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ENVIRONMENT

WIND PROSPECT PTY LTD
YANDIN WIND FARM
FLORA, VEGETATION AND AVIFAUNA ASSESSMENT

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Document Status						
Rev.	**Author(s)**	**Reviewer**	**Date**	**Approved for Issue**		
				Name	**Distributed To**	**Date**
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ACRONYMS

BAM Act	*Biosecurity and Agriculture Management Act 2007*
BOM	Bureau of Meteorology
BIF	Banded Ironstone Formation
CALM	Department of Conservation and Land Management (now DBCA and DER)
CAMBA	China – Australia Migratory Bird Agreement
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFWA	Department of Agriculture and Food Western Australia
DBCA	Department of Biodiversity, Conservation and Attractions (previously DPaW)
DEC	Department of Environment and Conservation (now DBCA)
DER	Department of Environmental Regulation
DoEE	Department of the Environment and Energy (Previously DSEWPaC)
DPaW	Department of Parks and Wildlife (now DBCA)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (now DoEE)
EPA	Environment Protection Authority
EP Act	*Environment Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESCAVI	Executive Steering Committee for Australian Vegetation Information
IA	International Agreement
IBRA	Interim Biogeographic Regionalisation for Australia
ICE	Incidence-based Coverage Estimators
IPA	Indigenous Protected Area
IUCN	International Union for Conservation of Nature
NVIS	National Vegetation Information System
PEC	Priority Ecological Community
TEC	Threatened Ecological Community
TPFL	Threatened and Priority Flora database
TP List	Threatened and Priority Flora List
WA	Western Australia
WAHERB	Western Australian Herbarium Specimen Database
WAOL	Western Australian Organism List
WC Act	*Wildlife Conservation Act 1950*
WONS	Weeds of National Significance

EXECUTIVE SUMMARY

ecologia Environment (*ecologia*) was commissioned by Wind Prospect Pty Ltd to undertake revised flora and fauna assessments of the Yandin Wind Farm project area located to the southeast of Cataby, Western Australia. A reconnaissance flora and vegetation survey, Threatened Ecological Community assessment, and avifauna survey were undertaken over the approximately 15,360 ha study area between September 18th and 20th 2017.

Flora and Vegetation

A total of 117 sub-generic vascular plant taxa from 35 families were recorded from the study area during the current survey. The most diverse families recorded were the Proteaceae (22 taxa), Myrtaceae (15 taxa), Fabaceae (10 taxa), and Poaceae (9 taxa).

DBCA database searches identified 61 conservation significant plant species that have been recorded within or have potential to occur within the study area. Only one Priority listed species (*Hypocalymma tetrapterum* P3) was recorded during the current survey, with targeted searches focussed on native vegetation patches in the vicinity of proposed development areas.

Vegetation data collected from 52 sites from across the study area were used to describe and map 16 vegetation units. Vegetation over 91.2% of the study area comprised scattered *Corymbia calophylla* or *Eucalyptus todtiana* trees over pasture weeds in 'completely degraded' condition. Low-lying areas dominated by **Juncus acutus* were also completely degraded. Two species rich shrubland units in good to excellent condition, five eucalypt woodland units in degraded condition, and seven eucalypt or *Banksia* woodland units in good to excellent condition, were described from remnant native vegetation patches.

Five patches of the 'Banksia Woodlands of the Swan Coastal Plain' ecological community were identified within the study area, in addition to two previously mapped patches. Based on vegetation structure and composition, patch size, and condition, each of these patches are considered to qualify as the TEC according to '*Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain Ecological Community*' (Threatened Species Scientific Committee 2016a).

Avifauna

Results of the current study verify those of a more comprehensive survey, impact assessment and risk assessment of potential bird strike with wind turbines undertaken by RPS Environment and Planning in 2010 (RPS 2010). That is, that there was a relatively low diversity of bird species recorded from open pasture areas characterising the proposed wind turbine positions, with the greatest diversity limited to stands of intact native vegetation comprised mainly of shrubland and heath. The presence of isolated trees within cleared areas often attracted birds, albeit in small numbers and at low diversities.

Although there are a number of regional wetlands in the wider locality wetland habitats at the study area were limited to small farm dams or degraded creeklines.

Forty-four species, within seven habitat types, were recorded during the survey. All species had previously been recorded by RPS (2010), apart from the Australasian Pipit and Emu. Birds recorded during the survey with at least the potential to fly within the rotor-swept area (RSA) potential collision zone were; Straw-necked Ibis, Black-shouldered Kite, Carnaby's Black-Cockatoo, Butler's Corella, Galah, and Australian Kestrel. All these species were similarly identified by RPS (2010).

RPS (2010) recorded species flying at RSA elevations 'on more than a rare occasion' as; Australian Kestrel, Wedge-tailed Eagle, Brown Falcon, White-backed Swallow, Black-shouldered Kite and Fairy

Martin. Of these, the Australian Kestrel and Black-shouldered Kite were also recorded within RSA elevations during this study.

Proteaceous heath and shrubland over the study area, as well as plantations of pine, provide foraging habitat for the threatened Carnaby's Black-Cockatoo. Flight movements are likely to follow movements to and from these food resources as well as roosting and/or breeding trees. RPS (2010) reported that this species primarily frequented lowland areas with movements tending to follow valleys with woodland vegetation.

RPS (2010) provide a comprehensive survey, impact assessment, and risk assessment of potential bird strike, with data obtained from this study corroborating the results presented there.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

Ecologia Environment (*ecologia*) was commissioned by Wind Prospect Pty Ltd to undertake revised flora and fauna assessments of the Yandin Wind Farm project area located to the southeast of Cataby, Western Australia to support a native vegetation clearing permit (NVCP) application and planning approvals for the proposed development (Figure 1.1). A reconnaissance flora and vegetation survey, Threatened Ecological Community assessment, and avifauna survey were undertaken over the approximately 15,360 ha study area (Figure 1.2) between September 18 and 20 2017.

1.2 SURVEY OBJECTIVES

The EPA's environmental objectives for the factors *Flora and Vegetation* (EPA 2016a) and *Terrestrial Fauna* (EPA 2016b) are: "To protect flora and vegetation and terrestrial fauna so that biological diversity and ecological integrity are maintained." In the context, 'ecological integrity' is the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements.

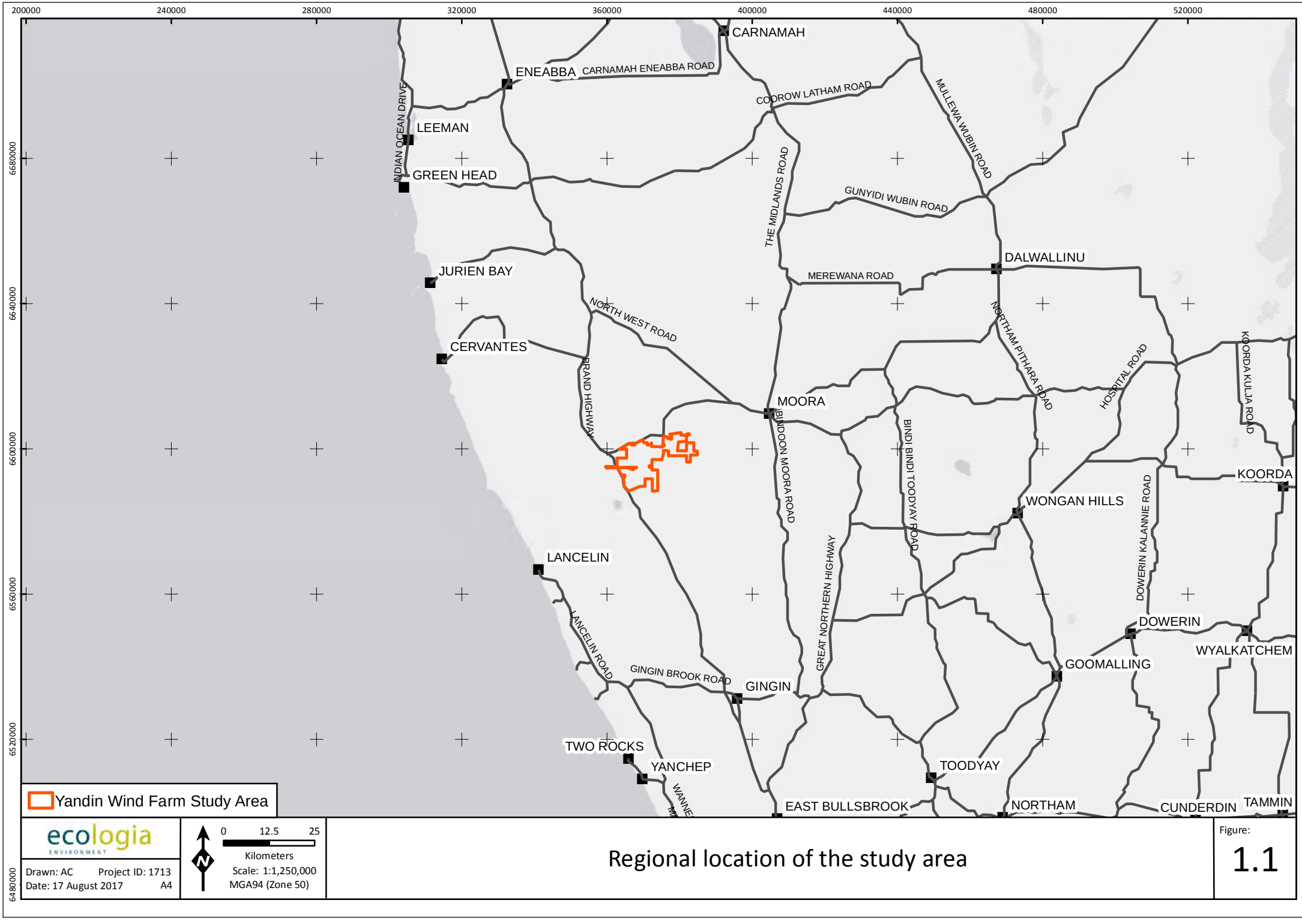
The primary objective of this flora and avifauna assessment was to provide sufficient information for the EPA to assess the impact of the proposed development on the flora, vegetation and avifauna of the study area, thereby ensuring that the EPA objectives will be upheld. To this end, the following were provided as part of this assessment:

- A desktop study to evaluate biological values of the study area and surrounds, including a review of existing environmental values, threatened and priority flora and vegetation databases, and other relevant available literature;
- A reconnaissance survey to confirm the findings of the desktop study and to verify the vegetation types described and mapped during a previous flora and vegetation survey (Outback Ecology 2009) and the assemblages and conservation status of bird species identified in the previous avifauna assessment (RPS 2010);
- An assessment of the EPBC Listed 'Banksia Woodlands of the Swan Coastal Plain' Threatened Ecological Community (TEC) within the study area;
- A targeted flora survey for Threatened and Priority listed plant species within remnant patches of native vegetation within the study area, with a focus on areas adjacent to proposed development;
- Vegetation community and condition mapping; and
- An up-to-date account of the birds of conservation significance potentially occurring, and augmentation and verification of the bird records obtained by RPS (2010) with an emphasis on flight patterns and movements.

1.3 LEGISLATIVE FRAMEWORK

The surveys were designed and undertaken to comply with the following guidance documents:

- Environmental Factor Guideline: Flora and Vegetation (EPA 2016a);
- Environmental Factor Guideline: Terrestrial Fauna (EPA 2016b);
- Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016c); and
- Technical Guidance: Terrestrial Fauna Surveys (EPA 2016d).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GREEN HEAD
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GUNYIDI WUBIN ROAD
DALWALLINU
JURIEN BAY
MEREWANA ROAD
NORTH WEST ROAD
NORTHAM PITHARA ROAD
HOSPITAL ROAD
KOORDA KULJA ROAD
CERVANTES
BRAND HIGHWAY
MOORA
BINDOON MOORA ROAD
BINDI BINDI TOODYAY ROAD
KOORDA
WONGAN HILLS
DOWERIN KALANNIE ROAD
LANCELIN
GREAT NORTHERN HIGHWAY
DOWERIN
WYALKATCHEM
LANCELIN ROAD
GINGIN BROOK ROAD
GOOMALLING
GINGIN
TWO ROCKS
YANCHEP
TOODYAY
EAST BULLSBROOK
NORTHAM
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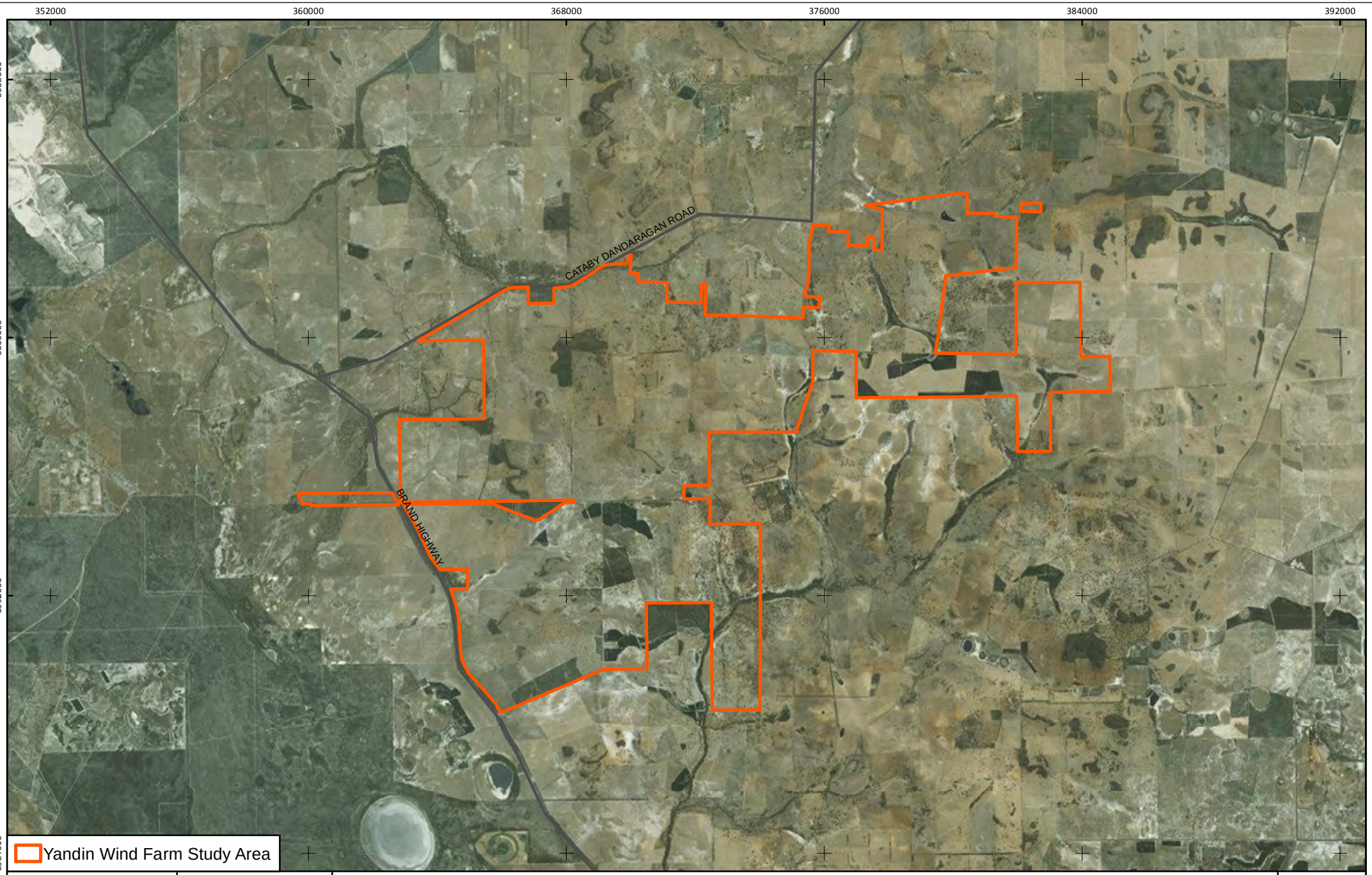

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Yandin Wind Farm study area

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2 DEFINITIONS

2.1 SIGNIFICANT FLORA

According to the *EPA Factor Guideline: Flora and Vegetation* (EPA 2016a), plant species (or records) may be considered significant for a number of reasons including, but not restricted to, the following:

- Being identified as Threatened or Priority species;
- Locally endemic species or those associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- New species or those having anomalous features that indicate a potential new species;
- Being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- Unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- Being representative of taxonomic groups that no longer occur widely in the broader landscape (relictual species/populations).

***Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia)**

At a Commonwealth level, Threatened Flora are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild (refer to Appendix A for category definitions).

***Wildlife Conservation Act 1950* (Western Australia)**

At State level, Threatened Flora species are protected under the WC Act. These are taxa which have been adequately surveyed and are deemed to be either rare, in danger of extinction, or otherwise in need of special protection in the wild, and are gazetted as Threatened (Declared Rare) Flora. Threatened Flora are further categorised by DBCA according to their level of threat using the International Union for Conservation of Nature (IUCN) red list criteria (IUCN 2001) (Appendix A). These taxa are legally protected and their removal or impact to their surroundings cannot be conducted without Ministerial approval, obtained specifically on each occasion for each population.

Priority Flora (DCBA)

DBCA maintains a list of Priority Flora species, which are considered poorly known, uncommon or under threat but for which there is insufficient justification to be listed as Threatened, based on known distribution and population sizes. Priority Flora species are assigned to one of four categories, described in Appendix A.

2.2 SIGNIFICANT VEGETATION

According to *EPA Factor Guideline: Flora and Vegetation* (EPA 2016a), vegetation may be considered significant for a number of reasons including, but not restricted to, the following:

- Being identified as Threatened or Priority Ecological Communities;
- Having a restricted distribution;
- The degree of historical impact from threatening processes;
- Playing a role as a refuge;
- Providing an important function required to maintain ecological integrity of a significant ecosystem.

Threatened Ecological Communities (Nationally Listed)

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat (DEC 2010). At a national level, Threatened Ecological Communities (TECs) are protected under the Commonwealth EPBC Act. An ecological community may be categorised into one of three sub-categories: Critically Endangered, Endangered, and Vulnerable (Appendix A).

Threatened Ecological Communities (State Listed)

DBCA maintains a list of state listed TECs which are further categorised into three subcategories, reflecting those of the EPBC Act. Within the Western Australian classification, an ecological community will be listed as Vulnerable "when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future".

Priority Ecological Communities

DBCA maintains a list of Priority Ecological Communities (PEC). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined. DBCA categorises PECs into five categories, P1 to P5, depending on the level of threat to the community (Appendix A).

Regional and Local Significance

Regional significance addresses the representation of habitats at a biogeographic regional level. Vegetation communities that are restricted or uncommon in a regional context are considered regionally significant. Vegetation communities supporting Threatened Flora species may also be considered regionally significant. Accurate assessment of regional significance requires sufficient regional vegetation community data to be available, and described at a similar level to the current study.

Locally significant vegetation may include vegetation communities that are locally restricted, contain comparatively high structural or species diversity, or contain Priority Flora species that are restricted to these vegetation communities.

3 METHODOLOGY

3.1 DESKTOP STUDY

The methodology adopted for this desktop study was consistent with that recommended by EPA (2016c) and EPA (2016d). A review of background environmental information for the study area was conducted including previous flora, vegetation, and fauna surveys, climate (BoM), biogeography (IBRA 7) (USE 2012), soils (Northcote *et al.* 1960-1968), and pre-European vegetation (Shepherd *et al.* 2001).

A search and review of all available relevant reports in the vicinity of the study area was undertaken, as well as searches of mapping resources and databases listed in Table 3.1 to determine conservation significant species and communities previously recorded within the study area or vicinity.

All results were reviewed on the basis of the likelihood of occurrence of relevant conservation significant species occurring within the study area with consideration given to previous records, habitat requirements, and landform.

The database searches and literature review resulted in an inventory of flora, vegetation and avifauna of conservation significance with at least the potential to occur within the study area.

Table 3.1 – Databases searched for the literature review

Database	Search Details
EPBC Act Protected Matters Database	Records of matters of national significance under the EPBC Act within 10 km of the study area
DBCA Threatened and Priority Ecological Communities Database	Records of TEC/PECs within 10km of the study area
DBCA Threatened and Priority flora Database	Records of significant flora within 10 km of the study area
Threatened and Priority flora List (TPList)	Records of significant flora by place names within 10 km of the study area
Western Australian Herbarium Specimen Database (WAHERB)	Records of significant flora within 10 km of the study area
DBCA NatureMap	All flora records within 10 km of the study area and avifauna records within 20 km of the study area

The database searches and literature review resulted in an inventory of flora, vegetation and avifauna of conservation significance with at least the potential to occur within the study area. The criteria listed in Table 3.2 were then applied to determine the likelihood of occurrence of significant species and vegetation occurring within the study area given the likely landforms and broad habitats present.

Table 3.2 – Criteria used to assess the likelihood of occurrence of significant fauna, flora and vegetation

Rating	Criteria (significant flora and fauna)	Criteria (TEC/PEC)
Recorded	The taxon has previously been recorded in the study area.	The TEC/PEC (not including buffer) has previously been recorded in the study area.
Possible (1)	The habitat preference of the taxon is well defined or broadly defined and this habitat likely occurs within the study area, and there are previous records in the vicinity of the study area.	Due to the proximity of previous records and the likely presence of suitable habitat/geology within the study area, the TEC/PEC possibly occurs within the study area.
Possible (2)	The habitat preference of the taxon is broadly defined or undefined and suitable habitat possibly occurs at the study area, but there are no records in the vicinity of the study area; or there is otherwise insufficient information available to exclude the possibility of occurrence at the study area.	The community is broadly defined and could possibly occur at the study area and there are records in the vicinity of the study area; or there is insufficient information available to exclude the possibility of occurrence at the study area.
Unlikely (3)	The habitat preference of the taxon is well defined and suitable habitat is considered unlikely to be present within the study area.	The community is well defined and suitable habitat/geology is considered unlikely to be present within the study area.

3.2 FLORA AND VEGETATION

3.2.1 Field Methodology

The flora and vegetation survey was conducted at the study area between 18 and 20 September 2017, and was consistent with guidelines for a reconnaissance flora and vegetation survey (EPA 2016c) and '*Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain Ecological Community*' (Threatened Species Scientific Committee 2016a).

Reconnaissance Survey

As part of the reconnaissance flora and vegetation assessment, 48 'check sites' were surveyed across the study area to provide ground-truthed data for vegetation community and condition mapping. Check sites are an unmarked area in which floristic data are collected, and are a low-intensity survey technique used to confirm the presence of vegetation communities and assess vegetation condition. The following data were recorded for each site:

- Site number and location (GPS co-ordinate of the north-west corner);
- Photograph of the vegetation;
- Dominant growth form, height, cover and up to three species for the three traditional strata (upper, mid and ground) compatible with NVIS Level V (ESCAVI 2003);
- Additional information to assist vegetation classification, including landform, soils, slope, aspect, rock type and abundance, litter, and fire history; and
- Vegetation condition (Table 3.3) and description of disturbance.

'Banksia woodland of the Swan Coastal Plain' TEC Survey

To assess presence of the 'Banksia woodlands of the Swan Coastal Plain' TEC, 10 m x 10 m quadrats were established and sampled within remnant vegetation patches that were considered to potentially represent the TEC. The following data were recorded at each quadrat:

- Site number and location (GPS co-ordinate of the north-west corner);
- Photograph from the north-west corner;
- Size and shape of quadrat;
- Dominant growth form, height, cover and up to three species for the three traditional strata (upper, mid and ground) compatible with NVIS Level V (ESCAVI 2003);
- A comprehensive species list (including weeds);
- Additional information to assist vegetation classification, including landform, soils, slope, aspect, rock type and abundance, litter, and fire history; and
- Vegetation condition (Table 3.3) and description of disturbance.

Community characteristics given in the *Banksia Woodlands of the Swan Coastal Plain Approved Conservation Advice* (Threatened Species Scientific Committee 2016a) were used to identify the TEC, primarily:

1. Key Diagnostic Features

- Location
  - Swan Coastal Plain IBRA Bioregion (SWA01, SWA02), and extending into the Jarrah Forest Bioregion (JAF01, JAF02).
- Soils and Landform
  - Well drained, low nutrient soils on sandplains - Bassendean and Spearwood sands and occasionally on Quindalup sands.
- Structure and Composition
  - A distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by *Banksia attenuata, Banksia menziesii, Banksia prionotes,* or *Banksia ilicifolia;*
  - Emergent trees of medium or tall (>10 m) eucalypts (typically *Corymbia calophylla*, *Eucalyptus gomphocephala*, or *Eucalyptus marginata*) or *Allocasuarina* may be present above the *Banksia* canopy;
  - An often highly species-rich understorey of shrubs and herbs.

2. Condition Thresholds

To be considered as part of the TEC, a patch should meet at least the 'Good' condition category (Keighery 1994), typically with at least 'low' native plant species diversity and weeds at 5-50% cover.

3. Minimum Patch Size

Minimum patch sizes are apply based on condition:

- 'Pristine' – no minimum patch size applies
- 'Excellent' – 0.5 ha
- 'Very Good' – 1 ha
- 'Good' – 2 ha

4. Additional Considerations

- A patch is a discrete and mostly continuous area of the ecological community and may include small-scale (<30 m) variations, gaps and disturbances, such as tracks, paths or breaks
- Restored (revegetated or replanted) sites are not excluded from the listed community.

Conservation Significant Flora Survey

Threatened and Priority Flora species identified from the database searches were targeted during the field survey, informed by previous record locations and known habitat preferences. Searches for conservation significant species involved searches of potential suitable habitat and opportunistic records taken during traverses walked between sites, specifically targeting areas that would potentially be impacted by the proposed development, or in close vicinity to impact areas. Where conservation significant species were observed the following data were recorded:

- Recorder and date;
- Individual GPS coordinates (GDA94) (for individual or localised plants), or GPS coordinates of population extent (for more extensive populations);
- Number of plants (count, for individual or localised plants) or estimated number of plants for more extensive populations;
- Reproductive state;
- Vegetation type; and
- Landform.

Specimen Identification

Plant specimen identification was undertaken with reference to current taxonomic literature and herbarium reference specimens. Scientific names used in this report follows the species nomenclature currently adopted by the Western Australian Herbarium. Specimens that were believed to differ significantly from typical materal were indicated with 'affinity' (aff.). Specimens that could not be adequately identified to genus or species level due to the absence of flowering or fruit material required for positive identification were indicated with a question mark, but were not considered to be otherwise anomolous.

3.2.2 Vegetation Mapping

Vegetation units were characterised by determining diagnostic or characteristic combinations of dominant species. Vegetation communities are naturally variable across wide geographic areas, and units here are delineated based on the overall floristic similarity of sites with various spatial coverage. Therefore, species used in descriptions are those that are most dominant or characteristic of the vegetation type as a whole, but were not necessarily recorded in the same combination at all sites. Species that are recorded as sometimes occurring in a vegetation unit are indicated in the description by "±" (ESCAVI 2003). Extrapolative vegetation mapping based on aerial imagery and ground-truth data provided by site assessments was then used to map the described vegetation units within study area.

Vegetation condition was mapped across the study area based on vegetation condition ratings recorded at quadrats and check sites, as well as additional observations made during the survey.

Table 3.3 – Vegetation condition scale (Keighery 1994)

Vegetation Condition	Criterion
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

3.3 AVIFAUNA

RPS (2010) previously undertook targeted and systematic avifauna field surveys within the study area, utilising 27 bird census points during three separate survey periods; from 29th October to 7th November 2008, from 18th to 26th November 2008, and from 15th to 16th January 2009. In addition, RPS (2010) also conducted comprehensive surveys at the nearby Waddi Wind Farm, as well as around wetland habitats in the wider locality to determine regional status, and movements of local waterbird populations and to assess habitat potential for migratory wading bird species.

The flight characteristics of all individual species throughout all bird surveys were recorded by RPS (2010), with flight height ranges split into three zones in consideration of the potential collision zine of the rotor-swept area (RSA), that is, from 40 m to 152 m above ground level:

- Zone 1 – 0 to 40 m (that is, below the tip of turbine blade).
- Zone 2 – 40 to–152 m (RSA and potential collision zone).
- Zone 3 – >152 m (above the tip of turbine blade).

Sixty-one species were recorded within the Yandin Study area with flight activity and behaviour recorded in respect to the three zones above. A comprehensive impact assessment including a risk assessment of bird strike with turbines was undertaken.

The objectives of the current survey were to provide an up-to-date account of the birds of conservation significance potentially occurring over the Yandin Study area (given status changes since the RPS, 2010 study), and to augment the avian records obtained by RPS (2010).

Avifauna were recorded opportunistically during the current survey at 22 census sites, as part of the associated flora and vegetation study, in close proximity to the proposed wind turbine locations as well as over the entire study area. Heights and flight patterns were recorded for each species in consideration of the three zones above, and compared with the results of RPS (2010). The NatureMap database was scrutinised to obtain a current list of birds of conservation significance potentially occurring over the study area and a likelihood assessment undertaken as to their potential to occur, given the results of regional records, the previous work of RPS (2010)and the results of the current survey.

3.4 STUDY TEAM AND LICENCES

The flora, vegetation, and fauna assessments undertaken by *ecologia* was planned, coordinated, executed and reported by those summarised below in Table 3.4. DBCA licences to take flora and fauna for scientific purposes are also provided.

Table 3.4 – Study team and licences

Project Staff			
Name	**Qualification**	**Role**	**Project role**
Dr Andrew Craigie	B.Sc (Hons.), PhD (Botany)	Senior Botanist	Flora & vegetation assessment, plant specimen identification, reporting (flora)
Andre Schmitz	B.Sc. Env. Man.	Principal Ecologist	Vegetation and avifauna assessment, reporting (fauna)
Licences - "Licence to Take Flora for Scientific Purposes"			
The flora, vegetation assessment and fauna assessment described in this report was conducted under the authorisation of the following licences issued by DBCA:			
Name		**Licence Number**	**Valid until**
Dr Andrew Craigie		SL012097	30/04/2018

4 DESKTOP RESULTS

4.1 CLIMATE

The closest Bureau of Meteorology (BOM) weather station to the study area is the Badgingarra Research Station, approximately 40 km to the north. Based on these data, the study area experiences a typical dry Mediterranean climate with a hot dry period from December to March and a mild winter from June to August (Figure 4.1). The current survey was conducted in mid-September 2016, following a higher than average period of rainfall during August (Figure 4.1).

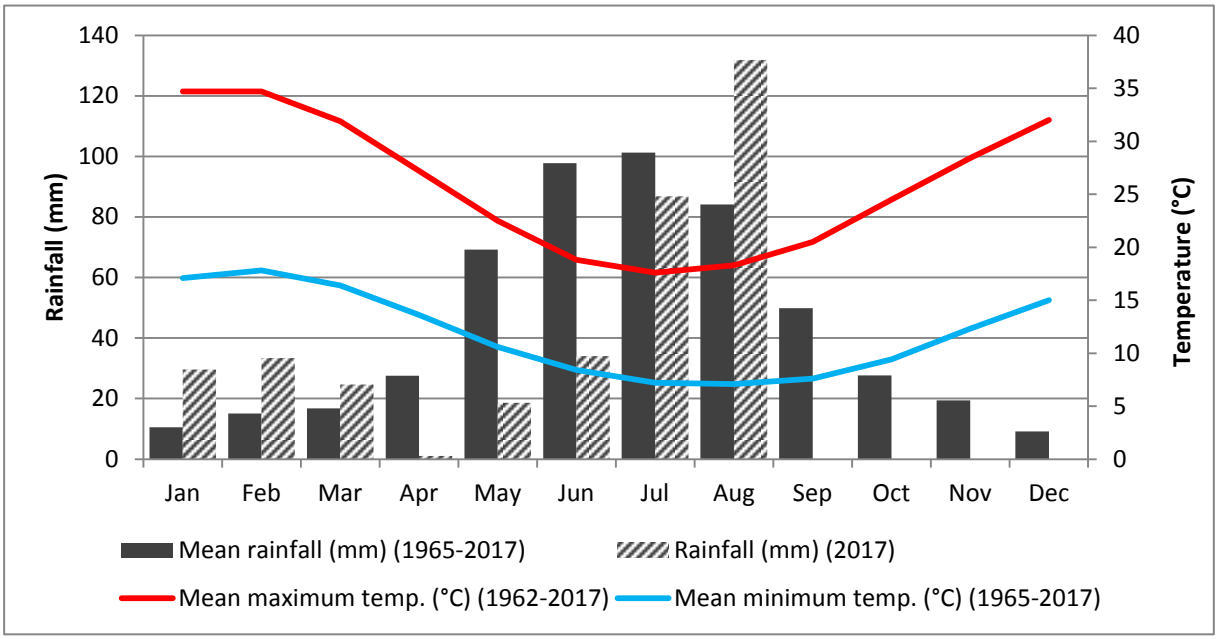


Figure 4.1 – Climate data from Badgingarra BOM weather station (Station No. 009037)

4.2 IBRA 7 BIOGEOGRAPHIC SUBREGIONS

The Interim Biogeographic Regionalisation for Australia (IBRA) (Version 7) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics, and has currently 89 recognised regions (DSEWPaC 2012). The study area is located on the boundary of two Bioregions; Swan Coastal Plain and Geraldton Sandplains.

Bioregions are further delineated into subregions, with the study area located on the junction of the Dandgaragan Plateau (SWA01), Swan Coastal Plain (SWA02), and Lesueur Sandplain (DES02) subregions (Figure 4.2).

The Dandgaragan Plateau subregion is bordered by the Derby and Dandaragan Faults, covering an area of approximately 447, 862 ha. Vegetation is typically dominated by low *Banksia* woodland, Jarrah-Marri woodlands, and scrub-heaths on laterite pavement and on gravelley sandplains (Desmond 2001). The subregion hosts a large number of rare plant and animal species, and supports a number of significant wetlands (Wannamal Lake System) and ecosystems (Desmond 2001), including the 'Banksia Woodlands of the Swan Coastal Plain' TEC.

The Swan Coastal Plain subregion is characterised by a low lying coastal plain of approximately 1,333,901 ha, mainly covered by woodlands dominated by *Banksia* or Tuart on sandy soils. *Casuarina obesa* is characteristic on outwash plains and *Melauleca* species are typical of swampy areas. In the

east, Jarrah woodland occur on elevated plains (Mitchell *et al.* 2002). The subregion exhibits very high species and ecosystem diversity, and supports numerous significant ecological communities, wetlands and other landscape features (Mitchell *et al.* 2002).

The Lesueur Sandplains subregion covers a total area of approximately 1,358,915 ha, comprising coastal aeolian sands and limestones, siltstones and sandstones, with extensive yellow sandplains in the south and east. Mosaics of lateritic mesas, sandplains, and coastal sands and limestones support shrub-heaths that are rich in endemics plant species, with heath occurring on the lateritised sandplains of the north and east eastern margins (Desmond and Chant 2003).

4.3 SOILS

Five soil units have been mapped within the study area using the Digital Atlas of Australian Soils (Northcote *et al.* 1960-1968) (Figure 4.3), none of which are considered to be restricted:

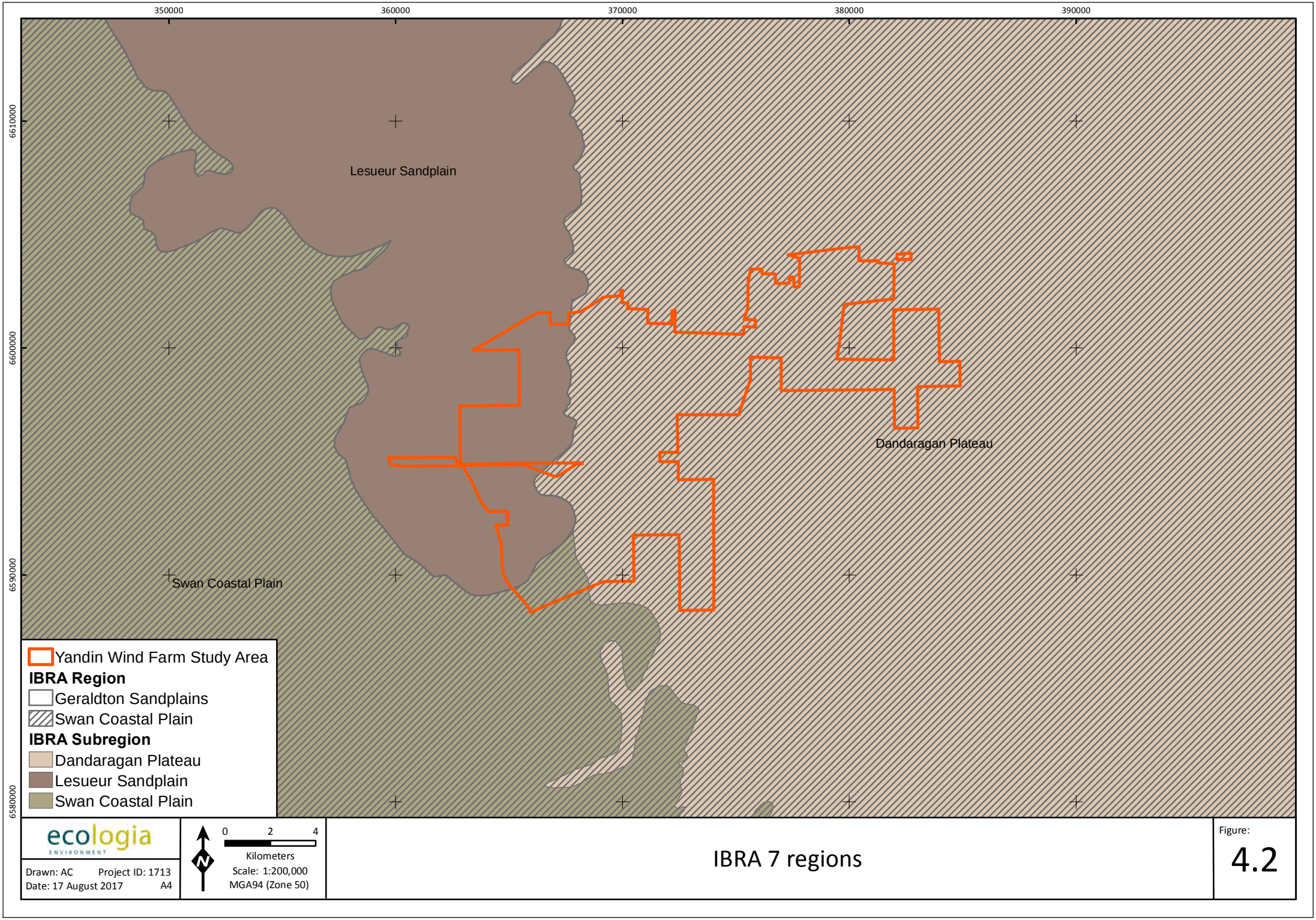
AB3 'Undulating to low hilly dissected plateau slopes often flanking areas of unit AC2, or occupying a zone between units AC2 and AB4: chief soils on the slopes are red earthy sands (Uc5.21). Associated are (Uc5.22) soils on ridges and (Uc2.21) soils in the centre of valleys, apart from limited areas of swamps in which occur diatomaceous earths' (Northcote *et al.* 1960-1968).

AB4 'Slopes flanking main trunk valleys; breakaways are common. There are two common sequences of soils: (i) on smooth slopes below breakaways red earthy sands (Uc5.21) occur, occasionally with (Gn2.12) soils and sometimes (Uc2.21) soils in the adjacent valley floors; (ii) on dissected slopes below breakaways red earthy sands (Uc5.21) occur but with some (Um6.21) soils on chalk outcrops, and further down slope are areas of (Dr), (Db), (Dy), and (Dd) soils, such as (Dr4.22), (Db2.22), (Dy3.12), and (Dd2.43) while adjacent valley floors also have (Dr) and (Db) soils. Areas of diatomaceous earths occur on some valley floors' (Northcote *et al.* 1960-1968).

AC2 'Gently undulating plateau underlain by sedimentary rocks: chief soils are yellow earthy sands (Uc5.22) with siliceous sands (Uc1.22). Associated are patches of (KS-Uc2. 12) and (Dy5. 84) soils; and (Uc2.21) soils in some shallow valley floors' (Northcote *et al.* 1960-1968).

Wd9 'Broad valleys and undulating interfluvial areas with some discontinuous breakaways and occasional mesas; lateritic materials mantle the area: chief soils are sandy acidic yellow mottled soils, (Dy5.81) containing much ironstone gravel in the A horizons, and (Dy5.84), both forming a complex pattern with each other and with lateritic sandy gravels (KS-Uc2.12). Associated are leached sands (Uc2.21) underlain by lateritic gravels and mottled clays that occur at a progressively greater depth down slope' (Northcote *et al.* 1960-1968).

Wd10 'Broad valleys and undulating interfluvial areas; some evenly sloping pediments with exposures of sandstone and shale: chief soils are sandy acidic yellow mottled soils, (Dy5.81) containing much ironstone gravel in the A horizons, and (Dy5.84), both forming a complex pattern with each other and with lateritic sandy gravels (KS-Uc2.12). Associated are leached sands (Uc2.21) underlain by lateritic gravels, and mottled clays that occur about 3 ft in depth and are shallower than in unit Wd9. Other soils include (Dy3.7 1), (Dy3 . 81), (Dy5.41) as well as (Uc2.21 and Uc2.22) on the pediments; and (Dr3.32), (Dy3.32), and (Dy3.22) in areas where country rock has been exposed' (Northcote *et al.* 1960-1968).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IBRA Region
Geraldton Sandplains
Swan Coastal Plain
IBRA Subregion
Dandaragan Plateau
Lesueur Sandplain
Swan Coastal Plain
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Date: 17 August 2017
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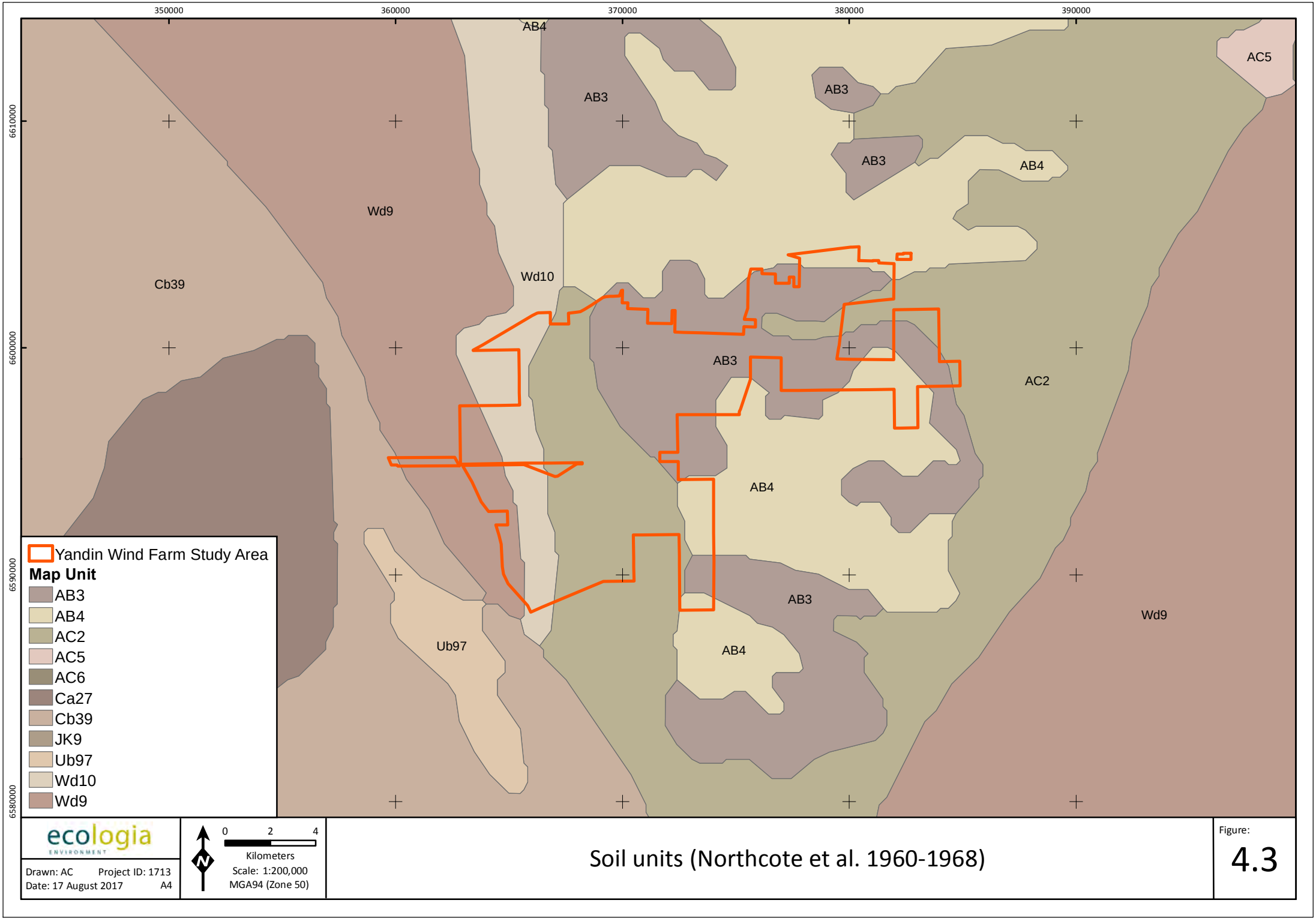
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Yandin Wind Farm Study Area
Map Unit
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MGA94 (Zone 50)
Soil units (Northcote et al. 1960-1968)
Figure:
4.3

4.4 VASCULAR FLORA

4.4.1 Floristic Diversity

A total of 485 vascular plant taxa (including species, infraspecific taxa, and phrase name taxa) have been recorded within 10 km of the study area (NatureMap) representing 59 families and 189 genera (Appendix B). The most diverse families were the Fabaceae (62 taxa), Proteaceae (58 taxa), Myrtaceae (57 taxa), and Cyperaceae (25 taxa). The most diverse genus was *Acacia* (19 taxa), *Eucalyptus* (15 taxa), *Stylidium* (15 taxa), *Hakea* (14 taxa), *Banksia* (13 taxa), and *Grevillea* (13 taxa).

4.4.2 Significant Plant Species

The TPFL and WAHERB database searches identified 61 conservation significant plant species occurring within a 10 km buffer of the study area (Figure 4.4; Figure 4.5, Figure 4.6). Eighteen of these, including two Threatened taxa and 14 Priority listed taxa have been recorded within the study area (Table 4.1). For the remaining taxa, due to the close proximity of previous records and habitat preferences, all are considered to have potential to occur within the study area.

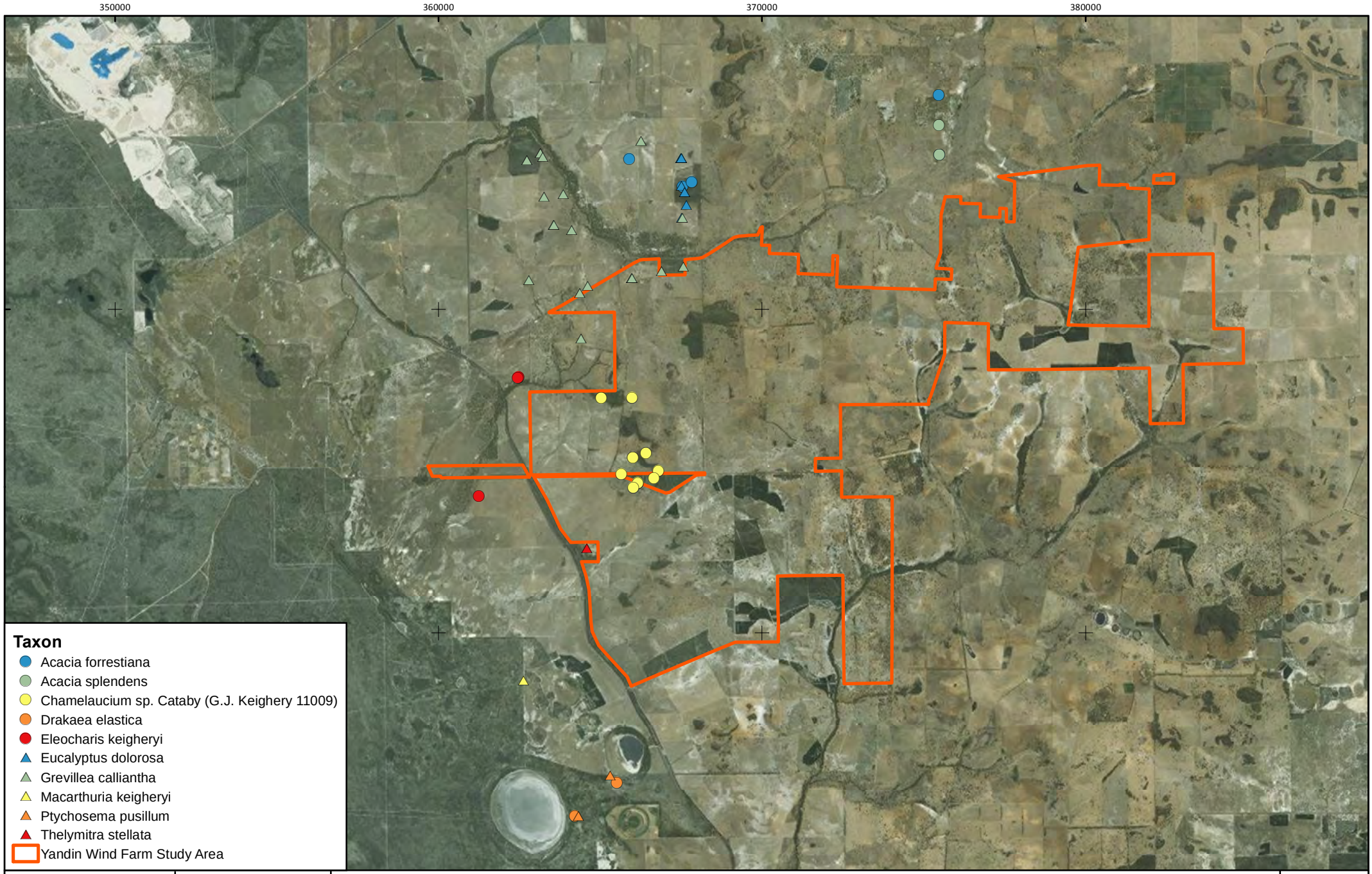
Habitat preferences and flowering times, as indicated in Table 4.1 were derived, where available, from relevant taxonomic literature, FloraBase (Western Australian Herbarium 1998-2016), Threatened species profiles (SPRATs) (Threatened Species Scientific Committee 2016b), or specimen data from Australia's Virtual Herbarium (AVH) (CHAH 2017). Herbarium catalogue numbers are provided if habitat information were derived from specimen data (AVH).

Table 4.1 – Threatened and Priority Flora records from database searches

Status	Taxon	Habitat	Flowering Time	Recorded within the study area
T	*Acacia forrestiana*	Lateritic gravelly soils, clay loam over sandstone. Gullies, hills, breakaways.	Nov to Dec	Possible
T	*Acacia splendens*	White sand over clay, pale brown loam, cracked brown soil, gravel, laterite, ironstone. Slopes of breakaways, especially southern slopes, hills.	May	Possible
T	*Chamelaucium* sp. Cataby (G.J. Keighery 11009)	Growing amongst laterite rocks on W-facing edge of breakaway (MEL 2013770A)	–	Recorded
T	*Drakaea elastica*	White or grey sand. Low-lying situations adjoining winter-wet swamps.	Oct to Nov	Possible
T	*Eleocharis keigheryi*	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Aug to Nov	Possible
T	*Eucalyptus dolorosa*	Laterite. Hillsides.	Feb to Mar	Possible
T	*Grevillea calliantha*	Grey or yellow sand over laterite, with gravel.	Apr or Jun or Aug	Recorded
T	*Macarthuria keigheryi*	White or grey sand.	Sep to Dec or Feb to Mar	Possible
T	*Ptychosema pusillum*	Sand. Rises.	Aug to Oct.	Possible
T	*Thelymitra stellata*	Sand, gravel, lateritic loam.	Oct to Nov	Possible
P1	*Babingtonia delicata*	Valley flat, slope. Pale grey sand / brown sandy clay. Winter wet area (PERTH 3255166)	–	Possible
P1	*Banksia prionophylla*	Dry grey sand over laterite with surface boulders. Rises.	Jul	Recorded
P1	*Eucalyptus annuliformis*	Shallow sandy soils. Rocky laterite slope.	May to Sep	Possible
P1	*Grevillea synapheae* subsp. A Flora of Australia (S.D. Hopper 6333)	Gravelly loam.	Sep	Possible
P1	*Grevillea synapheae subsp. minyulo*	Gravel, laterite.	Aug to Sep	Possible
P1	*Hypocalymma* sp. Dandaragan (C.A. Gardner 9014)	In grey sand with lateritic pebbles (PERTH 2353539)	–	Possible
P1	*Lasiopetalum* sp. Hill River (T.N. Stoate 5)	Hilltop, dry brown loam over laterite boulder (PERTH 3022080)	–	Possible
P1	*Rhetinocarpha suffruticosa*	Red-brown loamy clay, gravelly loam or clay loam over laterite. Slopes, small ridges.	–	Possible
P2	*Anigozanthos humilis* subsp. Badgingarra (S.D. Hopper 7114)	Grey-white sand, rich brown sandy loam, sandy clay, alluvial soils. Low plains, river-banks, winter-wet swamps.	–	Recorded

Status	Taxon	Habitat	Flowering Time	Recorded within the study area
P2	*Boronia scabra* subsp. *condensata*	Sandy clay or gravel. Upper slopes, edges of lateritic breakaways.	Aug	Possible
P2	*Dampiera tephrea*	Sand, gravelly loam.	Jul	Recorded
P2	*Desmocladus microcarpus*	–	–	Possible
P2	*Eucalyptus abdita*	Laterite, sandy clay with gravel over laterite. Slopes, breakaways.	–	Recorded
P2	*Gastrolobium nudum*	Red-brown clay, brown loam, gravel, laterite, granite. Flats, slopes, hilltops, ridges, valleys, breakaways.	Feb	Recorded
P2	*Hemigenia curvifolia*	Sandy soils.	Sep to Oct	Possible
P2	*Hypocalymma* sp. Cataby (G.J. Keighery 5151)	Grey sand.	Aug	Possible
P3	*Acacia cummingiana*	Grey or yellow sand, lateritic gravel. Sandplains, lateritic breakaways.	May to Jun or Aug	Possible
P3	*Acacia epacantha*	Lateritic gravelly loam or clay.	Jul to Aug	Possible
P3	*Acacia plicata*	Loamy & clayey soils, often over sandstone or siltstone. Along drainage lines.	Aug to Oct	Possible
P3	*Banksia dallanneyi* subsp. *pollosta*	Grey/yellow sand. Flats, lateritic rises.	Aug to Sep	Possible
P3	*Banksia kippistiana* var. *paenepeccata*	Lateritic gravelly soils.	Oct to Nov	Possible
P3	*Banksia pteridifolia* subsp. *vernalis*	White/grey sand over laterite	Sep to Oct	Possible
P3	*Beaufortia eriocephala*	Lateritic sandy soils. Slopes.	Sep to Nov	Possible
P3	*Calytrix ecalycata* subsp. *brevis*	Dry yellow sand. Sandplains, low rises.	Aug to Sep	Possible
P3	*Drosera marchantii* subsp. *prophylla*	Laterite-silica sand soils. Hilltops.	Jun to Jul	Possible
P3	*Grevillea florida*	Sand, sandy clay, gravel, laterite. Sandplain, slopes, road verges.	Jul to Sep	Possible
P3	*Grevillea thyrsoides* subsp. *thyrsoides*	Sand or sandy lateritic gravel.	Feb or Aug to Sep	Possible
P3	*Guichenotia alba*	Sandy & gravelly soils. Low-lying flats, depressions.	Jul to Aug	Possible
P3	*Haemodorum loratum*	Grey or yellow sand, gravel.	Nov	Possible
P3	*Hakea longiflora*	White sand, loam, gravel, laterite. Breakaway.	Jun to Sep	Recorded
P3	*Hypocalymma tetrapterum*	Grey sand, loam, lateritic gravel. Riverbanks, breakaways.	Aug	Recorded
P3	*Jacksonia carduacea*	Grey sand, sandy clay.	Aug to Dec	Recorded
P3	*Lechenaultia galactites*	Yellow sand, clay, gravel, laterite. Sandplains.	Jun to Oct	Possible
P3	*Lepidobolus quadratus*	Lateritic gravel, grey/white sand. Dry kwongan.	Aug to Sep	Possible
P3	*Leucopogon foliosus*	Dry grey/yellow sand and laterite (PERTH 5984475)	–	Possible

Status	Taxon	Habitat	Flowering Time	Recorded within the study area
P3	*Podotheca pritzelii*	Sand ridges in salt flats.	Sep to Oct	Recorded
P3	*Stylidium periscelianthum*	Loamy clay, moist soils pockets. Wet flats, low granitic hills.	Sep to Oct	Possible
P3	*Verticordia huegelii* var. *tridens*	Sandy or gravelly loam. Winter-wet areas, low hills.	Sep to Nov	Possible
P3	*Verticordia insignis* subsp. *eomagis*	Sandy soils over laterite. Sandplains, rocky rises.	Aug to Nov	Possible
P4	*Anigozanthos humilis* subsp. *chrysanthus*	Grey or yellow sand.	Jul to Oct	Recorded
P4	*Asterolasia drummondii*	Lateritic gravel & sand or loam. Lateritic hills & sandplains, breakaways.	Jul to Sep	Recorded
P4	*Conostephium magnum*	White-grey sands sometimes associated with laterite gravels. Sand dunes, swampland, disturbed roadside, drainage channels, open woodland.	Jul to Sep	Possible
P4	*Eucalyptus macrocarpa* subsp. *elachantha*	White or grey sand over laterite. Hillslopes, ridges, sandplains.	Aug to Sep or Nov to Dec	Recorded
P4	*Grevillea drummondii*	Lateritic soils (sandy clay, gravel, loam, sand), sand over granite. Rocky hillsides, boulders, granite outcrops.	Jun to Sep	Recorded
P4	*Grevillea olivacea*	White or grey sand. Coastal dunes, limestone rocks.	Jun to Sep	Possible
P4	*Grevillea saccata*	Yellow or brown sand, often with lateritic gravel.	Apr or Jun to Nov	Possible
P4	*Hypolaena robusta*	White sand. Sandplains.	Sep to Oct	Recorded
P4	*Stylidium aeonioides*	Sandy clay loam over laterite. Hillsides and breakaways. Low heath, open woodland.	Sep to Nov	Recorded
P4	*Thelymitra apiculata*	Grey sand, lateritic gravel.	May to Jul	Recorded
P4	*Thysanotus glaucus*	White, grey or yellow sand, sandy gravel.	Oct to Dec or Jan to Mar	Possible
P4	*Verticordia lindleyi* subsp. *lindleyi*	Sand, sandy clay. Winter-wet depressions.	May or Nov to Dec or Jan	Possible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Grevillea calliantha
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Ptychosema pusillum
Thelymitra stellata
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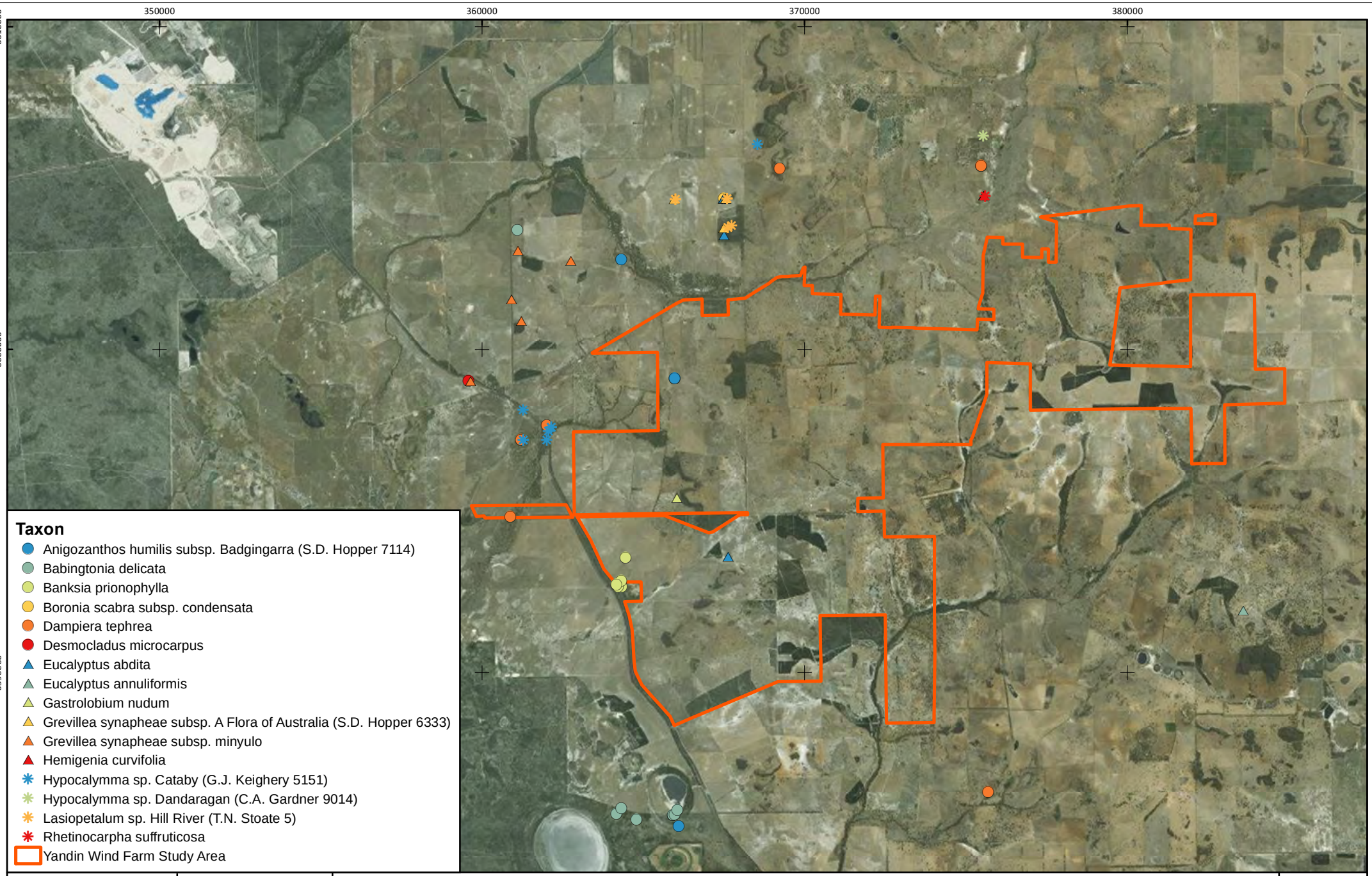
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Taxon
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Babingtonia delicata
Banksia prionophylla
Boronia scabra subsp. condensata
Dampiera tephrea
Desmocladus microcarpus
Eucalyptus abdita
Eucalyptus annuliformis
Gastrolobium nudum
Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)
Grevillea synapheae subsp. minyulo
Hemigenia curvifolia
Hypocalymma sp. Cataby (G.J. Keighery 5151)
Hypocalymma sp. Dandaragan (C.A. Gardner 9014)
Lasiopetalum sp. Hill River (T.N. Stoate 5)
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Yandin Wind Farm Study Area
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Figure:
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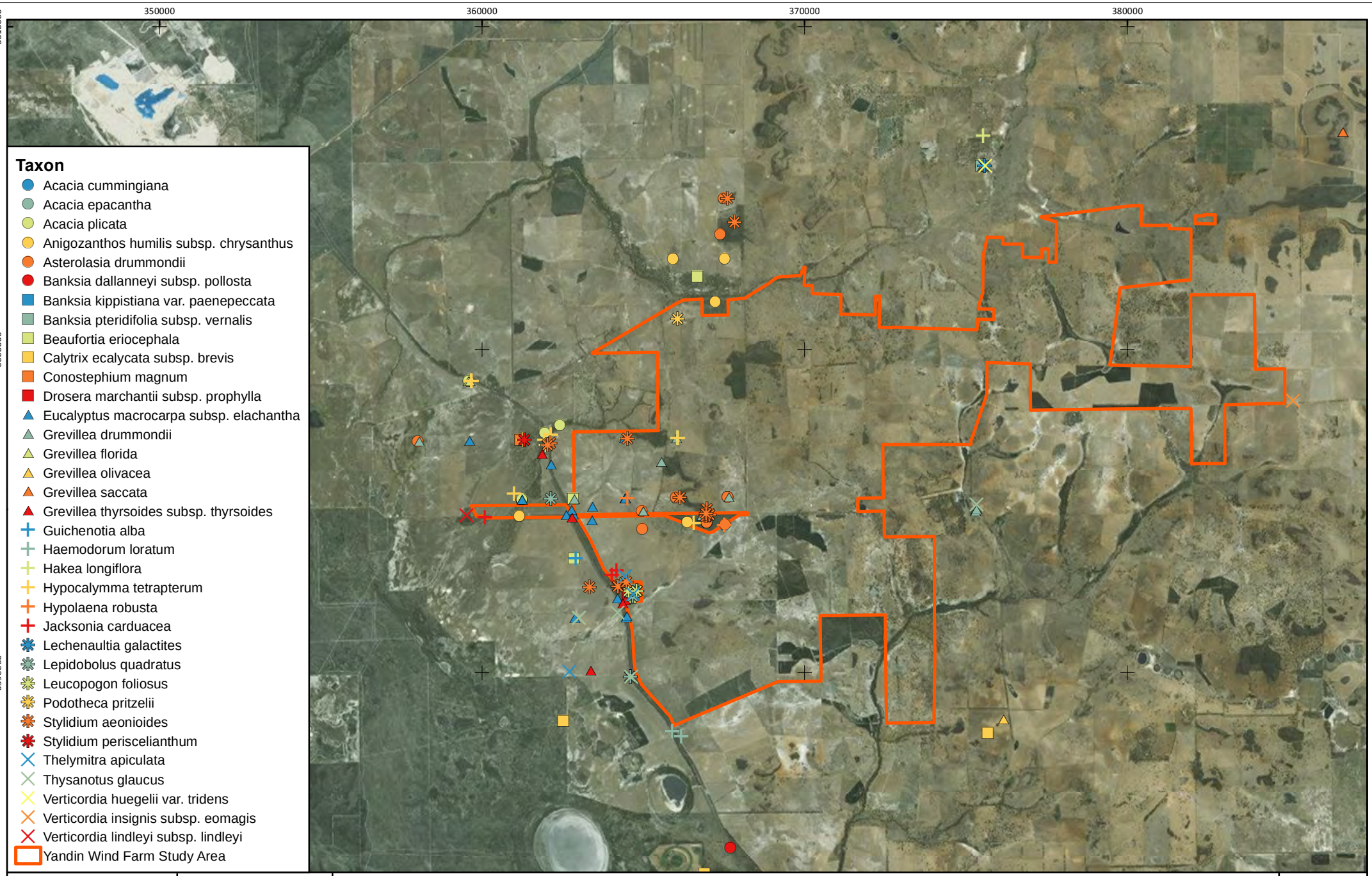
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Asterolasia drummondii
Banksia dallanneyi subsp. pollosta
Banksia kippistiana var. paenepeccata
Banksia pteridifolia subsp. vernalis
Beaufortia eriocephala
Calytrix ecalycata subsp. brevis
Conostephium magnum
Drosera marchantii subsp. prophylla
Eucalyptus macrocarpa subsp. elachantha
Grevillea drummondii
Grevillea florida
Grevillea olivacea
Grevillea saccata
Grevillea thyrsoides subsp. thyrsoides
Guichenotia alba
Haemodorum loratum
Hakea longiflora
Hypocalymma tetrapterum
Hypolaena robusta
Jacksonia carduacea
Lechenaultia galactites
Lepidobolus quadratus
Leucopogon foliosus
Podotheca pritzelii
Stylidium aeonioides
Stylidium periscelianthum
Thelymitra apiculata
Thysanotus glaucus
Verticordia huegelii var. tridens
Verticordia insignis subsp. eomagis
Verticordia lindleyi subsp. lindleyi
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4.6

4.5 VEGETATION

4.5.1 Pre-European Vegetation

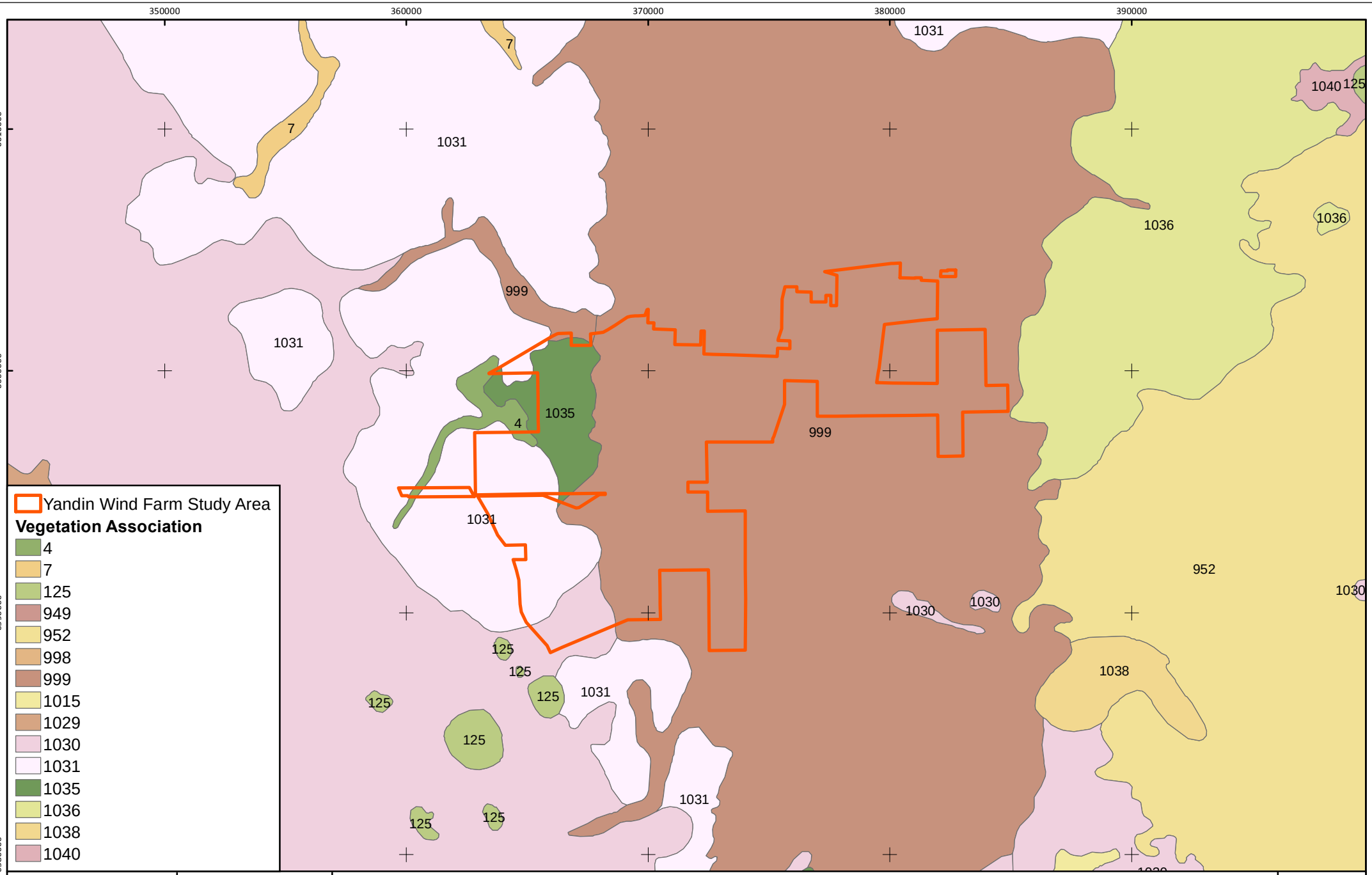
The pre-European vegetation of Western Australia was mapped at the 1:1,000,000 scale by Beard (1976), and was subsequently reinterpreted and updated to reflect the National Vegetation Information System (NVIS) standards (Shepherd *et al.* 2001). Five vegetation associations of Beard (1976) have been mapped within the area (Figure 4.7):

- Association 4: *Corymbia calophylla*, *Eucalyptus wandoo*, *Acacia acuminata* mid woodland over *Acacia nervosa*, *Gastrolobium* sp., *Hakea lissocarpha* tall open shrubland.
- Association 999: *Corymbia calophylla*, *Eucalyptus loxophleba*, *Acacia cyanophylla* mid woodland, over *Acacia pulchella*, *Boronia scabra*, *Bossiaea* sp. tall open shrubland, over *Hibbertia hypericoides*, *Hybanthus calycinus*, *Lechenaultia biloba* low open shrubland/forbland.
- Association 1030: *Banksia attenuata*, *Banksia menziesii*, *Eucalyptus todtiana* low woodland, over *Adenanthos cygnorum*, *Allocasuarina humilis*, *Jacksonia furcellata* tall open shrubland, over *Anigozanthos humilis*, *Conostylis aculeata*, *Eremaea fimbriata* low open shrubland.
- Association 1031: *Xanthorrhoea reflexa* tall open shrubland, over *Dryandra* (*Banksia*) *bipinnatifida*, *Hakea auriculata*, *Dryandra* (*Banksia*) *shuttleworthiana* mid shrubland, over *Banksia* sp., *Burchardia umbellata*, *Calectasia cyanea* low open shrubland/forbland.
- Association 1035: *Corymbia calophylla* mid open woodland.

The pre-European and current extent of each of these vegetation associations in the Swan Coastal Plain and Geraldton Sandplains bioregions, and within the study area, is presented in Table 4.2. The vegetation over most of the study area has been historically cleared, and therefore the area of each mapped within it does not accurately reflect current extent. A significant proportion (84.7%) of vegetation association 1035 within the Geraldton Sandplains Bioregion (pre-European) occurs within the study area; however, this association is very broadly defined as *Corymbia calophylla* mid open woodland.

Table 4.2 – Pre-European vegetation association extent

Vegetation Association	IBRA region	Pre-European extent (ha)	Current extent (ha)	% remaining	Area mapped in study area (ha)	Proportion of pre-European extent within study area (%)
4	GES	5,336.70	2,130.04	39.91	40.8	0.8
999		1,095.04	390.37	35.65	25.3	2.3
1030		3,848.52	2,790.59	72.51	NA	NA
1031		241,349.97	83,154.99	34.45	2270.6	0.9
1035		1,582.96	133.16	8.41	1340.9	84.7
4	SWA	15,897.08	3,010.45	18.94	NA	NA
999		102,939.79	9,609.84	9.34	10967.4	10.7
1030		134,788.56	86,061.30	63.85	606.0	0.4
1031		27,729.97	5,352.64	19.30	NA	NA
1035		3,435.37	360.96	10.51	NA	NA



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Pre-European vegetation (Beard 1976)

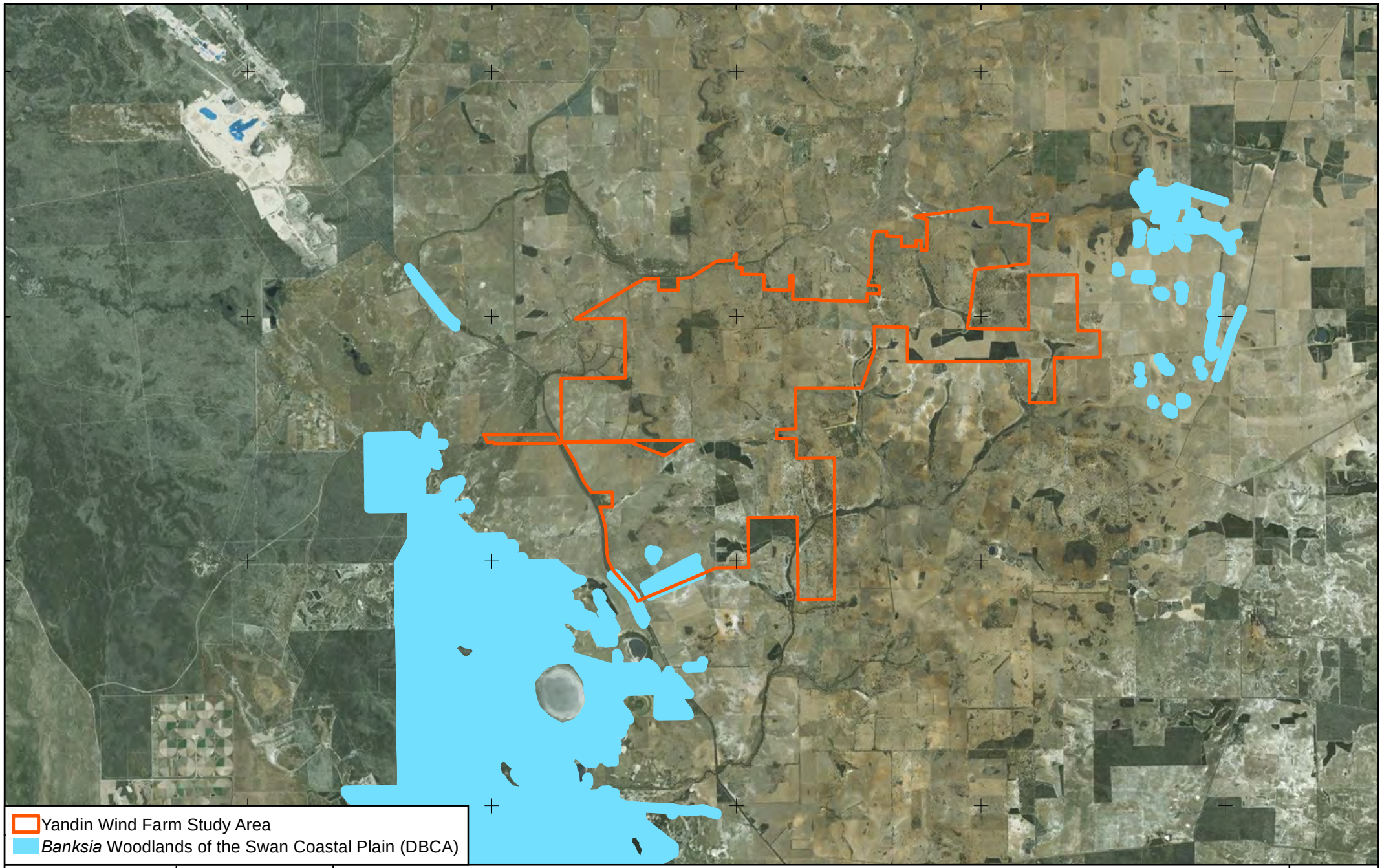
Figure: 4.7

4.6 SIGNIFICANT ECOLOGICAL COMMUNITIES

The EPBC Act listed (Endangered) 'Banksia woodlands of the Swan Coastal Plain' threatened ecological community has been recorded within the south-western boundary of the study area, and also in surrounding areas to the south-west and east (Table 4.3; Figure 4.8). This community is Priority 3 listed at a State level (DPaW 2017). No other TECs or PECs have been recorded within 10 km of the study area.

Table 4.3 – TECs in the vicinity of the study area

Name	EPBC Act Listing Status	WA Status	Description
Banksia woodlands of the Swan Coastal Plain	Endangered	Priority 3	'Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *B. menziesii*. Other *Banksia* species that can dominate in the community are *B. prionotes* or *B. ilicifolia*. It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and, in other less common scenarios' (DPaW 2017).



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Banksia Woodlands of the Swan Coastal Plain TEC (DBCA September 2017)

Figure: 4.8

4.7 PREVIOUS SURVEYS WITHIN THE STUDY AREA

4.7.1 Vegetation and Flora Assessments

Outback Ecology (2009)

Outback Ecology (2009) undertook a Level 1 Vegetation and Flora assessment at the Yandin Wind Farm project area (not corresponding exactly to the current study area) in November 2008 and January 2009, the purpose of which was to verify the findings of a desktop study, and to characterise the flora and vegetation communities present, including a targeted search for conservation significant plant species.

48 plant taxa were recorded within the study area from 16 families and 32 genera, one of which was a Priority Flora species (*Acacia plicata*), and four were introduced (*Cyperus congestus*, *Juncus acutus* subsp. *acutus*, *Typha orientalis*, and *Zantedeschia aethiopica*).

35 sampling points were assessed for vegetation condition. At all points, vegetation was considered degraded, occurring in 'parkland cleared' areas, occasionally with scattered native trees. An additional 14 relevés were assessed within remnant patches of native vegetation, within which 12 vegetation communities were described. Native vegetation patches were primarily dominated by eucalypt woodland communities, and were in degraded to excellent condition. An additional 11 relevés were surveyed along proposed access tracks, cable routes, and overhead transmission lines. At these sites, seven vegetation communities were described, which were primarily in degraded condition.

4.7.2 Avifauna Assessment

RPS (2010)

RPS Environment and Planning Pty Ltd undertook an avifauna assessment proposed Yandin Wind Farm Development in 2010 (RPS 2010). RPS (2010) undertook three separate targeted and systematic avifauna field surveys within the study area, utilising 27 bird census points. In addition, RPS (2010) also conducted comprehensive surveys at the nearby Waddi Wind Farm, as well as around wetland habitats in the wider locality to determine regional status, and movements of local waterbird populations and to assess habitat potential for migratory wading bird species.

Sixty-one species were recorded within the Yandin Study area by RPS (2010) with flight activity and behaviour recorded in respect to potential impact with wind turbines. A comprehensive impact assessment was undertaken that included a risk assessment of bird strike.

5 FIELD SURVEY RESULTS

5.1 FLORA

5.1.1 Flora of the Study Area

A total of 117 sub-generic vascular plant taxa (including species, infraspecific taxa, and phrase names) from 35 families were recorded from the study area during the current survey. A list of taxa recorded is included in Appendix G. This list is not considered to be comprehensive for the study area, and includes only taxa recorded within quadrats, dominant species at check sites, and some taxa recorded opportunistically. The most diverse families recorded were the Proteaceae (22 taxa), Myrtaceae (15 taxa), Fabaceae (10 taxa), and Poaceae (9 taxa).

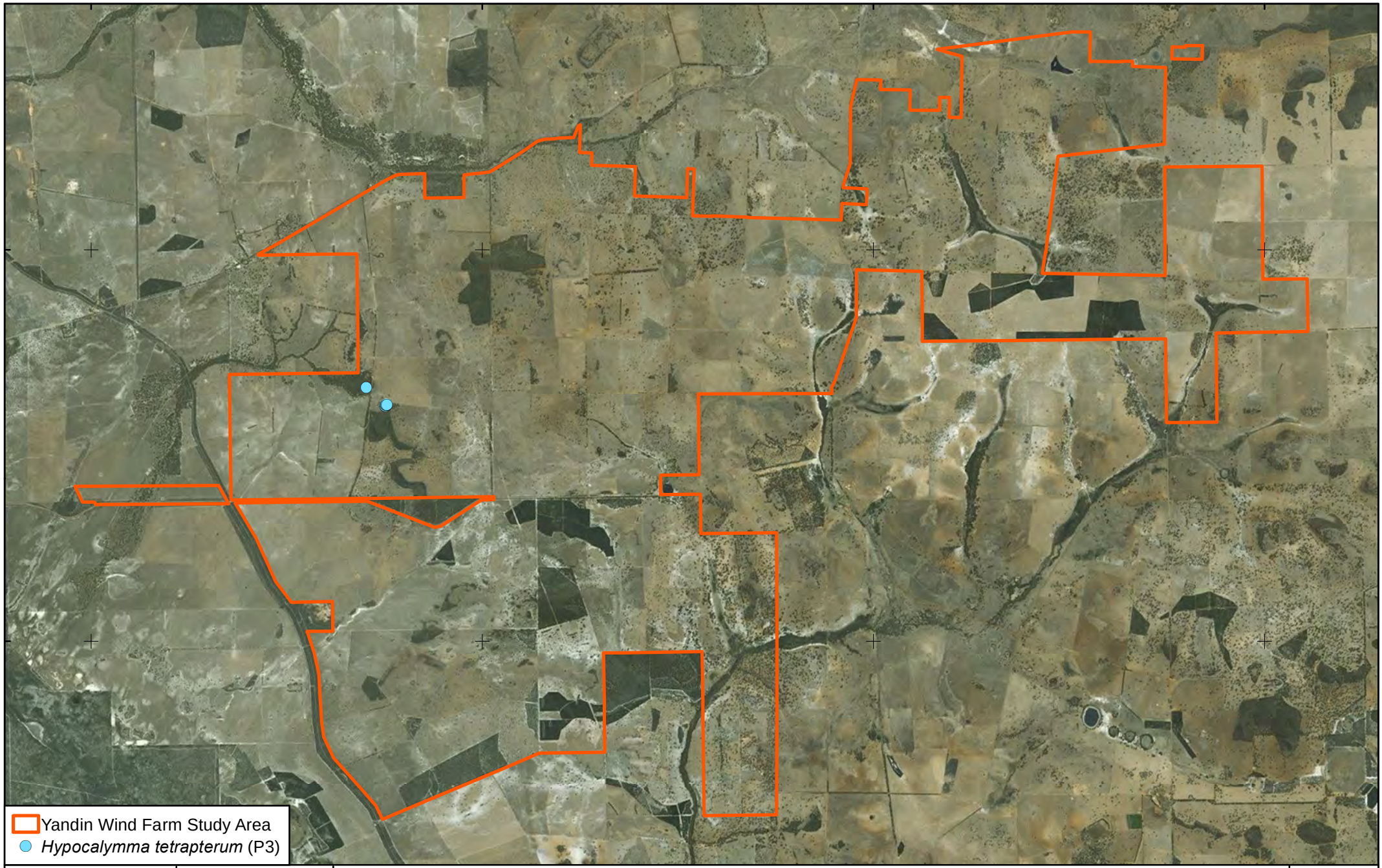
5.1.2 Conservation Significant Plant Species

No EPBC Act (1999) listed Threatened Flora taxa or any WC Act (1950) listed Threatened Flora taxa were recorded within the study area during the current survey. One State Listed Priority Flora species (*Hypocalymma tetrapterum* P3) was recorded during the current survey, with targeted searches focussed on native vegetation patches in the vicinity of proposed development areas.

Hypocallyma tetrapterum (Myrtaceae) is a low-growing perennial shrub primarily restricted to the northern Swan Coastal Plain and southern Geraldton Sandplains regions. It was recorded from two locations in the west of the study area, on loamy soils in degraded *Eucalyptus wandoo* woodland, and on an adjacent lateritic rise dominated by *Xanothorrhoea priessii* and mixed low shrubs. Individual locations are provided in Table 5.1, and mapped in Figure 5.1.

Table 5.1 – *Hypocalymma tetrapterum* (P3) records within the study area

Taxon	Easting	Northing	Estimated Abundance
Hypocalymma tetrapterum (P3)	365629.108	6597181.477	5
	366021.159	6596807.245	20-50
	366025.597	6596829.052	20-50
	366039.707	6596835.324	20-50
	366055.643	6596834.752	20-50



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Priority Flora Locations (*ecologia* 2017)

Figure: 5.1

5.2 VEGETATION

5.2.1 Vegetation Units and Vegetation Condition

Sixteen vegetation units within eight broader community types were described within the study area, which are summarised in Table 5.2 and mapped in Figure 5.2 to Figure 5.10. Vegetation condition is mapped in Figure 5.11.

Vegetation over 91.2% (14,015 ha) of the study area comprised scattered *Corymbia calophylla* (marri) or *Eucalyptus todtiana* (coastal blackbutt) trees over pasture weeds with no native understorey (vegetation unit W3) in 'completely degraded' condition. Low-lying areas occupied by **Juncus acutus* (spiny rush) rushland (R1), were also completely degraded, accounting for 0.6% (98.6 ha) of the study area. Plantations account for a further 3% (454.3 ha) of the study area.

Two species rich shrubland units in good to excellent condition were described from remnant vegetation patches, occurring primarily on lateritic rises and hills: *Banksia hewardiana* mid shrubland over mixed low shrubland (S1) accounts for 0.4% (56.8 ha) of the study area, and *Xanthorrhoea preissii* mid sparse shrubland over mixed low shrubland (S2) accounts for 0.6% (87.1 ha) of the study area.

Five eucalypt woodland units (*Eucalyptus rudis* woodland in creek lines [W11, W12], *Corymbia calophylla* and *Banksia attenuata* open woodland over pasture weeds [W6], *Eucalyptus wandoo* woodland [W13], and *Eucalyptus* sp. open mallee woodland [W10]), were in degraded condition due to historical clearing, heavy grazing, and/or the presence of abundant weed species. These account for 1% (156 ha) of the study area.

The remaining seven woodland units occurring in remnant vegetation patches broadly comprise *Corymbia calophylla* woodland, *Eucalyptus todtiana* woodland, and *Banksia attenuata* woodland, and are in good to excellent condition. These account for 3% (467.1 ha) of the study area, and include two units identified as the 'Banksia Woodlands of the Swan Coastal Plain' TEC (W1, W2).

Table 5.2 – Summary of vegetation units at the study area

Broad Community Type	Map Code	Vegetation Unit	Vegetation Condition	Banksia Woodlands TEC	Landforms	Sites	Area within study area (ha)	% of study area
**Juncus acutus* rushland	R1	**Juncus acutus* rushland with isolated *Acacia saligna* shrubs.	Completely Degraded		Valley	C2b	98.68	0.6%
Banksia hewardiana shrubland	S1	*Banksia hewardiana* (±*Banksia sessilis, ±Allocasuarina humilis, ±Xanthorrhoea preissii*) mid shrubland over mixed low shrubland.	Good - Excellent		Undulating Plains, Midslopes, Ridgetops	C17, C18, C31, C36, C42	56.88	0.4%
Xanthorrhoea preissii shrubland	S2	*Xanthorrhoea preissii* mid sparse shrubland over mixed low shrubland (±*Acacia pulchella*, *Hibbertia hypericoides*, *Leucopogon sprengelioides*, *Hakea incrassata*, *Hakea lissocarpha*, *Isopogon asper*, *Melaleuca ciliosa*).	Excellent		Midslopes, Ridgetops	C8, C9b, C10a, C16	87.19	0.6%
Banksia attenuata woodland	W1	*Banksia attenuata* (± *Corymbia calophylla*, *Eucalyptus todtiana*, *Banksia menziesii*) woodland to open woodland over *Hibbertia hypericoides* low sparse shrubland over *Mesomelaena pseudostygia* and *Desmocladus flexuosus* sparse sedgeland/herbland.	Good - Excellent	YES	Plains, Footslopes, Midslopes	Q1,Q4, Q8, Q33, C41	201.91	1.3%
	W2	*Banksia attenuata* and *Banksia menziesii* woodland over *Mesomelaena pseudostygia* and *Schoenus grandiflorus* open sedgeland.	Good	YES	Plains, Footslopes, Midslopes	C14, C15	10.10	0.1%
C. calophylla/E. todtiana woodland	W3	*Corymbia calophylla* and/or *Eucalyptus todtiana* open woodland/isolated trees over pasture weeds.	Completely Degraded - Degraded		Undulating Plains, Footslopes, Midslopes	C4, C9a, C10b, C11b, C24, C26, C28, C29, C30, C35, C38, C39	14015	91.2%
	W4	*Corymbia calophylla* mid open woodland over *Banksia hewardiana* and *Xanthorrhoea preissii* mid open shrubland.	Good - Excellent		Midslopes, Ridgetops	C5b, C19, C23, C25, C32	108.33	0.7%
	W5	*Corymbia calophylla* woodland over *Xanthorrhoea preissii* and *Macrozamia fraseri* mid sparse shrubland over *Hibbertia racemosa* low sparse shrubland.	Good - Very Good		Midslopes, Ridgetops	C5c, C6, C7	82.15	0.5%
	W6	*Corymbia calophylla* and *Banksia attenuata* open woodland over pasture weeds.	Degraded		Midslopes	C11a, C12b, C13	8.47	0.1%
	W7	*Corymbia calophylla* mid open woodland over *Hibbertia hypericoides* low open shrubland over *Mesomelaena pseudostygia* open sedgeland	Excellent		Midslopes	C3a, C98	29.52	0.2%
	W8	*Eucalyptus todtiana* open woodland over *Allocasuarina humilis* and *Adenanthos cygnorum* open shrubland over *Mesomelaena tetragona* sparse sedgeland.	Excellent		Floodplains, Midslopes	C3b, C37	22.90	0.1%
	W9	*Corymbia calophylla* mid open woodland over *Xanthorrhoea preissii* mid sparse shrubland over *Calothamnus quadrifidus*, *Hibbertia hypericoides*, and *Leucopogon polymorphus* low shrubland.	Excellent		Ridgetop	C34	12.23	0.1%

Broad Community Type	Map Code	Vegetation Unit	Vegetation Condition	Banksia Woodlands TEC	Landforms	Sites	Area within study area (ha)	% of study area
Eucalyptus sp. mallee woodland	W10	*Eucalyptus* sp. open mallee woodland over pasture weeds.	Degraded		Ridgetop	C40	8.43	0.1%
Eucalyptus rudis woodland	W11	*Eucalyptus rudis* mid woodland over Juncus acutus open rushland.	Degraded		Valley	C1	38.68	0.3%
	W12	*Eucalyptus rudis* and *Melaleuca rhaphiophylla* mid woodland over *Zantedeschia aethiopica* herbland.	Degraded		Floodplains, Valleys	C37, C3b	46.27	0.3%
Eucalyptus wandoo woodland	W13	*Eucalyptus wandoo* woodland.	Degraded - Good		Floodplain, Midslopes	C5a, C12a	54.61	0.4%
Rehab	Rehab	Roadside Rehabilitation (*Eucalyptus* spp., *Acacia pulchella*, *Acacia saligna*).	NA		Plain	C99	24.41	0.2%
Plantation	Plantation	Plantation	Completely Degraded		Plain	NA	454.38	3.0%

5.2.2 'Banksia Woodlands of the Swan Coastal Plain' TEC

Five patches of the 'Banksia Woodlands of the Swan Coastal Plain' Threatened Ecological Community were identified within the study area (Figure 5.12), in addition to two previously identified patches (Figure 4.8, DBCA database, Sept. 2017) (Table 5.3). Patches ECO1, ECO2, and ECO3 (vegetation unit W1) occur in remnant vegetation patches and are in 'excellent' condition (Keighery 1994), with few non-aggressive weed species present. Linear patches ECO4 (W1) and ECO5 (W2) occur along the verge of Yandin road and an adjacent fence line, and are in 'good' condition (Keighery 1994), due to partial clearing, heavy grazing, and weed invasion, although basic vegetation structure is intact. Based on vegetation structure and composition, patch size, and condition (Keighery 1994), each of these patches should qualify as the TEC.

Table 5.3 – Summary of 'Banksia Woodlands of the Swan Coastal Plain' patches within the study area

Patch Name	Area (ha)	Vegetation Unit	Vegetation Condition	Site
DBCA 1	139.19	W1	Excellent	Q1
DBCA 2	10.11	W1	Good - Excellent	NA
ECO 1	14.49	W1	Excellent	Q8
ECO 2	11.13	W1	Excellent	Q33
ECO 3	19.43	W1	Excellent	Q4
ECO 4	2.89	W1	Good	C41
ECO 5	5.84	W2	Good	C14, C15

360000
368000
376000
384000
6600000
6592000

A1
A2
A3
B1
B2
B3
C1
C2

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N

0 0.5 1
Kilometers
Scale: 1:70,000
MGA94 (Zone 50)

Vegetation units - Map Index

Figure:
5.2

360000 362000 364000 366000 368000

6604000

6602000

6600000

- Study area
- Flora survey site location
- WTG Location
- Grid Connection Route
- Access Track
- Underground Cable
- Onsite Substation
- Iluka Substation
- *Banksia* Woodland TEC

Vegetation Unit

- R1
- S1
- S2
- W1
- W2
- W3
- W4
- W5
- W6
- W7
- W8
- W9
- W10
- W11
- W12
- W13
- Rehab
- Plantation

W6
W4
W6
W3
W10
W5
W9
C5c
C6
W5
C5b
C34
W5
W9
C7
W4

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Date: 19 October 2017 A3

N

0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - A1

Figure:
5.3

368000 370000 372000 374000 376000

6604000

6602000

6600000

- Study area
- Flora survey site
- WTG Location
- Grid Connection Route
- Access Track
- Underground Cable
- Onsite Substation
- Iluka Substation
- *Banksia* Woodland TEC

Vegetation Unit

- R1
- S1
- S2
- W1
- W2
- W3
- W4
- W5
- W6
- W7
- W8
- W9
- W10
- W11
- W12
- W13
- Rehab
- Plantation

W6 W4 W10 W9 C6 W5 C5c W5 C5b C34 W5 W9 C7 W4 W3 C4 C10b C30 C38 C35 Plantation C3b

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Drawn: AC Project ID: 1713
Date: 19 October 2017 A3

0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - A2

Figure: 5.4

376000 378000 380000 382000 384000

6604000

6602000

6600000

Study area
Flora survey site
WTG Location
Grid Connection Route
Access Track
Underground Cable
Onsite Substation
Iluka Substation
Banksia Woodland TEC

Vegetation Unit

R1
S1
S2
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
W12
W13
Rehab
Plantation

C30
C1
C2b
C35
C38

R1
W11
W3
R1
R1
Plantation
Plantation
R1
W12

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Drawn: AC Project ID: 1713
Date: 19 October 2017 A3

0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - A3

Figure: 5.5

360000 362000 364000 366000 368000

6600000 6598000 6596000 6594000

- Study area
- Flora survey site
- WTG Location
- Grid Connection Route
- Access Track
- Underground Cable
- Onsite Substation
- Iluka Substation
- *Banksia* Woodland TEC

Vegetation Unit

- R1
- S1
- S2
- W1
- W2
- W3
- W4
- W5
- W6
- W7
- W8
- W9
- W10
- W11
- W12
- W13
- Rehab
- Plantation

W6 W10 W5 C6 C5c W9 C5b C34 W5 W5 C7 W9 W4 W13 W4 W4 W4 C5a W13 C10a C8 W6 S2 W6 W6 W3 C14 C9b C9a S2 W2 C15 S2 W2 C11b S2 C41 W1 W1 W1 W1 Plantation Rehab C99 Rehab W13 Plantation

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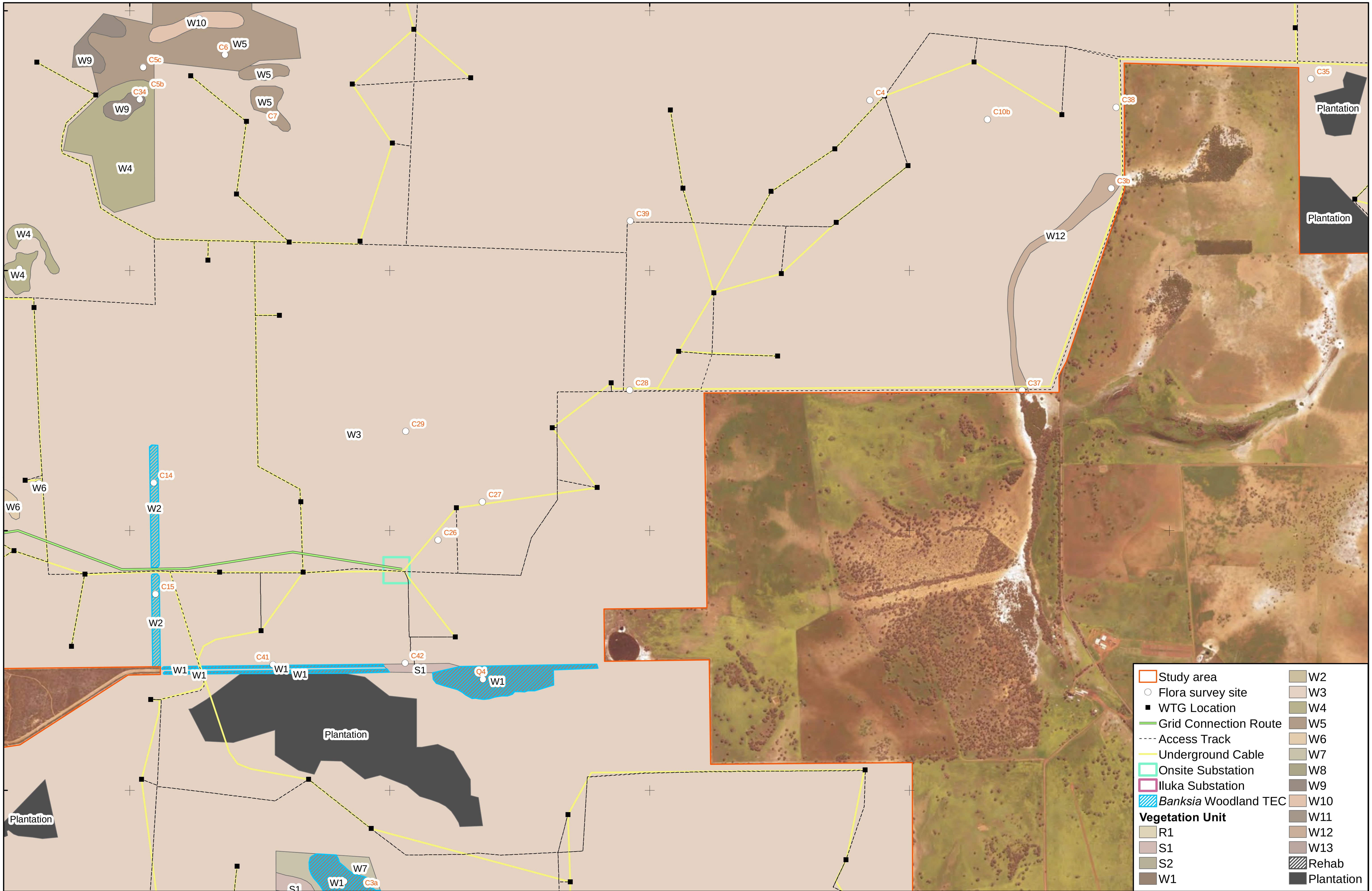
Drawn: AC Project ID: 1713
Date: 19 October 2017 A3

0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - B1

Figure: 5.6



368000
370000
372000
374000
376000
6600000
6598000
6596000
6594000
W10
W5
W9
C5c
C6
W5
C34
C5b
W9
W5
C7
W4
W4
W4
C4
C10b
C38
C35
Plantation
C3b
Plantation
C39
W12
C28
C37
C29
W3
C14
W6
W6
W2
C27
C26
C15
W2
C41
C42
W1
W1
W1
W1
S1
Q4
W1
Plantation
Plantation
W7
W1
C3a
S1
Study area
Flora survey site
WTG Location
Grid Connection Route
Access Track
Underground Cable
Onsite Substation
Iluka Substation
Banksia Woodland TEC
Vegetation Unit
R1
S1
S2
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
W12
W13
Rehab
Plantation

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N

0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - B2

Figure:
5.7

376000 378000 380000 382000 384000

6600000 6598000 6596000 6594000

C35 C38 W12 W3 R1 R1 Plantation Plantation Plantation Plantation

Study area
Flora survey site
WTG Location
Grid Connection Route
Access Track
Underground Cable
Onsite Substation
Iluka Substation
Banksia Woodland TEC

Vegetation Unit

R1 S1 S2 W1 W2 W3 W4 W5 W6 W7 W8 W9 W10 W11 W12 W13 Rehab Plantation

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0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - B3

Figure: 5.8

360000 362000 364000 366000 368000

6594000

6592000

6590000

6588000

Plantation

Plantation

W7 S1 W7 S1 W4

S1 S1 C17

W3 S2 C16

C25 W4 Q8 W1

C24

W6 C19 W4

C36 S1 S1

S1 S1

C18 S1

C2a W8

W1

Q1

W1

Study area
Flora survey site
WTG Location
Grid Connection Route
Access Track
Underground Cable
Onsite Substation
Iluka Substation
Banksia Woodland TEC

Vegetation Unit

R1
S1
S2
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
W12
W13
Rehab
Plantation

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Date: 19 October 2017 A3

N

0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - C1

Figure: 5.9

368000 370000 372000 374000 376000

6594000 6592000 6590000 6588000

Plantation
Plantation
Plantation
W7
W1
C3a
S1
W7
C98
W3
C31
S1
S1
C17
S1
C32
W4
S2
S2
C25
W4
W1
Q8
C24
W6
W12
C36
S1
S1
W4
S1
S1
C2a
W8
W3
Plantation
W3
Q1
W1

Study area
Flora survey site
WTG Location
Grid Connection Route
Access Track
Underground Cable
Onsite Substation
Iluka Substation
Banksia Woodland TEC

Vegetation Unit
R1
S1
S2
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
W12
W13
Rehab
Plantation

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0 0.25 0.5
Kilometers
Scale: 1:26,000
MGA94 (Zone 50)

Vegetation units - C2

Figure:
5.10

360000 368000 376000 384000

6600000

6592000

Study area

Average Condition

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

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Date: 19 October 2017 A3

0 0.5 1
Kilometers
Scale: 1:70,000
MGA94 (Zone 50)

Vegetation condition

Figure: 5.11

363000 366000 369000 372000 375000

6597000

6594000

6591000

6588000

ECO 5

ECO 4

ECO 3

ECO 2

ECO 1

DBCA 2

DBCA 1

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Drawn: AC Project ID: 1713
Date: 19 October 2017 A3

0 0.325 0.65
Kilometers
Scale: 1:35,000
MGA94 (Zone 50)

Banksia Woodlands of the Swan Coastal Plain TEC within the study area

Figure:
5.12

5.3 AVIFAUNA

One hundred and twenty-six bird species have been recorded within 20 km of the study area (Appendix E). Of these regional records the most diverse families were the ducks and swans (Anatidae - 13 species), the parrots (Psittacidae - 12 species) and the honeyeaters (Meliphagidae - 12 species).

Sixty-one species were recorded within the Yandin study area by RPS (2010) and the current survey recorded 44 species from 22 census sites within seven habitat types as well as the overall study area (Table 5.4).

All birds recorded had previously been recorded by RPS (2010) during the regional study, apart from the Australasian Pipit (*Anthus novaeseelandiae*) and the Emu (*Dromaius novaehollandiae*)(one individual sighted).

Table 5.4 – Avifauna records within sites and habitats

Species	Parkland Cleared	Marri Woodland	Proteraceous Heath	Dryandra-Allocasuarina Shrubland	*E. Todtiana* Woodland	Banksia Woodland	Creek-line	Overall study area
	C04, C09A, C28, C29, C35, C38, C40	C05, C09b, C13, C32	C10, C16, C18	C17, C31, C42	Q11, C19, C30	C41	C37	
Singing Honeyeater			2					4
Brown Honeyeater		3		4				
White-cheeked Honeyeater			6					12
New Holland Honeyeater				4				
Red Wattlebird		2		1				3
Western Little Wattlebird			1					
Yellow-throated Miner								3
Inland Thornbill		2						
Western Thornbill		1						
Yellow-rumped Thornbill					5			
Weebill	2	3						3
White-browed Scrubwren								
Striated Pardalote	2	1						
Western Gerygone		1						
Variegated Fairy-wren			3					
Splendid Fairy-wren				4				
Grey Fantail		1						
Willie Wagtail	2							4
Silvereye					3			
Australasian Pipit								6
Rufous Whistler	1	2		1				
Grey Shrike-thrush								1
Black-faced Cuckoo-shrike								3
Black-faced Woodswallow								6
Magpie-lark	2					1	2	4
Australian Magpie	3							
Grey Butcherbird			1					
Australian Raven								7
Tree Martin	5							
Emu								1
Australian Ringneck	4	6	5		4		2	11

Species	Parkland Cleared	Marri Woodland	Proteraceous Heath	Dryandra-Allocasuarina Shrubland	*E. Todtiana* Woodland	Banksia Woodland	Creek-line	Overall study area
	C04, C09A, C28, C29, C35, C38, C40	C05, C09b, C13, C32	C10, C16, C18	C17, C31, C42	Q11, C19, C30	C41	C37	
Butler's Corella	21	10		6				30
Galah	6	4	6		5			25
Carnaby's Black-Cockatoo			22	16				17
Common Bronzewing								2
Fan-tailed Cuckoo								1
*Laughing Kookaburra								2
Stubble Quail								2
Square-tailed Kite								1
Black-shouldered Kite								2
Australian Kestrel		1						3
Australian Hobby								1
White-faced Heron								1
Straw-necked Ibis								8

Bird flight patterns and activity were assessed using the same parameters as RPS (2010) within Zones 1 to 3 (Table 5.5). Birds recorded with at least the potential to fly within the RSA potential collision zone (Zone 2) were; Straw-necked Ibis, Black-shouldered Kite, Carnaby's Black-Cockatoo, Butler's Corella, Galah, and Austraian Kestrel.

All these species were similarly identified by RPS (2010). However the percentages of recordings within individual Zones differed for some species. This can be attributed to the smaller scale of the current study, and fewer observations, with an associated less robust data set. For example, just one observational record correlates with the highest percentage recording – *"Species commonly recorded at this height range during study (25% and >25%)"* whereas the record may potentially represent an aberration. Nevertheless, species recorded during this survey were generally observed within the same, or very similar zones, as RPS (2010) thereby verifying those results.

Table 5.5 – Avifauna records within flight zones

Species	Total Records	Zone 1 0m - 40m Below tip of turbine	Zone 2 40m - 152m RSA: Potential collision	Zone 3 >152m Above tip of turbine	Habitat (of RPS 2010)	Movements	Notes
Butler's Corella	62				Woodland, Grassland	Locally nomadic	Large flocks at medium speed
Carnaby's Black-Cockatoo	38				Forest/Woodland/Heath	Seasonally Nomadic	Large flocks at slow speed
Australian Ringneck	21				Forest/Woodland	Sedentary	Swift
Galah	21				Woodland/Grassland	Locally nomadic	Medium flocks at medium speed
Straw-necked Ibis	8				Wetlands/Grassland	Locally nomadic	Large flocks at slow speed
Brown Honeyeater	7				Forest/Woodland/Shrubland/Heath	Nomadic-Dispersive	Slow–Medium speed
Australian Raven	7				Woodland/Grassland	Locally nomadic	Slow–Medium speed
White-cheeked Honeyeater	6				Shrubland/Heath	Nomadic-Dispersive	Slow–Medium speed
Australasian Pipit	6				Grassland	Seasonally Nomadic	Slow–Medium speed
Black-faced Woodswallow	6				Forest/Woodland	Locally nomadic	Slow–Medium speed
Yellow-rumped Thornbill	5				Woodland/Grassland	Sedentary	Slow speed
Weebill	5				Forest/Woodland	Locally nomadic	Slow speed
Magpie-lark	5				Forest/Woodland	Sedentary	Slow speed
Tree Martin	5				Aerial proximate to nesting sites	Seasonally Nomadic	Swift
New Holland Honeyeater	4				Woodland/Shrubland/Heath	Nomadic-Dispersive	Medium speed
Splendid Fairy-wren	4				Shrubland/Heath	Sedentary	Slow speed
Rufous Whistler	4				Forest/Woodland/Shrubland	Locally nomadic	Medium speed
Australian Kestrel	4				Grassland/Woodland edges	Sedentary/Dispersive	Slow to swift
Red Wattlebird	3				Forest/Woodland/Shrubland/Heath	Seasonally Nomadic	Slow–Medium speed
Yellow-throated Miner	3				Woodland	Seasonally Nomadic	Slow–Medium speed
Striated Pardalote	3				Forest/Woodland	Seasonally Nomadic	Slow–Medium speed
Variegated Fairy-wren	3				Shrubland/Heath	Sedentary	Slow speed
Silvereye	3				Forest/Woodland/Shrubland/Heath	Seasonally Nomadic	Slow–Medium speed
Black-faced Cuckoo-shrike	3				Forest/Woodland	Seasonally Nomadic	Medium speed
Australian Magpie	3				Woodland/Grasslands	Sedentary	Medium speed
Singing Honeyeater	2				Forest/Woodland/Shrubland/Heath	Nomadic-Dispersive	Medium speed
Inland Thornbill	2				Forest/Woodland/Shrubland	Sedentary	Slow speed
White-browed Scrubwren	2				Shrubland/Heath	Sedentary	Slow speed

Species	Total Records	Zone 1	Zone 2	Zone 3	Habitat (of RPS 2010)	Movements	Notes
		0m - 40m	40m - 152m	>152m			
		Below tip of turbine	RSA: Potential collision	Above tip of turbine			
Willie Wagtail	2				Woodland/Grasslands	Sedentary	Slow speed
Common Bronzewing	2				Forest/Woodland	Sedentary	Medium to swift speed
*Laughing Kookaburra	2				Forest/Woodland	Sedentary	Medium speed
Stubble Quail	2				Woodland, Grassland	Nomadic/Irruptive	Medium to swift speed
Black-shouldered Kite	2				Grassland/Woodland edges	Locally nomadic/dispersive	Slow to swift
Western Little Wattlebird	1				Forest/Woodland/Shrubland/Heath	Seasonally Nomadic	Medium speed
Western Thornbill	1				Forest/Woodland	Sedentary	Slow speed
Western Gerygone	1				Forest/Woodland	Sedentary	Slow speed
Grey Fantail	1				Forest/Woodland	Seasonal Migrant	Slow speed
Grey Shrike-thrush	1				Forest/Woodland	Sedentary	Medium speed
Grey Butcherbird	1				Forest/Woodland	Sedentary	Medium speed
Emu	1				Woodland, Grassland	Seasonally Nomadic	Medium speed
Fan-tailed Cuckoo	1				Forest/Woodland	Seasonal Migrant	Medium speed
Square-tailed Kite	1				Grassland/Woodland edges	Seasonal Migrant	Medium speed
Australian Hobby	1				Woodland edges	Sedentary/Dispersive	Medium to swift
White-faced Heron	1				Grasslands/Wetlands	Nomadic	Medium speed

Legend

	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%)

Fifteen birds of conservation significance were identified by NatureMap (2017) as occurring within 20 km of the study area. A likelihood of occurrence over the study area was undertaken using the criteria presented in Table 3.2.

All species identified by NatureMap (Table 5.6) were also assessed by RPS (2010), apart from the inland sub-species of the Western Rosella (P4). The Western Rosella was not recorded during this survey or by RPS (2010) however a historical record from the vicinity is included in NatureMap (2017). Although habitat at the study area is fragmented, and no recent records have been obtained, there is the possibility that this species may occur. However it is unlikely that the Western Rosella would fly within the RSA of Zone 2 and is therefore at little risk from the project.

Apart from the Western Rosella, RPS (2010) undertook a significant risk assessment of all the species listed in Table 5.6, and results conform with the likelihood of occurrence table presented here.

Note that the likelihood of occurrence table (Table 5.6) refers a species likelihood of occurrence at the study area itself, however, birds may still be at risk flying over the study area to and from suitable habitat. For example migratory wading birds have been recorded from wetland habitats around Lake Guraga to the south-west, Lake Thetis near Cervantes and from the Upper Moore River area. Movements to and from these wetland habitats by migratory wading birds would occur, and RPS (2010) consider these factors in their impact assessment and risk assessment of bird strike.

Table 5.6 – Regional records of avifauna of conservation significance

Species	WA Status	EPBC Status	Notes	Likelihood of occurrence
Carnaby's Black-Cockatoo	EN	EN	Recorded regularly in the Study area and region	Recorded
Western Rosella (inland)	P4	-	Not recorded - historical record from Dandaragan	Possible
Malleefowl	VU	VU	Not recorded. Habitat not present.	Low
Peregrine Falcon	OS	-	Recorded in the region by RPS (2010)	Recorded
Rainbow Bee-eater	IA	-	Recorded regularly in the Study area and region	Recorded
Wetland/Estuarine Species				
Blue-billed Duck	P4	-	Not recorded. Deep water habitat not present	Low
Great Egret	IA	-	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Glossy Ibis	IA	-	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Red-necked Stint	IA	IA	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Curlew Sandpiper	VU	CR	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Sharp-tailed Sandpiper	IA	IA	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Pacific Golden Plover	IA	-	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Hooded Plover	P4	-	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Wood Sandpiper	IA	IA	Not recorded. Suitable wetland or estuarine habitat not present.	Low
Common Greenshank	IA	IA	Not recorded. Suitable wetland or estuarine habitat not present.	Low

5.4 SURVEY LIMITATIONS AND CONSTRAINTS

5.4.1 Flora Survey Limitations and Constraints

An assessment of survey-specific issues and limitations (EPA 2016c) is detailed in Table 5.7.

Table 5.7 – Flora and vegetation survey limitations

Constraint	Impact	Comment
Availability of contextual information at a regional and local scale	Nil	Broad scale vegetation, soil, and geology mapping data were available for the study area, in addition to flora database records, and conservation significant vegetation community records. This information is considered to be adequate to provide appropriate contextual information for the current survey.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed	Nil	The Senior Botanist undertaking the field work and specimen identification for the survey has conducted numerous botanical surveys in Western Australia, including the Swan Coastal Plain and Geraldton Sandplains bioregions.
Proportion of flora recorded and/or collected, any identification issues	Nil	Species were only recorded within quadrats, and dominant species were recorded at check sites. Only some taxa were recorded opportunistically. Providing a comprehensive species inventory for the study area was not part of the scope of this reconnaissance survey.
Was the appropriate area fully surveyed (effort and extent)	Nil	4 quadrats and 48 check sites were surveyed across the study area. This level of survey effort was considered to be sufficient for a reconnaissance survey of the study area.
Access restrictions within the survey area	Nil	All parts of the study area were accessible by walking from existing vehicle tracks.
Survey timing, rainfall, season of survey	Nil	Seasonal conditions were considered to be good for a flora and vegetation assessment.
Disturbance that may have affected the results of survey such as fire, flood or clearing	Nil	There were no natural or human interventions that constrained the survey of the study area.

6 DISCUSSION

6.1 FLORA

A total of 117 sub-generic vascular plant taxa from 35 families were recorded from the study area during the current survey. This list is not considered to be comprehensive, and includes only taxa recorded within quadrats, dominant species at check sites, and some taxa recorded opportunistically. The most diverse families recorded were the Proteaceae (22 taxa), Myrtaceae (15 taxa), Fabaceae (10 taxa), and Poaceae (9 taxa).

TPFL and WAHERB database searches identified 61 conservation significant plant species that have been recorded within or have potential to occur within the study area. One Priority listed species (*Hypocalymma tetrapterum* P3) was recorded within the study area during the current survey, where it occurred in degraded *Eucalyptus wandoo* woodland and on an adjacent lateritic hill within a species-rich low shrubland. These diverse shrubland communities (S1 and S2) are likely to support additional conservation significant plant species that were not observed during the current survey due to time constraints. However, the proposed development is unlikely to have any impact on any of these communities.

6.2 VEGETATION

6.2.1 Vegetation Units

The Yandin Wind Farm study area occupies an area of approximately 15,360 ha in the Swan Coastal Plain (Swan Coastal Plain and Dandaragan Plateau subregions) and Geraldton Sandplains (Lesueur Sandplain subregion) bioregions of Western Australia, within which five vegetation associations of Beard (1975) (4, 999, 1030, 1031, 1035) have been previously mapped. The vegetation units described here are broadly consistent with those of Beard (1975).

In a previous reconnaissance survey of the Yandin Wind Farm project area (not corresponding exactly to the current study area) (Outback Ecology 2009), nine woodland communities (primarily *C. calophylla*, *E. todtiana*, and other eucalypt woodlands), two shrubland communities (*Xanthorrhoea preissii* shrublands and mixed low heaths), and one sedgeland community (Cyperaceae spp. sedgelands), were described for several remnant vegetation patches. These communities broadly correspond to the sixteen vegetation units described as part of this survey.

Vegetation over 91.2% of the study area comprised scattered *Corymbia calophylla* or *Eucalyptus todtiana* trees over pasture weeds with no native understorey (W3) in 'completely degraded' condition. Low-lying areas occupied by **Juncus acutus* rushland (R1), were also completely degraded, accounting for 0.6% of the study area. Plantations account for a further 3% of the study area.

Two species rich shrubland units in good to excellent condition were occur in remnant vegetation patches, occurring primarily on lateritic rises and hills: *Banksia hewardiana* mid shrubland over mixed low shrubland (S1) accounts for 0.4% of the study area, and *Xanthorrhoea preissii* mid sparse shrubland over mixed low shrubland (S2) accounts for 0.6% of the study area.

Five eucalypt woodland units (*Eucalyptus rudis* woodland in creek lines [W11, W12], *Corymbia calophylla* and *Banksia attenuata* open woodland over pasture weeds [W6], *Eucalyptus wandoo* woodland [W13], and *Eucalyptus* sp. open mallee woodland [W10]), were in degraded condition due to historical clearing, heavy grazing, and/or the presence of abundant weed species. These account for 1% of the study area.

The remaining seven woodland units occurring in remnant vegetation patches broadly comprise *Corymbia calophylla* woodland, *Eucalyptus todtiana* woodland, and *Banksia attenuata* woodland, and are in good to excellent condition. These account for 3% of the study area.

A section of road reserve along Mimegarra Road to the west of the Brand Highway comprised a rehabilitated area dominated primarily by planted *Acacia pulchella*, *A. saligna*, and eucalypt species.

6.2.2 'Banksia Woodlands of the Swan Coastal Plain' TEC

Five patches of the 'Banksia Woodlands of the Swan Coastal Plain' Threatened Ecological Community were identified within the study area, in addition to two previously mapped patches (DBCA database, Sept. 2017). Three patches corresponding to vegetation unit W1 occur in remnant vegetation patches and are in 'excellent' condition (Keighery 1994), with few non-aggressive weed species present.

Two patches are linear (ECO4 [W1], ECO5 [W2]), occurring along the verge of Yandin road and an adjacent fence line, and are in 'good' condition due to partial clearing, heavy grazing, and weed invasion, although basic vegetation structure is intact. Existing vehicle tracks, roads, and fence lines intersect both of these patches.

Based on vegetation structure and composition, patch size, and condition, each of these patches are considered to qualify as the TEC according to '*Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain Ecological Community*' (Threatened Species Scientific Committee 2016a).

6.3 AVIFAUNA

Results of the current study verify those of a more comprehensive survey, impact assessment and risk assessment of potential bird strike undertaken by RPS (2010). That is, that there was a relatively low diversity of bird species recorded from open pasture areas characterising the proposed wind turbine positions, with the greatest diversity limited to stands of intact native vegetation comprised mainly of shrubland and heath. The presence of isolated trees within cleared areas often attracted birds, albeit in small numbers and at low diversities.

Although there are a number of regional wetlands in the wider locality, most wetland habitats at the study area were limited to small farm dams or degraded creeklines.

RPS (2010) recorded species flying at RSA elevations 'on more than a rare occasion' as; Australian Kestrel, Wedge-tailed Eagle, Brown Falcon, White-backed Swallow, Black-shouldered Kite and Fairy Martin. Of these, the Australian Kestrel and Black-shouldered Kite were also recorded within RSA elevations during this study.

The threatened Carnaby's Black-Cockatoo was found by RPS (2010) to primarily frequent low-land areas and movements tended to follow valleys with woodland vegetation. Proteaceous heath and shrubland, as well as plantations of pine, provide foraging habitat for this species and flight movements are likely to follow movements to and from these food resources as well as roosting and/or breeding trees.

RPS (2010) provide a comprehensive survey, impact assessment, and risk assessment of potential bird strike, with data obtained from this study corroborating the results presented there.

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8 APPENDICES

APPENDIX A DEFINITIONS

Threatened (WC Act) and Priority flora Categories

Code	Definition
T	**Threatened flora – (Declared Rare Flora – Extant)** Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*).
X	**Presumed Extinct Flora (Declared Rare Flora - Extinct)** Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such Schedule 2 under the *Wildlife Conservation Act 1950*).
P1	**Priority One – Poorly Known Species** Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	**Priority Two – Poorly Known Species** Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	**Priority Three – Poorly Known Species** Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	**Priority Four – Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	**Priority Five - Conservation Dependent species** Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Threatened flora (EPBC Act) Categories

Code	Definition
Ex	**Extinct** Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation programme, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Definition of codes for Threatened Ecological Communities

Code	Definition
PD: Presumed Totally Destroyed	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant
CR: Critically Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
EN: Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future.
VU: Vulnerable	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

Definition of codes for Priority Ecological Communities

Code	Definition
P1: Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or Pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2: Priority Two	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3: Priority Three	(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4: Priority Four	Ecological communities that are adequately known, Rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5: Priority Five	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Threatened (WC Act) Fauna Categories

Category	Code	Definition	Schedule
Critically Endangered	CR	Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.	**Schedule 1** Fauna that is rare or is likely to become extinct as critically endangered fauna
Endangered	EN	Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.	**Schedule 2** Fauna that is rare or is likely to become extinct as endangered fauna
Vulnerable	VU	Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.	**Schedule 3** Fauna that is rare or is likely to become extinct as vulnerable fauna
Presumed Extinct	EX	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.	**Schedule 4** Fauna presumed to be extinct
Migratory	IA	Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.	**Schedule 5** Migratory birds protected under an international agreement
Conservation Dependent	CD	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.	**Schedule 6** Fauna that is of special conservation need as conservation dependent fauna
Special Protection	OS	Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.	**Schedule 7** Other specially protected fauna

Fauna (EPBC Act) Categories

Category	Code	Definition
Extinct	Ex	Fauna not definitely located in the wild during the past 50 years
Extinct in the Wild	EW	Fauna which is known only to survive in captivity
Critically Endangered	CR	Fauna that is considered to be facing an extremely high risk of extinction in the wild in the immediate future
Endangered	EN	Fauna that is considered to be facing a very high risk of extinction in the wild in the near future
Vulnerable	VU	Fauna that is considered to be facing a high risk of extinction in the wild in the medium-term future
Conservation Dependent	CD	Fauna whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
Migratory	IA	Fauna that migrates to, over and within Australia and its external territories.

Definition of codes for Priority Fauna

Code	Definition
P1: Priority One	**Poorly-known species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2: Priority Two	**Poorly-known species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3: Priority Three	**Poorly-known species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4: Priority Four	**Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

APPENDIX B VASCULAR FLORA RECORDS - NATUREMAP

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 13/09/2017

Kingdom Plantae
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 36' 41" E,30° 44' 52" S
Buffer 10km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	3200	*Acacia acuminata (Jam, Mangard)*			
2.	15466	*Acacia applanata*			
3.	3231	*Acacia auronitens*			
4.	3242	*Acacia blakelyi*			
5.	14061	*Acacia clydonophora*			
6.	3271	*Acacia costata*			
7.	20435	*Acacia daphnifolia*			
8.	11926	*Acacia drewiana subsp. drewiana*			
9.	3341	*Acacia forrestiana (Forrest's Wattle)*		T	
10.	11611	*Acacia lasiocarpa var. lasiocarpa*			
11.	3442	*Acacia microbotrya (Manna Wattle, Kalyang)*			
12.	3493	*Acacia plicata*		P3	
13.	15481	*Acacia pulchella var. glaberrima*			
14.	15483	*Acacia pulchella var. pulchella*			
15.	30033	*Acacia saligna subsp. lindleyi*			
16.	3532	*Acacia scirpifolia*			
17.	3541	*Acacia sessilis*			
18.	15486	*Acacia sphacelata subsp. verticillata*			
19.	3557	*Acacia stenoptera (Narrow Winged Wattle)*			
20.	6205	*Actinotus leucocephalus (Flannel Flower)*			
21.	1779	*Adenanthos drummondii*			
22.	185	*Aira cupaniana (Silvery Hairgrass)*	Y		
23.	1056	*Alexgeorgea nitens*			
24.	1732	*Allocasuarina humilis (Dwarf Sheoak)*			
25.	1734	*Allocasuarina microstachya*			
26.	1739	*Allocasuarina thuyoides (Horned Sheoak)*			
27.	12025	*Amphipogon caricinus var. caricinus*			
28.	199	*Amphipogon strictus (Greybeard Grass)*			
29.	1058	*Anarthria gracilis*			
30.	1059	*Anarthria humilis*			
31.	6311	*Andersonia heterophylla*			
32.	40908	*Androcalva pulchella*			
33.	1409	*Anigozanthos humilis (Catspaw)*			
34.	29437	*Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)*		P2	
35.	11957	*Anigozanthos humilis subsp. chrysanthus (Golden Catspaw)*		P4	
36.	11434	*Anigozanthos humilis subsp. humilis*			
37.	1414	*Anigozanthos pulcherrimus (Yellow Kangaroo Paw)*			
38.		*Aristida sp.*			
39.	1265	*Arthropodium curvipes*			
40.	4397	*Asterolasia drummondii (Gairdner Range Starbush)*		P4	
41.	6328	*Astroloma glaucescens*			
42.	6332	*Astroloma microdonta (Sandplain Cranberry)*			
43.	6334	*Astroloma pallidum (Kick Bush)*			
44.	14501	*Astroloma sp. Eneabba (N. Marchant s.n. PERTH 01291777)*			
45.	6339	*Astroloma xerophyllum*			
46.	17237	*Austrostipa elegantissima*			
47.	17244	*Austrostipa macalpinei*			
48.	17257	*Austrostipa variabilis*			
49.	233	*Avena barbata (Bearded Oat)*	Y		
50.	45397	*Babingtonia cherticola*		P3	
51.	45395	*Babingtonia delicata*		P1	
52.	45416	*Babingtonia grandiflora (Large-flowered Babingtonia)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
53.	1800	*Banksia attenuata (Slender Banksia, Piara)*			
54.	32679	*Banksia bipinnatifida subsp. multifida*			
55.	32576	*Banksia dallanneyi (Couch Honeypot)*			
56.	32580	*Banksia dallanneyi var. dallanneyi*			
57.	32577	*Banksia dallanneyi var. mellicula*			
58.	32521	*Banksia fraseri*			
59.	1820	*Banksia grossa*			
60.	32518	*Banksia hewardiana*			
61.	32216	*Banksia kippistiana var. paenepeccata*		P3	
62.	32157	*Banksia prionophylla*		P1	Y
63.	32086	*Banksia sclerophylla*			
64.	32074	*Banksia shuttleworthiana (Bearded Dryandra)*			
65.	32033	*Banksia tortifolia*			
66.	5384	*Beaufortia eriocephala (Woolly Bottlebrush, Woolly Beaufortia)*		P3	
67.	1417	*Blancoa canescens (Winter Bell)*			
68.	11274	*Boronia coerulescens subsp. spinescens*			
69.	11381	*Boronia ramosa subsp. anethifolia*			
70.	4440	*Boronia scabra (Rough Boronia)*			
71.	16637	*Boronia scabra subsp. condensata*		P2	
72.	16639	*Boronia scabra subsp. scabra*			
73.	1273	*Borya sphaerocephala (Pincushions)*			
74.	3710	*Bossiaea eriocarpa (Common Brown Pea)*			
75.	1383	*Burchardia bairdiae*			
76.	12770	*Burchardia congesta*			
77.	29439	*Caesia sp. Wongan (K.F. Kenneally 8820)*			
78.	1586	*Caladenia discoidea (Dancing Orchid)*			
79.	15348	*Caladenia flava subsp. flava*			
80.	15360	*Caladenia longicauda subsp. borealis*			
81.	15369	*Caladenia lorea*			
82.	2848	*Calandrinia corrigioloides (Strap Purslane)*			
83.	19309	*Calectasia narragara*			
84.	35816	*Calothamnus quadrifidus subsp. quadrifidus*			
85.	5429	*Calothamnus sanguineus (Silky-leaved Blood flower, Pindak)*			
86.	5431	*Calothamnus torulosus*			
87.	5439	*Calytrix angulata (Yellow Starflower)*			
88.	5441	*Calytrix aurea*			
89.	5465	*Calytrix leschenaultii*			
90.	760	*Caustis dioica*			
91.	41564	*Cenchrus clandestinus (Kikuyu Grass)*	Y		
92.	1121	*Centrolepis aristata (Pointed Centrolepis)*			
93.	1125	*Centrolepis drummondiana*			
94.	1134	*Centrolepis polygyna (Wiry Centrolepis)*			
95.	17685	*Chaetanthus aristatus*			
96.	11299	*Chamaescilla corymbosa var. corymbosa*			
97.	35619	*Chamelaucium sp. Cataby (G.J. Keighery 11009)*		T	Y
98.	5498	*Chamelaucium uncinatum (Geraldton Wax)*			
99.	17706	*Chordifex sinuosus*			
100.	4566	*Comesperma volubile (Love Creeper)*			
101.	40922	*Commersonia densiflora*			
102.	1882	*Conospermum stoechadis (Common Smokebush)*			
103.	15611	*Conospermum stoechadis subsp. stoechadis (Common Smokebush)*			
104.	19026	*Conostephium magnum*		P4	
105.	6347	*Conostephium minus (Pink-tipped Pearl flower)*			
106.	6348	*Conostephium pendulum (Pearl Flower)*			
107.	1418	*Conostylis aculeata (Prickly Conostylis)*			
108.	11414	*Conostylis aculeata subsp. breviflora*			
109.	1420	*Conostylis androstemma (Trumpets)*			
110.	1421	*Conostylis angustifolia*			
111.	1423	*Conostylis aurea (Golden Conostylis)*			
112.	11438	*Conostylis candicans subsp. candicans*			
113.	11773	*Conostylis crassinervia subsp. absens*			
114.	11695	*Conostylis festucacea subsp. festucacea*			
115.	1436	*Conostylis juncea*			
116.	11870	*Conostylis teretifolia subsp. teretifolia*			
117.	1458	*Conostylis teretiuscula*			
118.	5502	*Conothamnus trinervis*			
119.	13354	*Craspedia variabilis*			
120.	31571	*Cryptandra intermedia*			
121.	9076	*Cryptandra myriantha*			
122.	4809	*Cryptandra pungens*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
123.	768	*Cyathochaeta avenacea*			
124.	783	*Cyperus congestus (Dense Flat-sedge)*	Y		
125.	816	*Cyperus tenuiflorus (Scaly Sedge)*	Y		
126.	7428	*Dampiera coronata (Wedge-leaved Dampiera)*			
127.	7451	*Dampiera lavandulacea*			
128.	7475	*Dampiera spicigera (Spiked Dampiera)*			
129.	7481	*Dampiera tephrea*		P2	
130.	7482	*Dampiera teres (Terete-leaved Dampiera)*			
131.	5518	*Darwinia neildiana (Fringed Bell)*			
132.	5524	*Darwinia pinifolia*			
133.	1220	*Dasypogon obliquifolius*			
134.	3793	*Daviesia angulata*			
135.	19747	*Daviesia decurrens subsp. decurrens*			
136.	18560	*Daviesia divaricata subsp. divaricata*			
137.	11879	*Daviesia hakeoides subsp. hakeoides*			
138.	15505	*Daviesia incrassata subsp. incrassata*			
139.	15506	*Daviesia incrassata subsp. teres*			
140.	12329	*Daviesia nudiflora subsp. hirtella*			
141.	16585	*Daviesia nudiflora subsp. nudiflora*			
142.	3833	*Daviesia podophylla*			
143.	3835	*Daviesia preissii*			
144.	3845	*Daviesia triflora*			
145.	17662	*Desmocladus lateriticus*			
146.	46364	*Desmocladus microcarpus*		P2	
147.	29078	*Dillwynia sp. Northern Sandplains (M. Hislop 3278)*			
148.	15275	*Diplolaena obovata*			
149.	3011	*Diplotaxis muralis (Wall Rocket)*	Y		
150.	42182	*Diuris perialla*			
151.	43300	*Diuris refracta*			
152.	4761	*Dodonaea ericoides*			
153.	13201	*Drosera eneabba*			
154.	13212	*Drosera erythrorhiza subsp. magna*			
155.	3098	*Drosera glanduligera (Pimpernel Sundew)*			
156.	3101	*Drosera heterophylla (Swamp Rainbow)*			
157.	13199	*Drosera leioblastus*			
158.	14298	*Drosera macrantha subsp. macrantha*			
159.	13208	*Drosera marchantii subsp. prophylla*		P3	
160.	3118	*Drosera pallida (Pale Rainbow)*			
161.	3119	*Drosera parvula (Small Sundew)*			
162.	29178	*Drosera porrecta*			
163.	13185	*Drosera spilos*			
164.	1066	*Ecdeiocolea monostachya*			
165.	11105	*Echinochloa crus-galli*	Y		
166.	347	*Ehrharta calycina (Perennial Veldt Grass)*	Y		
167.	349	*Ehrharta longiflora (Annual Veldt Grass)*	Y		
168.	17605	*Eleocharis keigheryi*		T	
169.	1643	*Elythranthera brunonis (Purple Enamel Orchid)*			
170.	13950	*Eremaea asterocarpa subsp. asterocarpa*			
171.	5541	*Eremaea pauciflora*			
172.	45244	*Ericomyrtus serpyllifolia*			
173.	45215	*Ericomyrtus tenuior*			
174.	12898	*Eucalyptus abdita*		P2	
175.	12895	*Eucalyptus arachnaea subsp. arachnaea*			
176.	13546	*Eucalyptus dolorosa*		T	Y
177.	5628	*Eucalyptus drummondii (Drummond's Gum)*			
178.	5658	*Eucalyptus gittinsii (Northern Sandplain Mallee)*			
179.	18292	*Eucalyptus gittinsii subsp. illucida*			
180.	5690	*Eucalyptus lane-poolei (Salmon White Gum)*			
181.	13531	*Eucalyptus macrocarpa subsp. elachantha (Small-leaved Mottlecah)*		P4	
182.	13530	*Eucalyptus macrocarpa subsp. macrocarpa (Mottlecah)*			
183.	5717	*Eucalyptus myriadena*			
184.	12866	*Eucalyptus pluricaulis subsp. pluricaulis*			
185.	5763	*Eucalyptus rudis (Flooded Gum, Kulurda)*			
186.	13511	*Eucalyptus rudis subsp. rudis*			
187.	5790	*Eucalyptus todtiana (Coastal Blackbutt)*			
188.	12905	*Eucalyptus wandoo subsp. pulverea*			
189.	20515	*Gastrolobium axillare*			
190.	20475	*Gastrolobium capitatum*			
191.	3906	*Gastrolobium ilicifolium*			
192.	20482	*Gastrolobium nervosum*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
193.	20514	*Gastrolobium nudum*		P2	
194.	3912	*Gastrolobium oxylobioides (Champion Bay Poison)*			
195.	3915	*Gastrolobium plicatum*			
196.	3916	*Gastrolobium polystachyum (Horned Poison)*			
197.	3924	*Gastrolobium spinosum (Prickly Poison)*			
198.	6143	*Glischrocaryon aureum (Common Popflower)*			
199.	8002	*Gnephosis tenuissima*			
200.	10909	*Gompholobium confertum*			
201.	3950	*Gompholobium knightianum*			
202.	3955	*Gompholobium preissii*			
203.	3957	*Gompholobium tomentosum (Hairy Yellow Pea)*			
204.	6149	*Gonocarpus cordiger*			
205.	6161	*Gonocarpus pithyoides*			
206.	7495	*Goodenia berardiana*			
207.	29362	*Goodenia coerulea*			
208.	12516	*Goodenia convexa*			
209.	12520	*Goodenia fasciculata*			
210.	7538	*Goodenia pulchella*			
211.	15763	*Grevillea biformis subsp. biformis*			
212.	12221	*Grevillea calliantha*		T	
213.	1994	*Grevillea drummondii (Drummond's Grevillea)*		P4	
214.	2001	*Grevillea eriostachya (Flame Grevillea, Kaliny-kalinypa)*			
215.	19567	*Grevillea florida*		P3	
216.	2087	*Grevillea saccata (Pouched Grevillea)*		P4	
217.	19569	*Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)*		P1	Y
218.	17450	*Grevillea synapheae subsp. minyulo*		P1	
219.	14420	*Grevillea synapheae subsp. pachyphylla*			
220.	14423	*Grevillea thyrsoides subsp. thyrsoides*		P3	
221.	2116	*Grevillea uncinulata (Hook-leaf Grevillea)*			
222.	19231	*Grevillea uncinulata subsp. Coomallo (S.J. Patrick 719)*			
223.	12824	*Grevillea vestita subsp. vestita*			
224.	13233	*Guichenotia alba*		P3	
225.	5014	*Guichenotia sarotes*			
226.	2783	*Gyrostemon racemiger*			
227.	2784	*Gyrostemon ramulosus (Corkybark)*			
228.	1469	*Haemodorum loratum*		P3	
229.	1473	*Haemodorum simulans*			
230.	1475	*Haemodorum spicatum (Mardja)*			
231.	17670	*Hakea anadenia*			
232.	2131	*Hakea auriculata*			
233.	2136	*Hakea candolleana*			
234.	2143	*Hakea conchifolia (Shell-leaved Hakea)*			
235.	2164	*Hakea gilbertii*			
236.	2175	*Hakea lissocarpha (Honey Bush)*			
237.	12230	*Hakea longiflora*		P3	
238.	45333	*Hakea neospathulata*			
239.	2197	*Hakea prostrata (Harsh Hakea)*			
240.	12233	*Hakea psilorrhyncha*			
241.	2205	*Hakea smilacifolia*			
242.	2206	*Hakea stenocarpa (Narrow-fruited Hakea)*			
243.	2214	*Hakea trifurcata (Two-leaf Hakea)*			
244.	2215	*Hakea undulata (Wavy-leaved Hakea)*			
245.	6838	*Hemiandra linearis (Speckled Snakebush)*			
246.	6839	*Hemiandra pungens (Snakebush)*			
247.	38320	*Hemiandra sp. Jurien (B.J. Conn & M.E. Tozer BJC 3885)*			
248.	6856	*Hemigenia incana (Silky Hemigenia)*			
249.	41020	*Hemiphora bartlingii (Woolly Dragon)*			
250.	5108	*Hibbertia acerosa (Needle Leaved Guinea Flower)*			
251.	5112	*Hibbertia aurea*			
252.	5116	*Hibbertia crassifolia*			
253.	20046	*Hibbertia hibbertioides var. hibbertioides*			
254.	45534	*Hibbertia hypericoides subsp. hypericoides*			
255.	5148	*Hibbertia mylnei*			
256.	5157	*Hibbertia polystachya*			
257.	5162	*Hibbertia racemosa (Stalked Guinea Flower)*			
258.		*Hibbertia sp.*			
259.	46435	*Hibbertia sp. Geraldton Sandplains (R. Edmiston E 421)*			
260.	48381	*Hibbertia striata*			
261.	5173	*Hibbertia subvaginata*			
262.	6222	*Homalosciadium homalocarpum*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
263.	3966	*Hovea pungens (Devil's Pins, Puyenak)*			
264.	3967	*Hovea stricta*			
265.	12741	*Hyalosperma cotula*			
266.	5216	*Hybanthus calycinus (Wild Violet)*			
267.	5221	*Hybanthus floribundus*			
268.	20044	*Hypocalymma hirsutum*			
269.	14493	*Hypocalymma sp. Cataby (G.J. Keighery 5151)*		P2	
270.	5828	*Hypocalymma tetrapterum*		P3	
271.	5829	*Hypocalymma xanthopetalum*			
272.	1070	*Hypolaena exsulca*			
273.	17622	*Hypolaena robusta*		P4	
274.	20200	*Isolepis cernua var. setiformis*			
275.	919	*Isolepis oldfieldiana*			
276.	2221	*Isopogon asper*			
277.	2227	*Isopogon divergens (Spreading Coneflower)*			
278.	2232	*Isopogon linearis*			
279.	7396	*Isotoma hypocrateriformis (Woodbridge Poison)*			
280.	3992	*Isotropis cuneifolia (Granny Bonnets)*			
281.	19700	*Isotropis cuneifolia subsp. cuneifolia*			
282.	4003	*Jacksonia carduacea*		P3	
283.	4010	*Jacksonia floribunda (Holly Pea)*			
284.	4019	*Jacksonia macrocalyx*			
285.	14778	*Jacksonia nutans*			
286.	4025	*Jacksonia restioides*			
287.	19632	*Johnsonia pubescens subsp. pubescens*			
288.	20454	*Juncus acutus subsp. acutus*	Y		
289.	1188	*Juncus pallidus (Pale Rush)*			
290.	4044	*Kennedia prostrata (Scarlet Runner)*			
291.	6780	*Lachnostachys eriobotrya (Lambswool)*			
292.	468	*Lamarckia aurea (Goldentop)*	Y		
293.	15528	*Lambertia multiflora var. multiflora*			
294.	5031	*Lasiopetalum drummondii*			
295.	15552	*Lasiopetalum sp. Hill River (T.N. Stoate 5)*		P1	
296.	1305	*Laxmannia omnifertilis*			
297.	11464	*Laxmannia sessiliflora subsp. australis*			
298.	1309	*Laxmannia squarrosa*			
299.	7568	*Lechenaultia biloba (Blue Leschenaultia)*			
300.	7586	*Lechenaultia stenosepala (Narrow-sepaled Leschenaultia)*			
301.	1073	*Lepidobolus chaetocephalus (Bristle-headed Chaff Rush)*			
302.	1075	*Lepidobolus preissianus*			
303.	13775	*Lepidobolus quadratus*		P3	
304.	930	*Lepidosperma costale*			
305.	937	*Lepidosperma longitudinale (Pithy Sword-sedge)*			
306.	944	*Lepidosperma scabrum*			
307.	945	*Lepidosperma squamatum*			
308.	1078	*Leptocarpus coangustatus*			
309.	5847	*Leptospermum erubescens (Roadside Teatree)*			
310.	5857	*Leptospermum spinescens*			
311.	48179	*Leucopogon foliosus*		P3	
312.	6400	*Leucopogon gracillimus*			
313.	6420	*Leucopogon oldfieldii*			
314.	6421	*Leucopogon oliganthus*			
315.	6434	*Leucopogon polymorphus*			
316.	39501	*Leucopogon sp. Coomallo (R.J. Cranfield 1457)*			
317.	20086	*Leucopogon sp. Northern Scarp (M. Hislop 2233)*			
318.	6444	*Leucopogon sprengelioides*			
319.	48184	*Leucopogon stenophyllus*			
320.	7677	*Levenhookia stipitata (Common Stylewort)*			
321.	9289	*Lobelia anceps (Angled Lobelia)*			
322.	7406	*Lobelia rhombifolia (Tufted Lobelia)*			
323.	475	*Lolium multiflorum (Italian Ryegrass)*	Y		
324.	1239	*Lomandra preissii*			
325.	1243	*Lomandra sericea (Silky Mat Rush)*			
326.	8564	*Lotus subbiflorus*	Y		
327.	1097	*Lyginia barbata*			
328.	18049	*Lyginia imberbis*			
329.	34736	*Lysinema pentapetalum*			
330.	5281	*Lythrum hyssopifolia (Lesser Loosestrife)*	Y		
331.	1477	*Macropidia fuliginosa (Black Kangaroo Paw)*			
332.	18119	*Macrozamia fraseri*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
333.	17633	*Marianthus erubescens*			
334.	19380	*Melaleuca calyptroides*			
335.	17982	*Melaleuca carrii*			
336.	19387	*Melaleuca clavifolia*			
337.	5893	*Melaleuca concreta*			
338.	5958	*Melaleuca radula (Graceful Honeymyrtle)*			
339.	18278	*Melaleuca tinkeri*			
340.	5983	*Melaleuca trichophylla*			
341.	954	*Mesomelaena preissii*			
342.	955	*Mesomelaena pseudostygia*			
343.	957	*Mesomelaena tetragona (Semaphore Sedge)*			
344.	15456	*Microcorys sp. Coomallo (L. Haegi 2677)*			
345.	4100	*Mirbelia spinosa*			
346.	29418	*Monoculus monstrosus*	Y		
347.	37440	*Monopsis debilis var. depressa*	Y		
348.	2401	*Nuytsia floribunda (Christmas Tree, Mudja)*			
349.	16347	*Oenothera laciniata*	Y		
350.	32716	*Olearia lehmanniana*			
351.	18256	*Opercularia spermacocea*			
352.	18255	*Opercularia vaginata (Dog Weed)*			
353.	46255	*Orianthera campanulata*			
354.	46254	*Orianthera spermacocea*			
355.	1537	*Orthrosanthus laxus (Morning Iris)*			
356.	4349	*Oxalis corniculata (Yellow Wood Sorrel)*	Y		
357.	1546	*Patersonia juncea (Rush Leaved Patersonia)*			
358.	1550	*Patersonia occidentalis (Purple Flag, Koma)*			
359.	40423	*Pentameris airoides (False Hairgrass)*	Y		
360.	13911	*Persicaria decipiens*			
361.	2258	*Persoonia comata*			
362.	20368	*Petrophile axillaris*			
363.	2286	*Petrophile brevifolia*			
364.	16874	*Petrophile recurva*			
365.	2306	*Petrophile rigida*			
366.	2309	*Petrophile serruriae*			
367.	2310	*Petrophile shuttleworthiana*			
368.	2312	*Petrophile striata*			
369.	18529	*Philotheca spicata (Pepper and Salt)*			
370.	1173	*Philydrella pygmaea (Butterfly Flowers)*			
371.	1478	*Phlebocarya ciliata*			
372.	4	*Phylloglossum drummondii (Pigmy Clubmoss)*			
373.	6985	*Physalis pubescens*	Y		
374.	5231	*Pimelea angustifolia (Narrow-leaved Pimelea)*			
375.	5244	*Pimelea floribunda*			
376.	11402	*Pimelea imbricata var. piligera*			
377.	5254	*Pimelea leucantha*			
378.	18353	*Pithocarpa pulchella var. pulchella*			
379.	6262	*Platysace xerophila*			
380.	45237	*Podolepis aristata subsp. aristata*			
381.	8177	*Podolepis lessonii*			
382.	8182	*Podotheca angustifolia (Sticky Longheads)*			
383.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
384.	12733	*Podotheca pritzelii*		P3	
385.	29919	*Polianthion wichurae*			
386.	582	*Polypogon monspeliensis (Annual Beardgrass)*	Y		
387.	1680	*Prasophyllum parvifolium (Autumn Leek Orchid)*			
388.	10853	*Prasophyllum plumiforme*			
389.	13255	*Pterochaeta paniculata*			
390.	1687	*Pterostylis dilatata*			
391.	45343	*Pterostylis platypetala*			
392.	1698	*Pterostylis vittata (Banded Greenhood)*			
393.	2742	*Ptilotus manglesii (Pom Poms, Mulamula)*			
394.	2751	*Ptilotus polystachyus (Prince of Wales Feather)*			
395.	4172	*Pultenaea ericifolia*			
396.	3061	*Raphanus raphanistrum (Wild Radish)*	Y		
397.	13300	*Rhodanthe citrina*			
398.	13234	*Rhodanthe manglesii*			
399.	2430	*Rumex brownii (Swamp Dock)*	Y		
400.	2433	*Rumex crispus (Curled Dock)*	Y		
401.	7595	*Scaevola anchusifolia*			
402.	7603	*Scaevola canescens (Grey Scaevola)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
403.	7613	*Scaevola glandulifera (Viscid Hand-flower)*			
404.	12585	*Scaevola repens*			
405.	12588	*Scaevola virgata*			
406.	979	*Schoenus caespititius*			
407.	982	*Schoenus clandestinus*			
408.	986	*Schoenus efoliatus*			
409.	17617	*Schoenus insolitus*			
410.	1000	*Schoenus minutulus*			
411.	1011	*Schoenus rigens*			
412.	1018	*Schoenus subfascicularis*			
413.	16252	*Schoenus subflavus subsp. subflavus*			
414.	1026	*Schoenus unispiculatus*			
415.	6033	*Scholtzia involucrata (Spiked Scholtzia)*			
416.	6037	*Scholtzia parviflora*			
417.	25884	*Senecio pinnatifolius var. latilobus*			
418.	7013	*Solanum hoplopetalum (Thorny Solanum)*			
419.	7018	*Solanum lasiophyllum (Flannel Bush, Mindjulu)*			
420.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
421.	8230	*Sonchus asper (Rough Sowthistle)*	Y		
422.	17551	*Sphaerolobium drummondii*			
423.	10800	*Sphaerolobium pulchellum*			
424.	4713	*Stachystemon axillaris (Leafy Stachystemon)*			
425.	4733	*Stackhousia monogyna*			
426.	9070	*Stackhousia pubescens (Downy Stackhousia)*			
427.	15065	*Stenanthemum notiale subsp. notiale*			
428.	14240	*Stenanthemum reissekii*			
429.	7680	*Stylidium aeonioides*		P4	
430.	7709	*Stylidium crossocephalum (Posy Triggerplant)*			
431.	7710	*Stylidium cygnorum*			
432.	7716	*Stylidium diuroides (Donkey Triggerplant)*			
433.	18420	*Stylidium flagellum*			
434.	7762	*Stylidium miniatum (Pink Butterfly Triggerplant)*			
435.	7768	*Stylidium obtusatum (Pinafore Triggerplant)*			
436.	7771	*Stylidium periscelianthum (Pantaloon Triggerplant)*		P3	
437.	25837	*Stylidium purpureum (Purple Fountain Triggerplant)*			
438.	20521	*Stylidium rigidulum*			
439.	7798	*Stylidium schoenoides (Cow Kicks)*			
440.		*Stylidium sp.*			
441.	17510	*Stylidium sp. Kalbarri (A. Carr 145)*			
442.	25836	*Stylidium spiciforme (Spiciform Triggerplant)*			
443.	17578	*Stylidium udusicola*			
444.	16882	*Synaphea aephynsa*			
445.	2329	*Synaphea spinulosa*			
446.	15532	*Synaphea spinulosa subsp. spinulosa*			
447.	1036	*Tetraria octandra*			
448.	4539	*Tetratheca paucifolia*			
449.	11032	*Thelymitra apiculata*		P4	
450.	10862	*Thelymitra stellata (Star Orchid)*		T	
451.	6060	*Thryptomene mucronulata*			
452.	1334	*Thysanotus glaucus*		P4	
453.	1343	*Thysanotus patersonii*			
454.	1351	*Thysanotus sparteus*			
455.	1357	*Thysanotus thyrsoideus*			
456.	1358	*Thysanotus triandrus*			
457.	6280	*Trachymene pilosa (Native Parsnip)*			
458.	1481	*Tribonanthes australis*			
459.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			
460.	29481	*Tricoryne sp. Eneabba (E.A. Griffin 1200)*			
461.	1038	*Tricostularia neesii*			
462.	4292	*Trifolium campestre (Hop Clover)*	Y		
463.	4298	*Trifolium hirtum (Rose Clover)*	Y		
464.	148	*Triglochin muelleri*			
465.	151	*Triglochin striata*			
466.	13479	*Trymalium ledifolium var. rosmarinifolium*			
467.	7665	*Velleia trinervis*			
468.	15725	*Verbesina encelioides*	Y		
469.	7666	*Verreauxia reinwardtii (Common Verreauxia)*			
470.	12411	*Verticordia densiflora var. cespitosa*			
471.	15432	*Verticordia densiflora var. densiflora*			
472.	6077	*Verticordia drummondii (Drummond's Featherflower)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
473.	14714	*Verticordia lindleyi subsp. lindleyi*		P4	
474.	10822	*Verticordia nobilis*			
475.	6107	*Verticordia pennigera*			
476.	6109	*Verticordia picta (Painted Featherflower)*			
477.	7386	*Wahlenbergia gracilenta (Annual Bluebell)*			
478.	8282	*Waitzia suaveolens (Fragrant Waitzia)*			
479.	13333	*Waitzia suaveolens var. suaveolens*			
480.	1252	*Xanthorrhoea drummondii*			
481.	1256	*Xanthorrhoea preissii (Grass tree, Palga)*			
482.	6285	*Xanthosia ciliata*			
483.	6287	*Xanthosia fruticulosa*			
484.	6289	*Xanthosia huegelii*			
485.	1049	*Zantedeschia aethiopica (Arum Lily)*	Y		

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

APPENDIX C EPBC PROTECTED MATTERS SEARCH TOOL

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

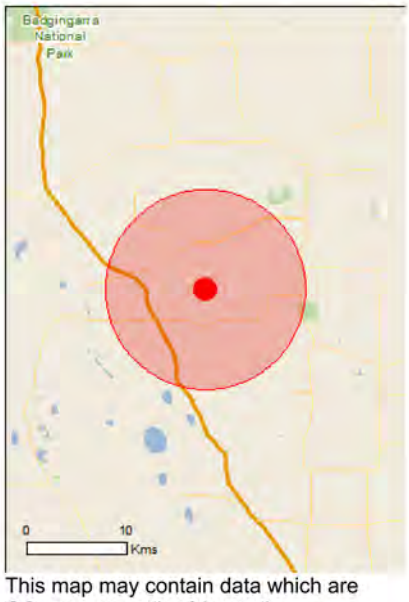
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 20/10/17 14:21:46

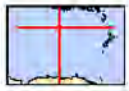
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	29
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	16
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat may occur within area
Plants		
Acacia forrestiana Forest's Wattle [17235]	Vulnerable	Species or species habitat known to occur within area
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
Chamelaucium sp. Cataby (G.J.Keighery 11009) Griffin's Waxflower [82509]	Vulnerable	Species or species habitat known to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [88881]	Endangered	Species or species habitat may occur within area
Conospermum densiflorum subsp. unicephalatum One-headed Smokebush [64871]	Endangered	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus absita Badgingarra Box [24260]	Endangered	Species or species habitat may occur within area
Eucalyptus dolorosa Dandaragan Mallee, Mount Misery Mallee [56709]	Endangered	Species or species habitat known to occur within area
Eucalyptus impensa Eneabba Mallee [56711]	Endangered	Species or species habitat may occur within area
Eucalyptus leprophloia Scaly Butt Mallee, Scaly-butt Mallee [56712]	Endangered	Species or species habitat may occur within area
Eucalyptus recta Silver Mallet [56430]	Endangered	Species or species habitat may occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area
Grevillea calliantha Foote's Grevillea, Cataby Grevillea, Black Magic Grevillea [56339]	Endangered	Species or species habitat known to occur within area
Hakea megalosperma Lesueur Hakea [10505]	Vulnerable	Species or species habitat likely to occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat may occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Paracaleana dixonii Sandplain Duck Orchid [86882]	Endangered	Species or species habitat may occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Thelymitra stellata		
Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Unnamed WA27993	WA
Unnamed WA39571	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit. European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering		Species or species habitat likely to occur

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-30.74778 115.61139

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX D SIGNIFICANT FLORA RECORDS - TPFL AND WAHERB

SIGNIFICANT FLORA RECORDS - TPFL AND WAHERB

Taxon	ConsStatus	WARank	Easting	Northing	Source
Acacia cummingiana	3		375470.0561	6605694.508	WAHERB
Acacia epacantha	3		375470.0561	6605694.508	WAHERB
Acacia epacantha	3		375470.0561	6605694.508	WAHERB
Acacia forrestiana	T	VU	367554.1158	6603795.499	TPFL
Acacia forrestiana	T		367826.4169	6603940.519	WAHERB
Acacia forrestiana	T		375459.3649	6606618.082	WAHERB
Acacia forrestiana	T		365901.4586	6604655.735	WAHERB
Acacia forrestiana	T		375480.75	6604770.933	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		361207.2789	6597205.74	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		359587.5841	6599032.311	WAHERB
Acacia plicata	3		359587.5841	6599032.311	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		361949.0844	6597430.819	WAHERB
Acacia plicata	3		361231.1935	6595358.402	WAHERB
Acacia plicata	3		362414.1884	6597664.715	WAHERB
Acacia splendens	T		375480.75	6604770.933	WAHERB
Acacia splendens	T		375470.0561	6605694.508	WAHERB
Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)	2		364328.1778	6602788.398	TPFL
Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)	2		365970.623	6599113.932	TPFL
Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)	2		365970.623	6599113.932	WAHERB
Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)	2		366100.0432	6585231.98	WAHERB
Anigozanthos humilis subsp. chrysanthus	4		361165.255	6594847.164	TPFL
Anigozanthos humilis subsp. chrysanthus	4		367225.1688	6601482.936	TPFL
Anigozanthos humilis subsp. chrysanthus	4		366369.2466	6594660.026	TPFL
Anigozanthos humilis subsp. chrysanthus	4		367520.8218	6602828.234	WAHERB
Anigozanthos humilis subsp. chrysanthus	4		365924.5025	6602808.435	WAHERB
Asterolasia drummondii	4		366964.2488	6594643.708	TPFL
Asterolasia drummondii	4		366964.2488	6594643.708	TPFL
Asterolasia drummondii	4		366964.2488	6594643.708	TPFL
Asterolasia drummondii	4		367385.4984	6603578.81	TPFL
Asterolasia drummondii	4		367498.0524	6604675.528	WAHERB
Asterolasia drummondii	4		367612.0101	6595439.125	WAHERB
Asterolasia drummondii	4		367612.0101	6595439.125	WAHERB
Asterolasia drummondii	4		364965.3675	6594451.532	WAHERB
Asterolasia drummondii	4		361207.2789	6597205.74	WAHERB
Asterolasia drummondii	4		358016.3347	6597163.967	WAHERB
Asterolasia drummondii	4		366016.7902	6595419.3	WAHERB
Asterolasia drummondii	4		366016.7902	6595419.3	WAHERB
Asterolasia drummondii	4		367536.4792	6594595.371	WAHERB
Asterolasia drummondii	4		366981.5467	6594815.524	WAHERB
Asterolasia drummondii	4		366981.1641	6594846.337	WAHERB
Asterolasia drummondii	4		367498.0524	6604675.528	WAHERB
Asterolasia drummondii	4		364958.3829	6595005.719	WAHERB
Babingtonia delicata	1		364173.3102	6585634.666	TPFL
Babingtonia delicata	1		365927.2605	6585595.194	TPFL
Babingtonia delicata	1		365927.2605	6585595.194	TPFL
Babingtonia delicata	1		361096.646	6603701.688	WAHERB
Babingtonia delicata	1		365972.0255	6585609.945	WAHERB
Babingtonia delicata	1		364321.8392	6585792.752	WAHERB
Babingtonia delicata	1		366062.8753	6585747.77	WAHERB
Babingtonia delicata	1		364786.5943	6585457.651	WAHERB

Taxon	ConsStatus	WARank	Easting	Northing	Source
Banksia dallanneyi subsp. pollosta	3		367699.0244	6584571.039	WAHERB
Banksia kippistiana var. paenepeccata	3		364684.8739	6592507.803	WAHERB
Banksia prionophylla	1		364331.4475	6592651.434	TPFL
Banksia prionophylla	1		364217.024	6592656.08	WAHERB
Banksia prionophylla	1		364444.9394	6593552.02	WAHERB
Banksia prionophylla	1		364317.825	6592842.819	WAHERB
Banksia prionophylla	1		364176.3589	6592723.297	WAHERB
Banksia pteridifolia subsp. vernalis	3		375470.0561	6605694.508	WAHERB
Beaufortia eriocephala	3		364600.8352	6592304.54	TPFL
Beaufortia eriocephala	3		362826.4298	6595378.94	WAHERB
Beaufortia eriocephala	3		366667.4176	6602264.301	WAHERB
Beaufortia eriocephala	3		364539.1616	6592413.84	WAHERB
Beaufortia eriocephala	3		362850.0795	6593531.715	WAHERB
Boronia scabra subsp. condensata	2		367498.0524	6604675.528	WAHERB
Calytrix ecalycata subsp. brevis	3		366903.028	6583772.073	WAHERB
Calytrix ecalycata subsp. brevis	3		375674.0558	6588114.919	WAHERB
Calytrix ecalycata subsp. brevis	3		362524.0226	6588501.953	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T	VU	366800.1175	6595011.145	TPFL
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T	VU	366421.0031	6595560.696	TPFL
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T	VU	366166.7449	6594633.775	TPFL
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T	VU	365658.1427	6594904.547	TPFL
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		366662.9428	6594780.747	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		366016.7902	6595419.3	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		365993.7009	6597266.618	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		366166.7449	6594633.775	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		366016.7902	6595419.3	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		366028.3384	6594495.695	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		365036.4205	6597254.614	WAHERB
Chamelaucium sp. Cataby (G.J. Keighery 11009)	T		365036.4205	6597254.614	WAHERB
Conostephium magnum	4		361180.6663	6597205.395	WAHERB
Dampiera tephrea	2		362006.4529	6597660.253	TPFL
Dampiera tephrea	2		369223.6728	6605602.863	TPFL
Dampiera tephrea	2		360885.9842	6594821.037	WAHERB
Dampiera tephrea	2		375695.1891	6586298.427	WAHERB
Dampiera tephrea	2		375470.0561	6605694.508	WAHERB
Dampiera tephrea	2		375470.0561	6605694.508	WAHERB
Dampiera tephrea	2		361207.2789	6597205.74	WAHERB
Desmocladus microcarpus	2		359587.5841	6599032.311	WAHERB
Drakaea elastica	T	CR	365518.2185	6585374.546	TPFL
Drakaea elastica	T		364216.3401	6584341.846	WAHERB
Drosera marchantii subsp. prophylla	3		364528.3456	6592429.112	TPFL
Drosera marchantii subsp. prophylla	3		364528.8156	6592429.783	WAHERB
Eleocharis keigheryi	T	VU	362481.9588	6597912.682	TPFL
Eleocharis keigheryi	T		362455.7382	6597881.638	WAHERB
Eleocharis keigheryi	T		361245.9452	6594219.318	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367634.8342	6593591.919	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367498.0524	6604675.528	WAHERB
Eucalyptus abdita	2		367511.9023	6603551.769	WAHERB
Eucalyptus annuliformis	1		383604.697	6591929.89	WAHERB
Eucalyptus dolorosa	T	CR	367515.5066	6603826.727	TPFL
Eucalyptus dolorosa	T		367611.2481	6603636.107	WAHERB
Eucalyptus dolorosa	T		367523.8218	6602828.234	WAHERB

Taxon	ConsStatus	WARank	Easting	Northing	Source
Eucalyptus dolorosa	T		367502.0524	6604675.528	WAHERB
Eucalyptus dolorosa	T		367503.0524	6604675.528	WAHERB
Eucalyptus dolorosa	T		367504.0524	6604675.528	WAHERB
Eucalyptus dolorosa	T		367505.0524	6604675.528	WAHERB
Eucalyptus dolorosa	T		367506.0524	6604675.528	WAHERB
Eucalyptus dolorosa	T		367657.927	6603230.101	WAHERB
Eucalyptus dolorosa	T		367619.2481	6603636.107	WAHERB
Eucalyptus dolorosa	T		367509.0524	6604675.528	WAHERB
Eucalyptus dolorosa	T		367510.0524	6604675.528	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		362155.2572	6596430.445	TPFL
Eucalyptus macrocarpa subsp. elachantha	4		364202.2152	6592299.491	TPFL
Eucalyptus macrocarpa subsp. elachantha	4		364475.4327	6591717.857	TPFL
Eucalyptus macrocarpa subsp. elachantha	4		362839.7455	6594899.547	TPFL
Eucalyptus macrocarpa subsp. elachantha	4		364434.5649	6595399.238	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		361245.1935	6595358.402	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		359626.7618	6597184.971	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		361247.1935	6595358.402	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		364438.5649	6595399.238	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		362891.7421	6591684.375	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		363433.4651	6595140.129	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		361251.1935	6595358.402	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		359608.5841	6599032.311	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		364443.5649	6595399.238	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		364498.0425	6591748.67	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		364445.5649	6595399.238	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		364423.2006	6597246.562	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		362784.3481	6595021.666	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		362620.4656	6594883.311	WAHERB
Eucalyptus macrocarpa subsp. elachantha	4		363421.3532	6594708.742	WAHERB
Gastrolobium nudum	2		366045.7902	6595419.3	WAHERB
Grevillea calliantha	T	CR	367573.8436	6601332.379	TPFL
Grevillea calliantha	T	CR	366899.9282	6601179.274	TPFL
Grevillea calliantha	T	CR	363873.0871	6603565.606	TPFL
Grevillea calliantha	T	CR	363158.1064	6604824.368	TPFL
Grevillea calliantha	T	CR	364119.3698	6602468.606	TPFL
Grevillea calliantha	T	CR	364378.3839	6600504.217	TPFL
Grevillea calliantha	T	CR	366272.4553	6605208.411	TPFL
Grevillea calliantha	T		365977.5578	6600961.13	WAHERB
Grevillea calliantha	T		365978.5578	6600961.13	WAHERB
Grevillea calliantha	T		362740.3503	6604615.439	WAHERB
Grevillea calliantha	T		367553.8218	6602828.234	WAHERB
Grevillea calliantha	T		365981.5578	6600961.13	WAHERB
Grevillea calliantha	T		365982.5578	6600961.13	WAHERB
Grevillea calliantha	T		363568.1727	6602612.037	WAHERB
Grevillea calliantha	T		363569.1727	6602612.037	WAHERB
Grevillea calliantha	T		363271.7947	6603476.566	WAHERB
Grevillea calliantha	T		364613.0224	6600741.587	WAHERB
Grevillea calliantha	T		364414.8477	6599093.883	WAHERB
Grevillea calliantha	T		363232.3378	6604720.144	WAHERB
Grevillea calliantha	T		362797.5478	6600920.808	WAHERB
Grevillea drummondii	4		375308.8219	6594990.491	TPFL
Grevillea drummondii	4		366828.6376	6594857.523	TPFL
Grevillea drummondii	4		375334.7122	6595052.314	TPFL
Grevillea drummondii	4		358059.3347	6597163.967	WAHERB
Grevillea drummondii	4		365568.3286	6596521.677	WAHERB
Grevillea drummondii	4		366038.7009	6597266.618	WAHERB
Grevillea drummondii	4		367658.0101	6595439.125	WAHERB
Grevillea drummondii	4		362873.4298	6595378.94	WAHERB
Grevillea drummondii	4		365006.3829	6595005.719	WAHERB

Taxon	ConsStatus	WARank	Easting	Northing	Source
Grevillea drummondii	4		365007.3829	6595005.719	WAHERB
Grevillea florida	3		359587.5841	6599032.311	TPFL
Grevillea florida	3		359637.5841	6599032.311	WAHERB
Grevillea olivacea	4		376171.6877	6588551.202	WAHERB
Grevillea olivacea	4		376172.6877	6588551.202	WAHERB
Grevillea saccata	4		375523.0561	6605694.508	WAHERB
Grevillea saccata	4		386690.9265	6606741.649	WAHERB
Grevillea saccata	4		386691.9265	6606741.649	WAHERB
Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)	1		367503.9577	6603761.071	TPFL
Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)	1		367554.0524	6604675.528	WAHERB
Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)	1		365958.4586	6604655.735	WAHERB
Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)	1		367556.0524	6604675.528	WAHERB
Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)	1		367557.0524	6604675.528	WAHERB
Grevillea synapheae subsp. minyulo	1		362764.0341	6602753.127	TPFL
Grevillea synapheae subsp. minyulo	1		361126.1458	6603064.65	TPFL
Grevillea synapheae subsp. minyulo	1		360919.5772	6601550.017	TPFL
Grevillea synapheae subsp. minyulo	1		361219.4866	6600900.29	WAHERB
Grevillea synapheae subsp. minyulo	1		359648.5841	6599032.311	WAHERB
Grevillea synapheae subsp. minyulo	1		359649.5841	6599032.311	WAHERB
Grevillea thyrsoides subsp. thyrsoides	3		361867.9744	6596763.05	WAHERB
Grevillea thyrsoides subsp. thyrsoides	3		363383.7857	6590058.053	WAHERB
Grevillea thyrsoides subsp. thyrsoides	3		364446.9953	6592227.053	WAHERB
Grevillea thyrsoides subsp. thyrsoides	3		364376.4718	6592146.885	WAHERB
Grevillea thyrsoides subsp. thyrsoides	3		362794.5865	6594792.687	WAHERB
Guichenotia alba	3		362918.0795	6593531.715	WAHERB
Haemodorum loratum	3		365902.2941	6588163.851	TPFL
Haemodorum loratum	3		366178.258	6588030.204	WAHERB
Hakea longiflora	3		366063.7009	6597266.618	WAHERB
Hakea longiflora	3		375530.3649	6606618.082	WAHERB
Hakea longiflora	3		361989.0176	6597050.946	WAHERB
Hakea longiflora	3		366066.7009	6597266.618	WAHERB
Hemigenia curvifolia	2		375554.75	6604770.933	WAHERB
Hemigenia curvifolia	2		375555.75	6604770.933	WAHERB
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		362145.6012	6597591.205	TPFL
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		362067.3602	6597473.247	TPFL
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		362145.6012	6597591.205	TPFL
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		368539.4129	6606351.083	TPFL
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		362017.0132	6597195.035	WAHERB
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		361284.2789	6597205.74	WAHERB
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		361285.2789	6597205.74	WAHERB
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		361274.3268	6598129.351	WAHERB
Hypocalymma sp. Dandaragan (C.A. Gardner 9014)	1		375539.3649	6606618.082	WAHERB
Hypocalymma tetrapterum	3		362143.3834	6597354.056	TPFL
Hypocalymma tetrapterum	3		362143.3834	6597354.056	TPFL
Hypocalymma tetrapterum	3		366565.4492	6594638.748	TPFL
Hypocalymma tetrapterum	3		361288.2789	6597205.74	WAHERB
Hypocalymma tetrapterum	3		361289.2789	6597205.74	WAHERB
Hypocalymma tetrapterum	3		366076.7009	6597266.618	WAHERB
Hypocalymma tetrapterum	3		361291.2789	6597205.74	WAHERB
Hypocalymma tetrapterum	3		360994.7859	6595539.034	WAHERB
Hypocalymma tetrapterum	3		359673.5841	6599032.311	WAHERB
Hypocalymma tetrapterum	3		359674.5841	6599032.311	WAHERB
Hypocalymma tetrapterum	3		359675.5841	6599032.311	WAHERB
Hypocalymma tetrapterum	3		359676.5841	6599032.311	WAHERB
Hypocalymma tetrapterum	3		359677.5841	6599032.311	WAHERB
Hypocalymma tetrapterum	3		364489.2006	6597246.562	WAHERB
Hypocalymma tetrapterum	3		361937.5034	6597213.981	WAHERB
Hypolaena robusta	4		364514.5649	6595399.238	WAHERB
Hypolaena robusta	4		367511.3078	6594556.872	WAHERB

Taxon	ConsStatus	WARank	Easting	Northing	Source
Hypolaena robusta	4		367512.3078	6594556.872	WAHERB
Jacksonia carduacea	3		360096.0065	6594802.957	WAHERB
Jacksonia carduacea	3		364028.4491	6593009.854	WAHERB
Jacksonia carduacea	3		364167.8109	6593147.852	WAHERB
Lasiopetalum sp. Hill River (T.N. Stoate 5)	1		367739.6795	6603850.106	TPFL
Lasiopetalum sp. Hill River (T.N. Stoate 5)	1		367597.0524	6604675.528	WAHERB
Lasiopetalum sp. Hill River (T.N. Stoate 5)	1		367598.0524	6604675.528	WAHERB
Lasiopetalum sp. Hill River (T.N. Stoate 5)	1		366002.4586	6604655.735	WAHERB
Lasiopetalum sp. Hill River (T.N. Stoate 5)	1		366003.4586	6604655.735	WAHERB
Lasiopetalum sp. Hill River (T.N. Stoate 5)	1		367625.4842	6603773.603	WAHERB
Lasiopetalum sp. Hill River (T.N. Stoate 5)	1		367626.4842	6603773.603	WAHERB
Lechenaultia galactites	3		375575.0561	6605694.508	WAHERB
Lepidobolus quadratus	3		364597.7255	6589857.349	WAHERB
Lepidobolus quadratus	3		362135.7645	6595368.7	WAHERB
Lepidobolus quadratus	3		364805.406	6592508.183	WAHERB
Lepidobolus quadratus	3		364600.7255	6589857.349	WAHERB
Lepidobolus quadratus	3		364672.0016	6592371.006	WAHERB
Lepidobolus quadratus	3		364673.0016	6592371.006	WAHERB
Leucopogon foliosus	3		364545.2994	6592521.027	WAHERB
Leucopogon foliosus	3		364314.9666	6592718.966	WAHERB
Leucopogon foliosus	3		364791.9121	6592521.018	WAHERB
Macarthuria keigheryi	T		362635.0401	6588528.951	WAHERB
Podotheca pritzelii	3		366063.5578	6600961.13	WAHERB
Ptychosema pusillum	T	VU	365308.2289	6585599.709	TPFL
Ptychosema pusillum	T		364333.3401	6584341.846	WAHERB
Rhetinocarpha suffruticosa	1		375598.75	6604770.933	WAHERB
Stylidium aeonioides	4		367826.4169	6603940.519	TPFL
Stylidium aeonioides	4		366978.4893	6595061.804	TPFL
Stylidium aeonioides	4		364217.024	6592656.08	TPFL
Stylidium aeonioides	4		364217.024	6592656.08	TPFL
Stylidium aeonioides	4		364517.2006	6597246.562	WAHERB
Stylidium aeonioides	4		367618.0524	6604675.528	WAHERB
Stylidium aeonioides	4		363328.0432	6592643.224	WAHERB
Stylidium aeonioides	4		366138.7902	6595419.3	WAHERB
Stylidium aeonioides	4		362109.9711	6597105.722	WAHERB
Stylidium aeonioides	4		364479.3844	6592794.075	WAHERB
Stylidium aeonioides	4		366946.6222	6594844.355	WAHERB
Stylidium aeonioides	4		362043.0176	6597050.946	WAHERB
Stylidium aeonioides	4		367054.5703	6594876.378	WAHERB
Stylidium aeonioides	4		366954.1028	6594915.136	WAHERB
Stylidium periscelianthum	3		361309.6663	6597205.395	WAHERB
Thelymitra apiculata	4		362706.1034	6590017.706	WAHERB
Thelymitra apiculata	4		364430.9357	6592978.169	WAHERB
Thelymitra apiculata	4		364688.8987	6592418.831	WAHERB
Thelymitra stellata	T	EN	364589.6971	6592617.677	TPFL
Thysanotus glaucus	4		364208.0744	6591837.629	TPFL
Thysanotus glaucus	4		375332.9211	6595206.263	TPFL
Thysanotus glaucus	4		364624.7255	6589857.349	WAHERB
Thysanotus glaucus	4		363007.7421	6591684.375	WAHERB
Thysanotus glaucus	4		363008.7421	6591684.375	WAHERB
Verticordia huegelii var. tridens	3		375606.0561	6605694.508	WAHERB
Verticordia insignis subsp. eomagis	3		385133.0531	6598410.9	WAHERB
Verticordia lindleyi subsp. lindleyi	4		359516.4709	6594856.492	TPFL

APPENDIX E REGIONAL BIRD RECORDS - NATUREMAP

Name ID	Species Name	Status
24260	Acanthiza apicalis (Inland Thornbill)	
24261	Acanthiza chrysorrhoa (Yellow-rumped Thornbill)	
24262	Acanthiza inornata (Western Thornbill)	
24560	Acanthorhynchus superciliosus (Western Spinebill)	
25536	Accipiter fasciatus (Brown Goshawk)	
25544	Aegotheles cristatus (Australian Owlet-nightjar)	
24310	Anas castanea (Chestnut Teal)	
24312	Anas gracilis (Grey Teal)	
24313	Anas platyrhynchos (Mallard)	
24315	Anas rhynchotis (Australasian Shoveler)	
24316	Anas superciliosa (Pacific Black Duck)	
47414	Anhinga novaehollandiae (Australasian Darter)	
24561	Anthochaera carunculata (Red Wattlebird)	
24562	Anthochaera lunulata (Western Little Wattlebird)	
24285	Aquila audax (Wedge-tailed Eagle)	
41324	Ardea modesta (Great Egret)	IA
24340	Ardea novaehollandiae (White-faced Heron)	
24341	Ardea pacifica (White-necked Heron)	
25566	Artamus cinereus (Black-faced Woodswallow)	
24356	Artamus personatus (Masked Woodswallow)	
24318	Aythya australis (Hardhead)	
24319	Biziura lobata (Musk Duck)	
24723	Cacatua pastinator subsp. butleri (Butler's Corella)	
25716	Cacatua sanguinea (Little Corella)	
42307	Cacomantis pallidus (Pallid Cuckoo)	
24779	Calidris acuminata (Sharp-tailed Sandpiper)	IA
24784	Calidris ferruginea (Curlew Sandpiper)	T
24788	Calidris ruficollis (Red-necked Stint)	IA
24734	Calyptorhynchus latirostris (Carnaby's Black-Cockatoo)	T
24377	Charadrius ruficapillus (Red-capped Plover)	
24321	Chenonetta jubata (Australian Wood Duck)	
47909	Cheramoeca leucosterna (White-backed Swallow)	
24288	Circus approximans (Swamp Harrier)	
24774	Cladorhynchus leucocephalus (Banded Stilt)	
25675	Colluricincla harmonica (Grey Shrike-thrush)	
25568	Coracina novaehollandiae (Black-faced Cuckoo-shrike)	
24416	Corvus bennetti (Little Crow)	
25592	Corvus coronoides (Australian Raven)	
24671	Coturnix pectoralis (Stubble Quail)	
24420	Cracticus nigrogularis (Pied Butcherbird)	
25595	Cracticus tibicen (Australian Magpie)	
25596	Cracticus torquatus (Grey Butcherbird)	
24322	Cygnus atratus (Black Swan)	

Name ID	Species Name	Status
30901	* Dacelo novaeguineae (Laughing Kookaburra)	
25673	Daphoenositta chrysoptera (Varied Sittella)	
24606	Daphoenositta chrysoptera subsp. pileata (Varied Sittella	
25607	Dicaeum hirundinaceum (Mistletoebird)	
24470	Dromaius novaehollandiae (Emu)	
24290	Elanus caeruleus subsp. axillaris (Black-shouldered Kite)	
47937	Elseyornis melanops (Black-fronted Dotterel)	
24567	Epthianura albifrons (White-fronted Chat)	
24570	Epthianura tricolor (Crimson Chat)	
24379	Erythrogonys cinctus (Red-kneed Dotterel)	
25621	Falco berigora (Brown Falcon)	
25622	Falco cenchroides (Australian Kestrel)	
25623	Falco longipennis (Australian Hobby)	
25624	Falco peregrinus (Peregrine Falcon)	S
25727	Fulica atra (Eurasian Coot)	
24763	Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)	
42314	Gavicalis virescens (Singing Honeyeater)	
24404	Geophaps plumifera (Spinifex Pigeon)	
25530	Gerygone fusca (Western Gerygone)	
47962	Glyciphila melanops (Tawny-crowned Honeyeater)	
24443	Grallina cyanoleuca (Magpie-lark)	
24295	Haliastur sphenurus (Whistling Kite)	
47965	Hieraaetus morphnoides (Little Eagle)	
25734	Himantopus himantopus (Black-winged Stilt)	
24491	Hirundo neoxena (Welcome Swallow)	
24511	Larus novaehollandiae subsp. novaehollandiae (Silver Gull)	
24557	Leipoa ocellata (Malleefowl)	T
25661	Lichmera indistincta (Brown Honeyeater)	
24582	Lichmera indistincta subsp. indistincta (Brown Honeyeater)	
24326	Malacorhynchus membranaceus (Pink-eared Duck)	
25651	Malurus lamberti (Variegated Fairy-wren)	
25652	Malurus leucopterus (White-winged Fairy-wren)	
25654	Malurus splendens (Splendid Fairy-wren)	
24583	Manorina flavigula (Yellow-throated Miner)	
25758	Megalurus gramineus (Little Grassbird)	
24736	Melopsittacus undulatus (Budgerigar)	
24598	Merops ornatus (Rainbow Bee-eater)	IA
25542	Milvus migrans (Black Kite)	
25610	Myiagra inquieta (Restless Flycatcher)	
24407	Ocyphaps lophotes (Crested Pigeon)	
24618	Oreoica gutturalis (Crested Bellbird)	
24328	Oxyura australis (Blue-billed Duck)	P4
25680	Pachycephala rufiventris (Rufous Whistler)	

Name ID	Species Name	Status
24624	Pachycephala rufiventris subsp. rufiventris (Rufous Whistler)	
	Pandion cristatus (Osprey)	
25682	Pardalotus striatus (Striated Pardalote)	
24648	Pelecanus conspicillatus (Australian Pelican)	
48061	Petrochelidon nigricans (Tree Martin)	
48066	Petroica boodang (Scarlet Robin)	
24659	Petroica goodenovii (Red-capped Robin)	
25698	Phalacrocorax melanoleucos (Little Pied Cormorant)	
24667	Phalacrocorax sulcirostris (Little Black Cormorant)	
24409	Phaps chalcoptera (Common Bronzewing)	
48071	Phylidonyris niger (White-cheeked Honeyeater)	
24596	Phylidonyris novaehollandiae (New Holland Honeyeater)	
24841	Platalea flavipes (Yellow-billed Spoonbill)	
24746	Platycercus icterotis subsp. xanthogenys (Western Rosella -inland)	P4
25721	Platycercus zonarius (Australian Ringneck)	
24843	Plegadis falcinellus (Glossy Ibis)	IA
24382	Pluvialis fulva (Pacific Golden Plover)	IA
24681	Poliocephalus poliocephalus (Hoary-headed Grebe)	
25722	Polytelis anthopeplus (Regent Parrot)	
25731	Porphyrio porphyrio (Purple Swamphen)	
24767	Porphyrio porphyrio subsp. bellus (Purple Swamphen)	
24776	Recurvirostra novaehollandiae (Red-necked Avocet)	
48096	Rhipidura albiscapa (Grey Fantail)	
25614	Rhipidura leucophrys (Willie Wagtail)	
25534	Sericornis frontalis (White-browed Scrubwren)	
30948	Smicrornis brevirostris (Weebill)	
24329	Stictonetta naevosa (Freckled Duck)	
25590	* Streptopelia senegalensis (Laughing Turtle-Dove)	
25705	Tachybaptus novaehollandiae (Australasian Grebe)	
24331	Tadorna tadornoides (Australian Shelduck)	
48135	Thinornis rubricollis (Hooded Plover)	P4
24845	Threskiornis spinicollis (Straw-necked Ibis)	
25549	Todiramphus sanctus (Sacred Kingfisher)	
48141	Tribonyx ventralis (Black-tailed Native-hen)	
24806	Tringa glareola (Wood Sandpiper)	IA
24808	Tringa nebularia (Common Greenshank	IA
24851	Turnix velox (Little Button-quail)	
24386	Vanellus tricolor (Banded Lapwing)	
25765	Zosterops lateralis (Silvereye)	

APPENDIX F CONSERVATION SIGNIFICANT BIRD RECORDS - NATUREMAP

NatureMap Species Report

Created By Andre Schmitz on 22/09/2017

Conservation Status	Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Birds
Method	'By Circle'
Centre	115° 40' 26" E,30° 45' 16" S
Buffer	20km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	41324	*Ardea modesta (great egret, white egret)*		IA	
2.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
3.	24784	*Calidris ferruginea (Curlew Sandpiper)*		T	
4.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	
5.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo)*		T	
6.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
7.	24557	*Leipoa ocellata (Malleefowl)*		T	
8.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
9.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
10.	24746	*Platycercus icterotis subsp. xanthogenys (Western Rosella (inland))*		P4	
11.	24843	*Plegadis falcinellus (Glossy Ibis)*		IA	
12.	24382	*Pluvialis fulva (Pacific Golden Plover)*		IA	
13.	48135	*Thinornis rubricollis (Hooded Plover, Hooded Dotterel)*		P4	
14.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
15.	24808	*Tringa nebularia (Common Greenshank, greenshank)*		IA	

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

APPENDIX G STUDY AREA PLANT SPECIES LIST

STUDY AREA PLANT SPECIES LIST

Family	Taxon
Anarthriaceae	*Lyginia barbata*
Apiaceae	*Xanthosia huegelii*
Araceae	**Zantedeschia aethiopica*
Asparagaceae	*Sowerbaea laxiflora*
Asteraceae	**Arctotheca calendula*
Asteraceae	*Brachyscome* sp.
Asteraceae	*Hyalosperma cotula*
Asteraceae	**Hypochaeris glabra*
Asteraceae	*Lagenophora huegelii*
Asteraceae	*Podotheca gnaphalioides*
Asteraceae	**Ursinia anthemoides*
Caryophyllaceae	**Petrorhagia dubia*
Casuarinaceae	*Allocasuarina humilis*
Colchicaceae	*Burchardia umbellata*
Cyperaceae	*?Schoenus* sp.
Cyperaceae	*Caustis dioica*
Cyperaceae	*Isolepis* sp.
Cyperaceae	*Lepidosperma longitudinale*
Cyperaceae	*Mesomelaena pseudostygia*
Cyperaceae	*Mesomelaena tetragona*
Cyperaceae	*Schoenus grandiflorus*
Dasypogonaceae	*Calectasia hispida*
Dennstaedtiaceae	*Pteridium esculentum*
Dilleniaceae	*Hibbertia huegelii*
Dilleniaceae	*Hibbertia hypericoides*
Dilleniaceae	*Hibbertia mylnei*
Dilleniaceae	*Hibbertia racemosa*
Droseraceae	*Drosera ?erythrorhiza* subsp. *magna*
Droseraceae	*Drosera subhirtella*
Elaeocarpaceae	*Tetratheca hirsuta*
Ericaceae	*Astroloma glaucescens*
Ericaceae	*Conostephium minus*
Ericaceae	*Conostephium ?pendulum*
Ericaceae	*Leucopogon ?polymorphus*
Ericaceae	*Leucopogon* sp.
Ericaceae	*Leucopogon sprengelioides*
Fabaceae	*Acacia pulchella*
Fabaceae	*Acacia saligna*
Fabaceae	*Bossiaea eriocarpa*
Fabaceae	*Daviesia decurrens*
Fabaceae	*Daviesia divaricata*
Fabaceae	*Gastrolobium nervosum*
Fabaceae	*Gompholobium knightianum*
Fabaceae	*Gompholobium tomentosum*

Family	Taxon
Fabaceae	*Jacksonia sternbergiana*
Fabaceae	**Trifolium* sp.
Geraniaceae	**Erodium cicutarium*
Goodeniaceae	*Leschenaultia biloba*
Haemodoraceae	*Anigozanthos humilis*
Haemodoraceae	*Conostylis candicans* subsp. *candicans*
Haemodoraceae	*Conostylis teretifolia* subsp. *planescens*
Hemerocallidaceae	*Johnsonia pubescens* subsp. *pubescens*
Iridaceae	**Romulea rosea*
Juncaceae	**Juncus acutus*
Juncaceae	*Juncus pallidus*
Loranthaceae	*Nuytsia floribunda*
Myrtaceae	*?Scholtzia* sp.
Myrtaceae	*Calothamnus quadrifidus*
Myrtaceae	*Corymbia calophylla*
Myrtaceae	*Eremaea asterocarpa*
Myrtaceae	*Eremaea pauciflora*
Myrtaceae	*Eucalyptus ?subangusta* subsp. *subangusta*
Myrtaceae	*Eucalyptus rudis*
Myrtaceae	*Eucalyptus todtiana*
Myrtaceae	*Eucalyptus wandoo*
Myrtaceae	*Hypocalymma tetrapterum* (P3)
Myrtaceae	*Hypocalymma xanthopetalum*
Myrtaceae	*Leptospermum erubescens*
Myrtaceae	*Melaleuca ?trichophylla*
Myrtaceae	*Melaleuca ciliosa*
Myrtaceae	*Melaleuca rhaphiophylla*
Orchidaceae	*Caladenia flava*
Orchidaceae	*Elythranthera brunonis*
Phyllanthaceae	*Phyllanthus calycinus*
Poaceae	**Briza maxima*
Poaceae	**Briza minor*
Poaceae	**Ehrharta longiflora*
Poaceae	**Eragrostis falcata*
Poaceae	**Hordeum sp.*
Poaceae	**Hordeum vulgare*
Poaceae	**Lolium perenne*
Poaceae	*Neurachne alopecuroidea*
Poaceae	**Vulpia bromoides*
Primulaceae	**Lysimachia arvensis*
Proteaceae	*Adenanthos cygnorum*
Proteaceae	*Banksia attenuata*
Proteaceae	*Banksia hewardiana*
Proteaceae	*Banksia menziesii*
Proteaceae	*Banksia sessilis*
Proteaceae	*Banksia shuttleworthiana*

Family	Taxon
Proteaceae	*Conospermum stoechadis*
Proteaceae	*Grevillea ?vestita*
Proteaceae	*Hakea ?stenocarpa*
Proteaceae	*Hakea conchifolia*
Proteaceae	*Hakea flabellifolia*
Proteaceae	*Hakea incrassata*
Proteaceae	*Hakea lissocarpha*
Proteaceae	*Hakea trifurcata*
Proteaceae	*Hakea undulata*
Proteaceae	*Isopogon asper*
Proteaceae	*Lambertia multiflora*
Proteaceae	*Petrophile brevifolia*
Proteaceae	*Petrophile linearis*
Proteaceae	*Petrophile recurva*
Proteaceae	*Stirlingia latifolia*
Proteaceae	*Synaphea spinulosa*
Restionaceae	*Desmocladus fasciculatus*
Restionaceae	*Desmocladus flexuosus*
Restionaceae	*Hypolaena exsulca*
Restionaceae	*Lepidobolus preissianus*
Rutaceae	*?Boronia* sp.
Rutaceae	*Boronia ramosa*
Sapindaceae	*Diplopeltis huegelii*
Stylidiaceae	*Levenhookia stipitata*
Stylidiaceae	*Stylidium* sp.
Xanthorrhoeaceae	*Xanthorrhoea preissii*
Zamiaceae	*Macrozamia fraseri*

APPENDIX H FLORA SURVEY SITE DATA

Site C1

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	378338.1029 mE 6600397.269 mN
Landform	Valley (Minor Creek (< 5 m))
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Loam
Rock Type	
Vegetation Condition	Degraded
Disturbance Type	Weeds; Grazing; Vegetation Structure Altered
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus rudis	Tree (10-30 m)	50
Ehrharta longiflora	Grass	5
Zantedeschia aethiopica	Herb	5
Isolepis sp.	Herb	1
Juncus acutus	Herb	30

Site C10a

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366425 mE 6596890 mN
Landform	Midslope
Slope & Aspect	Slope - Steep
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	No obvious disturbance
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Xanthorrhoea preissii	Shrub (1-2 m)	1
Acacia pulchella	Shrub (0-1 m)	5
Hakea lissocarpha	Shrub (0-1 m)	10
Hibbertia hypericoides	Shrub (0-1 m)	10
Leucopogon sprengelioides	Shrub (0-1 m)	15
Melaleuca ?trichophylla	Shrub (0-1 m)	10
Gastrolobium nervosum	Shrub (0-1 m)	10
Diplopeltis huegelii	Shrub (0-1 m)	5

Site C10b

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	374600.5827 mE 6599163.918 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Grazing; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus todtiana	Mallee (3-10 m)	20
Vulpia bromoides	Grass	10
Ehrharta longiflora	Grass	5
Arctotheca calendula	Herb	5

Site C11a

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366984 mE 6591765 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Sand
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Grazing; Vegetation Clearing; Animal Tracks
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Banksia attenuata	Tree (<10 m)	15
Eucalyptus todtiana	Tree (<10 m)	15

Site C11b

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	365333.118875 mE 6594959.755513 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus todtiana	Mallee (10-30 m)	5
Hordeum vulgare	Grass	70

Site C12a

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	361069.3507 mE 6594838.41 mN
Landform	Floodplain (Drainage Line)
Slope & Aspect	Slope - Negligible
Soil Colour	Orange
Soil Texture	Clay Loam
Rock Type	
Vegetation Condition	Good
Disturbance Type	Weeds; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus wandoo	Tree (10-30 m)	40
Acacia saligna	Shrub (1-2 m)	1
Grevillea ?vestita	Shrub (1-2 m)	5
Hibbertia mylnei	Shrub (0-1 m)	1
Briza minor	Grass	5
Eragrostis falcata	Grass	30
Desmocladus flexuosus	Sedge	5

Site C12b

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366235.2475 mE 6596780.537 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	
Vegetation Condition	Degraded
Disturbance Type	Weeds; Vegetation Structure Altered; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Banksia attenuata	Tree (<10 m)	5
Corymbia calophylla	Mallee (3-10 m)	20
Jacksonia sternbergiana	Shrub (>2 m)	1
Daviesia divaricata	Shrub (1-2 m)	5
Hibbertia racemosa	Shrub (0-1 m)	5
Briza maxima	Grass	1
Neurachne alopecuroidea	Grass	5
Schoenus grandiflorus	Sedge	5

Site C13

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	367301 mE 6596364 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Loamy Sand
Rock Type	Other
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	30
Banksia attenuata	Tree (<10 m)	5
Xanthorrhoea preissii	Shrub (1-2 m)	1

Site C14

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368183.7627 mE 6596367.406 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Good
Disturbance Type	Weeds; Vegetation Structure Altered
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	15
Banksia attenuata	Tree (<10 m)	10
Banksia menziesii	Tree (<10 m)	10
Acacia pulchella	Shrub (0-1 m)	1
Hibbertia racemosa	Shrub (0-1 m)	1
Mesomelaena pseudostygia	Sedge	5
Schoenus grandiflorus	Sedge	10

Site C15

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368197.8348 mE 6595510.8 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Good
Disturbance Type	Weeds; Vegetation Structure Altered
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Banksia attenuata	Tree (<10 m)	10
Banksia menziesii	Tree (<10 m)	10
Nuytsia floribunda	Tree (<10 m)	1
Eucalyptus todtiana	Mallee (3-10 m)	10
Acacia pulchella	Shrub (0-1 m)	1
Neurachne alopecuroidea	Grass	5
Mesomelaena pseudostygia	Sedge	10

Site C16

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366836 mE 6592107 mN
Landform	Midslope
Slope & Aspect	Slope - Moderate
Soil Colour	Grey
Soil Texture	Sand
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	Grazing; No obvious disturbance
Time since Fire	2-5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Xanthorrhoea preissii	Shrub (1-2 m)	15
Hakea incrassata	Shrub (0-1 m)	10
Hakea ?stenocarpa	Shrub (0-1 m)	5
Hibbertia hypericoides	Shrub (0-1 m)	40
Isopogon asper	Shrub (0-1 m)	5
Lambertia multiflora	Shrub (0-1 m)	5
Leschenaultia biloba	Shrub (0-1 m)	1
Melaleuca ciliosa	Shrub (0-1 m)	5
Burchardia umbellata	Herb	1

Site C17

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	367352 mE 6592737 mN
Landform	Ridgetop
Slope & Aspect	Slope - Negligible
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	Other; No obvious disturbance
Time since Fire	2-5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Banksia sessilis	Shrub (>2 m)	10
Banksia hewardiana	Shrub (1-2 m)	30
Xanthorrhoea preissii	Shrub (1-2 m)	5
Daviesia decurrens	Shrub (0-1 m)	1
Hibbertia hypericoides	Shrub (0-1 m)	15
Petrophile brevifolia	Shrub (0-1 m)	5
Lambertia multiflora	Shrub (0-1 m)	1

Site C18

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	365849 mE 6591112 mN
Landform	Ridgetop
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	Vehicle Tracks; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Xanthorrhoea preissii	Shrub (1-2 m)	10
Astroloma glaucescens	Shrub (0-1 m)	20
Allocasuarina humilis	Shrub (0-1 m)	20
Calothamnus quadrifidus	Shrub (0-1 m)	15
Calectasia hispida	Shrub (0-1 m)	5
Conospermum stoechadis	Shrub (0-1 m)	5
Banksia hewardiana	Shrub (0-1 m)	15
Banksia shuttleworthiana	Shrub (0-1 m)	10
Hakea conchifolia	Shrub (0-1 m)	5
Hibbertia hypericoides	Shrub (0-1 m)	10
Lambertia multiflora	Shrub (0-1 m)	10
Synaphea spinulosa	Shrub (0-1 m)	10

Site C19

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366909 mE 6591597 mN
Landform	Ridgetop
Slope & Aspect	Slope - Negligible
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Good
Disturbance Type	Grazing; Vegetation Clearing
Time since Fire	2-5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus todtiana	Tree (<10 m)	10
Banksia hewardiana	Shrub (>2 m)	60
Acacia pulchella	Shrub (0-1 m)	5
Daviesia decurrens	Shrub (0-1 m)	10
Schoenus grandiflorus	Sedge	20

Site C23

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	367149.3678 mE 6598014.941 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Very Good
Disturbance Type	Weeds; Grazing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Mallee (3-10 m)	5
Banksia hewardiana	Shrub (1-2 m)	20
Xanthorrhoea preissii	Shrub (1-2 m)	1
Acacia pulchella	Shrub (0-1 m)	1
Daviesia decurrens	Shrub (0-1 m)	1
Hibbertia racemosa	Shrub (0-1 m)	1
Schoenus grandiflorus	Sedge	5

Site C24

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	367951.2133 mE 6591827.148 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Vegetation Clearing; Grazing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus todtiana	Mallee (3-10 m)	10
Xanthorrhoea preissii	Shrub (>2 m)	1
Hordeum vulgare	Grass	70
Arctotheca calendula	Herb	20

Site C25

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368356.3838 mE 6592175.233 mN
Landform	Midslope
Slope & Aspect	Slope - Moderate
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Good
Disturbance Type	Weeds; Grazing; Vegetation Structure Altered
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Mallee (3-10 m)	10
Banksia hewardiana	Shrub (>2 m)	10
Acacia pulchella	Shrub (1-2 m)	1
Hibbertia mylnei	Shrub (0-1 m)	5
Briza maxima	Grass	30
Burchardia umbellata	Herb	1
Ursinia anthemoides	Herb	1

Site C26

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	370372.2013 mE 6595927.555 mN
Landform	Footslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Vegetation Structure Altered; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	50
Nuytsia floribunda	Tree (<10 m)	1
Ehrharta longiflora	Grass	30
Arctotheca calendula	Herb	1
Hypochaeris glabra	Herb	1
Trifolium sp.	Herb	5

Site C27

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	370714.8675 mE 6596219.73 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Vegetation Structure Altered; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	60
Ehrharta longiflora	Grass	60
Lolium perenne	Grass	1
Arctotheca calendula	Herb	1
Hypochaeris glabra	Herb	1
Romulea rosea	Herb	1

Site C28

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	371847 mE 6597080 mN
Landform	Undulating Plain
Slope & Aspect	Slope - Negligible
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	30

Site C29

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	370123.2922 mE 6596763.455 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Vegetation Structure Altered; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	20
Ehrharta longiflora	Grass	50
Arctotheca calendula	Herb	1
Hypochaeris glabra	Herb	1
Romulea rosea	Herb	1

Site C2a

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	369100.1329 mE 6590680.485 mN
Landform	Plain
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Excellent
Disturbance Type	Weeds
Time since Fire	
Leaf Litter Distribution and Cover	

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus todtiana	Mallee (3-10 m)	10
Adenanthos cygnorum	Shrub (>2 m)	5
Allocasuarina humilis	Shrub (>2 m)	5
Hibbertia racemosa	Shrub (1-2 m)	10
Caustis dioica	Sedge	5
Mesomelaena tetragona	Sedge	5
?Schoenus sp.	Sedge	5

Site C2b

Date	September 2017
Site Type	10 x 10 m
Location (GDA94 Zone 50)	378762.6069 mE 6600273.352 mN
Landform	Valley (Minor Creek (< 5 m))
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Loam
Rock Type	
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Grazing; Vegetation Structure Altered
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Acacia saligna	Tree (<10 m)	1
Ehrharta longiflora	Grass	5
Arctotheca calendula	Herb	1
Hordeum vulgare	Herb	1
Juncus acutus	Herb	80

Site C30

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	376857 mE 6600828 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Sand
Rock Type	Other
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey; Grazing
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus todtiana	Tree (<10 m)	40

Site C31

Date	September 2017
Site Type	10 x 10 m
Location (GDA94 Zone 50)	369303 mE 6592779 mN
Landform	Ridgetop
Slope & Aspect	Slope - Negligible
Soil Colour	Grey
Soil Texture	Sand
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	Vehicle Tracks; No obvious disturbance
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Allocasuarina humilis	Shrub (>2 m)	10
Banksia hewardiana	Shrub (>2 m)	30
Banksia sessilis	Shrub (1-2 m)	5
Hibbertia hypericoides	Shrub (0-1 m)	10
Lambertia multiflora	Shrub (0-1 m)	10
Leucopogon sprengelioides	Shrub (0-1 m)	15

Site C32

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	369391 mE 6592524 mN
Landform	Midslope
Slope & Aspect	Slope - Steep
Soil Colour	Grey
Soil Texture	Sand
Rock Type	Granite
Vegetation Condition	Excellent
Disturbance Type	No obvious disturbance
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	15
Banksia hewardiana	Shrub (1-2 m)	40
Hakea trifurcata	Shrub (1-2 m)	5
Macrozamia fraseri	Shrub (1-2 m)	1
Xanthorrhoea preissii	Shrub (1-2 m)	1
Hakea undulata	Shrub (0-1 m)	5
Leucopogon sprengelioides	Shrub (0-1 m)	10
Tetratheca hirsuta	Shrub (0-1 m)	5

Site C34

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368076.1227 mE 6599318.261 mN
Landform	Ridgetop
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Clay Loam
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	Weeds
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Mallee (3-10 m)	5
Xanthorrhoea preissii	Shrub (1-2 m)	5
Calothamnus quadrifidus	Shrub (0-1 m)	20
Hibbertia hypericoides	Shrub (0-1 m)	5
Leucopogon ?polymorphus	Shrub (0-1 m)	20

Site C35

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	377090 mE 6599475 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	40
Caladenia flava	Herb	< 1

Site C36

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368912.957 mE 6591581.081 mN
Landform	Midslope
Slope & Aspect	Slope - Moderate
Soil Colour	Brown
Soil Texture	Clay Loam
Rock Type	Latereite
Vegetation Condition	Good
Disturbance Type	Weeds; Vegetation Structure Altered; Grazing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Nuytsia floribunda	Tree (<10 m)	5
Allocasuarina humilis	Shrub (>2 m)	5
Banksia sessilis	Shrub (>2 m)	20
Banksia hewardiana	Shrub (>2 m)	10
Hibbertia racemosa	Shrub (0-1 m)	5
Arctotheca calendula	Herb	10
Erodium cicutarium	Herb	1
Ursinia anthemoides	Herb	1

Site C37

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	374867 mE 6597078 mN
Landform	Floodplain (Minor Creek (< 5 m))
Slope & Aspect	Slope - Moderate
Soil Colour	Grey
Soil Texture	Loamy Sand
Rock Type	Other
Vegetation Condition	Degraded
Disturbance Type	Weeds; No Native Understorey
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus rudis	Tree (10-30 m)	30
Melaleuca rhaphiophylla	Tree (<10 m)	10
Zantedeschia aethiopica	Herb	80

Site C38

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	375591 mE 6599257 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Loamy Sand
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	60

Site C39

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	371852.8296 mE 6598381.667 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; Grazing; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Brassica tournefortii	Herb	80

Site C3a

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	369765.1385 mE 6593375.173 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	
Vegetation Condition	Excellent
Disturbance Type	No obvious disturbance
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Nuytsia floribunda	Tree (<10 m)	1
Corymbia calophylla	Mallee (10-30 m)	30
Xanthorrhoea preissii	Shrub (1-2 m)	5
Acacia pulchella	Shrub (0-1 m)	1
Hibbertia hypericoides	Shrub (0-1 m)	5
Mesomelaena pseudostygia	Sedge	1
Desmocladus flexuosus	Herb	10

Site C3b

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	375554.7662 mE 6598633.753 mN
Landform	Valley (Minor Creek (< 5 m))
Slope & Aspect	Slope - Negligible
Soil Colour	Brown
Soil Texture	Loam
Rock Type	
Vegetation Condition	Degraded
Disturbance Type	Weeds; Grazing; Vegetation Structure Altered
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus rudis	Tree (10-30 m)	70
Acacia saligna	Tree (<10 m)	5
Melaleuca rhaphiophylla	Tree (<10 m)	5
Lepidosperma longitudinale	Sedge	50
Zantedeschia aethiopica	Herb	10
Pteridium esculentum	Herb	20
Juncus pallidus	Herb	5

Site C4

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	373696 mE 6599311 mN
Landform	Undulating Plain
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Sand
Rock Type	
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey; Grazing
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	20

Site C40

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368534 mE 6599940 mN
Landform	Ridgetop
Slope & Aspect	Slope - Steep
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Ironstone
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey; Grazing
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus sp.	Mallee (3-10 m)	50

Site C41

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	369103 mE 6594970 mN
Landform	Undulating Plain
Slope & Aspect	Slope - Negligible
Soil Colour	Grey
Soil Texture	Sand
Rock Type	Other
Vegetation Condition	Good
Disturbance Type	Weeds; Vehicle Tracks
Time since Fire	2-5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Banksia attenuata	Tree (<10 m)	15
Eucalyptus todtiana	Tree (<10 m)	10
Adenanthos cygnorum	Shrub (1-2 m)	30
Hibbertia racemosa	Shrub (1-2 m)	5
Hibbertia hypericoides	Shrub (0-1 m)	1
Stirlingia latifolia	Shrub (0-1 m)	1
?Boronia sp.	Shrub (0-1 m)	1

Site C42

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	370119 mE 6594980 mN
Landform	Undulating Plain
Slope & Aspect	Slope - Negligible
Soil Colour	Grey
Soil Texture	Sand
Rock Type	Other
Vegetation Condition	Very Good
Disturbance Type	Vehicle Tracks
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Allocasuarina humilis	Shrub (1-2 m)	20
Banksia hewardiana	Shrub (1-2 m)	15
Astroloma glaucescens	Shrub (0-1 m)	10
Banksia shuttleworthiana	Shrub (0-1 m)	1
Hakea incrassata	Shrub (0-1 m)	1
Hakea trifurcata	Shrub (0-1 m)	1
Hibbertia hypericoides	Shrub (0-1 m)	10
Leschenaultia biloba	Shrub (0-1 m)	5
Leucopogon sprengelioides	Shrub (0-1 m)	5

Site C5a

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	365646.4148 mE 6597191.339 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Clay Loam
Rock Type	Latereite
Vegetation Condition	Degraded
Disturbance Type	Weeds; Vegetation Structure Altered; Vegetation Clearing
Time since Fire	2-5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Eucalyptus wandoo	Tree (10-30 m)	30
Lagenophora huegelii	Herb	1
Lysimachia arvensis	Herb	1
Ursinia anthemoides	Herb	1

Site C5b

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368118.232 mE 6599378.829 mN
Landform	Ridgetop
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Clay Loam
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	Weeds
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Mallee (3-10 m)	20
Banksia hewardiana	Shrub (>2 m)	20
Calothamnus quadrifidus	Shrub (1-2 m)	10
Hibbertia hypericoides	Shrub (0-1 m)	5
Hibbertia racemosa	Shrub (0-1 m)	1
Leucopogon ?polymorphus	Shrub (0-1 m)	5

Site C5c

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368103 mE 6599565 mN
Landform	Ridgetop
Slope & Aspect	Slope - Negligible
Soil Colour	Grey
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Good
Disturbance Type	Weeds; Grazing
Time since Fire	1-2 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	40
Macrozamia fraseri	Shrub (1-2 m)	1
Xanthorrhoea preissii	Shrub (1-2 m)	1
Hibbertia racemosa	Shrub (0-1 m)	10
Phyllanthus calycinus	Shrub (0-1 m)	10

Site C6

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	368733.3156 mE 6599661.576 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	
Vegetation Condition	Very Good
Disturbance Type	Weeds
Time since Fire	2-5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Mallee (10-30 m)	50
Macrozamia fraseri	Shrub (1-2 m)	1
Xanthorrhoea preissii	Shrub (1-2 m)	1
Hibbertia racemosa	Shrub (0-1 m)	5
Phyllanthus calycinus	Shrub (0-1 m)	5
Sowerbaea laxiflora	Herb	1

Site C7

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	369017.6526 mE 6599282.258 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Brown
Soil Texture	Sandy Loam
Rock Type	Latereite
Vegetation Condition	Good
Disturbance Type	Weeds; Grazing; Vegetation Structure Altered
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	50
Xanthorrhoea preissii	Shrub (>2 m)	1
Hibbertia racemosa	Shrub (0-1 m)	5
Phyllanthus calycinus	Shrub (0-1 m)	1
Hordeum sp.	Grass	5

Site C8

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366033.9693 mE 6596715.222 mN
Landform	Ridgetop
Slope & Aspect	Slope - Moderate
Soil Colour	Brown
Soil Texture	Clay Loam
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	Weeds
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Xanthorrhoea preissii	Shrub (1-2 m)	10
Acacia pulchella	Shrub (0-1 m)	5
Hakea incrassata	Shrub (0-1 m)	1
Hibbertia hypericoides	Shrub (0-1 m)	5
Isopogon asper	Shrub (0-1 m)	1
Leucopogon sprengelioides	Shrub (0-1 m)	15
Desmocladus flexuosus	Herb	5

Site C98

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	369572.9238 mE 6593095.21 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Excellent
Disturbance Type	No obvious disturbance
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Mallee (3-10 m)	5
Eucalyptus todtiana	Mallee (3-10 m)	5
Allocasuarina humilis	Shrub (1-2 m)	5
Xanthorrhoea preissii	Shrub (1-2 m)	1
Hibbertia hypericoides	Shrub (0-1 m)	5
Leucopogon sprengelioides	Shrub (0-1 m)	5
Mesomelaena pseudostygia	Sedge	1

Site C99

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	361907.492 mE 6594848.232 mN
Landform	Plain
Slope & Aspect	Slope - Gentle
Soil Colour	Orange
Soil Texture	Clay Loam
Rock Type	
Vegetation Condition	Good
Disturbance Type	Rehab; Weeds; Vegetation Clearing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Dominant Species

Taxon	Stratum	Cover (%)
Acacia saligna	Shrub (1-2 m)	5
Acacia pulchella	Shrub (0-1 m)	20
Hakea flabellifolia	Shrub (0-1 m)	1
Eragrostis falcata	Grass	10

Site C9a

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366607 mE 6595939 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	Grey
Soil Texture	Loamy Sand
Rock Type	Latereite
Vegetation Condition	Completely Degraded
Disturbance Type	Weeds; No Native Understorey
Time since Fire	No Evidence
Leaf Litter Distribution and Cover	High (> 40 %)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	50

Site C9b

Date	September 2017
Site Type	Check Site
Location (GDA94 Zone 50)	366568 mE 6595959 mN
Landform	Midslope
Slope & Aspect	Slope - Steep
Soil Colour	Grey
Soil Texture	Loamy Sand
Rock Type	Latereite
Vegetation Condition	Excellent
Disturbance Type	No obvious disturbance
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Dominant Species

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	20
Xanthorrhoea preissii	Shrub (1-2 m)	15
Acacia pulchella	Shrub (0-1 m)	15
Hakea lissocarpha	Shrub (0-1 m)	5
Hibbertia hypericoides	Shrub (0-1 m)	15
Leucopogon sprengelioides	Shrub (0-1 m)	10

Site Q1

Date	September 2017
Site Type	10 x 10 m
Location (GDA94 Zone 50)	368106.9246 mE 6590001.358 mN
Landform	Plain
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Excellent
Disturbance Type	Weeds
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Stratum Table

Taxon	Stratum	Cover (%)
Banksia attenuata	Tree (<10 m)	5
Banksia sessilis	Tree (<10 m)	5
Xanthorrhoea preissii	Shrub (>2 m)	1
Petrophile recurva	Shrub (1-2 m)	1
Melaleuca ciliosa	Shrub (1-2 m)	< 1
?Scholtzia sp.	Shrub (1-2 m)	< 1
Astroloma glaucescens	Shrub (0-1 m)	< 1
Banksia shuttleworthiana	Shrub (0-1 m)	< 1
Bossiaea eriocarpa	Shrub (0-1 m)	< 1
Conospermum stoechadis	Shrub (0-1 m)	1
Conostephium ?pendulum	Shrub (0-1 m)	< 1
Gompholobium tomentosum	Shrub (0-1 m)	< 1
Gompholobium knightianum	Shrub (0-1 m)	< 1
Hibbertia hypericoides	Shrub (0-1 m)	5
Hibbertia huegelii	Shrub (0-1 m)	< 1
Hypocalymma xanthopetalum	Shrub (0-1 m)	< 1
Leptospermum erubescens	Shrub (0-1 m)	< 1
Leucopogon sprengelioides	Shrub (0-1 m)	1

Taxon	Stratum	Cover (%)
Leucopogon sp.	Shrub (0-1 m)	< 1
Petrophile brevifolia	Shrub (0-1 m)	< 1
Synaphea spinulosa	Shrub (0-1 m)	< 1
Neurachne alopecuroidea	Grass	< 1
Mesomelaena pseudostygia	Sedge	1
Anigozanthos humilis	Herb	< 1
Hyalosperma cotula	Herb	< 1
Boronia ramosa	Herb	< 1
Burchardia umbellata	Herb	< 1
Caladenia flava	Herb	< 1
Caustis dioica	Herb	< 1
Drosera subhirtella	Herb	< 1
Drosera ?erythrorhiza subsp. magna	Herb	< 1
Elythranthera brunonis	Herb	< 1
Levenhookia stipitata	Herb	< 1
Petrorhagia dubia	Herb	< 1
Podotheca gnaphalioides	Herb	< 1
Ursinia anthemoides	Herb	< 1

Site Q33

Date	September 2017
Site Type	10 x 10 m
Location (GDA94 Zone 50)	369649.9081 mE 6593302.207 mN
Landform	Footslope
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Excellent
Disturbance Type	Weeds
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Stratum Table

Taxon	Stratum	Cover (%)
Banksia attenuata	Tree (<10 m)	10
Banksia menziesii	Tree (<10 m)	10
Stirlingia latifolia	Shrub (1-2 m)	1
Bossiaea eriocarpa	Shrub (0-1 m)	< 1
Conostephium ?pendulum	Shrub (0-1 m)	< 1
Conostephium minus	Shrub (0-1 m)	< 1
Eremaea asterocarpa	Shrub (0-1 m)	< 1
Eremaea pauciflora	Shrub (0-1 m)	< 1
Gompholobium tomentosum	Shrub (0-1 m)	< 1
Hibbertia hypericoides	Shrub (0-1 m)	5
Hibbertia racemosa	Shrub (0-1 m)	1
Hypocalymma xanthopetalum	Shrub (0-1 m)	< 1
Leucopogon sprengelioides	Shrub (0-1 m)	10
Leucopogon sp.	Shrub (0-1 m)	< 1
Melaleuca ciliosa	Shrub (0-1 m)	< 1
Petrophile linearis	Shrub (0-1 m)	< 1
Xanthorrhoea preissii	Shrub (0-1 m)	< 1
Daviesia decurrens	Sedge	< 1

Taxon	Stratum	Cover (%)
Conostylis candicans subsp. candicans	Herb	< 1
Desmocladus flexuosus	Herb	5
Drosera subhirtella	Herb	< 1
Drosera ?erythrorhiza subsp. magna	Herb	< 1
Xanthosia huegelii	Herb	< 1
Johnsonia pubescens subsp. pubescens	Herb	< 1
Lepidobolus preissianus	Herb	< 1
Lyginia barbata	Herb	< 1
Hypolaena exsulca	Herb	1
Stylidium sp.	Herb	< 1
Ursinia anthemoides	Herb	< 1

Site Q4

Date	September 2017
Site Type	10 x 10 m
Location (GDA94 Zone 50)	370718.0377 mE 6594856.118 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Excellent
Disturbance Type	Weeds
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Moderate (10-40%)

Stratum Table

Taxon	Stratum	Cover (%)
Corymbia calophylla	Tree (10-30 m)	10
Banksia attenuata	Tree (<10 m)	10
Acacia pulchella	Shrub (0-1 m)	< 1
Allocasuarina humilis	Shrub (0-1 m)	1
Bossiaea eriocarpa	Shrub (0-1 m)	< 1
Daviesia decurrens	Shrub (0-1 m)	< 1
Drosera subhirtella	Shrub (0-1 m)	< 1
Gompholobium knightianum	Shrub (0-1 m)	< 1
Gompholobium tomentosum	Shrub (0-1 m)	< 1
Hibbertia hypericoides	Shrub (0-1 m)	5
Hibbertia racemosa	Shrub (0-1 m)	< 1
Melaleuca ciliosa	Shrub (0-1 m)	< 1
?Scholtzia sp.	Shrub (0-1 m)	< 1
Petrophile linearis	Shrub (0-1 m)	< 1
Xanthorrhoea preissii	Shrub (0-1 m)	5
Briza maxima	Grass	< 1
Mesomelaena pseudostygia	Sedge	5

Taxon	Stratum	Cover (%)
Lagenophora huegelii	Herb	< 1
Caladenia flava	Herb	< 1
Calectasia hispida	Herb	< 1
Conostylis teretifolia subsp. planescens	Herb	< 1
Conostylis candicans subsp. candicans	Herb	< 1
Desmocladus fasciculatus	Herb	< 1
Desmocladus flexuosus	Herb	5
Drosera ?erythrorhiza subsp. magna	Herb	< 1
Hypochaeris glabra	Herb	< 1
Lepidobolus preissianus	Herb	5
Lyginia barbata	Herb	< 1
Hypolaena exsulca	Herb	1
Ursinia anthemoides	Herb	< 1

Site Q8

Date	September 2017
Site Type	10 x 10 m
Location (GDA94 Zone 50)	368989.9645 mE 6592092.794 mN
Landform	Midslope
Slope & Aspect	Slope - Gentle
Soil Colour	White
Soil Texture	Sand
Rock Type	
Vegetation Condition	Excellent
Disturbance Type	Weeds; Grazing
Time since Fire	> 5 Years
Leaf Litter Distribution and Cover	Low (< 10%)

Stratum Table

Taxon	Stratum	Cover (%)
Banksia attenuata	Tree (<10 m)	5
Eucalyptus todtiana	Tree (<10 m)	5
Jacksonia sternbergiana	Shrub (>2 m)	1
Xanthorrhoea preissii	Shrub (>2 m)	5
Acacia pulchella	Shrub (0-1 m)	1
Banksia shuttleworthiana	Shrub (0-1 m)	< 1
Hibbertia hypericoides	Shrub (0-1 m)	10
Hibbertia racemosa	Shrub (0-1 m)	1
Leucopogon sp.	Shrub (0-1 m)	< 1
Melaleuca ciliosa	Shrub (0-1 m)	< 1
Petrophile linearis	Shrub (0-1 m)	< 1
Briza maxima	Grass	< 1
Caustis dioica	Sedge	1
Mesomelaena pseudostygia	Sedge	< 1
Anigozanthos humilis	Herb	< 1
Hyalosperma cotula	Herb	< 1
Brachyscome sp.	Herb	< 1

Taxon	Stratum	Cover (%)
Caladenia flava	Herb	< 1
Desmocladus flexuosus	Herb	< 1
Drosera subhirtella	Herb	< 1
Drosera ?erythrorhiza subsp. magna	Herb	< 1
Stylidium sp.	Herb	< 1
Ursinia anthemoides	Herb	< 1
Hyalosperma cotula	Herb	< 1

Document Number: 1

NOVEMBER 2022

Providing sustainable environmental strategies,
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[redacted]

ALINTA ENERGY

YANDIN WIND FARM AVIAN FAUNA MONITORING PROGRAM

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Document status						
***ecologia* project number: 1910**						
Rev.	**Author(s)**	**Reviewer**	**Date**	**Approved for Issue**		
				Name	**Distributed To**	**Date**
0	[redacted]	[redacted]	18/11/2022	[redacted]	[redacted]	18/11/2022

[redacted]

[redacted]

EXECUTIVE SUMMARY

Alinta Energy requires operational phase avian fauna collision monitoring to be undertaken at Yandin Wind Farm (YWF) under Condition 20 of planning approvals which states that "the proponent shall develop and implement an Avian Fauna Collision Monitoring Program (AFCMP) to satisfaction of the Western Australian Department of Water and Environment Regulation (DWER) to monitor the impact of the Wind Farm on avian fauna in the project area, specifically in respect to the Endangered Carnaby's cockatoo." The YWF is located approximately 34 kilometres north-east of Lancelin, approximately 150 kilometres north of Perth and contains 51 operational wind turbines.

[redacted] was engaged by Alinta Energy to undertake monthly monitoring for a period of 24 months to fulfill this requirement. The purpose of regular monitoring undertaken by [redacted] is to collect bird and bat mortality data during monthly carcass searches at 33% of all turbines (17 turbines) as per the Avian Fauna Collision Monitoring Program (AFCMP).

No Carnaby's cockatoos, or other Threatened and Priority avifauna or bat species were recorded during the construction phase ([redacted] data) or first year of YWF operation ([redacted] data).

A total of five carcasses were recorded by [redacted] during the first year of monitoring including two magpies, one nankeen kestrel, one juvenile goshawk and one feather spot belonging to a little corella. Four carcasses were recorded at Turbine WTG31, and one feather spot (little corella) was recorded at WTG27. During the construction phase, [redacted] staff working at YWF incidentally recorded three wedge-tailed eagles, three nankeen kestrels and one black-shouldered kite which were suspected to have collided with turbine blades.

The Carnaby's cockatoo, listed as Endangered under the EPBC Act and BC Act, was recorded foraging and overflying habitat within the YWF on nine occasions during the first year of surveys. The wedge-tailed eagle was recorded overflying or perching on six occasions and raptors were recorded flying or perching on eight occasions including seven nankeen kestrel observations and one whistling kite record.

Scavenger trials were undertaken in February (short grass) and September (long grass) within the first year of monitoring to accord with the AFCMP. During the short grass trials (February 2022), bat replicate carcasses were scavenged at an average rate of 2.6 days, small bird carcasses were scavenged at an average rate of 2.5 days and medium bird carcasses were scavenged at an average rate of 2.1 days. During the long grass trials (September 2022), bat replicate carcasses were scavenged at an average rate of 6 days, small bird carcasses were scavenged at an average rate of 1.8 days and medium bird carcasses were scavenged at an average rate of 2.7 days. As large raptor carcasses were not encountered during the first year of monitoring, scavenger trails were not undertaken for this size class (as stipulated in the AFCMP). Motion camera footage and tracks around carcass sites indicate that foxes appear to be scavenging majority of the carcasses, with feral cats and raptors also recorded scavenging carcasses.

Detector trials were undertaken once during the first year of surveying to accord with the AFMCP. Three [redacted] staff members completed detector trials under long grass/crop conditions and the second round of detector trials (short grass) is scheduled for December 2022/January 2023 once harvesting has been completed. Detector rates ranged from 50% to 70% of carcasses detected. Thick crops (canola, wheat and lupins) around the base of some turbines resulted in lower rates of detection at some turbines. On average, bat replicates were recorded 60% of the time, small birds were recorded 46.6% of the time, medium birds were detected 60% of the time and large birds were detected 66.6% of the time. As very few carcasses were encountered during monthly monitoring and those that were could not be used for detector trials, detector trials were undertaken using artificial substitutes (stuffed toys) intended to accurately represent the size and colour of birds and bats which may be encountered at the YWF.

A full analysis and mortality estimates were not completed for the first year of monitoring due to the small number of carcasses recorded. Statistical analysis and mortality estimates will be provided in the second annual report together with recommendations on the scope of future monitoring.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

Alinta Energy required operational phase avian fauna collision monitoring to be undertaken under Condition 20 of planning approvals for the Yandin Wind Farm (YWF) which states that "the proponent shall develop and implement an Avian Fauna Collision Monitoring Program (AFCMP) to satisfaction of the Western Australian Department of Water and Environment Regulation (DWER) to monitor the impact of the YWF on avian fauna in the project area, specifically in respect to the Endangered Carnaby's cockatoo." [redacted] ([redacted] was engaged by Alinta Energy to undertake monthly monitoring for a period of 24 months to fulfill this requirement. This report covers preliminary results associated with the first year of avifauna strike monitoring, with a more comprehensive second year annual report to follow at the completion of the 24-month survey period.

The purpose of regular monitoring undertaken by [redacted] is to collect bird and bat mortality collected during monthly carcass searches at 33% of all turbines (17 turbines) within the YWF as stipulated in the Avian Fauna Collision Monitoring Program (AFCMP) ([redacted] 2018). The YWF is located approximately 34 kilometres north-east of Lancelin and approximately 150 kilometres north of Perth (Figure 1.1).

1.2 SURVEY OBJECTIVES

The primary objectives of the monitoring program are to:

1. Undertake monthly carcass searches and monitoring for a period of 24 months following the commencement of the operational phase, beginning in December 2021 and ending in September 2023 as outlined in AFCMP.
2. Undertake detector trials and scavenger trials under short and long grass/crop conditions as outlined in the AFCMP.
3. Preparation of first annual report based on data collected between December 2021 and November 2022.
4. Preparation of final report after second year of monitoring (September 2023).

1.3 REGULATORY FRAMEWORK

The survey was designed and undertaken to comply with the following guidance document:

- Yandin Wind Farm Avian Fauna Collision Monitoring Program ([redacted] 2018).
- Onshore Wind Farms – Interim Guidance on Bird and Bat Management (DAWE 2021).

336000 344000 352000 360000 368000 376000 384000 392000 400000

6608000 6600000 6592000 6584000 6576000 6568000

CERVANTES
MOORA
WONGAN HILLS
LANCELIN
Map inset
GINGIN
GOOMALLING
MUCHEA
TOODYAY
NORTHAM
WANNEROO
WUNDOWIE
MARMION
TRIGG
MUNDARING
YORK
DAGLISH
PORT
KALAMUNDA
CARMEL
BICKLEY
MIDDLE DAKOT

CATABY DANDARAGAN ROAD

WTG01
WTG02
WTG03
WTG05
WTG06
WTG08
WTG09
WTG12
WTG16
WTG13
WTG11
WTG15
WTG22
WTG21
WTG20
WTG23
WTG25
WTG27
WTG30
WTG29
WTG28
WTG33
WTG36
WTG41
WTG43
WTG39
WTG48
WTG49
WTG51

BRAND HIGHWAY

LANCELIN
LANCELIN ROAD

Turbine locations
Towns
Roads

Project: 1910
Date: 10 November 2022
Author: [redacted]
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Absolute Scale: 1:176,781 @A3

Figure 1.1: Location of the Yandin Windfarm.

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

0 1.5 3 6 9
Kilometers

2 METHODOLOGY

2.1 TURBINE SELECTION

Avian fauna collision monitoring at the YWF turbines was undertaken by two [redacted] on a monthly basis to determine mortality rates of 'at risk' species including raptors, migratory birds and the Carnaby's cockatoo (Table 2.1). The survey methods adopted accorded with the AFCMP documentation developed by ([redacted] 2018).

As per the AFCMP, the 51 turbines at YWF were split into four clusters (North-east, North-central, Central and South) and 33% (17 turbines total) were randomly selected based on a 'stratified random' sampling design ([redacted] 2018). The cluster of turbines closest to the Cataby Brook Carnaby's cockatoo breeding area (North-central) was represented by five turbines (including all three turbines located closest to the roost) to ensure adequate coverage of the most at risk area.

Locations of turbines surveyed during monthly monitoring activities are provided in Figure 2.1 and Table 2.2.

2.2 MONTHLY SEARCH PROTOCOL

The YWF turbines blades are up to 70 metres in radius. On this basis the majority of carcasses were expected to be distributed within 120 metres of turbines ([redacted] 2018). An inner (0-60 metres) and outer (60-120 metres) circular search zone outlined in the AFCMP ([redacted] 2018) was used to conduct monthly searches (Figure 2.2).

- The inner zone targets the detection of carcasses of bats and small to medium and large sized birds. In the inner zone, a circle is formed with a 60-metre radius from the turbine and transects are spaced every six metres across this circle.
- The outer zone is comprised of the space between the 60 metre and 120 metre radius. Search transects in the outer zone are spaced 12 metres apart and extend out from the edge of the inner zone out to the edge of the outer zone.
- The searching of zones beyond 120 metres is not necessary, given the distance of the circumference of a search circle at 120 metres is above 700 metres and the lack of finds recorded beyond a 100 metres radius ([redacted] unpublished data).

For any carcass detected during monthly searches the following parameters were recorded as per the AFCMP ([redacted]2018):

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

Carcasses encountered during routine monitoring were handled according to the procedure below:

- Carcass removed from the site to avoid re-counting;
- If not desiccated or decomposed, carcass to be packed into a plastic bag, wrapped in newspaper and put into a second plastic bag:
- Carcass labelled with a copy of the carcass search data sheet to ensure that its origin can be traced at a later date, if required; and
- Carcass transferred to a freezer for storage so a second opinion on the species identity may be sought, if necessary, and for potential use in scavenger and/or detectability trials.

Table 2.1: Monthly carcass search dates and observers.

Month	Date	Observers
Dec-21	1/12/2021 - 2/12/2021	[redacted]
Jan-22	13/01/2022 - 14/01/2022	
Feb-22	8/02/2022, 9/02/2022, 14/2/2022, 21/2/2022	
Mar-22	15/03/2022 - 16/3/2022	
Apr-22	12/04/2022, 14/04/2022	
May-22	4/05/2022, 30/05/2022	
Jun-22	23/06/2022 - 24/06/2022	
Jul-22	26/07/2022 - 27/07/2022	
Aug-22	23/08/2022 - 24/08/2022	
Sep-22	9/09/2022, 12/9/2022, 14/9/2022	
Oct-22	4/10/2022 - 5/10/2022	
Nov-22	2/11/2022 - 3/11/2022	

Table 2.2: Turbines randomly selected to survey for bird and bat collisions.

Turbine ID	Easting	Northing
WTG02	376528	6601679
WTG06	374673	6599985
WTG08	378488	6599712
WTG10	374246	6599644
WTG11	367653	6598635
WTG14	381374	6599259
WTG20	373156	6598389
WTG24	367260	6597730
WTG26	371984	6597395
WTG27	366072	6597042
WTG30	366344	6596200
WTG31	370526	6596154
WTG34	368625	6595819
WTG39	368901	6592987
WTG41	368125	6594551
WTG49	366504	6591688
WTG50	367375	6591534

366000 368000 370000 372000 374000 376000 378000 380000 382000

6602000 6600000 6598000 6596000 6594000 6592000

WTG01 WTG02 WTG03 WTG04 WTG05 WTG06 WTG07 WTG08 WTG09 WTG10 WTG11 WTG12 WTG13 WTG14 WTG15 WTG16 WTG17 WTG18 WTG19 WTG20 WTG21 WTG22 WTG23 WTG24 WTG25 WTG26 WTG27 WTG28 WTG29 WTG30 WTG31 WTG32 WTG33 WTG34 WTG35 WTG36 WTG37 WTG38 WTG39 WTG40 WTG41 WTG42 WTG43 WTG44 WTG45 WTG46 WTG47 WTG48 WTG49 WTG50

Turbines monitored monthly
Turbine locations

Project: 1910
Date: 7 November 2022
Author: [redacted]
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Absolute Scale: 1:45,559 @A3

Figure 2.1: Locations of randomly selected turbines to survey for bird and bat collisions on a monthly basis.

0 0.4 0.8 1.6 2.4
Kilometers

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

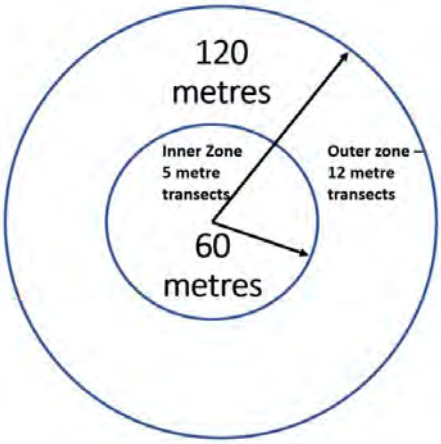

Figure 2.2: Inner and outer carcass search zones under turbines.

2.3 SCAVENGER RATES AND TRIALS

Scavenger trials were undertaken over two seasons, the short grass season (February 2022) and long grass season (September 2022) for the first year of operational phase strike monitoring to comply with methodologies outlined in the AFCMP. As suitable carcasses were not encountered during routine monthly monitoring, scavenger trials were undertaken using surrogate species for three carcass size classes including 10 rats (bats), 10 quails (small birds) and 10 chickens/galahs (medium birds). As no large raptor carcasses were encountered during the initial 12-month monitoring period, scavenger trials for large raptors were not conducted. The different size categories used were to determine differences in scavenging rates on birds and bats, with carcasses placed during early morning and late afternoon to account for different scavenger's active times.

Scavenger trials were conducted at the same randomly selected turbine sites used for mortality searches. The first five carcasses of each category (15 carcasses in total) were randomly placed outside the hardstand of each turbine in the morning (one carcass per turbine) and checked in the afternoon, with an additional 15 carcasses distributed in the same way during the first afternoon. Locations of carcasses were recorded using a GPS to ensure they were not confused with incidental avifauna strikes found beneath a turbine during the trials.

Each carcass was checked according to the schedule outlined in the AFCMP until they either disappeared or at the end of 30 days (Table 2.3).

Table 2.3: Scavenger trial search timetable

Day (Time)	Day (Time)
Day 1: Morning	Day 9: Anytime
Day 1: Afternoon	Day 12: Anytime
Day 2: Morning	Day 15: Anytime
Day 2: Afternoon	Day 18: Anytime
Day 3: Morning	Day 21: Anytime
Day 3: Afternoon	Day 24: Anytime
Day 4: Anytime	Day 27: Anytime
Day 5: Anytime	Day 30: Anytime
Day 7: Anytime	

2.4 DETECTABILITY AND TRIALS

Detector trials were undertaken using five carcass surrogates (realistic soft toys representative of species present at YWF) for each size category of carcass (micro-bat, small birds, medium sized birds, and large birds). Trials were undertaken by [redacted] personnel conducting the monthly monitoring activities to determine the probability that a carcass would be detected during routine avifauna strike monitoring activities ([redacted] 2018). At each monitoring turbine, the carcass controller threw one or more carcasses into the air to simulate some of the fall and the potential ruffling of fur and feathers and marked the location with a GPS. All bat replicates were placed in the inner 60m circle.

[redacted] involved in detector trials utilised routine survey methodologies at each turbine and reported the number of carcass surrogates detected during a regular search. Detection efficiency (percentage of carcasses detected) will be incorporated into analyses to inform mortality estimates following the 24-month survey period.

2.5 INCIDENTAL SEARCH PROTOCOL

Incidental carcasses recorded by YWF staff are recorded following the same parameters outlined in Section 2.2, with details to be reported to [redacted] staff.

2.6 ANALYSIS AND MORTALITY ESTIMATION

The results of the mortality monitoring surveys were analysed to provide information on:

- the species, number, age and sex of birds and bats being struck by the turbines; and
- any variation in the number of bird and bat strikes.

3 RESULTS

3.1 MONTHLY CARCASS SEARCHES

A total of five carcasses were recorded during the first year of monthly searches including two magpies, two nankeen kestrels and one feather spot belonging to a little corella (Table 3.1). Four carcasses were recorded at WTG31 with an additional feather spot recorded at WTG 27. Photos and report forms for each carcass recorded during the initial 12-month monitoring period are provided in Appendix A.

There is some speculation whether the intact magpie is related to a turbine blade strike or from territorial interactions as impact injuries associated with strike mortalities were not observed on the carcass.

Table 3.1: Carcass search results

Date	Turbine ID	Wind direction and strength	Distance from turbine	Direction	Species ID	Signs of injury, comments
2/12/2021	WTG31	S - SSW, 25-30 kmph	80m	NW	Nankeen kestrel	Yes, no head evident, wings broken.
4/05/2022	WTG31	ENE 54 kmph	10m	SE	Australian magpie	Nil impact injuries evident, no broken bones, carcass intact, minor damage to face. Potential territory dispute?
4/05/2022	WTG31	ENE 54 kmph	10m, feathers spread between 10-20m	NW	Australian magpie	Carcass absent, large number of feathers present. Feathers not associated with other magpie recorded at same turbine.
4/10/2022	WTG31	SSW, 10kmph	40m	NE	Juvenile goshawk	Difficult to determine COD, bottom half scavenged, wings and head present, one leg present.
3/11/2022	WTG27	SSW 25-30kmph	50m	SW	Little corella	Feather spot of about six feathers, no carcass evident.

3.1.1 'At risk' groups recorded

Birds considered to be in 'at risk' groups according to the AFCMP (wedge-tailed eagles, other raptors and Carnaby's cockatoo) were recorded on 23 occasions within the boundary of the YWF. The Threatened Carnaby's cockatoo was recorded on nine occasions, the wedge-tailed eagle was recorded on six occasions and raptors were recorded on eight occasions. No avifauna strike mortalities associated with 'at risk' groups were recorded during the 12-month monitoring period.

3.1.1.1 Carnaby's cockatoo

The Carnaby's cockatoo is listed as Endangered under the EPBC Act and BC Act and was recorded on nine occasions during the first year of surveys (Table 3.2, Figure 3.1). Carnaby's cockatoos were recorded overflying the windfarm and foraging in bushland, pine plantations and trees within the YWF. The largest flock (approximately 80 birds) was recorded foraging in marri (*Corymbia calophylla*) trees and pine plantations north and south of Dambadjie Road between WTG08 and WTG13. Other records include small flocks or individuals overflying the windfarm below the lowest point at which a turbine blade spins (<28m).

No injured birds or Carnaby's cockatoo carcasses were recorded during the first year of surveys.

Table 3.2: Carnaby's cockatoos recorded during the surveys.

Date	Location	Flight path	Flight height	No. birds occurring within YWF	Behaviour	Habitats used within YWF
7/01/2022	WTG08	North East	5m	Four	Over-flying	Airspace
30/05/2022	East of WTG08	Sedentary	<10m	80	Foraging	Flock foraging in pine plantation and in Marri trees between WTG13 and WTG08.
24/08/2022	WTG41	East	>20m	Five observed (2x pairs and 1 x single)	Over-flying	Flock flying around pine plantation east of turbine and surrounds
23/08/2022	WTG34	West	>20m	Two	Over-flying	Utilising airspace more than 500m from turbine while transiting
24/08/2022	WTG24	East	>20m	Two	Over-flying	Utilising airspace more than 500m from turbine while transiting
6/09/2022	<100m north of [redacted] office	East	>10m	Three	Over-flying	Utilising airspace more than 500m from turbine while transiting
6/09/2022	Remnant bushland between WTG34 and WTG30	Sedentary		Four	Foraging	Group foraging in remnant banksia perpendicular to track from WTG34 to WTG30
6/09/2022	Above track on route to WTG27	South West	<20m	Two	Over-flying	Utilising airspace less than 200m from turbine while transiting
7/09/2022	Above track on route between WTG34 and WTG30	South West	<20m	One	Over-flying	Utilising airspace more than 400m from turbine while transiting

3.1.1.2 Wedge-tailed eagle

No wedge-tailed eagle carcasses were recorded during the first year of monitoring by [redacted] During the construction phase, [redacted] staff recorded a total of three wedge-tailed eagle carcasses beneath turbines which were suspected to be the result of a collision with a turbine blade. Wedge-tailed eagle carcasses were recorded by [redacted] personnel at WTG49, WTG30 and WTG07 in 2020 during the construction phase (Appendix A).

A total of 10 wedge-tailed eagles were recorded by [redacted] staff during routine avifauna monitoring activities at YWF during the 12-month monitoring period (Table 3.3). A pair of wedge-tailed eagles were recorded on numerous occasions in the vicinity of WTG32 and they appear to be resident birds coexisting with the windfarm.

3.1.1.3 Raptors

One nankeen kestrel and one juvenile brown goshawk were recorded during monthly monitoring in the first year of surveys, both under turbine WTG31 (Table 3.3, Appendix B). During the construction phase in 2020, staff working at YWF recorded a total of three nankeen kestrel and one black shouldered kite underneath turbines suspected of being struck by turbine blades. Nankeen kestrel carcasses were recorded under turbines WTG10, WTG29 and WTG41 and the black-shouldered kite was recorded under WTG04 (Appendix A).

Nine raptors were recorded within the vicinity of the YWF while undertaking the surveys over the first year of monitoring at YWF (Table 3.3). Nankeen kestrels were recorded on seven occasions and one whistling kite was recorded near turbine WTG37.

3.1.2 Migratory

No migratory birds were recorded during the construction phase or first year of operational monitoring.

Table 3.3: Raptors recorded during the surveys.

Date	Species observed	Location	Duration of observation period	Number of birds	Minimum flight height above ground (m)	Maximum flight height above ground (m)	Habitat over which flight was observed	Flight behaviour	Occasional behaviours
1/12/2021	Nankeen kestrel	WTG08	opportunistic	2	perched on fence post	8	Open crop	Circling	Perching
1/12/2021	Nankeen kestrel	WTG14	opportunistic	1	perched on fence post	8	Open crop	Circling	Perching
1/12/2021	Nankeen kestrel	WTG26	opportunistic	1	8	12	Open crop	Gliding	
7/02/2022	Nankeen kestrel	WTG14	5 mins	1	2	6	Pasture	Circling	
7/02/2022	Nankeen kestrel	WTG41	1 minute	1	2	5	Pasture	Gliding	Feeding
8/02/2022	Nankeen kestrel	WTG14	5 mins	1	2	8	Pasture	Circling	
10/02/2022	Nankeen kestrel	WTG08	2 mins	1	3	5	Pasture	Circling	Perching
10/02/2022	Whistling kite	Yandin Road near WTG37	5mins	1	7	30	Pine plantation, pasture	Circling	
7/02/2022	Wedge-tailed eagle	WTG34	5 mins	2	20	200	Pasture	Soaring	
10/02/2022	Wedge-tailed eagle	WTG30	1 min	2	50	60	Pasture	Circling	
10/02/2022	Wedge-tailed eagle	WTG33	1 min	1			Pasture	N/A	Feeding
16/03/2022	Wedge-tailed eagle	WTG32	15 mins	2	10	100	Paddock with low scrub	Gliding	
24/08/2022	Wedge-tailed eagle	WTG27	5 mins	1	N/A	N/A	Pasture	N/A	Feeding
14/01/2022	Wedge-tailed eagle	Approximately 1km west of WTG27	5 mins	2	15	35	Remnant woodland	Circling	

3.1.3 Opportunistic Species List

Twenty-seven opportunistic species were recorded in the first year of monitoring including 20 avian fauna and seven mammals (three introduced) (Table 3.4).

Table 3.4: Opportunistic Species Recorded.

Common name	Scientific names
BIRD	
Wedge-tailed eagle	*Aquila audax*
Galah	*Eolophus roseicapilla*
Australian ringneck	*Barnardius zonarius*
Australian kestrel (nankeen kestrel)	*Falco cenchroides*
Australian pipit	*Anthus australis*
Willie wagtail	*Rhipidura leucophrys*
Australian magpie	*Gymnorhina tibicen*
Australian raven	*Corvus coronoides*
Whistling kite	*Haliastur sphenurus*
Black-faced cuckooshrike	*Coracina novaehollandiae*
Carnaby's cockatoo	*Calyptorhynchus latirostris*
Little corella	*Cacatua sanguinea*
Magpie-lark	*Grallina cyanoleuca*
Pied butcherbird	*Cracticus nigrogularis*
Australian wood duck	*Chenonetta jubata*
Welcome swallow	*Hirundo neoxena*
Laughing kookaburra	*Dacelo novaeguineae*
Australian pelican	*Pelecanus conspicillatus*
Yellow-throated miner	*Manorina flavigula*
REPTILE	
Bobtail	*Tiliqua rugosa rugosa*
Gould’s monitor	*Varanus gouldii*
Dugite	*Pseudonaja affinis*
MAMMAL	
Sheep	*Ovis aries*
European cattle	*Bos primigenius taurus*
Horse	*Equus ferus caballus*
Short-beaked echidna	*Tachyglossus aculeatus acanthion*
Rabbit	*Oryctolagus cuniculus*
Cat	*Felis catus*
Red fox	*Vulpes vulpes*

368000 376000 384000

6600000

6592000

WTG01 WTG02 WTG03 WTG04 WTG05 WTG06 WTG07 WTG08 WTG09 WTG10 WTG11 WTG12 WTG13 WTG14 WTG15 WTG16 WTG17 WTG18 WTG19 WTG20 WTG21 WTG22 WTG23 WTG24 WTG25 WTG26 WTG27 WTG28 WTG29 WTG30 WTG31 WTG32 WTG33 WTG34 WTG35 WTG36 WTG37 WTG38 WTG39 WTG40 WTG41 WTG42 WTG43 WTG44 WTG45 WTG46 WTG47 WTG48 WTG49 WTG50 WTG51

Carnaby's cockatoo
Turbine locations

Project: 1910
Date: 10 November 2022
Author [redacted]
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Absolute Scale: 1:51,406 @A3

Figure 3.1: Carnaby's cockatoo records.

0 0.45 0.9 1.8 2.7
Kilometers

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

3.2 SCAVENGER TRIALS

Scavenger trails were undertaken in February (short grass season) and September (long grass season) to accord with the AFCMP. As no large raptor carcasses were encountered during the initial 12 month monitoring period, scavenger trials were not undertaken (as per the AFCMP) ([redacted] 2018). The average number of days for each carcass type was calculated for each season, with average scavenging duration for each carcass category provided in Table 3.5 and Table 3.6. Raw data associated with individual carcasses can be seen in Appendix B.

Camera traps deployed to monitor carcasses during staff absence from the windfarm and tracks recorded around carcass locations indicate that foxes are the main culprit scavenging carcasses at YWF. A relatively large population of foxes appears to exist within the YWF, with numerous day sightings recorded during monthly monitoring activities. In addition to scavenging by foxes, a feral cat was recorded scavenging a quail carcass and evidence of feeding by raptors recorded on some carcasses that were not moved out of the area. Scavenger activity appeared to be lower for bat and medium bird carcasses under long grass conditions; however, scavenging rats for small birds were slightly higher.

Table 3.5: Average duration of carcass types in short grass (February).

Carcass type	Average number of days until carcass scavenged
Bat (n=10)	2.6
Small bird (n=10)	2.5
Medium bird (n=10)	2.1

Table 3.6: Average duration of carcass types in long grass (September).

Carcass type	Average number of days until carcass scavenged
Bat (n=10)	6
Small bird (n=10)	1.8
Medium bird (n=10)	2.7

3.3 DETECTOR TRIALS

A single round of detector trials was conducted in long grass in the first year of surveys as per the AFCMP. Further detector trials will be undertaken under short grass conditions for all [redacted] staff members in December 2022/January 2023.

Table 3.7: Detectability trials conducted in long grass.

Staff member	Sam Plant		Claudia Buters		Lydia Ellwood	
	# detected	% detected	# detected	% detected	# detected	% detected
Bats detected (n=5)	1	20	4	80	4	80
Small birds detected (n=5)	2	40	2	40	3	60
Medium birds detected (n=5)	4	80	2	40	3	60
Large birds/raptors detected (n=5)	3	60	3	60	4	80
Total proportion of carcass surrogates detected (%)	50		55		70	

3.4 INCIDENTAL FINDINGS

No incidental findings were recorded to [redacted] by Yandin personnel within the first year of sampling.

3.5 ANALYSIS AND MORTALITY ESTIMATION

To accord with the AFCMP, a full analysis and estimate of mortality will be provided in the second annual report together with recommendations on the scope of future monitoring, if required.

4 REFERENCES

[redacted] 2018. Yandin Wind Farm - Avain Fauna Collision Management Program. [redacted].

DAWE. 2021. Onshore Wind Farms – interim guidance on bird and bat management, Department of Agriculture Water and the Environment.

5 APPENDICES

Appendix A Carcass report forms.

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	4/05/2022			
Start Time:	1330			
Finish Time:	1420			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	ENE 54 kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	10m			
Bearing of Carcass from Tower (deg):	143 degrees SE			
Preliminary Species Identification:	Australian Magpie (*Gymnorhina tibicen*)			
Photo Taken**	**Yes**		**Time:**	1337
Signs of injury:	nill impact evident, no broken bones, carcass intact, minor damage to face			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
		X		
Other Notes (e.g. substrate/vegetation):	Found on hardstand			
Sex/age/number/species	Mature male			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	4/05/2022			
Start Time:	1330			
Finish Time:	1420			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	ENE 54 kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	10m, feathers spread between 10-20m			
Bearing of Carcass from Tower (deg):	310 degrees NW			
Preliminary Species Identification:	Australian Magpie (*Gymnorhina tibicen*)			
Photo Taken**	**Yes**		**Time:**	1342
Signs of injury:	carcass absent, large no of feathers present			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				X
	Found on hardstand			
Sex/age/number/species	Mature bird based on tail feathers			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	2/12/2021			
Start Time:	1009			
Finish Time:	1030			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	S - SSW, 25-30 kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	80m			
Bearing of Carcass from Tower (deg):	NW			
Preliminary Species Identification:	Nankeen kestrel (*Falco cenchroides*)			
Photo Taken**	**Yes**		**Time:**	1012
Signs of injury:	yes, no head evident, wings broken			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
			X	
Other Notes (e.g. substrate/vegetation):	Found partially submerged in wheat crop/agricultural land. Carcass unsuitable to be retained due to age and condition.			
Sex/age/number/species	N/A			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	4/10/2022			
Start Time:	1212			
Finish Time:	1230			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	SSW, 10kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	40m			
Bearing of Carcass from Tower (deg):	30 degrees NE			
Preliminary Species Identification:	Brown Goshawk (juvenile) (*Accipiter fasciatus*)			
Photo Taken**	**Yes**		**Time:**	1245
Signs of injury:	Yes, heavily scavenged upon.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
			X	
Other Notes (e.g. substrate/vegetation):	bottom half scavenged, wings and head present, one leg present			
Sex/age/number/species	Juvinile			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	3/11/2022			
Start Time:	940			
Finish Time:	1000			
Turbine Number:	WTG27			
Wind direction and strength in preceding 24 hours:	SSW 25-30kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	50m			
Bearing of Carcass from Tower (deg):	SW			
Preliminary Species Identification:	Little corella (*Cacatua sanguinea*)			
Photo Taken**	**Yes**		**Time:**	948
Signs of injury:	feather spot of about 6 feathers, no carcass or signs			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				X
Other Notes (e.g. substrate/vegetation):	white feathers with yellow tinge - small			
Sex/age/number/species				
Post Find Actions: Nil				

Carcass Search Data Sheet

[redacted]

Date and location:				
Date: **5-9-20**			Observer/s: [redacted]	
Time animal was found: **Approx. 2pm**			Turbine ID: **WTG 41**	
Detection:				
Survey method (circle):	*Monthly search*		***Incidental***	
Distance of carcass / injured animal from tower (m): **10**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **Phone, saved to Z: Drive**	
Weather details at time of detection (please circle):				
Temperature: **21.1C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	***Calm***	*Breeze*	*Moderate*	*Strong*
Wind direction: **West**			Cloud cover (%): **0**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Falco cenchroides*** **- Nankeen Kestrel**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Found at WTG 41 Hardstand. Potential strike, all parts in tacked**				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Carcass Search Data Sheet

[redacted]

Date and location:				
Date: **15-9-20**			Observer/s: [redacted]	
Time animal was found: **14.00**			Turbine ID: **WTG 30**	
Detection:				
Survey method (circle):	*Monthly search*			***Incidental***
Distance of carcass / injured animal from tower (m): **100m**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on MC 31 adjacent to WTG 30 hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **I Phone, loaded onto Z Drive**	
Weather details at time of detection (please circle):				
Temperature: **27 C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	*Calm*	***Breeze***	*Moderate*	*Strong*
Wind direction: **24km/hr. South**			Cloud cover (%): **0**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): **Aquila Audax - (Wedge-tailed Eagle)**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead*** *(carcass)*	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass in tacked, only recent, no feather spots**				
Describe evidence of scavenging, if any: **Droppings found on carcass**				
Notes / additional information:				

Carcass Search Data Sheet

[redacted]

Date and location:				
Date: **20-11-20**			Observer/s: [redacted]	
Time animal was found: **11:30**			Turbine ID: **WTG 04**	
Detection:				
Survey method (circle):	*Monthly search*			***Incidental***
Distance of carcass / injured animal from tower (m): **8 M**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **iPhone, photos saved in IMS & register**	
Weather details at time of detection (please circle):				
Temperature: **27C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	*Calm*	***Breeze***	*Moderate*	*Strong*
Wind direction: **SSW 24km/h**			Cloud cover (%): **43**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Elanus axillaris* – Black-shouldered kite**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass in tacked, only recent, no feather spot**s. Carcass presumably been there a couple of days due to the infestation of bugs. Due to projects outage as off the 10th Nov, potential strike occurred over the weekend				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Carcass Search Data Sheet

[redacted]

Date and location:				
Date: **21-12-20**			Observer/s: [redacted]	
Time animal was found:			Turbine ID: **WTG 7**	
Detection:				
Survey method (circle):	*Monthly search*			***Incidental***
Distance of carcass / injured animal from tower (m): **50**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on WTG 7 hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **I Phone, loaded onto Z Drive**	
Weather details at time of detection (please circle):				
Temperature: **38 C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	*Calm*	***Breeze***	*Moderate*	*Strong*
Wind direction: **30km/hr. South East**			Cloud cover (%): **0**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Aquila Audax* - (Wedge-tailed Eagle)**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead*** *(carcass)*	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass in tacked, only recent, no feather spots**				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Carcass Search Data Sheet

[redacted]

Date and location:				
Date: **25-9-20**			Observer/s: [redacted]	
Time animal was found: **11.20**			Turbine ID: **WTG 29**	
Detection:				
Survey method (circle):	*Monthly search*		***Incidental***	
Distance of carcass / injured animal from tower (m): **35m**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **iPhone, photos saved in IMS & register**	
Weather details at time of detection (please circle):				
Temperature: **23 C**				
Precipitation:	*Fine*	*Showers*	*Rain*	
Wind strength:	*Calm*	*Breeze*	*Moderate*	*Strong*
Wind direction: **W 17km/h**			Cloud cover (%): **48**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Falco cenchroides* (Nankeen Kestral)**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass intact, only recent, no feather spots**				
Describe evidence of scavenging, if any:				
Notes / additional information:				

Carcass Search Data Sheet

[redacted]

Date and location:				
Date: **29-8-20**			Observer/s: [redacted]	
Time animal was found: **11am**			Turbine ID: **WTG 49**	
Detection:				
Survey method (circle):	*Monthly search*		***Incidental***	
Distance of carcass / injured animal from tower (m): **85m**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Grassed Area**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **Phone, saved to Z: Drive**	
Weather details at time of detection (please circle):				
Temperature: **15C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	***Calm***	*Breeze*	*Moderate*	*Strong*
Wind direction:			Cloud cover (%): 95	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Aquila Audax* - Wedge- tailed Eagle**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Head was missing, all other parts intact, no missing feathers or feather spots.** Carcass presumably been there a couple of days due to the infestation of magnets				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Carcass Search Data Sheet

[redacted]

Date and location:				
Date: **29-11-20**			Observer/[redacted]	
Time animal was found: **11:15**			Turbine ID: **WTG 10**	
Detection:				
Survey method (circle):	***Monthly search***			*Incidental*
Distance of carcass / injured animal from tower (m): **60m**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on MC 63 which is adjacent to WTG 10**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **iPhone, photos saved in IMS & register**	
Weather details at time of detection (please circle):				
Temperature: **29C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	*Calm*	***Breeze***	*Moderate*	*Strong*
Wind direction: **W 17km/h**			Cloud cover (%): **63**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Falco Cenchroides*** **(Nankeen Kestral)**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass in tacked, no feather spots, found on side of road. Carcass no more than 1-2 days old. Due to the wind direction and the location of the carcass Friday/Saturday**				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Appendix B Scavenger trial results.

Short grass scavenger trial (February 2022)					
Turbine ID	Carcass type	Replicate of	Deployment date/time	Date Scavenged	Duration of carcass scavenged
WTG02	Rat	Bat	7/2/2022 AM	7/2/2022 PM	0
WTG06	Rat	Bat	7/2/2022 PM	9/2/2022 AM	2
WTG10	Rat	Bat	7/2/2022 PM	9/2/2022 AM	2
WTG20	Rat	Bat	7/2/2022 AM	9/2/2022 AM	2
WTG27	Rat	Bat	7/2/2022 PM	8/02/2022 AM	2
WTG30	Rat	Bat	7/2/2022 PM	15/02/2022	9
WTG34	Rat	Bat	7/2/2022 AM	9/2/2022 AM	2
WTG41	Rat	Bat	7/2/2022 AM	8/02/2022 AM	1
WTG49	Rat	Bat	7/2/2022 PM	10/02/2022	3
WTG50	Rat	Bat	7/2/2022 AM	10/02/2022	3
WTG02	Quail	Small bird	7/2/2022 PM	8/02/2022 AM	1
WTG08	Quail	Small bird	7/2/2022 AM	8/02/2022 AM	1
WTG10	Quail	Small bird	7/2/2022 AM	9/2/2022 AM	2
WTG14	Quail	Small bird	7/2/2022 PM	9/2/2022 AM	2
WTG26	Quail	Small bird	7/2/2022 PM	8/02/2022 AM	1
WTG30	Quail	Small bird	7/2/2022 AM	15/02/2022	9
WTG31	Quail	Small bird	7/2/2022 AM	10/02/2022	3
WTG34	Quail	Small bird	7/2/2022 PM	8/02/2022 AM	1
WTG39	Quail	Small bird	7/2/2022 PM	9/2/2022 AM	2
WTG49	Quail	Small bird	7/2/2022 AM	10/02/2022	3
WTG06	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG14	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG26	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG27	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG39	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG08	Chicken	Medium bird	7/2/2022 PM	16/02/2022	10
WTG20	Chicken	Medium bird	7/2/2022 PM	8/02/2022 AM	1
WTG31	Chicken	Medium bird	7/2/2022 PM	8/02/2022 AM	1
WTG41	Chicken	Medium bird	7/2/2022 PM	8/02/2022 AM	1
WTG50	Chicken	Medium bird	7/2/2022 PM	10/02/2022	3
Long grass scavenger trial (September 2022)					
Turbine ID	Carcass	Replicate of	Deployment date/time	Date Scavenged	Days until scavenged
WTG02	Rat	Bat	6/9/2022 AM	7/9/2022 AM	1
WTG06	Rat	Bat	6/9/2022 PM	08/09/2022 AM	2
WTG10	Rat	Bat	6/9/2022 PM	08/09/2022 AM	2
WTG20	Rat	Bat	6/9/2022 AM	08/09/2022 AM	2
WTG27	Rat	Bat	6/9/2022 PM	07/09/2022 AM	1
WTG30	Rat	Bat	6/9/2022 PM	5/10/2022	29
WTG34	Rat	Bat	6/9/2022 AM	07/09/2022 AM	1
WTG41	Rat	Bat	6/9/2022 AM	9/09/2022	3
WTG49	Rat	Bat	6/9/2022 PM	12/09/2022	6

[redacted]

Turbine ID	Carcass	Replicate of	Deployment date/time	Date Scavenged	Days until scavenged
WTG50	Rat	Bat	6/9/2022 AM	19/09/2022	13
WTG02	Quail	Small bird	6/9/2022 PM	7/9/2022 AM	1
WTG08	Quail	Small bird	6/9/2022 AM	07/09/2022 AM	1
WTG10	Quail	Small bird	6/9/2022 AM	07/09/2022 AM	1
WTG14	Quail	Small bird	6/9/2022 PM	08/09/2022 AM	2
WTG26	Quail	Small bird	6/9/2022 PM	9/09/2022	3
WTG30	Quail	Small bird	6/9/2022 AM	08/09/2022 AM	2
WTG31	Quail	Small bird	6/9/2022 AM	07/09/2022 PM	1
WTG34	Quail	Small bird	6/9/2022 PM	10/09/2022	4
WTG39	Quail	Small bird	6/9/2022 PM	08/09/2022 AM	2
WTG49	Quail	Small bird	6/9/2022 AM	07/09/2022 AM	1
WTG06	Corella/Lorikeet	Medium bird	6/9/2022 AM	7/9/2022 AM	1
WTG08	Corella/Lorikeet	Medium bird	6/9/2022 PM	07/09/2022 PM	1
WTG14	Corella/Lorikeet	Medium bird	6/9/2022 AM	07/09/2022 AM	1
WTG20	Corella/Lorikeet	Medium bird	6/9/2022 PM	9/09/2022	3
WTG26	Corella/Lorikeet	Medium bird	6/9/2022 AM	07/09/2022 PM	1
WTG27	Corella/Lorikeet	Medium bird	6/9/2022 AM	9/09/2022	3
WTG31	Corella/Lorikeet	Medium bird	6/9/2022 PM	10/09/2022	4
WTG39	Corella/Lorikeet	Medium bird	6/9/2022 AM	12/09/2022	6
WTG41	Corella/Lorikeet	Medium bird	6/9/2022 PM	10/09/2022	4
WTG50	Corella/Lorikeet	Medium bird	6/9/2022 PM	9/09/2022	3

MARCH 2024

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ENVIRONMENT

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YANDIN WIND FARM AVIAN FAUNA MONITORING PROGRAM

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Document status						
***ecologia* project number: 1910**						
Rev.	**Author(s)**	**Reviewer**	**Date**	**Approved for Issue**		
				Name	**Distributed To**	**Date**
0	T McCabe, C Buters, L Ellwood	S Grein	12/03/2023	S Grein	S Algera	13/03/2023

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EXECUTIVE SUMMARY

As a condition of operation, Alinta Energy is required to undertake operational phase avian fauna collision monitoring at Yandin Wind Farm (YWF) in accordance with Condition 20 of the Shire of Dandaragan Planning Approval (Document ID: 50238) which states that "the proponent shall develop and implement an Avian Fauna Collision Monitoring Program (AFCMP) to the satisfaction of the Western Australian Department of Water and Environment Regulation (DWER) to monitor the impact of the Wind Farm on avian fauna in the project area, specifically in respect to the Endangered Carnaby's cockatoo". The YWF is located approximately 34 kilometres north-east of Lancelin, approximately 150 kilometres north of Perth and contains 51 operational wind turbines.

Ecologia Environment (*ecologia*) was engaged by Alinta Energy to undertake monthly monitoring for a period of 24 months to fulfill the monitoring requirement. The primary purpose of regular monitoring undertaken was to collect bird and bat mortality data during monthly carcass searches at a third of all turbines (17 turbines) as per the Avian Fauna Collision Monitoring Program (AFCMP).

No Carnaby's cockatoos, or other Threatened and Priority avifauna or bat species collisions were recorded during the construction phase (Vestas data) or over the 24-month monitoring period of YWF operation.

A total of 11 carcasses were recorded by *ecologia* during the 24 months of monitoring including two magpies, four nankeen kestrels, one juvenile goshawk, one Australian ringneck, two feather spots belonging to little corellas and one unidentifiable feather spot. During the construction phase, Vestas staff working at YWF incidentally recorded three wedge-tailed eagles, three nankeen kestrels and one black-shouldered kite which were suspected to have collided with turbine blades. Two bat carcasses were recorded incidentally by Vestas staff members in March and April of 2023; however, one carcass was recorded on the steps at the base of the turbine and has been recorded as a collision mortality while the other was recorded desiccated inside the turbine hub.

None of the impact trigger values outlined in the AFCMP were triggered and no significant species were found to have collided with the turbines during the monitoring program.

Flocks of Carnaby's cockatoos (Endangered under the EPBC Act and BC Act), ranging from one to 80 individual birds, were recorded on 13 occasions during the two years of surveys. Carnaby's cockatoos were recorded foraging within Banksia woodland and pine plantations and utilising the airspace within the YWF while transiting. Maximum flight height observed was consistently below the Rotor Swept Area (RSA). The wedge-tailed eagle was recorded overflying or perching on eight occasions and other raptor taxa were recorded flying or perching on 23 occasions including 19 nankeen kestrel observations, three black-shouldered kite and one whistling kite record.

Scavenger trials were undertaken in February (short grass) and September (long grass) within the first year of monitoring to accord with the AFCMP. Statistical analysis of scavenger rates was undertaken and median time to carcass removal (birds and bats) via scavenge is 1.7 days, with a 95% confidence interval of [1,2.1] days. Searcher efficiency trials were undertaken during the seasons of long and short vegetation cover over the 24-month survey period to accord with the AFMCP. According to the AICc "intercept-only" model (i.e. all carcasses have the same expected searcher efficiency), mean detectability proportion of carcasses found was 0.73 with a 95% confidence interval of [0.66, 0.79).

Accounting for detected carcasses, measured detectability, scavenge rate, and survey effort, it is expected that there was a total site loss of around 618 birds over the full survey period, and are 95% confident that fewer than 1055 individuals were lost.

Accounting for detected carcasses, measured detectability, scavenge rate, and survey effort, it is expected that there was a total site loss of around 36 bats over the full survey period, and are 95% confident that fewer than 160 individuals were lost.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

As a condition of operation, Alinta Energy is required to undertake operational phase avian fauna collision monitoring at Yandin Wind Farm (YWF) in accordance with Condition 20 of the Shire of Dandaragan Planning Approval (Document ID: 50238) which states that "the proponent shall develop and implement an Avian Fauna Collision Monitoring Program (AFCMP) to the satisfaction of the Western Australian Department of Water and Environment Regulation (DWER) to monitor the impact of the YWF on avian fauna in the project area, specifically in respect to the Endangered Carnaby's cockatoo." Ecologia Environment (*ecologia*) was engaged by Alinta Energy to undertake monthly monitoring for a period of 24 months to fulfill this requirement. This report is a comprehensive report of the completed 24-month monitoring period, between December 2021- November 2023.

The primary purpose of regular monitoring undertaken by *ecologia* is to collect bird and bat mortality data during monthly carcass searches at a third of operational turbines (17 turbines) within the YWF as stipulated in the Avian Fauna Collision Monitoring Program (AFCMP) (BL&A 2018). The YWF is located approximately 34 kilometres north-east of Lancelin and approximately 150 kilometres north of Perth (Map 1).

1.2 SURVEY OBJECTIVES

The primary objectives of the monitoring program were to:

1. Undertake monthly carcass searches and monitoring for a period of 24 months following the commencement of the operational phase, beginning in December 2021 and ending in November 2023 as outlined in AFCMP.
2. Undertake detector trials and scavenger trials under short and long grass/crop conditions as outlined in the AFCMP.
3. Preparation of first annual report based on data collected between December 2021 and November 2022.
4. Preparation of final report after second year of monitoring (November 2023).

1.3 REGULATORY FRAMEWORK

The survey was designed and undertaken to comply with the following guidance document:

- Yandin Wind Farm Avian Fauna Collision Monitoring Program (BL&A 2018).
- Onshore Wind Farms – Interim Guidance on Bird and Bat Management (DAWE 2021).

336000 344000 352000 360000 368000 376000 384000 392000 400000

6608000 6600000 6592000 6584000 6576000 6568000

CERVANTES
MOORA
WONGAN HILLS
LANCELIN
Map inset
GINGIN
GOOMALLING
MUCHEA
TOODYAY
NORTHAM
BAKERS HILL
WUNDOWIE
YORK
ARMADALE
MUNDARING

DANDARAGAN

CATABY
DANDARAGAN ROAD

WTG01
WTG02
WTG03
WTG04
WTG05
WTG06
WTG07
WTG08
WTG09
WTG10
WTG11
WTG12
WTG13
WTG14
WTG15
WTG16
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WTG45
WTG46
WTG47
WTG48
WTG49
WTG50
WTG51

BRAND HIGHWAY

REGANS FORD

LANCELIN

LANCELIN
ROAD

Wind turbine
Town
Road

ecologia ENVIRONMENT

Project: 1910
Date: 5 October 2023
Author: LE
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Absolute Scale: 1:175,000 @A3

Map 1: Location of the Yandin Wind Farm.

0 1.5 3 6 9
Kilometers

2 METHODOLOGY

2.1 TURBINE SELECTION

Collision monitoring at the YWF turbines was undertaken by two *ecologia* zoologists on a monthly basis to determine mortality rates of 'at risk' species including raptors, migratory birds and the Carnaby's cockatoo as per the schedule outlined in Table 1. The survey methods adopted accorded with the AFCMP documentation developed by (BL&A 2018).

In accordance with the AFCMP, the 51 turbines at YWF were split into four clusters (North-east, North-central, Central and South) and 33% (17 turbines total) were randomly selected based on a 'stratified random' sampling design (BL&A 2018). The cluster of turbines closest to the Cataby Brook Carnaby's cockatoo breeding area (North-central) was represented by five turbines (including all three turbines located closest to the roost) to ensure adequate coverage of the turbines where black cockatoo mortalities were most likely to be recorded.

Locations of turbines surveyed during monthly monitoring activities are provided in Map 1 and Table 2.

2.2 MONTHLY SEARCH PROTOCOL

The YWF turbines blades are up to 70 metres in radius. On this basis the majority of carcasses were expected to be distributed within 120 metres of turbines (BL&A 2018). An inner (0-60 metres) and outer (60-120 metres) circular search zone were used to conduct monthly searches as outlined in the AFCMP (BL&A 2018) (Figure 1).

- The inner zone targets the detection of carcasses of bats, small, medium, and large sized birds. In the inner zone, a circle is formed with a 60-metre radius from the turbine and transects were traversed every six metres across this circle.
- The outer zone is comprised of the space between the 60 metre and 120 metre radius. Search transects in the outer zone were spaced 12 metres apart, extending outward from the edge of the inner zone to the border of the outer zone.
- The searching of zones beyond 120 metres is not necessary, given the distance of the circumference of a search circle at 120 metres is above 700 metres and the lack of finds recorded beyond a 100 metres radius (BL&A unpublished data).

For any carcass detected during monthly searches the following parameters were recorded as per the AFCMP (BL&A 2018):

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

Carcasses encountered during routine monitoring were handled according to the procedure below:

- Carcass removed from the site to avoid re-counting;
- If not desiccated or decomposed, carcass to be packed into a plastic bag, wrapped in newspaper and put into a second plastic bag:
- Carcass labelled with a copy of the carcass search data sheet to ensure that its origin can be traced at a later date, if required; and
- Carcass transferred to a freezer for storage so a second opinion on the species identity may be sought, if necessary, and for potential use in scavenger and/or detectability trials.

Table 1: Monthly carcass search dates and personnel.

Month	Date	Observers	
Dec-21	1/12/2021 - 2/12/2021	Tim McCabe	Claudia Buters
Jan-22	13/01/2022 - 14/01/2022	Lydia Ellwood	Tim McCabe/Claudia Buters
Feb-22	8/02/2022, 9/02/2022, 14/2/2022, 21/2/2022	Tim McCabe	Claudia Buters/Lydia Ellwood
Mar-22	15/03/2022 - 16/3/2022	Lydia Ellwood	Tim McCabe/Sam Plant
Apr-22	12/04/2022, 14/04/2022	Lydia Ellwood	Claudia Buters/Sam Plant
May-22	4/05/2022, 30/05/2022	Sam Plant	Tim McCabe/Claudia Buters
Jun-22	23/06/2022 - 24/06/2022	Lydia Ellwood	Sam Plant
Jul-22	26/07/2022 - 27/07/2022	Lydia Ellwood	Sam Plant
Aug-22	23/08/2022 - 24/08/2022	Sam Plant	Claudia Buters
Sep-22	9/09/2022, 12/9/2022, 14/9/2022	Sam Plant	Lydia Ellwood/Julia Svanberg
Oct-22	4/10/2022 - 5/10/2022	Lydia Ellwood	Julia Svanberg
Nov-22	2/11/2022 - 3/11/2022	Lydia Ellwood	Julia Svanberg
Dec-22	14/12/2022 - 15/12/2022	Lydia Ellwood/Julia Svanberg	Tim McCabe/Claudia Buters
Jan-23	11/01/2023 - 12/01/2023	Lydia Ellwood	Tim McCabe/Claudia Buters
Feb-23	27/02/2023 - 28/02/2023	Lydia Ellwood	Claudia Buters
Mar-23	21/03/2023 - 22/03/2023	Tim McCabe	Claudia Buters
Apr-23	13/04/2023 - 14/04/2023	Lydia Ellwood	Ada Shackleton
May-23	18/05/2023 - 19/05/2023	Lydia Ellwood	Ada Shackleton
Jun-23	07/06/2023 - 08/06/2023	Lydia Ellwood	Ada Shackleton
Jul-23	11/07/2023 - 12/07/2023	Tim McCabe	Claudia Buters
Aug-23	09/08/2023, 11/08/2023	Tim McCabe	Claudia Buters
Sep-23	27/09/2023 - 28/09/2023	Lydia Ellwood	Claudia Buters
Oct-23	24/10/2023-25/10/2023	Ada Shackleton	Claudia Buters
Nov-23	29/11/2023-30/11/2023	Tim McCabe	Claudia Buters

Table 2:Turbines randomly selected to survey for bird and bat collisions.

Turbine ID	Easting	Northing
WTG02	376528	6601679
WTG06	374673	6599985
WTG08	378488	6599712
WTG10	374246	6599644
WTG11	367653	6598635
WTG14	381374	6599259
WTG20	373156	6598389
WTG24	367260	6597730
WTG26	371984	6597395
WTG27	366072	6597042
WTG30	366344	6596200
WTG31	370526	6596154
WTG34	368625	6595819
WTG39	368901	6592987
WTG41	368125	6594551
WTG49	366504	6591688
WTG50	367375	6591534

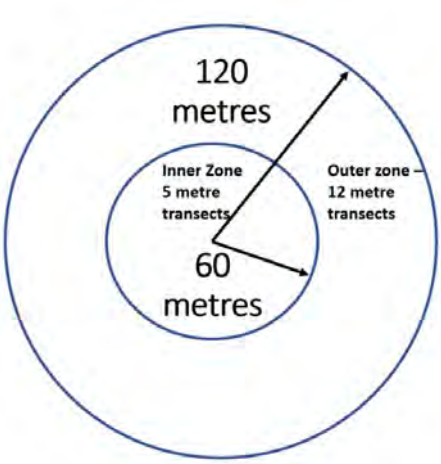

Figure 1: Inner and outer carcass search zones under turbines.

366000 368000 370000 372000 374000 376000 378000 380000 382000

6602000 6600000 6598000 6596000 6594000 6592000

WTG01 WTG02 WTG03 WTG04 WTG05 WTG06 WTG07 WTG08 WTG09 WTG10 WTG11 WTG12 WTG13 WTG14 WTG15 WTG16 WTG17 WTG18 WTG19 WTG20 WTG21 WTG22 WTG23 WTG24 WTG25 WTG26 WTG27 WTG28 WTG29 WTG30 WTG31 WTG32 WTG33 WTG34 WTG35 WTG36 WTG37 WTG38 WTG39 WTG40 WTG41 WTG42 WTG43 WTG44 WTG45 WTG46 WTG47 WTG48 WTG49 WTG50

Wind turbine monitored monthly

Wind turbine

ecologia ENVIRONMENT

Project: 1910
Date: 5 October 2023
Author: LE
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Absolute Scale: 1:47,000 @A3

Map 2: Location of randomly selected turbines for monthly bird and bat collision monitoring.

0 0.4 0.8 1.6 2.4
Kilometers

2.3 SCAVENGER RATES AND TRIALS

Scavenger trials were undertaken over two seasons, the short grass season (February 2022) and long grass season (September 2022) for the first year of operational phase strike monitoring to comply with methodologies outlined in the AFCMP. As suitable carcasses were not encountered during routine monthly monitoring, scavenger trials were undertaken using surrogate species for three carcass size classes including 10 wiener rats (bats), 10 quails (small birds) and 10 chickens/galahs (medium birds). As no large raptor carcasses were encountered during the initial 12-month monitoring period, scavenger trials for large raptors were not conducted in accordance with the AFCMP. The different size categories used were to determine differences in scavenging rates on birds and bats, with carcasses placed during early morning and late afternoon to account for different scavenger's active times.

Scavenger trials were conducted at the same randomly selected turbine sites used for mortality searches. The first five carcasses of each category (15 carcasses in total) were randomly placed outside the hardstand of each turbine in the morning (a maximum of one carcass per size class per turbine) and checked in the afternoon, with the remaining 15 carcasses distributed in the same way during the afternoon of the first day. Locations of carcasses were recorded using a GPS to ensure they were not confused with incidental avifauna strikes found beneath a turbine during the trials.

Each carcass was checked according to the schedule outlined in the AFCMP until they either disappeared or at the end of 30 days (Table 3).

Table 3: Scavenger trial search timetable.

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

Survival analysis was undertaken by Symbolix (2024) used to determine the distribution of time until complete loss from scavenge (or decay). Survival analysis was required to account for the fact that we do not necessarily know the exact time of scavenge loss, only an interval in which the scavenge event happened. By performing survival analysis, it is possible to estimate the time until carcass loss after a given length of time, despite these unknowns. Full methodology can be seen in Appendix C.

2.4 SEARCHER EFFICIANCY TRIALS

Detector trials were undertaken using five carcass surrogates (realistic soft toys representative of species present at YWF) for each size category of carcass (micro-bat, small birds and medium sized birds). Detector trials were undertaken by *ecologia* personnel conducting monthly monitoring activities to assess detector efficiency and calculate the probability that a carcass would be detected by an observer during routine avifauna strike monitoring activities (BL&A 2018). At each monitoring turbine, the carcass controller threw one or more carcasses into the air to simulate some of the fall and the potential ruffling of fur and feathers and marked the location with a GPS. All bat replicates were placed in the inner 60m circle in accordance with the AFCMP.

The *ecologia* zoologists involved in detector trials utilised routine survey methodologies at each turbine and reported the number of carcass surrogates detected during a regular search. Detection efficiency

(percentage of carcasses detected) for the 24-month survey period were incorporated into analyses to inform mortality estimates following.

Searcher efficiency was estimated by fitting binomial generalised linear models (GLMs) (Symbolix 2024) (Appendix C). The optimal model was determined, guided by the small-sample Akaike Information Criterion (Anderson and Burnham 2004), otherwise known as the AICc (Symbolix 2024). Full details of the methodology is provided in Appendix C.

2.5 INCIDENTAL SEARCH PROTOCOL

Incidental carcasses recorded by YWF staff were recorded following the same parameters outlined in Section 2.2, with details reported to *ecologia* staff.

2.6 ANALYSIS AND MORTALITY ESTIMATION

The analysis of bid and bat mortality at Yandin Windfarm during the first two years of operation was undertaken using the Monte Carlo method as developed by Symbolix (2024). In order to estimate the mortality loss at Yandin wind farm, differences in survey effort, searcher and scavenger efficiency were accounted for and methodology utilised can be seen in the report developed by Symbolix (2024) (Appendix C.

Best practice estimators project the number of found carcasses (C) up to the number of actual mortalities (M). They should account for:

- the probability a carcass will be detected by the searcher (p)
- the probability a carcass is not lost to scavenge or decay prior to the search (r)
- the probability a carcass falls within the searched area (a)
- the fraction of turbines searched (f)

Most mortality estimators, e.g. (Huso 2011), can be conceptualised as a ratio estimator

$$\hat{M} = \frac{C}{\hat{p} \cdot \hat{r} \cdot \hat{a} \cdot f}$$

with the terms in the denominator providing a “boost factor” to the number of carcasses found, C.

3 RESULTS

3.1 MONTHLY CARCASS SEARCHES

A total of 11 carcasses were recorded during the two years of monthly searches including two magpies, four nankeen kestrels, one juvenile goshawk, one Australian ringneck, two feather spots belonging to little corellas. An additional feather spot comprising down feathers belonging to a young bird were recorded at WTG49 in October 2023 and were unable to be identified to species level due to the absence of primary feathers or diagnostic features.

Carcasses were recorded at five turbines with four carcasses recorded at turbine WTG31, three carcasses at turbine WTG49, two at turbine WTG26, and one carcass each at turbines WTG08 and WTG27 (Table 4). Photos and report forms for each carcass recorded during the 24-month monitoring period are provided in Appendix A.

There is speculation regarding whether the intact magpie carcass detected at turbine WTG31 on the 4th of January 2022 is related to a turbine blade strike or resulted from territorial interactions as no impact injuries typically associated with strike mortalities were observed on the carcass. Additionally, it is difficult to determine cause of death for the juvenile goshawk, Australian ringneck, and little corellas due to the absence of intact carcasses, extent of scavenging damage to carcasses and close proximity of little corella and Australian ringneck debris to a fox den located at turbine WTG26.

Table 4: Carcass search results

Date	Turbine ID	Wind direction and strength	Distance from tower (metres)	Bearing	Species ID	Signs of injury
2/12/2021	WTG31	S-SSW, 25-30 kmph	80	NW	Nankeen kestrel	No head evident, both wings broken.
4/05/2022	WTG31	ENE , 54 kmph	10	143˚ SE	Magpie	No impact evident. No noticeable broken bones, carcass intact, minor damage to face. Potential territory dispute.
4/05/2022	WTG31	ENE, 54 kmph	10	310˚ NW	Magpie	Carcass absent however, large number of feathers present.
4/10/2022	WTG31	S - SW, 10 kmph	40	30 ˚ NE	Juvenile goshawk	Difficult to determine cause of death. Bottom half scavenged, wings and head present, one leg present.
3/11/2022	WTG27	SSW, 25-30 kmph	50	SW	Little corella	Feather spot of about six feathers, no carcass evident.
11/01/2023	WTG49	SSW, 10 kmph	60	North	Nankeen kestrel	Partially scavenged, with torso, legs and wing present.
27/02/2023	WTG26	ENE, Strong	60	North	Little corella	Feather spots scattered over approximately 100 square metres.
27/02/2023	WTG26	ENE, Strong	100	West	Australia ringneck	Feather spots scattered over approximately 100 square metres under canopy of several trees, concentrated under tree in vicinity of fox den. Difficult to determine if turbine strike or unrelated death.
28/09/2023	WTG49	NE, 20 - 30 kmph	20	North	Nankeen kestrel	Broken neck.
24/10/2023	WTG08	ENE	40	SW	Nankeen kestrel	Extensive feather spot, no carcass present
25/10/2023	WTG49	N 30 kmph	23	NE	Nankeen kestrel	Feather spot, downy feathers, no primaries or carcass observed

3.1.1 'At risk' groups recorded

Birds considered to be in 'at risk' groups according to the AFCMP (wedge-tailed eagles, other raptors and Carnaby's cockatoo) were recorded on 44 occasions within the boundary of the YWF. The Threatened Carnaby's cockatoo was recorded on 13 occasions, the wedge-tailed eagle was recorded on eight occasions, the black-shouldered kite on three occasions, the whistling kite on one occasion and the nankeen kestrel on 19 occasions raptors were recorded on 19 occasions.

3.1.1.1 Carnaby's cockatoo

The Carnaby's cockatoo is listed as Endangered under the EPBC Act and BC Act and was recorded on 13 occasions during the two year survey (Table 5, Map 3). Carnaby's cockatoos were recorded overflying the windfarm and foraging in bushland, pine plantations and trees within the YWF. The largest flock (comprising approximately 80 birds) was recorded foraging in marri (*Corymbia calophylla*) trees and pine plantations north and south of Dambadjie Road between WTG08 and WTG13. Other records include small flocks or individuals overflying the windfarm below the lowest point at which a turbine blade spins (<28m).

No injured Carnaby's cockatoo or carcasses were recorded by or reported to *ecologia* during the 24 months of avifauna monitoring surveys.

Table 5: Carnaby's cockatoos recorded during the surveys.

Date	Location	Flight path	Flight height	No. birds occurring within YWF	Behaviour	Habitats used within YWF
7/01/2022	WTG08	North-east	5m	Four	Over-flying	Airspace
30/05/2022	East of WTG08 opposite pine plantation	Sedentary	<10m	80	Foraging	Flock foraging in pine plantation and in Marri trees between WTG13 and WTG08.
23/08/2022	WTG34	West	>20m	Two	Over-flying	Utilising airspace more than 500m from turbine while transiting
24/08/2022	WTG41	East	>20m	Five (two pairs and one single)	Over-flying	Flock flying around pine plantation east of turbine and surrounds
24/08/2022	WTG24	East	>20m	Two	Over-flying	Utilising airspace more than 500m from turbine while transiting
6/09/2022	<100m north of Vestas office	East	>10m	Three	Over-flying	Utilising airspace more than 500m from turbine while transiting
6/09/2022	Remnant bushland between WTG34 and WTG30	Sedentary	N/A	Four	Foraging	Group foraging in remnant banksia perpendicular to track from WTG34 to WTG30
6/09/2022	Above track on route to WTG27	South-west	<20m	Two	Over-flying	Utilising airspace less than 200m from turbine while transiting
7/09/2022	Above track on route between WTG34 and WTG30	South-west	<20m	One	Over-flying	Utilising airspace more than 400m from turbine while transiting
18/05/2023	WTG27	Sedentary	>20m	Two	Forgaing	Perching in canopy of trees to the south of turbine
7/06/2023	Admin office car park	North-west	20m	Six	Over-flying	Flying over office building
9/08/2023	Pine plantation south of WTG14	Sedentary	>20m	22	Foraging	Pine plantation
11/08/2023	Main road to office	Sedentary	Canopy	Six	Foraging	Pine plantation

3.1.1.2 Wedge-tailed eagle

No wedge-tailed eagle carcasses were recorded during the two years of monitoring by *ecologia*. During the construction phase, Vestas staff recorded a total of three wedge-tailed eagle carcasses beneath turbines which were suspected to be the result of a collision with a turbine blade. The wedge-tailed eagle carcasses were recorded by Vestas personnel at WTG49, WTG30 and WTG07 in 2020 (Appendix A).

Wedge-tailed eagles were recorded on eight occasions by *ecologia* staff during routine avifauna monitoring activities at YWF during the 24-month monitoring period (Table 6). A pair of wedge-tailed eagles were recorded on five occasions, which appear to be resident birds coexisting with the windfarm.

3.1.1.3 Raptors

Four nankeen kestrel carcasses and one juvenile brown goshawk carcass were recorded during monthly monitoring in the 24 months of surveys, with two nankeen kestrels found under turbine WTG49, one under turbine WTG08 and the remaining nankeen and brown goshawk found beneath WTG31 (Table 6, Appendix B). During the construction phase in 2020, staff working at YWF recorded a total of three nankeen kestrel and one black-shouldered kite underneath turbines suspected of being struck by turbine blades. Nankeen kestrel carcasses were recorded under turbines WTG10, WTG29 and WTG41 and the black-shouldered kite was recorded under WTG04 (Appendix A).

Raptors (other than the wedge-tailed eagle) were recorded on 23 occasions in the vicinity of the YWF while undertaking avifauna monitoring surveys over 24 months (Table 6). Nankeen kestrels were recorded on 19 occasions, black-shouldered kites were recorded on three occasions and a single whistling kite was recorded near turbine WTG37.

3.1.2 Migratory birds

A squadron of 26 pelicans (*Pelecanus conspicillatus*) were recorded whilst monitoring at turbine WTG33, flying at heights of between 50 - 100 metres. No other migratory birds were recorded during the construction phase or two years of operational monitoring.

Table 6: Raptors recorded during the surveys.

Date	Species observed	Location	Duration of observation period	Number of birds	Minimum flight height (m)	Maximum flight height (m)	Habitat	Flight behaviour	Occasional behaviours
11/07/2023	Black shouldered kite	Main access track east of admin office	1 minute	1	3m	12m	Pasture	Directional flight (flapping)	N/A
9/08/2023	Black shouldered kite	WTG06 (approximately 300m south)	5 minutes	3	15m	20m	Pasture	Directional flight (flapping)	Territorial displays
9/08/2023	Black shouldered kite	WTG20 (approximately 500m west)	Opportunistic	1	10m	10m	Cropped	Directional flight (flapping)	Perching
1/12/2021	Nankeen kestrel	WTG08	Opportunistic	2	Perched	8m	Open crop	Circling	Perching
1/12/2021	Nankeen kestrel	WTG14	Opportunistic	1	Perched	8m	Open crop	Circling	Perching
1/12/2021	Nankeen kestrel	WTG26	Opportunistic	1	8m	12m	Open crop	Gliding	N/A
7/02/2022	Nankeen kestrel	WTG14	5 minutes	1	2m	6m	Pasture	Circling	N/A
7/02/2022	Nankeen kestrel	WTG41	1 minute	1	2m	5m	Pasture	Gliding	Feeding
8/02/2022	Nankeen kestrel	WTG14	5 minutes	1	2m	8m	Pasture	Circling	N/A
10/02/2022	Nankeen kestrel	WTG08	2 minutes	1	3m	5m	Pasture	Circling	Perching
15/12/2022	Nankeen kestrel	WTG14	3 minutes	1	5m	12m	Pasture	Circling	N/A
11/01/2023	Nankeen kestrel	WTG41	3 minutes	1	5m	15m	Pasture	Directional flight (flapping)	
12/01/2023	Nankeen kestrel	WTG06	1 minute	1	15m	15m	Pasture and shrubs	Directional flight (flapping)	Perching
11/08/2023	Nankeen kestrel	WTG49	2 minutes	2	0m	8m	Cropped	Directional flight (flapping)	Perching
27/09/2023	Nankeen kestrel	WTG08	1 minute	1	8m	15m	Pasture, cleared	Directional flight (flapping)	
27/09/2023	Nankeen kestrel	On road near WTG08	1 minute	1	8m	10m	Pasture, cleared	Soaring	
27/09/2023	Nankeen kestrel	WTG14	5 minutes	1	20m	35m	Pasture	Soaring	Feeding
28/09/2023	Nankeen kestrel	WTG41	5 minutes	1	50m	80m	Pasture	Circling	
24/10/2023	Nankeen kestrel	Road to WTG02	3 minutes	1	4m	8m	pasture	Directional flight (flapping)	

Date	Species observed	Location	Duration of observation period	Number of birds	Minimum flight height (m)	Maximum flight height (m)	Habitat	Flight behaviour	Occasional behaviours
25/10/2023	Nankeen kestrel	Road to WTG02	5 minutes	2	2m	8m	pasture	Directional flight (flapping)	
28/11/2023	Nankeen kestrel	Road near WTG20	1 min	1	2m	10m	pasture, cleared	Directional flight (flapping)	
28/11/2023	Nankeen kestrel	NE of WTG50	1 min	3	1m	7m	pasture, cleared	Directional flight (flapping)	
14/01/2022	Wedge-tailed eagle	WTG27 (1km west WTG27)	5 minutes	2	15m	35m	Remnant woodland	Circling	None observed
7/02/2022	Wedge-tailed eagle	WTG34	5 minutes	2	20m	200m	Pasture	Soaring	N/A
10/02/2022	Wedge-tailed eagle	WTG30	1 minute	2	50m	60m	Pasture	Circling	N/A
10/02/2022	Wedge-tailed eagle	WTG33	1 minute	1	N/A	N/A	Pasture	N/A	Feeding
16/03/2022	Wedge-tailed eagle	WP466	15 minutes	2	10m	100m	Paddock with low scrub	Gliding	N/A
24/08/2022	Wedge-tailed eagle	WTG27	5 minutes	1	N/A	N/A	Pasture	N/A	Feeding
28/02/2023	Wedge-tailed eagle	WTE2 (just south of WTG08)	5 minutes	2	20m	60m	Planted trees/harvested crop	Soaring	N/A
24/10/2023	Wedge-tailed eagle	Road to WTG02	Ongoing	1	100m	120m	pasture	Circling	Fighting
10/02/2022	Whistling kite	Near WTG37 (Yandin Rd between south turbines and office)	5 minutes	1	7m	30m	Pine plantation, pasture	Circling	N/A

3.1.3 Opportunistic species list

Thirty-five opportunistic species were recorded in the first year of monitoring including 24 avifauna species, four reptiles and seven mammals (six introduced) (Table 7).

Table 7: Opportunistic species recorded.

Common name	Scientific names
BIRD	
Australian kestrel (nankeen kestrel)	*Falco cenchroides*
Australian magpie	*Gymnorhina tibicen*
Australian pelican	*Pelecanus conspicillatus*
Australian pipit	*Anthus australis*
Australian raven	*Corvus coronoides*
Australian ringneck	*Barnardius zonarius*
Australian wood duck	*Chenonetta jubata*
Black-faced cuckooshrike	*Coracina novaehollandiae*
Black-shouldered kite	*Elanus axillaris*
Carnaby's cockatoo	*Calyptorhynchus latirostris*
Common bronzewing	*Phaps chalcoptera*
Crested pigeon	*Ocyphaps lophotes*
Galah	*Eolophus roseicapilla*
Grey butcherbird	*Cracticus torquatus*
Laughing kookaburra	*Dacelo novaeguineae*
Little corella	*Cacatua sanguinea*
Magpie-lark	*Grallina cyanoleuca*
Pacific black duck	*Anas superciliosa*
Pied butcherbird	*Cracticus nigrogularis*
Wedge-tailed eagle	*Aquila audax*
Welcome swallow	*Hirundo neoxena*
Whistling kite	*Haliastur sphenurus*
Willie wagtail	*Rhipidura leucophrys*
Yellow-throated miner	*Manorina flavigula*
REPTILE	
Bobtail	*Tiliqua rugosa rugosa*
Black-headed monitor	*Varanus tristis*
Dugite	*Pseudonaja affinis*
Gould’s monitor	*Varanus gouldii*
MAMMAL	
Sheep	*Ovis aries*
Cat	*Felis catus*
European cattle	*Bos primigenius taurus*
Horse	*Equus ferus caballus*
Rabbit	*Oryctolagus cuniculus*

Common name	Scientific names
Red fox	*Vulpes vulpes*
Short-beaked echidna	*Tachyglossus aculeatus acanthion*

368000

376000

6600000

6592000

WTG01
WTG02
WTG03
WTG04
WTG05
WTG06
WTG07
WTG08
WTG09
WTG10
WTG11
WTG12
WTG13
WTG14
WTG15
WTG16
WTG17
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WTG45
WTG46
WTG47
WTG48
WTG49
WTG50
WTG51

Carnaby's cockatoo record
Wind turbine

ecologia ENVIRONMENT

Project: 1910
Date: 5 October 2023
Author: LE
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Absolute Scale: 1:50,000 @A3

Map 3: Carnaby's cockatoo observations recorded during monthly surveys over 24-month monitoring period.

0 0.45 0.9 1.8 2.7
Kilometers

3.2 SCAVENGER TRIALS

Scavenger trials were undertaken in February (short grass conditions) and September, 2022 (long grass conditions) to accord with the AFCMP. As large raptor carcasses were not recorded during the initial 12 month monitoring period, scavenger trials were not undertaken for this size of carcass (as per the AFCMP) (BL&A 2018). Raw data associated with individual carcasses can be seen in Appendix B.

Camera traps were deployed to monitor carcasses during staff absence from the windfarm between scheduled visits and identify scavengers associated with carcass removal. Camera detections and tracks recorded in the vicinity of scavenged carcasses indicate that foxes are the primary carcasses scavengers at YWF. A large population of foxes appears to exist within the YWF, with numerous day sightings recorded by *ecologia* staff members during routine monitoring activities. In addition to scavenging by foxes, a feral cat was recorded scavenging a quail carcass and evidence of feeding by raptors was noticeable on some carcasses that were partially scavenged. Scavenging of rats (bat surrogate) and small birds was slightly higher than medium birds in short grass conditions; however, scavenger activity appeared to be lower for rat (bat surrogate) and medium bird carcasses under long grass conditions.

Aggregated survival curves were used in the mortality estimations (Appendix C) and a survival curve was fitted to the combined set of bats and birds. The median time to carcass removal via scavenge is 1.7 days, with a 95% confidence interval of [1,2.1] days.

3.3 SEARCHER EFFICIENCY

Detector trials were conducted in both long and short grass conditions over the 24-month period as per the AFCMP. Five *ecologia* staff members conducted detector trials in long grass conditions, and four *ecologia* staff members conducted trials in short grass conditions to reflect the season and vegetation conditions that staff members were scheduled for monthly monitoring.

According to the AICc “intercept-only” model (i.e. all carcasses have the same expected searcher efficiency), mean detectability proportion of carcasses found was 0.73 with a 95% confidence interval of [0.66, 0.79).

Table 8: Detectability trials conducted in long grass.

Staff member	Sam Plant		Claudia Buters		Lydia Ellwood		Tim McCabe		Julia Svanberg	
	# detected	% detected	# detected	% detected	# detected	% detected	# detected	% detected	# detected	% detected
Bats detected (n=5)	1	20	4	80	4	80	4	80	3	60
Small birds detected (n=5)	2	40	2	40	3	60	2	40	5	100
Medium birds detected (n=5)	4	80	2	40	3	60	4	80	3	60
Large birds/raptors detected (n=5)	3	60	3	60	4	80	3	60	5	100
Total proportion of carcass surrogates detected (%)	50		55		70		65		80	

Table 9: Detectability trials conducted in short grass.

Staff member	Claudia Buters		Lydia Ellwood		Tim McCabe		Ada Shackleton	
	# detected	% detected	# detected	% detected	# detected	% detected	# detected	% detected
Bats detected (n=5)	3	60	3	60	5	100	4	80
Small birds detected (n=5)	5	100	4	80	3	60	4	80
Medium birds detected (n=5)	5	100	4	80	4	80	4	80
Large birds/raptors detected (n=5)	5	100	5	100	4	80	5	100
Total proportion of carcass surrogates detected (%)	90		80		80		85	

3.4 INCIDENTAL FINDINGS

Two bat carcasses were incidentally reported by Vestas staff members in March and April of 2023. Both carcasses were discovered intact and desiccated but with little injury, on the exterior stairs of turbine WTG20 and inside the nacelle hatch of turbine WTG47. The incidental bat recorded at turbine WTG20 has been attributed to a collision with the blade.

A total of seven incidental avian fauna species carcasses were recorded by Yandin personnel during the construction phase of the YWF and provided to *ecologia* (Appendix A). Incidental carcasses recorded include three Nankeen kestrels, three wedge-tailed eagles and one black-shouldered kite.

3.5 ANALYSIS AND MORTALITY ESTIMATION

With estimates for scavenge loss, searcher efficiency, and survey coverage, Symbolix (2024) converted the number of bat and bird carcasses detected, into an estimate of overall mortality at Yandin Wind Farm from 2021-12-01 to 2023-11-30 (i.e. year one and two of operation) (Symbolix 2024).

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, it is expected that there was a total site loss of around 36 bats over the full survey period, and are 95% confident that fewer than 160 individuals were lost (Symbolix 2024).

Table 10: Percentiles id estimated total bat losses.

0%	50% (median)	90%	95%	99%	99.9%
1	36	123	160	234	317

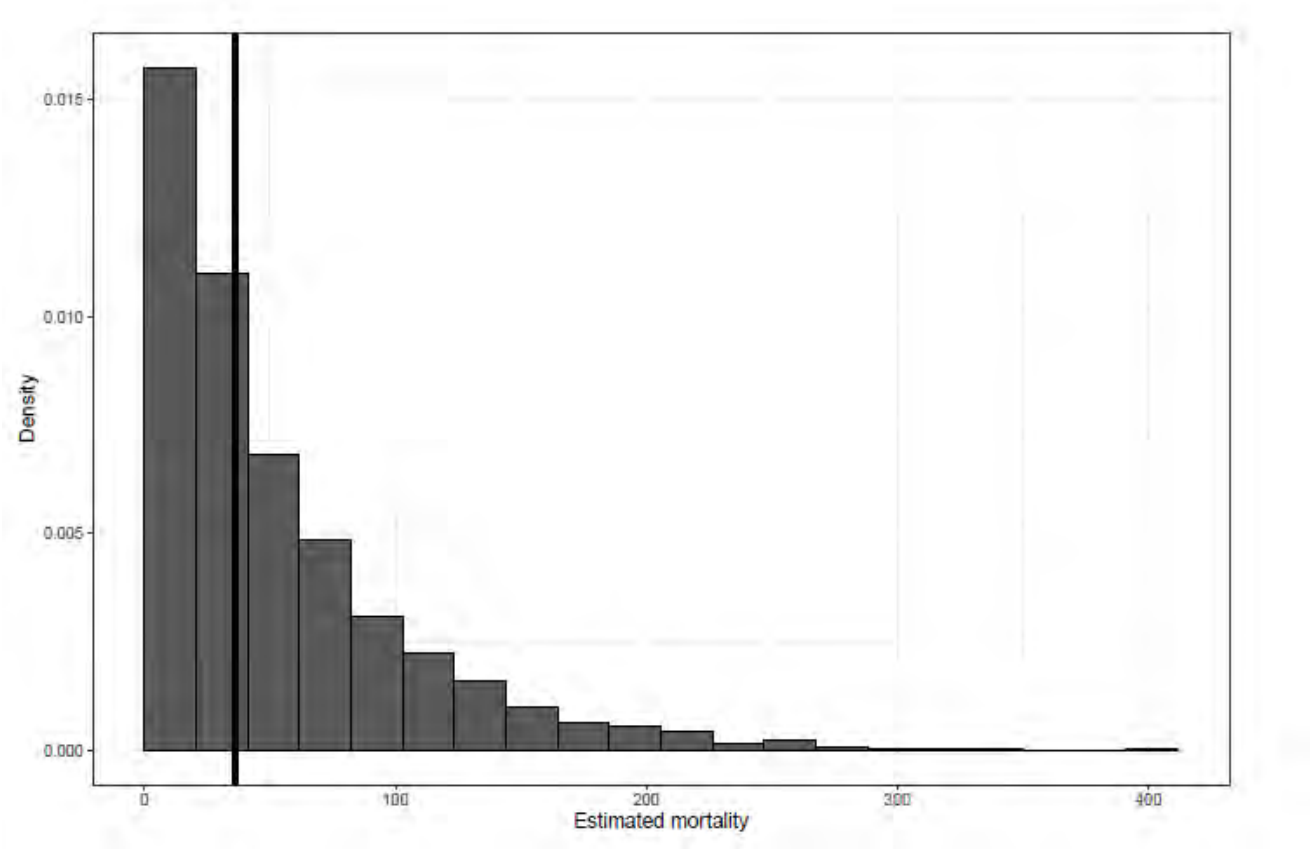

Figure 2: Histogram of the total losses distribution (bats). The solid black line shows the median.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, it is expected that there was a total site loss of around 618 birds over the full survey period, with a 95% confidence level that fewer than 1055 individuals were lost (Symbolix 2024).

Table 11: Percentiles of estimated total bird losses.

0%	50% (median)	90%	95%	99%	99.9%
189	618	905	1055	1299	1477

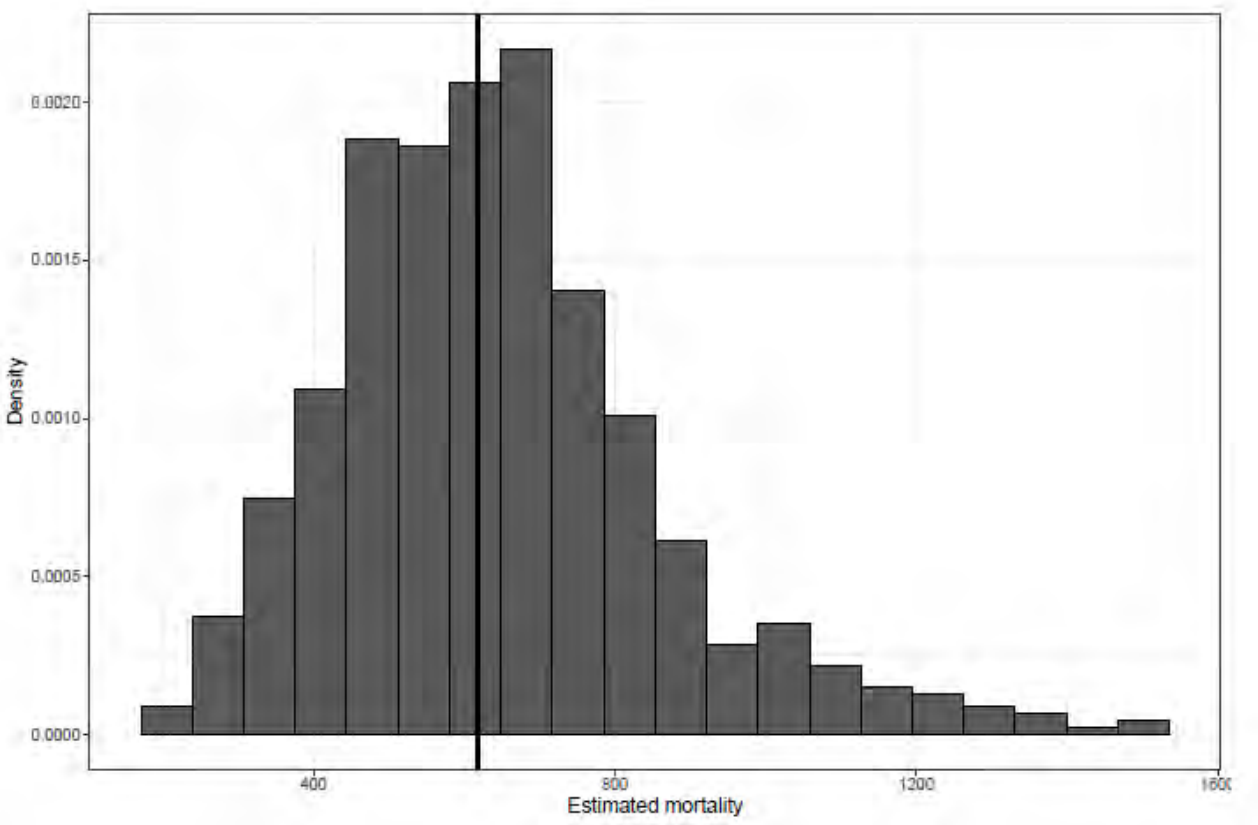

Figure 3: Histogram of the total losses distribution (birds). The solid black line shows the median.

4 REFERENCES

BL&A. 2018. Yandin Wind Farm - Avain Fauna Collision Management Program. Brett Lane & Associates Pty. Ltd.

DAWE. 2021. Onshore Wind Farms – interim guidance on bird and bat management, Department of Agriculture Water and the Environment.

Symbolix. 2024. Yandin Wind Farm Year 1-2 Mortality Estimates.

5 APPENDICES

APPENDIX A CARCASS REPORT FORMS

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	2/12/2021			
Start Time:	1009			
Finish Time:	1030			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	S - SSW, 25-30 kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	80m			
Bearing of Carcass from Tower (deg):	NW			
Preliminary Species Identification:	Nankeen kestrel (*Falco cenchroides*)			
Photo Taken**	**Yes**		**Time:**	1012
Signs of injury:	yes, no head evident, wings broken			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
			X	
Other Notes (e.g. substrate/vegetation):	Found partially submerged in wheat crop/agricultural land. Carcass unsuitable to be retained due to age and condition.			
Sex/age/number/species	N/A			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	4/05/2022			
Start Time:	1330			
Finish Time:	1420			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	ENE 54 kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	10m			
Bearing of Carcass from Tower (deg):	143 degrees SE			
Preliminary Species Identification:	Australian Magpie (*Gymnorhina tibicen*)			
Photo Taken**	**Yes**		**Time:**	1337
Signs of injury:	nill impact evident, no broken bones, carcass intact, minor damage to face			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
		X		
Other Notes (e.g. substrate/vegetation):	Found on hardstand			
Sex/age/number/species	Mature male			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	4/05/2022			
Start Time:	1330			
Finish Time:	1420			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	ENE 54 kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	10m, feathers spread between 10-20m			
Bearing of Carcass from Tower (deg):	310 degrees NW			
Preliminary Species Identification:	Australian Magpie (*Gymnorhina tibicen*)			
Photo Taken**	**Yes**		**Time:**	1342
Signs of injury:	carcass absent, large no of feathers present			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				X
	Found on hardstand			
Sex/age/number/species	Mature bird based on tail feathers			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	4/10/2022			
Start Time:	1212			
Finish Time:	1230			
Turbine Number:	WTG31			
Wind direction and strength in preceding 24 hours:	SSW, 10kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	40m			
Bearing of Carcass from Tower (deg):	30 degrees NE			
Preliminary Species Identification:	Brown Goshawk (juvenile) (*Accipiter fasciatus*)			
Photo Taken**	**Yes**		**Time:**	1245
Signs of injury:	Yes, heavily scavenged upon.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
			X	
Other Notes (e.g. substrate/vegetation):	bottom half scavenged, wings and head present, one leg present			
Sex/age/number/species	Juvenile			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	3/11/2022			
Start Time:	940			
Finish Time:	1000			
Turbine Number:	WTG27			
Wind direction and strength in preceding 24 hours:	SSW 25-30kmph			
Any unusual weather conditions in last 48 hours?	N/A			
Distance of Carcass from Tower(m):	50m			
Bearing of Carcass from Tower (deg):	SW			
Preliminary Species Identification:	Little corella (*Cacatua sanguinea*)			
Photo Taken**	**Yes**		**Time:**	948
Signs of injury:	Feather spot of about 6 feathers, no carcass or signs			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				X
Other Notes (e.g. substrate/vegetation):	White feathers with yellow tinge - small			
Sex/age/number/species				
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	11/01/2023			
Start Time:	1230			
Finish Time:	1250			
Turbine Number:	WTG49			
Wind direction and strength in preceding 24 hours:	SSW 10kmph			
Any unusual weather conditions in last 48 hours?	Clear			
Distance of Carcass from Tower(m):	60m			
Bearing of Carcass from Tower (deg):	N			
Preliminary Species Identification:	Nankeen kestrel (*Falco cenchroides*)			
Photo Taken**	**Yes**		**Time:**	1240
Signs of injury:	Yes, partially scavenged. Torso, legs and wing present.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				X
Other Notes (e.g. substrate/vegetation):	Less than a week old			
Sex/age/number/species				
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	27/02/2023			
Start Time:	1000			
Finish Time:	1021			
Turbine Number:	WTG26			
Wind direction and strength in preceding 24 hours:	ENE strong			
Any unusual weather conditions in last 48 hours?	Clear			
Distance of Carcass from Tower(m):	60m			
Bearing of Carcass from Tower (deg):	N			
Preliminary Species Identification:	Little corella (*Cacatua sanguinea*)			
Photo Taken**	**Yes**		**Time:**	1000
Signs of injury:	No carcass present.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				X
Other Notes (e.g. substrate/vegetation):	White feather spot present scattered over approximately 10m. Difficult to determine whether cause by turbine strike or unrelated.			
Sex/age/number/species				
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	27/02/2023			
Start Time:	1000			
Finish Time:	1021			
Turbine Number:	WTG26			
Wind direction and strength in preceding 24 hours:	ENE strong			
Any unusual weather conditions in last 48 hours?	Clear			
Distance of Carcass from Tower(m):	100m			
Bearing of Carcass from Tower (deg):	W			
Preliminary Species Identification:	Australian ringneck (*Barnardius zonarius*)			
Photo Taken**	**Yes**		**Time:**	0958
Signs of injury:	No carcass present.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				X
Other Notes (e.g. substrate/vegetation):	Feather spots scattered over approximately 10m under canopy of several trees, concentrated under tree near fox den. Difficult to determine whether cause by turbine strike or unrelated.			
Sex/age/number/species				
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	28/09/2023			
Start Time:	0928			
Finish Time:	0948			
Turbine Number:	WTG49			
Wind direction and strength in preceding 24 hours:	SSW 10kmph			
Any unusual weather conditions in last 48 hours?	Clear			
Distance of Carcass from Tower(m):	20m			
Bearing of Carcass from Tower (deg):	N			
Preliminary Species Identification:	Nankeen kestrel (*Falco cenchroides*)			
Photo Taken**	**Yes**		**Time:**	0927
Signs of injury:	Yes, broken neck.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
		X		
Other Notes (e.g. substrate/vegetation):	Mature bird.			
Sex/age/number/species				
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	24/10/2023			
Start Time:	0930			
Finish Time:	0954			
Turbine Number:	WTG08			
Wind direction and strength in preceding 24 hours:	ENE strength unknown			
Any unusual weather conditions in last 48 hours?	Clear			
Distance of Carcass from Tower(m):	40m			
Bearing of Carcass from Tower (deg):	SW			
Preliminary Species Identification:	Nankeen kestrel (*Falco cenchroides*)			
Photo Taken**	**Yes**		**Time:**	0950
Signs of injury:	Extensive feather spots, no evidence of carcass.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				x
Other Notes (e.g. substrate/vegetation):				
Sex/age/number/species	Unable to determine due to absence of carcass.			
Post Find Actions: Nil				

YANDIN WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM				
Yandin WF				
Date:	24/10/2023			
Start Time:	1117			
Finish Time:	1141			
Turbine Number:	WTG49			
Wind direction and strength in preceding 24 hours:	North, 30 km/h			
Any unusual weather conditions in last 48 hours?	Clear			
Distance of Carcass from Tower(m):	23m			
Bearing of Carcass from Tower (deg):	NE			
Preliminary Species Identification:	Undetermined (possibly nankeen kestrel)			
Photo Taken**	**Yes**		**Time:**	1144
Signs of injury:	Small feather spot comprising nondescript downy feather with no identifiable feature. Carcass scavenged in entirety.			
How old is carcass estimated to be (tick category):	**<24 hrs**	**1-3 days**	**>3 days**	**Other**
				x
Other Notes (e.g. substrate/vegetation):	Juvenile			
Sex/age/number/species	Unable to determine due to absence of carcass.			
Post Find Actions: Nil				

Carcass Search Data Sheet

Date and location:				
Date: **5-9-20**			Observer/s: **Craig Strickland/Windhoist**	
Time animal was found: **Approx. 2pm**			Turbine ID: **WTG 41**	
Detection:				
Survey method (circle):	*Monthly search*			***Incidental***
Distance of carcass / injured animal from tower (m): **10**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **Phone, saved to Z: Drive**	
Weather details at time of detection (please circle):				
Temperature: **21.1C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	***Calm***	*Breeze*	*Moderate*	*Strong*
Wind direction: **West**			Cloud cover (%): **0**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Falco cenchroides*** **- Nankeen Kestrel**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Found at WTG 41 Hardstand. Potential strike, all parts in tacked**				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Carcass Search Data Sheet

Date and location:				
Date: **15-9-20**			Observer/s: **Kerry Armstrong (Decmil Peggy)**	
Time animal was found: **14.00**			Turbine ID: **WTG 30**	
Detection:				
Survey method (circle):	*Monthly search*		***Incidental***	
Distance of carcass / injured animal from tower (m): **100m**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on MC 31 adjacent to WTG 30 hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **I Phone, loaded onto Z Drive**	
Weather details at time of detection (please circle):				
Temperature: **27 C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	*Calm*	***Breeze***	*Moderate*	*Strong*
Wind direction: **24km/hr. South**			Cloud cover (%): **0**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): **Aquila Audax - (Wedge-tailed Eagle)**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead*** *(carcass)*	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass in tacked, only recent, no feather spots**				
Describe evidence of scavenging, if any: **Droppings found on carcass**				
Notes / additional information:				

Carcass Search Data Sheet

Date and location:			
Date: **20-11-20**		Observer/s: **Andrew Wragg**	
Time animal was found: **11:30**		Turbine ID: **WTG 04**	
Detection:			
Survey method (circle):	*Monthly search*		***Incidental***
Distance of carcass / injured animal from tower (m): **8 M**			
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on hardstand**			
Carcass / injured animal photographed? ***Yes*** / *No*		Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **iPhone, photos saved in IMS & register**	
Weather details at time of detection (please circle):			
Temperature: **27C**			
Precipitation:	***Fine***	*Showers*	*Rain*
Wind strength:	*Calm*	***Breeze***	*Moderate* *Strong*
Wind direction: **SSW 24km/h**		Cloud cover (%): **43**	
Carcass / injured animal information and condition:			
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Elanus axillaris* – Black-shouldered kite**			
Age (circle):	***Unknown***	*Adult*	*Juvenile*
Sex (circle):	***Unknown***	*Male*	*Female*
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*
Describe location and type of any injuries evident: **Carcass in tacked, only recent, no feather spot**s. Carcass presumably been there a couple of days due to the infestation of bugs. Due to projects outage as off the 10th Nov, potential strike occurred over the weekend			
Describe evidence of scavenging, if any: **None**			
Notes / additional information:			

Carcass Search Data Sheet

Date and location:				
Date: **21-12-20**			Observer/s: **Rick McLoughlin**	
Time animal was found:			Turbine ID: **WTG 7**	
Detection:				
Survey method (circle):	*Monthly search*		***Incidental***	
Distance of carcass / injured animal from tower (m): **50**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on WTG 7 hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **I Phone, loaded onto Z Drive**	
Weather details at time of detection (please circle):				
Temperature: **38 C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	*Calm*	***Breeze***	*Moderate*	*Strong*
Wind direction: **30km/hr. South East**			Cloud cover (%): **0**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Aquila Audax* - (Wedge-tailed Eagle)**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead*** *(carcass)*	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass in tacked, only recent, no feather spots**				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Carcass Search Data Sheet

Date and location:				
Date: **25-9-20**			Observer/s: **Andrew Ferris & Andrew Wragg**	
Time animal was found: **11.20**			Turbine ID: **WTG 29**	
Detection:				
Survey method (circle):	*Monthly search*		***Incidental***	
Distance of carcass / injured animal from tower (m): **35m**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on hardstand**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **iPhone, photos saved in IMS & register**	
Weather details at time of detection (please circle):				
Temperature: **23 C**				
Precipitation:	*Fine*	*Showers*	*Rain*	
Wind strength:	*Calm*	*Breeze*	*Moderate*	*Strong*
Wind direction: **W 17km/h**			Cloud cover (%): **48**	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Falco cenchroides*** **(Nankeen Kestral)**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Carcass intact, only recent, no feather spots**				
Describe evidence of scavenging, if any:				
Notes / additional information:				

Carcass Search Data Sheet

Date and location:				
Date: **29-8-20**			Observer/s: **Menzel Electrician**	
Time animal was found: **11am**			Turbine ID: **WTG 49**	
Detection:				
Survey method (circle):	*Monthly search*		***Incidental***	
Distance of carcass / injured animal from tower (m): **85m**				
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Grassed Area**				
Carcass / injured animal photographed? ***Yes*** / *No*			Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **Phone, saved to Z: Drive**	
Weather details at time of detection (please circle):				
Temperature: **15C**				
Precipitation:	***Fine***	*Showers*	*Rain*	
Wind strength:	***Calm***	*Breeze*	*Moderate*	*Strong*
Wind direction:			Cloud cover (%): 95	
Carcass / injured animal information and condition:				
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Aquila Audax*** **- Wedge- tailed Eagle**				
Age (circle):	***Unknown***	*Adult*	*Juvenile*	
Sex (circle):	***Unknown***	*Male*	*Female*	
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*	
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*	
Describe location and type of any injuries evident: **Head was missing, all other parts intact, no missing feathers or feather spots.** Carcass presumably been there a couple of days due to the infestation of magnets				
Describe evidence of scavenging, if any: **None**				
Notes / additional information:				

Carcass Search Data Sheet

Date and location:			
Date: **29-11-20**		Observer/s: **Andrew Wragg**	
Time animal was found: **11:15**		Turbine ID: **WTG 10**	
Detection:			
Survey method (circle):	***Monthly search***		*Incidental*
Distance of carcass / injured animal from tower (m): **60m**			
Describe ground visibility within a 1 m radius of where carcass / injured animal was found: **Carcass found on MC 63 which is adjacent to WTG 10**			
Carcass / injured animal photographed? ***Yes*** / *No*		Photo and camera details (e.g. camera number, photo numbers, location of saved photos): **iPhone, photos saved in IMS & register**	
Weather details at time of detection (please circle):			
Temperature: **29C**			
Precipitation:	***Fine***	*Showers*	*Rain*
Wind strength:	*Calm*	***Breeze***	*Moderate* *Strong*
Wind direction: **W 17km/h**		Cloud cover (%): **63**	
Carcass / injured animal information and condition:			
Species (e.g. wedge-tail eagle, Carnaby cockatoo, bat): ***Falco Cenchroides*** **(Nankeen Kestral)**			
Age (circle):	***Unknown***	*Adult*	*Juvenile*
Sex (circle):	***Unknown***	*Male*	*Female*
Condition (circle):	***Dead (carcass)***	*Injured but alive*	*Feather spot (≥ 10 feathers)*
Degree of decay (circle):	***Fresh***	*More than a week old*	*Very old or highly decayed*
Describe location and type of any injuries evident: **Carcass in tacked, no feather spots, found on side of road. Carcass no more than 1-2 days old. Due to the wind direction and the location of the carcass Friday/Saturday**			
Describe evidence of scavenging, if any: **None**			
Notes / additional information:			

APPENDIX B SCAVENGER TRIAL RESULTS

Short grass scavenger trial (February 2022)					
Turbine ID	Carcass type	Replicate of	Deployment date/time	Date Scavenged	Duration of carcass scavenged
WTG02	Rat	Bat	7/2/2022 AM	7/2/2022 PM	0
WTG06	Rat	Bat	7/2/2022 PM	9/2/2022 AM	2
WTG10	Rat	Bat	7/2/2022 PM	9/2/2022 AM	2
WTG20	Rat	Bat	7/2/2022 AM	9/2/2022 AM	2
WTG27	Rat	Bat	7/2/2022 PM	8/02/2022 AM	2
WTG30	Rat	Bat	7/2/2022 PM	15/02/2022	9
WTG34	Rat	Bat	7/2/2022 AM	9/2/2022 AM	2
WTG41	Rat	Bat	7/2/2022 AM	8/02/2022 AM	1
WTG49	Rat	Bat	7/2/2022 PM	10/02/2022	3
WTG50	Rat	Bat	7/2/2022 AM	10/02/2022	3
WTG02	Quail	Small bird	7/2/2022 PM	8/02/2022 AM	1
WTG08	Quail	Small bird	7/2/2022 AM	8/02/2022 AM	1
WTG10	Quail	Small bird	7/2/2022 AM	9/2/2022 AM	2
WTG14	Quail	Small bird	7/2/2022 PM	9/2/2022 AM	2
WTG26	Quail	Small bird	7/2/2022 PM	8/02/2022 AM	1
WTG30	Quail	Small bird	7/2/2022 AM	15/02/2022	9
WTG31	Quail	Small bird	7/2/2022 AM	10/02/2022	3
WTG34	Quail	Small bird	7/2/2022 PM	8/02/2022 AM	1
WTG39	Quail	Small bird	7/2/2022 PM	9/2/2022 AM	2
WTG49	Quail	Small bird	7/2/2022 AM	10/02/2022	3
WTG06	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG14	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG26	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG27	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG39	Chicken	Medium bird	7/2/2022 AM	8/02/2022 AM	1
WTG08	Chicken	Medium bird	7/2/2022 PM	16/02/2022	10
WTG20	Chicken	Medium bird	7/2/2022 PM	8/02/2022 AM	1
WTG31	Chicken	Medium bird	7/2/2022 PM	8/02/2022 AM	1
WTG41	Chicken	Medium bird	7/2/2022 PM	8/02/2022 AM	1
WTG50	Chicken	Medium bird	7/2/2022 PM	10/02/2022	3
Long grass scavenger trial (September 2022)					
Turbine ID	Carcass	Replicate of	Deployment date/time	Date Scavenged	Days until scavenged
WTG02	Rat	Bat	6/9/2022 AM	7/9/2022 AM	1
WTG06	Rat	Bat	6/9/2022 PM	08/09/2022 AM	2
WTG10	Rat	Bat	6/9/2022 PM	08/09/2022 AM	2
WTG20	Rat	Bat	6/9/2022 AM	08/09/2022 AM	2
WTG27	Rat	Bat	6/9/2022 PM	07/09/2022 AM	1
WTG30	Rat	Bat	6/9/2022 PM	5/10/2022	29
WTG34	Rat	Bat	6/9/2022 AM	07/09/2022 AM	1
WTG41	Rat	Bat	6/9/2022 AM	9/09/2022	3
WTG49	Rat	Bat	6/9/2022 PM	12/09/2022	6

Turbine ID	Carcass	Replicate of	Deployment date/time	Date Scavenged	Days until scavenged
WTG50	Rat	Bat	6/9/2022 AM	19/09/2022	13
WTG02	Quail	Small bird	6/9/2022 PM	7/9/2022 AM	1
WTG08	Quail	Small bird	6/9/2022 AM	07/09/2022 AM	1
WTG10	Quail	Small bird	6/9/2022 AM	07/09/2022 AM	1
WTG14	Quail	Small bird	6/9/2022 PM	08/09/2022 AM	2
WTG26	Quail	Small bird	6/9/2022 PM	9/09/2022	3
WTG30	Quail	Small bird	6/9/2022 AM	08/09/2022 AM	2
WTG31	Quail	Small bird	6/9/2022 AM	07/09/2022 PM	1
WTG34	Quail	Small bird	6/9/2022 PM	10/09/2022	4
WTG39	Quail	Small bird	6/9/2022 PM	08/09/2022 AM	2
WTG49	Quail	Small bird	6/9/2022 AM	07/09/2022 AM	1
WTG06	Corella/Lorikeet	Medium bird	6/9/2022 AM	7/9/2022 AM	1
WTG08	Corella/Lorikeet	Medium bird	6/9/2022 PM	07/09/2022 PM	1
WTG14	Corella/Lorikeet	Medium bird	6/9/2022 AM	07/09/2022 AM	1
WTG20	Corella/Lorikeet	Medium bird	6/9/2022 PM	9/09/2022	3
WTG26	Corella/Lorikeet	Medium bird	6/9/2022 AM	07/09/2022 PM	1
WTG27	Corella/Lorikeet	Medium bird	6/9/2022 AM	9/09/2022	3
WTG31	Corella/Lorikeet	Medium bird	6/9/2022 PM	10/09/2022	4
WTG39	Corella/Lorikeet	Medium bird	6/9/2022 AM	12/09/2022	6
WTG41	Corella/Lorikeet	Medium bird	6/9/2022 PM	10/09/2022	4
WTG50	Corella/Lorikeet	Medium bird	6/9/2022 PM	9/09/2022	3

APPENDIX C YANDIN WIND FARM YEAR 1-2 MORTALITY ESTIMATE (SYMBOLIX 2024)

symbolix

Yandin Wind Farm Year 1-2 Mortality Estimate

Prepared for Ecologia Environmental Consultants, 27 February 2024, Ver. 1.1

This report outlines an analysis of bird and bat mortality at Yandin Wind Farm from 2021-12-01 to 2023-11-30. Mortalities surveys were undertaken by ecologia Environmental Consultants (ecologia) during the first two years of operation. The analysis is broken into the three related components below:

- Searcher efficiency / detectability – estimated from trials in August 2022, October 2022, March 2023, April 2023 and August 2023
- Scavenger loss rates – estimated from trials in February 2022 and September 2022
- Mortality estimates - based on surveys at 17 turbines, from 2021-12-01 to 2023-11-30

We estimate overall bird and bat mortality separately for the first two years of operation.

1 Available data

Turbine data, mortality survey data, and adjunct survey data was provided by ecologia[1]. A brief summary of the data is provided below, and the ultimate focus of this report is a discussion of the potential mortality.

Turbine parameter data (rotor diameter and height) was provided by ecologia on behalf of RATCH-Australia & Alinta Energy.

Species archetype data was taken from Hull and Muir (2010).

1.1 Data cleaning

Data was used as provided by ecologia, with species name cleaning and assignment of unique turbine identification codes conducted before analysis.

[1] MortalityTemplate.xlsx

2 Statistical methodology overview

Mortality through collision is an ongoing environmental management issue for wind facilities. Different sites present different risk levels; consequently different sites have different monitoring requirements. In order to estimate the mortality loss at a given site (in a way that is comparable with other facilities) we must account for differences in survey effort, searcher and scavenger efficiency. We used a Monte Carlo method to achieve this.

Best practice estimators project the number of found carcasses (C) up to the number of actual mortalities (M). They should account for:

- The probability a carcass will be detected by the searcher (p)
- The probability a carcass is not lost to scavenge or decay prior to the search (r)
- The probability a carcass falls within the searched area (a)
- The fraction of turbines searched (f)

Most mortality estimators, e.g. (Huso 2011), can be conceptualised as a ratio estimator

$$\hat{M} = \frac{C}{\hat{p} \cdot \hat{r} \cdot \hat{a} \cdot f} \tag{1}$$

with the terms in the denominator providing a "boost factor" to the number of carcasses found, C.

However, a limitation of analytical methods is estimating r when the time between surveys is not constant. In Australia, it is common for the time between searches to vary due to seasonal changes in effort or the use of a pulsed design in which the turbine is searched monthly with a return visit a few days later. Additionally, ratio estimators cannot handle the cases when zero carcasses are found, as zero multiplied by any number still gives zero.

To address this, Symbolix have developed a Monte Carlo algorithm. We have used this method for mortality estimates at over forty wind farms in Australia to date.

Monte Carlo methods (Sawilowsky (2003), Ripley (1987)) simulate a large set of possible survey results, by simulating the actual survey protocol, and sampling from empirical distributions for scavenge loss and searcher efficiency. In this way, we directly sample the probability a carcass was lost before the survey, negating the need to calculate r analytically each time.

We then estimate how many carcasses were truly generated, given the range of searcher and scavenger efficiencies, the survey frequency and coverage, and the true "found" details. After many simulations, we can estimate the likely range of mortalities that could have resulted in the recorded survey outcome (number of carcasses found).

This method has been benchmarked against analytical approaches (Huso (2011), Korner-Nievergelt et al. (2011)). Its outputs are equivalent but it is able to robustly model more complex survey designs (e.g. pulsed surveys, rotating survey list).

Figure 1 provides an overview of the methodology. A detailed explanation can be found in Stark

and Muir (2020).

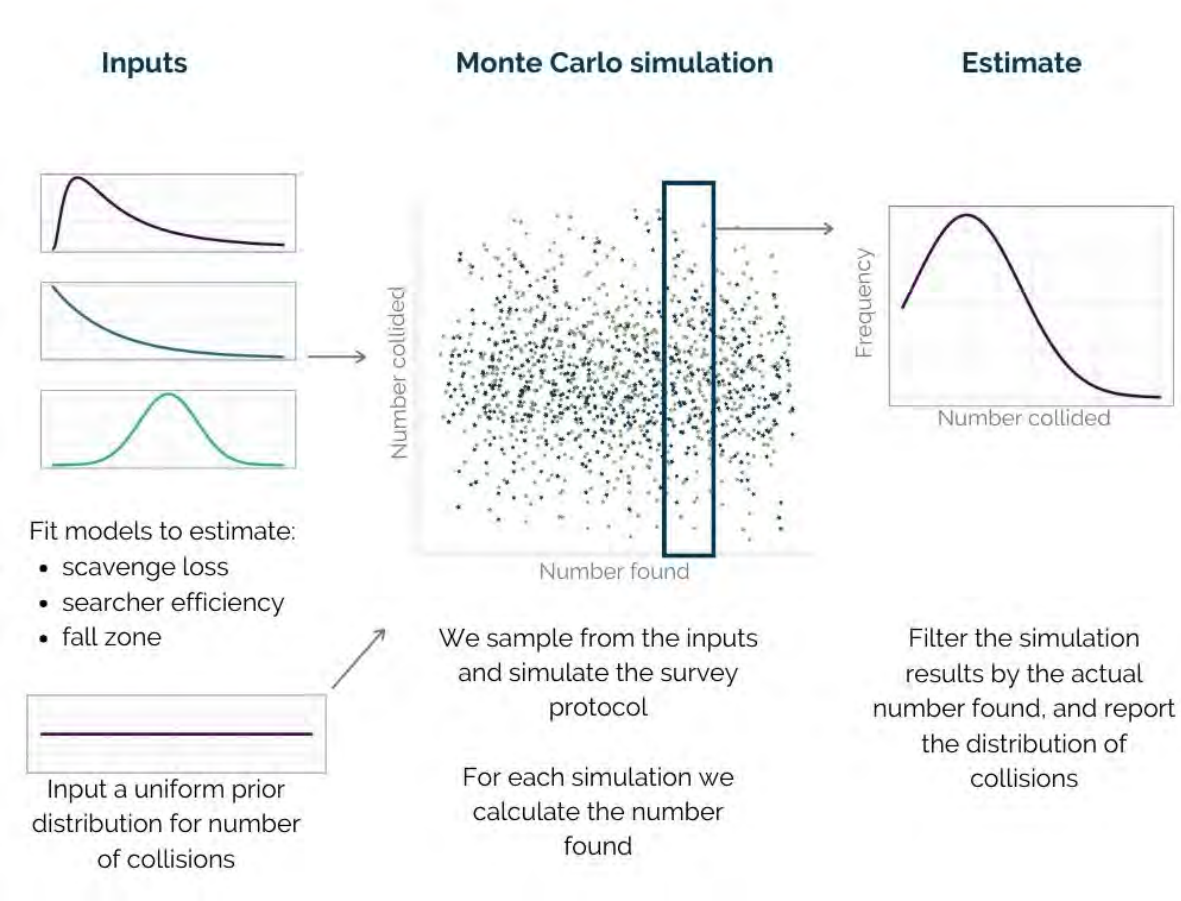

Figure 1: Overview of how the mortality estimation works.

The following sections outline how we estimate p, r and a. $\mathbf{C}$ is given by the field observation data, and f is defined by the survey design.

3 Analysis and modelling

The survey program consisted of carcass searches, and adjunct scavenger and detection trials as outlined in Brett Lane and Associates (2018) provided by ecologia. We summarise the methods, field data and analysis results for each below.

3.1 Carcass search data

Carcass searches were undertaken monthly at each turbine site to a 120m radius from the turbine tower. An ecologist walked concentric transects around each turbine tower at six metre intervals to a radius of 60m and then twelve metres from 60m to the 120m outer search radius.

The carcass searches provide the C and f terms in Section 2.

3.1.1 Survey effort

The mortality estimate was based on a dated list of turbine surveys. The survey frequency is summarised in Table 1. Of the 51 turbines on site, 17 turbines were surveyed once each month out to 120 m. Turbines were randomly selected from across the site, except for the three turbines closest to the "Cataby Brook Carnaby's breeding area", which Brett Lane and Associates (2018) designated to have to be included. In no month were any turbines not surveyed. No pulse surveys (i.e. follow-up surveys several days after the main survey in the inner search area) were included in this design.

Table 1: Number of surveys per month.

Year	Month	N
2021	Dec	17
2022	Jan	17
2022	Feb	17
2022	Mar	17
2022	Apr	17
2022	May	17
2022	Jun	17
2022	Jul	17
2022	Aug	17
2022	Sep	17
2022	Oct	17
2022	Nov	17
2022	Dec	17
2023	Jan	17
2023	Feb	17
2023	Mar	17
2023	Apr	17
2023	May	17
2023	Jun	17
2023	Jul	17
2023	Aug	17
2023	Sep	17
2023	Oct	17
2023	Nov	17

3.1.2 Carcass finds

The breakdown of found carcasses per species are summarised in Table 2. No Bats were found during the formal surveys. Carcasses found incidentally (i.e. not within the formal surveys) are not included in the data that produces the mortality estimate as they do not have a known and standardised survey effort. However, the incidental data confirms that at least one Bat has been struck on the wind farm in the first two years of operation as two Bat carcasses were found incidentally (at least one of which was deemed by ecologia to be likely a strike). No Bird carcasses were found incidentally.

Table 2: Carcasses found during formal surveys over the first two years.

Species	Bird
Australian Magpie	2
Australian Ringneck	1
Brown Goshawk	1
Little Corella	2
Nankeen Kestrel	5

3.2 Searcher efficiency

The aim of searcher efficiency trials is the quantify the effectiveness of observers, at finding carcasses. They provide the p term in 2.

3.2.1 Field methods

The searcher efficiency data is primarily sourced from trials conducted in 2022 Aug, 2022 Oct, 2023 Mar, 2023 Apr and 2023 Aug. Carcasses were laid out, and an ecologist searched for the carcasses using the same protocol as the main mortality survey. If the carcass was found, "success" was recorded, else "failure" was the ecologist missing the carcass.

The detectability trials used stuffed replicates of various size classes as proxies for bats and birds (Table 3).

Table 3: Count of surrogate types and sizes used during the detection trials.

Date	Bat Proxy	Large Bird Proxy	Medium Bird Proxy	Small Bird Proxy
Aug-2022	10	10	10	10
Oct-2022	10	10	10	10
Mar-2023	10	10	10	10
Apr-2023	10	10	10	10
Aug-2023	5	5	5	5

3.2.2 Statistical methods

We estimated searcher efficiency by fitting binomial generalised linear models (GLMs). We included proxy type (Large Toy Bird, Medium Toy Bird, Small Toy Bird and Toy Bat) as a as predictors in the model.

The optimal model was determined, guided by the small-sample Akaike Information Criterion (Anderson and Burnham 2004), otherwise known as the AICc.

The theory of AIC is deep and complex, and beyond the scope of this report. However, to summarise, AIC is a method for choosing the best approximating model of the "truth". For each model we fit to the data, we calculate the AIC. We compare the differences in AIC between models, which in turn informs us of the weight of evidence for that particular model.

AIC is not the same as significance testing. We do not aim to state anything is significant at the 5% level, instead we aim to find a good model fit for the data. Additionally, we also consider two other principles guiding model selection. They are parsimony (a simpler model is preferable to a more complex model), and application (for example, it's all well and good to find that cloud cover affects detection rates, but it's not feasible to incorporate cloud cover into a mortality estimate).

AICc is a modification of AIC, which is appropriate for smaller sample sizes.

3.2.3 Results

The most parsimonious model of searcher efficiency according to AICc was the "intercept-only" model (i.e. all carcasses have the same expected searcher efficiency).

Table 4: Detection efficiencies for Birds and Bats.

Variable	Birds/Bats
Number found	131
Number placed	180
Mean detectability proportion	0.73
Detectability lower bound (95% CI)	0.66
Detectability upper bound (95% CI)	0.79

3.3 Scavenger efficiency

In order to accurately estimate mortality, we must account for carcass loss to scavengers. Scavenger trials are performed to quantify the time until a carcass is completely lost as a result of scavenger activity, which is the r term in Section 2.

3.3.1 Field methods

Scavenger efficiency trials were conducted in February 2022 and September 2022. The trials ran over approximately 30 days. In total, 40 bird carcasses and 20 bat proxy (rat) carcasses were used. Trials used human checks in order to determine approximate timing of scavenger events.

Table 5: Species types for scavenger trials.

Species	Date	Replicates
Domestic Rat	Feb-2022	10
Quail	Feb-2022	10
Chicken	Feb-2022	10
Domestic Rat	Sep-2022	10
Quail	Sep-2022	10
Parrot	Sep-2022	10

3.3.2 Statistical methods

Survival analysis (Kaplan and Meier (1958), Kalbfleisch and Prentice (2011)) was used to determine the distribution of time until complete loss from scavenge (or decay). Survival analysis was required to account for the fact that we do not necessarily know the exact time of scavenge loss, only an interval in which the scavenge event happened. For example, any carcass which is unscavenged at the end of the trial, has its scavenge event in the interval [x, ∞] (where x is the length of the trial).

By performing survival analysis we can estimate the time until carcass loss after a given length of time, despite these unknowns.

We fit parameterised models to analyse significant factors influencing time to scavenge (carcass species type etc), and to find the most appropriate distribution to fit the time-to-loss curve (e.g. log-normal, exponential).

Time to carcass loss is influenced by the parameters discussed above and the distribution of the loss curve we fit to the data (Huso, Dalthorp, and Korner-Nievergelt 2015). The choice of loss function is important because it should capture the behaviours and relative time dependence of the various scavengers. Generally, the best distribution is the log-normal distribution (Stark and Muir 2020).

3.3.3 Results

AICc analysis and visualisation of the survival regression models, showed the most parsimonious model was the “intercept-only” - i.e., no difference between the bat and bird scavenger rates. Therefore, in the following mortality estimations, aggregated survival curves are used.

Figure 2 shows the survival curve fitted to the combined set of bats and birds. The survival curve (smooth solid line for fitted regression curve, jagged step function for empirical removal rate) shows the estimated proportion of the set remaining at any given time. The shaded portions are the 95% confidence intervals on the estimate.

Under these assumptions, the median time to carcass removal via scavenge is 1.7 days, with a 95% confidence interval of [1, 2.1] days.

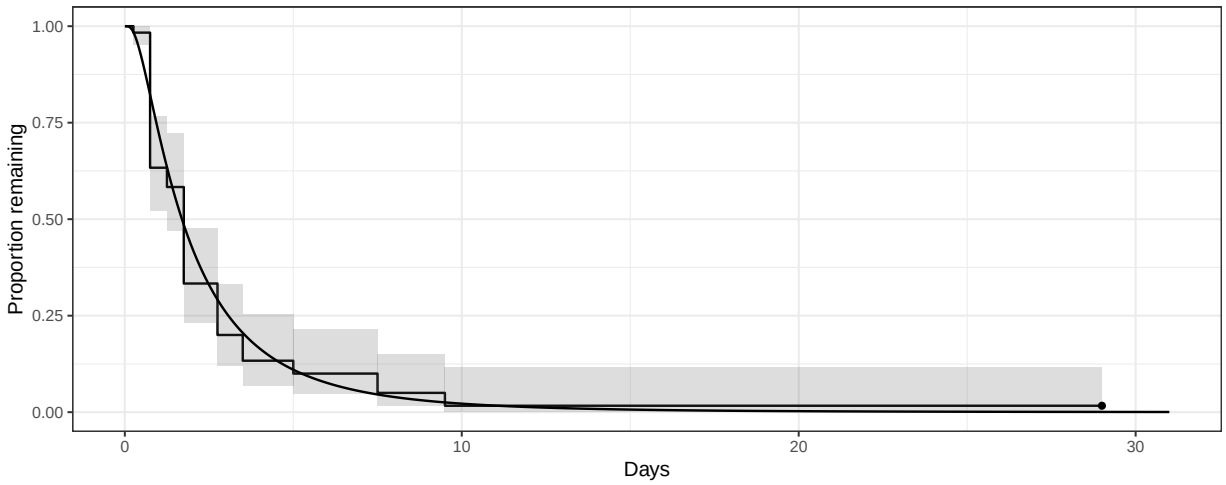

Figure 2: Empirical survival curve (the step function), with 95% confidence intervals shaded. The smooth curve presents the fitted model.

3.4 Proportion of turbines searched

Seventeen (of 51 total) turbines were searched at Yandin. In the Monte Carlo algorithm, we explicitly simulate the survey design. The proportion of turbines sampled is therefore accounted for in the simulation.

3.5 Coverage factor

The coverage factor estimates the probability that, given a carcass falls at a searched turbine, that the carcass falls within the searched area. This contributes to the a term in Section 2.

3.5.1 Fall zone simulation - methods

We generated a carcass fall-zone distribution for the each species class (i.e. birds and bats), given the turbine size at the wind farm. The fall-zone distribution is the end result of the simulation method detailed in Hull and Muir (2010). The simulation method is a ballistics model describing avifauna strikes by turbine blades.

3.5.2 Coverage factor calculation - methods

The percentage of the fall zone not covered by the survey area, provides a correction factor in the mortality estimate. Because carcasses that fall outside the searched area have a zero

probability of being detected by a survey, the likelihood of landing in this region is essential to understanding the relationship between detections and actual losses.

3.5.3 Simulation inputs

Table 6 displays the dimensions and RPM of the turbines at Yandin Wind Farm while Table 7 shows the bird and bat physical parameters used. These are input into the fall zone simulation.

Turbine specifications were provided by ecologia. Bird and bat parameters were sourced from the archetypes in Hull and Muir (2010).

Table 6: Turbine specifications for Yandin Wind Farm.

Rotor Diameter (m)	Tower Height (m)	RPM
150	105	12

Table 7: Species size archetype parameters.

Species type	Archetype	Mass (kg)	Min. area (sq m)	Max. area (sq m)
Bat	Gould's Wattled Bat	0.014	0.0028	0.014
Bird	Raven	0.68	0.0450	0.100

3.5.4 Results

Figure 3 displays the simulation results, given the factors specified above. We display the cumulative density function (CDF) on the y axis versus the distance from turbine on the x axis for each species type. The CDF describes the expected proportion of carcass which fall less than or equal to a certain distance from the turbine. We see that we expect approximately 100% of bat carcasses and 100% of bird carcasses to fall within 120 m of the turbine (i.e. the search area).

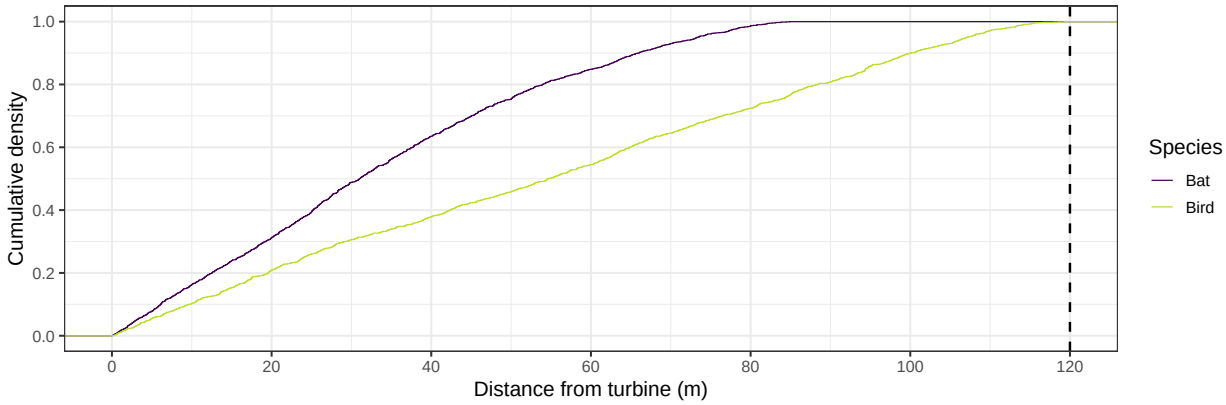

Figure 3: Cumulative distribution function of the fall zone simulation output, for birds and bats. Vertical line indicates survey radius

Once the fall zone distribution is calculated, we generate a "coverage factor" for each species type. The coverage factor represents the proportion of carcasses which fall within the searched area.

We assume that 100% of bird strikes and 100% of bat strikes land within the searched area.

4 Mortality estimate

With estimates for scavenge loss, searcher efficiency, and survey coverage, we converted the number of Bat and Bird carcasses detected, into an estimate of overall mortality at Yandin Wind Farm from 2021-12-01 to 2023-11-30 (i.e. year one and two of operation).

The mortality estimation is done via a Monte Carlo algorithm. We used 25000 simulations for bats and 25000 simulations for birds, with the survey design simulated each time. Random numbers of virtual mortalities were simulated, along with the scavenge time and searcher efficiency (based on the measured confidence intervals). The proportion of virtual carcasses that were "found" was recorded for each simulation. Finally, those trials that had the same outcome as the reported survey detections were collated, and the initial conditions (i.e. how many true losses there were) reported on.

The model assumptions are listed below:

- There were 51 turbines on site available to strike Birds and Bats.
- Search frequency for each turbine was taken from a list of actual survey dates (see Table 1 for a summary).
- Mortalities were allowed to occur up to a month before the initial survey (2021-12-01) and until the final surveyed date (2023-11-30).
- All Birds and Bats are on-site at all times during this period.
- Bats and birds that are struck are immediately replaced (i.e. strikes one day do not affect the chance of strikes the next).
- We have used the standard practice of assuming that all carcasses and all feather spots (regardless of size or composition) are attributable to the wind turbines.
- Finds are random and independent, and not clustered with other finds.
- There was equal chance of any turbine being involved in a collision / mortality.
- We took scavenge loss and searcher efficiency rates as outlined above.
- We assumed a log-normal scavenge shape.
- 17 turbines were surveyed, and were searched out to a 120 metre radius, in accordance with the supplied survey data.
- The coverage factor was 100% for Birds and 100% for Bats.
- The minimum Bat mortality possible was 1, given the incidental records.

4.1 Bats

During the two years of surveys no bats were found during formal surveys, however two bats were found incidentally. Therefore we have evidence at least one bat was struck by a turbine at the site over the two year period. The resulting (median) estimate of total mortality is 36 bats lost on site over the two year period.

Table 8 and Figure 4 display the percentiles of the distributions, to show the confidence on the mortality estimate.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, we expect that there was a total site loss of around 36 bats over the full survey period, and are 95% confident that fewer than 160 individuals were lost.

Table 8: Percentiles of estimated total bat losses.

0%	50% (median)	90%	95%	99%	99.9%
1	36	123	160	234	317

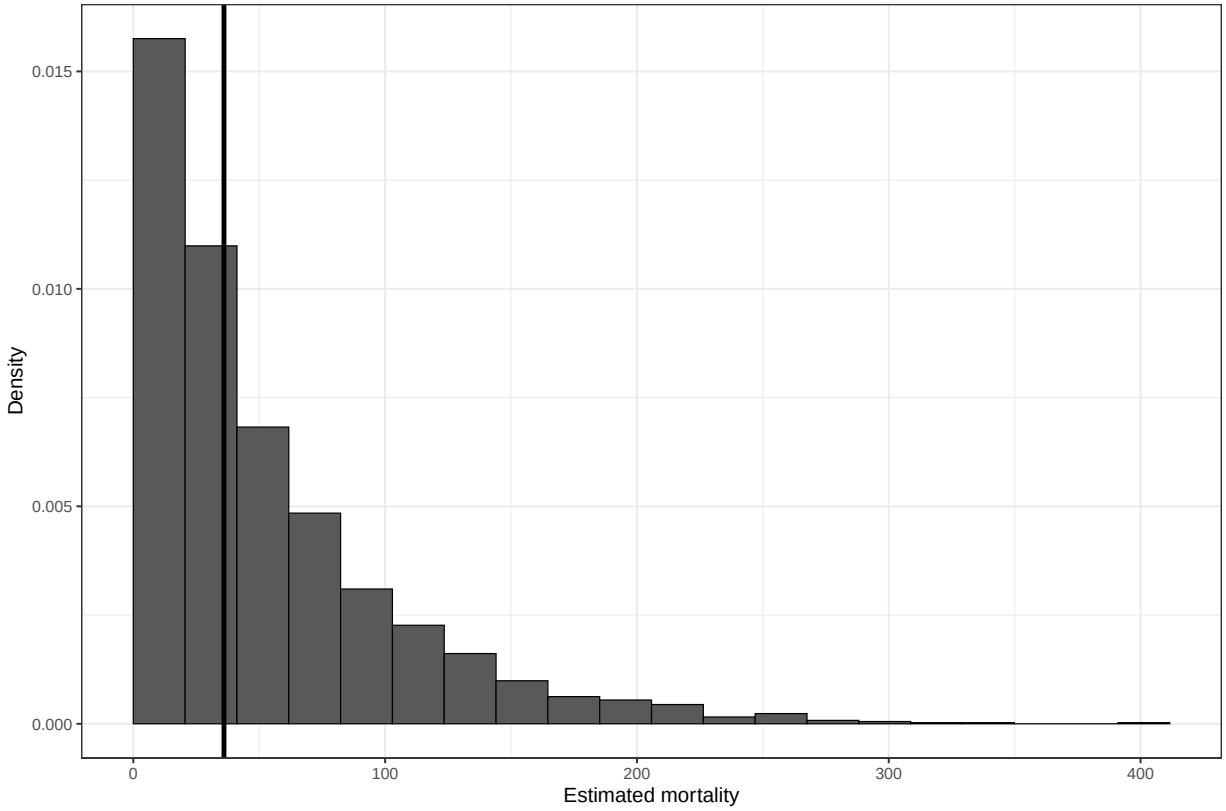

Figure 4: Histogram of the total losses distribution (bats). The solid black line shows the median.

4.2 Birds

During the first two years of surveys a total of 11 birds were found during formal surveys. The resulting (median) estimate of total mortality is 618 birds lost on site over the survey period.

Table 9 and Figure 5 display the percentiles of the distributions, to show the confidence on the mortality estimate.

Based on the detected carcasses, measured detectability, scavenge rate, and survey effort, we expect that there was a total site loss of around 618 birds over the full survey period, and are 95% confident that fewer than 1055 individuals were lost.

Table 9: Percentiles of estimated total bird losses.

0%	50% (median)	90%	95%	99%	99.9%
189	618	905	1055	1299	1477

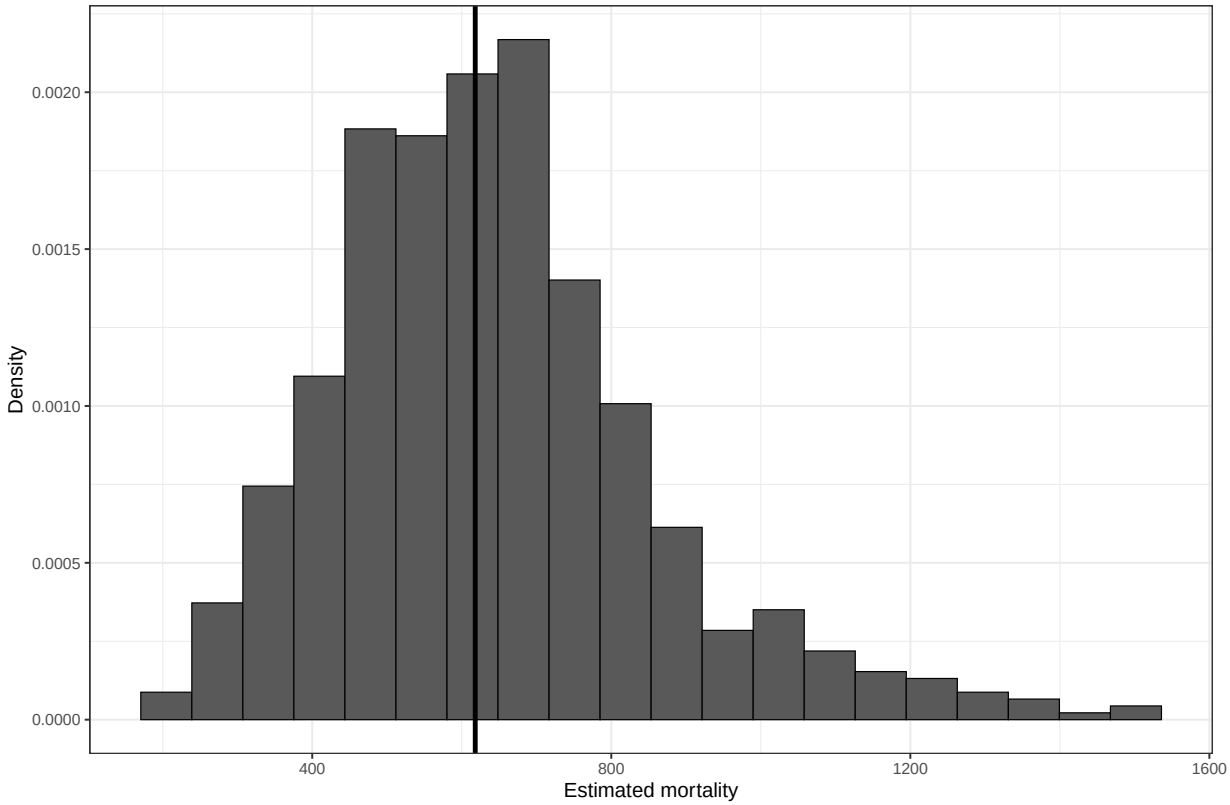

Figure 5: Histogram of the total losses distribution (birds). The solid black line shows the median.

5 Concluding remarks

In evaluating the potential impact, it is important to remember that all mortality estimators have an inherent assumption that there is an unlimited supply of carcasses to be found. In particular, we did not apply an upper limit on the number of bats that could be onsite, and we assumed that bats were present all year round. The ecological feasibility of this assumption should be accounted for if using these results to comment on overall ecological impact.

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