



Nyamba Buru Yawuru Flora and Fauna Survey

Nyamba Buru Yawuru

ecoscape



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SUMMARY

Nyamba Buru Yawuru (NBY) Ltd is the operating arm of the Yawuru Prescribed Body Corporate (PBC) that holds native title in trust for the Yawuru community and is developing an agricultural project on their property at Roebuck Plains Station. The proposal is to develop a pivot agriculture system over approximately 300 hectares (ha). This report represents the findings of the flora and fauna investigations that are required for development approvals.

The desktop assessment of the approximately 900 ha study area that included the lands proposed for agriculture identified:

- the pre-European vegetation association associated with the study area (vegetation association 699) has more than 99% of its original extent remaining at all scales (State-wide to Local Government Area)
- the area does not correspond with any currently described Threatened or Priority Ecological Community
- 36 Threatened Flora and Priority Flora were identified by database searches and literature review as having been previously recorded from nearby; based on known habitat, seven of these were considered to have a possible occurrence
- 74 conservation significant fauna species were identified by the database and literature searches as having previously recorded nearby; four species have a high likelihood of occurring and six have a medium likelihood of occurring
- A total of 44 morpho-species of invertebrate species have previously been recorded from the region which are currently considered potential Short-ranged Endemic (SRE) species; the assessment is made based on taxonomic and biological knowledge
- A subterranean fauna letter has been provided (see Appendix) which states that the presence of stygofauna and troglifauna on site is likely; however, the community is expected to be depauperate.

The detailed flora and vegetation field survey (formerly known as a Level 2 survey) identified:

- 117 vascular flora species from 10 floristic quadrats within the study area and three regional quadrats
- one conservation significant flora species; P3 *Triodia caelestialis* that was a characteristic and sometimes dominant ground stratum species
- one introduced species **Stylosanthes hamata*, that is not a Declared Pest plant or WONS species
- three vegetation types, none of which were of conservation significance and were considered representative of the vegetation of the region
- the vegetation was largely in Excellent condition, with the remainder in Very Good or Good condition.

The Level 2 fauna survey identified:

- two fauna habitat types; Shrubland over mixed tussock grassland occupying 77% of the study area and *Aristida* and *Chrysopogon* tussock grassland occupying 23%
- 82 fauna species (seven native mammals, three introduced species of mammal, 38 birds, 25 species of reptile, three amphibians and six SRE species)
- three conservation significant fauna species:
 - Rainbow Bee-eater (*Merops ornatus*) (WC Act S5), from nine locations
 - Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) (DBCA P3), from 16 locations through secondary evidence
 - Dampier Peninsula Goanna (*Varanus sparnus*) (DBCA P1), from four locations consisting of seven individuals
- 258 invertebrate specimens were recorded of which 20 specimens from six morpho-species represent potential SRE species based on the current level of taxonomic knowledge and/or lack thereof
- The habitats are not unique to the study area and continue outside the site
- All vertebrate species are not restricted and known to occur in the surrounding area with invertebrate SRE species likely to inhabit areas outside.

1 INTRODUCTION

1.1 PROJECT PURPOSE

Nyamba Buru Yawuru (NBY) Ltd is the operating arm of the Yawuru Prescribed Body Corporate (PBC) that holds native title in trust for the Yawuru community. NBY's investments include residential properties, agricultural land and a range of diversified investments. NBY is developing an agricultural project on their property at Roebuck Plains Station.

NBY is planning to invest in a five x 50 ha pivot agriculture system covering approximately 300 hectares (ha) within an area defined as having high value for agriculture. The pivots will be constructed within a study envelope of 961 ha, with a smaller infrastructure area.

To achieve the development approvals for the project, NBY is required to undertake flora and fauna surveys to satisfy both Commonwealth and State Environmental legislation.

1.1.1 PROJECT SCOPE

The scope of works for survey included:

- a Level 2 flora and vegetation survey, as it was previously known (now known as Desktop Assessment and Detailed Flora and Vegetation Survey in the *Flora and Vegetation Technical Guidance* – see below), incorporating desktop assessment, field survey and targeted conservation significant flora searches
- a Level 2 fauna and targeted Greater Bilby and Spectacled Hare Wallaby assessment.
- Provision of a desktop letter assessing the likelihood of subterranean fauna to occur on site

The methods are described in more detail in **Section 3** and follow the relevant guidelines including:

- Environmental Protection Authority (EPA) *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual 2016* (where relevant) (Environmental Protection Authority 2016c)
- EPA *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (2016e), known as the *Flora and Vegetation Technical Guidance*
- EPA *Technical Guide: Sampling methods for Terrestrial vertebrate fauna* (2016g)
- EPA *Technical Guidance: Terrestrial Fauna Surveys* (2016f)
- EPA *Technical Guidance – Sampling of short range endemic invertebrate fauna* (2016h)
- EPA *Environmental Factor Guideline: Terrestrial Fauna* (2016b)
- EPA *Environmental Factor Guideline: Terrestrial Environmental Quality* (2016a)
- EPA *Statement of Environmental Principles, Factors and Objectives* (2016d)
- Department of Sustainability, Environment, Water, Water, Population and Communities (DSEWPaC) *Survey guidelines for Australia's threatened mammals* (2011a)
- DSEWPaC *Survey guidelines for Australia's threatened reptiles* (2011b)
- Department of Environment, Water, Heritage and the Arts (DEWHA) *Survey guidelines for Australia's threatened bats* (2010a)
- DEWHA *Survey guidelines for Australia's threatened birds* (2010b).

1.2 STUDY AREA

The study area is located on Roebuck Plains Station, in the Western Australian Kimberley region, approximately 45 km east southeast of Broome. The study area configuration and location is shown in **Figure 1**.

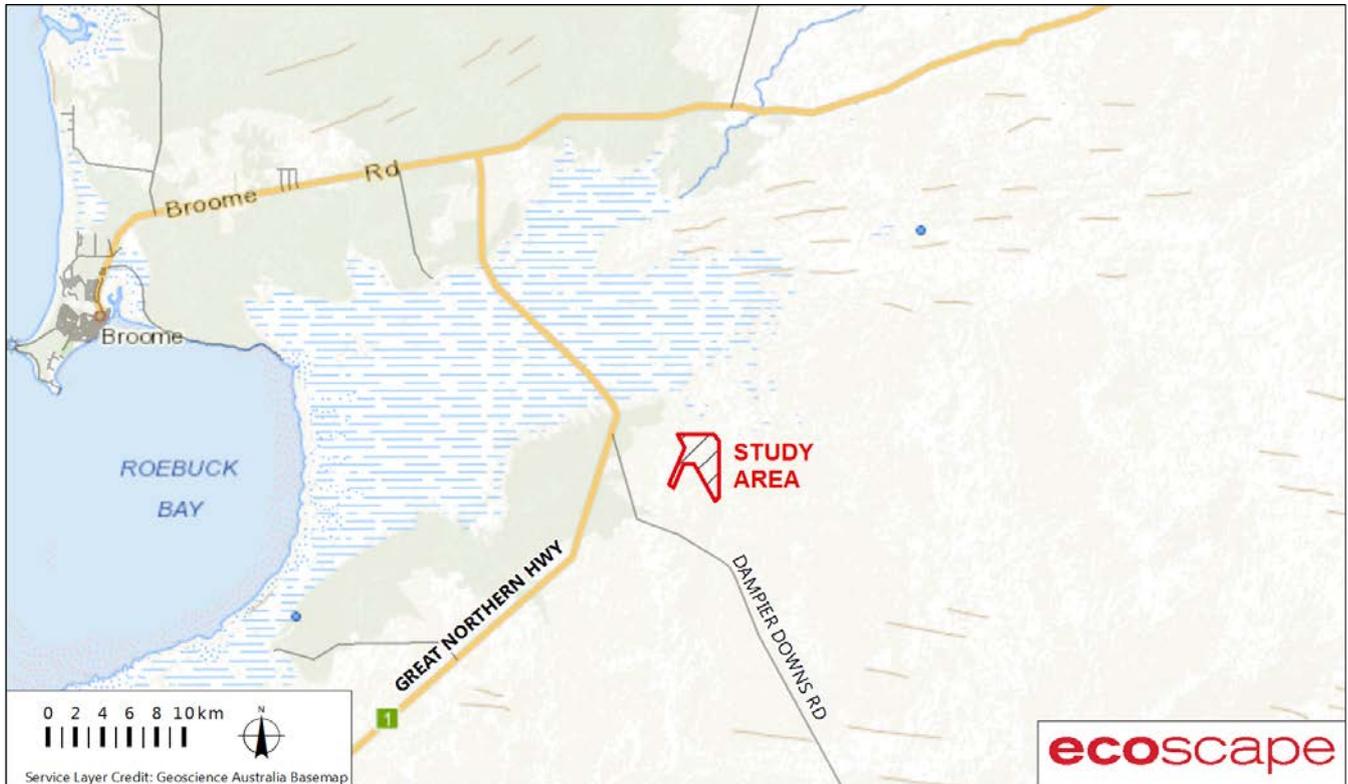


Figure 1: Study area location

1.3 STATUTORY FRAMEWORK

This environmental assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Wildlife Conservation Act 1950* (WC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act)
- Western Australian *Animal Welfare Act 2002*
- Department of Environment Water Heritage and the Arts (2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*.

In addition, the Western Australian Minister for the Environment has published lists of fauna and flora species in need of special protection because they are considered rare, likely to become extinct, or are presumed extinct. The current listings were published in the *Government Gazette* on 3 January 2017 (Government of Western Australia 2017b) and were taken into account.

1.3.1 WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian *Biodiversity Conservation Act 2016* (BC Act) provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. It will eventually replace the *Wildlife Conservation Act 1950* (WC Act). Until relevant Conservation Regulations are

in place, provisions under the WC Act still apply. The Regulations are expected to be implemented in late 2017 (DPaW 2016).

Threatened species (both flora and fauna) that meet the categories listed within the BC Act are highly protected and require authorisation by the Minister to take or disturb. These are known as Threatened Flora and Threatened Fauna. The conservation categories of critically endangered, endangered and vulnerable have been aligned with those detailed in the EPBC Act, as below.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species in the BC Act.

Threatened Ecological Communities are also protected under the BC Act and are categorised using the same criteria as threatened species.

At the time of writing this report, most provisions within the BC Act have not been yet been proclaimed, including those relating to species of conservation interest (Specially Protected Species) and Threatened Ecological Communities. As these are not included in the WC Act, there is currently no specific legal protection afforded to these within Western Australia beyond the usual protection of unlisted species and native vegetation under the *Native Vegetation Clearing Regulations* (Government of Western Australia 2004), unless they are protected under the Commonwealth EPBC Act. Threatened Flora and Threatened Fauna are protected under the provisions of the WC Act until further sections of the BC Act are enacted.

1.3.2 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

At a Commonwealth level, Threatened taxa are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, or Extinct in the Wild (detailed in **Table 23** in **Appendix One**).

1.3.3 THREATENED AND PRIORITY FLORA

Conservation significant flora species are those that are listed as TF (Threatened Flora) and (within Western Australia) as PF (Priority Flora). TF species are listed as threatened by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA, formerly Department of Parks and Wildlife (DPaW)) and protected under the provisions of the BC Act. Some State-listed TF are provided with additional protection as they are also listed under the Commonwealth EPBC Act.

Flora are listed as PF where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to TF categories. Whilst PF are not specifically listed in the BC Act, some may qualify as being of special conservation interest and these have a greater level of protection than unlisted species.

There are seven categories covering State-listed TF and PF species (DPaW 2017) which are outlined in **Table 24** in **Appendix One** (noting that the definitions for TF included in the BC Act have been aligned with those in the EPBC Act). PF for Western Australia are regularly reviewed by the DBCA whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet the requirements outlined in **Table 24**.

1.3.4 INTRODUCED FLORA

Introduced plant species, known as weeds, are plants that are not indigenous to an area and have been introduced either directly or indirectly (unintentionally) through human activity. Species are regarded as introduced if they are listed as 'alien' on *FloraBase* (Western Australian Herbarium 1998-2017).

1.3.4.1 Weeds of National Significance (WONS)

At a national level there are thirty-two weed species listed as Weeds of National Significance (WONS) (Weeds Australia 2012). The Commonwealth *National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance* (2012) describes broad goals and objectives to manage these species.

1.3.4.2 Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Under the BAM Act, Declared Pests are listed as one of the three categories (Government of Western Australia 2007):

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage.

1.3.5 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

1.3.5.1 Nationally Listed Threatened Ecological Communities

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat (Government of Western Australia 2016c). At Commonwealth level, Threatened Flora and Threatened Ecological Communities (TECs) are protected under the Commonwealth EPBC Act. An ecological community may be categorised into one of the three sub-categories:

- Critically Endangered, if it is facing an extremely high risk of extinction in the wild in the immediate future.
- Endangered, if it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
- Vulnerable, if it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

1.3.5.2 State Listed Threatened Ecological Communities

The Western Australian DBCA also maintains a list of TECs (DPaW Species & Communities Branch 2016a) which are further categorised into three subcategories much like those of the EPBC Act. The full details of DBCA criteria are shown in **Table 25** in **Appendix One**.

1.3.5.3 State Listed Priority Ecological Communities

DBCA maintains a list of Priority Ecological Communities (PECs; DPaW Species & Communities Branch 2016b). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined.

1.3.6 THREATENED AND PRIORITY FAUNA

Certain fauna species are listed in conservation categories under the Commonwealth EPBC Act (outlined in **Table 23** in **Appendix One** and/or Western Australian BC Act. In addition to these statutory listings, DBCA maintains a list of 'Priority' species (P1-P5) that are also of conservation interest, outlined in **Table 25** in **Appendix One**. It is a requirement of fauna survey for environmental impact assessment that potential for presence of these species, and for impact due to the proposed action, are investigated using all appropriate sources of information.

Migratory species are matters of Commonwealth environmental significance under the EPBC Act and also listed for special protection under the Western Australian BC Act. Recognised migratory species include any native species identified in an international agreement approved by the Minister and those listed under:

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

1.3.7 ENVIRONMENTALLY SENSITIVE AREAS

There are a number of areas around Western Australia identified as being of environmental significance within which the exemptions to the Native Vegetation Clearing Regulations do not apply. These are referred to as Environmentally Sensitive Areas (ESAs), and are declared under section 51B of the EP Act and described in the Environmental Protection (Environmentally Sensitive Areas) Notice (Government of Western Australia 2005).

1.3.8 CONSERVATION ESTATE

The National Reserve System (NRS) is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate and representative reserve system for Western Australia. Areas vested in the Conservation Estate are managed by the Conservation Commission.

2 EXISTING ENVIRONMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 CLIMATE

Broome has a semi-arid climate like most parts of the Australian tropics, it has two seasons: a dry season and a wet season. The dry season is from April to November with nearly every day clear and maximum temperatures around 30 °C. The wet season extends from December to March, with maximum temperatures of around 35 °C, rather erratic tropical downpours and high humidity. Broome's annual rainfall average is 615.1 mm, 75% of which falls from January to March (Bureau of Meteorology [BoM] 2017).

Broome is susceptible to tropical cyclones and these, along with the equally unpredictable nature of summer thunderstorms, play a large part in the erratic nature of the rainfall. For instance, in January 1922, Broome Post Office recorded just 2.8 mm of rainfall while in the same month of 1997, the airport received 910.8 mm (BoM 2017).

Figure 2 shows the mean monthly rainfall and temperature data for Broome Airport (BoM station 3003, active 1939-current) and monthly data for the period July 2016-June 2017 (BoM 2017). This data indicates that, during the monsoon (wet) season prior to the surveys (December 2016-March 2017), the area experienced a significantly wetter than average season, followed by a drier than average season immediately prior to the field survey, although the rainfall at this time of year is expected to be relatively low.

Table 1 below shows the temperature and rainfall experienced during the survey. The weather data was collated from the Broome Airport weather station which is approximately 42 km north-west of the study area (BoM 2017). The conditions during the fauna survey were warm with an average minimum temperature of 15.9 °C and an average maximum temperature of 31.6 °C. Rainfall was very minimal with 0.2 mm recorded on the 17th May 2017 (**Table 1**).

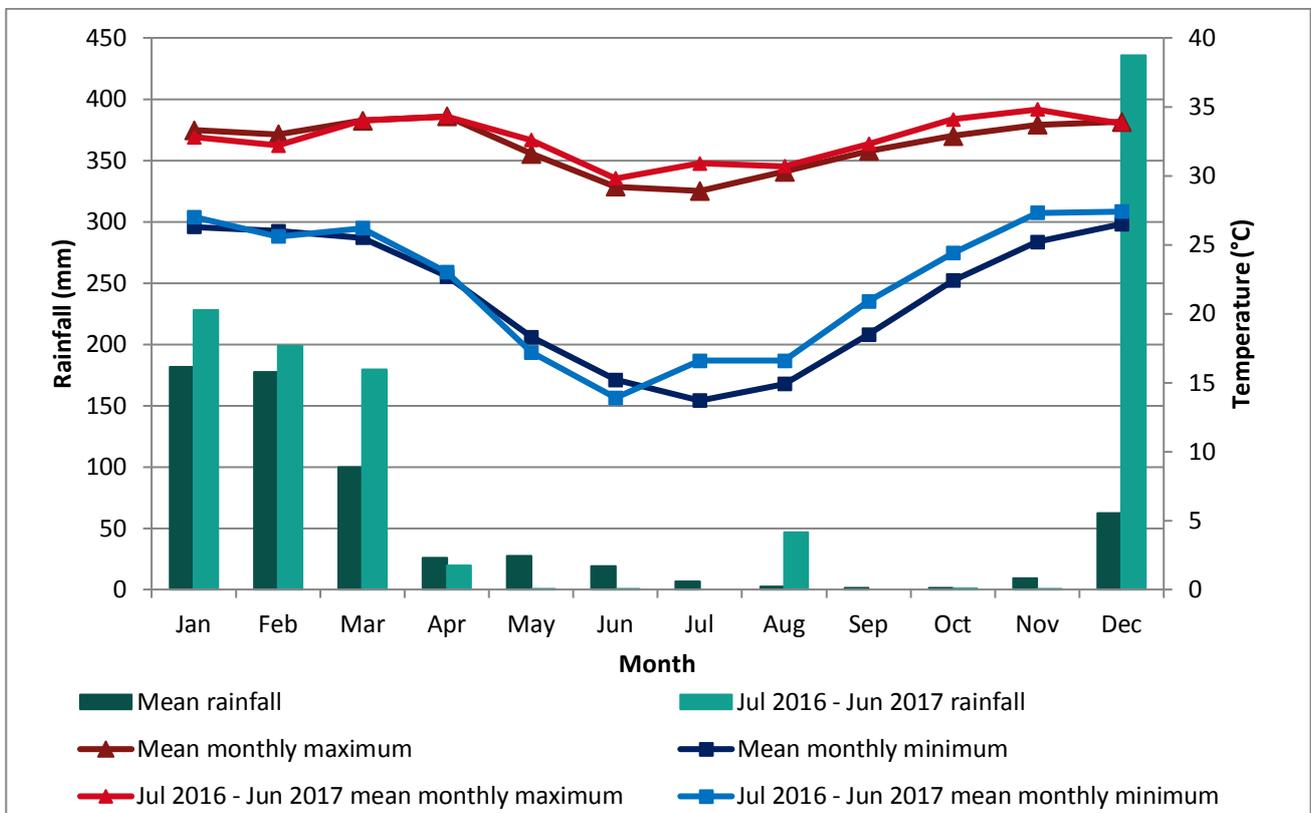


Figure 2: : Rainfall and temperature data, Broome Airport (BoM 2017)

Table 1: Weather experienced during the fauna survey

Survey date	Min Temp (°C)	Max Temp (°C)	Rainfall (mm)
10/05/017	16.4	32.7	0
11/05/17	17.9	32.6	0
12/05/17	14.6	33.4	0
13/05/17	15.0	32.9	0
14/05/17	13.5	30.1	0
15/05/17	15.0	31.1	0
16/05/17	16.3	30.4	0
17/05/17	17.7	31.1	0.2
18/05/17	17.2	30.4	0

2.1.2 LANDSYSTEMS

The study area lies entirely in the Yeeda land system (Department of Agriculture and Food Western Australia 2012b). It is dominated by red sandplains supporting pindan vegetation with dense Acacia shrubs, scattered bloodwood and grey box trees and curly spinifex and ribbon grass.

State land type: Sandplains and occasional dunes with shrubby spinifex grasslands or pindan woodlands

Geology: Quaternary Aeolian sands.

Geomorphology: Sandplain and Dunefields with little organised drainage; sandplain up to 16 km in extent, with shallow valleys, plains with thin sand cover, and scattered pans; limited surface drainage in zones of sheet-flow up to 3.2 km wide and extending up to 8 km downslope from adjacent uplands (Payne & Schoknecht 2011).

2.1.3 HYDROLOGY, WETLANDS AND RIVERS

An area of wetland listed in the Commonwealth Directory of Important Wetlands has been identified as occurring in proximity to the study area.

Several areas of wetland mapped as corresponding with the Roebuck Plains System (WA021) are located approximately 900 m to the north and north east of the study area (Government of Western Australia 2017a).

Map 1 shows the locations of these wetlands. This area is also known as an ANCA (Australian Nature Conservation Agency) Wetland in the pre-application desktop review conducted by DER (Government of Western Australia 2017a).

2.1.4 ENVIRONMENTALLY SENSITIVE AREAS

The study area does not correspond with any ESA.

Several areas mapped as ESA's are located approximately 900 m to the north and east of the study area; these are associated with the wetlands listed in the Directory of Important Wetlands discussed above.

Map 1 shows the locations of these ESAs.

2.1.5 FIRE AGE

The vegetation fire age on site was supplied by NBY as part of this project. The study area consists of areas burnt approximately 2 years ago, 3 to 4 years ago and some areas have not been burnt within the last 5 years. The areas and categories are shown in **Map 2**. The majority of the study area has an old fire age history of more than 5 years.

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 BIOGEOGRAPHIC REGION

Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna and are defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Department of the Environment and Energy 2016).

The study area is located in IBRA Region Dampierland (DAL), subregion Pindanland (DAL02). According to the *2002 Biodiversity Audit for Western Australia* (Graham 2002), the Pindanland subregion comprises sandplains of the Dampier Peninsular and western parts of Dampierland, including the hinterland of Eighty Mile Beach. It is a fine-textured sand-sheet with subdued dunes and includes the paleodelta of the Fitzroy River. The vegetation is described primarily as pindan. This is the coastal, semi-arid, north-western margin of the Canning Basin.

2.2.2 PRE-EUROPEAN VEGETATION

During the 1970s, John Beard and associates conducted a systematic survey of native vegetation, describing the vegetation systems in Western Australia at a scale of 1:250 000 in the south-west and at a scale of 1:1 000 000 in less developed areas. The *Vegetation Survey of Western Australia* maps and explanatory memoirs (1974-1981) are credited to J.S. Beard (or Beard with various co-authors).

Beard's vegetation maps attempted to depict the native vegetation as it was presumed to be at the time of settlement, and is known as the pre-European vegetation type and extent and has since been developed in digital form by Shepherd *et al.* (2002), and updated by DAFWA (2012a). This mapping indicates that the study area is associated with Beard Vegetation Association 699 described as; Shrublands, pindan; *Acacia eriopoda* shrubland with scattered low bloodwood (*Eucalyptus dicromophloia*) & *E. setosa* over soft & curly spinifex on sandplain.

The pre-European vegetation association identified from the study area (DAFWA 2012a) and its pre-European and current extents are listed in **Table 2** (Government of Western Australia 2016a).

According to The vegetation of Western Australia at the 1:3,000,000 scale. Explanatory memoir. (Beard *et al.* 2013), the study area occurs within Vegetation Type 22 *Pindan with low trees*, which covers over 4 million ha.

Table 2: Pre-European vegetation association representation (Government of Western Australia 2016a)

Region	Vegetation association	Original extent (ha)	Current extent (ha)	% Remaining
Western Australia	699	1,986,450.05	1,984,438.79	99.90
IBRA biogeographic region (Dampierland DAL)	699	1,976,313.51	1,974,958.06	99.93
IBRA biographic sub-region (Pindanland DAL02)	699	1,796,194.92	1,794,994.18	99.93
LGA (Shire of Broome)	699	1,628,642.72	1,626,791.54	99.89

2.2.3 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

A search was conducted of the DBCA ecological communities database (search reference 09-0717EC), for the study area and a surrounding 40 km radius buffer. No TECs or PECs were recorded within the study area. An area of Priority 3 PEC *Kimberley vegetation association 67* is mapped as occurring approximately 400 m to the north of the study area. An area of Priority 3 PEC *Kimberley vegetation association 73* is mapped as occurring approximately 3 km to the north of the study area. Results are shown in **Map 1**.

Table 3: Ecological communities database search results (TEC indicated by shading)

Community name	EPBC Act status	DBCA status
<i>Vine thickets on coastal sandunes of Dampier Peninsular</i>	EN	VU
<i>Species-rich faunal community of the intertidal mudflats of Roebuck Bay</i>	-	VU
<i>Relict dune system dominated by extensive stands of Minyjuru (Mangarr) Sersalisia (formerly Pouteria) sericea.</i>	-	P1 PEC
<i>Corymbia paractia dominated community on dunes</i>	-	P1 PEC
<i>Kimberley vegetation association 37 (Shrublands; teatree thicket)</i>	-	P3 PEC
<i>Kimberley vegetation association 67 (Grasslands, tall bunch grass savanna, sparse low tree; ribbon grass & paperbarks)</i>	-	P3 PEC
<i>Kimberley vegetation association 73 (Grasslands, short bunch grass savanna, grass; salt water grassland (<i>Sporobolus virginicus</i>))</i>	-	P3 PEC
<i>Roebuck land system</i>	-	P3 PEC

A search, using the Department of Environment and Energy's (DotEE) Protected Matters Search Tool (PMST), was also conducted (Australian Government & DotEE 2017) and identified no Commonwealth-listed TECs within the study area. One ecological community was identified as 'likely to occur' within 50 km of the study area: the Endangered *Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula* TEC. Given that this community is mainly restricted to white or grey sand on coastal Holocene dunes, although it also occurs occasionally on pindan soil but only in protected areas within 1-2 km of the coast (Threatened Species Scientific Committee 2013), it is highly unlikely to occur within the study area.

None of the above TECs or PECs were identified as occurring in any of the survey reports listed in **Section 2.4** below, except the one that specifically targeted such areas (i.e. V & C Semeniuk Research Group 2014).

2.2.4 CONSERVATION SIGNIFICANT SPECIES

2.2.4.1 Flora

A search of the Western Australian DBCA databases (search reference 30-0517FL) and the Commonwealth DotEE PMST was undertaken for State and Commonwealth listed TF and PF within a 50 km radius of the study area. The results are shown in **Map 1**.

The combined database searches identified 33 conservation significant vascular flora species from within the search radius, none of which had been previously recorded within the study area. Two are TF, nine are P1, two are P2, 19 are P3, and one is P4.

Regional flora and vegetation reports and the Department of Environment Regulation (Government of Western Australia 2017a) *Desktop Review of Yawuru's Application* were also reviewed for results that may not have yet been included in the database search results. This review resulted in three additional species being added to the database results (*Bonamia oblongifolia*, *Fuirena nudiflora* and *Goodenia crenata*, although the latter two are unverified as the nearest records listed on *NatureMap* (DPaW 2007-2017) are respectively approximately 680 km and 500 km distant from the study area.)

Table 29 lists all identified TF and PF vascular flora and their habitats, as well as their likelihood of occurrence. The likelihood of a species occurring in the study area is based on the following attributes listed on *FloraBase* (WAH 1998-2017; 2017a), tailored to local Kimberley populations. The attributes were:

- broad soil type usually associated with the species
- broad landform usually associated with the species
- usual vegetation (characteristic species) with which the species is usually associated
- species having previously been recorded from within approximately 40 km of the study area (considered as 'nearby').

The likelihood rating is assigned using the categories indicated in **Table 4**.

Table 4: Conservation significant flora likelihood of occurrence categories

Likelihood	Categories
Recorded	Recorded during the field survey or previously (i.e. identified during the database searches as occurring within the study area)
Possible	May occur within the study area (but was not recorded); broadly, 2-4 of the required attributes (but always including reliable, recent records from nearby) are present in the study area
Unlikely	Could occur but is not expected; 1-3 of the required attributes are present in the study area but: <ul style="list-style-type: none"> • it is not known from nearby, or • it is known from nearby but has no other required attributes, or • it is known from nearby but has at least one well-defined attribute that does not occur in the study area (e.g. it is associated with a specific landform or soil type that does not occur in the study area)
Highly unlikely	The species characteristics include none of the required attributes of soil, landform, associated vegetation and having previously been recorded nearby, or a critical element (often landform) is not within the study area and as such it almost certainly does not occur within the study area.

Table 29 in **Appendix Two** lists the 36 TF and PF vascular flora identified from the database searches and literature review, and their habitats, as well as their likelihood of occurrence. The species considered to have a possible likelihood of occurring in the study area were targeted for field survey.

No species have been previously recorded from within the study area. A further seven, *Bonamia oblongifolia* (P1), *Croton aridus* (P3), *Glycine pindanica* (P3), *Haemodorum capitatum* (P1), *Phyllanthus eremicus* (P3), *Tribulopsis marliesiae* (P3) and *Triodia caelestialis* (P3) have been identified as having a 'possible' occurrence, based on the assessment described above (Government of Western Australia 2017a).

2.2.4.2 Fauna

A review of databases and previous survey reports in the proximity of the study area was undertaken, including following sources:

- DBCA database search request (search reference 5470)
- Commonwealth Department of the Environment and Energy (DotEE) *EPBC Protected Matters* (Search Tool) database (Australian Government & DotEE 2017)
- *NatureMap* (DPaW 2007-2017)
- *Atlas of Living Australia* (ALA 2016).
- *WAM Crustacean database search* (search reference WAMDBC13)
- *WAM Mollusc database search* (search reference WAMDB_S015)
- *WAM Arachnid database search* (search reference WAMDBC13)

Details of each database search including custodian, date of search and coordinates are provided in the below **Table 5** below. Previous survey reports reviewed for relevant information are listed in **Section 2.4** below.

Table 5: Fauna database searches

Source	Custodian	Details/Distance to study area
Commonwealth <i>Protected Matters Search</i> (PMST)*	Department of the Environment and Energy (DotEE)	Date: 07 Jun 2017 Buffer 40 km Centre Point: -18.06376 122.65738
<i>Atlas of Living Australia</i>	National Research Infrastructure for Australia (NCRIS) & Global Biodiversity Information Facility (GBIF)	Date: 06 Jun 2017 Buffer: 40 km Centre point: -18.055166 122.658250
<i>NatureMap</i>	DBCA / WAM	Date: 19 Apr 2017 Buffer: 40 km Centre point: 122° 37' 35" E 18° 02' 11" S
<i>WAM crustacean</i>	WA Museum	Date: 19 Apr 2017 Search Area: Top left corner: -17.501219° 122.128198° Bottom right corner: -18.500046° 123.120000°
<i>WAM Molluscs</i>	WA Museum	Date: 19 Apr 2017 Search Area: Top left corner: -17.501219° 122.128198° Bottom right corner: -18.500046° 123.120000°
<i>WAM Arachnids</i>	WA Museum	Date: 19 Apr 2017 Search Area: Top left corner: -17.751576° 122.304795° Bottom right corner: -18.437007° 122.983874°

*Marine reptile and mammal species such as Turtles and Whales have been included

The likelihood of occurrence of the conservation significant fauna species identified by the database and literature searches as being known from nearby was assessed in a similar manner to flora, using the following criteria:

- suitability of habitats present within the study area
- distance between previous record of conservation significant species and the study area
- frequency and number of records in the region, and
- date of record of conservation significant species (recent or historical).

The sufficiency of information and behavioural and ecological characteristics, such as cryptic behaviours were also taken into account. Using the above criteria, the categories of likelihood of occurrence are shown in **Table 6**.

Table 6: Categories for likelihood of occurrence of conservation significant fauna

Likelihood	Categories
Recorded	Species recorded within the study area within a reasonable timeframe (0-5 years)
High	Species recorded in close proximity to the study area (<10 km) within the past 10 years; suitable habitat occurs within the study area
Medium	Species historically recorded in close proximity (<40 km) to the study area, more than 15 years ago; suitable habitat may exist within the study area
Low	Species not recorded in the proximity of the study area or rarely recorded within 40 km of the study area; suitable habitat unlikely to occur within the study area
Very Low	Species not recorded by multiple surveys/databases within 40 km of the study area or species is specialised to inhabit habitats that are not present inside the study area, however species or suitable habitat is listed as potentially occurring in the wider region.

Table 37 in **Appendix Five** lists the conservation significant fauna species identified by the database searches as having the potential to occur in the study area. Their conservation categories and likelihood of occurrence is based on the categories listed in **Table 6**. Exclusively marine and shore species were not included as the required habitat does not occur within the study area.

Definitions and criteria for conservation codes are presented in **Table 23** and **Table 24** in **Appendix One**. Of the 74 identified species of conservation significance that have a potential to occur, four species have a high likelihood to utilise the study area (highlighted in yellow in **Table 37**): Greater Bilby, Rainbow Bee-eater, Spectacled Hare-wallaby and Dampier Peninsula Goanna. Six species have a moderate likelihood to occur at least on an irregular basis (highlighted in green in **Table 37**) and the remaining 67 species have a low or very low likelihood of occurrence due to the lack of habitat on site. One species, the Burrowing Bettong, has been excluded from the assessment despite a historic record from 1895 from within 20 km of the study area (DBCA 2017) as this species is presumed extinct on the mainland and now only occurs on islands off the Western Australian coast (Van Dyck & Strahan 2008).

Marine bird species such as the Great Frigatebird or Wilson’s Storm-Petrel previously recorded along the coast within 80 km of the study area have been assessed as having a very low likelihood of occurrence due to the inland location of the study area. Waterbird species that are predominantly coastal but have also been recorded from the wetlands north of the study area have been assessed as having a low likelihood of occurrence at the study area. This is due to the elevated ground and the absence of any wetlands within the study area or the immediate surrounds. The species are not expected to occur at the study area and are likely to travel between the coast and these wetlands not passing over the study area.

The conservation significant fauna identified as most likely to occur in the study area and their habitats formed the basis of searches during the field survey.

2.2.5 INVERTEBRATE SRE FAUNA

The SRE status of taxa collected is based on categories developed by the Western Australian Museum (WAM) (**Table 7**). These categories are used by taxonomists and consultants to describe the SRE status of taxa collected from the study area. The classifications are based on knowledge of the taxa (species or genus), distribution (if known) and the representation of records in collections. Information gaps lead to classing taxa as potential SREs, a requirement under the precautionary principle.

Table 7: WAM SRE categories (2015)

	Taxonomic Certainty	Taxonomic Uncertainty
Distribution < 10 000km ²	<p>Confirmed SRE</p> <ul style="list-style-type: none"> • A known distribution of <10 000km². • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling 	<p>Potential/Likely SRE</p> <ul style="list-style-type: none"> • Patchy sampling has resulted in incomplete knowledge of the geographic distribution of the group. • We have incomplete taxonomic knowledge. • The group is not well represented in collections. • This category is most applicable to situations where there are gaps in our knowledge of the taxon. <p>Sub-categories for this SRE designation are outlined below</p>
Distribution > 10 000km ²	<p>Widespread (not an SRE)</p> <ul style="list-style-type: none"> • A known distribution of >10 000km². • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling. 	

2.2.5.1 SRE SUB-CATEGORIES

If a taxon is determined to be a “Potential SRE”, the following sub-categories will further elucidate this status.

A. Data Deficient:

- Insufficient data available to determine SRE status.
- Factors that fall under this category include:
 - o Lack of geographic information
 - o Lack of taxonomic information
 - o The group may be poorly represented in collections
 - o The individuals sampled (e.g. juveniles) may prevent identification to species level.

B. Habitat Indicators:

- Habitat data is indicative (surrogate) of SRE status
- Habitat is associated with SRE taxa (and vice versa)

C. Morphology Indicators:

- A suite of morphological characters are characteristic of SRE taxa
- Morphological characters are known to be associated with SRE taxa and vice versa

D. Molecular Evidence:

- Molecular work undertaken on this taxon (or a close relative) and it may reveal patterns congruent or incongruent with SRE status.

E. Research & Expertise:

- Previous research and/ or WAM expertise elucidates taxon SRE status
- Expert knowledge held within the WAM.

Table 8: SRE categories used

SRE category	Criteria	Typical representatives
Confirmed	Confirmed or almost certainly SRE; taxonomy of the group is well known (but not necessarily published); group well represented in collections, in particular from the region in question; high levels of endemism in documented species; inference is often possible from immature specimens.	<i>Antichiropus</i> millipedes (Paradoxosomatidae); scorpions in the genus <i>Aops</i> (Urodacidae)
Likely	Taxonomically poorly resolved group; unusual morphology for the group (i.e. some form of troglomorphism); often singleton in survey and few, if any, regional records.	Opiliones in the genus <i>Dampetrus</i> ; some pseudoscorpions (<i>Synsphyronus</i>) and slaters (Philosciidae); araneomorph spiders in the genus <i>Karaops</i> (Selenopidae)
Potential	Taxonomically poorly resolved group; often common in certain microhabitats in SRE surveys (i.e. litter dwellers), but no other regional records; congeners often widespread.	Many mygalomorph spiders; some centipedes (Cryptopidae; Geophilomorpha)
Widespread/Not SRE	Taxonomically well resolved (but often not published) and demonstrated wide distribution (i.e. > 10,000 km ²)	Many spiders (not mygalomorphs), centipedes or some scorpions (<i>Cercophonius sulcatus</i>)

All females and juveniles of species that cannot be identified to species level are required to be treated as 'potential SRE' under the precautionary principle. In addition, all likely, potential and unknown SREs should be treated as confirmed SREs under the precautionary principle (Section 4a of the Western Australian *Environmental Protection Act 1986* [EP Act])

2.3 ABORIGINAL HERITAGE

Aboriginal heritage sites are established and maintained under the *Aboriginal Heritage Act 1972* (1972). There are no Registered Aboriginal sites within the study area (Government of Western Australia & Department of Aboriginal Affairs 2016).

2.4 LITERATURE REVIEW

The following documents have been reviewed for relevance to this project (**Table 9**).

Table 9: Literature review

Author	Project	Type	Distance/ direction to study area
V & C Semeniuk Research Group (2014)	<i>Wetlands on the Roebuck Plains - Distribution, plant composition, ecological values and status</i>	Wetland survey	Adjacent (N)
Biota Environmental Sciences (2015)	<i>Roebuck Plains Station ESRM Plan - Draft</i>	Management plan	25 km (N)
Biota Environmental Sciences (2013a)	<i>Orange Flat Level 1 Vegetation, Flora and Fauna Assessment</i>	Level 1 flora and vegetation Level 1 fauna	35 km (E)
Outback Ecology (2014)	<i>Jackaroo Level 1 Flora, Vegetation and Vertebrate Fauna Survey</i>	Level 1 flora and vegetation Level 1 fauna	38 km (E)
Government of Western Australia & Department of State Development (2010)	<i>Request for Cultural Directions for Non-Ground Disturbing Activity for the LNG Precinct: James Price Point Access Road Flora and Fauna Study</i>	Level 2 flora and vegetation Fauna habitat survey	40 km (NW)
Biota Environmental Sciences (2013b)	<i>Ungani Pipeline, Access Track and Highway Depot Level 1 Vegetation, Flora and Fauna Assessment</i>	Level 1 flora and vegetation Level 1 fauna	45 km (E)
Biota Environmental Sciences (2013c)	<i>Ungani Study Area Flora and Fauna Assessment</i>	Level 1 flora and vegetation Level 1 fauna	45 km (E)
Ecologia Environment (2011)	<i>Woodside James Price Point: LIA, Worker's Association Camp and Southern Pipeline Terrestrial Vertebrate Fauna Assessment</i>	Level 2 fauna	70 km (NW)
Ecologia Environment (2012a)	<i>James Price Point: Light Industrial Area, Workers' Accommodation Camp and Southern Pipeline. Short Range Endemic Invertebrate Fauna Assessment for Woodside Energy Ltd.</i>	Level 2 SRE invertebrate fauna	70 km (NW)
Biota Environmental Sciences (2009b)	<i>James Price Point. Terrestrial Fauna Survey: Wet Season 2009</i>	Level 2 fauna Level 2 SRE	70 km (NW)
Biota Environmental Sciences (2009a)	<i>A vegetation and flora survey of James Price Point: wet season 2009</i>	Flora and vegetation (unspecified Level)	70 km (NW)
AECOM (2010)	<i>Supplementary Terrestrial Fauna and Habitat Assessment: James Price Point, WA</i>	Targeted fauna survey	75 km (NW)
Ecologia Environment (2016a)	<i>Thunderbird Haul Road & Accommodation Camp. Flora and Fauna Assessment</i>	Level 1 flora and vegetation Level 1 fauna	70 km (N)
Ecologia Environment (2016b)	<i>Thunderbird Project Terrestrial and Subterranean Fauna Assessment</i>	Level 2 fauna (terrestrial vertebrate and SRE) Level 2 subterranean fauna	75 km (N)
Ecologia Environment (2014b)	<i>Sheffield Resources Limited - Thunderbird Project Level 2 Flora and Vegetation Assessment</i>	Level 2 flora and vegetation	75 km (N)
Ecologia Environment (2014c)	<i>Sheffield Resources Ltd Thunderbird Project Terrestrial and Subterranean Fauna Assessment</i>	Level 2 fauna (terrestrial vertebrate and SRE) Level 2 subterranean fauna	75 km (N)
Ecologia Environment (2014d)	<i>Thunderbird Project Short Range Endemic Invertebrate Targeted Survey</i>	Targeted SRE survey	75 km (N)

Author	Project	Type	Distance/ direction to study area
Ecologia Environment (2012b)	<i>Thunderbird Dampier Peninsula Project Level 1 Flora and Fauna Assessment</i>	Level 1 flora and vegetation Level 1 fauna	75 km (N)
Buru Energy Limited (2013) (quoted in Outback Ecology 2014)	<i>Yakka Munga 1: Landscape and Level 1 Flora, Vegetation and Fauna Survey Report</i>	Level 1 flora and vegetation Level 1 fauna	80 km (E)
Astron Environmental Services (2013) (quoted in Outback Ecology 2014)	<i>Frome Rocks Level 1 Flora and Fauna Survey</i>	Level 1 flora and vegetation Level 1 fauna	98 km (E)
Ecologia Environment (2005a)	<i>Beagle Bay Big Tree Country Project Fauna Assessment Survey</i>	Level 1 fauna	110 km
Ecologia Environment (2005b)	<i>Tropical Timber Plantations Beagle Bay Project. Public Environmental Review Submissions Responses</i>	PER submissions responses	112 km (N)
EPA (2005)	<i>Tropical Timber Plantation Beagle Bay, Tropical Timber Plantations Pty Ltd. Report and recommendations of the Environmental Protection Authority. Bulletin 1200.</i>	EPA report and recommendations	112 km (N)
Bennelongia Environmental Consultants (2011)	<i>Desktop Assessment of Short Range Endemic Fauna in the Duchess Paradise Study Area</i>	SRE desktop	110 km (E)
Western Wildlife (2011)	<i>Rey Resources Duchess Paradise Study Area, West Kimberley: Baseline Fauna Surveys Oct 2009, Apr 2010, Oct 2010 & Jun 2011</i>	Level 2 fauna survey	140 km (E)
GHD (2006)	<i>Derby Highway Reconstruction Environmental Impact Assessment and Management Plan</i>	Desktop and basic flora, vegetation and fauna field surveys	128 km (NE)

Note: unless otherwise specified, fauna surveys refer to terrestrial vertebrate surveys and flora and vegetation surveys refer to terrestrial vascular flora and vegetation surveys.

3 METHODS

3.1 FLORA AND VEGETATION FIELD SURVEY

The assessment was conducted as a detailed flora and vegetation survey, incorporating desktop study and targeted survey, as described in the *Flora and Vegetation Technical Guidance* (EPA 2016e). The combination of desktop, detailed and targeted field surveys is considered to represent the equivalent of a Level 2 flora and vegetation survey, according to the superseded *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessments in Western Australia* (EPA 2004).

According to the *Flora and Vegetation Technical Guidance*:

- the purpose of the desktop study (referred to as 'Existing Environment' in this report) is to gather contextual information on the study area. It should incorporate literature reviews (including previous surveys), database searches and spatial information. One of the aims of the desktop study is to identify flora and vegetation of conservation and other significance (and associated habitat) that may occur in the study area.
- the purpose of the detailed survey (i.e. the field survey component) is to provide adequate local and regional context relative to the values of flora and vegetation of the survey and adequately address the EPA's objectives. The survey requires comprehensive survey design, including optimal survey timing, and may require multiple sampling events. Multiple quadrats are required throughout each preliminary vegetation type, with three quadrats recorded from each vegetation type. Field survey techniques can include a combination of quadrats, relevés (although not as a primary sampling technique), transects, traverses and opportunistic surveys.
- the purpose of the targeted survey component is to gather comprehensive information on significant flora and/or vegetation, and includes generally systematic searches of all potentially suitable habitat.

3.1.1 FIELD SURVEY

The flora and vegetation field survey was conducted over a single phase by Christopher Parker (flora collecting permit SW018606), with assistance from Michael Wysong and others, sporadically between 27 April and 12 May 2017, over approximately five days of intensive survey, and additional time for conservation significant flora searches during traverses during the fauna survey (an additional four days).

The *Flora and Vegetation Technical Guidance* indicates that the optimal period for survey in the northern botanical province is during the wet season (January-March), with supplementary survey post wet season. This survey corresponds with the supplementary survey period. The first day of survey was 30 days after the last significant rainfall, although there had been two days with some rainfall approximately one week earlier.

3.1.1.1 Floristic Quadrats

Floristic quadrat ('quadrat') locations were selected using aerial photography, environmental values and field observations to represent the vegetation values existing at the site. The quadrats sampled were 50 m x 50 m in size.

The following information was collected from within each quadrat sampled:

- observer
- date
- quadrat/site number
- GPS location (GDA94 datum)
- digital photograph (spatially referenced with a reference number)
- soil type and colour
- topography
- list of flora species recorded with the average height and the total cover within the quadrat for each species
- vegetation community

- vegetation condition.

Where there was sufficient representation, three quadrats were recorded from each vegetation type as identified during the field survey.

3.1.1.2 Conservation Significant Flora Search

Due to the lack of variation in flora habitat and large extent of the study area, no grid searches were conducted for conservation significant flora. Significant portions of the study area were traversed between recording quadrats, and during targeted fauna transect walks.

3.1.1.3 Range Extensions

Taxa recorded during the current survey that are outside of their known distribution were identified as range extensions. Known taxa records (WAH 1998-2017) were used as a guide to determine if each taxon recorded in the study area was representative of a range extension (in this case defined as greater than 100 km from nearest record) or outlier population.

3.1.1.4 Introduced Species

Declared Pest plants (listed under the BAM Act) were searched in DAFWA's website (2017) for the local government areas that the study area is located within to determine if any of the recorded species are listed as Declared Pest plants.

3.1.1.5 Vegetation Description and Classification

Vegetation was described from each of the quadrats using the height and estimated cover of dominant and characteristic species of each stratum based on the National Vegetation Information System (NVIS, ESCAVI 2003), recorded at Level V. Up to three species per stratum from each stratum (upper, mid and ground) were used to formulate vegetation descriptions for each quadrat and each vegetation type.

Vegetation type descriptions were created by combining quadrat descriptions and modifying them, where necessary, based on the wider vegetation. Vegetation codes were formulated using the dominant species of the tallest stratum and the vegetation structure (e.g. **BdLOW** refers to *Brachychiton diversifolius* subsp. *diversifolius* low open woodland), as per NVIS structure and height terminology (**Table 26** and **Table 27** in **Appendix One**).

3.1.1.6 Vegetation Condition and Mapping

Vegetation condition was assessed continuously throughout the study area and at each quadrat using the Vegetation Condition Scale for the Eremaean and Northern Botanical Provinces (EPA 2016e), shown in **Table 28** in **Appendix One**.

The spatial extent of the varying vegetation condition was mapped using GIS and vegetation condition maps are provided in this report.

3.1.2 STATISTICAL ANALYSIS

PATN© software (Belbin & Collins 2006) was used to undertake statistical analysis to generate floristic groups using the data collected from the floristic quadrats, in order to better understand local significance of floristic units. PATN analysis has been used for several local floristic analyses including Gibson *et al.* (1994) for the Swan Coastal Plain.

PATN is a multivariate analysis tool that generates estimates of association (resemblance, affinity, distance) between sets of objects described by a suite of variables (attributes), and classifies the objects into groups and condenses the information and displays the patterns in the data graphically.

PATN offers a choice of data transformations prior to multivariate analysis.

Floristic groups, identified using a dendrogram output of the analysis, are used as a tool to inform vegetation type groups at various levels and scales. Floristic quadrat data is used for the analysis.

For this analysis, Two-step association are used. This was followed by Flexible UPMGA (Un-weighted Pair Group Using Arithmetic Averaging) fusion to produce clusters of related objects (species); these are the floristic groups that are displayed as a dendrogram.

Interpretation of these purely floristic groups into recognisable and mappable on-ground units is a tool used to identify vegetation types. Generally, quadrats that are closely floristically related on the dendrogram form identifiable vegetation units, however, as presence-absence data is usually used in the analysis and there is no weighting given to dominant species, at times the floristic groups are not easily related to on-ground vegetation types. Vegetation types are therefore determined as a combination of floristic analysis and on-ground interpretation using dominant and characteristic species.

No regional data, except from nearby quadrats, were available for a more wide-spread (regional) analysis.

3.1.3 ADEQUACY OF SAMPLING

In order to demonstrate adequacy of sampling, a Species Accumulation Curve (SAC) was generated by the computer programme Species Diversity and Richness (Pisces Conservation Ltd 2010) using five random selections of sample order, and using only quadrat data.

A taxa by area plot was also created using floristic quadrat data for the study area and nearby. This plot gives an indication of relative species richness, and can also provide an indication of survey adequacy.

Adequacy of sampling is also assessed in terms of representation of various attributes, including vegetation types and representation of land systems.

3.1.4 BOTANICAL LIMITATIONS

Survey design: The survey was based on assessing floristic quadrats across vegetation types. Due to the low variability in habitat across the site, conservation significant flora searches were conducted during site traverses.

Survey type: The survey was conducted as a detailed flora and vegetation survey, with desktop assessment and broad-scale targeted conservation significant flora searches conducted during site traverses and along fauna transects. A detailed survey is required due to the scale of impact anticipated by the proposed works.

Type of vegetation classification system: National Vegetation Information System (NVIS, ESCAVI 2003), recorded at Level V (association) as this is the usual and recommended system.

Table 10: Botanical limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Availability of contextual information at a regional and local scale	No	A reasonable number of reports from the same IBRA subregion were available for contextual information.
Competency/experience of the team conducting the survey, including experience in the bioregion surveyed	No	Christopher Parker has been conducting flora and vegetation surveys in Western Australia, including the Kimberley region, for over five years.
Proportion of the flora recorded and/or collected, and any identification issues	Negligible	Only two <i>Acacia</i> species (<2% of total flora species) were unable to be identified due to lack of reproductive material. A species accumulation curve identified that 96% of anticipated species were recorded during the field survey.
Was the appropriate area fully surveyed (effort and extent)	No	The study area was surveyed adequately; the effort and extent of the survey was sufficient to describe the flora and vegetation of the area. The study area was extensively traversed on foot during floristic surveys, with additional opportunistic observations and targeted searches for conservation significant flora conducted during fauna transect surveys.
Access restrictions within the survey area	No	The area was accessible via tracks and by walking.
Survey timing, rainfall, season of survey	Negligible	The survey was conducted during the period considered suitable for supplementary survey (i.e. was not within the optimal period). Despite this, there was only a negligible constraint in relation to flora species' presence or their ability to be identified due to the above average rainfall in the season preceding the survey and supplementary rainfall before the field survey.
Disturbance that may have affected the results of the survey e.g. fire, flood, clearing	Negligible	There was no disturbance that may have affected the results of the survey. Cattle grazing and fire are usual factors in the Kimberley and are not considered to have had any greater impact in the study area as elsewhere. The fire age varied from two years previously to greater than five years.

3.2 FAUNA FIELD SURVEY

Prior to the development of field survey methods, a review was undertaken of factors likely to influence survey design and intensity. Based on this review, it was deemed necessary for a Level 2 vertebrate fauna assessment to be conducted within the study area.

Table 11: Factors likely to influence survey design

Factor	Relevance
Bioregion – level of existing survey/knowledge of the region and associated ability to predict accurately.	The Dampierland region has been surveyed extensively in recent years. However, due to the restriction of preferred survey timing (wet season) the majority of surveys was undertaken as Level 1 assessments. A Level 2 survey is recommended to accurately assess the fauna assemblage present on site.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The landforms associated with the study area consist of an elevated sandplain bordered by a wetland and low laying floodplain to the north-west and extensive elevated sandplains to the east and south. The sandplains near Broome are known to support Greater Bilby populations and recently Spectacled Hare-wallaby populations.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present.	The survey area is associated with an arid climate. Fauna populations generally peak during and after significant rainfall (wet season), with activity linked to warmer humid conditions.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	A total of eight Level 1 and six Level 2 surveys in addition to one targeted SRE surveys have been undertaken within 80 km of the study area. The fauna assemblage around Broome (40 km north-west of the study area) is well documented.
Number of different habitats or degree of similarity between habitats within a study area.	One to two habitat types have been identified based on aerial photography, land systems and vegetation units.
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods).	The Dampierland region experiences a hot climate during the wet season (December to March) with heavy cyclonic rain events, followed by warm, dry winters with little rainfall throughout the majority of the year (April to November). Rainfall was adequate during the wet season 2016/2017 and conditions are favourable for animal activity during and immediately after the wet season.
Sensitivity of the environment to the proposed activities.	The study area contains habitat types that are well represented and typical in the surrounding region.
Size, shape and location of the proposed activities.	The study area is 970 ha and of compact shape (polygon), and is located in the Dampierland region, approximately 44 km south-east of Broome. The actual proposed area to be cleared totals 300 ha.
Scale and impact of the proposal.	The proposed impact area is focused on vegetation clearing for pivot infrastructure covering approximately 300 ha. It is expected that only one third of the study area will be cleared.

3.2.1 SURVEY TIMING

The fauna field survey was conducted from 10th to 18th May 2017, immediately after the wet season which is in accordance with the Technical Guideline (EPA & DEC 2010). The Technical Guideline recommends that vertebrate fauna surveys are to be undertaken during or immediately after the wet season when temperatures are warm to ensure high vertebrate fauna activity. The climate experienced during the fauna survey was warm and favourable for animal activity (**Section 2.1.1**).

3.2.2 SURVEY TECHNIQUES

A Level 2 fauna survey was conducted incorporating a number of survey techniques, including a systematic trapping program as well as opportunistic searches. Systematic survey methods can be utilised for statistical analysis, whereas opportunistic searches can be completed in areas not suitable for the set-up of trap sites (e.g. less accessible, areas likely to be flooded, substrate unsuitable for digging). All survey methods used on site are detailed below.

Systematic Vertebrate Fauna Survey Methods

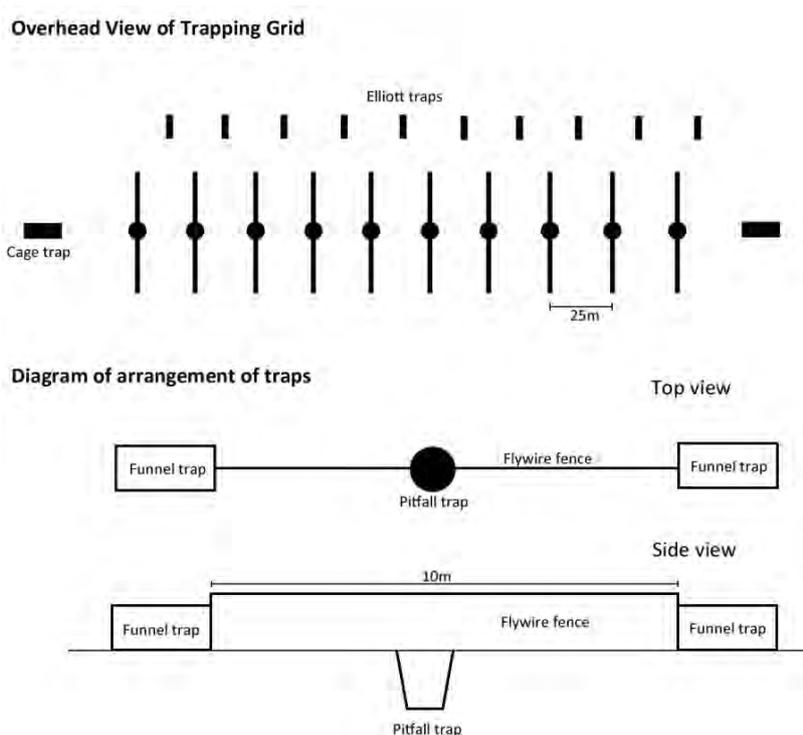
Ecoscape utilised a standardised survey method allowing direct comparison of survey results with some of the surveys conducted in the area. The Level 2 survey method includes a detailed examination of the local fauna using a suite of trapping techniques. The traps used in the Level 2 survey include:

- **20 L bucket and 50 cm PVC pipe traps:** these are dug into the ground and act as pitfall traps. A 10 m long, 30cm high fence is passed across the top of the pit to direct fauna into it. A trapping grid comprises 10 of these traps.
- **Fraser-type funnel traps:** these are placed at the ends of each fence to capture fauna that do not readily fall into pit traps (20 per trapping grid). All funnel traps are covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- **Elliott traps:** aluminium box traps baited with 'universal bait' to attract and capture smaller mammals (10 per trapping grid) and re-baited daily. All Elliott traps are covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- **Cage traps:** larger wire-frame box traps, also baited with 'universal bait', to capture medium-sized mammals (2 per trapping grid). All Cage traps are covered by Hessian shades to reduce the likelihood of animals suffering from overheating.

Trapping grids are set up in each major fauna habitat, as applicable with each trapping grid surveyed over a seven night period (as per guidelines).

Systematic SRE Invertebrate Fauna Survey Methods

- **Dry Pitfall Trapping:** The Pitfall traps and Funnel traps used in the vertebrate fauna trapping grids are also highly effective at collecting SRE invertebrate fauna. Each trap is open for seven nights and results in 210 trap nights per site
- **Leaf Litter Collection:** At each site, three quadrats (3m²) of leaf litter are collected and separately placed into a leaf-litter reducer. The contents from each collection is then placed into a paper bag inside a zip-lock bag and kept separate. A small amount of wet tissue paper is placed into each sample to maintain humidity. Samples are then transported back to Perth in a cool, dark container where they were placed on Tullgren funnels to extract any specimens.



Opportunistic Vertebrate Fauna Survey Methods

Trapping surveys typically only target small to medium terrestrial species. Ecoscape compliments the systematic surveys with a suite of non-systematic sampling that target specific species and habitats not normally covered by standard trapping. These active survey techniques are listed below:

- **Reptiles, Amphibians and SRE invertebrates:** Minimum 30 minute surveys of 1 ha areas within the study area by an experienced zoologist. Microhabitats favoured by reptiles, amphibians and SRE invertebrates will be searched. Survey techniques include raking of leaf litter and soil under shrubs, searching in rock piles and searching under and inside fallen timber. Nocturnal species searches will also be performed (if safe access is available) using spotlights and recordings of frog calls if present.
- **Birds:** Minimum of 30 minute surveys within the study area by an experienced ornithologist during optimal periods of the day (early morning and late afternoon) as per Birdlife Australia standard methodology. All bird species opportunistically observed inside the study area will also be recorded and nocturnal species searches performed (if safe access is available).
- **Mammals:** Mammals observed during the above surveys and opportunistically were recorded. Tracks, scats and other traces of mammals are recorded and identified where possible. Bats are recorded using SM2BAT acoustic equipment and identified by call analysis. SM2BAT recorders were installed at each systematic trap site and in addition at a number of other sites likely to be used by bats (e.g. flyways between trees or rocky outcrops).
- **Remote Sensing:** Motion sensitive cameras capable of recording both normal (day) and infra-red (night) images were set up in areas of interest, in particular near animal tracks, walkways and signs of species of interest (e.g. Spectacled Hare-wallaby).
- **Targeted Fauna Searches:** Rare or otherwise significant fauna species potentially occurring in the area (based on database searches) were opportunistically targeted during the survey. Targeted searches for conservation significant fauna species were conducted in suitable habitat across the study area.

Targeted survey methods

A targeted survey for the Greater Bilby and Spectacled Hare-wallaby was conducted. Methods followed the recommendations of the *Guidelines for Australia's threatened mammals* (DSEWPaC 2011a).

Greater Bilby

Methods used during the targeted survey to target the Greater Bilby included searches on foot for secondary evidence and the installation of motion cameras. Searches on foot were predominantly in consistency with the Greater Bilby verification methods using 2 hectare plots (Southgate *et al.* 2017). A 2 ha area was searched by four to five people walking in parallel lines (10-12 m apart). Evidence of fauna such as diffing, tracks, scats and burrows were recorded. Other areas were walked in parallel lines using two to five people to search for any evidence of the Greater Bilby. Motion cameras were used where there was any potential signs were recorded. If the species has been confirmed as present additional survey techniques may be deployed:

- nocturnal spotlighting surveys
- cage trapping using universal bait
- methodical scat collection in accordance with the DBCA procedure

Spectacled Hare-wallaby

Methods used for the Spectacle Hare-wallaby were based on the methods tailored for the Barrow Island Spectacled Hare-wallaby as outlined in the *Guidelines for Australia's threatened mammals* (DSEWPaC 2011a). Targeted search effort for the Spectacled Hare-wallaby included daytime searches for secondary evidence targeting areas of suitable habitat but also covering the majority of the study area. The species was also targeted during the 2 hectare plots conducted as part of the Bilby searches (Southgate *et al.* 2017). When suitable habitat was identified an intensified search was conducted with 2-5 people and the area was searched, looking for scats, tracks or shelters under grass. When signs of the species are identified motion cameras were installed and baited (peanut butter, oats, sardines and honey).

3.2.3 SPECIMEN SORTING AND IDENTIFICATION

All vertebrate fauna specimens were identified in the field and released at the location of capture. Invertebrate samples collected in pitfall traps were drained and sorted in collaboration with Bennelongia Environmental Consultants (Bennelongia) and separated into taxonomic groups. All samples were identified by Bennelongia taxonomists (**Appendix One**).

3.2.4 SITE SELECTION

Sites were established on the basis of the desktop assessment including the review of existing information such as land systems, vegetation communities, landforms, literature collected from the desktop review and the fauna habitats identified within the study area. This information was ground-truthed during the field survey. Sites were set-up so that the number of trap sites was proportional to the extent of fauna habitats within the study area.

A total of four systematic vertebrate fauna trap sites were established across the single land system unit and two habitat units. These trap sites were also utilised as dry pitfall sites for SRE invertebrate fauna. Invertebrate fauna was also targeted during foraging searches across the study area. In addition to trapping, bat recorders were set at all four systematic sites, motion cameras were installed at eight locations to target threatened species, leaf litter was collected from the four systematic trap sites and additional bird surveys were undertaken during transects across the study area. Details and locations of each site location are presented in **Appendix Four** and shown on **Map 4**.

3.2.5 SURVEY EFFORT

The survey effort completed was as follows:

- a total of four systematic trap sites were installed for seven consecutive nights resulting 1,176 trap nights of surveying
- a total of four systematic avian sites were surveyed for bird species totalling eight hours of birding plus 8.5 hours of opportunistic observations
- a total of 10 sites across the study area were searched for vertebrate and invertebrate fauna resulting in 44 hours of search time
- a total of 44 hours were spent searching for signs of Greater Bilby and Spectacled Hare-wallabies
- motion cameras were installed at eight sites for 23 days resulting in 276 hours of recording
- SM2 Bat recorders were set-up at a total of four sites for a total of 72 hours of recording
- vertebrate fauna trap sites were also utilised as invertebrate fauna dry pitfalls and funnel trapping resulting in 840 trap nights of trapping
- Three leaf litter samples were collected from four locations resulting in 12 samples.

Details of the survey effort are shown in **Table 12**.

Table 12: Survey effort

Trap Site	Pitfalls (nights)	Funnels (nights)	Cages (nights)	Elliot (nights)	Birding (min)	Searches (person hrs)	Motion cameras (days)	Bat analysis (hrs)	SRE dry pitfall (nights)	SRE funnel (nights)	Leaf litter collections (NO.)
NBY S1	70	140	14	70	120	6		24	70	140	3
NBY S2	70	140	14	70	120	-	2	24	70	140	3
NBY S3	70	140	14	70	120	-		12	70	140	3
NBY S4	70	140	14	70	120	4		12	70	140	3
Opportunistic	-	-	-	-	510	33	21				
Total	280	560	56	280	990	44	23	72	280	560	12

3.2.6 TAXONOMY AND NOMENCLATURE

Nomenclature for all terrestrial vertebrate fauna follows the *Western Australian Museum Checklist of the Vertebrates of Western Australia* as well as Christidis and Boles (Christidis & Boles 2008). Literature used for the identification of fauna (including electronic versions) is listed in **Table 13**.

Table 13: Literature used for identification of vertebrate fauna species

Trap site	Type
Mammals	Menkhorst & Knight (2011), Van Dyck & Strahan (2008)
Bats	Churchill (1998), Menkhorst & Knight (2011)
Birds	Simpson and Day (2004), Morcombe (2012)
Reptiles	Cogger (2000), Storr <i>et al.</i> (1983; 1990; 1999; 2002) Wilson & Swan (2013), Macdonald (2013), recent publications and updates
Amphibians	Tyler & Doughty(2011), Cogger (2000)

3.2.7 FAUNA HABITAT ASSESSMENT AND MAPPING

The fauna habitats present within the study area were identified and mapped during the survey. Fauna habitats were described as an area which is distinguishable from its surrounding area by its land form, vegetation and fauna assemblage occupying the area. In addition, the likelihood to harbour specialised fauna species which are not found in adjacent areas was taken into consideration.

For the identification and mapping of all existing fauna habitats within the study area following information was utilised:

- Land systems (Wilcox & McKinnon 1972)
- Vegetation type and condition mapping (Government of Western Australia 2016b), other previous surveys)
- Aerial imagery
- Landforms
- Soil characteristic
- Fauna assemblage.

The composition and characteristics of each fauna habitat were recorded and their extent mapped using ArcGIS v10.4.

3.2.8 DATA ANALYSIS

3.2.8.1 Habitat Analysis

The similarity and degree of differences between habitat types was identified by interpreting the fauna groups and sorting them into recognisable and mappable on-ground units. As presence-absence data is usually used in the analysis and there is no weighting given to dominant species, the habitat types may not correlate to on-ground observations of habitat types. Fauna habitats are therefore determined as a combination of fauna data analysis and on-ground interpretation using the methods discussed in **Section 3.2.2**

To assess patterns in overall species composition among trapping sites, and to evaluate these patterns in relation to habitat type, an analyses was performed using PATN: hierarchical cluster analysis.

Hierarchical Cluster Analysis

For these analyses, bird species and terrestrial trappable fauna (non-volant mammals, reptiles and amphibians) were assessed separately. For the purposes of this analysis, species were treated as either present or absent within each site. A distance matrix was calculated from the site by species matrix using the Bray-Curtis similarity coefficient for binary data, which is widely used for estimating ecological distances. A dendrogram was constructed from the distance matrix using UPGMA (Unweighted Pair Group Method with Arithmetic Mean), where sites with more similar species composition cluster more closely together.

3.2.9 SURVEY ADEQUACY

In order to determine adequacy of sampling, a Species Accumulation Curve (SAC) was generated by the computer programme Estimate. Five random selections of sample order data from systematic trapping sites were utilised. For geographical illustration, a diagram was created which accumulates the occurrence of each species each time a new individual is recorded. In addition, a number of species richness estimators were provided in order to estimate a realistic maximum number of species potentially recorded within the study area. These estimators were then compared with the number of species trapped and observed during the survey. This indicates the survey adequacy of each of the utilised methods.

3.2.10 ANIMAL ETHICS

Ecoscape's surveying methodology conforms with the Australian code of practice for the care and use of animals for scientific purposes (National Health and Medical Research Council 2013). All survey staff were experienced with conducting fauna surveys using the described methods, or supervised by experienced staff. In all cases, vertebrate fauna individuals were identified in the field and released at the point of capture.

Invertebrate fauna were kept cool after collection and then euthanised and stored in chilled 100% Ethanol.

3.2.11 SURVEY TEAM AND FAUNA LICENCE

The fauna team consisted of one Ecoscape zoologist and one NBY botanist. The team was assisted by Country Managers that were familiar with the study area. The fauna survey was undertaken under the Regulation 17 licence number 08-000631-1 issued by the Department of Parks and Wildlife, specifically for this project. Survey staff included the personnel shown in **Table 14**.

Table 14: Survey staff

Survey Member	Affiliation
Astrid Heidrich (MSc Biol.)	Ecoscape Australia
Chris Parker (B.AQ. Sc., B.Sc.)	Nyamba Buru Yawuru
Michael Wysong (MSc. Bot., PhD Zool.)	Nyamba Buru Yawuru
Johani Mamid (Cert II Cons. & Land Man.)	Yawuru Country Manager
Pius Gregory (Cert II Cons. & Land Man.)	Yawuru Country Manager
Jacob Smith (Cert II Cons. & Land Man.)	Yawuru Country Manager
Edwardo Maher (Cert II Cons. & Land Man.)	Yawuru Country Manager
Vaughn Lee (Cert II Cons. & Land Man.)	Yawuru Country Manager

4 RESULTS

4.1 FLORA AND VEGETATION

4.1.1 FLORA

A total of 13 floristic quadrats were recorded during the field survey; three of these were outside the study area boundary and are considered to be regional quadrats, used to confirm that vegetation within the study area was not confined to it.

4.1.1.1 Flora Inventory

A flora inventory was collated by combining species recorded in the quadrats and from opportunistic observations.

A total of 117 vascular flora species from 81 genera and 33 families were recorded from within the study area. One of these (*Stylosanthes hamata*) was introduced. Two taxa (1.7%) of the taxa recorded could not be identified to species level because of insufficient (sterile) material. The full list of vascular flora inventory, presented as a site by species table, is shown in **Table 30** in **Appendix Two**.

The families with the highest number of taxa were Fabaceae with 28 taxa (one introduced), Poaceae (18 taxa), Malvaceae (12 taxa), Boraginaceae and Cyperaceae (five taxa each). The most commonly recorded genera were *Acacia* (six taxa), *Aristida*, *Crotalaria*, *Eriachne*, *Fimbristylis*, *Heliotropium*, *Indigofera*, *Portulaca*, *Ptilotus*, *Sida*, *Solanum* and *Tephrosia* (three taxa each).

Vascular flora species were recorded from 13 floristic quadrats located within the study and regional areas and opportunistic observations. Floristic quadrat details are included in **Appendix Three**.

4.1.1.2 Flora of Conservation Significance

No Threatened EPBC Act, BC Act flora taxa were recorded in the study area.

One Priority 3-listed taxa, *Triodia caelestialis*, was recorded. *Triodia caelestialis* (**Plate 1**) is a hummock grass known from 19 records within the Dampierland, Central Kimberley and Northern Kimberley Bioregions of Western Australia (*NatureMap*, DPaW 2007-2017). Of the 24 records listed on *FloraBase* (1998-2017), two (from the same survey in 2012, presumably 'Thunderbird', 70 km west of Derby) list the plant frequency as '40 plants', one (2007, from Point Torment, 35 km north of Derby) provides a cover estimate of 3%, one (locality data as previous) provides a cover of 0.4%, one from Kalumburu Road (1995) describes the frequency as 'locally common', two 1992 collections from James Price Point and Alistairs Bore (approximately 25 km from the study area) and another from Ellendale in 1990 describe the frequency as 'common'.

This species was recorded from 12 of the 13 quadrats where it was typically a characteristic species, although not always dominant, of the ground stratum in quadrats and overall study area. It was also a characteristic and dominant ground stratum species in several vegetation types in the Thunderbird (Ecologia 2012b; 2014b; 2016b) area, approximately 75 km northwest of the study area.



Plate 1: *Triodia caelestialis* (Ecologia 2014b)

4.1.1.3 Flora of Significance According to the Flora and Vegetation Technical Guidance

No flora with range extensions over 100 km from their nearest historical occurrence (assessed using *NatureMap*, DPaW 2007-2017) were recorded.

No flora species were of significance according to the criteria outlined in the *Flora and Vegetation Technical Guidance* (EPA 2016e).

4.1.1.4 Introduced Flora

One flora species was introduced; **Stylosanthes hamata* (Verano Stylo) (**Plate 2** and **Plate 3**). This species is not listed as a Declared Pest plant and is not a WONS species and was also observed along road verges and fence lines that cattle use as thoroughfares.



Plate 2: **Stylosanthes hamata*



Plate 3: **Stylosanthes hamata*

4.1.2 VEGETATION

4.1.2.1 Vegetation Types

Three native vegetation types were recorded from within the study area (**Table 15**). Their locations and extents are shown on **Map 3**. Of the three mapped vegetation types BdCzLOW was the most widespread accounting for approximately 77% of the study area (740.15 ha), followed by CzCgBcLW at 15% (142.44 ha) occurring within north-western and western areas, and lastly BdBcLOW with the remaining 8% (78.08 ha) within the western and south-western portions of the study area.

These vegetation types were formulated by a combination of floristic analysis and field mapping using dominant and characteristic species and vegetation structure (see **Section 4.1.2.2**). Despite vegetation types generally being described in terms of the upper stratum (in this case, as woodlands), the mid stratum is dominant (based on biomass and structural appearance), and the vegetation should be considered to represent a shrubland.

Table 15: Vegetation types of the study area (bold font indicates regional quadrats)

Mapping Unit	Vegetation Community	Floristic Quadrats	Representative Photograph	Characteristic Species	Area (ha) and Extent (%) of Study Area
BdCzLOW	<p><i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i> and <i>Corymbia zygophylla</i> low open woodland over <i>Acacia eriopoda</i> tall open shrubland over <i>Chrysopogon fallax</i>, <i>Sorghum plumosum</i> and <i>Aristida holathera</i> var. <i>latifolia</i> mid tussock grassland</p> <p>NVIS: U ^ <i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>, ^ <i>Corymbia zygophylla</i>, ^ tree\6\r;M ^ <i>Acacia eriopoda</i> ^ shrub\4\i;G+ ^ ^ <i>Chrysopogon fallax</i>, <i>Sorghum plumosum</i>, <i>Aristida holathera</i> var. <i>latifolia</i> ^ tussock grass\2\c</p>	<p>Q01, Q02, Q03, Q04, Q05, Q07</p>		<p><i>Acacia eriopoda</i> <i>Aristida holathera</i> var. <i>holathera</i> <i>Aristida hygrometrica</i> <i>Brachychiton diversifolius</i>, <i>Bulbostylis barbata</i> <i>Chrysopogon fallax</i> <i>Corchorus sidoides</i> <i>Corymbia zygophylla</i>, <i>Goodenia sepalosa</i> var. <i>sepalosa</i> <i>Heliotropium leptaleum</i> <i>Indigofera linifolia</i> <i>Senna notabilis</i> <i>Solanum cunninghamii</i> <i>Sorghum plumosum</i> <i>Stackhousia intermedia</i> <i>Trianthema pilosum</i> <i>Triodia caelestialis</i> <i>Waltheria indica</i> <i>Yakirra australiensis</i></p>	<p>740.15 ha 77.04%</p>

Mapping Unit	Vegetation Community	Floristic Quadrats	Representative Photograph	Characteristic Species	Area (ha) and Extent (%) of Study Area
BdBcLOW	<p><i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i> and <i>Bauhinia cunninghamii</i> low open woodland over <i>Acacia eriopoda</i> tall open shrubland over <i>Aristida holathera</i> var. <i>latifolia</i>, <i>Chrysopogon fallax</i> and <i>Sorghum timorense</i> low tussock grassland</p> <p>NVIS: U ^ <i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>, ^ <i>Bauhinia cunninghamii</i> \ ^tree\6r;M ^ <i>Acacia eriopoda</i> \ ^shrub\4i;G+ ^^ <i>Aristida holathera</i> var. <i>latifolia</i>, <i>Chrysopogon fallax</i>, <i>Sorghum timorense</i> \ ^tussock grass\1\c</p>	<p>Q06, Q08, Q09, Q10</p>		<p><i>Acacia eriopoda</i> <i>Aristida holathera</i> var. <i>holathera</i> <i>Aristida holathera</i> var. <i>latifolia</i> <i>Bauhinia cunninghamii</i> <i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i> <i>Bulbostylis barbata</i> <i>Chrysopogon fallax</i> <i>Cleome tetrandra</i> <i>Corchorus sidoides</i> <i>Evolvulus alsinoides</i> var. <i>decumbens</i> <i>Fimbristylis ammobia</i> <i>Goodenia sepalosa</i> var. <i>sepalosa</i> <i>Indigofera linifolia</i> <i>Ptilotus calostachyus</i> <i>Sorghum timorense</i> <i>Spermacoce occidentalis</i> <i>Tephrosia remotiflora</i> <i>Trianthema pilosum</i> <i>Waltheria indica</i> <i>Yakirra australiensis</i></p>	<p>78.08 ha 8.13%</p>

Mapping Unit	Vegetation Community	Floristic Quadrats	Representative Photograph	Characteristic Species	Area (ha) and Extent (%) of Study Area
<p>CzCgBcLW</p>	<p><i>Corymbia zygophylla</i>, <i>Corymbia greeniana</i> and <i>Bauhinia cunninghamii</i> low woodland over <i>Acacia eriopoda</i> tall open shrubland over <i>Sorghum plumosum</i>, <i>Aristida holathera</i> var. <i>holathera</i> and <i>Chrysopogon fallax</i> mid tussock grassland</p> <p>NVIS: U ^ ^ ^ <i>Corymbia zygophylla</i>, ^ <i>Corymbia greeniana</i>, <i>Bauhinia cunninghamii</i> \ ^ tree \ 6 \ i ; M ^ <i>Acacia eriopoda</i> \ ^ shrub \ 4 \ i ; G + ^ <i>Sorghum plumosum</i>, ^ <i>Aristida holathera</i> var. <i>holathera</i>, <i>Chrysopogon fallax</i> \ ^ tussock grass \ 2 \ c</p>	<p>Q12, Q13, Q19</p>		<p><i>Abutilon otocarpum</i> <i>Acacia eriopoda</i> <i>Aristida holathera</i> var. <i>holathera</i> <i>Bauhinia cunninghamii</i> <i>Bulbostylis barbata</i> <i>Calandrinia strophiolata</i> <i>Chrysopogon fallax</i> <i>Cleome tetrandra</i> <i>Corchorus sidoides</i> <i>Corymbia greeniana</i> <i>Corymbia zygophylla</i> <i>Goodenia sepalosa</i> var. <i>sepalosa</i> <i>Senna notabilis</i> <i>Solanum cunninghamii</i> <i>Sorghum plumosum</i> <i>Stackhousia intermedia</i> <i>Striga squamigera</i> <i>Tephrosia leptoclada</i> <i>Tinospora smilacina</i> <i>Trichodesma zeylanicum</i> <i>Triodia caelestialis</i> <i>Waltheria indica</i></p>	<p>142.44 ha 14.83%</p>

4.1.2.2 Study Area Floristic Analysis

The floristic analysis dendrogram (**Figure 3**) for the PATN analysis (Belbin & Collins 2006) indicates that there are three vegetation types at association level 0.0766.

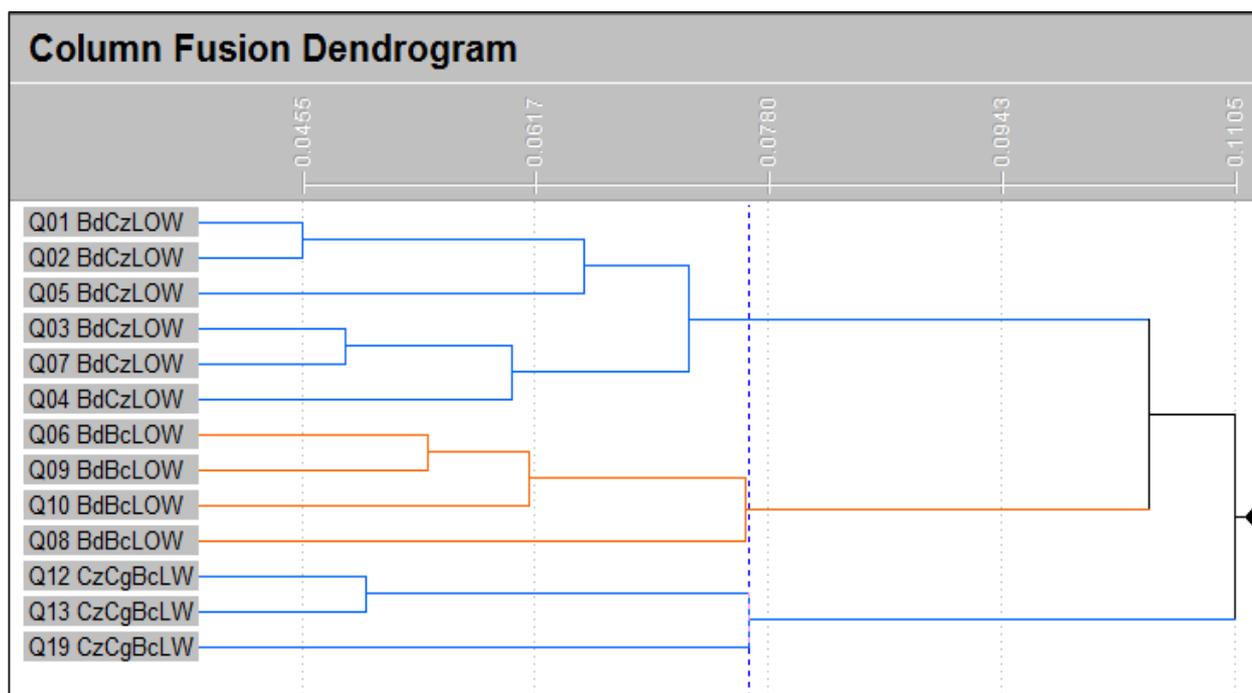


Figure 3: Study area floristic analysis (PATN dendrogram)

4.1.2.3 Vegetation Condition and Fire History

Eleven of the 13 quadrats were observed to be in Excellent condition with the remaining two in Very Good condition. Six quadrats were located in areas burnt within 2-3 years, the remaining seven quadrats were located in areas not burnt within the past 5 years (**Table 16** and **Map 2**). There is no correlation between fire age and vegetation condition, despite the fire 2 years prior to the survey having been deliberately lit. Grazing, trampling of plants and soil disturbance by cattle were the most common attributes contributing to the lesser vegetation condition. However, while present at low levels throughout, disturbance by cattle was concentrated along roads and fence lines.

Vegetation condition extents within the study area are provided in **Table 16** and shown on **Map 3**.

Table 16: Vegetation condition extents (EPA 2016e)

Categories	Quadrats	Extent (ha)	Extent (%)
Vegetation Condition			
Excellent	Q01, Q02, Q03, Q04, Q05, Q06, Q07, Q09, Q12, Q13, Q19	888.99	92.53
Very Good	Q08, Q10	49.94	2.26
Good	-	21.76	5.20
Poor	-	0	0
Degraded	-	0	0
Completely Degraded	-	0	0
Fire Age			
2 years	Q07, Q19	374.07	38.94
3 years	Q04, Q05, Q06, Q08	106.95	11.13
>5 years	Q01, Q02, Q03, Q09, Q10, Q12, Q13	479.65	49.93

4.1.3 ADEQUACY OF FLORA SURVEY

A species accumulation curve (**Figure 4**) was generated to display adequacy of sampling. The curve has reached (or nearly reached) an asymptote, and it is considered likely that most species have been recorded from the study area.

The species accumulation curve for the study area, based on flora recorded within quadrats, suggests that additional survey would only slightly increase the number of species recorded within the study area. The bootstrap estimate of species richness generated from this data indicates that 121.6 species could be expected from the study area based on the diversity recorded within quadrats. The total species inventory of the study area is 117 flora taxa including six opportunistic records, which is 96% of the predicted species diversity estimate. Therefore Ecoscape considers that this survey has documented the majority of flora that may occur within the study area.

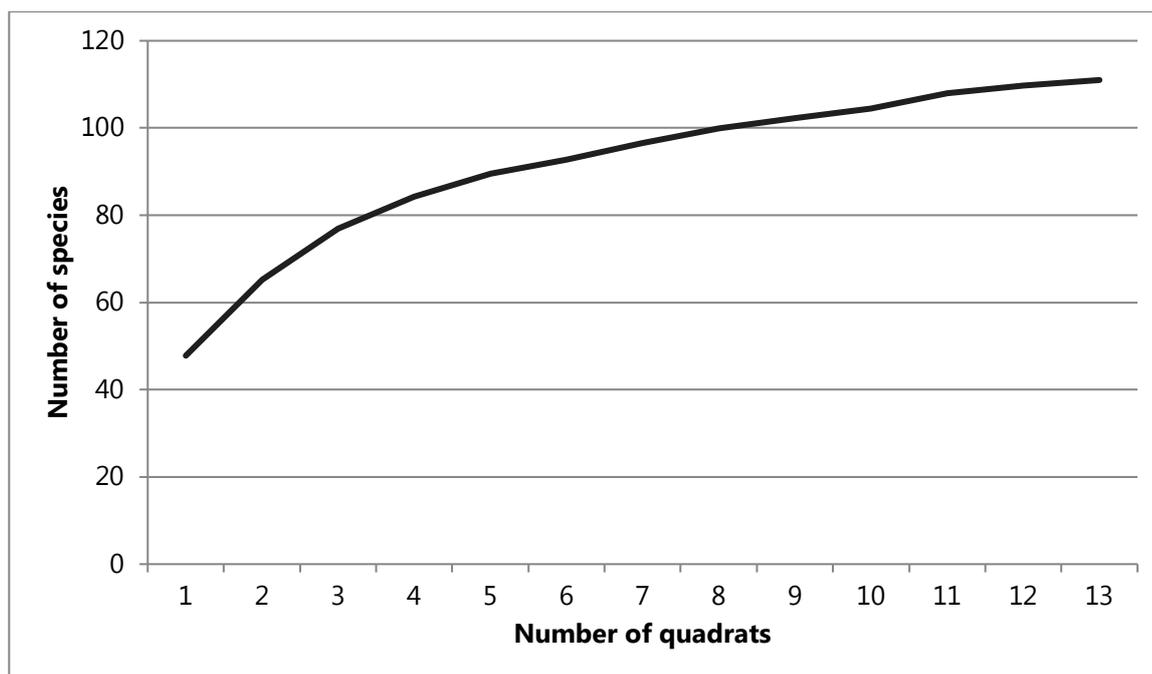


Figure 4: Species accumulation curve

Where available within reports, the number of taxa recorded during the various flora and vegetation surveys in the same IBRA subregion were plotted against their survey area to provide an indication of species richness (Biota Environmental Sciences 2009a; 2013a; 2013b; 2013c; Ecologia Environment 2012b; 2014b; 2016a). The results indicate that this survey (NBY 2017 in **Figure 5**) is one of the smaller surveys in terms of extent, and also has the lowest number of taxa recorded. **Table 17** includes that data used in **Figure 5**; note that some of the referenced reports in **Table 9** did not include study area extents and could not be included in the calculations.

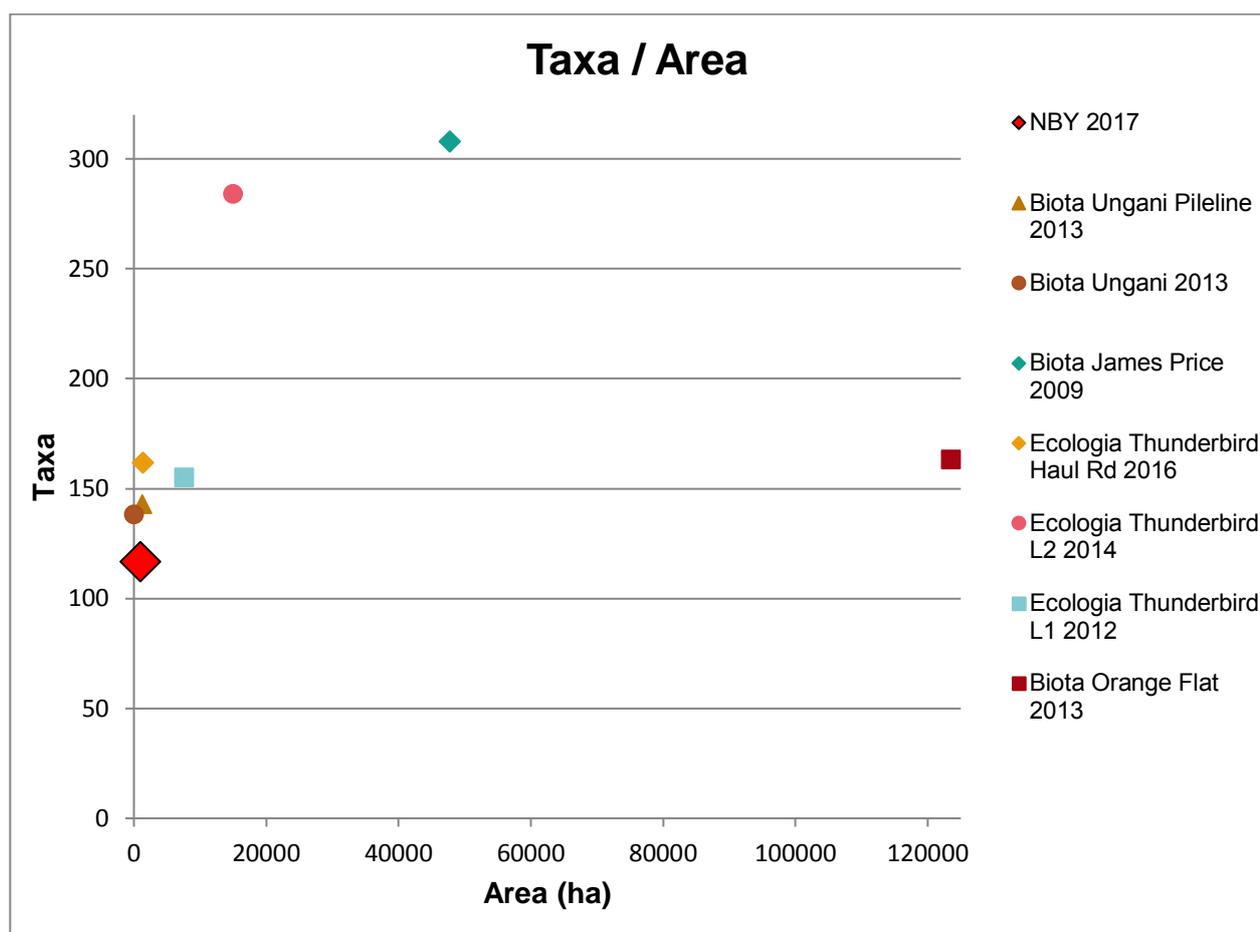


Figure 5: Flora species richness

Table 17: Regional flora and vegetation data

Author	Project	Survey type	Extent (ha)	No. species	No. vegetation types
Ecoscope 2017	This survey	Level 2	961	117	3
Biota Environmental Sciences (2013a)	<i>Orange Flat Level 1 Vegetation, Flora and Fauna Assessment</i>	Level 1	123,532	163	28
Biota Environmental Sciences (2013b)	<i>Ungani Pipeline, Access Track and Highway Depot Level 1 Vegetation, Flora and Fauna Assessment</i>	Level 1	1,250	143	6
Biota Environmental Sciences (2013c)	<i>Ungani Study Area Flora and Fauna Assessment</i>	Level 1	32	138	7
Biota Environmental Sciences (2009a)	<i>A vegetation and flora survey of James Price Point: wet season 2009</i>	Unspecified	47,682	308	5
Ecologia Environment (2016a)	<i>Thunderbird Haul Road & Accommodation Camp. Flora and Fauna Assessment</i>	Level 1	1,349	162	11
Ecologia Environment (2014b)	<i>Sheffield Resources Limited - Thunderbird Project Level 2 Flora and Vegetation Assessment</i>	Level 2	15,031	284	9
Ecologia Environment (2012b)	<i>Thunderbird Dampier Peninsula Project Level 1 Flora and Fauna Assessment</i>	Level 1	7,677	155	6

4.2 VERTEBRATE FAUNA

4.2.1 HABITAT TYPES

Two fauna habitat types were recorded from the study area: Shrubland over mixed Tussock Grassland and *Aristida* and *Chrysopogon* Tussock Grassland (**Map 5**). The shrubland over mixed Tussock Grassland was more widespread in the study area (corresponding with vegetation type BdCzLOW) than the *Aristida* and *Chrysopogon* Tussock Grassland (corresponding to vegetation types BdBcLOW and CzCgBcLW) with a ratio of about 77% to 23% (**Table 18, Map 5**). The details and compositions of each habitat type are described below.

Table 18: Fauna habitat types

Name	Correlating vegetation unit	Extent (ha)	Percentage in study area (%)
Shrubland over mixed Tussock Grassland	BdCzLOW	740.16	77.05
<i>Aristida</i> and <i>Chrysopogon</i> Tussock Grassland	BdBcLOW & CzCgBcLW	220.52	22.95

4.2.1.1 Shrubland over mixed Tussock Grassland

The shrubland over mixed Tussock Grassland habitat type was recorded from the majority of the study area. It covers 77% of the total area (740 ha). This habitat type correlates to vegetation unit 1 (BdCzLOW). It comprises of open to moderately open *Acacia eriopoda* shrubland and very open woodland (*Corymbia zygophylla*, *C. greeniana*, *Bauhinia cunninghamii*, and *Brachychiton diversifolius*). The understorey consists of a moderately open to moderately dense to dense grass layer of *Sorghum* grasses (**Plate 4**). Some scattered patches of *Aristida latifolia* tussocks and *Chrysopogon fallax* can also be present. The two trapping sites NBY S1 and NBY S2 were installed in this habitat type in the western section of the study area (**Map 4**).



Plate 4: Shrubland over mixed Tussock Grassland

4.2.1.2 *Aristida* and *Chrysopogon* Tussock Grassland

Similar to the Shrubland mixed Tussock Grassland habitat type the *Aristida* and *Chrysopogon* Tussock Grassland habitat type comprises of low open shrublands over *Aristida* and *Chrysopogon* Tussock Grass (**Plate 5**). This habitat types relates to vegetation units 2 (BdBcLOW) and 3 (CzCgBcLW). It covers 220 ha which represents 22.9% of the total area and is limited to the northern and eastern sections of the study area (**Map 5**). The two trapping sites NBY S3 and NBY S4 were located in this habitat in the southern and eastern section of the study area. Site NBY S3 contained a substrate of grey soft loamy clay which differed to the remaining sites. The grass layer at site NBY S4 in the south of the study area was dense to very dense.



Plate 5: *Aristida* and *Chrysopogon* Tussock Grassland habitat type

4.2.2 FAUNA INVENTORY

During the survey, a total of 82 species (seven native mammals, three introduced species of mammal, 38 birds, 25 species of reptile, three amphibians and six potential SRE species) were recorded from the study area. A site by species matrix for each species group is presented in **Appendix Seven**.

Mammals species recorded comprised of the Echidna (secondary evidence only), two macropods, three bat species (of which one cannot be determined based only on call pattern), one murid and three introduced species (Cattle, Dog/Dingo and Cat) (**Appendix Seven**).

The avifauna recorded from site belonged to 25 families with five families recorded from only outside the study area. The most abundant bird species recorded from inside the study area was the Budgerigar with 22 individuals; however, the species was only recorded on two occasions inside the study area (trap sites NBY S1 and S2). The Pied Butcherbird and the White-throated Gerygone were the most common species on site with records from all four systematic trap sites. In addition, the Rainbow Bee-eater was also recorded from a total of nine locations inside the study area (**Appendix Seven**).

It is noteworthy that water bird species occurring at the wetlands, north-east of the study area have not been included in the fauna assemblage of the current survey and they were not recorded from the area. The species utilising these areas are mostly specialised in inhabiting wetlands and are highly unlikely to use the habitat (elevated sandplain) within the study area. Previous surveys undertaken in the region typically comprised of a variety of fauna habitat including drainage lines, wetlands, water holes or coastal areas. The presence of these habitats considerably increases the number of bird species present on a regional level; however, they do not occur at the current study area.

The reptile assemblage consisted of three species of agamid (dragons), three species of gecko, two species of legless lizard, 11 species of skink, two species of varanid, one species of blind snake and three snakes. The most abundant species captured during the survey were the Bar-shouldered Ctenotus (*Ctenotus saxatilis*) with 101 captures, the North-western Sandslider (*Lerista bipes*) with 82 records and the Pindan Dragon (*Diporiphora pindan*) with 34 captures (**Appendix Seven**).

The amphibian assemblage on site was moderate and as expected for sandplain country. Three species of frog were identified; the Green Tree Frog (*Litoria caerulea*), Desert Spadefoot (*Notaden nichollsi*) and the Mjoberg's Toadlet (*Uperoleia mjobergii*). The Green Tree Frog was captured at site NBY S1, in the shrubland with mixed tussock grassland habitat whereas the majority of the other two frog species (all but one record) were trapped at site NBY S3 (**Appendix Seven, Map 4**). The site consisted of *Aristida* and *Chrysopogon* Tussock Grassland on a grey loamy sandy substrate. The species are burrowing species and likely to be very abundant on site during the wet season.

A skink species of the genus *Ctenotus* was recorded from all four trap sites which is currently unnamed (**Plate 6**). A total of 16 individuals were recorded from across the study area. The species awaits further taxonomic resolution. It is currently classified as belonging to the species complex *C. leonhardii* which

requires taxonomic revision. However, individuals of this species complex have been previously recorded from Liveringa Station (South-east of Derby) which is located approximately 150 km from the study area (B. Maryan, *pers. comms.*, 2017). The species complex is not likely to be of conservation significance



Plate 6: Unnamed *Ctenotus* sp. (*leonhardii* group)

4.2.3 CONSERVATION SIGNIFICANT FAUNA

During the survey three species of conservation significance were recorded from the study area, the Rainbow Bee-eater (*Merops ornatus*) (WC Act S5), the Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) (DBCA P3) and the Dampier Peninsula Goanna (*Varanus sparnus*) (DBCA P1).

The Rainbow Bee-eater was recorded from nine locations across the study area (**Table 44** in **Appendix Eight, Map 5**). No nesting or breeding activities were observed; however, these have potential to occur on site due to the sandy and soft substrate. The Spectacled Hare-wallaby was recorded from 16 locations across the study area through secondary evidence only (**Plate 7, Map 5**). A number of recent and old shelters, fresh and old scats and fresh tracks were recorded from across the study area (**Table 44** and **Plate 8**). The Dampier Peninsula Goanna was recorded from all trap sites, totalling seven individuals all of which were adults (**Plate 9**).

The majority of these records appear to have a correlation to the areas that have been unburnt for more than 5 years with records accumulated in these unburnt areas (**Map 2**).

The location of each conservation significant fauna record is listed in **Table 44** in **Appendix Eight** and displayed in **Map 5**.



Plate 7: Spectacled Hare-wallaby shelter



Plate 8: Fresh scats of the Spectacled Hare-wallaby



Plate 9: Dampier Peninsula Goanna (*Varanus sparnus*)

4.3 INVERTEBRATE SRE FAUNA

The desktop assessment identified 44 species of potential and undetermined SRE as recorded from the region (**Table 38** in **Appendix Six**). The SRE status is mostly due to the lack of taxonomic knowledge of the species and therefore they have to be considered potential SREs under the precautionary principle. The species have a moderate likelihood to occur at the study area.

During the survey a total of 258 invertebrate specimens were recorded from dry pitfall trapping, opportunistic searches and leaf litter collections. Dry pitfall trapping and opportunistic collections were selective and were focused on species group that are known to support Short-ranged Endemic species such as scorpions or Mygalomorph spiders. Leaf litter collections were sieved and then sorted in the Perth laboratory into groups that include SRE species. Of the 258 individuals, 20 individuals were sorted into six morpho-species which have the potential to represent potential Short-range Endemic species: one isopod (*Buddelundia* sp. B74), two species of scorpion (*Lychas splendens* and *Lychas* sp. B11), and three species of pseudoscorpion of which two species could be identified to species complex level (*Beierolpium* 8/4 sp. B18 and *Euryolpium* sp. B09) and the remaining morpho-species could only be identified to family name (Oolpidae sp.) (**Map 5**).

Two of the above species (*Buddelundia* sp. B74 and *Euryolpium* sp. B09) were recorded from only one location within the study area, three species (*Lychas* sp. B11, *Beierolpium* 8/4 sp. B18, Oolpidae sp.) were recorded from two locations and the remaining taxa (*Lychas splendens*) were recorded from three locations (**Appendix One**).

4.4 DATA ANALYSIS

4.4.1.1 Habitat Analysis

The PATN cluster analysis of trappable species data produced the dendrogram of similarity in **Figure 6**. The dendrogram shows two closely related habitat types. This was expected given the vegetation structure observed was similar and the majority of species were recorded from both habitat types. However, species recorded from trap site 3 differed in the field from the remaining fauna assemblage by capturing two species of burrowing frog which were not recorded from any of the other sites. The PATN cluster did not select this site out based on the trapping data.

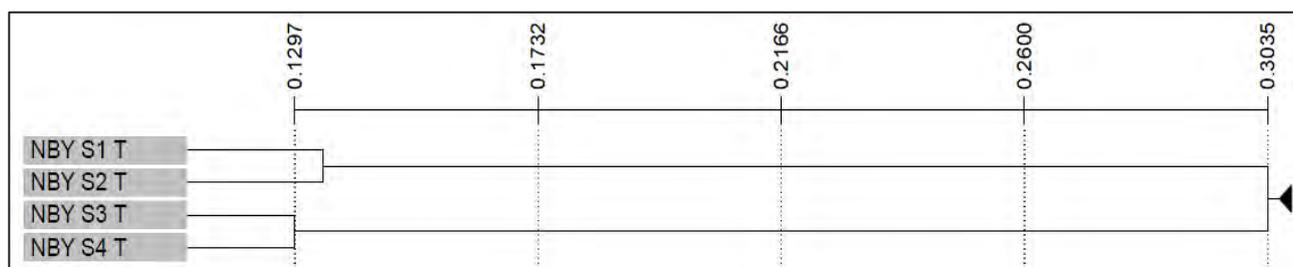


Figure 6: Fauna habitat similarity dendrogram.

4.4.2 SURVEY ADEQUACY

Systematically obtained data (trapping results for terrestrial fauna and set-time survey for birds, excluding opportunistic data) was analysed for survey adequacy. Mammal, reptile and amphibian trapping data were combined for analysis as 'terrestrial vertebrate fauna', as these fauna groups were sampled using the same methods. The invertebrate fauna species were separated and analysed. It should be noted that the invertebrate dataset comprises of individuals collected from species groups that potentially include SRE species such as scorpions, slaters and pseudoscorpions. Species such as common spider groups were not included in the analysis.

Species Accumulation Curves (SACs) were generated through 10,000 randomisations of the sample sequence of the data sets for trappable fauna and avifauna. The SE line reflects the actual number of species recorded. The Michaelis-Menten (MM) means (1 run) line represents the predicated total number of species that could be recorded if additional survey effort were undertaken.

Analysis of the terrestrial vertebrate trapping data produced a climbing SAC (**Figure 7**). An asymptote was not yet reached. Visually the shape of the curve in this SAC indicates that the number of species recorded was still increasing and additional survey effort would have recorded additional species. Extrapolation of the MM curve suggests that 92% of the theoretical total number of terrestrial fauna able to be trapped had been captured at the completion of the 28 trap nights of the Level 2 vertebrate fauna survey (**Table 19**). The value of the MM mean estimator is 32.5 whereas the species observed was 30 (**Table 19**). The results of the MM mean estimator indicates that additional trapping may have recorded a few more species.

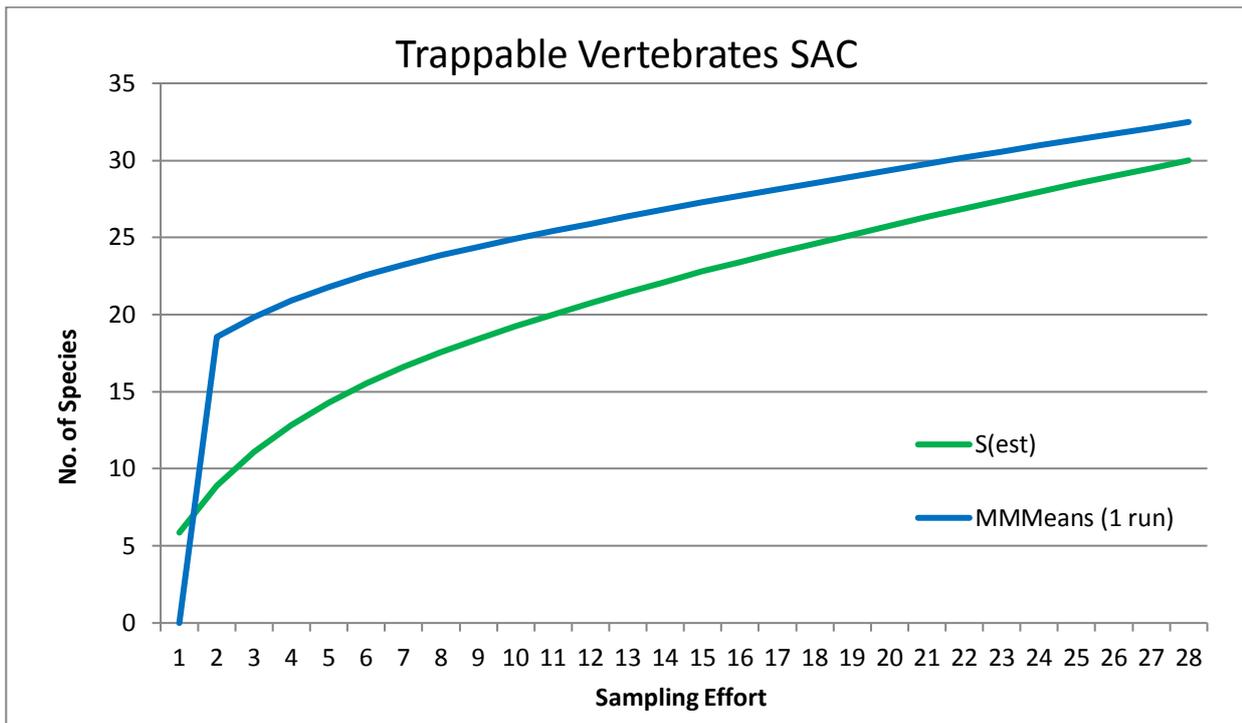


Figure 7: Species Accumulation Curve for Trappable Vertebrate Fauna

The SAC analysis of the avifauna set-time survey dataset also produced a typical SAC, almost reaching the asymptotic plateau (**Figure 8**). Used as a stopping rule, the MM estimator indicated that at the completion of the systematic bird surveys (34 set-time surveys) the survey was to 70% sufficient. The MM mean estimator generated the highest theoretical maximum of 33 species (**Table 19**), suggesting further survey effort would have detected approximately 10 additional species.

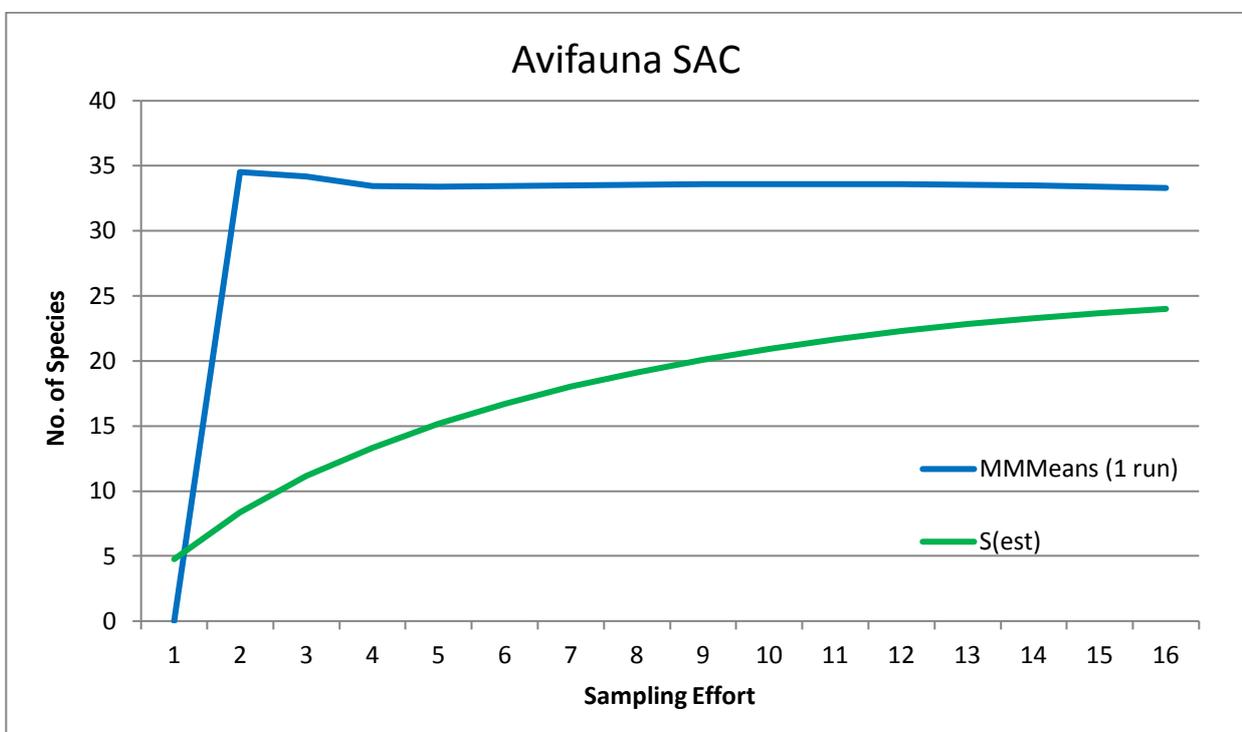


Figure 8: Species Accumulation Curve for Observed Avifauna

SAC analysis of the collected invertebrate species produced a similar SAC to the avifauna SAC, almost reaching the asymptotic plateau (**Figure 9**). The MM mean estimator indicated that at the completion of the systematic invertebrate fauna collection (dry pitfall and leaf litter collection) the survey was to 79% sufficient.

The MM mean estimator generated the highest theoretical maximum of 25 species (**Table 19**), suggesting further survey effort would have detected another five species of invertebrate species.

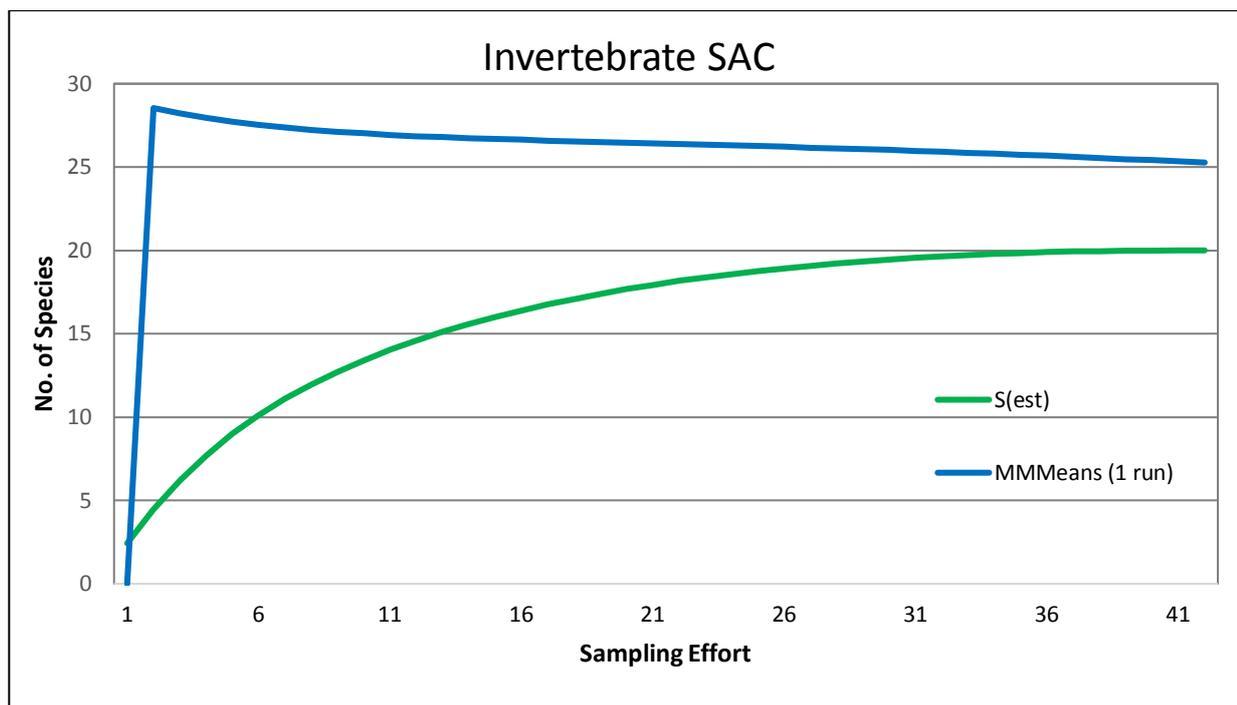


Figure 9: Species Accumulation Curve for Collected Invertebrate Species

Parametric analysis of systematically obtained survey data for birds and terrestrial faunal groups (reptiles, non-volant mammals, amphibians and invertebrate) revealed that survey effort was adequate. **Table 19** provides a summary of the theoretical maximum number of species using the MM mean estimator which provides the most accurate representation of the potential species number with 32.5 trappable vertebrates, 33.3 bird species and 25.3 invertebrates predicted. This is compared against the actual number of species observed, with any inconsistencies smoothed by an algorithm (Mao Tau) which simulates an infinite number of randomisations of the sample order.

Table 19: Mean estimates of total species richness

Richness Estimators	Trappable Vertebrates	Birds	Invertebrates
Michaelis-Menten	32.5	33.3	25.3
Species Trapped/Recorded	30	24	20
Total Species Observed	38	30	20

4.4.3 ZOOLOGICAL LIMITATIONS

Table 20: Zoological limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Competency/experience of the consultant carrying out the survey	No constraints	All survey staff have relevant recent experience surveying in a number of bioregions including the Kimberley, Murchison, Gascoyne, Pilbara and the Wheatbelt region.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions)	No constraints	Sampling techniques were deemed adequate and sufficient. The majority of faunal groups were sampled and no constraints were experienced.
Proportion of fauna identified, recorded and/or collected	No constraints	All vertebrate fauna individuals were identified in the field. Where further identification was necessary, the individuals were taken back to camp, identified and released within 24 hours of capture. All fauna was released at the point of capture. Invertebrate fauna was collected, kept cool and euthanised in cool ethanol and submitted to external taxonomists for identification (Bennelongia). Species accumulation curves revealed that the majority of vertebrate fauna and invertebrate fauna was sampled during the current survey, however further sampling would have recorded additional species.
Sources of information (historic/recent or new data)	No constraints	A large number of surveys have been undertaken previously in the region (within 80 km of the study area) which results in a detailed knowledge of the faunal assemblage of the area. Database search results were consulted in a thorough manner and assisted in the assessment of fauna values on a regional level.
Proportion of the task achieved and further work that may need to be undertaken	No constraints	The level of surveying required was assessed to be a Level 1 fauna survey; however NBY decided that a more detailed Level 2 fauna survey was the more adequate survey effort. All components of a Level 2 survey were completed with a total of four systematic trapping sites, 10 opportunistic foraging sites for vertebrate and SRE fauna, 14 birding sites, four SM2 bat recorder sites and four leaf litter collection sites.
Timing/weather/season/cycle	No constraints	The survey was conducted in May, shortly after the rain season when temperatures were warm and moisture was still present. Reptile activity and consequently detection rates were relatively high and amphibians were active due to the moisture present during night time. Bird activity was high in the morning periods and the majority of the expected avian species was recorded.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention)	No constraints	No disturbances were experienced in connection with the survey effort or results.

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Intensity of survey	No constraints	Level 2 surveys are the most intensive survey type in accordance with EPA, OEPA and DBCA guidance. A one phase Level 2 assessment was carried out and was appropriate for the project.
Completeness (e.g. was relevant area fully surveyed)	No constraints	All representative habitat types were sampled adequately. Some access restriction existed, however less accessible areas of the study area were accessed and sampled on foot. This is not expected to have impacted the completeness of sampling as all habitats were surveyed in detail.
Resources (e.g. degree of expertise available for species identification)	Negligible	All vertebrate fauna was identified in the field. Invertebrate SRE fauna was submitted to external taxonomists who experienced some issues in the liaison with WA Museum staff and collection. This may have impacted the regional knowledge of invertebrate species distribution and regional information on the unnamed <i>Ctenotus</i> sp. (<i>leonhardii</i> group). However, these issues had a negligible impact on the final results.
Remoteness and/or access problems	No constraints	All areas of the study area have been accessed and sampled adequately.

5 DISCUSSION

5.1 ENVIRONMENT

Several areas of wetland mapped as corresponding with the Roebuck Plains System (WA021) are located approximately 900 m to the north and north east of the study area; dependent on the site hydrology, proposed activities and land use may have the potential to impact the values of these areas of wetland (Government of Western Australia 2017a). Hydrology and subsurface connectivity within the landscape is not within the scope of this project, however, based on Ecoscape's understanding of the area's ecology, impacts on the wetland having a terrestrial origin are likely to be low or negligible.

5.2 FLORA

The flora and vegetation survey was conducted between 27 April and 12 May 2017, which is within the supplementary survey period rather than optimal survey period according to the *Flora and Vegetation Technical Guidance* (EPA 2016e), however there were no constraints identified in relation to flora species presence due to the above average wet season rainfall and some supplementary recent rain, and only negligible constraint in relation to the ability to identify them.

Thirteen floristic quadrats were assessed, ten of which were within the study area and three considered as regional. The regional quadrats were similar in species and structure to the study area quadrats, indicating that the species and vegetation of the study area was not unique, and occurs elsewhere in the region. The literature review concurs that similar vegetation occurs widely throughout the IBRA subregion (e.g. Biota Environmental Sciences 2009a; Ecologia Environment 2016b; Outback Ecology 2014).

One hundred and seventeen vascular flora species were recorded from the floristic quadrats and opportunistic and targeted searches. The species richness recorded during this survey is the lowest of any similar surveys (where comparable data was available; **Section 0**) within the same IBRA subregion. The apparently low species richness may be due to the relatively uniform habitat and low number of vegetation types within the study area. In comparison, this study area (with three vegetation types) had half (or less) than the number of mapped vegetation types in similar sized areas (Biota Environmental Sciences 2013b, six vegetation types; Biota Environmental Sciences 2013c, seven vegetation types; Ecologia Environment 2012b, six vegetation types; Ecologia Environment 2016a, 11 vegetation types). The study area occupied Pindan plains, and did not have habitat diversity that could have included floodplains, salt pans, hills or similar features that have niches for a wider range of flora species; some of these features occurred within the other survey areas.

No TF species listed under the Western Australian BC Act or Commonwealth EPBC Act were recorded, and none were considered likely to occur based on a likelihood assessment.

One PF species, *Triodia caelestialis* (P3), was recorded; it was a dominant or characteristic species in 12 of the 13 floristic quadrats and was considered as common within the study area and immediate region. *Triodia caelestialis* is known to occur within three Kimberley bioregions, with an east-west range of approximately 440 km, and north-south range of approximately 200 km (*NatureMap*, DPaW 2007-2017). There are 24 records listed on *FloraBase* (Western Australian Herbarium 1998-2017), several of which describe the frequency as 'common' or provide a cover value that suggests the species is common (Western Australian Herbarium 2017b). It was also a characteristic and dominant ground stratum species in several vegetation types in the Thunderbird (Ecologia 2012b; 2014b; 2016b) area, approximately 75 km northwest of the study area. Based on this information, it is likely that the P3 categorisation is due to the species being poorly collected, rather than being of conservation concern.

One species (**Stylosanthes hamata*) was introduced but is not listed as a Declared Pest plant listed under the Western Australian BAM Act or WONS (Weeds Australia 2012) species. It was recorded as an opportunistic observation, and was observed to be associated with areas of concentrated cattle movement, including roads and fencelines.

The flora species recorded from the study area and regional quadrats are considered to be representative of 'Pindan Scrub', with the dominant and characteristic species are also commonly recorded in other Kimberley flora surveys (Biota Environmental Sciences 2009a; Biota Environmental Sciences 2013a; Ecologia Environment 2012b; 2014b; 2016a; Outback Ecology 2014).

5.3 VEGETATION

Three vegetation types were recorded from within the study area:

- *Brachychiton diversifolius* subsp. *diversifolius* and *Corymbia zygophylla* low open woodland over *Acacia eriopoda* tall open shrubland over *Chrysopogon fallax*, *Sorghum plumosum* and *Aristida holathera* var. *latifolia* mid tussock grassland
- *Brachychiton diversifolius* subsp. *diversifolius* and *Bauhinia cunninghamii* low open woodland over *Acacia eriopoda* tall open shrubland over *Aristida holathera* var. *latifolia*, *Chrysopogon fallax* and *Sorghum timorense* low tussock grassland
- *Corymbia zygophylla*, *Corymbia greeniana* and *Bauhinia cunninghamii* low woodland over *Acacia eriopoda* tall open shrubland over *Sorghum plumosum*, *Aristida holathera* var. *holathera* and *Chrysopogon fallax* mid tussock grassland.

The vegetation types were derived from floristic analysis and field observations of structure and species composition, with the descriptions derived from the quadrats recorded from each vegetation type. The first-listed vegetation type (**BdCzLOW**) occupied almost 75% of the study area.

None of the vegetation is considered of conservation significance, and does not represent any currently described TEC or PEC.

Each vegetation type within the study area had a representative regional quadrat recorded from the near vicinity, and the vegetation is also considered similar to vegetation described in other Kimberley flora and vegetation surveys (**Table 21**), that ranged up to 75 km distance from the study area. Thus, the similar vegetation is considered to occupy a wide extent within the IBRA subregion.

Table 21: Similar vegetation types from other Kimberley surveys

Survey reference	Vegetation type description
Biota Environmental Sciences (2013a): Orange Flat	<i>Acacia</i> tall open scrub: <i>Acacia eriopoda</i> tall open scrub over <i>Chrysopogon fallax</i> tussock grassland
	<i>Corymbia</i> low open woodland: <i>Corymbia greeniana</i> , <i>C. zygophylla</i> low open woodland over <i>Acacia tumida</i> tall open shrubland over <i>Chamaecrista symonii</i> low scattered shrubs over <i>Chrysopogon fallax</i> tussock grassland
	<i>Acacia</i> tall shrubland: <i>Acacia eriopoda</i> tall shrubland over <i>Chrysopogon fallax</i> tussock grassland
Ecologia Environment (2012b): Thunderbird Level 1	CgApTcAh: <i>Corymbia greeniana</i> and <i>Erythrophleum chlorostachys</i> open woodland over <i>Acacia platycarpa</i> and <i>A. tumida</i> var. <i>tumida</i> open shrubland, over <i>Triodia caelestialis</i> hummock grassland and <i>Aristida holathera</i> var. <i>holathera</i> , <i>Chrysopogon</i> sp., <i>Eriachne obtusa</i> and <i>Sorghum plumosum</i> tussock grassland
	CzAtSpTc: <i>Corymbia greeniana</i> and <i>C. zygophylla</i> open woodland over <i>Acacia tumida</i> var. <i>tumida</i> shrubland over <i>Sorghum plumosum</i> tussock grassland and <i>Triodia caelestialis</i> sparse hummock grassland
Ecologia Environment (2016a): Thunderbird Haul Road and Ecologia Environment (2014b) Thunderbird	BdEcAtApSt: <i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i> and <i>Erythrophleum chlorostachys</i> low open woodland over <i>Acacia tumida</i> var. <i>tumida</i> and <i>Acacia platycarpa</i> tall sparse shrubland over <i>Sorghum timorense</i> sparse tussock grassland
	CgApSt: <i>Corymbia greeniana</i> mid, open woodland over <i>Acacia platycarpa</i> tall sparse shrubland over <i>Sorghum timorense</i> open tussock grassland
Outback Ecology (2014): Jackaroo	2. <i>Corymbia greeniana</i> Open Low Woodland on sandy flats: Open to Very Open Low Woodland of <i>Corymbia greeniana</i> over a Tall Shrubland of <i>Terminalia canescens</i> , <i>Dolichandrone heterophylla</i> , <i>Acacia colei</i> and <i>Bauhinia cunninghamii</i> (\pm <i>Carissa lanceolata</i> , <i>Grevillea pyramidalis</i> , <i>Hakea chordophylla</i> and <i>Ehretia saligna</i>) over a very Open Tussock Grassland of <i>Aristida holathera</i> , <i>A. latifolia</i> and <i>Chrysopogon fallax</i> (\pm <i>Sehima nervosa</i>) on loamy sand flat.
	3. Broome Pindan Wattle (<i>Acacia eriopoda</i>) Tall Open Shrubland on red pindan plains: Open Low Woodland to Tall Open Shrubland of <i>Acacia eriopoda</i> , <i>Gyrocarpus americanus</i> , <i>Bauhinia cunninghamii</i> and (\pm <i>Ficus aculeata</i> var. <i>aculeata</i> , <i>Dolichandrone heterophylla</i> and <i>Hakea macrocarpa</i>) over a sparse low shrubland of <i>Flueggea virosa</i> , <i>Waltheria indica</i> , <i>Corchorus sidoides</i> and <i>Solanum dioicum</i> (\pm <i>Carissa lanceolata</i> and <i>Dodonaea hispidula</i>) over an Open Grassland of <i>Aristida holathera</i> and <i>Chrysopogon fallax</i> (\pm <i>Triodia bitextura</i> , <i>Eragrostis eriopoda</i> and <i>Aristida latifolia</i>) on red pindan sands.
	7. <i>Corymbia greeniana</i> Low Woodland over Medium Pindan Shrubland: Open to Very Open Medium to Low Woodland of <i>Corymbia greeniana</i> , <i>C. zygophylla</i> , <i>Gyrocarpus americanus</i> (\pm <i>C. flavescens</i> , <i>C. polycarpa</i> , <i>Brachychiton diversifolius</i> , <i>Bauhinia cunninghamii</i> and <i>Dolichandrone heterophylla</i>) over an Open, Medium shrubland of <i>Acacia eriopoda</i> , <i>A. colei</i> , <i>A. tumida</i> , <i>A. platycarpa</i> (\pm <i>Carissa lanceolata</i> , <i>Hakea arborescens</i> , <i>Flueggea virosa</i> , <i>Ehretia saligna</i> , <i>Wrightia saligna</i> , <i>Ventilago viminalis</i> , <i>Grevillea pyramidalis</i> and <i>Melaleuca nervosa</i>) over a very open grassland of <i>Aristida holathera</i> and <i>Triodia bitextura</i> (\pm <i>Aristida latifolia</i> and <i>Sehima nervosa</i>) on red sand.

The pre-European vegetation association corresponding with the study area (Vegetation Association 699) has over 99% of its original extent remaining (Government of Western Australia 2016a).

The vegetation was assessed as being largely in Excellent condition (92.53%), with the remainder in Very Good or Good condition (**Map 3**). The area is currently grazed by cattle and is subject to frequent fires, with the time since the last fire ranging from 2 years to over 5 years. Grazing and frequent fires are common throughout the Kimberley, and are considered to not have affected the study area any more than any other part of the region occupying a similar landform.

5.4 FAUNA

5.4.1 HABITAT TYPES

The two habitat types recorded from the study area are similar in composition and structure. Both habitats are dominated by grasslands and have an open to moderately open taller vegetation layer (shrubs and trees). The two habitats intersect each other at several locations (**Map 5**). The *Aristida* and *Chrysopogon* Tussock Grassland has a slightly more significant role in the area as it supports more suitable conditions for the Spectacled Hare-wallaby in the region. In particular, where the grass layer is denser, it provides suitable shelter for the species during the hot conditions of the day. The shrubland over tussock grassland has potential to provide some suitable conditions for the Greater Bilby, however, the species was not recorded during extensive searches within this habitat type.

5.4.2 FAUNA INVENTORY

During the survey, a total of 82 species (seven native mammals, three introduced species of mammal, 38 birds, 25 species of reptile, three amphibians and six SRE species) were recorded from the study area. In comparison to other surveys in the region, this is a comparable number in particular when considering the small size of the study area (900 ha) and the low diversity of habitat types present (lack of drainage lines and rocky areas) (**Table 22**).

The number of mammals, amphibians and SRE invertebrate species recorded during the survey was moderate and as expected in the region (**Table 22**). The number of mammal species was moderate with 11 recorded species out of 44 potential species comprising of three introduced species and seven native mammals of which three species were bats (one species could not be determined based on the call alone). There is a potential to encounter additional bat species on site based on the records of an additional 10 bat species from within 80 km of the study area (**Appendix Five**). Some of these species are specialised in preferring particular habitats such as mangroves or caves which are not present on site, therefore the likelihood of the species to occur is very low.

The remaining mammal species recorded during the survey are all typical inhabitants and expected to occur. Species such as the Red Kangaroo or the Western Chestnut Mouse may occasionally occur on site but their presence depends on the conditions in the region and further inland. Other species such as the water-rat or the Short-tailed Mouse are highly habitat dependent (Water pools and Cracking Clay plains). These species have been recorded in the surrounding area but are highly unlikely to inhabit the site.

The bird assemblage was with 38 recorded species relatively low in comparison to other surveys previously undertaken in the region which averaged 64.6 species (**Table 22**). The relatively low number is caused by the composition of the habitat types present at the study area. In particular habitats that attract a variety of bird species such as riparian vegetation or water holes were not present on site which lowers the overall number of occurring bird species.

The majority of birds recorded from site comprise of generalist species such as the Pied Butcherbird, Black-faced Cuckoo-shrike or the White-throated Gerygone. Some species that are more water dependent, such as the White-necked Heron, were recorded from outside the study area (**Appendix Five**). These species are highly unlikely to be present in the habitat types inside the study area but are likely to be encountered in the surrounding area where conditions are more suitable.

A total of 25 reptile species was recorded from site which is a comparable number to similar surveys (average of 17.7 recorded species) when considering the small size of the study area and the limited diversity of habitats on site. The SAC predicted that additional trapping and survey effort may have recorded a few more species (**Section 3.2.9**). These are likely to have included additional ground dwelling gecko species such *Lucasium stenodactylum*, *Heteronotia binoei* or *Gehyra pilbara*, but also snake species such as the Moon Snake (*Furina ornata*), the Mulga Snake (*Pseudechis australis*) or Spotted Snake (*Suta punctata*) which have been recorded in the region and typically inhabit grasslands and plains (**Appendix Five**). It is expected that larger snakes such as the mulga snake would be found in the wetlands north of the study area where prey is plentiful.

Based on the type of habitats present and the lack of creeklines or other drainage lines, the number of amphibians recorded was as expected, totalling three species (two burrowing species and one arboreal species). There is a total of 15 species of frog that have been previously recorded in the region, nine of which are not burrowing species and require permanent moisture (**Table 35** in **Appendix Five**). For this reason they are not likely to occur on site, with the exception of the Green Tree Frog which was recorded from arboreal habitats. The remaining four burrowing species are likely to inhabit the substrate on site and be active after heavy rainfall when conditions are wet above ground (2009).

Table 22: Regional fauna species recorded

Source	Mammals native (feral)	Birds	Reptiles	Amphibians	Invertebrate SRE	Total
Commonwealth <i>Protected Matters Search</i> (PMST)*	2(0)	39	0	0	0	41
<i>Atlas of Living Australia</i>	1(0)	90	5	3	0	99
<i>NatureMap</i>	19(2)	224	48	8	1	302
<i>WAM crustacean</i>	-	-	-	-	1	1
<i>WAM Molluscs</i>	-	-	-	-	4	4
<i>WAM Arachnids</i>	-	-	-	-	0	0
Orange Flat (Biota 2013a)	0	5	0	0	0	5
Jackaroo (Outback 2014)	3(3)	66	2	1	0	75
Ungani (2013b; Biota 2013c)	2(1)	27	6	0	0	36
James Price Point Vertebrate (ecologia 2011)	10(1)	82	33	2	-	128
James Price Point SRE (ecologia 2012a)	-	-	-	-	10	10
James Price Point (Biota 2009b)	9(2)	67	40	0	12	130
James Price Point (AECOM 2010)	4(4)	103	17	0	0	128
Thunderbird Haul Road (ecologia 2016a)	10(3)	63	3	0	0	19
Thunderbird Baseline Lv1 (ecologia 2012b)	5(3)	71	7	1	0	87
Thunderbird Baseline Lv2 (ecologia 2016b)	5(3)	106	41	8	24	187
Frome Rocks (Astron 2013)	4(4)	38	4	0	0	50
Yakka Munga (Buru Energy 2013)	1(2)	16	2	0	0	21
Beagle Bay (ecologia 2005a)	5(2)	65	27	4	0	103
Duchess Paradise Fauna survey (Western Wildlife 2011)	18(6)	131	48	11	0	214
This survey	7(3)	38	25	3	6	82

5.4.2.1 Greater Bilby (*Macrotis lagotis*) (EPBC Act Vulnerable; WA/BC Act Schedule 3)

The greater bilby is currently listed under the *EPBC Act* as Vulnerable and the *WC/BC Act* as Schedule 3 (fauna that is rare or is likely to become extinct as vulnerable fauna). Once very widespread, the only extant species of Bilby- the Greater Bilby (*Thylacomyidae*, *Macrotis lagotis*), is now rare and scattered. The Greater Bilby is mostly confined to northern and mostly inland locations, in particularly sandy deserts. It occupies a variety of habitats with uncluttered ground-level vegetation, including cracking clays, desert sandplains, and dune fields with hummock grassland and Acacia shrubland (Van Dyck & Strahan 2008). In the Dampier Peninsula, it is often associated with open woodland and open forest pindan habitat, with a lower preference for pindan shrubland and other vegetation communities (Southgate 2012). Mixed shrublands dominated by *Acacia* and *Grevillea* along paleo-drainage systems are also preferred (Southgate & Carthew 2006).

The Greater Bilby has been recorded from a number of locations in the local region including active burrows at Sheffield's proposed Thunderbird mineral sands project site, 75 km north of the study area (**Map 1, Table 32 in Appendix Six**). A desktop review was completed identifying 643 records of the Greater Bilby within 40 km of the study area (Government of Western Australia 2017a). No evidence of Greater Bilby presence was recorded within the study area. The four plot searches and all other searches across the study area (**Map 4**) did not record any diggings, burrows or scats. When present, the Greater Bilby is considered relatively easy to locate because of its distinctive tracks, burrows and foraging holes. Cryptic presence within the study area is therefore highly unlikely. Habitat was recorded that potentially provides suitable conditions within the shrubland over Tussock Grassland habitat. The species is also known to follow smaller drainage lines where food sources are more common. There are no drainage lines or land features supporting riparian vegetation within the study area.

Any vegetation clearing or development within the study area is highly unlikely to impact the Greater Bilby in the region. The study area shows no signs of the species and in the event that the species may move occasionally into the area then the loss of habitat is negligible on a regional scale.

5.4.2.2 Rainbow Bee-eater (*Merops ornatus*) (WC/BC Act Schedule 5)

The Rainbow Bee-eater is currently listed under the *WC/BC Act* as Schedule 5 (Migratory birds protected under an internal agreement). The Rainbow Bee-eater is found throughout mainland Australia, eastern Indonesia, New Guinea and, rarely, the Solomon Islands. In Australia it is widespread, except in desert areas, and breeds throughout most of its range. Southern birds move north to winter over. Its preferred habitat is shrublands, major drainage lines and rivers where their main food, insects, are most abundant. Nest tunnels are built in the sandy substrate either along river banks or on flat ground.

The species has been recorded from numerous sites and other project areas in the vicinity (AECOM 2010; Biota 2009b; ecologia 2005a; 2012a; 2016a; 2016b; Outback 2014; Western Wildlife 2011) (**Table 33 in Appendix Six**). The species has been recorded across the study area and is one of the most abundant bird species on site. They were found in both habitat types. Breeding activities or nesting tunnels were not recorded and neither habitat was particularly suitable for breeding.

Vegetation clearing has the potential to impact some individuals at the site. The habitats identified during the survey are common throughout the area. Rainbow Bee-eaters are highly mobile and will move from areas of disturbance.

5.4.2.3 Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*) (DBCA Priority 3)

The Spectacled Hare-wallaby occurs in grasslands and open woodlands in the lower rainfall regions of northern Australia. Its distribution and abundance has contracted since European settlement and has declined in Western Australia but remains relatively common in some parts of the Northern Territory and northern Queensland (Van Dyck & Strahan 2008).

The Spectacled Hare-wallaby is listed by DBCA as Priority 3 (P3) and was presumed locally extinct prior to 2015 when road kill and several other records were discovered in close vicinity to the study area. A total of 159 records are currently known from within 10 km of the study area including records from the Roebuck Plain station in 2015 (Government of Western Australia 2017a; WWF-Australia 2015).

The study area comprises suitable habitat for this species. This survey recorded scats and shelter scrapes providing evidence for the presence of this species, in particular in areas not burnt within the past 5 years (**Map 5**). Further investigation using spotlight transects would confirm this. Any vegetation clearing on site is likely to impact the species and reduce the availability of habitat for the species on a local level. However, regional impacts on the species are unlikely.

5.4.2.4 Dampier Peninsula Goanna (*Varanus sparnus*) (DBCA Priority 1)

The Dampier Peninsula Goanna was described in 2014 after it was originally found in 2009 at Coloumb Point, approximately 88 km north-west of the study area (Doughty *et al.* 2014). The species is now known across the Dampier Peninsula. It was recorded during the Thunderbird project survey, 75 km north-east of the study

area (ecologia 2014c). The species is listed as DBCA Priority 1. This is based on the limited number of records to date (Priority 1 applies to species known from only a few locations, typically from lands not managed for conservation) (DPaW 2007-2017). The species is very closely related to the common Short-tailed Pygmy Monitor *Varanus brevicauda* and the morphological similarities may be the cause for the limited number of records of *V. sparnus* to date. The species is likely more common in the Kimberley region than currently known.

During the current survey, the Dampier Peninsula Goanna was recorded from all trap sites, totalling seven individuals (**Table 44, Map 5**). The species inhabits the two habitat types present on site and is highly likely to also inhabit surrounding areas of grassland and shrubland habitat. The majority of surveys undertaken in the vicinity did not include trapping (Level 1 surveys) which may be a major factor in the low number of records of the species. The species is difficult to observe and record without trapping effort due to its cryptic life history. The Dampier Peninsula Goanna appears to be abundant on site and the habitats are not restricted to the study area.

Vegetation clearing is unlikely to significantly impact the species on a local or regional level. Tussock grasslands with shrubs are common in the region.

5.4.2.5 SRE Invertebrate species

Pseudoscorpions (Pseudoscorpiones)

- **Family Olpiidae**

- *Olpiidae sp.*

A mixed shrub layer provided leaf litter at two sites, NBY S1 and S2. Two specimens were collected but at an early stage of development. As a result the specimens cannot be identified to genus level. Further, the current knowledge of the taxonomy of this group is insufficient to accurately determine the geographic distribution of the species, therefore the species is categorised as a potential SRE. Molecular identification would potentially provide additional information on the specimen's identity. The specimens were recorded from the common habitat type 'shrubland over tussock grassland' thus the distribution of the taxa is unlikely to be restricted.

- *Euryolpium sp. B09*

One individual of the morpho-taxa *Euryolpium sp. B09* was recorded from leaf litter collection at site NBY S3, in the north-east of the study area. The site is dominated by *Aristida* and *Chrysopogon* Tussock Grassland characterised by scattered shrubs and trees and very sparse leaf litter. Species of *Euryolpium* are commonly found under bark and under rocks throughout Australia. They can be locally abundant, and at least one species is widespread across northern Australia. The species is likely widespread based on the habitat it was found in. Based on the precautionary principle, the morpho-species is considered a potential SRE until further taxonomic work has been completed.

- *Beierolpium 8/4 sp. B18*

Beierolpium is a genus in the pseudoscorpion family *Olpiidae* and defined by a specific arrangement of the trichobothria on the chela fingers (**Figure 10**). There is no taxonomic framework for these pseudoscorpions in Australia but adult specimens in the 8/4 group have four trichobothria on the movable pedipalp finger. Two specimens of the species *Beierolpium 8/4 sp. B18* were recorded from leaf litter collections at trap sites NBY S3 and NBY S4. The sites are located in the *Aristida* and *Chrysopogon* Tussock Grassland habitat. The habitat is particularly low on leaf litter due to the very sparse shrub and tree layer. Species of this genus have been reported from several surveys throughout Western Australia and the SRE status is currently undetermined (Biologic 2015; Phoenix 2010). The systematics for members of this genus have not been established adequately and it is not possible to confirm its identity until a complete systematic revision of the genus *Beierolpium* in Western Australian has been undertaken (ecologia 2010, K. M. Abrams, WA Museum, 2015 pers. comm.). Similar specimens of the species *Beierolpium 8/4* collected from the Coolgardie and Gascoyne region have previously been assessed to not be of conservation concern (Bennelongia2016; Ecologia 2014a). Based on the precautionary principle the species is considered a potential SRE until a

taxonomic revision has been completed. The species was recorded from a habitat that is widespread in the region.



Figure 10: *Beierolpium 8/4* recorded from the Gascoyne region (Ecologia 2014a).

Slater (Isopoda)

- **Armadillidae**
 - *Buddelundia sp. B74*

One specimen was recorded as *Buddelundia sp. B74* from one dry pitfall site (NBY S1). The site was located in shrubland over tussock grassland habitat. The genus *Buddelundia* has been recorded frequently from across Western Australia (Bennelongia 2012; Biologic 2015; ecologia 2007). Some species of this genus are regarded as widespread whereas others are considered confirmed SRE species (Ecologia 2014b). At this stage, the information available is not sufficient to determine the status of this taxa (Bennelongia 2016). For this reason *Buddelundia sp. B74* is considered a potential SRE species as per the precautionary principle.

Scorpions (Scorpiones)

- **Buthidae**
 - *Lychas sp. B11*

In total five specimens of *Lychas sp. B11* were recorded from two dry pitfall sites: NBY S1 and NBY S4. The two sites were located in different habitat types, the *Aristida* and *Chrysopogon* Tussock Grassland (NBY S4) and the Shrubland over Tussock Grassland habitat (NBY S1). Four male individuals were recorded from site NBY S1 and one male individual was collected at site NBY S4. Most species of the genus *Lychas* are widespread and have been recorded from across Western Australia. *Lychas sp. B11* has some characteristics that may indicate the species is limited in its distribution. Records of this species are currently limited and the species should be considered a potential SRE based on the precautionary principle. It is likely that the species is widespread such as other *Lychas* species in WA (ecologia 2014a).

- *Lychas splendens*

Three individuals of the morpho-species *Lychas splendens* were recorded from three sites: NBY S1, NBY S2, and NBY S4. The taxonomic assessment of these specimens indicates classification as potential SRE species. The species has been recorded from across Western Australia with records from as far as the northern Coolgardie region (ecologia 2014a).

6 CONCLUSIONS

6.1 FLORA AND VEGETATION

The flora and vegetation survey was conducted between 27 April and 12 May 2017, which is not within the optimal survey period according to the *Flora and Vegetation Technical Guidance* (EPA 2016e). However, there were no botanical survey constraints due to the above average wet season rainfall followed by sporadic showers supplementing soil moisture prior to the survey.

The species richness of the study area (117 species) was low in comparison with other flora and vegetation surveys in same IBRA bioregions, however, Ecoscape considers that this is related to the lack of habitat diversity within the study area rather than any deficiency in survey; this opinion is confirmed by the species accumulation curve that indicates that 96% of expected species were recorded during the field survey.

Only one conservation significant flora species was recorded: *Triodia caelestialis* (P3), which was recorded as a characteristic species throughout much of the study area, and occurred within 12 of the 13 floristic quadrats recorded (that included three regional quadrats outside the study area). The range that this species occupies, that takes in three IBRA regions, indicates that it is poorly collected rather than being of conservation concern.

No weeds of significance were recorded.

Three vegetation types were recorded from the study area; review of other Kimberley flora and vegetation surveys indicate that similar vegetation occurs over a much wider area within the IBRA subregion. None of the vegetation is of any conservation significance i.e. none is representative of any currently described TEC or PEC, nor has any other significance according the *Flora and Vegetation Technical Guidance* (EPA 2016e).

The vegetation was largely in Excellent condition, with less than 8% being in lesser condition (Very Good or Good), due to the effects of cattle grazing, tramping and soil disturbance that were largely confined to thoroughfares along the roads and fencelines. The study area had experienced a number of recent fires, including one approximately 2 years prior to the field survey that was deliberately lit. However, there was no correlation between fire age and vegetation condition, likely due to frequent fires (generally caused by lightning) being a common occurrence in the region, and the vegetation having adapted to the natural fire regime.

Ecoscape concludes that the flora and vegetation of the study area is representative of similar areas throughout the IBRA subregions, and is of no specific significance.

6.2 FAUNA AND FAUNA HABITAT

Two fauna habitat types were recorded from the study area: Shrubland over mixed Tussock Grassland and *Aristida* and *Chrysopogon* Tussock Grassland. The shrubland over mixed Tussock Grassland was more widespread in the study area than the *Aristida* and *Chrysopogon* Tussock Grassland with a ratio of about 77% to 23%. The two habitat types are widespread in the region and are not limited to the study area.

The recorded 82 species of fauna (seven native mammals, three introduced species of mammal, 38 birds, 25 species of reptile, three amphibians and six potential SRE species) are a moderate result for a Level 2 survey of a small sized study area containing two habitat types. The sampling recorded an adequate number of fauna during the survey with 70% of 75% of invertebrate species recorded, 92% of the trappable fauna species.

Drainage lines are not present at the study area and often harbour a large number of species. The presence of this habitat types would have increased the species of fauna recorded.

Four species of conservation significance have a moderate to high likelihood to occur or have been recorded from site: Greater Bilby, Rainbow Bee-eater, Spectacled Hare-wallaby and Dampier Peninsula Goanna. None of the species are likely to be significantly impacted by the proposed development of the study area.

258 invertebrate specimens were recorded from dry pitfall trapping, opportunistic searches and leaf litter collections. Of these, 20 individuals were sorted into six morpho-species which have the potential to represent potential Short-range Endemic species based on the current level of taxonomic knowledge and/or lack thereof. All species are currently not known to be restricted and it is unlikely that the species are significantly impacted by the proposed development.

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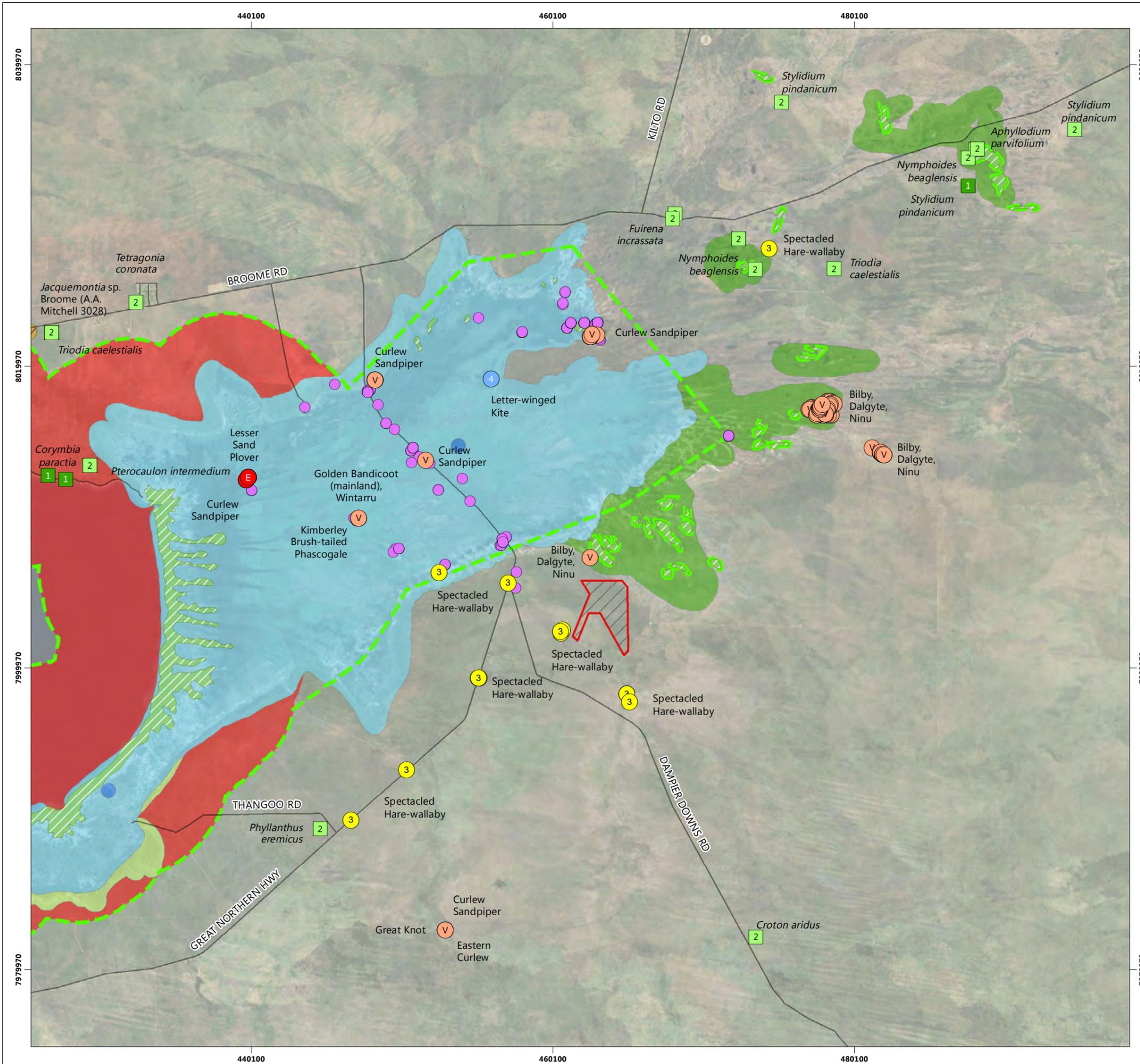
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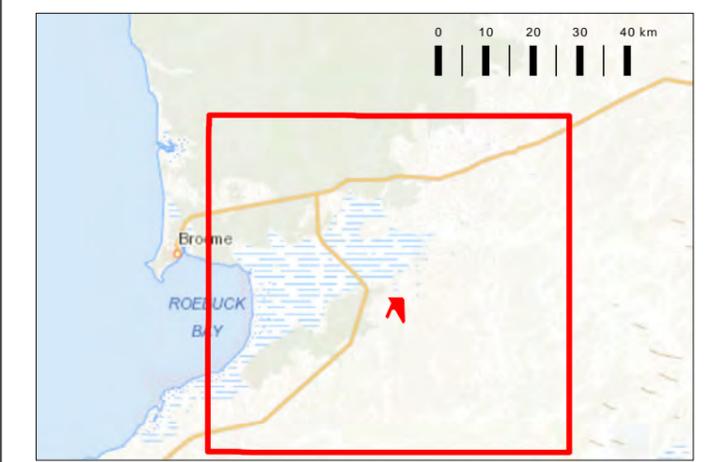
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MAPS



- Study Area
- Directory of Important Wetlands
- Environmentally Sensitive
- Conservation Significant Vegetation Community**
- Vulnerable, Vine thickets on coastal sand dunes of Dampier Peninsula
- Vulnerable, Species-rich faunal community of the intertidal mudflats of Roebuck Bay
- Priority 1, Relict dune system dominated by extensive stands of Minyjuru (Mangarr) Sersalisia (formerly Pouteria) sericea.
- Priority 1, *Corymbia paractia* dominated community on dunes
- Priority 3, Kimberley Vegetation Association
- Priority 3, Kimberley Vegetation Association
- Priority 3, Kimberley Vegetation Association
- Priority 3, Roebuck Land System
- Conservation Significant Fauna Search Results**
- EN & IA
- VU
- P3
- P4
- IA
- Conservation Significant Flora Search Results**
- P1
- P3

DATASOURCES:
 SOURCE DATA: DPAW DATABASE SEARCH RESULTS
 AERIAL: ESRI BASEMAP
 SERVICE LAYERS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRIID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY



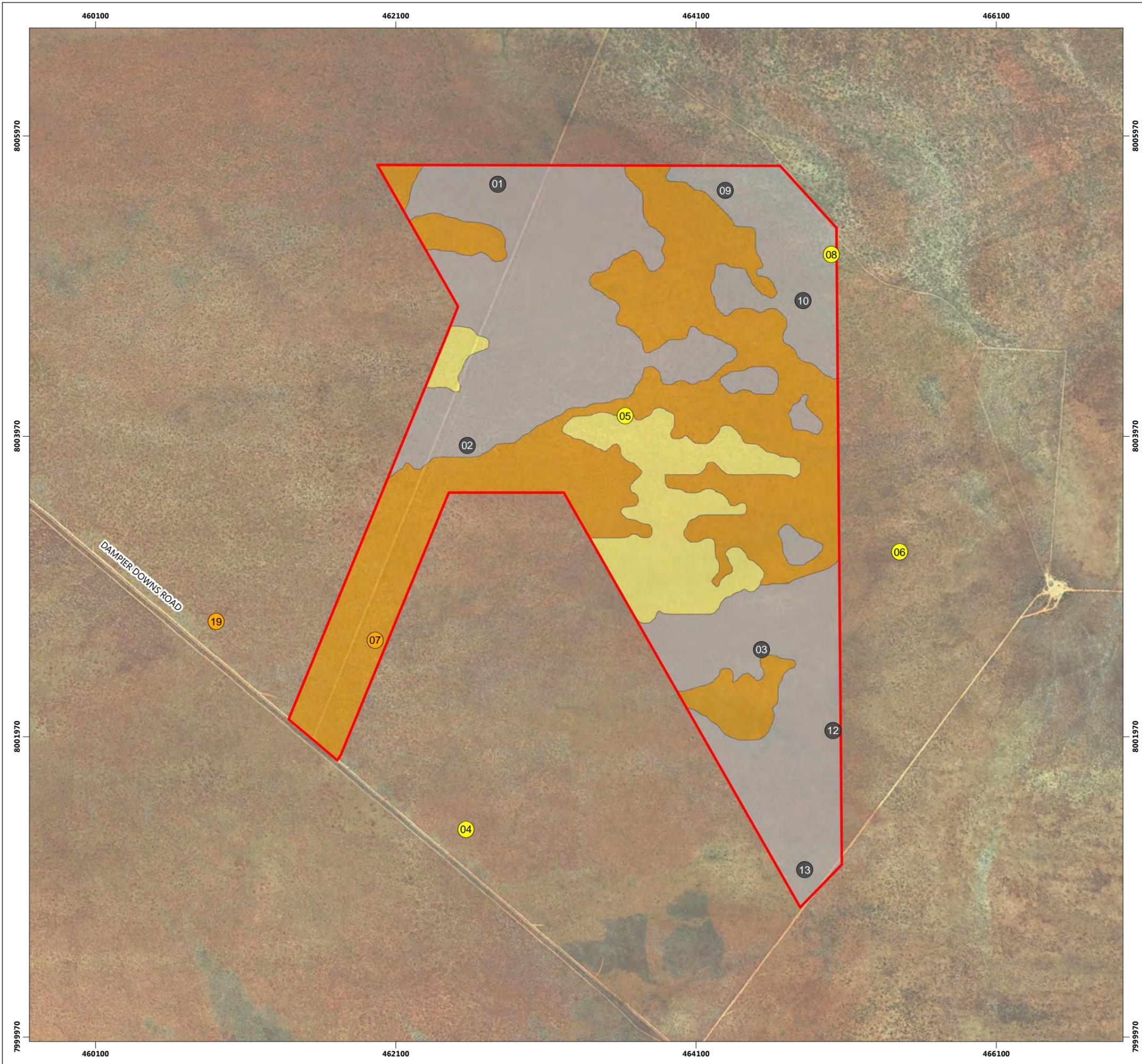
**NYAMBA BURU YAWURU FLORA AND FAUNA SURVEY
 DESKTOP ENVIRONMENTAL FACTORS ASSESSMENT**

COORDINATE SYSTEM: GDA 1994 MGA ZONE 51
 PROJECTION: TRANSVERSE MERCATOR
 DATUM: GDA 1994
 UNITS: METER



PROJECT NO: 3930-17

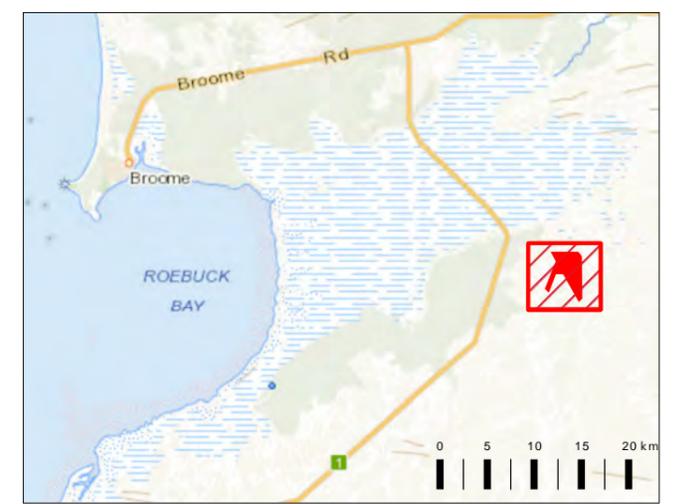
REV	AUTHOR	APPROVED	DATE
01	AF	LA	5/7/2017
02	JN	AH	8/8/2017



LEGEND

- Study Area
- Flora Quadrat Location**
- 2 years
- 3 to 4 years
- 5 years or greater
- Fire Age Mapping**
- 2 years
- 3 to 4 years
- 5 years or greater

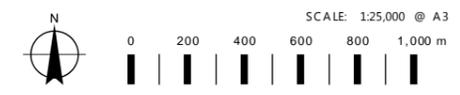
DATASOURCES :
 SOURCE DATA:
 AERIAL:
 SERVICE LAYERS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY



**NYAMBA BURU YAWURU FLORA AND FAUNA SURVEY
 FIRE AGE**



COORDINATE SYSTEM: GDA 1994 MGA ZONE 51
 PROJECTION: TRANSVERSE MERCATOR
 DATUM: GDA 1994
 UNITS: METER



PROJECT NO: 3930-17

REV	AUTHOR	APPROVED	DATE
01	JN	AH	8/8/2017

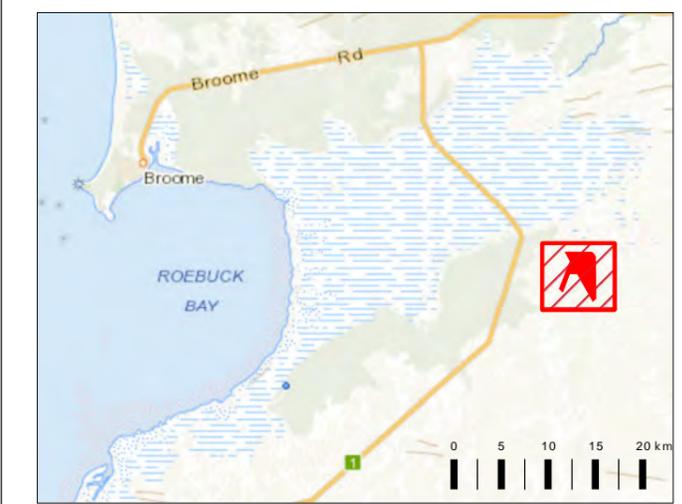
**MAP
 02**



LEGEND

- Study Area
- Conservation Significant Flora
 - Triodia caelestialis*
- Introduced Flora
 - **Stylosanthes hamata*
- Flora Quadrat Location and Condition
 - Excellent
 - Very Good
- Vegetation Community Type
 - BdBcLOW
 - BdCzLOW
 - CzCgBcLW
- Vegetation Condition
 - Excellent
 - Very Good
 - Good

DATASOURCES :
 SOURCE DATA:
 AERIAL:
 SERVICE LAYERS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY



NYAMBA BURU YAWURU FLORA AND FAUNA SURVEY

VEGETATION COMMUNITIES, CONDITION AND QUADRAT LOCATIONS

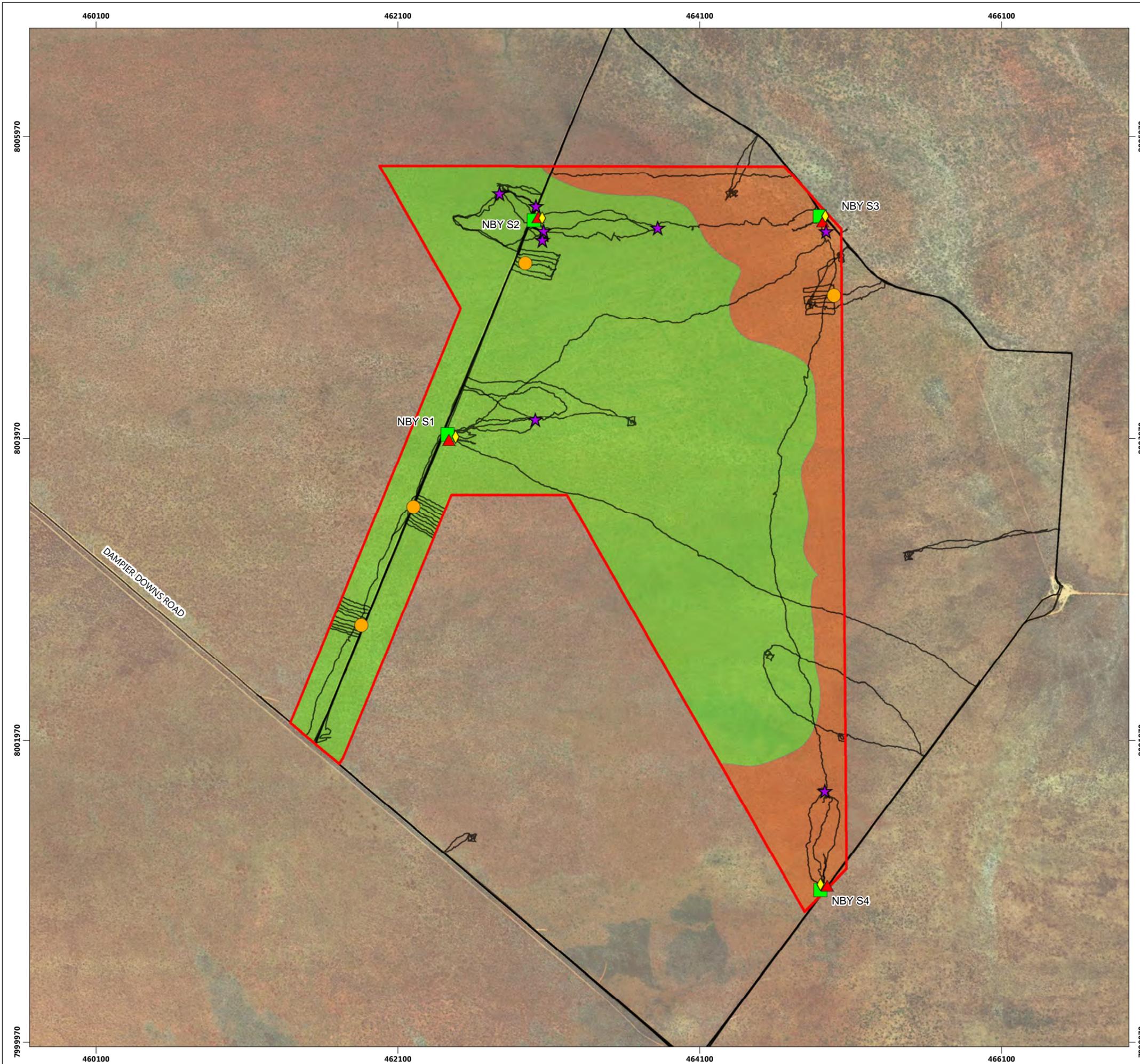


COORDINATE SYSTEM: GDA 1994 MGA ZONE 51
 PROJECTION: TRANSVERSE MERCATOR
 DATUM: GDA 1994
 UNITS: METER



PROJECT NO: 3930-17

REV	AUTHOR	APPROVED	DATE
01	AF	LA	5/7/2017
02	JN	AH	8/8/2017



LEGEND

- Study Area
- Tracks walked

Fauna Survey Site Locations

Survey Site Type

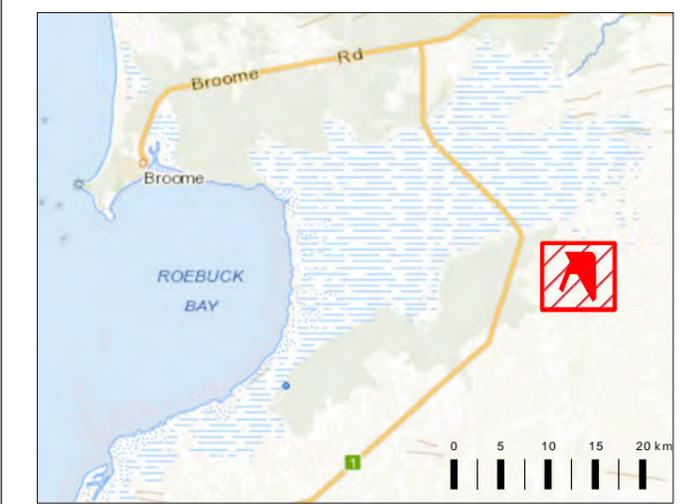
- Vertebrate Trap site, Invertebrate Dry Pitfall and Leaf litter site
- Systematic Bird site
- Bat call recorder site
- Motion Camera
- Bilby Plot

Fauna Habitat Mapping

Fauna Habitat Type

- Aristida* and *Chrysopogon* Tussock Grassland
- Shrubland over mixed Tussock Grassland

DATASOURCES :
 SOURCE DATA:
 AERIAL:
 SERVICE LAYERS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY



NYAMBA BURU YAWURU FLORA AND FAUNA SURVEY

FAUNA SURVEY SITE LOCATIONS AND SURVEY TRACKS



COORDINATE SYSTEM: GDA 1994 MGA ZONE 51
 PROJECTION: TRANSVERSE MERCATOR
 DATUM: GDA 1994
 UNITS: METER

SCALE: 1:25,000 @ A3

PROJECT NO: 3930-17

REV	AUTHOR	APPROVED	DATE
01	AF	AXH	5/7/2017
02	JN	AXH	8/8/2017

MAP
04



LEGEND

- Study Area
- Fire Age of > 5 years

Potential SRE species recorded

- ◆ Beierolpium 8/4 sp. B18
- ◆ Buddelundia sp. B74
- ◆ Euryolpium sp. B09
- ◆ Lychas sp. B11
- ◆ Lychas splendens
- ◆ Oolpidae sp.

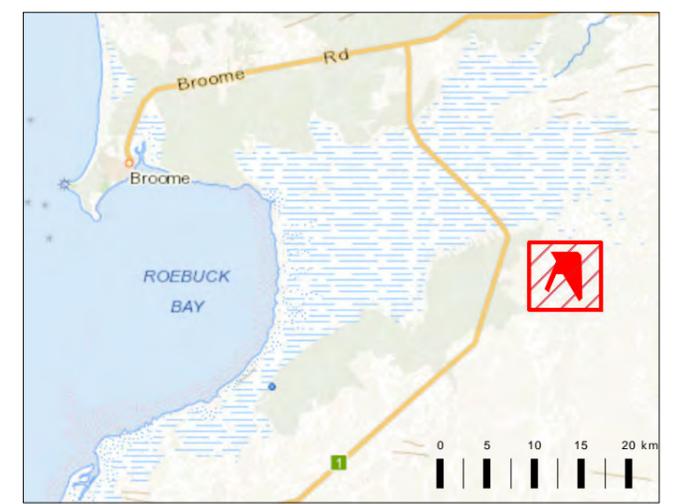
Conservation Significant Vertebrate Species Records

- Dampier Peninsula goanna
- Rainbow Bee-eater
- Spectacled Hare-Wallaby

Fauna Habitat Type

- Aristida* and *Chrysopogon* Tussock Grassland
- Shrubland over mixed Tussock Grassland

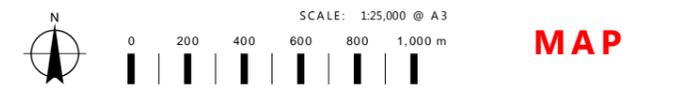
DATASOURCES:
 SOURCE DATA:
 AERIAL:
 SERVICE LAYERS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AERGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY



NYAMBA BURU YAWURU FLORA AND FAUNA SURVEY
FAUNA HABITAT AND CONSERVATION SIGNIFICANT FAUNA LOCATIONS



COORDINATE SYSTEM: GDA 1994 MGA ZONE 51
 PROJECTION: TRANSVERSE MERCATOR
 DATUM: GDA 1994
 UNITS: METER



PROJECT NO: 3930-17

REV	AUTHOR	APPROVED	DATE
01	AF	AXH	5/7/2017
02	JN	AXH	8/8/2017

APPENDIX ONE

DEFINITIONS AND CRITERIA

Table 23: EPBC Act 1999 categories for flora and fauna

EPBC ACT 1999 category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time:
	(a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) 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.
Critically Endangered (CE)	A native species is eligible to be included in the critically endangered category 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.
Endangered (EN)	A native species is eligible to be included in the endangered category at a particular time if, at that time:
	(a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the vulnerable category at a particular time if, at that time:
	(a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time:
	(a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or
	(b) the following subparagraphs are satisfied:
	(i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised;
	(iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 24: Conservation codes for Western Australian flora and fauna (DPaW 2017)

Conservation Codes for Western Australian Flora and Fauna	
T	<p>Threatened species* Published as Specially Protected under the <i>Wildlife Conservation Act 1950</i>, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).</p> <ul style="list-style-type: none"> • Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act. • Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or is otherwise in need of special protection' pursuant to section 23F(2) of the Wildlife Conservation Act. <p>The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.</p>
CR	<p>Critically Endangered species Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the <i>Wildlife Conservation Act 1950</i>, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.</p>
EN	<p>Endangered species Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the <i>Wildlife Conservation Act 1950</i>, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.</p>
VU	<p>Vulnerable species Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the <i>Wildlife Conservation Act 1950</i>, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.</p>
EX	<p>Presumed extinct species 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 <i>Wildlife Conservation Act 1950</i>, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.</p>
IA	<p>Migratory birds protected under an international agreement 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 <i>Wildlife Conservation Act 1950</i>, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.</p>
CD	<p>Conservation Dependent fauna 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 <i>Wildlife Conservation Act 1950</i>, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice</p>
OS	<p>Other specially protected fauna Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the <i>Wildlife Conservation Act 1950</i>, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice</p>
P	<p>Priority species Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.</p>
P1	<p>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 or 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 localities 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.</p>
P2	<p>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 localities 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.</p>
P3	<p>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 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. Such species are in need of further survey.</p>

Conservation Codes for Western Australian Flora and Fauna	
P4	<p>Priority Four: Rare, Near Threatened and other species in need of monitoring</p> <p>(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.</p> <p>(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.</p> <p>(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</p>
<p>¹The definition of flora includes algae, fungi and lichens.</p> <p>²Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).</p>	

Table 25: DBCA definitions and criteria for TECs and PECs (DEC 2013)

Criteria	Definition
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	<p>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.</p> <p>An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):</p> <ul style="list-style-type: none"> A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	<p>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.</p> <p>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. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C):</p> <ul style="list-style-type: none"> A. The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): <ul style="list-style-type: none"> i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): <ul style="list-style-type: none"> i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	<p>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.</p> <p>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. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C):</p> <ul style="list-style-type: none"> A. The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): <ul style="list-style-type: none"> i. the estimated geographic range, and/or total area occupied and/or number of discrete

Criteria	Definition
	<p>occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);</p> <ul style="list-style-type: none"> ii. modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. <p>B. Current distribution is limited, and one or more of the following apply (i, ii or iii):</p> <ul style="list-style-type: none"> i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii. there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii. there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. <p>The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).</p>
Vulnerable (VU)	<p>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.</p> <p>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. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):</p> <ul style="list-style-type: none"> A. The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B. The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C. The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.
Priority ecological communities	
Priority One	<p><i>Poorly known ecological communities</i></p> <p>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.</p>
Priority Two	<p><i>Poorly known ecological communities</i></p> <p>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.</p>
Priority Three	<p><i>Poorly known ecological communities</i></p> <ul style="list-style-type: none"> 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 may 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. <p>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.</p>
Priority Four	<p>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.</p> <ul style="list-style-type: none"> i. 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.

Criteria	Definition
	<ul style="list-style-type: none"> ii. 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. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	<p><i>Conservation Dependent Ecological Communities</i></p> <p>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.</p>

Table 26: NVIS structural formation terminology, terrestrial vegetation (ESCAVI 2003)

		Cover characteristics							
		Foliage cover *	70-100	30-70	10-30	<10	» 0 (scattered)	0-5 (clumped)	unknown
		Cover code	d	c	i	r	bi	bc	unknown
Growth Form	Height Ranges (m)	Structural Formation Classes							
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	tree, palm	
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	tree mallee	
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrub, cycad, grass-tree, tree-fern	
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrub	
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrub	
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrub	
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrub	
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grass	
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grass	
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grass	
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedge	
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rush	
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs	forb	
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	fern	
bryophyte	<0.5	closed bryophyte-land	bryophyte-land	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophyte	
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichen	
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vine	

Table 27: NVIS height classes (ESCAVI 2003)

Height		Growth form				
Height Class	Height Range (m)	Tree, vine (M & U), palm (single-stemmed)	Shrub, heath shrub, chenopod shrub, ferns, samphire shrub, cycad, tree-fern, grass-tree, palm (multi-stemmed)	Tree mallee, mallee shrub	Tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)	Bryophyte, lichen, seagrass, aquatic
8	>30	tall	NA	NA	NA	NA
7	10-30	mid	NA	tall	NA	NA
6	<10	low	NA	mid	NA	NA
5	<3	NA	NA	low	NA	NA
4	>2	NA	tall	NA	tall	NA
3	1-2	NA	mid	NA	tall	NA
2	0.5-1	NA	low	NA	mid	tall
1	<0.5	NA	low	NA	low	low

Source: (based on Walker & Hopkins 1990)

Table 28: Vegetation Condition Scale for the Eremaean and Northern Botanical Provinces (EPA 2016e)

Condition rating	Description
Excellent	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX TWO

FLORA RESULTS

Table 29: Conservation significant flora database and literature search results (vascular flora)

Note: 'possible' species highlighted

Species name	Data source*	EPBC Act status	DBCAs status	Habitat	Likelihood of occurrence
<i>Acacia monticola x tumida</i> var. <i>kulparn</i>	1	-	P3	Rocky sand loam, sand. Gullies, cliffs, near coastal. Low <i>Corymbia</i> woodland over low/shrubland/grassland.	Unlikely
<i>Aphyllodium glossocarpum</i>	1	-	P3	Sand. Pindan, mostly near coastal.	Unlikely
<i>Aphyllodium parvifolium</i>	1,3,10	-	P1	Swampy margins of lagoon, sand, sandhills. Melaleuca shrubland, Acacia shrubland.	Unlikely
<i>Bonamia oblongifolia</i>	9	-	P1	Sandy or gravelly soils, swampy area. <i>Corymbia</i> woodland over <i>Acacia</i> shrubland, <i>Acacia</i> shrubland.	Possible
<i>Corymbia paractia</i>	1	-	P1	Skeletal soils. In transition zone between coastal beach dunes & red pindan soils.	Highly unlikely
<i>Croton aridus</i>	1,10	-	P3	Deep red sand, pindan soil. Sandplains or ridges, spinifex sandplains.	Possible
<i>Decaisnina signata</i> subsp. <i>cardiophylla</i>	1	-	P1	Parasitic on <i>Banksia dentata</i> .	Highly unlikely
<i>Fuirena incrassata</i>	1,8,10	-	P3	Sand, sandy clay. Swamps, creek beds, claypans, semi-saline lakes.	Unlikely
<i>Fuirena nudiflora</i>	8	-	P1	Swamps, creek beds.	Highly unlikely
<i>Glycine pindanica</i>	1	-	P3	Pindan soils. Low woodland over grassland.	Possible
<i>Gomphrena pusilla</i>	1	-	P2	Largely coastal Pilbara. Fine beach sand. Behind foredune, on limestone.	Highly unlikely
<i>Goodenia bymesii</i>	1,4	-	P3	Sand. <i>Corymbia</i> woodland over grassland.	Unlikely
<i>Goodenia crenata</i>	4,9	-	P3	Sandplain, sandstone.	Highly unlikely
<i>Goodenia sepalosa</i> var. <i>glandulosa</i>	1	-	P3	Red sand or loam. Woodland over shrubland/grassland.	Unlikely
<i>Haemodorum capitatum</i>	1,10	-	P1	Sand. Pindan shrubland.	Possible
<i>Hibiscus kenneallyi</i>	1	-	P3	Coastal soils, sandstone. In rock crevices, cliff tops.	Unlikely
<i>Isolepis humillima</i>	1,10	-	P2	Red/brown clay. Claypans, seepages, along watercourses.	Unlikely
<i>Jacquemontia</i> sp. Broome (A.A. Mitchell 3028)	1	-	P1	Pindan. <i>Corymbia</i> or <i>Acacia</i> woodland.	Unlikely
<i>Nicotiana heterantha</i>	1	-	P1	Black clay. Seasonally wet flats. Near coastal in Kimberley.	Highly unlikely
<i>Nymphoides beaglensis</i>	1	-	P3	In shallow freshwater. Edges of permanent waterholes or in seasonally inundated claypans & depressions.	Highly unlikely
<i>Pandanus spiralis</i> var. <i>flammeus</i>	1	EN	T	White clay. Springs, gully.	Highly unlikely
<i>Phyllanthus eremicus</i>	1,10	-	P3	Rocky outcrops, red sandplains. Low shrubs over <i>Triodia</i> .	Possible
<i>Pittosporum moluccanum</i>	1	-	P4	White sand. Sand dunes, coastal.	Highly unlikely
<i>Polymeria</i> sp. Broome (K.F. Kenneally 9759)	1	-	P1	Drainage lines, pindan sand, near coastal. <i>Acacia</i> shrubland.	Unlikely
<i>Pterocaulon intermedium</i>	1,3,4,5,6,7,8,9	-	P3	Sandy loam. Plain. Melaleuca woodland over grassland.	Unlikely
<i>Schoenus punctatus</i>	1	-	P3	Sedgefield, woodland.	Unlikely
<i>Seringia exastia</i> Formerly <i>Keraudrenia</i>	1,2	CR	T	Red sand, Pindan. <i>Corymbia</i> woodland over <i>Acacia</i> shrubs over grassland.	Unlikely

Species name	Data source*	EPBC Act status	DBCAs status	Habitat	Likelihood of occurrence
<i>exastia</i>					
<i>Seringia katatona</i>	1	-	P3	Red sand. Desert dunes. Corymbia woodland over Triodia.	Unlikely
<i>Stylidium pindanicum</i>	1	-	P3	Seasonally damp areas over pindan sands, clay. Eucalypt woodlands over grasses.	Unlikely
<i>Tephrosia andrewii</i>	1	-	P1	Sand. In pindan country. Acacia shrubland.	Unlikely
<i>Tephrosia velleculata</i>	8	-	P3		
<i>Terminalia kumpaja</i>	1	-	P3	Pindan sand. Acacia shrubland. Mostly Pilbara species.	Unlikely
<i>Tetragonia coronata</i>	1	-	P3	Pindan plain (market garden). Mostly Carnarvon bioregion.	Highly unlikely
<i>Thespidium basiflorum</i>	1	-	P1	Sandy soils. Creeks. Melaleuca forest. Mostly NT and Qld species.	Highly unlikely
<i>Tribulopsis marliesiae</i>	1,10	-	P3	Red sand. Pindan shrubland.	Possible
<i>Triodia acutispicula</i>	1	-	P3	Sandy soils. River levees, pindan plains, rocky hillslopes & outcrops. Mostly coastal.	Unlikely
<i>Triodia caelestialis</i>	1,5,6,7,8,9,10	-	P3	Sand. Pindan scrub, Corymbia woodland over grassland.	Possible

* Data sources:

- 1 = DPaW/DBCAs database search results
- 2 = PMST result
- 3 = Biota Environmental Sciences (2013a) *Orange Flat Level 1 Vegetation, Flora and Fauna Assessment*, ~35 km N
- 4 = Biota Environmental Sciences (2013c) *Ungani Study Area Flora and Fauna Assessment*, ~45 km E
- 5 = Biota Environmental Sciences (2013b) *Ungani Pipeline, Access Track and Highway Depot Level 1 Vegetation, Flora and Fauna Assessment*, ~45 km E
- 6 = Ecologia Environment (2012b) *Thunderbird Dampier Peninsula Project Level 1 Flora and Fauna Assessment*, ~75 km N
- 7 = Ecologia Environment (2016a) *Thunderbird Haul Road & Accommodation Camp. Flora and Fauna Assessment*, ~70 km N
- 8 = Ecologia Environment (2014b) *Sheffield Resources Limited - Thunderbird Project Level 2 Flora and Vegetation Assessment*, ~75 km N
- 9 = Outback Ecology (2014) *Jackaroo Level 1 Flora, Vegetation and Vertebrate Fauna Survey*, ~38 km E
- 10 = Government of Western Australia (2017a) *Desktop Review Lot 270 on Plan 220197 (Crown Lease 3114-499) (Roebuck Plain Station)*.

Table 30: Site x species (flora inventory)

Family	Name	Naturalised	Cons. Code	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10	Q12	Q13	Q19	OPP
Aizoaceae	<i>Trianthema pilosum</i>			X	X	X	X	X	X	X	X	X	X		X	X	
Amaranthaceae	<i>Ptilotus calostachyus</i>			X		X			X	X	X	X	X	X	X		
	<i>Ptilotus lanatus</i>					X											
	<i>Ptilotus polystachyus</i>			X				X								X	
Apocynaceae	<i>Carissa lanceolata</i>				X										X	X	
	<i>Marsdenia viridiflora</i>					X	X	X			X				X		
	<i>Tylophora cinerascens</i>									X							
Araliaceae	<i>Trachymene oleracea</i>		X														
Bignoniaceae	<i>Dolichandrone heterophylla</i>				X		X			X	X		X			X	
Boraginaceae	<i>Ehretia saligna</i>																X
	<i>Heliotropium foliatum</i>													X		X	
	<i>Heliotropium leptaleum</i>			X	X	X	X	X	X	X	X	X				X	
	<i>Heliotropium paniculatum</i>								X								
	<i>Trichodesma zeylanicum</i>			X			X			X	X	X	X	X	X	X	
Caryophyllaceae	<i>Polycarpaea longiflora</i>							X	X	X	X					X	
Celastraceae	<i>Stackhousia intermedia</i>			X	X	X	X	X		X		X	X	X	X	X	
Cleomaceae	<i>Cleome tetrandra</i>			X	X	X	X		X	X	X	X	X	X	X	X	
Commelinaceae	<i>Murdannia graminea</i>						X	X	X					X		X	
Convolvulaceae	<i>Evolvulus alsinoides</i> var. <i>decumbens</i>			X	X	X	X		X	X	X	X	X			X	
	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>					X		X		X			X				
	<i>Polymeria ambigua</i>			X								X	X		X	X	
Cucurbitaceae	<i>Cucumis variabilis</i>			X	X	X	X			X			X	X	X		
Cyperaceae	<i>Bulbostylis barbata</i>			X	X	X	X	X	X	X	X	X	X	X	X	X	
	<i>Crosslandia setifolia</i>											X					
	<i>Fimbristylis ammobia</i>								X		X	X	X		X		
	<i>Fimbristylis oxystachya</i>							X							X		
	<i>Fimbristylis rara</i>										X						
Euphorbiaceae	<i>Euphorbia psilosperma</i>															X	
	<i>Microstachys chamaelea</i>													X			
Fabaceae	<i>Acacia eriopoda</i>			X	X	X	X	X	X	X	X	X	X	X	X	X	
	<i>Acacia platycarpa</i>						X		X						X	X	
	<i>Acacia plectocarpa</i> subsp. <i>plectocarpa</i>				X						X	X	X				
	<i>Acacia</i> sp.															X	
	<i>Acacia</i> sp. indet.								X								
	<i>Acacia tumida</i>														X		
	<i>Bauhinia cunninghamii</i>			X	X		X	X	X	X	X	X	X	X	X	X	

Family	Name	Naturalised	Cons. Code	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10	Q12	Q13	Q19	OPP
	<i>Cajanus marmoratus</i>						X				X					X	
	<i>Chamaecrista symonii</i>						X			X							
	<i>Crotalaria cunninghamii</i>										X						
	<i>Crotalaria medicaginea</i> var. <i>neglecta</i>				X	X	X		X	X		X	X	X	X		
	<i>Crotalaria ramosissima</i>																X
	<i>Cullen corallum</i>													X			
	<i>Desmodium filiforme</i>						X			X			X				
	<i>Erythrophleum chlorostachys</i>					X								X			
	<i>Glycine tomentella</i>			X							X	X					
	<i>Indigofera colutea</i>			X				X			X	X	X	X		X	
	<i>Indigofera linifolia</i>			X	X	X	X	X	X	X	X	X	X				
	<i>Indigofera linnaei</i>			X	X				X	X			X	X			
	<i>Rhynchosia minima</i>							X	X								
	<i>Senna costata</i>				X						X		X	X	X		
	<i>Senna notabilis</i>			X	X	X	X	X	X	X	X		X	X	X	X	
	<i>Stylosanthes hamata</i>	*															X
	<i>Tephrosia leptoclada</i>					X		X		X			X	X	X	X	
	<i>Tephrosia remotiflora</i>			X	X			X	X		X	X	X		X		
	<i>Tephrosia</i> sp. D Kimberley Flora (R.D. Royce 1848)									X							
	<i>Zornia chaetophora</i>			X				X									
	<i>Zornia prostrata</i>			X			X				X	X		X		X	
Goodeniaceae	<i>Goodenia sepalosa</i> var. <i>sepalosa</i>			X	X	X	X	X	X	X	X	X	X	X	X	X	
Malvaceae	<i>Abutilon otocarpum</i>			X				X			X		X	X	X	X	
	<i>Brachychiton diversifolius</i>						X			X				X		X	
	<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>			X	X		X	X	X			X	X				
	<i>Corchorus sidoides</i>			X	X	X	X	X	X	X	X	X	X	X	X	X	
	<i>Corchorus tridens</i>					X		X						X		X	
	<i>Gossypium australe</i>				X												
	<i>Hibiscus leptocladus</i>			X						X			X	X	X		
	<i>Melhania oblongifolia</i>			X	X	X		X	X	X	X	X		X		X	
	<i>Sida hackettiana</i>						X										
	<i>Sida rohlenae</i> subsp. <i>occidentalis</i>			X	X	X		X	X	X				X	X		
	<i>Sida</i> sp. Pindan (B.G. Thomson 3398)			X	X	X		X	X				X	X	X		
	<i>Waltheria indica</i>			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Menispermaceae	<i>Tinospora smilacina</i>			X	X	X	X					X	X	X	X	X	

Family	Name	Naturalised	Cons. Code	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10	Q12	Q13	Q19	OPP	
Moraceae	<i>Ficus aculeata</i>							X	X		X		X	X				
Myrtaceae	<i>Calytrix exstipulata</i>																X	
	<i>Corymbia greeniana</i>															X		
	<i>Corymbia zygophylla</i>				X	X		X		X				X	X	X		
Nyctaginaceae	<i>Boerhavia coccinea</i>				X			X			X							
Oleaceae	<i>Jasminum didymum</i> subsp. <i>lineare</i>													X	X			
Orobanchaceae	<i>Striga squamigera</i>												X	X	X	X		
Phyllanthaceae	<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>				X										X			
	<i>Phyllanthus maderaspatensis</i>						X	X	X	X		X						
Poaceae	<i>Aristida holathera</i> var. <i>holathera</i>			X	X	X	X	X	X	X	X	X	X	X	X	X		
	<i>Aristida holathera</i> var. <i>latifolia</i>			X	X				X		X	X	X	X	X			
	<i>Aristida hygrometrica</i>			X	X	X	X	X	X	X		X	X			X		
	<i>Chrysopogon fallax</i>			X	X	X	X	X		X		X	X	X	X	X		
	<i>Cynodon convergens</i>													X				
	<i>Eragrostis eriopoda</i>			X	X	X	X	X	X			X	X					
	<i>Eriachne melicacea</i>					X							X					
	<i>Eriachne obtusa</i>								X			X			X			
	<i>Eriachne pindanica</i>				X	X	X	X		X			X	X	X			
	<i>Panicum decompositum</i>														X			
	<i>Perotis rara</i>											X	X	X	X			
	<i>Sorghum plumosum</i>			X	X	X	X	X		X				X	X	X		
	<i>Sorghum timorense</i>									X		X	X					
	<i>Thaumastochloa pubescens</i>												X	X				
	<i>Triodia caelestialis</i>		P3	X	X	X	X	X	X	X		X	X	X	X	X	X	
	<i>Urochloa pubigera</i>									X								
	<i>Whiteochloa airoides</i>					X												
<i>Yakirra australiensis</i>			X	X	X	X	X	X	X	X	X	X	X	X	X			
Portulacaceae	<i>Calandrinia strophilata</i>			X	X	X		X		X	X	X	X	X	X	X		
	<i>Portulaca bicolor</i>				X							X	X					
	<i>Portulaca filifolia</i>			X	X						X					X		
	<i>Portulaca oleracea</i>							X										
Proteaceae	<i>Grevillea pyramidalis</i>								X									
	<i>Grevillea refracta</i> subsp. <i>refracta</i>												X	X				
	<i>Hakea ?arborescens</i>															X		
	<i>Hakea macrocarpa</i>						X								X			
Rhamnaceae	<i>Ventilago viminalis</i>				X					X			X					

Family	Name	Naturalised	Cons. Code	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10	Q12	Q13	Q19	OPP
Rubiaceae	<i>Gardenia pyriformis</i>			X	X	X	X	X	X			X	X	X		X	
	<i>Oldenlandia mitrasacmoides</i>																X
	<i>Spermacoce occidentalis</i>			X	X			X	X		X	X	X	X	X		
Sapindaceae	<i>Atalaya hemiglauca</i>															X	
	<i>Dodonaea hispidula</i>					X	X								X		
Solanaceae	<i>Solanum cunninghamii</i>			X	X	X	X	X	X	X		X	X	X	X	X	
	<i>Solanum dioicum</i>																X
	<i>Solanum diversiflorum</i>						X	X	X					X		X	
Violaceae	<i>Hybanthus aurantiacus</i>						X	X	X	X		X	X		X	X	
Zygophyllaceae	<i>Tribulopsis angustifolia</i>				X				X		X			X		X	

APPENDIX THREE FLORISTIC QUADRAT DATA

Q01

Staff CWP **Date** 28/04/2017 **Season** E
Revisit
Type Q
Location
MGA Zone 51 462780 **mE** 8005650 **mN** **Lat.** -18.0373 **Long.** 122.6483
Habitat Sandplain
Aspect NW **Slope** Very Gentle
Soil Type Pindan
Rock Type None
Loose Rock 0% cover **Litter** 1% cover ; .2 cm in depth
Bare ground 30% cover **Weeds** 0% cover
Vegetation U ^ *Brachychiton diversifolius* subsp. *diversifolius* \^tree\6\; M ^ *Acacia eriopoda* \^shrub\4\; G+
 \^ \^ *Sorghum plumosum*, *Triodia caelestialis*, *Aristida holathera* var. *latifolia* \^tussock grass,
 hummock grass\2\c
Veg. Condition Excellent
Disturbance Cattle
Fire Age 5 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Abutilon otocarpum</i>		.3	<1	
<i>Acacia eriopoda</i>		2.5	25	
<i>Aristida holathera</i> var. <i>holathera</i>		.4	2	
<i>Aristida holathera</i> var. <i>latifolia</i>		.4	20	
<i>Aristida hygrometrica</i>		.3	3	

<i>Bauhinia cunninghamii</i>	2.3	1
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>	7	3
<i>Bulbostylis barbata</i>	.15	<1
<i>Calandrinia strophiolata</i>	.1	<1
<i>Chrysopogon fallax</i>	.4	10
<i>Cleome tetrandra</i>	.15	<1
<i>Corchorus sidoides</i>	.3	<1
<i>Cucumis variabilis</i>	.2	<1
<i>Eragrostis eriopoda</i>	.2	2
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	.1	<1
<i>Gardenia pyriformis</i>	1.8	<1
<i>Glycine tomentella</i>	.15	<1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.15	<1
<i>Heliotropium leptaleum</i>	.15	<1
<i>Hibiscus leptocladus</i>		<1
<i>Indigofera colutea</i>	.15	<1
<i>Indigofera linifolia</i>	.15	<1
<i>Indigofera linnaei</i>	.15	<1
<i>Melhania oblongifolia</i>	.3	1
<i>Polymeria ambigua</i>	.1	<1
<i>Portulaca filifolia</i>	.1	<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Ptilotus polystachyus</i>	.3	<1
<i>Senna notabilis</i>	1.2	<1
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	.25	<1
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.3	<1
<i>Solanum cunninghamii</i>	.2	<1
<i>Sorghum plumosum</i>	1	5
<i>Spermacoce occidentalis</i>	.1	<1
<i>Stackhousia intermedia</i>	.25	<1
<i>Tephrosia remotiflora</i>	.15	<1
<i>Tinospora smilacina</i>	.2	<1
<i>Trachymene oleracea</i>	.4	<1
<i>Trianthema pilosum</i>	.05	<1
<i>Trichodesma zeylanicum</i>	.3	<1
<i>Triodia caelestialis</i>	P3 .5	15
<i>Waltheria indica</i>	.7	2
<i>Yakirra australiensis</i>	.15	1
<i>Zornia chaetophora</i>	.2	<1
<i>Zornia prostrata</i>	.1	<1

Q02

Staff CWP **Date** 27/04/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 462575 **mE** 8003910 **mN** **Lat.** -18.0530 **Long.** 122.6464

Habitat Sandplain

Aspect NW **Slope** Very Gentle

Soil Type Pindan sand clay

Rock Type None

Loose Rock 0% cover **Litter** 2% cover ; .05 cm in depth

Bare ground 20% cover **Weeds** 0% cover

Vegetation U ^^ *Corymbia zygophylla*, *Brachychiton diversifolius* subsp. *diversifolius*, *Bauhinia cunninghamii* \^tree\6\r;M \^ *Acacia eriopoda* \^shrub\4\i;G+ \^ *Sorghum plumosum*, \^ *Triodia caelestialis* \^tussock grass, hummock grass\2\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age 5 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Acacia eriopoda</i>		2	15	
<i>Acacia plectocarpa</i> subsp. <i>plectocarpa</i>		1.8	1	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	1	
<i>Aristida holathera</i> var. <i>latifolia</i>		.3	1	
<i>Aristida hygrometrica</i>		.6	1	

<i>Bauhinia cunninghamii</i>	4	5
<i>Boerhavia coccinea</i>	.16	<1
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>	6	3
<i>Bulbostylis barbata</i>	.15	<1
<i>Calandrinia strophilata</i>	.1	<1
<i>Carissa lanceolata</i>	1.2	<1
<i>Chrysopogon fallax</i>	.5	2
<i>Cleome tetrandra</i>	.3	<1
<i>Corchorus sidoides</i>	.3	1
<i>Corymbia zygophylla</i>	6	2
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.25	<1
<i>Cucumis variabilis</i>	.2	<1
<i>Dolichandrone heterophylla</i>	1.1	<1
<i>Eragrostis eriopoda</i>	.25	<1
<i>Eriachne pindanica</i>	.15	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	.15	<1
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>	1.5	<1
<i>Gardenia pyriformis</i>	.25	1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.15	<1
<i>Gossypium australe</i>	.5	<1
<i>Heliotropium leptaleum</i>	.15	<1
<i>Indigofera linifolia</i>	.2	<1
<i>Indigofera linnaei</i>	.15	<1
<i>Melhania oblongifolia</i>	.3	1
<i>Portulaca bicolor</i>	.05	<1
<i>Portulaca filifolia</i>	.2	<1
<i>Senna costata</i>	1.2	1
<i>Senna notabilis</i>	1.2	<1
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	.2	<1
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.2	<1
<i>Solanum cunninghamii</i>	.4	1
<i>Sorghum plumosum</i>	1.7	45
<i>Spermacoce occidentalis</i>	.2	<1
<i>Stackhousia intermedia</i>	.3	<1
<i>Tephrosia remotiflora</i>	.3	1
<i>Tinospora smilacina</i>	.1	<1
<i>Trianthema pilosum</i>	0.1	<1
<i>Tribulopsis angustifolia</i>	.1	<1
<i>Triodia caelestialis</i>	P3 .6	10
<i>Ventilago viminalis</i>	.5	<1
<i>Waltheria indica</i>	.6	2
<i>Yakirra australiensis</i>	.15	

Q03

Staff CWP **Date** 28/04/2017 **Season** E
Revisit
Type Q 50 m x 50 m
Location
MGA Zone 51 464536 **mE** 8002550 **mN** **Lat.** -18.0654 **Long.** 122.6649
Habitat Sandplain
Aspect NW **Slope** Very Gentle
Soil Type Pindan sand clay
Rock Type None
Loose Rock 0% cover **Litter** 5% cover ; .01 cm in depth
Bare ground 15% cover **Weeds** 0% cover
Vegetation M ^ *Acacia eriopoda*, ^ *Waltheria indica* \ ^ shrub \ 4 \ ; G+ ^ *Chrysopogon fallax*, ^ *Whiteochloa airoides* \ ^ tussock grass \ 2 \ c
Veg. Condition Excellent
Disturbance Cattle
Fire Age 5 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Acacia eriopoda</i>		2.5	15	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	2	
<i>Aristida hygrometrica</i>		.3	1	
<i>Bulbostylis barbata</i>			1	
<i>Calandrinia strophiolata</i>		.15	<1	
<i>Chrysopogon fallax</i>		1	30	

<i>Cleome tetrandra</i>	.2	<1
<i>Corchorus sidoides</i>	.3	1
<i>Corchorus tridens</i>	.15	<1
<i>Corymbia zygophylla</i>	3.5	1
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.2	1
<i>Cucumis variabilis</i>	.4	<1
<i>Dodonaea hispidula</i>	.5	<1
<i>Eragrostis eriopoda</i>	.2	1
<i>Eriachne melicacea</i>	.25	<1
<i>Eriachne pindanica</i>	.2	2
<i>Erythrophleum chlorostachys</i>	.8	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>		<1
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	.15	<1
<i>Gardenia pyriformis</i>	.25	<1
<i>Gardenia pyriformis</i>	3.5	1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.15	<1
<i>Heliotropium leptaleum</i>	.2	<1
<i>Indigofera linifolia</i>	.15	<1
<i>Marsdenia viridiflora</i>	.3	<1
<i>Melhania oblongifolia</i>	.2	<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Ptilotus lanatus</i>	.15	<1
<i>Senna notabilis</i>	1.2	1
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	.3	<1
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.3	<1
<i>Solanum cunninghamii</i>	.3	<1
<i>Sorghum plumosum</i>	.8	4
<i>Stackhousia intermedia</i>	.2	<1
<i>Tephrosia leptoclada</i>	.15	<1
<i>Tinospora smilacina</i>	.2	<1
<i>Trianthema pilosum</i>	.05	<1
<i>Triodia caelestialis</i>		
	P3	
<i>Waltheria indica</i>	1.2	5
<i>Whiteochloa airoides</i>	.7	25
<i>Yakirra australiensis</i>	.15	2

Q04

Staff CWP **Date** 28/04/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 462567 **mE** 8001352 **mN** **Lat.** -18.0762 **Long.** 122.6462

Habitat Sandplain

Aspect NE **Slope** Very Gentle

Soil Type Pindan sand clay

Rock Type None

Loose Rock 0% cover **Litter** 1% cover ; .1 cm in depth

Bare ground 30% cover **Weeds** 0% cover

Vegetation U ^ *Brachychiton diversifolius* subsp. *diversifolius*, ^ *Bauhinia cunninghamii* ^tree\6\r;M ^ *Acacia eriopoda* ^shrub\4\i;G+ ^^ *Chrysopogon fallax*, *Triodia caelestialis*, *Sorghum plumosum* ^tussock grass, hummock grass\2\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age 3 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Acacia eriopoda</i>		2	15	
<i>Acacia platycarpa</i>		1.4	1	
<i>Aristida holathera</i> var. <i>holathera</i>		.2	<1	
<i>Aristida hygrometrica</i>		.4	1	
<i>Bauhinia cunninghamii</i>		4	3	

<i>Brachychiton diversifolius</i>	.5	<1
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>	4	2
<i>Bulbostylis barbata</i>	.2	<1
<i>Cajanus marmoratus</i>		<1
<i>Chamaecrista symonii</i>	.35	1
<i>Chrysopogon fallax</i>	1.2	20
<i>Cleome tetrandra</i>	.2	<1
<i>Corchorus sidoides</i>	.25	1
<i>Corchorus sidoides</i>	.25	<1
<i>Corchorus sidoides</i>	.2	<1
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.3	<1
<i>Cucumis variabilis</i>	2	1
<i>Desmodium filiforme</i>	.2	<1
<i>Dodonaea hispidula</i>	.6	2
<i>Dolichandrone heterophylla</i>	3.5	<1
<i>Eragrostis eriopoda</i>	.2	<1
<i>Eriachne pindanica</i>	.2	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	.15	<1
<i>Gardenia pyriformis</i>	3	1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.15	<1
<i>Hakea macrocarpa</i>	2.5	1
<i>Heliotropium leptaleum</i>	.1	<1
<i>Hybanthus aurantiacus</i>	.2	<1
<i>Indigofera linifolia</i>	.2	<1
<i>Marsdenia viridiflora</i>	.2	<1
<i>Murdannia graminea</i>	.35	<1
<i>Phyllanthus maderaspatensis</i>	.15	<1
<i>Senna notabilis</i>	1.2	<1
<i>Sida hackettiana</i>	.8	1
<i>Solanum cunninghamii</i>	.4	<1
<i>Solanum diversiflorum</i>	.2	<1
<i>Sorghum plumosum</i>	1.2	10
<i>Stackhousia intermedia</i>	.3	1
<i>Tinospora smilacina</i>	1.2	<1
<i>Trianthema pilosum</i>	.05	<1
<i>Trichodesma zeylanicum</i>	.4	<1
<i>Triodia caelestialis</i>	P3 .8	10
<i>Waltheria indica</i>	.5	1
<i>Yakirra australiensis</i>	.2	1
<i>Zornia prostrata</i>	.1	<1

Q05

Staff CWP **Date** 2/05/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 463627 **mE** 8004106 **mN** **Lat.** -18.0513 **Long.** 122.6563

Habitat Sandplain

Aspect W **Slope** Very Gentle

Soil Type Pindan

Rock Type None

Loose Rock 0% cover **Litter** 2% cover ; .1 cm in depth

Bare ground 25% cover **Weeds** 0% cover

Vegetation U ^ *Brachychiton diversifolius* subsp. *diversifolius*, ^ *Corymbia zygophylla* ^tree\6\r;M ^ *Acacia eriopoda* ^shrub\4\i;G+ ^ ^ *Chrysopogon fallax*, *Sorghum plumosum*, *Eragrostis eriopoda* ^tussock grass\2\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age 3 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Abutilon otocarpum</i>		.4	<1	
<i>Acacia eriopoda</i>		2.4	15	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	3	
<i>Aristida hygrometrica</i>		.3	1	
<i>Bauhinia cunninghamii</i>		1.2	1	

<i>Boerhavia coccinea</i>	.15	<1	
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>	6	2	
<i>Bulbostylis barbata</i>	.15	<1	
<i>Calandrinia strophiolata</i>	.2	<1	
<i>Chrysopogon fallax</i>	.3	10	
<i>Corchorus sidoides</i>	.3	1	
<i>Corchorus tridens</i>	.2	<1	
<i>Corymbia zygophylla</i>	6	2	
<i>Eragrostis eriopoda</i>	.3	5	
<i>Eriachne pindanica</i>	.15	<1	
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	.2	<1	
<i>Ficus aculeata</i>	1.2	1	
<i>Fimbristylis oxystachya</i>	.15	<1	
<i>Gardenia pyriformis</i>	.2	<1	
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.15	<1	
<i>Heliotropium leptaleum</i>	.15	<1	
<i>Hybanthus aurantiacus</i>	.25	<1	
<i>Indigofera colutea</i>	.15	<1	
<i>Indigofera colutea</i>	.15	<1	
<i>Indigofera linifolia</i>	.15	<1	
<i>Marsdenia viridiflora</i>	.3	<1	
<i>Melhania oblongifolia</i>	.2	<1	
<i>Murdannia graminea</i>	.25	<1	
<i>Phyllanthus maderaspatensis</i>	.15	<1	
<i>Portulaca oleracea</i>	.15	<1	
<i>Ptilotus polystachyus</i>	.3	<1	
<i>Rhynchosia minima</i>	.15	<1	
<i>Senna notabilis</i>	.3	<1	
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	.2	<1	
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.3	<1	
<i>Solanum cunninghamii</i>	.2	<1	
<i>Solanum diversiflorum</i>	.2	<1	
<i>Sorghum plumosum</i>	1	10	
<i>Spermacoce occidentalis</i>	.15	<1	
<i>Stackhousia intermedia</i>	.3	<1	
<i>Tephrosia leptoclada</i>	.15	<1	
<i>Tephrosia remotiflora</i>	.3	<1	
<i>Trianthema pilosum</i>	.15	<1	
<i>Triodia caelestialis</i>	P3	.3	4
<i>Waltheria indica</i>	.6	P3	
<i>Yakirra australiensis</i>	.14	<1	
<i>Zornia chaetophora</i>			

Q06

Staff CWP **Date** 2/05/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 465457 **mE** 8003201 **mN** **Lat.** -18.0595 **Long.** 122.6736

Habitat Sandplain

Aspect NE **Slope** Very Gentle

Soil Type Pindan clay

Rock Type None

Loose Rock 0% cover **Litter** 1% cover ; 0.5 cm in depth

Bare ground 30% cover **Weeds** 0% cover

Vegetation U ^ *Brachychiton diversifolius* subsp. *diversifolius*, ^ *Bauhinia cunninghamii* ^tree\6\r;M ^ *Acacia eriopoda* ^shrub\4\i;G+ ^^ *Sorghum timorense*, *Aristida holathera* var. *holathera*, *Eragrostis eriopoda* ^tussock grass\2\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age 3 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Acacia eriopoda</i>		2.5	27	
<i>Acacia platycarpa</i>		2.1	4	
<i>Acacia</i> sp. indet.		.3	<1	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	10	
<i>Aristida holathera</i> var. <i>latifolia</i>		.4	3	

<i>Aristida hygrometrica</i>	.3	1
<i>Bauhinia cunninghamii</i>	5	5
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>	5	2
<i>Bulbostylis barbata</i>	.15	<1
<i>Cleome tetrandra</i>	.1	<1
<i>Corchorus sidoides</i>	.3	3
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.3	<1
<i>Eragrostis eriopoda</i>	.3	15
<i>Eriachne obtusa</i>	.3	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	.2	<1
<i>Ficus aculeata</i>	2.3	1
<i>Fimbristylis ammobia</i>	.15	<1
<i>Gardenia pyriformis</i>	.3	<1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.1	<1
<i>Grevillea pyramidalis</i>	1.9	<1
<i>Heliotropium leptaleum</i>	.15	<1
<i>Heliotropium paniculatum</i>	.25	<1
<i>Hybanthus aurantiacus</i>	.3	<1
<i>Indigofera linifolia</i>	.2	<1
<i>Indigofera linnaei</i>	.1	<1
<i>Melhania oblongifolia</i>	.3	1
<i>Murdannia graminea</i>	.3	<1
<i>Phyllanthus maderaspatensis</i>	.15	<1
<i>Polycarpaea longiflora</i>		<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Rhynchosia minima</i>	.15	<1
<i>Senna notabilis</i>	.3	<1
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>		<1
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.3	<1
<i>Solanum cunninghamii</i>	.2	<1
<i>Solanum diversiflorum</i>	.2	<1
<i>Sorghum timorense</i>	1	5
<i>Spermacoce occidentalis</i>	.1	<1
<i>Tephrosia remotiflora</i>	.25	<1
<i>Trianthema pilosum</i>	.1	<1
<i>Tribulopsis angustifolia</i>	.15	<1
<i>Triodia caelestialis</i>	P3	4
<i>Urochloa pubigera</i>	.1	<1
<i>Waltheria indica</i>	.5	2
<i>Yakirra australiensis</i>	.15	<1

Q07

Staff CWP **Date** 27/04/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location Roebuck plains south

MGA Zone 51 461961 **mE** 8002612 **mN** **Lat.** -18.0648 **Long.** 122.6405

Habitat Sandplain

Aspect NW **Slope** Very Gentle

Soil Type Pindan sand clay

Rock Type None

Loose Rock 0% cover **Litter** 1% cover ; .05 cm in depth

Bare ground 25% cover **Weeds** 0% cover

Vegetation U ^ *Corymbia zygophylla* ^tree\6\r;M ^ *Acacia eriopoda*, ^ *Waltheria indica* ^shrub\3\r;G+ ^ *Sorghum plumosum* var. *plumosum* ^tussock grass\2\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age 2 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Acacia eriopoda</i>		1.5	10	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	<1	
<i>Aristida hygrometrica</i>		.3	1	
<i>Bauhinia cunninghamii</i>		1.5	3	
<i>Brachychiton diversifolius</i>		.7	1	
<i>Bulbostylis barbata</i>		.1	<1	

<i>Calandrinia strophiolata</i>	.2	1
<i>Chamaecrista symonii</i>	.3	1
<i>Chrysopogon fallax</i>	.6	1
<i>Cleome tetrandra</i>	.3	<1
<i>Corchorus sidoides</i>	.3	2
<i>Corymbia zygophylla</i>	4	5
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.3	1
<i>Cucumis variabilis</i>	.3	<1
<i>Desmodium filiforme</i>	.15	<1
<i>Dolichandrone heterophylla</i>	1.5	2
<i>Eriachne pindanica</i>	.2	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	0.1	<1
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	.15	<1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.15	1
<i>Heliotropium leptaleum</i>	.25	1
<i>Hibiscus leptocladus</i>	.5	<1
<i>Hybanthus aurantiacus</i>	.3	1
<i>Indigofera linifolia</i>	.2	1
<i>Indigofera linnaei</i>	.15	<1
<i>Melhania oblongifolia</i>	.4	1
<i>Phyllanthus maderaspatensis</i>	.3	<1
<i>Polycarpaea longiflora</i>	.2	<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Senna notabilis</i>	.4	1
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	.3	<1
<i>Solanum cunninghamii</i>	.4	1
<i>Sorghum plumosum</i>	1	60
<i>Sorghum plumosum</i>	1.4	4
<i>Stackhousia intermedia</i>	.3	1
<i>Tephrosia leptoclada</i>	.1	<1
<i>Tephrosia</i> sp. D Kimberley Flora (R.D. Royce 1848)	.2	<1
<i>Trianthema pilosum</i>	.05	1
<i>Trichodesma zeylanicum</i>	1	<1
<i>Triodia caelestialis</i>	P3 .4	<1
<i>Tylophora cinerascens</i>	.3	<1
<i>Ventilago viminalis</i>	.6	1
<i>Waltheria indica</i>	.5	5
<i>Yakirra australiensis</i>	.15	1

Q08

Staff CWP **Date** 1/05/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 465001 **mE** 8005179 **mN** **Lat.** -18.0416 **Long.** 122.6693

Habitat Sandplain

Aspect N **Slope** Very Gentle

Soil Type Pindan clay

Rock Type None

Loose Rock 0% cover **Litter** 1% cover ; .1 cm in depth

Bare ground 30% cover **Weeds** 0% cover

Vegetation U ^ *Bauhinia cunninghamii* \ ^tree\6\r; M ^ *Acacia eriopoda* \ ^shrub\4\i; G+ ^ *Aristida holathera* var. *latifolia* \ ^tussock grass\1\i

Veg. Condition Very Good

Disturbance Cattle

Fire Age 4 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Abutilon otocarpum</i>		.4	<1	
<i>Acacia eriopoda</i>		2.4	12	
<i>Acacia plectocarpa</i> subsp. <i>plectocarpa</i>		1.1	<1	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	1	
<i>Aristida holathera</i> var. <i>latifolia</i>		.4	20	
<i>Aristida hygrometrica</i>		.3	2	

<i>Bauhinia cunninghamii</i>	5	<1
<i>Boerhavia coccinea</i>	.15	<1
<i>Bulbostylis barbata</i>	.16	1
<i>Cajanus marmoratus</i>	.1	<1
<i>Calandrinia strophilata</i>	.2	<1
<i>Cleome tetrandra</i>	.15	<1
<i>Corchorus sidoides</i>	.3	1
<i>Crotalaria cunninghamii</i>	1.2	1
<i>Dolichandrone heterophylla</i>	1	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	0.1	<1
<i>Ficus aculeata</i>	2	1
<i>Fimbristylis ammobia</i>	.3	1
<i>Fimbristylis rara</i>	.3	1
<i>Glycine tomentella</i>	.25	3
<i>Glycine tomentella</i>	.1	<1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.1	<1
<i>Heliotropium leptaleum</i>	.2	<1
<i>Indigofera colutea</i>	.15	<1
<i>Indigofera linifolia</i>	.15	<1
<i>Marsdenia viridiflora</i>	.3	<1
<i>Melhania oblongifolia</i>	.3	<1
<i>Perotis rara</i>	.15	<1
<i>Polycarpaea longiflora</i>	.15	<1
<i>Portulaca filifolia</i>	.15	<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Senna costata</i>	1.2	<1
<i>Senna notabilis</i>	.2	<1
<i>Sorghum timorense</i>	1	8
<i>Spermacoce occidentalis</i>	.15	1
<i>Tephrosia remotiflora</i>	.2	<1
<i>Trianthema pilosum</i>	.1	<1
<i>Tribulopsis angustifolia</i>	.15	<1
<i>Trichodesma zeylanicum</i>	.3	<1
<i>Waltheria indica</i>	.7	1
<i>Yakirra australiensis</i>	.15	<1
<i>Zornia prostrata</i>	.1	<1

Q09

Staff CWP **Date** 1/05/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 464294 **mE** 8005607 **mN** **Lat.** -18.0377 **Long.** 122.6626

Habitat Sandplain

Aspect N **Slope** Very Gentle

Soil Type Pindan clay

Rock Type None

Loose Rock 0 % cover **Litter** 2 % cover ; .1 cm in depth

Bare ground 25 % cover **Weeds** 0 % cover

Vegetation U ^ *Brachychiton diversifolius* subsp. *diversifolius* \^tree\6\; M ^ *Acacia eriopoda* \^shrub\4\; G+
 ^^ *Aristida holathera* var. *latifolia*, *Chrysopogon fallax*, *Eragrostis eriopoda* \^tussock grass\1\c

Veg. Condition Excellent

Disturbance None

Fire Age**Notes**

Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Acacia eriopoda</i>		2.2	15	
<i>Acacia plectocarpa</i> subsp. <i>plectocarpa</i>		.5	<1	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	5	
<i>Aristida holathera</i> var. <i>latifolia</i>		.4	30	
<i>Bauhinia cunninghamii</i>		2.5	3	
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>		7	2	

<i>Bulbostylis barbata</i>		<1
<i>Calandrinia strophiolata</i>	.15	<1
<i>Chrysopogon fallax</i>	.5	10
<i>Cleome tetrandra</i>	.2	<1
<i>Corchorus sidoides</i>	.3	1
<i>Crosslandia setifolia</i>	.15	<1
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.3	<1
<i>Eragrostis eriopoda</i>	.25	10
<i>Eriachne obtusa</i>	.4	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	.15	<1
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	.2	<1
<i>Fimbristylis ammobia</i>	.15	<1
<i>Gardenia pyriformis</i>	2.2	1
<i>Glycine tomentella</i>	.26	<1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.1	<1
<i>Heliotropium leptaleum</i>	.2	<1
<i>Hybanthus aurantiacus</i>	.3	<1
<i>Indigofera colutea</i>	.15	<1
<i>Indigofera linifolia</i>	.2	<1
<i>Melhania oblongifolia</i>	.3	<1
<i>Perotis rara</i>	.15	<1
<i>Phyllanthus maderaspatensis</i>	.15	<1
<i>Polycarpaea longiflora</i>	.15	<1
<i>Polymeria ambigua</i>	.1	<1
<i>Portulaca bicolor</i>	.05	<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Solanum cunninghamii</i>	.3	<1
<i>Sorghum timorense</i>	.7	5
<i>Spermacoce occidentalis</i>	.1	<1
<i>Stackhousia intermedia</i>	.3	<1
<i>Tephrosia remotiflora</i>	.2	<1
<i>Thaumastochloa pubescens</i>	.2	<1
<i>Tinospora smilacina</i>	.2	<1
<i>Trianthema pilosum</i>	.1	<1
<i>Trichodesma zeylanicum</i>	.2	<1
<i>Triodia caelestialis</i>	P3	4
<i>Waltheria indica</i>	.4	2
<i>Yakirra australiensis</i>	.15	<1
<i>Zornia prostrata</i>	.1	<1

Q10

Staff CWP **Date** 1/05/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 464813 **mE** 8004872 **mN** **Lat.** -18.0444 **Long.** 122.6675

Habitat Sandplain

Aspect **Slope** Very Gentle

Soil Type Pindan clay

Rock Type None

Loose Rock 0% cover **Litter** .5 % cover ; .05 cm in depth

Bare ground 30% cover **Weeds** 0 % cover

Vegetation U ^ *Brachychiton diversifolius* subsp. *diversifolius*, ^ *Bauhinia cunninghamii* ^tree\6\r;M ^ *Acacia eriopoda* ^shrub\4\i;G+ ^ *Chrysopogon fallax*, ^ *Sorghum timorense*, *Eragrostis eriopoda* ^tussock grass\2\c

Veg. Condition Very Good

Disturbance Cattle

Fire Age 5 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Abutilon otocarpum</i>		.4	<1	
<i>Acacia eriopoda</i>		2.4	20	
<i>Acacia plectocarpa</i> subsp. <i>plectocarpa</i>		1.2	1	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	3	
<i>Aristida holathera</i> var. <i>latifolia</i>		.5	2	

<i>Aristida hygrometrica</i>	.3	<1
<i>Bauhinia cunninghamii</i>	6	4
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>	5	2
<i>Bulbostylis barbata</i>		1
<i>Calandrinia strophilata</i>	.15	<1
<i>Chrysopogon fallax</i>	.3	30
<i>Cleome tetrandra</i>	.2	<1
<i>Corchorus sidoides</i>	.25	1
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.25	<1
<i>Cucumis variabilis</i>	.4	<1
<i>Desmodium filiforme</i>	.2	<1
<i>Dolichandrone heterophylla</i>	1	<1
<i>Eragrostis eriopoda</i>	.3	5
<i>Eriachne melicacea</i>	.2	<1
<i>Eriachne pindanica</i>	.2	<1
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	.1	<1
<i>Ficus aculeata</i>	.6	<1
<i>Fimbristylis ammobia</i>	.15	<1
<i>Gardenia pyriformis</i>	.6	<1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.1	<1
<i>Grevillea refracta</i> subsp. <i>refracta</i>	1.2	<1
<i>Hibiscus leptocladus</i>	.4	<1
<i>Hybanthus aurantiacus</i>	.3	<1
<i>Indigofera colutea</i>	.15	<1
<i>Indigofera linifolia</i>	.15	<1
<i>Indigofera linnaei</i>	.2	<1
<i>Perotis rara</i>	.15	<1
<i>Polymeria ambigua</i>	.2	<1
<i>Portulaca bicolor</i>	.1	<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Senna costata</i>	1.1	1
<i>Senna notabilis</i>	1	<1
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.2	<1
<i>Solanum cunninghamii</i>	.25	<1
<i>Sorghum timorense</i>	1	7
<i>Spermacoce occidentalis</i>	.1	<1
<i>Stackhousia intermedia</i>	.3	<1
<i>Striga squamigera</i>	.35	<1
<i>Tephrosia leptoclada</i>	.15	<1
<i>Tephrosia remotiflora</i>		<1
<i>Thaumastochloa pubescens</i>	.15	<1
<i>Tinospora smilacina</i>		

<i>Tinospora smilacina</i>		.4	<1
<i>Trianthera pilosum</i>		.1	<1
<i>Trichodesma zeylanicum</i>		.3	<1
<i>Triodia caelestialis</i>	P3	.3	2
<i>Waltheria indica</i>		.5	2
<i>Yakirra australiensis</i>		.15	<1

Q12

Staff CWP **Date** 28/04/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 465012 mE 8002011 mN **Lat.** -18.0702 **Long.** 122.6694

Habitat Sandplain

Aspect NW **Slope** Very Gentle

Soil Type Pindan sandy clay

Rock Type None

Loose Rock 0 % cover **Litter** 2 % cover ; .05 cm in depth

Bare ground 25 % cover **Weeds** 0 % cover

Vegetation U ^^ *Corymbia zygophylla*, *Bauhinia cunninghamii*, *Brachychiton diversifolius* \ ^tree\6\; M ^ *Acacia eriopoda* \ ^shrub\4\; G+ ^ *Sorghum plumosum* \ ^tussock grass\2\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age 5 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Abutilon otocarpum</i>		.3	<1	
<i>Acacia eriopoda</i>		2.4	10	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	<1	
<i>Aristida holathera</i> var. <i>latifolia</i>		.35	<1	
<i>Aristida hygrometrica</i>		.3	1	
<i>Bauhinia cunninghamii</i>		4	4	

<i>Brachychiton diversifolius</i>	5	
<i>Bulbostylis barbata</i>	.15	<1
<i>Calandrinia strophiolata</i>	.15	1
<i>Chrysopogon fallax</i>	.9	2
<i>Cleome tetrandra</i>	.2	<1
<i>Corchorus sidoides</i>	.3	<1
<i>Corchorus tridens</i>	.15	<1
<i>Corymbia zygophylla</i>	4	2
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.3	<1
<i>Cucumis variabilis</i>	.1	<1
<i>Cullen corallum</i>	.3	<1
<i>Cynodon convergens</i>	.15	<1
<i>Eriachne pindanica</i>	.15	<1
<i>Erythrophleum chlorostachys</i>	.4	1
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	.15	<1
<i>Ficus aculeata</i>	2.5	2
<i>Gardenia pyriformis</i>	.3	1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.1	<1
<i>Grevillea refracta</i> subsp. <i>refracta</i>	2	2
<i>Heliotropium foliatum</i>	.1	<1
<i>Hibiscus leptocladus</i>	.25	<1
<i>Indigofera colutea</i>	.15	<1
<i>Indigofera linnaei</i>	.15	<1
<i>Jasminum didymum</i> subsp. <i>lineare</i>	.8	<1
<i>Melhania oblongifolia</i>	.3	1
<i>Microstachys chamaelea</i>	.2	<1
<i>Murdannia graminea</i>	.2	<1
<i>Perotis rara</i>	.15	<1
<i>Ptilotus calostachyus</i>		<1
<i>Senna costata</i>	1	<1
<i>Senna notabilis</i>	.4	<1
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	.3	<1
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.3	<1
<i>Solanum cunninghamii</i>	.3	<1
<i>Solanum diversiflorum</i>	.1	<1
<i>Sorghum plumosum</i>	1.2	35
<i>Spermacoce occidentalis</i>	.15	<1
<i>Stackhousia intermedia</i>	.2	<1
<i>Striga squamigera</i>	.2	<1
<i>Tephrosia leptoclada</i>	.1	<1
<i>Tinospora smilacina</i>	.1	<1
<i>Tribulopsis angustifolia</i>		

<i>Trichodesma zeylanicum</i>		.4	<1
<i>Triodia caelestialis</i>	P3	1	1
<i>Ventilago viminalis</i>		.5	<1
<i>Waltheria indica</i>		.13	3
<i>Yakirra australiensis</i>		.15	<1
<i>Zornia prostrata</i>		.05	<1

Q13

Staff CWP **Date** 12/05/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 51 464824 **mE** 8001084 **mN** **Lat.** -18.0786 **Long.** 122.6676

Habitat Sandplain

Aspect NE **Slope** Very Gentle

Soil Type Pindan clay

Rock Type None

Loose Rock 0 % cover **Litter** 4 % cover ; .1 cm in depth

Bare ground 15 % cover **Weeds** 0 % cover

Vegetation M ^ *Acacia eriopoda* \^shrub\4\i;G+ ^ *Aristida holathera* var. *holathera*, ^ *Sorghum plumosum* \^tussock grass\2\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age >5

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Abutilon otocarpum</i>		.3	<1	
<i>Acacia eriopoda</i>		2.5	27	
<i>Acacia platycarpa</i>		2.1	2	
<i>Acacia tumida</i>		1.1	1	
<i>Aristida holathera</i> var. <i>holathera</i>		.3	25	
<i>Aristida holathera</i> var. <i>latifolia</i>		.3	5	

<i>Bauhinia cunninghamii</i>	2.3	1
<i>Bulbostylis barbata</i>	.2	<1
<i>Calandrinia strophiolata</i>	.2	<1
<i>Carissa lanceolata</i>	.7	1
<i>Chrysopogon fallax</i>	.3	18
<i>Cleome tetrandra</i>	.2	<1
<i>Corchorus sidoides</i>		<1
<i>Corymbia zygophylla</i>	2.4	2
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	.3	<1
<i>Cucumis variabilis</i>	.3	<1
<i>Dodonaea hispidula</i>	1.4	1
<i>Eriachne obtusa</i>	.25	1
<i>Eriachne pindanica</i>	.2	<1
<i>Ficus aculeata</i>	2.6	1
<i>Fimbristylis ammobia</i>	.2	<1
<i>Fimbristylis oxystachya</i>	.2	<1
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>	.9	<1
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.2	<1
<i>Hakea macrocarpa</i>	1.7	<1
<i>Hibiscus leptocladus</i>	.9	<1
<i>Hybanthus aurantiacus</i>	.3	<1
<i>Jasminum didymum</i> subsp. <i>lineare</i>	3	1
<i>Marsdenia viridiflora</i>	.15	<1
<i>Panicum decompositum</i>	.2	1
<i>Polymeria ambigua</i>	.15	<1
<i>Ptilotus calostachyus</i>	.3	<1
<i>Senna costata</i>	.14	<1
<i>Senna notabilis</i>	1.2	1
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	.3	<1
<i>Sida</i> sp. <i>Pindan</i> (B.G. Thomson 3398)	.3	1
<i>Solanum cunninghamii</i>	.3	<1
<i>Sorghum plumosum</i>	1.4	10
<i>Spermacoce occidentalis</i>	.15	<1
<i>Stackhousia intermedia</i>	.3	<1
<i>Striga squamigera</i>	.4	<1
<i>Tephrosia leptoclada</i>	.2	<1
<i>Tephrosia remotiflora</i>	.35	<1
<i>Tinospora smilacina</i>	3	1
<i>Trianthema pilosum</i>	.1	<1
<i>Trichodesma zeylanicum</i>	.3	<1
<i>Triodia caelestialis</i>	P3	.4
<i>Waltheria indica</i>		<1

Yakirra australiensis

.2

1

Q19

Staff CWP **Date** 26/04/2017 **Season** E

Revisit

Type Q 50 m x 50 m

Location RPS south

MGA Zone 51 460904 **mE** 8002738 **mN** **Lat.** -18.0636 **Long.** 122.6306

Habitat Sandplain

Aspect NE **Slope** Very Gentle

Soil Type Pindan sand/clay

Rock Type None

Loose Rock 0% cover; 2-6 mm in size **Litter** 1% cover ; .5 cm in depth

Bare ground 30% cover **Weeds**

Vegetation U+ ^ *Bauhinia cunninghamii*, ^ *Corymbia greeniana*, *Corymbia zygomphyllo* ^tree\6\c;G
^ *Chrysopogon fallax*, *Acacia platycarpa* ^tussock grass,shrub\1\c

Veg. Condition Excellent

Disturbance Cattle

Fire Age 2 years

Notes



Species	WA Cons.	Height (m)	Cover (%)	Count
<i>Abutilon otocarpum</i>		.4	1	
<i>Acacia eriopoda</i>		.8	5	
<i>Acacia platycarpa</i>		0.6	20	
<i>Acacia</i> sp.		1.5	1	
<i>Aristida holathera</i> var. <i>holathera</i>		.6	1	
<i>Aristida hygrometrica</i>		.3	<1	

<i>Atalaya hemiglauca</i>	.5	1	
<i>Bauhinia cunninghamii</i>	4	10	
<i>Brachychiton diversifolius</i>	6	2	
<i>Bulbostylis barbata</i>	.15	<1	
<i>Cajanus marmoratus</i>	.1	<1	
<i>Calandrinia strophiolata</i>		<1	
<i>Carissa lanceolata</i>	1.2	<1	
<i>Chrysopogon fallax</i>	1.2	25	
<i>Chrysopogon fallax</i>	1.2	25	
<i>Cleome tetrandra</i>	.3	1	
<i>Corchorus sidoides</i>	.2	1	
<i>Corchorus tridens</i>	.2	<1	
<i>Corymbia greeniana</i>	7	10	
<i>Corymbia zygophylla</i>	3.5	5	
<i>Dolichandrone heterophylla</i>	3	2	5
<i>Euphorbia psilosperma</i>	.2	<1	
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>		<1	
<i>Gardenia pyriformis</i>	3	2	4
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>	.1	<1	
<i>Hakea ? arborescens</i>	1.5	1	
<i>Heliotropium foliatum</i>	.2	1	
<i>Heliotropium leptaleum</i>	.2	1	
<i>Hybanthus aurantiacus</i>	.3	<1	
<i>Indigofera colutea</i>	.2	1	
<i>Melhania oblongifolia</i>	.1	1	
<i>Murdannia graminea</i>	.5	<1	
<i>Polycarpaea longiflora</i>	.1	<1	
<i>Polymeria ambigua</i>		<1	
<i>Portulaca filifolia</i>	.2	<1	
<i>Ptilotus polystachyus</i>	.3	<1	
<i>Senna notabilis</i>	.4	1	
<i>Solanum cunninghamii</i>	.5	1	
<i>Solanum diversiflorum</i>	.3	1	
<i>Sorghum plumosum</i>	1.2	1	
<i>Stackhousia intermedia</i>		1	
<i>Striga squamigera</i>	.3	<1	
<i>Tephrosia leptoclada</i>	0.2	1	
<i>Tinospora smilacina</i>	.2	1	
<i>Trianthema pilosum</i>	.1	1	
<i>Tribulopsis angustifolia</i>	.2	<1	
<i>Trichodesma zeylanicum</i>	.8	<1	
<i>Triodia caelestialis</i>			

NBY

<i>Waltheria indica</i>	.5	1
<i>Zornia prostrata</i>	1	<1

APPENDIX FOUR

FAUNA SITE LOCATIONS

Table 31: Fauna site locations

Trap site	Type	Date set	Date collected	Easting	Northing
Vertebrate Fauna					
NBY S1	Vertebrate Trap site	10/5/17	17/5/17	462402	8004013
NBY S2	Vertebrate Trap site	10/5/17	17/5/17	462982	8005418
NBY S3	Vertebrate Trap site	11/5/17	18/5/17	464922	8005442
NBY S4	Vertebrate Trap site	11/5/17	18/5/17	464927	8000979
NBY S1	Systematic Bird site	10/5/17	17/5/17	462402	8004013
NBY S2	Systematic Bird site	10/5/17	17/5/17	462982	8005418
NBY S3	Systematic Bird site	11/5/17	18/5/17	464922	8005442
NBY S4	Systematic Bird site	11/5/17	18/5/17	464927	8000979
NBY S1	Bat call recorder site	14/5/17	16/5/17	462402	8004013
NBY S2	Bat call recorder site	14/5/17	16/5/17	462982	8005418
NBY S3	Bat call recorder site	12/5/17	14/5/17	464922	8005442
NBY S4	Bat call recorder site	12/5/17	14/5/17	464927	8000979
NBY S1	Opportunistic site	12/5/17	-	462402	8004013
NBY S4	Opportunistic site	12/5/17	-		
Transect S1-3	Opportunistic site	13/5/17	-	See map	See map
Transect S1 East	Opportunistic site	13/5/17	-	See map	See map
Transect S3-2	Opportunistic site	15/5/17	-	See map	See map
Transect S4-3	Opportunistic site	16/5/17	-	See map	See map
ECO PLOT 1	Bilby Plot	16/5/17	-	464989	8004917
ECO PLOT 2	Bilby Plot	16/5/17	-	462944	8005133
ECO PLOT 3	Bilby Plot	16/5/17	-	462204	8003515
ECO PLOT 4	Bilby Plot	16/5/17	-	461858	8002731
MC081	Motion Camera	15/5/17	17/5/17	463820	8005363
REC03	Motion Camera	17/5/17	18/5/17	463064	8005343
REC06	Motion Camera	12/5/17	16/5/17	463009	8004094
REC22	Motion Camera	13/5/17	17/5/17	463013	8005507
REC28	Motion Camera	13/5/17	17/5/17	464927	8001634
REC36	Motion Camera	17/5/17	18/5/17	463056	8005284
REC41	Motion Camera	14/5/17	17/5/17	464935	8005340
REC42	Motion Camera	13/5/17	17/5/17	462772	8005591
SRE Invertebrate Fauna					
NBY S1	Dry Pitfall site	10/5/17	17/5/17	462402	8004013
NBY S2	Dry Pitfall site	10/5/17	17/5/17	462982	8005418
NBY S3	Dry Pitfall site	11/5/17	18/5/17	464922	8005442
NBY S4	Dry Pitfall site	11/5/17	18/5/17	464927	8000979
NBY S1	Leaf-litter collection	17/5/17	-	462402	8004013
NBY S2	Leaf-litter collection	17/5/17	-	462982	8005418
NBY S3	Leaf-litter collection	18/5/17	-	464922	8005442
NBY S4	Leaf-litter collection	18/5/17	-	464927	8000979

Table 32: Mammal species previously recorded from the region

Family and Species	Common name	EPBC Act	BC Act	DBCA	Western Wildlife 2011 (Duchess Paradise)	Beagle Bay (ecologia 2005)	Yakka Munga (Buru Energy 2013)	Frome Rocks (Astron 2013)	Thunderbird (ecologia 2016)	Thunderbird Lv1 (ecologia 2012b)	Thunderbird Haul Road (ecologia 2016a)	James Price Point (AECOM 2010)	James Price Point (Biota 2009)	James Price Point (ecologia 2011)	Ungani Project (Biota 2013; 2013b)	Jackaroo (Outback 2014)	Orange Flat (Biota 2013a)	NatureMap Search	DPaW threatened database search	PMST	ALA	Current Survey
TACHYGLOSSIDAE																						
<i>Tachyglossus aculeatus</i>	Echidna				✓				S		S	S										S
DASYURIDAE																						
<i>Phascogale tapoatafa subsp. kimberleyensis</i>	Kimberley Brush-tailed Phascogale		S3															✓				
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart				✓																	
<i>Sminthopsis youngsoni</i>	Lesser Hairy-footed Dunnart								✓					✓								
PERAMELIDAE																						
<i>Isoodon auratus subsp. auratus</i>	Golden Bandicoot		S3	VU														✓	✓			
<i>Isoodon macrourus</i>	Northern Brown Bandicoot																	✓				
THYLACOMYIDAE																						
<i>Macrotis lagotis</i>	Bilby	VU	S1	VU				✓	✓		S	s		✓		✓		✓	✓	✓		
MACROPODIDAE																						
<i>Lagorchestes conspicillatus leichardti</i>	Spectacled Hare-wallaby			P3														✓	✓		✓	✓
<i>Macropus agilis</i>	Aqile Wallaby				✓			✓	✓		✓	✓	S	✓	✓			✓				✓
<i>Macropus robustus</i>	Euro							✓	✓	✓												
<i>Macropus rufus</i>	Red Kangaroo				✓		✓	✓							✓	✓		✓				
<i>Onychogalea unguifera</i>	Northern Nailtail Wallaby				✓													✓				
PHALANGERIDAE																						
<i>Trichosurus vulpecula arnhemensis</i>	Northern Brushtail Possum (Kimberley)		S3		✓													✓				
PTEROPODIDAE																						
<i>Pteropus alecto</i>	Black Flying-fox				✓																	
<i>Pteropus scapulatus</i>	Litte Red Flying-fox				✓																	
EMBALLONURIDAE																						
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat				✓				✓		✓	✓										✓
<i>Taphozous georgianus</i>	Common Sheathtail Bat				✓																	
VESPERTILIONIDAE																						
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat				✓				✓	✓	✓	✓	✓					✓				
<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat					✓			✓	✓	✓	✓	✓					✓				Δ
<i>Miniopterus schreibersii</i>	Common Bent-wing Bat				✓				✓													
<i>Myotis macropus</i>	Large-footed Myotis								✓													
<i>Nyctophilus arnhemensis</i>	Arnhem Land Long-eared Bat												✓					✓				
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat								✓		✓			✓								
<i>Pipistrellus westralis</i>	Northern Pipistrelle				✓													✓				
<i>Scotorepens greyii</i>	Little Broad-nosed Bat					✓			✓	✓	✓	✓	✓									Δ
<i>Scotorepens sanborni</i>	Northern Broad-nosed Bat												✓					✓				
<i>Vespadelus douglasorum</i>	Yellow-lipped Cave Bat			P2		✓																
MOLOSSIDAE																						
<i>Chaerophon jobensis</i>	Northern Freetail Bat				✓				✓	✓	✓	✓	✓					✓				✓
<i>Mormopterus loriae</i>	Little Northern Freetail Bat																	✓				
MURIDAE																						

Family and Species	Common name	EPBC Act	BC Act	DFCA	Western Wildlife 2011 (Duchess Paradise)	Beagle Bay (ecologia 2005)	Yakka Munga (Buru Energy 2013)	Frome Rocks (Astron 2013)	Thunderbird (ecologia 2016)	Thunderbird Lv1 (ecologia 2012b)	Thunderbird Haul Road (ecologia 2016a)	James Price Point (AECOM 2010)	James Price Point (Biota 2009)	James Price Point (ecologia 2011)	Ungani Project (Biota 2013; 2013b)	Jackaroo (Outback 2014)	Orange Flat (Biota 2013a)	NatureMap Search	DPaW threatened database search	PMST	ALA	Current Survey
<i>Leggadina lakedownensis</i>	Short-tailed Mouse			P4	✓				✓													
<i>Notomys alexis</i>	Spinifex Hopping-mouse																	✓				
<i>Pseudomys delicatulus</i>	Delicate Mouse				✓	✓			✓		✓	S	✓	✓				✓				✓
<i>Pseudomys desertor</i>	Desert Mouse				✓																	
<i>Pseudomys johnsoni</i>	Central Pebble-mound Mouse																					
<i>Pseudomys nanus</i>	Western Chestnut Mouse				✓	✓			✓													
<i>Hydromys chrysoqaster</i>	Water-rat			P4														✓		✓		
INTRODUCED MAMMALS																						
<i>Mus musculus</i>	House Mouse				✓				✓				✓					✓				
<i>Rattus rattus</i>	Black Rat											✓										
<i>Canis lupus</i>	Dog/Dingo				✓		✓	✓	✓	✓	✓	✓	✓	✓		✓						✓
<i>Felis catus</i>	Cat				✓	✓		✓	✓	✓	✓	✓										✓
<i>Vulpes vulpes</i>	Red Fox																	✓				
<i>Equus asinus</i>	Donkey				✓	✓																
<i>Sus scrofa</i>	Pig				✓			✓								✓						
<i>Bos taurus</i>	Cow				✓		✓	✓	✓	✓	✓	✓			✓	✓						✓

S= Secondary evidence recorded

Δ Either species was recorded, calls are very similar so could not be identified.

Table 33: Bird species previously recorded from the region

Family and Species	Common name	EPBC Act	BC Act	DBCA	Western Wildlife 2011 (Duchess Paradise)	Beagle Bay (ecologia 2005)	Yakka Munga (Buru Energy 2013)	Frome Rocks (Astron 2013)	Thunderbird (ecologia 2016)	Thunderbird Lv1 (ecologia 2012b)	Thunderbird Haul Road (ecologia 2016a)	James Price Point (ecologia 2011)	James Price Point (Biota 2009)	James Price Point (AECOM 2010)	Ungani Project (Biota 2013; 2013b)	Jackaroo (Outback 2014)	Orange Flat (Biota 2013a)	NatureMap Search	DPaW threatened database search	PMST	ALA	Current Survey
CASUARIIDAE																						
<i>Dromaius novaehollandiae</i>	Emu				✓			✓										✓				
PHASIANIDAE																						
<i>Coturnix ypsilophora</i>	Brown Quail				✓				✓			✓	✓	✓	✓	✓		✓				
ANSERANATIDAE																						
<i>Anseranas semipalmata</i>	Magpie Goose								✓									✓		✓		
ANATIDAE																						
<i>Dendrocygna arcuata</i>	Spotted Whistling-Duck				✓				✓							✓		✓			✓	
<i>Dendrocygna eytoni</i>	Plumed Whistling-Duck				✓				✓									✓			✓	
<i>Stictonetta naevosa</i>	Freckled Duck								✓									✓				
<i>Cygnus atratus</i>	Black Swan																	✓				
<i>Tadorna tadomoides</i>	Australian Shelduck																	✓				
<i>Tadorna radjah</i>	Radjah Shelduck																	✓				
<i>Chenonetta jubata</i>	Australian Wood Duck								✓									✓				
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck								✓									✓			✓	
<i>Nettapus pulchellus</i>	Green Pygmy-Goose								✓									✓				
<i>Anas rhynchotis</i>	Australasian Shoveler																	✓				
<i>Anas gracilis</i>	Grey Teal								✓	✓						✓		✓			✓	
<i>Anas castanea</i>	Chestnut Teal																	✓				
<i>Anas querquedula</i>	Garganey	M	S5															✓	✓			
<i>Anas superciliosa</i>	Pacific Black Duck				✓				✓	✓								✓			✓	
<i>Aythya australis</i>	Hardhead								✓									✓			✓	
PODICIPEDIDAE																						
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe				✓				✓									✓				
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe																	✓				
<i>Podiceps cristatus</i>	Great Crested Grebe																	✓				
COLUMBIDAE																						
<i>*Columba livia</i>	Rock Dove																	✓				
<i>Phaps histrionica</i>	Flock Bronzewing			P4	✓						✓							✓				
<i>Ocyphaps lophotes</i>	Crested Pigeon				✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
<i>Geopelia cuneata</i>	Diamond Dove				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
<i>Geopelia striata</i>	Peaceful Dove				✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	x
<i>Geopelia humeralis</i>	Bar-shouldered Dove				✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓			✓	
<i>Ducula bicolor</i>	Pied Imperial-Pigeon																	✓				
PODARGIDAE																						
<i>Podargus strigoides</i>	Tawny Frogmouth				✓	✓			✓		✓	✓	✓	✓				✓				x
EUROSTOPODIDAE																						
<i>Eurostopodus argus</i>	Spotted Nightjar				✓				✓		✓			✓				✓				
AEGOTHELIDAE																						
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar				✓	✓			✓		✓			✓				✓				
APODIDAE																						

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<i>Apus pacificus</i>	Fork-tailed Swift	M	S5		✓	✓			✓			✓		✓				✓	✓	✓	✓	
OCEANITIDAE																						
<i>Oceanites oceanicus</i>	Wilson's Storm-Petrel	M	S5															✓	✓			
PROCELLARIIDAE																						
<i>Calonectris leucomelas</i>	Streaked Shearwater																	✓				
FREGATIDAE																						
<i>Fregata ariel</i>	Lesser Frigatebird	M	S5									✓	✓	✓				✓	✓	✓		
<i>Fregata minor</i>	Great Frigatebird	M	S5																✓			
SULIDAE																						
<i>Sula leucogaster</i>	Brown Booby											✓						✓				
ANHINGIDAE																						
<i>Anhinga novaehollandiae</i>	Australasian Darter				✓													✓				
PHALACROCORACIDAE																						
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant				✓				✓	✓												
<i>Phalacrocorax carbo</i>	Great Cormorant																	✓				
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant				✓													✓				
<i>Phalacrocorax varius</i>	Pied Cormorant				✓									✓				✓				
PELECANIDAE																						
<i>Pelecanus conspicillatus</i>	Australian Pelican								✓			✓		✓				✓				
CICONIIDAE																						
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork				✓													✓				
ARDEIDAE																						
<i>Ixobrychus flavicollis</i>	Black Bittern			P3														✓				
<i>Ardea pacifica</i>	White-necked Heron				✓			✓	✓	✓	✓					✓		✓			✓	×
<i>Ardea modesta</i>	Eastern Great Egret	M	S5		✓			✓										✓	✓		✓	
<i>Ardea intermedia</i>	Intermediate Egret				✓													✓				
<i>Ardea ibis</i>	Cattle Egret	M	S5															✓	✓			
<i>Butorides striatus</i>	Striated Heron																	✓				
<i>Egretta novaehollandiae</i>	White-faced Heron				✓				✓	✓				✓							✓	
<i>Egretta garzetta</i>	Little Egret				✓																✓	
<i>Egretta sacra</i>	Eastern Reef Egret																	✓				
<i>Nycticorax caledonicus</i>	Nankeen Night-Heron				✓								✓					✓				
THRESKIORNITHIDAE																						
<i>Plegadis falcinellus</i>	Glossy Ibis	M	S5		✓											✓		✓	✓		✓	
<i>Threskiornis molucca</i>	Australian White Ibis				✓																✓	
<i>Threskiornis spinicollis</i>	Straw-necked Ibis				✓				✓	✓	✓			✓		✓		✓			✓	
<i>Platalea regia</i>	Royal Spoonbill				✓				✓									✓			✓	
<i>Platalea flavipes</i>	Yellow-billed Spoonbill																	✓				
ACCIPITRIDAE																						
<i>Pandion cristatus</i>	Eastern Osprey	M	S5										✓	✓						✓		
<i>Elanus axillaris</i>	Black-shouldered Kite				✓									✓							✓	

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<i>Elanus scriptus</i>	Letter-winged Kite			P4															✓			
<i>Lophoictinia isura</i>	Square-tailed Kite				✓						✓	✓	✓						✓			
<i>Hamirostra melanostemon</i>	Black-breasted Buzzard				✓			✓		✓	✓					✓		✓			✓	✓
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle				✓							✓	✓	✓				✓				
<i>Haliastur sphenurus</i>	Whistling Kite				✓			✓	✓	✓				✓				✓			✓	
<i>Haliastur indus</i>	Brahminy Kite											✓		✓				✓				
<i>Milvus migrans</i>	Black Kite				✓	✓		✓	✓	✓	✓			✓				✓			✓	x
<i>Accipiter fasciatus</i>	Brown Goshawk				✓	✓			✓	✓		✓	✓	✓				✓			✓	✓
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk				✓	✓			✓									✓				
<i>Circus assimilis</i>	Spotted Harrier				✓				✓									✓				
<i>Circus approximans</i>	Swamp Harrier																	✓			✓	
<i>Aquila audax</i>	Wedge-tailed Eagle				✓				✓	✓	✓				✓			✓			✓	
<i>Hieraetus morphnoides</i>	Little Eagle				✓							✓						✓				
FALCONIDAE																						
<i>Falco cenchroides</i>	Nankeen Kestrel				✓	✓			✓	✓	✓	✓	✓	✓				✓			✓	✓
<i>Falco berigora</i>	Brown Falcon				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓
<i>Falco longipennis</i>	Australian Hobby								✓		✓			✓				✓			✓	
<i>Falco hypoleucos</i>	Grey Falcon		S3															✓				
<i>Falco subniger</i>	Black Falcon																	✓				
<i>Falco peregrinus</i>	Peregrine Falcon		S7										✓	✓					✓		✓	
GRUIDAE																						
<i>Grus rubicunda</i>	Brolga				✓			✓		✓					✓	✓		✓				
RALLIDAE																						
<i>Porphyrio porphyrio</i>	Purple Swamphen																	✓				
<i>Gallirallus philippensis</i>	Buff-banded Rail																	✓				
<i>Porzana pusilla</i>	Baillon's Crake																	✓				
<i>Porzana fluminea</i>	Australian Spotted Crake																	✓				
<i>Tribonyx ventralis</i>	Black-tailed Native-hen																	✓				
<i>Fulica atra</i>	Eurasian Coot								✓									✓				
OTIDIDAE																						
<i>Ardeotis australis</i>	Australian Bustard				✓	✓		✓	✓	✓	✓	✓			✓	✓		✓			✓	✓
BURHINIDAE																						
<i>Burhinus grallarius</i>	Bush Stone-curlew				✓	✓			✓	✓	✓		✓		✓			✓				
<i>Esacus magnirostris</i>	Beach Stone-curlew													✓				✓				
HAEMATOPODIDAE																						
<i>Haematopus longirostris</i>	Australian Pied Oystercatcher											✓	✓	✓				✓				
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher											✓		✓				✓				
RECURVIROSTRIDAE																						
<i>Himantopus himantopus</i>	Black-winged Stilt				✓				✓							✓		✓			✓	
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet																	✓				
<i>Cladorhynchus leucocephalus</i>	Banded Stilt																	✓				

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CHARADRIIDAE																						
<i>Pluvialis fulva</i>	Pacific Golden Plover	M	S5															✓	✓	✓		
<i>Pluvialis squatarola</i>	Grey Plover	M	S5															✓	✓	✓		
<i>Charadrius dubius</i>	Little Ringed Plover																	✓	✓			
<i>Charadrius ruficapillus</i>	Red-capped Plover											✓						✓			✓	
<i>Charadrius mongolus</i>	Lesser Sand Plover	M	S2, S5											✓				✓	✓	✓		
<i>Charadrius leschenaultii</i>	Greater Sand Plover	M	S3, S5											✓				✓	✓	✓		
<i>Charadrius veredus</i>	Oriental Plover	M	S5		✓													✓	✓			
<i>Eseyornis melanops</i>	Black-fronted Dotterel				✓				✓	✓				✓		✓		✓			✓	
<i>Erythrogonys cinctus</i>	Red-kneed Dotterel				✓				✓									✓			✓	
<i>Vanellus miles</i>	Masked Lapwing				✓				✓	✓				✓				✓			✓	
JACANIDAE																						
	Fairy Tern																					
<i>Irediparra gallinacea</i>	Comb-crested Jacana								✓									✓				
ROSTRATULIDAE																						
	Fairy Tern																					
<i>Rostratula australis</i>	Australian Painted Snipe	EN	S2	EN														✓		✓	✓	
GALLINAGONIAE																						
	Fairy Tern																					
<i>Gallinago megala</i>	Swinhow's Snipe																	✓				
SCOLOPACIDAE																						
<i>Limosa limosa</i>	Black-tailed Godwit	M	S5																✓	✓		
<i>Limosa lapponica</i>	Bar-tailed Godwit	M	S5											✓				✓	✓	✓		
<i>Limnodromus semipalmatus</i>	Asian Dowitcher	M	S5															✓	✓	✓		
<i>Numenius arquata</i>	Eurasian Curlew	M	S5																			
<i>Numenius minutus</i>	Little Curlew	M	S5															✓	✓	✓		
<i>Numenius phaeopus</i>	Whimbrel	M	S5											✓				✓	✓	✓		
<i>Numenius madagascariensis</i>	Eastern Curlew	CR, M	S3, S5	VU										✓				✓	✓	✓		
<i>Phalaropus lobatus</i>	Red-necked Phalarope	M	S5															✓	✓			
<i>Xenus cinereus</i>	Terek Sandpiper	M	S5															✓		✓		
<i>Actitis hypoleucos</i>	Common Sandpiper	M	S5		✓							✓				✓		✓		✓		
<i>Tringa brevipes</i>	Grey-tailed Tattler	M	S5											✓				✓		✓		
<i>Tringa nebularia</i>	Common Greenshank	M	S5		✓						✓			✓		✓		✓	✓	✓	✓	
<i>Tringa stagnatilis</i>	Marsh Sandpiper	M	S5																✓		✓	
<i>Tringa totanus</i>	Common Redshank	M	S5																	✓	✓	
<i>Tringa glareola</i>	Wood Sandpiper	M	S5						✓					✓				✓	✓	✓	✓	
<i>Arenaria interpres</i>	Ruddy Turnstone	M	S5											✓				✓	✓	✓		
<i>Calidris tenuirostris</i>	Great Knot	CR, M	S3, S5															✓	✓	✓		
<i>Calidris canutus</i>	Red Knot	M	S5															✓	✓	✓		
<i>Calidris alba</i>	Sanderling	M	S5											✓				✓	✓	✓		
<i>Calidris minuta</i>	Little Stint		S5																			
<i>Calidris ruficollis</i>	Red-necked Stint	M	S5											✓				✓	✓	✓		
<i>Calidris subminuta</i>	Long-toed Stint	M	S5															✓	✓			
<i>Calidris melanotos</i>	Pectoral Sandpiper	M	S5															✓		✓		

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<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	M	S5											✓		✓		✓				
<i>Calidris alpina</i>	Dunlin		S5																			
<i>Calidris ferruginea</i>	Curlew Sandpiper	M	S5															✓	✓	✓		
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	M	S5															✓	✓	✓		
<i>Philomachus pugnax</i>	Ruff	M	S5															✓	✓			
TURNICIDAE																						
<i>Turnix maculosus</i>	Red-backed Button-quail																	✓				
<i>Turnix castanotus</i>	Chestnut-backed Button-quail			P4										✓				✓				
<i>Turnix pyrrhоторax</i>	Red-chested Button-quail				✓			✓			✓		✓					✓				
<i>Turnix velox</i>	Little Button-quail				✓	✓		✓	✓		✓							✓				✓
GLAREOLIDAE																						
<i>Glareola maldivarum</i>	Oriental Pratincole	M	S5															✓	✓		✓	
<i>Stiltia isabella</i>	Australian Pratincole				✓													✓			✓	
LARIDAE																						
<i>Onychoprion fuscata</i>	Sooty Tern																	✓				
<i>Sternula albifrons</i>	Little Tern	M	S5											✓						✓		
<i>Gelochelidon nilotica</i>	Gull-billed Tern													✓				✓			✓	
<i>Hydroprogne caspia</i>	Caspian Tern	M	S5															✓	✓			
<i>Chlidonias hybrida</i>	Whiskered Tern				✓													✓			✓	
<i>Chlidonias leucopterus</i>	White-winged Black Tern	M	S5		✓														✓			
<i>Sterna dougallii</i>	Roseate Tern	M	S5															✓				
<i>Sterna hirundo</i>	Common Tern	M	S5									✓		✓				✓	✓			
<i>Thalasseus bengalensis</i>	Lesser Crested Tern	M	S5									✓		✓				✓				
<i>Thalasseus bergii</i>	Crested Tern											✓		✓				✓				
<i>Chroicocephalus novaehollandiae</i>	Silver Gull													✓				✓				
CACATUIDAE																						
<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo				✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	
<i>Cacatua roseicapillus</i>	Galah				✓	✓		✓	✓	✓	✓					✓					✓	✓
<i>Cacatua sanguinea</i>	Little Corella				✓			✓	✓	✓	✓			✓	✓	✓		✓			✓	
<i>Nymphicus hollandicus</i>	Cockatiel				✓			✓	✓	✓	✓					✓		✓				
PSITTACIDAE																						
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet					✓						✓	✓		✓	✓		✓				×
<i>Trichoglossus haematodus rubritorquis</i>	Red-collared Lorikeet				✓			✓	✓	✓				✓								
<i>Psitteuteles versicolor</i>	Varied Lorikeet				✓	✓		✓	✓	✓	✓	✓				✓						
<i>Aprosmictus erythropterus</i>	Red-winged Parrot				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	×
<i>Polytelis anthoepus</i>	Regent Parrot							✓														
<i>Polytelis alexandrae</i>	Princess Parrot	VU		P4																✓		
<i>Melopsittacus undulatus</i>	Budgerigar				✓	✓		✓	✓	✓					✓			✓			✓	✓
CUCULIDAE																						
<i>Centropus phasianinus</i>	Pheasant Coucal				✓	✓		✓	✓		✓	✓	✓					✓			✓	
<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo													✓				✓				

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<i>Chalcites basal</i>	Horsfield's Bronze-Cuckoo				✓	✓			✓	✓		✓	✓	✓	✓	✓					✓	✓
<i>Chalcites osculans</i>	Black-eared Cuckoo				✓								✓	✓				✓				✓
<i>Chalcites minutillus</i>	Little Bronze-Cuckoo					✓			✓			✓										✓
<i>Cacomantis pallidus</i>	Pallid Cuckoo				✓	✓			✓	✓		✓		✓		✓		✓				
<i>Cacomantis variolosus</i>	Brush Cuckoo				✓	✓			✓				✓	✓		✓		✓				
<i>Cuculus optatus</i>	Oriental Cuckoo													✓				✓		✓		
STRIGIDAE																						
<i>Ninox connivens</i>	Barking Owl				✓			✓										✓				
<i>Ninox novaeseelandiae</i>	Southern Boobook				✓	✓			✓	✓		✓										✓
TYTONIDAE																						
<i>Tyto novaehollandiae</i>	Masked Owl			P1																✓		
<i>Tyto javanica</i>	Eastern Barn Owl				✓																	
<i>Tyto longimembris</i>	Eastern Grass Owl																	✓				
HALCYONIDAE																						
<i>Dacelo leachii</i>	Blue-winged Kookaburra				✓	✓			✓	✓	✓	✓	✓	✓		✓		✓				✓
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher				✓		✓		✓				✓	✓		✓		✓				✓
<i>Todiramphus sanctus</i>	Sacred Kingfisher				✓	✓			✓			✓	✓	✓	✓	✓		✓				
<i>Todiramphus chloris</i>	Collared Kingfisher																	✓				
MEROPIDAE																						
<i>Merops ornatus</i>	Rainbow Bee-eater		S5		✓	✓			✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓
CORACIIDAE																						
<i>Eurystomus orientalis</i>	Dollarbird				✓				✓			✓	✓	✓		✓		✓				
CLIMACTERIDAE																						
<i>Climacteris melanura</i>	Black-tailed Treecreeper				✓	✓			✓	✓	✓											
PTILONORHYNCHIDAE																						
<i>Ptilonorhynchus nuchalis</i>	Great Bowerbird				✓	✓			✓	✓		✓	✓	✓				✓				✓
MALURIDAE																						
<i>Malurus melanocephalus</i>	Red-backed Fairy-wren				✓	✓	✓		✓	✓	✓	✓	✓	✓		✓		✓			✓	✓
<i>Malurus lamberti</i>	Variogated Fairy-wren				✓			✓	✓		✓	✓	✓	✓		✓		✓			✓	✓
ACANTHIZIDAE																						
<i>Smicromis brevirostris</i>	Weebill				✓	✓			✓	✓	✓	✓						✓				
<i>Gerygone levigaster</i>	Mangrove Gerygone													✓				✓				
<i>Gerygone fusca</i>	Western Gerygone																	✓				
<i>Gerygone tenebrosa</i>	Dusky Gerygone																	✓				
<i>Gerygone albogularis</i>	White-throated Gerygone				✓	✓			✓	✓	✓	✓	✓	✓		✓					✓	✓
PARDALOTIDAE																						
<i>Pardalotus rubricatus</i>	Red-browed Pardalote				✓				✓	✓	✓		✓	✓		✓		✓				
<i>Pardalotus striatus</i>	Striated Pardalote				✓	✓			✓	✓	✓	✓	✓		✓			✓				✓
MELIPHAGIDAE																						
<i>Certhionyx variegatus</i>	Pied Honeyeater				✓																	
<i>Lichenostomus virescens</i>	Singing Honeyeater				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓					✓	✓

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<i>Lichenostomus unicolor</i>	White-gaped Honeyeater				✓							✓		✓							✓	
<i>Lichenostomus flavescens</i>	Yellow-tinted Honeyeater				✓	✓			✓	✓	✓	✓	✓					✓			✓	
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater				✓								✓	✓								
<i>Manorina flavigula</i>	Yellow-throated Miner				✓		✓	✓								✓		✓				
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater																	✓				
<i>Conopophila rufogularis</i>	Rufous-throated Honeyeater				✓	✓			✓			✓	✓	✓		✓		✓			✓	
<i>Epthianura crocea</i>	Yellow Chat																	✓			✓	
<i>Epthianura aurifrons</i>	Orange Chat																	✓				
<i>Sugomel niger</i>	Black Honeyeater				✓				✓	✓												
<i>Myzomela erythrocephala</i>	Red-headed Honeyeater													✓				✓				
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater												✓									
<i>Cissomela pectoralis</i>	Banded Honeyeater				✓	✓			✓			✓						✓				
<i>Lichmera indistincta</i>	Brown Honeyeater				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓
<i>Melithreptus gularis</i>	Black-chinned Honeyeater				✓	✓			✓	✓	✓	✓	✓	✓		✓						
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater																					
<i>Melithreptus albugularis</i>	White-throated Honeyeater					✓			✓			✓		✓				✓				
<i>Philemon argenticeps</i>	Silver-crowned Friarbird													✓	✓							
<i>Philemon citreogularis</i>	Little Friarbird				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	
POMATOSTOMIDAE																						
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
NEOSITTIDAE																						
<i>Daphoenositta chrysoptera</i>	Varied Sittella				✓	✓			✓	✓	✓	✓	✓	✓				✓			✓	
CAMPEPHAGIDAE																						
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓
<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike				✓						✓							✓				
<i>Lalage sueurii</i>	White-winged Triller				✓	✓		✓	✓	✓	✓		✓			✓		✓			✓	✓
PACHYCEPHALIDAE																						
<i>Pachycephala melanura</i>	Mangrove Golden Whistler																	✓				
<i>Pachycephala rufiventris</i>	Rufous Whistler				✓	✓	✓		✓	✓	✓	✓	✓			✓		✓			✓	✓
<i>Pachycephala lanioides</i>	White-breasted Whistler																	✓				
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				✓	✓			✓	✓	✓	✓	✓			✓		✓			✓	✓
<i>Oreoica gutturalis</i>	Crested Bellbird																	✓				
ORIOLIDAE																						
<i>Oriolus sagittatus</i>	Olive-backed Oriole					✓			✓	✓	✓	✓		✓		✓		✓				
ARTAMIDAE																						
<i>Artamus leucorhynchus</i>	White-breasted Woodswallow								✓		✓		✓	✓		✓		✓			✓	
<i>Artamus personatus</i>	Masked Woodswallow					✓		✓	✓		✓					✓		✓				
<i>Artamus superciliosus</i>	White-browed Woodswallow										✓							✓				
<i>Artamus cinereus</i>	Black-faced Woodswallow				✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓			✓	✓
<i>Artamus cyanopterus</i>	Dusky Woodswallow														✓							
<i>Artamus minor</i>	Little Woodswallow				✓	✓			✓	✓	✓	✓	✓			✓		✓				
<i>Cecropis daurica</i>	Red-rumped Swallow	M	S5	M														✓		✓		

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<i>Cracticus torquatus</i>	Grey Butcherbird												✓					✓				
<i>Cracticus nigrogularis</i>	Pied Butcherbird				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓
<i>Cracticus tibicen</i>	Australian Magpie				✓			✓			✓							✓			✓	✓
RHIPIDURIDAE																						
<i>Rhipidura albiscapa</i>	Grey Fantail									✓	✓							✓				
<i>Rhipidura phasiana</i>	Mangrove Grey Fantail																	✓				
<i>Rhipidura rufiventris</i>	Northern Fantail											✓	✓	✓				✓				
<i>Rhipidura leucophrys</i>	Willie Wagtail				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓
CORVIDAE																						
<i>Corvus coronoides</i>	Australian Raven																					
<i>Corvus bennetti</i>	Little Crow				✓	✓												✓				
<i>Corvus orru</i>	Torresian Crow				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓
MONARCHIDAE																						
<i>Myiagra rubecula</i>	Leaden Flycatcher					✓						✓	✓	✓				✓				
<i>Myiagra alecto</i>	Shining Flycatcher																					
<i>Myiagra inquieta</i>	Restless Flycatcher				✓	✓	✓	✓		✓		✓	✓	✓		✓		✓			✓	
<i>Myiagra nana</i>	Paperbark Flycatcher				✓				✓		✓											
<i>Myiagra ruficollis</i>	Broad-billed Flycatcher																	✓				
<i>Cyanoptila cyanomelana</i>	Blue and White Flycatcher																	✓				
<i>Grallina cyanoleuca</i>	Magpie-lark				✓	✓		✓	✓	✓	✓			✓		✓		✓			✓	✓
PETROICIDAE																						
<i>Microeca fascinans</i>	Jacky Winter					✓			✓	✓	✓	✓	✓	✓		✓		✓				
<i>Microeca flavigaster</i>	Lemon-bellied Flycatcher															✓		✓				
<i>Petroica goodenovii</i>	Red-capped Robin																	✓				
<i>Melanodryas cucullata</i>	Hooded Robin					✓			✓		✓							✓				
ALAUDIDAE																						
<i>Mirafrja javanica</i>	Horsfield's Bushlark				✓		✓											✓				
CISTICOLIDAE																						
<i>Cisticola exilis</i>	Golden-headed Cisticola				✓								✓					✓				
ACROCEPHALIDAE																						
<i>Acrocephalus australis</i>	Australian Reed-Warbler							✓										✓				
MEGALURIDAE																						
<i>Megalurus timoriensis</i>	Tawny Grassbird																	✓				
<i>Cincloramphus mathewsi</i>	Rufous Songlark				✓		✓		✓	✓		✓				✓						
<i>Cincloramphus cruralis</i>	Brown Songlark				✓							✓										
<i>Eremiomis carteri</i>	Spinifexbird				✓																	
TIMALIIDAE																						
<i>Zosterops luteus</i>	Yellow White-eye													✓				✓			✓	
HIRUNDINIDAE																						
<i>Hirundo rustica</i>	Barn Swallow	M	S5															✓	✓	✓		
<i>Hirundo neoxena</i>	Welcome Swallow																	✓				

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<i>Petrochelidon ariel</i>	Fairy Martin				✓			✓		✓		✓				✓		✓				
<i>Petrochelidon nigricans</i>	Tree Martin				✓	✓			✓	✓	✓	✓	✓			✓		✓			✓	
NECTARINIIDAE																						
<i>Dicaeum hirundinaceum</i>	Mistletoebird				✓	✓	✓		✓	✓	✓			✓	✓	✓		✓			✓	x
ESTRILDIDAE																						
<i>Taeniopygia guttata</i>	Zebra Finch				✓			✓	✓	✓	✓		✓		✓	✓	✓	✓			✓	✓
<i>Taeniopygia bichenovii</i>	Double-barred Finch				✓			✓				✓	✓					✓			✓	
<i>Poephila acuticauda</i>	Long-tailed Finch					✓	✓	✓	✓		✓	✓	✓					✓			✓	✓
<i>Neochmia phaeton</i>	Crimson Finch				✓																	
<i>Neochmia ruficauda</i>	Star Finch				✓																	
<i>Stagonopleura oculata</i>	Red-eared Firetail																					
<i>Emblema pictum</i>	Painted Finch				✓													✓				
<i>Erythrura gouldiae</i>	Gouldian Finch			P4																✓		
<i>Lonchura castaneothorax</i>	Chestnut-breasted Mannikin																			✓		
<i>Heteromunia pectoralis</i>	Pictorella Mannikin				✓															✓		
PASSERIDAE																						
<i>*Passer domesticus</i>	House Sparrow																					
MOTACILLIDAE																						
<i>Anthus novaeseelandiae</i>	Australasian Pipit				✓								✓	✓								✓
<i>Motacilla cinerea</i>	Grey Wagtail	M	S5						✓											✓		
<i>Motacilla flava</i>	Yellow Wagtail	M	S5																	✓		
<i>Motacilla tschutschensis</i>	Eastern Yellow Wagtail								✓													
x Outside the study area (within 1km)																						
* Introduced species																						
† Species recorded just outside project area																						

Table 34: Reptile species previously recorded from the region

Family and Species	Common name	EPBC Act	BC Act	DBCA	Western Wildlife 2011 (Duchess Paradise)	Beagle Bay (ecologia 2005)	Yakka Munga (Buru Energy 2013)	Frome Rocks (Astron 2013)	Thunderbird (ecologia 2016)	Thunderbird Lv1 (ecologia 2012b)	Thunderbird Haul Road (ecologia 2016a)	James Price Point (ecologia 2011)	James Price Point (Biota 2009)	James Price Point (AECOM 2010)	Ungani Project (Biota 2013; 2013b)	Jackaroo (Outback 2014)	Orange Flat (Biota 2013a)	NatureMap Search	DPaW threatened database search	PMST	ALA	This survey
AGAMIDAE																						
<i>Amphibolurus gilberti</i>								✓	✓			✓	✓	✓	✓			✓				
<i>Chlamydosaurus kingii</i>	Frill-necked Lizard					✓						✓	✓	✓	✓			✓			✓	✓
<i>Ctenophorus isolepis</i>	Central Military Dragon				✓			✓														
<i>Ctenophorus nuchalis</i>	Central Netted Dragon				✓													✓				
<i>Diporiphora bennettii</i>					✓																	
<i>Diporiphora lalliae</i>					✓		✓								✓							
<i>Diporiphora magna</i>					✓	✓			✓													
<i>Diporiphora pindan</i>					✓	✓			✓			✓	✓	✓	✓	✓		✓			✓	✓
<i>Pogona minor</i>	Dwarf Bearded Dragon				✓	✓			✓	✓		✓	✓	✓				✓				✓
DIPODACTYLIDAE																						
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko								✓			✓	✓	✓								✓
<i>Lucasium stenodactylum</i>					✓	✓			✓			✓	✓									
<i>Oedura rhombifer</i>														✓				✓				
<i>Rhynchoedura ornata</i>	Beaked Gecko					✓												✓				
<i>Strophurus ciliaris</i>					✓	✓			✓			✓	✓	✓				✓			✓	✓
GEKKONIDAE																						
<i>Gehyra australis</i>					✓							✓										
<i>Gehyra nana</i>					✓				✓													
<i>Gehyra occidentalis</i>																						
<i>Gehyra pilbara</i>					✓	✓			✓	✓		✓	✓					✓				
<i>Gehyra punctata</i>					✓								✓									
<i>Gehyra purpurascens</i>																		✓				
<i>Gehyra variegata</i>					✓									✓				✓			✓	✓
<i>Heteronotia binoei</i>	Bynoe's Gecko				✓	✓			✓			✓	✓					✓				
PYGOPODIDAE																						
<i>Delma borea</i>					✓																	
<i>Delma tincta</i>					✓				✓				✓									✓
<i>Lialis burtonis</i>					✓				✓			✓	✓	✓				✓				✓
<i>Pygopus nigriceps</i>						✓												✓				
<i>Pygopus steelescotti</i>									✓				✓									
SCINCIDAE																						
<i>Carlia amax</i>																		✓				
<i>Carlia munda</i>					✓	✓			✓	✓		✓						✓				
<i>Carlia rufilatus</i>									✓			✓	✓									
<i>Carlia triacantha</i>						✓												✓				
<i>Cryptoblepharus ruber</i>						✓			✓	✓		✓	✓					✓				
<i>Cryptoblepharus tyttos</i>																		✓				
<i>Ctenotus angusticeps</i>	Airlie Island Ctenotus																	✓				
<i>Ctenotus colletti</i>	Buff-tailed Finesnout Ctenotus								✓									✓				✓
<i>Ctenotus sp. (leonhardii group)</i>																						✓

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<i>Ctenotus pantherinus</i>	Leopard Ctenotus				✓				✓			✓						✓				✓
<i>Ctenotus robustus</i>					✓				✓													
<i>Ctenotus inornatus (former C. saxatilis)</i>	Bar-shouldered Ctenotus				✓	✓			✓	✓	✓	✓	✓			✓		✓				✓
<i>Ctenotus serventyi</i>						✓			✓			✓	✓									
<i>Ctenotus uber johnstonei</i>				P2	✓								✓									
<i>Cyclodomorphus melanops</i>	Slender Blue-tongue				✓																	
<i>Eremiascincus isolepis</i>	Northern Bar-lipped Skink				✓	✓			✓			✓	✓	✓				✓				✓
<i>Lerista apoda</i>									✓	✓		✓	✓					✓				
<i>Lerista bipes</i>	North-western Sandslider				✓				✓			✓	✓					✓				✓
<i>Lerista greeri</i>									✓													
<i>Lerista griffini</i>						✓						✓	✓					✓				
<i>Lerista labialis</i>																		✓				
<i>Lerista separanda</i>													✓									
<i>Liopholis kintorei</i>	Great Desert Skink	VU	S1	VU														✓				
<i>Menetia greyii</i>	Common Dwarf Skink				✓													✓				✓
<i>Menetia maini</i>	Northern Dwarf Skink								✓									✓				✓
<i>Morethia ruficauda</i>					✓			✓										✓				
<i>Morethia storri</i>	Top End Fire-tailed Skink					✓			✓	✓		✓	✓					✓				✓
<i>Notoscincus ornatus</i>	Ornate Soil-crevice Skink				✓																	✓
<i>Proablepharus tenuis</i>					✓				✓				✓									
<i>Tiliqua multifasciata</i>	Central Blue-tongue				✓								✓					✓				
<i>Tiliqua scincoides</i>	Eastern Blue-tongue				✓	✓			✓			✓	✓	✓	✓			✓				✓
VARANIDAE																						
<i>Varanus acanthurus</i>	Spiny-tailed Monitor				✓				✓					✓				✓				
<i>Varanus brevicauda</i>	Short-tailed Pygmy Monitor				✓				✓			✓	✓									
<i>Varanus eremius</i>	Pygmy Desert Monitor				✓																	
<i>Varanus gouldii</i>	Sand Monitor				✓	✓	✓		✓		✓	✓	✓	✓	✓			✓				x
<i>Varanus panoptes</i>	Yellow-spotted Monitor				✓								✓	✓				✓				
<i>Varanus scalaris</i>	Spotted Tree Monitor				✓	✓																
<i>Varanus sparnus</i>	Dampier Peninsula goanna			P1					✓													✓
<i>Varanus tristis</i>	Racehorse Monitor								✓			✓	✓	✓				✓				
TYPHLOPIDAE																						
<i>Anilius diversus</i>	Northern Blind Snake				✓	✓						✓	✓									✓
<i>Anilius grypus</i>	Beaked Blink Snake				✓																	
BOIDAE																						
<i>Antaresia stimsoni</i>	Stimson's Python				✓	✓			✓				✓	✓				✓				
<i>Aspidites melanocephalus</i>	Black-headed Python				✓	✓						✓										
ELAPIDAE																						
<i>Acanthophis pyrrhus</i>	Desert Death Adder																	✓				
<i>Brachyuropsis roperi</i>	Northern Shovel-nosed Snake				✓	✓			✓			✓	✓					✓				✓
<i>Demansia angusticeps</i>	Narrow-headed Whipsnake				✓				✓			✓	✓					✓			✓	✓
<i>Ephalophis greyae</i>	Mangrove Sea Snake																	✓				

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<i>Furina ornata</i>	Moon Snake				✓	✓			✓			✓	✓										
<i>Pseudechis australis</i>	Mulga Snake				✓			✓	✓		✓	✓	✓					✓					
^Δ <i>Pseudonaja mengdeni</i>	Western Brown Snake				✓	✓			✓			✓	✓					✓					✓
<i>Simoselaps anomalus</i>	Desert Banded Snake																	✓					
<i>Simoselaps minimus</i>	Dampierland Burrowing Snake												✓										
<i>Suta punctata</i>	Spotted Snake				✓				✓				✓					✓					

^Δformerly recorded as *P. nuchalis*

^x Species recorded outside the study area (within 1km)

Table 35: Amphibian species previously recorded from the region

Family and Species	Common name	EPBC Act	BC Act	DBCA	Western Wildlife 2011 (Duchess Paradise)	Beagle Bay (ecologia 2005)	Yakka Munga (Buru Energy 2013)	Frome Rocks (Astron 2013)	Thunderbird (ecologia 2016)	Thunderbird Lv1 (ecologia 2012b)	Thunderbird Haul Road (ecologia 2016a)	James Price Point (ecologia 2011)	James Price Point (Biota 2009)	James Price Point (AECOM 2010)	Ungani Project (Biota 2013; 2013b)	Jackaroo (Outback 2014)	Orange Flat (Biota 2013a)	NatureMap Search	DPaW threatened database search	PMST	ALA	Current Survey
HYLIDAE																						
<i>Cyclorana australis</i>	Giant Frog	▪	▪	▪	✓	✓			✓			✓						✓			✓	
<i>Cyclorana cryptotis</i>	Hidden-ear Frog	▪	▪	▪	✓																	
<i>Cyclorana longipes</i>	Long-footed Frog	▪	▪	▪	✓				✓			✓						✓				
<i>Cyclorana vagitus</i>	Wailing Frog	▪	▪	▪	✓																	
<i>Litoria caerulea</i>	Green Tree Frog	▪	▪	▪	✓	✓			✓		✓	✓			✓			✓			✓	✓
<i>Litoria inermis</i>	Bumpy Rocket Frog	▪	▪	▪	✓																	
<i>Litoria pallida</i>	Pale Rocket Frog	▪	▪	▪	✓																	
<i>Litoria rothii</i>	Northern Laughing Tree Frog	▪	▪	▪	✓				✓	✓								✓				
<i>Litoria rubella</i>	Little Red Tree Frog	▪	▪	▪	✓	✓			✓									✓				
LIMNODYNASTIDAE																						
<i>Notaden nichollsi</i>	Desert Spadefoot	▪	▪	▪	✓				✓									✓			✓	✓
<i>Opisthodon ornatus</i>	Ornate Burrowing Frog	▪	▪	▪					✓		✓	✓										
MYOBATRACHIDAE																						
<i>Uperoleia mjobergii</i>	Mjoberg's Toadlet	▪	▪	▪	✓													✓				✓
<i>Uperoleia talpa</i>	Mole Toadlet	▪	▪	▪		✓			✓									✓				

Table 36: Invertebrate SRE species previously recorded from the region

Family	Order and Species	Conservation Status				Western Wildlife 2011 (Duchess Paradise)	Beagle Bay (ecologia 2005)	Yakka Munga (Buru Energy 2013)	Frome Rocks (Astron 2013)	ecologia 2016 (Thunderbird)	James Price Point (Biota 2009)	James Price Point (ecologia 2011)	Ungani Project (Biota 2013; 2013b)	Jackaroo (Outback 2014)	Orange Flat (Biota 2013a)	NatureMap Search	WAM database search	Current Survey
		EPBC Act	SRE	BC Act	DBCA													
CRUSTACEAN																		
ISOPODA																		
ARMADILLIDAE	<i>Buddelundia</i> 43		Potential													✓		
	<i>Buddelundia</i> sp. 1		Potential								✓							
	<i>Buddelundia</i> sp. B74		Potential															
	<i>Armadillidae</i> 'EE1501C'		Potential						✓									
	<i>Buddelundiinae</i> 'genus indet. NE Broome'		Potential						✓									
	<i>Buddelundia</i> sp. 74		Potential						✓									✓
	<i>Buddelundia</i> '90'		Potential						✓									
<i>Buddelundia</i> '91'		Potential						✓										
DIPLOPODA																		
PACHYBOLIDAE	<i>Pachybolidae</i> sp.		Potential							✓								
CHILOPODA																		
SCUTIGERIDAE	<i>Pilbarascutigera incola</i>		Potential							✓								
ARACHNIDA																		
NEMESIIDAE	<i>Aname</i> 'MYG 231'		Potential							✓	✓							
	<i>Aname</i> MYG232		Potential								✓							
	<i>Aname</i> 'MYG284'		Potential						✓									
	<i>Aname</i> 'MYG285'		Potential						✓									
	<i>Aname</i> 'MYG387'		Potential						✓									
	<i>Aname</i> 'MYG387?'		Potential						✓									
	<i>Aname</i> 'MYG388'		Potential						✓									
	<i>Aname</i> 'sp. indet.'		Potential						✓									
<i>Aname</i> 'sp.juv.'		Potential						✓										
IDIOPIDAE	? <i>Aganippe</i> sp.		Potential							✓								
BARYCHELIDAE	<i>Synothele</i> 'MYG179'		Potential							✓								
CTENIZIDAE	<i>Conothele</i> sp.		Potential							✓								
ACTINOPODIDAE	<i>Missulena</i> sp.		Undetermined							✓								
ASSAMIIDAE	<i>Dampestrus</i> sp.		Potential						✓		✓							
SCORPIONES																		
URODACIDAE	<i>Urodacus granifrons</i>		Potential												✓			
	<i>Urodacus 'rugosus'</i>		Potential							✓								
	<i>Urodacus</i> 'JP'		Potential							✓								
URODACIDAE	<i>Urodacus</i> sp. indet.		Undetermined								✓							
	<i>Urodacus 'kraepelini'</i>		Potential						✓									
BUTHIDAE	<i>Urodacus</i> sp. indet.		Potential						✓									
	<i>Lychas</i> 'JPP'		Potential						✓		✓							
	<i>Lychas</i> 'JPP1'		Potential						✓									
	<i>Lychas</i> 'JPP2'		Potential						✓									

Family	Order and Species	Conservation Status				Western Wildlife 2011 (Duchess Paradise)	Beagle Bay (ecologia 2005)	Yakka Munga (Buru Energy 2013)	Frome Rocks (Astron 2013)	ecologia 2016 (Thunderbird)	James Price Point (Biota 2009)	James Price Point (ecologia 2011)	Ungani Project (Biota 2013; 2013b)	Jackaroo (Outback 2014)	Orange Flat (Biota 2013a)	NatureMap Search	WAM database search	Current Survey
		EPBC Act	SRE	BC Act	DBCA													
	<i>Lychas 'JPP3'</i>		Potential						✓									
	<i>Lychas 'Broome'</i>		Potential						✓									
	<i>Lychas splendens</i>		Potential														✓	
	<i>Lychas sp. B11</i>		Potential														✓	
PSEUDOSCORPIONES																		
	Oolpidae sp.		Potential														✓	
	<i>Euryolpium</i> sp.		Potential							✓								
	<i>Euryolpium</i> sp. B09		Potential														✓	
	<i>Austrohorus</i> sp.		Undetermined								✓							
	<i>Beierolpium</i> sp 8/4		Undetermined								✓							
	<i>Beierolpium</i> 8/4 sp. B18		Potential														✓	
	<i>Beierolpium</i> sp. '(juv)'		Undetermined								✓							
	<i>Indolpium</i> sp.		Undetermined								✓							
	<i>Olpiidae 'genus indet. (juvenile)'</i>		Potential						✓									
GASTROPODA																		
	<i>Quistrachia leptogramma</i>		Potential						✓	✓							✓	
	<i>Rhagada bulgana</i>		Confirmed						✓	✓							✓	
	<i>Gastrocopta aff. bannertonensis</i>		Potential														✓	
	<i>Magilaoma</i> sp. nov.		Potential						✓									
PUNCTIDAE																		

APPENDIX SIX

**CONSERVATION SIGNIFICANT FAUNA
RECORDED IN THE REGION**

CONSERVATION SIGNIFICANT FAUNA RECORDED IN THE REGION

Table 37: Conservation significant fauna species potentially occurring

Common name	Scientific name	EPBC ACT*	WC/BC Act	DBCA status	Likelihood of occurrence
Mammals					
Kimberley Brush-tailed Phascogale	<i>Phascogale tapoatafa subsp. kimberleyensis</i>		S3		Very Low
Golden Bandicoot	<i>Isoodon auratus subsp. auratus</i>		S3	VU	Very Low
Greater Bilby	<i>Macrotis lagotis</i>	VU	S1	VU	High
Spectacled Hare-wallaby	<i>Lagorchestes conspicillatus leichardti</i>			P3	High
Northern Brushtail Possum (Kimberley)	<i>Trichosurus vulpecula arnhemensis</i>		S3		Low
Yellow-lipped Cave Bat	<i>Vespadelus douglasorum</i>			P2	Very low
Short-tailed Mouse	<i>Leggadina lakedownensis</i>			P4	Low
Water-rat	<i>Hydromys chrysogaster</i>				Low
Birds					
Garganey	<i>Anas querquedula</i>	M	S5		Low
Flock Bronzewing	<i>Phaps histrionica</i>			P4	Moderate
Fork-tailed Swift	<i>Apus pacificus</i>	M	S5		Moderate
Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>	M	S5		Very Low
Lesser Frigatebird	<i>Fregata ariel</i>	M	S5		Very Low
Great Frigatebird	<i>Fregata minor</i>	M	S5		Very Low
Black Bittern	<i>Ixobrychus flavicollis</i>			P3	Low
Eastern Great Egret	<i>Ardea modesta</i>	M	S5		Moderate
Cattle Egret	<i>Ardea ibis</i>	M	S5		Low
Glossy Ibis	<i>Plegadis falcinellus</i>	M	S5		Low
Eastern Osprey	<i>Pandion cristatus</i>	M	S5		Low
Letter-winged Kite	<i>Elanus scriptus</i>			P4	Moderate
Grey Falcon	<i>Falco hypoleucos</i>		S3		Moderate
Peregrine Falcon	<i>Falco peregrinus</i>		S7		Moderate
Pacific Golden Plover	<i>Pluvialis fulva</i>	M	S5		Low
Grey Plover	<i>Pluvialis squatarola</i>	M	S5		Low
Lesser Sand Plover	<i>Charadrius mongolus</i>	M	S2, S5		Low
Greater Sand Plover	<i>Charadrius leschenaultii</i>	M	S3, S5		Low
Oriental Plover	<i>Charadrius veredus</i>	M	S5		Low
Australian Painted Snipe	<i>Rostratula australis</i>	EN	S2	EN	Low
Black-tailed Godwit	<i>Limosa limosa</i>	M	S5		Low
Bar-tailed Godwit	<i>Limosa lapponica</i>	M	S5		Low
Asian Dowitcher	<i>Limnodromus semipalmatus</i>	M	S5		Low
Eurasian Curlew	<i>Numenius arquata</i>	M	S5		Low
Little Curlew	<i>Numenius minutus</i>	M	S5		Low
Whimbrel	<i>Numenius phaeopus</i>	M	S5		Low
Eastern Curlew	<i>Numenius madagascariensis</i>	CR, M	S3, S5	VU	Low
Red-necked Phalarope	<i>Phalaropus lobatus</i>	M	S5		Low
Terek Sandpiper	<i>Xenus cinereus</i>	M	S5		Low
Common Sandpiper	<i>Actitis hypoleucos</i>	M	S5		Low
Grey-tailed Tattler	<i>Tringa brevipes</i>	M	S5		Low
Common Greenshank	<i>Tringa nebularia</i>	M	S5		Low
Marsh Sandpiper	<i>Tringa stagnatilis</i>	M	S5		Low

CONSERVATION SIGNIFICANT FAUNA RECORDED IN THE REGION

Common name	Scientific name	EPBC ACT*	WC/BC Act	DBC status	Likelihood of occurrence
Common Redshank	<i>Tringa totanus</i>	M	S5		Low
Wood Sandpiper	<i>Tringa glareola</i>	M	S5		Low
Ruddy Turnstone	<i>Arenaria interpres</i>	M	S5		Low
Great Knot	<i>Calidris tenuirostris</i>	CR, M	S3, S5		Low
Red Knot	<i>Calidris canutus</i>	M	S5		Low
Sanderling	<i>Calidris alba</i>	M	S5		Low
Little Stint	<i>Calidris minuta</i>		S5		Low
Red-necked Stint	<i>Calidris ruficollis</i>	M	S5		Low
Long-toed Stint	<i>Calidris subminuta</i>	M	S5		Low
Pectoral Sandpiper	<i>Calidris melanotos</i>	M	S5		Low
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	M	S5		Low
Dunlin	<i>Calidris alpina</i>		S5		Low
Curlew Sandpiper	<i>Calidris ferruginea</i>	M	S5		Low
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	M	S5		Low
Ruff	<i>Philomachus pugnax</i>	M	S5		Low
Chestnut-backed Button-quail	<i>Turnix castanotus</i>			P4	Low
Oriental Pratincole	<i>Glareola maldivarum</i>	M	S5		Low
Little Tern	<i>Sternula albifrons</i>	M	S5		Low
Caspian Tern	<i>Hydroprogne caspia</i>	M	S5		Low
White-winged Black Tern	<i>Chlidonias leucopterus</i>	M	S5		Low
Roseate Tern	<i>Sterna dougallii</i>	M	S5		Low
Common Tern	<i>Sterna hirundo</i>	M	S5		Low
Lesser Crested Tern	<i>Thalasseus bengalensis</i>	M	S5		Low
Princess Parrot	<i>Polytelis alexandrae</i>	VU		P4	Low
Masked Owl	<i>Tyto novaehollandiae</i>			P1	Low
Rainbow Bee-eater	<i>Merops ornatus</i>		S5		High
Red-rumped Swallow	<i>Cecropis daurica</i>	M	S5	M	Low
Barn Swallow	<i>Hirundo rustica</i>	M	S5		Low
Gouldian Finch	<i>Erythrura gouldiae</i>			P4	Low
Grey Wagtail	<i>Motacilla cinerea</i>	M	S5		Low
Yellow Wagtail	<i>Motacilla flava</i>	M	S5		Moderate
Reptiles					
A skink	<i>Ctenotus uber johnstonei</i>			P2	Low
Great Desert Skink	<i>Liopholis kintorei</i>	VU	S1	VU	Low
Dampier Peninsula goanna	<i>Varanus sparnus</i>			P1	High

*M = Migratory, S=Schedule, VU=Vulnerable, EN=Endangered; CR=Critically Endangered

Table 38: SRE invertebrate fauna species recorded in the region

Common name	Scientific name	SRE status
Isopoda		
Armadillidae	<i>Buddelundia 43</i>	Potential
	<i>Buddelundia sp. 1</i>	Potential
	<i>Armadillidae 'EE1501C'</i>	Potential
	<i>Buddelundiinae 'genus indet. NE Broome'</i>	Potential
	<i>Buddelundia sp. 74</i>	Potential
	<i>Buddelundia'90'</i>	Potential
	<i>Buddelundia'91'</i>	Potential
Diplopoda		
Pachybolidae	<i>Pachybolidae sp.</i>	Potential
Chilopoda		
Scutigerae	<i>Pilbarascutigera incola</i>	Potential
Arachnida		
Nemesiidae	<i>Aname 'MYG 231'</i>	Potential
	<i>Aname MYG232</i>	Potential
	<i>Aname 'MYG284'</i>	Potential
	<i>Aname 'MYG285'</i>	Potential
	<i>Aname 'MYG387'</i>	Potential
	<i>Aname 'MYG387?'</i>	Potential
	<i>Aname 'MYG388'</i>	Potential
	<i>Aname 'sp. indet.'</i>	Potential
	<i>Aname 'sp.juv.'</i>	Potential
Idiopidae	<i>?Aganippe sp.</i>	Potential
Barychelidae	<i>Synothele 'MYG179'</i>	Potential
Ctenizidae	<i>Conothele sp.</i>	Potential
Actinopodidae	<i>Missulena sp.</i>	Undetermined
Assamiidae	<i>Dampestrus sp.</i>	Potential
Scorpiones		
Urodacidae	<i>Urodacus granifrons</i>	Potential
	<i>Urodacus 'rugosus'</i>	Potential
	<i>Urodacus 'JP'</i>	Potential
	<i>Urodacus sp. indet.</i>	Undetermined
	<i>Urodacus 'kraepelini'</i>	Potential
	<i>Urodacus sp. indet.</i>	Potential
Buthidae	<i>Lychas 'JPP'</i>	Potential
	<i>Lychas 'JPP1'</i>	Potential
	<i>Lychas 'JPP2'</i>	Potential
	<i>Lychas 'JPP3'</i>	Potential
	<i>Lychas 'Broome'</i>	Potential
Pseudoscorpiones		
Olpidae	<i>Euryolpium sp.</i>	Potential

CONSERVATION SIGNIFICANT FAUNA RECORDED IN THE REGION

Common name	Scientific name	SRE status
	<i>Austrohorus sp.</i>	Undetermined
	<i>Beierolpium sp 8/4</i>	Undetermined
	<i>Beierolpium sp. '(juv)'</i>	Undetermined
	<i>Indolpium sp.</i>	Undetermined
	<i>Olpiidae 'genus indet. (juvenile)'</i>	Potential
Gastropoda		
Camaenidae	<i>Quistrachia leptogramma</i>	Potential
	<i>Rhagada bulgana</i>	Confirmed
	<i>Gastrocopta aff. bannertonensis</i>	Potential
Punctidae	<i>Magilaoma sp. nov.</i>	Potential

APPENDIX SEVEN

FAUNA RECORDED FROM THE STUDY AREA

Table 39: Mammals recorded from the study area

Family and Species	Common name	EPBC Act	BC Act	DBCA	NBY S1	NBY S2		NBY S3	NBY S4	Opp (inside)	Opp (outside)
TACHYGLOSSIDAE											
<i>Tachyglossus aculeatus</i>	Echidna									S	
MACROPODIDAE											
<i>Lagorchestes conspicillatus leichardti</i>	Spectacled Hare-wallaby			P3		S			S	S	
<i>Macropus agilis</i>	Agile Wallaby				S	S	S		S	S	
EMBALLONURIDAE											
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat						R		R		
VESPERTILIONIDAE											
<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat						□		□	□	□
<i>Scotorepens greyii</i>	Little Broad-nosed Bat						Δ		Δ	□	□
MOLOSSIDAE											
<i>Chaerophon jobensis</i>	Northern Freetail Bat						□		□	□	□
MURIDAE											
<i>Pseudomys delicatulus</i>	Delicate Mouse				6	4	2		5		
INTRODUCED MAMMALS											
<i>Canis lupus</i>	Dog/Dingo						1			1	S
<i>Felis catus</i>	Cat									S	S
<i>Bos taurus</i>	Cow				10	13	S		S		200

× Species recorded outside the study area (within 1km)

Δ Either species was recorded, calls are very similar so could not be identified.

R Species recorded

S Secondary evidence recorded

Table 40: Bird species recorded from the study area

Family and Species	Common name	EPBC Act	BC Act	DBCA	NBY S1	NBY S2	NBY S3	NBY S4	Opp (inside)	Opp (outside)
COLUMBIDAE										
<i>Ocyphaps lophotes</i>	Crested Pigeon							2	2	
<i>Geopelia cuneata</i>	Diamond Dove							1	1	
<i>Geopelia striata</i>	Peaceful Dove									1
PODARGIDAE										
<i>Podargus strigoides</i>	Tawny Frogmouth									1
ARDEIDAE										
<i>Ardea pacifica</i>	White-necked Heron									2
ACCIPITRIDAE										
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard					1				2
<i>Milvus migrans</i>	Black Kite								1	
<i>Accipiter fasciatus</i>	Brown Goshawk						1	1		
FALCONIDAE										
<i>Falco cenchroides</i>	Nankeen Kestrel						5		1	3
<i>Falco berigora</i>	Brown Falcon					1				
OTIDIDAE										
<i>Ardeotis australis</i>	Australian Bustard								S	
TURNICIDAE										
<i>Turnix velox</i>	Little Button-quail									1
CACATUIDAE										
<i>Cacatua roseicapillus</i>	Galah									2
PSITTACIDAE										
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet									1
<i>Aprosmictus erythropterus</i>	Red-winged Parrot									2
<i>Melopsittacus undulatus</i>	Budgerigar				12	10				8

FAUNA RECORDED FROM THE STUDY AREA

Family and Species	Common name	EPBC Act	BC Act	DBCA	NBY S1	NBY S2	NBY S3	NBY S4	Opp (inside)	Opp (outside)
CUCULIDAE										
<i>Chalcites basal</i>	Horsfield's Bronze-Cuckoo				3	2			4	2
HALCYONIDAE										
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher								1	
MEROPIIDAE										
<i>Merops ornatus</i>	Rainbow Bee-eater		S5		1	1	3	1	8	
MALURIDAE										
<i>Malurus melanocephalus</i>	Red-backed Fairy-wren								2	
<i>Malurus lamberti</i>	Variegated Fairy-wren						4	3	6	
ACANTHIZIDAE										
<i>Gerygone albogularis</i>	White-throated Gerygone				2	3	3	1	2	4
PARDALOTIDAE										
<i>Pardalotus striatus</i>	Striated Pardalote								1	
MELIPHAGIDAE										
<i>Lichenostomus virescens</i>	Singing Honeyeater				2				3	
<i>Lichmera indistincta</i>	Brown Honeyeater						1	1		
POMATOSTOMIDAE										
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler				2		1	1	2	
CAMPEPHAGIDAE										
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				1		2	2	3	
<i>Lalage sueurii</i>	White-winged Triller				2	1			5	
PACHYCEPHALIDAE										
<i>Pachycephala rufiventris</i>	Rufous Whistler				2	1			2	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				1				3	
ARTAMIDAE										
<i>Artamus cinereus</i>	Black-faced Woodswallow							1	5	7

FAUNA RECORDED FROM THE STUDY AREA

Family and Species	Common name	EPBC Act	BC Act	DBCA	NBY S1	NBY S2	NBY S3	NBY S4	Opp (inside)	Opp (outside)
<i>Cracticus nigrogularis</i>	Pied Butcherbird				3	2	1	3	2	
<i>Cracticus tibicen</i>	Australian Magpie								1	4
RHIPIDURIDAE										
<i>Rhipidura leucophrys</i>	Willie Wagtail					1			2	
CORVIDAE										
<i>Corvus orru</i>	Torresian Crow				3		1	2	1	22
MONARCHIDAE										
<i>Grallina cyanoleuca</i>	Magpie-lark						1			
NECTARINIIDAE										
<i>Dicaeum hirundinaceum</i>	Mistletoebird									1
ESTRILDIDAE										
<i>Taeniopygia guttata</i>	Zebra Finch				3	1			4	
<i>Poephila acuticauda</i>	Long-tailed Finch						1		1	

O = Outside the study area (within 1km)

* Introduced species

† Species recorded just outside project area

Table 41: Reptile species recorded from the study area

Family and Species	Common name	EPBC Act	BC Act	DBCA	NBY S1	NBY S2	NBY S3	NBY S4	Opp (inside)	Opp (outside)
AGAMIDAE										
<i>Chlamydosaurus kingii</i>	Frill-necked Lizard							1		
<i>Diporiphora pindan</i>	Pindan Dragon				10	12	6	6		
<i>Pogona minor</i>	Dwarf Bearded Dragon				3	3	1		2	
DIPLODACTYLIDAE										
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko				6	3				
<i>Strophurus ciliaris</i>	Northern Spiny-tailed Gecko					1				
GEKKONIDAE										
<i>Gehyra variegata</i>	Tree Dtella				2	1				
PYGOPODIDAE										
<i>Delma tinctoria</i>						1		1		
<i>Lialis burtonis</i>	Burton's Legless lizard							1		
SCINCIDAE										
<i>Ctenotus colletti</i>	Buff-tailed Finesnout Ctenotus				1		1	1		
<i>Ctenotus sp. (leonhardii group)</i>					6	5	2	3		
<i>Ctenotus pantherinus</i>	Leopard Ctenotus				1	1	5	4		
<i>Ctenotus inornatus (former saxatilis)</i>	Bar-shouldered Ctenotus				19	25	24	33		
<i>Eremiascincus isolepis</i>	Northern Bar-lipped Skink				3	3	1			
<i>Lerista bipes</i>	North-western Sandslider				25	26	16	15		
<i>Menetia greyii</i>	Common Dwarf Skink							1		
<i>Menetia maini</i>	Northern Dwarf Skink				1	6	2	3		
<i>Morethia storri</i>	Top End Fire-tailed Skink				1	1			1	
<i>Notoscincus ornatus</i>	Ornate Soil-crevice Skink				1					
<i>Tiliqua scincoides</i>	Eastern Blue-tongue								1	
VARANIDAE										

Family and Species	Common name	EPBC Act	BC Act	DFCA	NBY S1	NBY S2	NBY S3	NBY S4	Opp (inside)	Opp (outside)
<i>Varanus gouldii</i>	Sand Monitor									1
<i>Varanus sparnus</i>	Dampier Peninsula goanna			P1	1	2	1	3		
TYPHLOPIDAE										
<i>Anilius diversus</i>	Northern Blind Snake						1			
ELAPIDAE										
<i>Brachyuropsis roperi</i>	Northern Shovel-nosed Snake					1				
<i>Demansia angusticeps</i>	Narrow-headed Whipsnake							1		
<i>Pseudonaja mengdeni</i>	Western Brown Snake						1			

**formerly recorded as P. nuchalis*
O Species recorded outside the study area (within 1km)

Table 42: Amphibian species recorded from the study area

Family and Species	Common name	EPBC Act	BC Act	DFCA	NBY S1	NBY S2	NBY S3	NBY S4	Opp (inside)	Opp (outside)
HYLIDAE										
<i>Litoria caerulea</i>	Green Tree Frog				1					
LIMNODYNASTIDAE										
<i>Notaden nichollsi</i>	Desert Spadefoot					1	30			
MYOBATRACHIDAE										
<i>Uperoleia mjobergii</i>	Mjoberg's Toadlet						1			

Table 43: Invertebrate SRE species recorded from the study area

Family	Order and Species	EPBC Act	SRE	BC Act	DFCA	NBY S1	NBY S2	NBY S3	NBY S4	Leaf Litter NBY 1	Leaf Litter NBY 2	Leaf Litter NBY 3	Leaf Litter NBY 4
CRUSTACEAN													
ISOPODA													
ARMADILLIDAE	<i>Buddelundia</i> sp. B74		Potential			1							
SCORPIONES													
BUTHIDAE	<i>Lychas splendens</i>		Potential			1	1		1				
	<i>Lychas</i> sp. B11		Potential			4			1				
PSEUDOSCORPIONES													
OLPIIDAE	Oolpidae sp.		Potential							1	1		
	<i>Euryolpium</i> sp. B09		Potential									1	
	<i>Beierolpium 8/4</i> sp. B18		Potential									1	1

APPENDIX EIGHT CONSERVATION SIGNIFICANT VERTEBRATE FAUNA SPECIES RECORDED

Table 44: Conservation significant fauna recorded

Species	Scientific Name	Con. status	Coordinates		Details
			Easting	Northing	
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	463815	8005359	Fresh scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	463568	8005280	Fresh/recent scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	463145	8005096	Old shelter & scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464668	8005386	Old shelter
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464867	8004847	Potential shelter and old scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464841	8004369	Fresh shelter
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	455334	8010317	Old/recent shelter
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464941	8001623	Fresh and old scats, fresh shelter
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	463010	8004093	Recent scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464615	8003873	Fresh scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	463061	8004092	Fresh tracks
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464971	8001591	Old scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	462665	8004109	Fresh scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	462665	8004089	Fresh tracks
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464341	8005720	Recent shelter
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464810	8004366	Recent shelter
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	464610	8003872	Recent scats
Spectacled Hare-Wallaby	<i>Lagorchestes conspicillatus</i>	DBCA P3	462665	8004109	Fresh scats
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	464930	8001436	1 individual
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	462666	8005478	4 individuals
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	462814	8005609	1 individual
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	464906	8001853	1 individual
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	462197	8003517	1 individual
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	462402	8004013	1 individual (Site NBY1)
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	462982	8005418	1 individual (Site NBY2)
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	464922	8005442	3 individuals (Site NBY3)
Rainbow Bee-eater	<i>Merops ornatus</i>	BC Act S5	464927	8000979	1 individual (Site NBY4)
Dampier Peninsula goanna	<i>Varanus sparnus</i>	DBCA P1	462402	8004013	1 individual (NBY S1)
Dampier Peninsula goanna	<i>Varanus sparnus</i>	DBCA P1	462982	8005418	2 individuals (NBY S2)
Dampier Peninsula goanna	<i>Varanus sparnus</i>	DBCA P1	464922	8005442	1 individuals (NBY S3)
Dampier Peninsula goanna	<i>Varanus sparnus</i>	DBCA P1	464927	8000979	3 individuals (NBY S4)

APPENDIX NINE

CONSERVATION SIGNIFICANT FAUNA PROFILES

Bilby (*Macrotis lagotis*)

Conservation status

EPBC Act Vulnerable, WC Act Schedule3, DBCA Vulnerable.

Distribution and Preferred habitat

Once very widespread, the only extant species of the Greater Bilby (*Macrotis lagotis*, Thylacomyidae) is now rare and scattered, confined to northern and mostly inland locations, particularly sandy deserts (patchily distributed through the Tanami Desert in the Northern Territory, west to Broome and south to Warburton in Western Australia). It occupies a variety of habitats, including cracking clays, desert sandplains, and dune fields with hummock grassland and Acacia shrubland (Van Dyck & Strahan 2008).

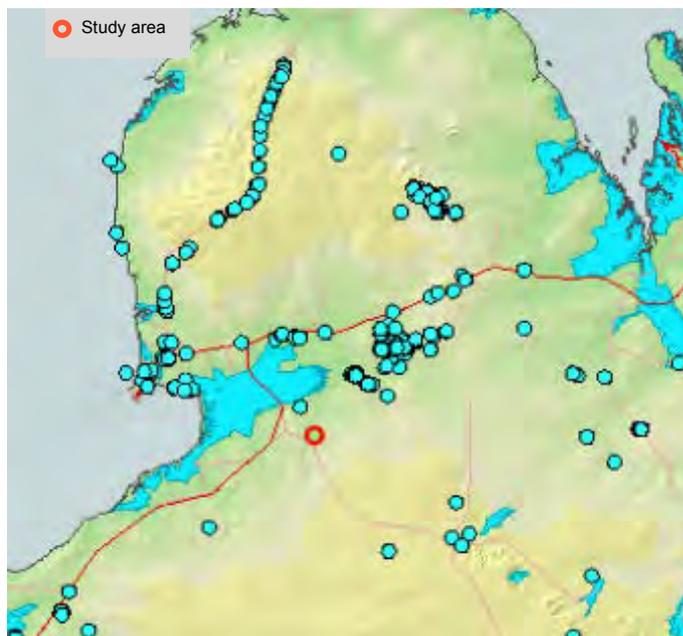
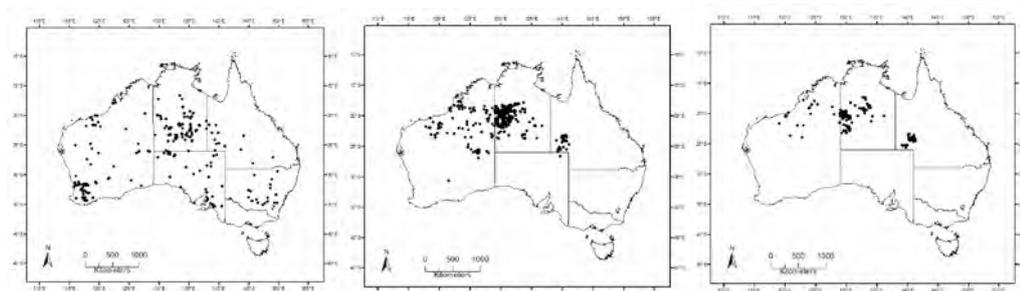


Figure 11: Regional records of the Greater Bilby (DPaW 2007-2017)



Records (left) up to and including 1970, (middle) 1971-1990, (right) 1991-2004 (Pavey 2006)

Ecology

The Bilby is terrestrial, nocturnal and omnivorous, constructing an extensive burrow where it remains during the day, emerging at night to dig for insects, very small vertebrates, seeds, fruit and fungi. The burrow provides refuge from fires and many of its food plants are promoted by disturbance, so Bilbies are able to occupy recently burnt areas and have been considered 'dependent on fire' (Friend *et al.* 2011). Lavery & Kirkpatrick (1997) suggest that very small populations may leave traces that incorrectly suggest much larger numbers and healthier populations than is actually the case. Gait dimensions from trackways, and diameter of faecal pellets, can be used to estimate the size/age-class of individuals, and hence the minimum number of individuals present at a locality (Southgate 2005).

Likelihood of Occurrence

There are several historic and recent records of the Greater Bilby in the vicinity (**Figure 11**) (*NatureMap*, DPaW 2007-2015), with the closest record in 2003 and several records from 2016 from approximately 23 km north-east of the study area. The Greater Bilby is considered relatively easy to locate when present because of its distinctive tracks, burrows and foraging holes, so cryptic presence within the study area is very unlikely. No signs of the species was recorded during thorough searches.

Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*)

Conservation status

DPaW Priority 3

Distribution and Preferred habitat

This mainland subspecies of the Spectacled Hare-wallaby is a medium-sized wallaby found across northern Australia and in the Pilbara region. It inhabits grasslands, open forests, open woodlands and tall shrublands, and shelters during the day under *Triodia* tussocks (DEWHA 2008a).

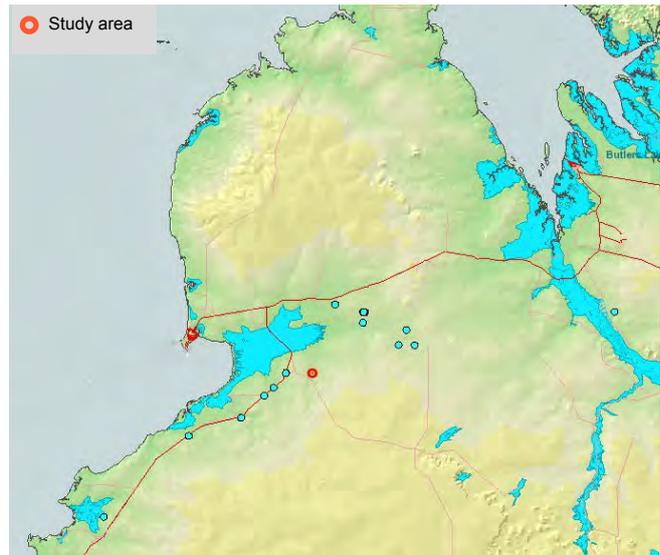


Figure 12: Regional records of the Spectacled Hare-wallaby (DPaW 2007-2017)

Ecology

The Spectacled Hare-wallaby is solitary, but up to three individuals may occasionally be seen feeding together. Breeding takes place throughout the year. Its diet consists of grass and herbs. It is well adapted to harsh conditions; it has a low urine production and the water turnover is far less than has been measured in any other mammal of comparative size (Burbidge and Johnson 2008). Its home range is estimated to be up to 177 ha (based on observations in QLD) which is quite large for solitary animals (Rootourism 2010).

Likelihood of Occurrence

The Spectacled Hare-wallaby is listed by DPaW as Priority 3 (P3) and was presumed locally extinct prior to 2015 when road kill and several other records were discovered in close vicinity to the study area. A total of 159 records are currently known from within 10 km of the study area of which the majority of the records were made since 2015 (Government of Western Australia 2017a). The species was recorded via secondary evidence from 16 locations across the study area. The records comprised of older shelters, fresh and recent scats as well as fresh tracks. Despite the species' presence at the time of surveying, it is unknown if the species inhabits the study area on a permanent basis. The survey was conducted after the rain season when herbs and annuals were present. The Spectacled Hare-wallaby is likely to move into the area when conditions are favourable and may leave the area during the dry season when temperatures are high and conditions harsh.

Rainbow Bee-eater (*Merops ornatus*)

Conservation Status

WC Act Schedule 5

Distribution and Preferred Habitat

The Rainbow Bee-eater is widespread throughout most of Australia with several records in the vicinity of the study area (**Figure 13**), and does not depend on any particular habitat or vegetation type for feeding or breeding. They are scarce to common throughout much of Western Australia except for the arid interior, preferring lightly wooded, sandy country near water (DSEWPaC 2012).

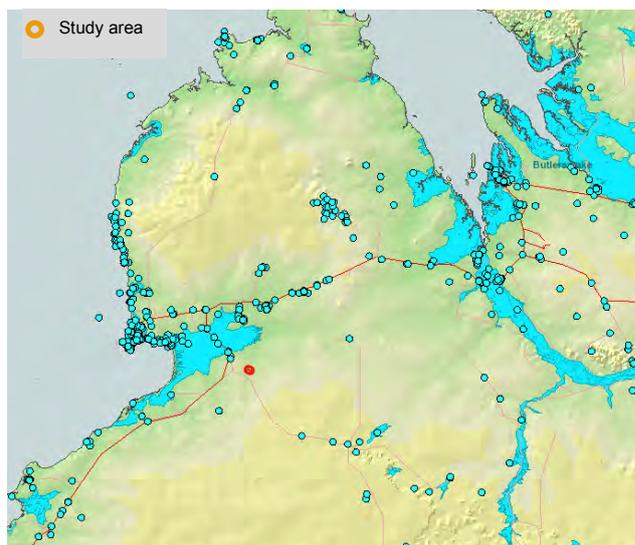


Figure 13: Regional records of the Rainbow Bee-eater

Ecology

Bee-eaters feed mainly on insects taken in flight (hawking), but also take prey from the ground and foliage (gleaning). Populations in southern Australia are migratory, wintering in Indonesia and New Guinea, moving south over summer and breeding in Australia, but the species is resident and present year-round in parts of northern Australia including the Pilbara (DSEWPaC 2012). Nesting occurs in burrows dug in flat or slightly sloping ground, sandy banks or cuttings, and often at the margins of roads or tracks; breeding is often colonial and cooperative (Boland 2004).

Likelihood of Occurrence and Potential Impact

The Rainbow Bee-eater was recorded from nine locations within the study area, all observations were foraging adult individuals. The species is widespread in the area and find suitable condition for foraging inside and outside the study areas. The proposal area does not contain quality breeding habitat in the form of sandy river banks. For this reason, any clearing of habitat in the study area is not expected to have a significant impact on the Rainbow Bee-eater.

Dampier Peninsula Goanna (*Varanus sparnus*)

Conservation Status

DPaW Priority 1

Distribution and Preferred Habitat

The Dampier Peninsula Goanna was described in 2014 after it was originally found in 2009 at Coloumb Point, approximately 88 km north-west of the study area (Doughty *et al.* 2014). The species is now known from across the Dampier Peninsula and has previously been recorded from the Thunderbird project, 75 km north-east of the study area (ecologia 2014c). The species is very closely related to the common Short-tailed Pygmy Monitor *Varanus brevicauda* and the morphological similarities may be the cause for the limited number of records of *V. sparnus* to date (Doughty *et al.* 2014). The species is likely more common in the Kimberley region than currently known.

Ecology

The ecology of the Dampier Peninsula Goanna is not well known due to the recent discovery. However, based on the similar morphology between the species and the Short-tailed Pygmy Monitors as well as previous records, the habitat preference and ecology is likely to be very similar between the species. *Triodia* and Tussock Grasses as well as pindan vegetation on sandy substrate are typically inhabited (Doughty *et al.* 2014). They can dig burrows into spinifex clumps and other grasses where they find shelter during hot conditions.

Likelihood of Occurrence and Potential Impact

The Dampier Peninsula Goanna was recorded from across the study area from both the habitat types. The vegetation also continues in the surrounding areas and is not limited to study site. It is highly likely that the species is common across the Dampier Peninsula and possibly further inland. The vegetation clearing associated with the proposed development is unlikely to significantly impact the species on a regional level, in particular because the habitat found on site is not unique for the region and is connected to surrounding areas.

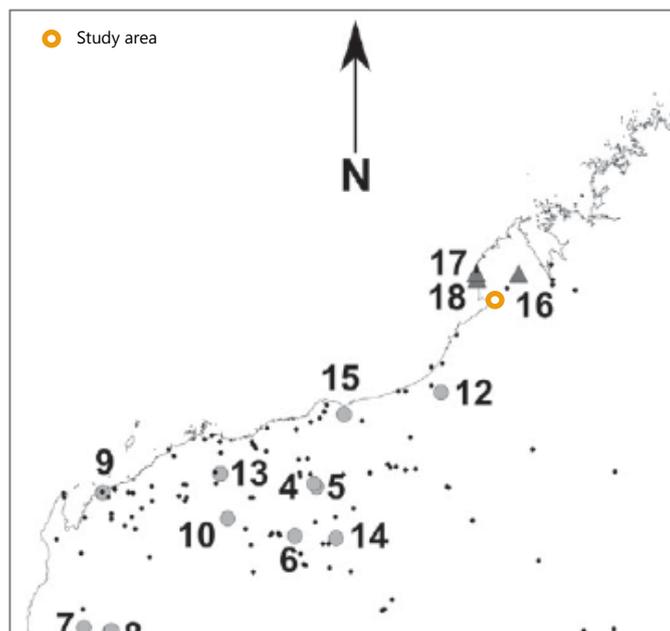


Figure 14: Regional records of the Dampier Peninsula Goanna (triangles) and Short-tailed Pygmy Monitor (circles) (Doughty *et al.* 2014)

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Roebuck Plains Agricultural
Development: Subterranean
Fauna Desktop

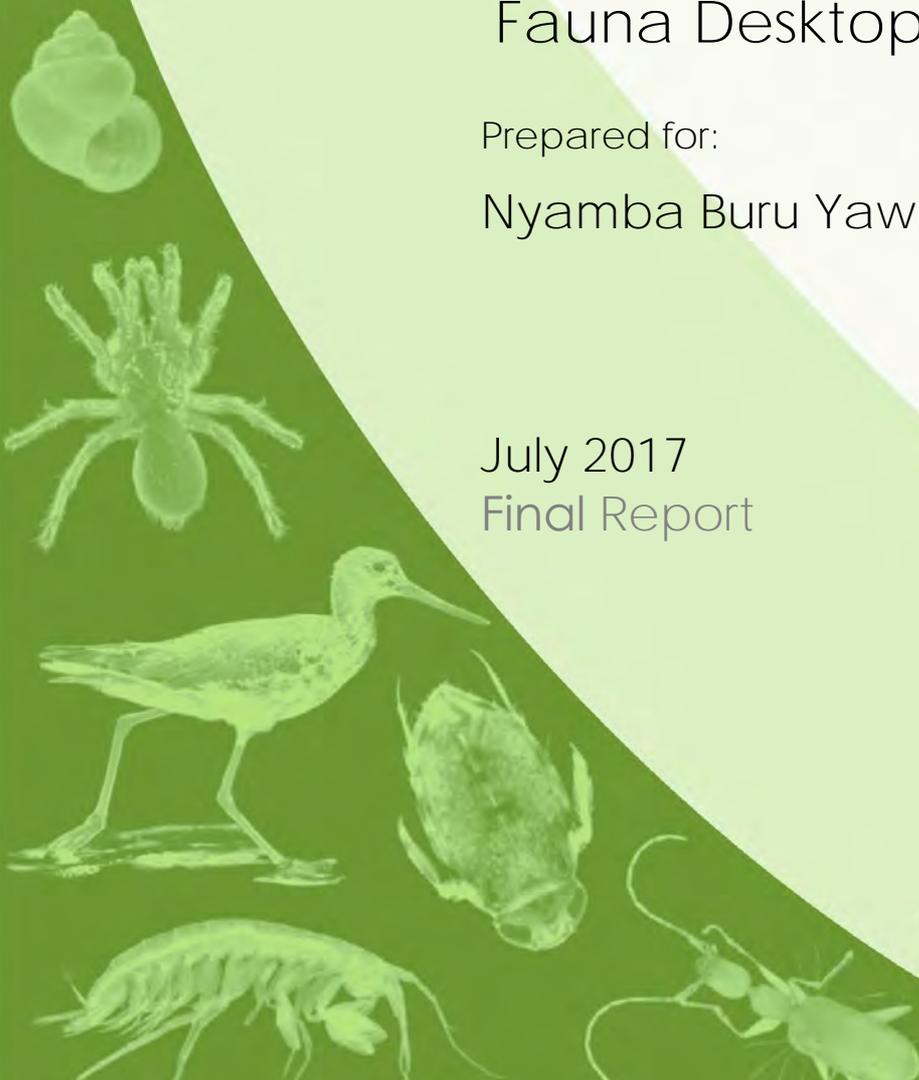
Prepared for:

Nyamba Buru Yawuru Ltd

July 2017
Final Report

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands



Nyamba Buru Yawuru (NBY) Roebuck Plains Agricultural Development Subterranean Fauna Desktop

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EXECUTIVE SUMMARY

Nyamba Buru Yawuru (NBY) is the organisation representing the native title holders, the Yawuru people, of Broome and surrounding areas. NBY owns a number of properties in the Roebuck Plains / La Grange area including Roebuck Plains Station (RPS). The area is complex, with overlapping values and land uses present, including Yawuru cultural sites, cattle grazing, Ramsar wetlands Threatened Ecological Communities and Environmentally Sensitive Areas.

NBY is planning to invest in a five x 50 ha pivot agriculture system covering approximately 300 ha within the La Grange area. The La Grange area is considered to have a high potential for irrigated agriculture. The pivots will be constructed within an envelope of 960 ha, referred to as the Proposal, and NBY have applied for a water license to extract 3 gigalitres (GL) of water annually for irrigation supply.

This report assesses the likelihood of subterranean fauna occurring within the Proposal. Subterranean fauna are animal species that spend all, or most, of their life cycle below ground. There are two types of subterranean fauna: stygofauna are found in groundwater, while troglifauna are air-breathing and occur the vadose zone between the surface and the watertable. Several aspects of the Proposal, including groundwater extraction, and possibly elevated levels of nutrients, herbicides, pesticides and salinisation, have the potential to significantly impact on subterranean fauna species.

There has been no sampling for subterranean fauna in close proximity to the Proposal. In the broader area from the Dampier Peninsula to south of La Grange area, subterranean fauna have been surveyed for three environmental impact assessments and a baseline study of Mandora Marsh (140 km south-east of Broome) with 23 species of stygofauna and three species of troglifauna collected. Most of the species were new or undescribed. The stygofauna species collected at Mandora Marsh came from mound springs, while the remaining stygofauna and troglifauna species appear to originate from the Broome Sandstone.

The Broome aquifer is treated in this report as an unconfined aquifer lying under up to 10 m of pindan soils. These soils are not prospective for subterranean fauna because of their high clay content. And small particle size. The Broome Sandstone containing the Broome aquifer is about 110 m thick and regarded as suitable for both troglifauna (in the unsaturated part of its profile) and stygofauna (in the saturated part of the profile). The Broome Sandstone extends widely across the La Grange area and there is probably extensive habitat connectivity within Broome Sandstone between the Proposal and surrounding areas.

The likely richness of the stygofauna community within the Proposal is unclear. Other surveys in Broome Sandstone suggest that only a modest stygofauna community will be present but surveys in the Pilbara in a similar landscape setting have collected rich stygofauna communities. It is likely that any troglifauna community present at the Proposal will be depauperate and its distribution will be dependent on the occurrence of unsaturated Broome Sandstone under a layer of pindan sand.

No listed stygofauna or troglifauna species occurs in the vicinity of the Proposal.

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1. INTRODUCTION

Nyamba Buru Yawuru (NBY) is the organisation representing the native title holders, the Yawuru people, of Broome and surrounding areas. NBY owns a number of properties in the Roebuck Plains / La Grange area including Roebuck Plains Station (RPS). The area supports overlapping values and land uses, including Yawuru cultural sites, cattle grazing, Ramsar wetlands, Threatened Ecological Communities (TECs), Environmentally Sensitive Areas (ESAs) and habitat for the Greater Bilby and Spectacled Hare-wallaby.

NBY is planning to invest in a five x 50 ha pivot agriculture system covering approximately 300 ha within the La Grange area. The La Grange area is considered to have a high potential for irrigated agriculture. The pivots will be constructed within an envelope of 960 ha, referred to as the Proposal (Figure 1). NBY have applied for a water license to extract 3 gegalitres (GL) of groundwater annually for irrigation purposes.

This report assesses whether subterranean fauna are likely to occur within the Proposal. The specific aims of the assessment are to:

- Review of existing data from the sub-region to determine the likelihood of occurrence of subterranean fauna in the vicinity of the Project and adjacent regional area;
- Assess the suitability for subterranean fauna of the habitat within the Proposal area, including the borefield to supply irrigation water;
- Determine the degree of connectivity between suitable subterranean fauna habitat within the Proposal area and surrounding areas of the same habitat outside the Proposal area; and
- Identify known occurrences of any listed subterranean fauna communities or species in the vicinity of the Proposal.

2. BACKGROUND

2.1. Project Description

A land assessment of the La Grange area identified over 50,000 hectares of pindan soils with high to fair capability for irrigated agriculture (potable groundwater within 20 m of surface). Groundwater is the main limiting resource for irrigated agriculture in the La Grange area but it is estimated that at least 50 GL of surficial groundwater from the Broome Aquifer could be used sustainably (Smolinski *et al.* 2016). The Proposal lies within the north sub-area of the La Grange groundwater allocation, which has 35 GL of water available (Smolinski *et al.* 2016). Most of the Proposal straddles the two most preferred agricultural areas, i.e. those with groundwater at 3 to 20 m or 20 to 40 m below the surface.

The soils of the La Grange area are spatially uniform and extend to the sandstone layer. They consist of a loamy sand or clayey sand topsoil texture to 30 cm and then clay content increases gradually with depth. Laterite has been encountered at 3 to 8 m. The soil of the Proposal area is classed as "sandy pindan" according to Smolinski *et al.* (2016), who have assigned component soil classes via the system developed by Schoknecht and Pathan (2012). Pindan soils generally have very low levels of soil organic carbon and low capacity to fix phosphorus. The soil phosphorus retention index (PRI) is positively correlated with clay content. PRI values are low to medium in topsoil and medium to high in subsoil (Moore 1998).

2.2. Subterranean Fauna

Subterranean fauna can be divided into two groups: aquatic stygofauna and air-breathing troglifauna. Both groups typically lack eyes and are poorly pigmented due to the absence of light in their subterranean habitat. Other characteristic morphological and physiological adaptations, such as vermiform bodies, elongate sensory structures, loss of wings, increased lifespan, a shift towards K-selection breeding strategy and decreased metabolism, reflect low inputs of carbon and nutrients in

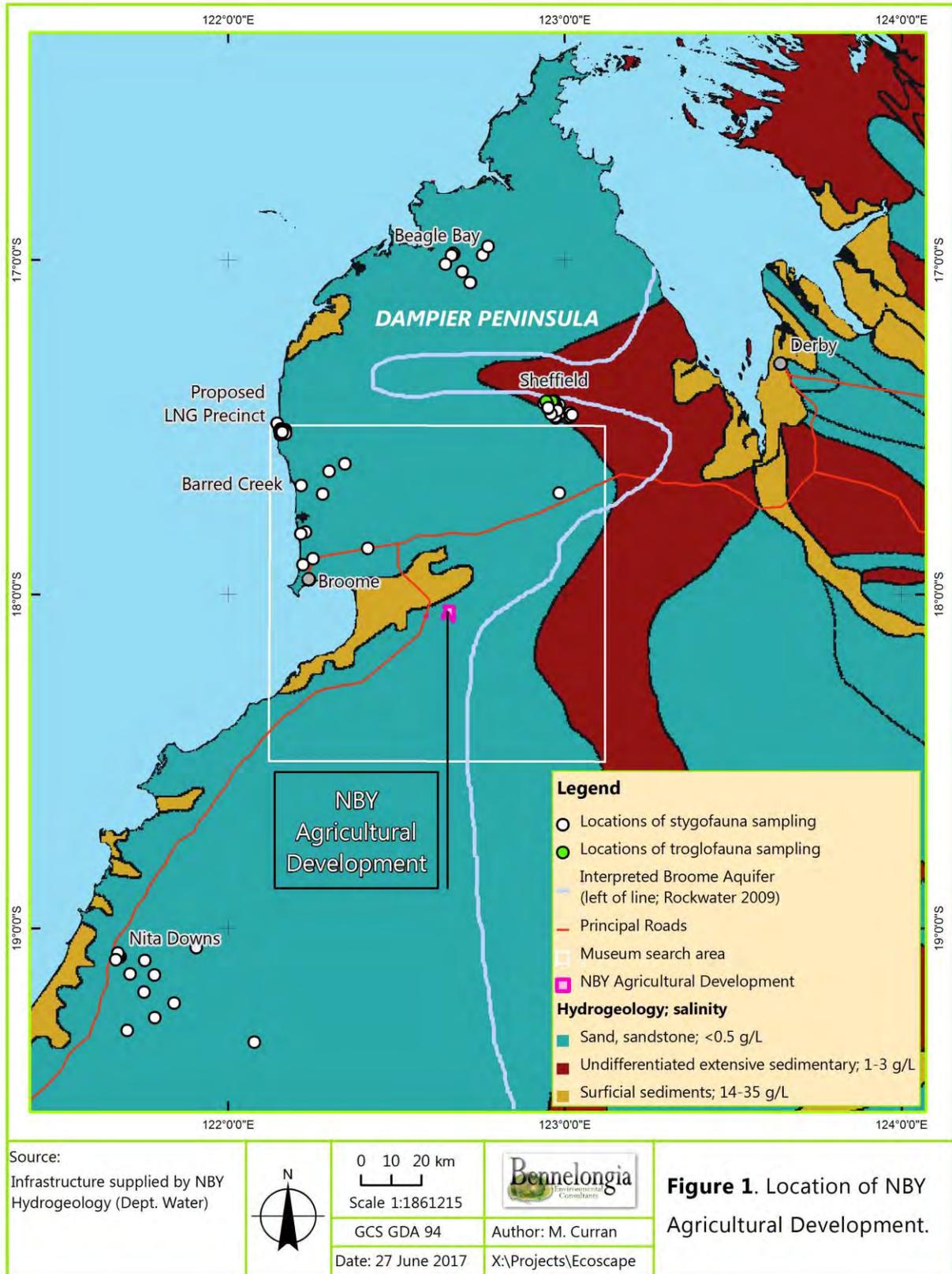


Figure 1. Location of NBY Agricultural Development.

Figure 1. Location of the NBY Agricultural Development, regional stygofauna sampling and museum search area.

the subterranean environment and the requirement to navigate small enclosed spaces (Gibert & Deharveng 2002). Nearly all subterranean fauna in Western Australia are invertebrates.

Geology influences the presence, richness and distribution of subterranean fauna by determining the types of habitat available (Eberhard *et al.* 2005; Hose *et al.* 2015). Highly transmissive or vuggy geologies support greater assemblages of subterranean fauna, both in terms of abundance and diversity, than consolidated ones. Alluvial deposits may host subterranean fauna in interstitial spaces between constituent sand and gravel, and coarser sediments tend to host greater assemblages than silty or clay-rich substrates (Korbelt and Hose 2011). Physical and chemical weathering of consolidated strata can also provide fissures, vugs and caves to support subterranean species. Fluctuating groundwater levels and resulting precipitation of carbonates along the internal palaeoriver system of Western Australia has resulted in the formation of many calcrete bodies, which are often karstic and provide habitat for both stygofauna in aquifers and troglofauna above the water table (Humphreys 2001).

Principally because of the poor dispersal possible below ground, there has been extensive speciation within subterranean fauna, which exhibit a very high level of short-range endemism. Genetic investigation suggests there may also have been extensive cryptic speciation (Trotter *et al.* 2017).

2.2.1. Stygofauna

Groups occurring as stygofauna include earthworms, beetles and crustaceans (principally Amphipoda, Isopoda, Copepoda, Ostracoda and Syncarida). In Western Australia, surveys of alluvial and calcrete aquifers have revealed rich and endemic stygofaunal assemblages, while less transmissive geologies such as banded iron formations (BIF), saprolite, mafics and ultramafics tend to be less prospective. Nevertheless, stygofauna have been recorded in geologies of relatively poor permeability (Ecologia 2009; GHD 2009). Stygofauna occur in varying salinities, but are mostly found in fresh to brackish waters with conductivities of less than 5,000 $\mu\text{S cm}^{-1}$ (approximately 3,000 mg L^{-1} TDS), and are seldom found in hypoxic groundwater ($<0.3 \text{ mg O}_2 \text{ L}^{-1}$) despite being tolerant of low oxygen levels (Hose *et al.* 2015).

2.2.2. Troglofauna

Groups occurring as troglofauna include isopods, palpigrids, spiders, schizomids, pseudoscorpions, harvestmen, millipedes, centipedes, pauropods, symphylans, bristletails, silverfish, cockroaches, bugs, beetles and fungus-gnats. Troglofauna have been recorded throughout the Western Australian landscape, with the greatest diversity and abundance occurring in the Pilbara, where they have been found to occur widely in mineralised and weathered iron formations, calcretes and alluvial-detrital deposits (e.g. Biota 2006; Bennelongia 2008a, b; Edward and Harvey 2008).

Troglofauna surveys outside the Pilbara have been limited and, in most cases, have recorded modest abundances and diversities of troglofauna. However, various troglofaunal groups have been collected from caves and the broader landscape in the Kimberley, including isopods (Dalens 1993), spiders (Harvey Edward 2007), pseudoscorpions (Harvey and Volschenk 2007), cockroaches (Roth 1995), hemipterans (Humphreys 1998), ants (Andersen and Brault 2010), silverfish (Smith and McRae 2016) and diplurans (Conde 1009).

2.3. Conservation Framework

The Environmental Protection Authority recognises the need to conserve subterranean fauna and stipulates its consideration as part of environmental impact assessment in the *Environmental Factor Guideline: Subterranean Fauna* (EPA 2016a). The protection of subterranean fauna can also be viewed in the wider context of state and federal conservation legislation. At the state level, the *Wildlife Conservation 1950* and *Biodiversity Conservation Act 2016* provide for the listing of species as Threatened or Priority following recommendations by the Threatened Species Scientific Committee and the Department of Parks and Wildlife (Parks and Wildlife). At the federal level, species may be listed as Threatened under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In addition to individual species, ecological communities may be listed as needing special protection at both the state and federal levels. At the state level, the Minister for the Environment may list an ecological community as being threatened (i.e. a TEC) if the community is presumed to be destroyed or at risk of becoming totally destroyed. Ecological communities with insufficient information available to be considered a threatened ecological community or which are rare but not currently threatened are listed by Parks and Wildlife as Priority Ecological Communities (PECs). Ecological communities may also be listed as threatened nationally under the EPBC Act.

3. HYDROGEOLOGY

3.1. Geology

The Proposal lies in a subdivision of the Canning Basin called the Fitzroy Trough that is mostly comprised of sedimentary strata and a few east-west anticlines north of Broome. The stratigraphy of the Fitzroy Trough is summarised as follows from the surface (Rockwater 2012):

- Quaternary Superficial deposits (pindan at the Proposal);
- Early Cretaceous Broome Sandstone, up to 280 m thick;
- Late-Jurassic to early Cretaceous Jarlemai Siltstone, 260 m thick;
- Late-Jurassic Alexander Formation, 20 m thick;
- Early- to late-Jurassic Wallal Sandstone, 360 m thick;
- Early-Permian Noonkanbah Formation, 200 m thick;
- Early-Permian Poole Sandstone, 50 m thick; and
- Early-Permian Grant Group, 200 m thick.

3.2. Hydrology

Two aquifers occur within the Proposal (Figure 2).

Broome Aquifer

The Broome Sandstone contains the unconfined Broome aquifer, which is the uppermost aquifer over most of the La Grange area. Groundwater in the overlying pindan is probably in hydraulic connection with, and is thus included as part of, the Broome aquifer (Rockwater 2012). The Broome aquifer is a multi-layered, unconfined system characteristically comprised of conglomerate and unconsolidated coarse-grained sandstone with intervening minor lenses of siltstone and claystone and thin coal seams (Laws 1991). There are some smaller gravel and laterite units that appear occasionally in the sandstone (Smolinski *et al.* 2016). The saturated thickness of the aquifer at the Proposal is approximately 120 m. The watertable is estimated to occur between 10 m and 20 m below the surface of the Proposal, with shallower groundwater (5 to 10 m) immediately adjacent to the north and east including several wetlands (Wright *et al.* 2016). Jarlemai Siltstone, which is a semi-confining or confining layer between the Broome and Wallal sandstones occurs approximately 90 and 120 m below ground (Wright *et al.* 2016).

Pump tests less than 1.5 km east of the Proposal recorded a surficial water table aquitard overlying the Broome Aquifer (Groundwater Consulting Services 2016), although it is unclear how widespread this is and its potential occurrence within the Proposal has not been taken into account in this report. Groundwater recharge of the Broome aquifer in the La Grange area does not appear to be driven by annual rainfall and is more likely to be the result of large episodic events associated with tropical cyclones (IGS 2016).

The salinity of groundwater in the Broome aquifer ranges from 250 to 500 mg/L TDS inland from the coast, with a wedge of saltwater occupying the lower part of the aquifer for 10 - 13 km inland from the coast (Laws 1991). Thus, there may be a wedge of saltwater underlying the Proposal. The Broome aquifer is close to the surface near the coast (around 0 to 2 m AHD), reflecting its occurrence as an unconfined

aquifer with groundwater flow to the sea (Rockwater 2009). The interpreted extent of the Broome aquifer (Rockwater 2009) is shown in Figure 1.

The shallow groundwater between the coast and 10 m AHD supports some phreatophytic vegetation and possibly the TEC *Bunda Bunda Mound Spring*, which may support a small number of subterranean species (see Storey et al 2011 for a description of the fauna of mound springs).

Wallal Aquifer

The Wallal aquifer occurs in the Wallal Sandstone and Alexander Formation. It is mostly confined or semi-confined by the Jarlemai Siltstone, which separates it from the overlying Broome aquifer. The Wallal aquifer has large quantities of brackish to saline groundwater and has measured salinity of 5,500 mg/L TDS in Broome from bore ACP No. 1. The Wallal Sandstone is a substantial aquifer and with its upper level being approximately -300 m AHD at the Proposal. The aquifer appears to have very high transmissivity.

3.2.1. Assessment of Habitat

The occurrence of subterranean fauna depends on the presence of suitable habitat. Neither consolidated geologies nor fine silts offer such habitat. Additionally, consolidated geologies restrict the downward movement of carbon and nutrients into the subterranean environment.

For the purposes of predicting whether stygofauna are likely to occur, two geological formations are of interest because they have potential to be saturated and occur close to the surface. These are Superficial Deposits and Broome Sandstone. A third formation (Wallal Sandstone) is also likely to be saturated but is unsuitable for stygofauna due to its great depth from the surface and occurrence under a confining layer.

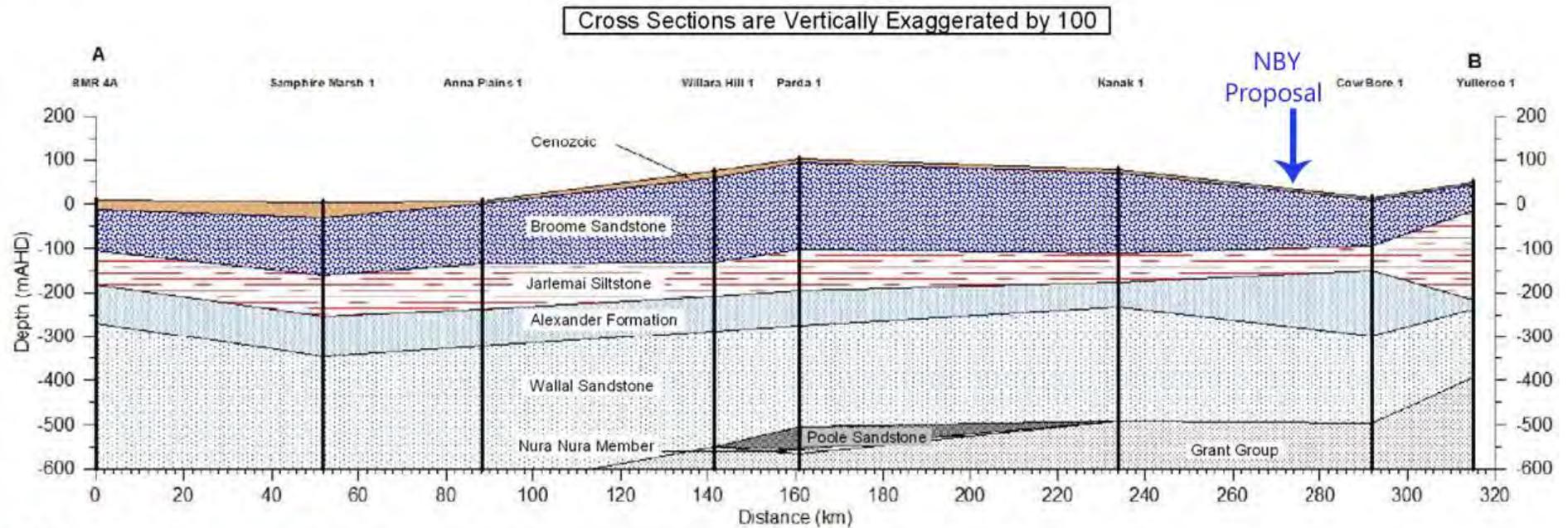
There is probably less than 10 m of pindan soils overlying the Broome Sandstone. The pindan soils are considered unsuitable for most troglofauna and stygofauna species because of their fine matrix. In contrast, the Broome Sandstone is considered to be suitable for troglofauna (in the unsaturated part of its profile) and stygofauna (in the saturated part of the profile).

The Broome Sandstone extends widely across the La Grange area and there is probably extensive habitat connectivity within Broome Sandstone between the Proposal and surrounding areas (Figure 2).

3.3. Subterranean Fauna near the Proposal

The Kimberley region is poorly surveyed for subterranean fauna but available information shows stygofauna occur in alluvium and karstic limestone, dolomite and sandstone systems, alluvial sediments and offshore islands in the region (EPA 2016b; Rockwater 2012; Subterranean Ecology 2012; Bennelongia 2012). While stygofauna communities currently known from the Kimberley appear to be depauperate compared with those from the Pilbara and Goldfields, sampling effort has also been far lower. Few surveys have been conducted for troglofauna in the region outside caves but a few species have been found in sandstone systems and quite rich communities have been recorded in ironstone formations and limestone caves (Ecologia 2016; Bennelongia 2014; EPA 2016b). The EPA ranks the probability of karst, limestone, sandstone, alluvium and islands containing a rich subterranean fauna community as high (EPA 2016b).

Records of subterranean fauna were compiled from Western Australian Museum and Bennelongia databases for a search area of 10,000 km² surrounding the Proposal (defined by 17.501219°S 122.128198°E and 18.500046°S 123.12°E) (Figure 1). Published research papers, available environmental reports and online resources such as the Atlas of Living Australia (ALA 2017) and the Australian Faunal Directory (ABRS 2009) were also reviewed.



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Oil Well data used to create cross sections has been sourced from the Department of Mines and Petroleum Western Australia

Figure 2. Cross-section of geology in La Grange area (Smolinski *et al.* 2016) and proximate location of the Proposal.

There appears to have been very limited sampling of subterranean fauna in the search area (and no records of fauna) and so the search was broadened to include three surveys for environmental impact assessments and a published paper:

- the proposed Browse LNG Precinct (Rockwater 2012);
- the Sheffield Project (Ecologia 2016);
- study of Mandora Marsh (Storey *et al.* 2011); and
- the Canning Basin (Subterranean Ecology 2012).

The first two surveys (Rockwater 2012, Ecologia 2016) collected 221 stygofauna samples (comprising pump and net samples) and 24 troglofauna samples (comprising 12 scrape and 12 trap samples) from across the Dampier Peninsula and further south at the Nita Downs Station. The two surveys combined recorded at least 18 species of stygofauna and three species of troglofauna (Table 1). Three of the stygofauna species are widespread across Western Australia and the remaining stygofauna and all troglofauna species all appear to be new (Table 1).

Further south, 140 km south-east of Broome, a study of the Mandora Marsh aquatic system (Storey *et al.* 2011) recorded five species of stygofauna from a shallow superficial aquifer sustaining a mound spring system (a syncarid, copepods and ostracods). The marsh lies in the La Grange South groundwater subarea and at the transition between the Kimberley and Pilbara. One species of aphaneruran worm has also been recorded from the Canning Basin in the Wallal Sandstone aquifer around 160 km east of Port Hedland (Subterranean Ecology 2012).

3.3.1. Assessment of Likelihood of Fauna

There appears to be a high likelihood that stygofauna will occur at the Proposal. It seems probable that the community will be a modest one but parts of the Pilbara coastal plain support rich stygofauna communities, as does the coastal plain on the Exmouth peninsula (Bennelongia 2008c; Eberhard *et al.* 2009), and it is possible that a richer stygofauna community occurs at the Proposa, which is on coastal plain.

Given that potential troglofauna habitat is restricted to a small depth of unsaturated sandstone lying under pindan soil, it is expected that any troglofauna community occurring at the Proposal will be depauperate. It is also possible that the extent of occurrence of unsaturated Broome Sandstone is too limited and patchy to support populations of troglofauna.

3.4. Conclusions

Based on available habitat information, the limited results of nearby surveys and the broader picture of subterranean fauna distribution in Western Australia, it is considered likely that stygofauna occur within the Proposal. The richness of the stygofauna community, and its biological characteristics, are uncertain.

Any troglofauna community occurring at the Proposal is likely to be depauperate. The extent of potential habitat is uncertain.

No listed stygofauna or troglofauna species occurs in the vicinity of the Proposal.

Table 1. Subterranean fauna recorded near the Proposal.

Higher order identifications, which do not represent species, are shaded in grey; studies associated with the areas are shown below.

Higher Classification	LowestID	Broome to LNG Precinct ¹	Beagle Bay ¹	Sheffield Project ²	Nita Downs ¹	Mandora Marsh ³ / Canning Basin ⁴	Notes on taxonomy and distribution
<i>Stygofauna</i>							
Rotifera	Bdelloidea sp. 2:2	42					Not assessed in EIAs ⁵ , very likely to comprise many species
Nematoda	Nematoda sp.	330					Not assessed in EIAs ⁵ , very likely to comprise many species
Annelida							
Aphanoneura	Aphanoneura sp.					1	Likely a new species
	<i>Rheomorpha</i> sp.	52					Likely a new species
Clitellata							
Oligochaeta	Oligochaeta sp.	17					The oligochaete worms in WA appear to be highly diverse with many short-range endemics ² . These taxa should be interpreted as species complexes
Naididae	Naididae sp.			10			
Phreodrilidae	<i>Insulodrilus</i> sp.	1					
Tubificidae	Tubificidae cf. spp. WA12/14/22	57	28				
	Tubificidae sp.		1				
Arthropoda							
Crustacea							
Copepoda							
Harpacticoida							
Canthocamptidae	nr <i>Canthocamptus</i> sp. B01				3		Singleton, new species
Parastenocarididae	Parastenocarididae sp.	1					Higher order identification
	<i>Parastenocaris</i> sp.	5			6		Higher order identification
	<i>Parastenocaris</i> sp. B14	38					New species with a 46 km linear range between Bilingurr and the LNG precinct
	<i>Parastenocaris</i> sp. B15				1		Singleton, new species
	<i>Dussartstenocaris</i> sp. B04	9					New species with a 1.5 km linear range in the vicinity of the LNG precinct
Cyclopoida							
Cyclopidae	<i>Mesocyclops brooksi</i>				1	4	A widespread species that has both surface and stygal forms
	<i>Metacyclops mortoni</i>					1	A widespread species that has both surface and stygal forms
Malacostraca							

Higher Classification	LowestID	Broome to LNG Precinct ¹	Beagle Bay ¹	Sheffield Project ²	Nita Downs ¹	Mandora Marsh ³ / Canning Basin ⁴	Notes on taxonomy and distribution
Syncairida							
Parabathynellidae	<i>Kimberleybathynella mandorana</i>					1	Only known from Mandora Marsh
	<i>Kimberleybathynella</i> sp. B01	41					New species with a 3.5 km linear range near the LNG precinct
	<i>Kimberleybathynella</i> sp. B03				1		Singleton, new species
	<i>Kimberleybathynella</i> sp. B04				13		Singleton, new species
	<i>Notobathynella</i> sp. B04	5					Singleton, new species
Ostracoda	Ostracoda sp. unident.	2					Higher order identification
Candonidae	? <i>Candona</i> sp.					2	Singleton, new species
Darwinulidae	<i>Vestalenula marmonieri</i>					2	A widespread species that has surface, stygal and interstitial forms
Cyprididae	<i>Bennelongia strellyensis</i>			2			A widespread species that has both surface and stygal forms
	<i>Cypretta seurati</i>			40			A widespread species that has both surface and stygal forms
Mollusca							
Hydrobiidae	Hydrobiidae sp.			2			Singleton, new species
Troglofauna							
Myriapoda							
Scolopendromorpha							
Cryptopidae	<i>Cryptops</i> sp. indet.			1			Singleton, new species
Crustacea							
Isopoda							
Armadillidae	<i>Troglarmadillo</i> sp. B25	1					Singleton, new species ⁶
Hexapoda							
Coleoptera							
Staphylinidae	Staphylinidae sp. indet.			1			Singleton, new species

¹Rockwater 2012; ²Ecologia 2016; ³Storey et al. 2011; ⁴Subterranean Ecology 2012

⁵EPA 2016c; ⁶Bennelongia database

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