observer efficiency should be developed from these trials and applied to the monitored number of dead birds in order to derive an estimate of collision rate (Brett Lane & Associates Pty Ltd, 2005).

If carcasses are identified repeatedly for a period of 3 months a strategy will be developed to manage the risk of collision and monitoring design will be updated to confirm the level of impact.

It is assumed that a fauna collision with the turbine will be fatal. However, injured wildlife will be referred to local wildlife carers:

Western Qld Wildlife Rehabilitation Centres: Cloncurry – 0419 422 900

4.3. Management

Table 7: General Management Strategies

Threat	Impact	Controls/Management				
		Avoid	Minimise	Mitigate	Monitor	Timing
Introduction and/or spread of weed species due to vehicle and machinery movements across the landscape.	Modification of native habitats.	Where possible, activities must be planned to avoid movement of vehicles or machinery between properties, corridors, or areas with weed infestations. All equipment that enters site must be washed down on each occasion (including vehicles, earthmovers, generators, etc.)	General vehicle and machinery hygiene procedures implemented to minimise spreading of seeds.	Weed management and control methods will be implemented based on infestation size, location, and species of which it is comprised.	Monitoring performed as per DRM Land and Biodiversity Management Plan and management as per DRM Weed Control Program.	During construction and operation
Introduction of pest species or increase of their populations in the project area.	Competing with, predating on, or otherwise harming native species.	Not applicable.	Not applicable.	Implement a pest management plan (PMP) for pest species found in the project area.	Monitoring and management performed as per DRM Land and Biodiversity Management Plan.	During construction and operation
	Facilitating the infection of native species with diseases/parasites					
	Indirectly modifying the habitat of native species.					
	Indirect harm to native fauna through degradation of their habitat.	All waste generated must be stored, handled, and transported in sealed containers.	Not applicable.	Green waste produced may be used on site for rehabilitation, sediment, or erosion control.		
Noise, dust, light pollution, and vibrations (particularly	Confusion of birds by light causing increased risk of interactions.	Works will not occur at night.	Hours and amount of artificial light will be minimised wherever practical.	Not applicable.	Light meters can be used to monitor light pollution and ensure it stays at or below acceptable levels during works.	During construction and operation

during night-time works).	Disturbing surrounding habitat making it less preferable for native species or conditioning avoidance and affecting normal distribution patterns	Works will not occur at night. Misting or wetting can be used to manage airborne dust particles.	Hours and amount of artificial light and noisy machine operation will be minimised wherever practical to reduce impact on surrounding habitat. Watering down and implementation of sensible driving speeds on the access roads will minimise dust generation and reduce impact on surrounding habitat.		Light meters can be used to monitor light pollution and ensure it stays at or below acceptable levels during works. Air quality, Noise and Vibration monitoring and management performed as per DRM Air Quality, Noise and Vibration Management Plan.	
Construction or clearing activities.	Injury/fatality of fauna.	Pre-clearance surveys to be undertaken by qualified fauna spotter/catchers to avoid unintentional tampering of animal breeding places. Clearing will be performed sequentially to direct fauna towards adjacent habitat and away from work sites.	All people driving on site to stay on roads to lower risk of hitting an animal, and follow vehicle speed limits to further lower risk. Speed limit along turbine access roads will be 20km/h or less.	Fauna spotter/catchers operating under an approved rehabilitation permit to check areas prior to work commencing, and to be present during clearing. Fauna will preferably be allowed to move on their own accord, but if this does not occur and access is required immediately then fauna spotter/catchers operating under an approved rehabilitation permit will relocate them. Injured wildlife can be brought to local wildlife carers: **Western Qld Wildlife Rehabilitation Centres: Cloncurry – 0419 422 900**	Maintaining records of any fauna interactions on site as per existing WAF Permits to inform management adjustments.	During design and construction

	Destruction of native habitat	Where possible, avoid the clearing of areas of habitat	Not applicable.	Rehabilitate cleared areas that are no longer required after construction has finished.	Monitor and maintain rehabilitated sites to ensure they are progressing as required (control of weeds, etc.).	
Wind turbine structures, primarily rotor blades and associated RSA.	Collisions between flying fauna and wind turbine rotors or other structures, or barotrauma as a result of flight close to rotors, resulting in injury or fatality.	Not applicable.	Maintain slashed grass transitioning into low shrub cover surrounding turbine pad to minimise bird and bat foraging and to facilitate carcass counts/removal. Project design including turbine selection and siting to minimise on ground disturbance footprint and total RSA, and increase RSA low boundary to reduce impact on aerial fauna.	Follow impact triggers and associated adaptive management strategies.	Follow impact triggers and associated adaptive management strategies.	During design and construction

5. Impact triggers and Adaptive Management

The impact triggers below are in accordance with the interim standards for risk assessment for wind farms and birds (Brett Lane & Associates Pty Ltd, 2005).

An impact trigger for threatened species occurs where a carcass (or recognisable part) of a threatened bird or bat species (listed under the NCA or EPBC Act) is found under or in close proximity to a turbine during any carcass search or incidentally during commissioning or operation.

For non-threatened birds and bat species, an impact trigger is where two or more of the same species, in two successive searches at the same turbine is recorded (i.e. a total of four or more carcasses of the same species in two successive searches at the same turbine) (Brett Lane & Associates Pty Ltd, 2005).

Under Condition D34 of the EA Permit (EPML00731213), this information will be made available to the administering authority upon request, and within forty eight (48) hours of the discovery of any fauna mortalities. Details of mortalities will include but not be limited to:

- animal species of the discovery of any fauna mortality;
- number of animals;
- location; and
- likely cause of death.

If the event is considered a potentially regular occurrence (based on assessment of survey data), or likely to lead to an impact to the population (at the appropriate scale i.e. Local, Regional, State, National); species specific monitoring may be required to determine potential causes and mitigation measures.

Table 8: Impacts and Mitigation Measures

Potential cause of impact	Monitoring to determine cause of impact	Mitigation Measure in response to impact trigger	Likelihood of impact after implementation of mitigation
Foraging source identified that attracts 'at risk' species to impact areas (e.g. flowering eucalypts, carrion associated with road kills, or spawning of insects).	Conduct additional targeted BBUS to assist in determining activity during these events. Conduct additional carrion monitoring in response to these events to determine if events are linked to impacts.	Trial acoustic or visual deterrents at turbine/s responsible for impact trigger.	Low
			Low
Bushfire, low pressure systems and storm fronts creating favourable conditions for aerial foragers.			Low
Low visibility due to wind/rain/fog.			Low

Potential options for acoustic deterrents include:

- The NRG ultrasonic acoustic Bat Deterrent System – which showed a 50% reduction in bat fatalities between turbines with 5 modules and turbines with none over a two year study in Texas (NRG Systems, 2020); and
- The Scarecrow 180™ - a well-researched bio-acoustic bird dispersal system. When coupled with a Scarecrow 360™ ‘slave’ unit it creates a system that provides 360º of dispersal.

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Appendix A – incidental species records

Common Name (*Scientific Name*)	Order	Status*	
		NCA	EPBC
Collared Sparrowhawk (*Accipiter cirrocephalus*)	Accipitriformes	LC	NL
Spotted Harrier (*Circus assimilis*)	Accipitriformes	LC	NL
Black Swan (*Cygnus atratus*)	Anseriformes	LC	NL
Australian Owlet-nightjar (*Aegotheles cristatus*)	Caprimulgiformes	LC	NL
Spotted Nightjar (*Eurostopodus argus*)	Caprimulgiformes	LC	NL
Tawny Frogmouth (*Podargus strigoides*)	Caprimulgiformes	LC	NL
Black-fronted Dotterel (*Elseyornis melanops*)	Charadriiformes	LC	NL
Pied Stilt (*Himantopus leucocephalus*)	Charadriiformes	LC	NL
Little Button-quail (*Turnix velox*)	Charadriiformes	LC	NL
Peaceful Dove (*Geopelia placida*)	Columbiformes	LC	NL
Spinifex Pigeon (*Geophaps plumifera*)	Columbiformes	LC	NL
Crested Pigeon (*Ocyphaps lophotes*)	Columbiformes	LC	NL
Common Bronzewing (*Phaps chalcoptera*)	Columbiformes	LC	NL
Red-backed Kingfisher (*Todiramphus pyrrhopygius*)	Coraciiformes	LC	NL
Pallid Cuckoo (*Heteroscenes pallidus*)	Cuculiformes	LC	NL
Pheasant Coucal (*Centropus phasianinus*)	Cuculiformes	LC	NL
Horsefield's Bronze Cuckoo (*Chalcites basalis*)	Cuculiformes	LC	NL
Common Koel (*Eudynamys orientalis*)	Cuculiformes	LC	NL
Australian Hobby (*Falco longipennis*)	Falconiformes	LC	NL
Black Falcon (*Falco subniger*)	Falconiformes	LC	NL
Brown Quail (*Synoicus ypsilophorus*)	Galliformes	LC	NL
Australian Bustard (*Ardeotis australis*)	Otidiformes	LC	NL
Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*)	Passeriformes	LC	NL
Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*)	Passeriformes	LC	NL
Kalkadoon Grasswren (*Amytornis ballarae*)	Passeriformes	LC	NL
Dusky Woodswallow (*Artamus cyanopterus*)	Passeriformes	LC	NL
White-browed Woodswallow (*Artamus superciliosus*)	Passeriformes	LC	NL
Pied Honeyeater (*Certhionyx variegatus*)	Passeriformes	LC	NL
Spotted Bowerbird (*Chlamydera maculata*)	Passeriformes	LC	NL
Great bowerbird (*Chlamydera nuchalis*)	Passeriformes	LC	NL
Banded Honeyeater (*Cissomela pectoralis*)	Passeriformes	LC	NL
Black-tailed Treecreeper (*Climacteris melanurus*)	Passeriformes	LC	NL
Grey Shrike-thrush (*Colluricincla harmonica*)	Passeriformes	LC	NL
Little Shrike-thrush (*Colluricincla megarhyncha*)	Passeriformes	LC	NL
White-bellied Cuckoo-shrike (*Coracina papuensis*)	Passeriformes	LC	NL
Grey Butcherbird (*Cracticus torquatus*)	Passeriformes	LC	NL
Varied Sittella (*Daphoenositta chrysoptera*)	Passeriformes	LC	NL
Crimson Chat (*Epthianura tricolor*)	Passeriformes	LC	NL
Singing Honeyeater (*Gavicalis virescens*)	Passeriformes	LC	NL
Western Gerygone (*Gerygone fusca*)	Passeriformes	LC	NL

Magpie Lark (*Grallina cyanoleuca*)	Passeriformes	LC	NL
Australian Magpie (*Gymnorhina tibicen*)	Passeriformes	LC	NL
Pictorella Mannikin (*Heteromunia pectoralis*)	Passeriformes	LC	NL
White-winged Triller (*Lalage tricolor*)	Passeriformes	LC	NL
White-plumed Honeyeater (*Lichenostomus penicillatus*)	Passeriformes	LC	NL
Brown Honeyeater (*Lichmera indistincta*)	Passeriformes	LC	NL
Purple-backed Fairy-wren (*Malurus assimilis*)	Passeriformes	LC	NL
Red-backed Fairy-wren (*Malurus melanocephalus*)	Passeriformes	LC	NL
Yellow-throated Miner (*Manorina flavigula*)	Passeriformes	LC	NL
Rufous Songlark (*Megalurus mathewsi*)	Passeriformes	LC	NL
Northern Inland Hooded Robin (*Melanodryas cucullata picata*)	Passeriformes	LC	NL
Brown-headed Honeyeater (*Melithreptus brevirostris*)	Passeriformes	LC	NL
Black-chinned Honeyeater (*Melithreptus gularis*)	Passeriformes	LC	NL
Jacky Winter (*Microeca fascinans*)	Passeriformes	LC	NL
Paperbark Flycatcher (*Myiagra nana*)	Passeriformes	LC	NL
Crested Bellbird (*Oreoica gutturalis*)	Passeriformes	LC	NL
Olive-backed Oriole (*Oriolus sagittatus*)	Passeriformes	LC	NL
Rufous Whistler (*Pachycephala rufiventris*)	Passeriformes	LC	NL
Red-browed Pardalote (*Pardalotus rubricatus*)	Passeriformes	LC	NL
Striated Pardalote (*Pardalotus striatus*)	Passeriformes	LC	NL
Red-capped Robin (*Petroica goodenovii*)	Passeriformes	LC	NL
Long-tailed Finch (*Poephila acuticauda*)	Passeriformes	LC	NL
Grey-crowned Babbler (*Pomatostomus temporalis*)	Passeriformes	LC	NL
Spinifexbird (*Poodytes carteri*)	Passeriformes	LC	NL
Yellow-tinted Honeyeater (*Ptilotula flavescens*)	Passeriformes	LC	NL
Grey Fantail (*Rhipidura fuliginosa*)	Passeriformes	LC	NL
Weebill (*Smicrornis brevirostris*)	Passeriformes	LC	NL
Double-barred Finch (*Taeniopygia bichenovii*)	Passeriformes	LC	NL
Glossy Ibis (*Plegadis falcinellus*)	Pelicaniformes	SL	M
Australasian Grebe (*Tachybaptus novaehollandiae*)	Podicepediformes	LC	NL
Red-winged Parrot (*Aprosmictus erythropterus*)	Psittaciformes	LC	NL
Cloncurry Ringneck (*Barnardius zonarius macgilvrayi*)	Psittaciformes	LC	NL
Sulphur-crested Cockatoo (*Cacatua galerita*)	Psittaciformes	LC	NL
Southern Boobook (*Ninox boobook*)	Strigiformes	LC	NL
Eastern Barn Owl (*Tyto alba*)	Strigiformes	LC	NL
Emu (*Dromaius novaehollandiae*)	Struthioniformes	LC	NL

* NCA = *Nature Conservation Act 1992*; EPBC = *Environment Protection and Biodiversity Conservation Act 1999*; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; SLC = Special Least Concern; LC = Least Concern; M = Migratory; Ma = Marine

Appendix B - General Collision Risk Assessment For Bird Orders/Families

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Risk Susceptibility	Collision Consequence
Accipitriformes	Foraging and dispersing	Accipitriformes is an order of birds that includes most of the diurnal birds of prey, including hawks, eagles, vultures, and kites, but not falcons (Atlas of Living Australia, n.d.).	Fast flight with medium manoeuvrability	Within RSA	Medium to large	16	High	Occasional loss of individuals
Anseriformes	Dispersal	Anseriformes is an order of birds also known as waterfowl that comprises about 180 living species of birds in three families. Most modern species in the order are highly adapted for an aquatic existence at the water surface. (Atlas of Living Australia, n.d.)	Slow with low manoeuvrability	Typically below RSA height, other than migration.	Large		Low	No loss of individuals
Caprimulgiformes	Dispersal	Caprimulgiformes are soft-plumaged birds, the major groups of which are called nightjars, nighthawks, potoos, frogmouths, and owlet-frogmouths. Most are twilight- or night-flying birds (Schwartz, 2008).	Medium speed with medium manoeuvrability	Typically below RSA height, other than dispersal.	Medium		Low	No loss of individuals
Charadriiformes	Dispersal	Charadriiformes is a diverse order of small to medium-large birds. Most charadriiform birds live near water and eat invertebrates or other small animals; however, some are pelagic (seabirds), others frequent deserts, and a few are found in dense forest. Members of this group can also collectively be referred to as shorebirds (Atlas of Living Australia, n.d.).	Slow to medium speed with low manoeuvrability	Foraging activities occur under RSA height, but dispersal flight height is within the RSA	Small to medium		Low	No loss of individuals

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Risk Susceptibility	Collision Consequence
Columbiformes	Not likely	Columbiformes is an order of birds containing the pigeons and doves in one family, and the extinct dodo and solitaire in another. The pigeon family (Columbidae) contains about 316 species (Murton, 2023).	Medium speed with medium manoeuvrability	Typically below RSA height	Small to medium	43	Low	Rare loss of individuals
Coraciiformes	Dispersal and foraging for some species	Coraciiformes is an order of usually colourful birds including kingfishers and bee-eaters. The members of this order are linked by their “slamming” behaviour in which they thrash their prey into surfaces (Rand, 2023).	Medium speed with high manoeuvrability	Dispersal flight height is within the RSA. Foraging may occur in the RSA for some species	Small to medium	11	Moderate to high	Rare to repeated loss of individuals
Cuculiformes	Dispersal	Cuculiformes is an order of birds containing the cuckoos and the hoatzin. Most cuckoos are solitary, often furtive birds that are inconspicuous even when relatively common, and they do not form flocks (Friedmann, 2024).	Medium speed with medium manoeuvrability	May fly within height of RSA	Small to medium		Low	No loss of individuals
Falconiformes	Foraging and dispersal	Falconiformes is an order of birds containing falcons; diurnal raptors but not included in the order Accipitriformes with the others. Although rarely abundant, falcons are widespread and live in diverse habitats (Gill & Brown, falconiform, 2016).	Fast flight with high manoeuvrability	Within RSA	Medium	8	High	Occasional loss of individuals
Galliformes	Not likely	Galliformes is an order of fowl-like birds containing 290 species including turkeys, chickens, quail, pheasant, and peacock (Haverschmidt, 2023).	Fast flight but rarely sustained for long distances. Low manoeuvrability	Typically below RSA height	Small to large		Low	No loss of individuals

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Risk Susceptibility	Collision Consequence
Otidiformes	Not likely	Otidiformes is an order of large birds containing bustards, floricans, and korhaans. They are highly terrestrial, often seen walking slowly or staying motionless among the vegetation. They don't fly very often but can sustain strong flight when they do (Bouglouan, n.d.).	Fast flight with low manoeuvrability	Typically below RSA height	Large		Moderate	Rare loss of individuals
Passeriformes *Artamidae*	Foraging and dispersal	The *Artamidae* family of the Order Passeriformes includes the woodswallows, butcherbirds and the Australian magpie. Most are predatory, feeding on a vast array of prey items, from insects to reptiles and other birds.	Variable. Some species fast and agile.	Some species frequently within RSA	Small to medium	292	Moderate to High	Occasional to repeated loss of individuals
Passeriformes *Hirundinidae*	Foraging and dispersal	The *Hirundinidae* family of the Order Passeriformes includes swallows and martins. These passerine birds are specifically adapted for aerial feeding on insects.	Fast flight with high manoeuvrability.	Within the RSA	Small	31	Moderate	Repeated loss of individuals
Passeriformes *Other families*	Foraging and dispersal	Passeriformes is the largest order of birds and the dominant avian group comprised of approximately 5700 species. Passeriformes are true perching birds characterised by their four toes, three directed forward and one backward. The majority are insectivorous, some being aerial feeders and others gleaning insects from surfaces (Austin, Clench, & Gill, 2024).	Variable. Some species fast and agile.	May fly within height of RSA	Small to medium	174	Low to Moderate	Occasional loss of individuals

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Risk Susceptibility	Collision Consequence
Pelecaniformes	Dispersal	Pelecaniformes is an order of large aquatic birds with webbing or partial webbing between all four toes, including pelicans, egrets, ibises, and spoonbills. The various groups of Pelecaniformes are specialized for different feeding methods, however they all feed at bodies of water (Ashmole, 2022).	Medium speed with low manoeuvrability	May fly within height of RSA	Large	5	Moderate	Rare loss of individuals
Podicipediformes	Dispersal	Podicipediformes is an order comprised of a single family of foot-propelled diving birds called Grebes. Grebes feed and breed on still or slow-moving bodies of water (Storer, 2023).	Medium speed with low manoeuvrability	May fly within height of RSA	Medium		Moderate	Rare loss of individuals
Psittaciformes	Dispersal	Psittaciformes is an order of more than 360 species of generally bright coloured, noisy birds. Typically, parrots are gregarious and noisy, often forming small groups, sometimes huge flocks, flying rapidly high overhead and screeching. Parrots feed almost entirely on plant materials. The smaller species tend to utilize grass seeds, berries, fruits, and the juices of blossoms; the larger forms obtain fruits and nuts from trees and bulbs, tubers, and roots from the ground (Gill & Woolfenden, 2024).	Medium speed with medium manoeuvrability	May fly within height of RSA	Medium	98	Moderate	Rare loss of individuals

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Risk Susceptibility	Collision Consequence
Strigiformes	Foraging and dispersing	Strigiformes is an order of primarily nocturnal raptors known as owls. Owls often attain higher population densities than hawks, the distribution and density of most species seem to be limited by the availability of suitable nesting sites, rather than by the number of potential prey animals. Owls that hunt over grassland hunt by sustained flight, dropping into the grass to catch rodents. Many woodland owls secure prey by dropping from perches at the edges of forest openings. The nocturnal routine of most owls involves peaks of activity at dusk and dawn (Marshall & Gill, 2024).	Fast flight with high manoeuvrability	May fly within height of RSA	Medium to large		Moderate	Rare loss of individuals
Struthioniformes	Not likely	Struthioniformes is an order of large flightless birds of which there are approximately 15 species. In Australia this refers to Emus and Cassowaries. They are omnivorous, and often good runners due to their long muscular legs (Bollich, n.d.).	Flightless	Flightless	Large		Low	No loss of individuals
Suliformes	Dispersal	Suliformes is a relatively new order of birds that includes cormorants, anhingas, frigatebirds, and boobies. These birds are adapted for life in the water and are generally large, with long wings and webbed feet. Suliformes are social animals and can often be found in large groups (Ocean Animals, 2023).	Medium speed with medium manoeuvrability	May fly within height of RSA	Large	2	Moderate	Rare loss of individuals

Appendix C - Collision Risk for NC and EPBC Act Listed Species

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Risk Susceptibility	Collision Consequence
	NCA	EPBC									
Cattle Egret (*Bubulcus ibis*)	LC	Ma	Possible	Dispersing	Capable of flying large distances. Is not considered highly mobile in the air	Would fly within the RSA.	Medium	The cattle egret has undergone one of the most rapid and wide-reaching natural expansions of any bird species (Telfair II, 2006). Cattle egret populations can be both sedentary and migratory (Maddock, 1990). If migrating, migration takes place from the south during spring. The cattle egret feeds on a wide range of prey, particularly insects, especially grasshoppers, crickets, flies (adults and maggots), and moths, (Seedikkoya, Azeez, & Shukkur, 2007)	Nil	Moderate	No loss
Sharp-tailed Sandpiper (*Calidris acuminata*)	SL	M, Ma, V	Possible	Dispersing	Capable of flying great distance during migration.	Likely to fly within RSA height during migration	Medium	The Sharp-tailed sandpiper prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewage farms, flooded fields, mudflats, mangroves, rocky shores and beaches. Its breeding habitat in Siberia is the peat hummock and lichen tundra of the high Arctic The Sharp-tailed sandpiper feeds on aquatic insects and their larvae, as well as worms, molluscs, crustaceans and sometimes, seeds. It is often found in large flocks, often with other waders, foraging in shallow waters (Pringle, 1987) (Simpson & Day, 1999).	Nil	Low	No loss

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Risk Susceptibility	Collision Consequence
	NCA	EPBC									
Black-eared Cuckoo (*Chalcites osculans*)	LC	Ma	Possible	Dispersing	Mobile agile flyer	May fly within height of RSA, but not normally at this height	Small	The Black-eared cuckoo is a parasitic breeder, that is, it lays its eggs in the nests of other birds. By preference, the Black-eared cuckoo chooses the domed or enclosed nests of species such as the Speckled Warbler, or the Redthroat (Birdlife Australia, 2024) It is migratory, moving into the sub-coastal areas of south-east and south-west Australia for the summer. The Black-eared Cuckoo perches on a shrub or tree, and drops from its perch to forage for insects on the ground. Would generally forage within canopy height (Birdlife Australia, 2024).	Nil	Low	No loss of individuals
Latham's Snipe (*Gallinago hardwickii*)	SL	M, Ma, V	Possible	Dispersing	Capable of flying great distance during migration. Moderate mobility	May fly to RSA during migration	Medium	Latham's Snipe is a migratory wader, travelling to Australia during the warmer months, typically arriving in Australia in September. Birds may fly directly between Japan and Australia, stopping at a few staging areas. They leave their breeding areas from August to November, arriving in Australia mainly in September. They leave the south-east by the end of February, moving northwards along the coast. Most have left Queensland by mid-April (Pringle, 1987) (Higgins & Davies, 1996). Latham's snipes are omnivorous, eating seeds and plant material, worms, spiders and insects, some molluscs, isopods and centipedes (Higgins & Davies, 1996) (Lane, 1987).	Nil	Low	No loss of individuals

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Risk Susceptibility	Collision Consequence
	NCA	EPBC									
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	LC	Ma	Possible	Dispersing	Capable of flying great distance. Moderate mobility	Likely to fly within RSA height	Large	Inhabits a variety of habitats including coasts, islands, estuaries, inlets, large rivers, inland lakes, reservoirs. Widespread along all Australian coasts, travels inland along large rivers or to large water sources. (Pizzey & Knight, 2012). The White-bellied Sea-Eagle feeds opportunistically on a variety of fish, birds, reptiles, mammals and crustaceans, and on carrion and offal (Rose, 2001). The White-bellied Sea-Eagle hunts its prey from a perch, or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). When a prey item is located, the sea-eagle usually launches into a dive or shallow glide to snatch its prey, usually in one foot, from the ground or water surface (Clunie, 1994) (del Hoyo, Elliott, & Sargatal, Handbook of the Birds of the World. Volume 2: New World Vultures to Guineafowl, 1994) (Ferguson-Lees & Christie, 2001) (Marchant & Higgins, 1993).	Nil	High	No loss of individuals
Caspian tern (*Hydroprogne caspia*)	SL	M, Ma	Possible	Dispersing	Capable of flying great distance during migration. Moderate mobility	May fly to RSA during migration	Medium	A large, part-migratory to migratory species of tern with a cosmopolitan distribution. In Australia, this species is primarily coastal, though travels inland to visit large bodies of water (Pizzey & Knight, 2012). The Caspian Tern's diet consists predominantly of fish (5–25 cm in length) as well as the eggs and young of other birds, carrion, aquatic invertebrates (e.g. crayfish), flying insects and earthworms (Birdlife International 2010a). They	Nil	Low	No loss of individuals

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Risk Susceptibility	Collision Consequence
	NCA	EPBC									
								forage diurnally, mostly early to mid-morning, patrolling in slow lazy flight, 3–15 m above the water. The species may forage up to 60 km from their nesting site (BirdLife International, 2023) (Higgins & Davies, 1996).			
Purple-crowned Fairy-wren (*Malurus coronatus*)	V		Possible	Foraging	Highly agile	Unlikely to fly within the RSA	Small	The species occurs from the Kimberly region to the gulf of Carpentaria drainage of western Queensland and north-eastern Northern Territory (TSSC, 2015). The species is restricted to a narrow band around well-vegetated river channels. They prefer thick riparian vegetation, typically of cane grass and/or pandanus, but also dense patchy shrubs up to 3 m (Ward & Woinarski, 2012). Purple-crowned fairy-wrens are territorial and sedentary, feeding in loose groups in the undergrowth or on the ground. The species is mainly insectivorous, consuming a range of small invertebrates such as beetles, ants, bugs, wasps, grasshoppers, moths, larvae, spiders, and worms and small quantities of seeds. They forage for their prey amongst foliage and in the leaf litter on the ground that may have accumulated as debris during floods.	Nil	Low	No loss of individuals

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Risk Susceptibility	Collision Consequence
	NCA	EPBC									
Rainbow Bee-eater (*Merops ornatus*)	LC	M	Known	Dispersing / Foraging	Highly mobile and agile in flight. Able to forage for insects on the wing. On migration, the Rainbow bee-eater may also fly over the top of non-preferred habitats such as rainforest or treeless plains	Would fly within the RSA.	Small	The Rainbow Bee-eater is most often found in open forests, woodlands and shrublands, and cleared areas, usually near water. It will be found on farmland with remnant vegetation and in orchards and vineyards. It will use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels (Birdlife Australia, 2022). The species is mainly insectivorous. Birds consume a range of small invertebrates captured in flight, including wasps, bees, dragonflies and similar.	11 (BBUS)	High	Repeated loss of individuals
Glossy ibis (*Plegadis falcinellus*)	SL	Ma, M	Known	Dispersing	Capable of flying large distances. Is not considered highly mobile in the air	Would fly within the RSA.	Medium	Prefers well-vegetated wetlands, floodplains, irrigated pastures, sewage ponds, mangroves, mudflats though may occur in dry grasslands further inland, particularly during good rainfall years. The migratory and nomadic species breeds in southern Australia between October to December and in north Australia between February to April (Pizzey & Knight, 2012). Glossy Ibis feed mainly on aquatic invertebrates/insects such as freshwater snails, mussels, crabs and crayfish. The species will also, however, eat fish, frogs and tadpoles, dryland invertebrates (such as beetles and grasshoppers), lizards, small snakes and nestling birds (del Hoyo, Elliot, & Sargatal, 1992) (Gowland, 1988) (Marchant & Higgins, 1990) (Vestjens, 1977).	One (prelim. surveys)	Moderate	Rare loss of individuals

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Risk Susceptibility	Collision Consequence
	NCA	EPBC									
Australian Painted Snipe (*Rostratula australis*)	E	E, Ma	Possible	Dispersing	Capable of flying great distances. Moderate mobility	No reference to flight height.	Medium	The Australian painted snipe occurs in shallow freshwater (occasionally brackish) waters, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland, dams, rice crops, sewage farms and bore drains, generally with a good cover of grasses, rushes and reeds, low scrub, *Muehlenbeckia* spp. (lignum), open timber or samphire (Reader's Digest, 1997) (Marchant & Higgins, 1993). This species feeds on insects, freshwater snails and worms from dusk to early morning, mostly in shallow water.	Nil	Low	No loss of individuals
Common Greenshank (*Tringa nebularia*)	SL	Ma, M, E	Possible	Dispersing	Capable of flying great distances. Highly agile.	Would fly within the RSA.	Medium	Inhabits mudflats, estuaries, saltmarshes, lake and pond margins, wetlands. Generally found in coastal environments, but present inland where habitat is suitable. Widespread summer migrant, with some overwintering. (Pizzey & Knight, 2012). The Common Greenshank is carnivorous. In Australia is has been recorded eating molluscs, crustaceans, insects, and occasionally fish and frogs. Elsewhere, it has also been recorded eating annelids, lizards, and rodents. The species feeds during both day and nighttime. It is active and agile, finding prey by sight or, occasionally, by touch (Higgins & Davies, 1996).	Nil	Low	No loss of individuals