Biota Environmental Sciences

Asian Renewable Energy Hub Terrestrial Fauna and SRE Fauna Survey

Prepared for NW Interconnected Power

November 2018

Biota Environmental Sciences

ABN 49 092 687 119
Level 1, 228 Carr Place
Leederville Western Australia 6007
Ph: (08) 9328 1900 Fax: (08) 9328 6138

Project No.: 1290C

Prepared by: V. Ford, J. King

Document Quality Checking History

Version:	1	Peer review:	S. Schmidt, P. Brooshooft
	Rev 0	Director review:	G. Humphreys
	Rev 0	Format review:	G. Humphreys
		Approved for issue:	G. Humphreys

Asian Renewable Energy Hub Level 2 Terrestrial Fauna and SRE Fauna Survey

Contents

Tables

Figures

Plates

1.0 Executive Summary

1.1 Project Background

NW Interconnected Power Pty Ltd is seeking to develop the Asian Renewable Energy Hub. The proposal is to construct and operate a large-scale wind and solar hybrid renewable energy project (hereafter 'the project') at a site approximately 220 km east of Port Hedland and 270 km southwest of Broome, in the northwest of Western Australia. The project will be constructed within a 660,686 ha development envelope (hereafter 'the study area').

Biota was commissioned to conduct a Level 2 terrestrial fauna survey and targeted sampling for conservation significant fauna and short-range endemic (SRE) fauna. The first phase of the terrestrial fauna survey was carried out from 24th August – 5th September 2017. The second sampling phase of the survey was undertaken from 13th – 21st March 2018, following summer rainfall.

All surveys were completed as far as practicable in accordance with relevant State and Commonwealth policy, with key policy and guidelines that were considered including:

- Environmental Factor Guideline: Terrestrial Fauna (EPA 2016a);
- Technical Guide - Terrestrial Fauna Surveys (EPA 2016b); and
- Technical Guide - Sampling of Short Range Endemic Invertebrates (EPA 2016c).

1.2 Methods

A total of 22 fauna trapping sites were installed across the study area, representatively sampling the range of habitat types present. Sixteen sites comprised a systematic trapping regime of 10 pitfall traps and four funnel traps and were sampled during both phases for up to eight consecutive nights. The remainder of the trapping sites comprised Elliott, cage and funnel traps as appropriate to habitat and fauna being targeted. Birds were sampled via dedicated censuses at the trapping sites as well as in other areas of favourable habitat identified during the course of the survey. Additional bird census work was conducted outside of the two phases of the terrestrial fauna survey during a separate study (also conducted by Biota 2018a), which targeted migratory shorebird species in relation to the proposal. This latter study also incorporated the long-term deployment of automated acoustic recorders for birdcalls, which were scanned for Night Parrot calls and any other birds recorded were also noted. All records of terrestrial birds, including those recorded from the study area during the migratory shorebird study, have been included in this report, while all survey effort relating primarily to shorebirds, and results of that survey from outside of the current study area, are reported separately (Biota 2018a).

In addition to systematic sampling, passive sampling methods such as remote cameras and ultrasonic bat call recorders, were placed at locations identified as having the potential to support conservation significant fauna.

Sampling of potential SRE invertebrate fauna was also undertaken using a combination of dry pitfall trapping and hand searching at a range of sites considered to comprise prospective habitat for groups supporting SRE species, utilising method consistent with those identified in EPA (2016c).

1.3 Vertebrate Fauna

A total of 177 vertebrate fauna species were recorded from the study area during the seasonal survey. While the study area is situated on the boundary of the Pilbara and Kimberley, the faunal assemblage showed a strong association with the Pilbara bioregion and very few species with typical Kimberley distributions were recorded. The locality has been subject to little previous fauna survey effort and the records of a number of species represented northerly extensions to their previously known distributions.

1.3.1 Mammals

Thirty-one mammal species were recorded comprising 18 native non-volant (ground-dwelling) species, nine bats species and five introduced species. The native non-volant mammal fauna consisted of four macropods, seven dasyurid marsupials, one notorcytid marsupial, one thylacomyid marsupial, four murid rodents and one canid. The introduced mammal species recorded were the House Mouse, Camel, Fox, Dog and Feral Cat.

The most abundant native mammals recorded from the study area were the Long-tailed Planigale (*Planigale ingrami),* the Spinifex Hopping-mouse (*Notomys alexis)* and the Sandy Inland Mouse (*Pseudomys hermannsburgensis*). Seven mammal species of conservation significance were recorded during the survey: Black-footed Rock-wallaby (*Petrogale lateralis lateralis* - Schedule 2; Endangered), Northern Quoll (*Dasyurus hallucatus* - Schedule 2; Endangered), Bilby (*Macrotis lagotis* - Schedule 3; Vulnerable), Western Pebble-mound Mouse (*Pseudomys chapmani* - Priority 4), Brush-tailed Mulgara (*Dasycercus blythi* - Priority 4), Spectacled Hare-wallaby (*Lagorchestes conspicillatus* - Priority 4) and the Northern Marsupial Mole (*Notoryctes caurinus* - Priority 4).

Nine bat species were identified from ultrasonic call recordings, comprising two from the family Emballonuridae, three from the family Molossidae and four from the family Vespertilionidae. The most frequently recorded species were the Common Sheath-tailed Bat (*Taphozous georgianus*) and Gould's Wattled Bat (*Chalinolobus gouldii*). None of the bat species recorded during the survey were of elevated conservation significance.

1.3.2 Birds

Sixty-eight bird species from 26 families were recorded. The most species-rich families recorded were the Accipitridae (all diurnal raptors except falcons and kestrels), with eight species, and the Meliphagidae (honeyeaters and chats), with seven species. The most abundant bird species were the Singing Honeyeater (*Lichenostomus virescens*) and the Crimson Chat (*Epthianura tricolor*), which accounted for 26% and 18% respectively of all individual bird records from the study area (1,889 individuals). One species of elevated conservation significance, the Oriental Pratincole (*Glareola maldivarum* - Schedule 5; Migratory), was recorded opportunistically during the migratory shorebird study (Biota 2018a), but was recorded within terrestrial habitat feeding over spinifex.

1.3.3 Reptiles

The recorded reptile assemblage consisted of 73 species inclusive of one turtle species, 16 species of gecko, five legless lizards, nine dragons, 24 skinks, six goannas, three blind snakes, two pythons and seven elapid snake species. Two conservation significant reptiles were recorded: the Flatback Turtle (*Natator depressus* - Schedule 3; Vulnerable, Marine, Migratory), which was only recorded from a body hole on Eighty Mile Beach at the northernmost limit of the study area, and the Dampier Plain Slider (*Lerista separanda* - Priority 2).

1.3.4 Amphibians

Four frog species were recorded across the two phases of survey. The most commonly recorded species was the Desert Spadefoot (*Notaden nichollsi*). No frogs of conservation significance were recorded or have distributions overlapping the study area.

1.4 Vertebrate Fauna of Conservation Significance

Eleven vertebrate species of conservation significance were recorded in the study area during the survey, comprising:

- Bilby (*Macrotis lagotis*) – Schedule 3; Vulnerable;
- Black-footed Rock-wallaby (*Petrogale lateralis lateralis*) – Schedule 2; Endangered;

- Northern Quoll (*Dasyurus hallucatus*) – Schedule 2; Endangered;
- Flatback Turtle (*Natator depressus*) – Schedule 3; Vulnerable, Marine, Migratory;
- Oriental Pratincole (*Glareola maldivarum*) - Schedule 5; Migratory;
- Rainbow Bee-eater (*Merops ornatus*) - Marine
- Dampierland Plain Slider (*Lerista separanda*) – Priority 2;
- Spectacled Hare-wallaby *Lagorchestes conspicillatus* – Priority 3;
- Brush-tailed Mulgara (*Dasycercus blythi*) – Priority 4;
- Northern Marsupial Mole (*Notoryctes caurinus*) – Priority 4; and
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – Priority 4.

Previous records and habitat availability indicate a further five conservation significant species are likely to occur, but no evidence of any of these was recorded during the seasonal survey.

1.5 Invertebrate Fauna

In total, 63 invertebrate fauna samples were collected from a combination of dry pitfall trapping and targeted searching of microhabitats likely to support potential SRE fauna.

The collected specimens comprised 29 mygalomorph spiders from 10 sampling locations, 10 scorpions from four sampling locations, and 24 land snails from four sampling locations. None of the land snail or scorpion specimens represented SRE taxa.

Three potential SRE taxa, all trapdoor spiders, were recorded from the study area, but they are likely to be more widespread, considering all three came from widely-connected sandplain habitats with no barriers to dispersal, within the very widespread Nita and Little Sandy land systems.

This page intentionally blank.

2.0 Introduction

2.1 Project Background

NW Interconnected Power Pty Ltd is seeking to develop the Asian Renewable Energy Hub. The proposal is to construct and operate a large-scale wind and solar hybrid renewable energy project (hereafter 'the project') at a site approximately 220 km east of Port Hedland and 270 km southwest of Broome, in the northwest of Western Australia (Figure 2.1). The project will be constructed within a 660,686 ha development envelope (hereafter 'the study area').

The onshore components of the project will comprise a series of linear arrays of wind turbines and solar panels, with a transmission cable corridor to the coast. The offshore component of the proposal comprises two inert subsea power cables, with the marine component of the current proposal only extending to the limit of State Waters (Commonwealth Waters and any international permitting required will be the subject of a separate assessment).

2.2 Study Objectives and Scope

Biota Environmental Sciences (Biota) was commissioned to conduct a Level 2 terrestrial vertebrate fauna survey with targeted sampling for conservation significant fauna species, and sampling for potential short-range endemic (SRE) invertebrate fauna within the study area.

A comprehensive survey for migratory shorebirds and waterbirds has also been undertaken for the project and is reported separately (Biota 2018a). Separate studies conducted by BMT Global (2018) have assessed the potential for the project to impact the marine environment, including marine fauna. Given the scope of those concurrent studies, only fauna likely to utilise the terrestrial habitats of the study area are addressed here.

This study is intended for use as a supporting document for the environmental impact assessment of the proposal, which has been referred under Section 38 of the *Environmental Protection Act 1986* (EP Act). The project is also being assessed as controlled action under the terms of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and the document provides technical support and data to inform that assessment.

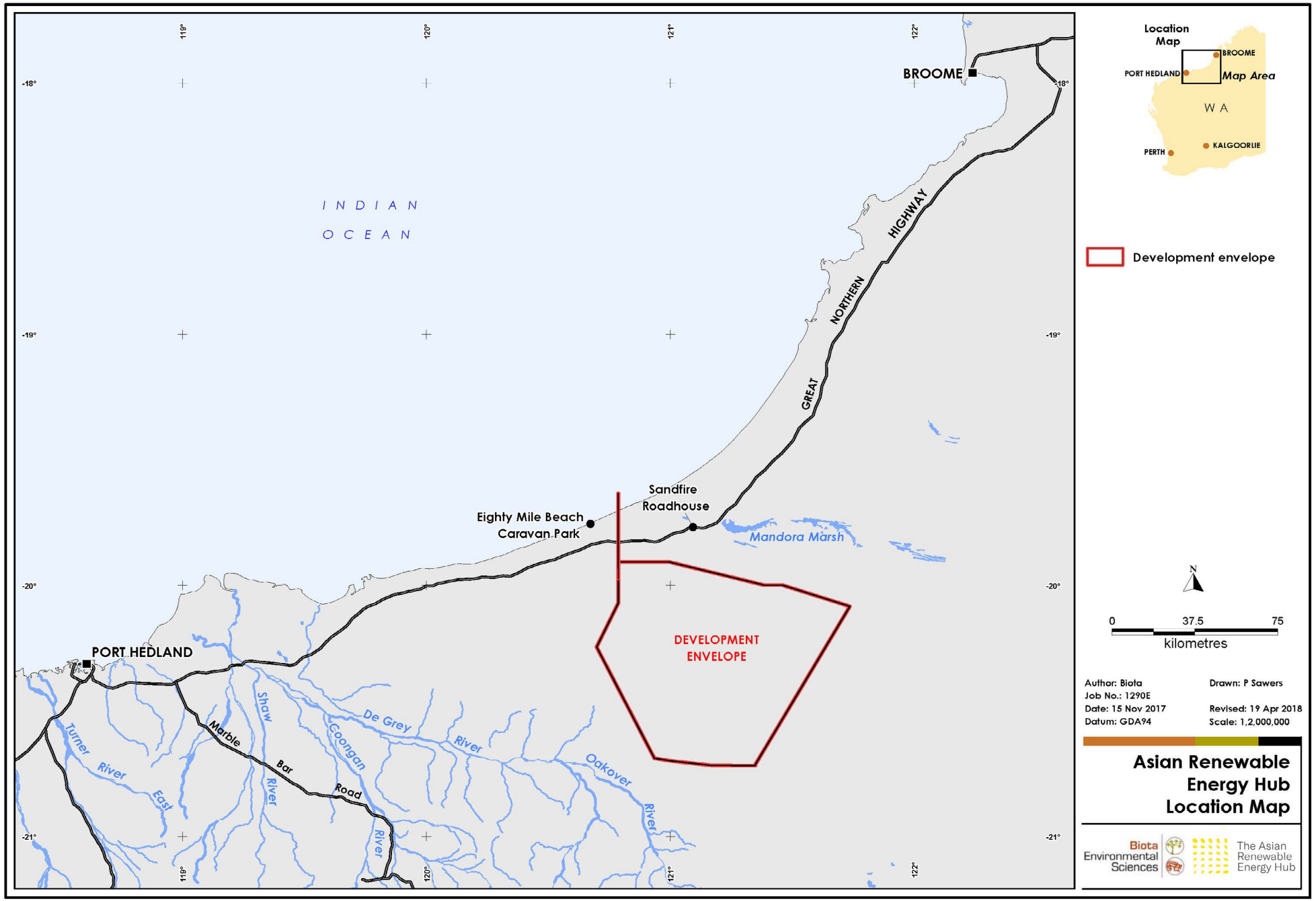


Figure 2.1: Location of the study area.

3.0 Existing Environment

3.1 IBRA Bioregions and Subregions

The Interim Biogegographic Regionalisation of Australia (IBRA) identifies 85 bioregions across Australia (Environment Australia 2000). The study area is located within the Dampierland and Great Sandy Desert IBRA bioregions, and includes sections of three subregions within these:

- The Dampierland bioregion is divided into two subregions, with the Pindanland subregion relevant to the western part of the study area.
- The Great Sandy Desert bioregion is divided into six subregions, two of which are relevant: McLarty and Mackay dominate the inland sections of the study area (Figure 3.1).

These subregions are summarised as follows:

- The Pindanland subregion (5,198,904 ha) "comprises sandplains of the Dampier Peninsula and western part of Dampier Land, including the hinterland of the Eighty Mile Beach. It is a fine-textured sand-sheet with subdued dunes and includes the paleodelta of the Fitzroy River. This is the coastal, semi-arid, northwestern margin of the Canning Basin. The climate is described as dry hot tropical and semi-arid with summer rainfall. The average annual rainfall is between 450 – 700 mm, slightly lower than the Fitzroy Trough subregion" (Graham 2003a). The vegetation is described primarily as pindan, but includes *Melaleuca alsophila* low forests on coastal plains, and *Spinifex* spp. – *Crotalaria* spp. strand communities (Graham 2003a).
- The McLarty subregion (13,173,266 ha) "includes the Mandora paleoriver system and red-brown dunefields with finer texture than further south. It also includes gravelly surfaces of Anketell Ridge along its northern margin. The subregion is arid tropical with summer rain and is influenced by monsoonal activity. Morning fogs are recorded during the dry season. The vegetation is mainly tree steppe grading to shrub steppe in the south; comprising open hummock grassland of *Triodia pungens* and *Triodia schinzii* with scattered trees of *Owenia reticulata* and Bloodwoods (*Corymbia* spp.), and shrubs of *Acacia* spp., *Grevillea wickhamii* and *G. refracta*, on Quaternary red longitudinal sand dune fields overlying Jurassic and Cretaceous sandstones of the Canning and Armadeus Basins. Gently undulating lateritised uplands support shrub steppe" (Graham 2003b). Wetland features in the subregion include isolated mound springs supporting *Melaleuca leucadendra* closed forests, and *Melaleuca glomerata - M. lasiandra* shrublands around salt lakes (Graham 2003b).
- The Mackay subregion (18,636,695 ha) comprises the "tropical inland 'red-centre' desert, and includes the 'Percival' and 'Auld' palaeoriver systems. The climate is arid tropical with summer rainfall, and monsoonal influences are apparent in the northwestern sector of this region" (Kendrick 2003). Vegetation is similar to the McLarty subregion.

3.2 Conservation Reserves

The nearest conservation reserves to the study area comprise the following (all distances are from the closest point of the study area):

- **Eighty Mile Beach Marine Park** – a small section at the northern end of the transmission cable corridor extends into this park, which incorporates the Kujungurru-Warrarn Nature Reserve on its inland margin.
- **Walyarta Conservation Park (Mandora Marsh)** – the southwestern corner of this park abuts the northeastern boundary of the study area.
- **Ex-Meentheena Station Conservation Reserve** – 50 km southwest of the study area (Figure 3.1).

In addition, the main study area lies entirely within the western section of the Nyangumarta Warrarn Indigenous Protected Area (IPA). The transmission cable corridor follows a cleared track along the eastern edge of Wallal Downs Station, at its boundary with Mandora Station

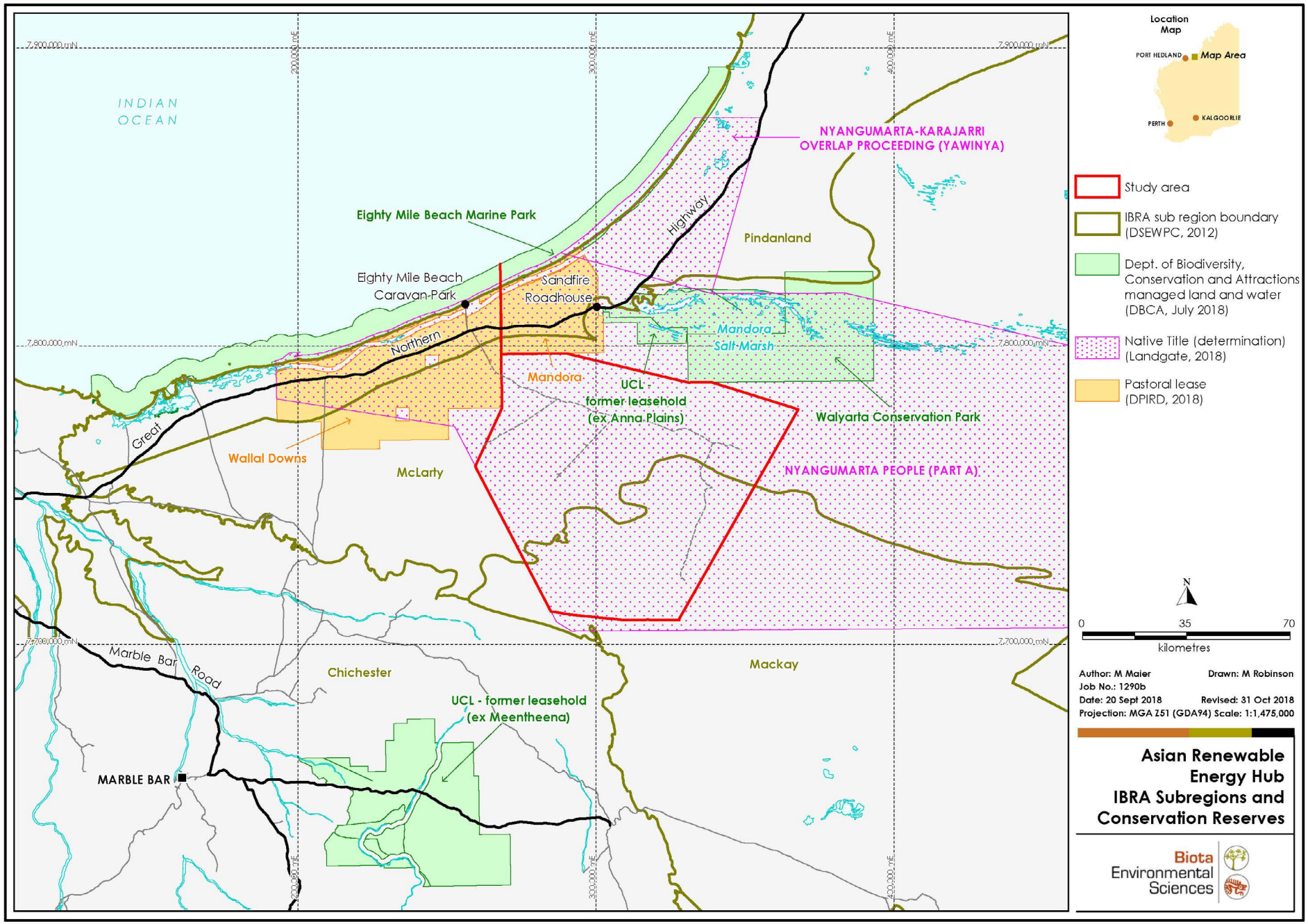


Figure 3.1: IBRA sub-regions and conservation reserves in proximity to the study area.

3.3 Land Systems

The then Department of Agriculture Western Australia mapped land systems for the Rangelands regions of WA, including much of the study area (van Vreeswyk et al. 2004). This classification divides the region into broad units (land systems), each consisting of a series of "land units" that occur on characteristic physiographic types within the land system. The study area intersects eight land systems; Anna, Buckshot, Callawa, Eighty Mile, Little Sandy, Mannerie, Nita and Robertson (Table 3.1 and Figure 3.2). Assessment of the regional extent of these land systems is complicated by a lack of mapping for large areas of the Great Sandy Desert, mostly south and east of the study area (van Vreeswyk et al. 2004, Payne and Schoknecht 2011). This included a portion of the study area, and the eastern margin of the study area was therefore extrapolated from surrounding land systems based on aerial imagery. The extent of some land systems in the broader locality may therefore be greater than is indicated by the available data.

The study area is dominated by two land systems; the Nita land system occupying the northwestern half (55.1%) and the Little Sandy land system occupying most of the southeast (38.4%). These land systems both feature sandy substrates with vegetation dominated by hummock grasses, the most significant difference between the two being the significant east-west dune systems dominating the Little Sandy land system. The Buckshot (1.1%) and Callawa (5.4%) land systems contain most of the low stony rise and rocky habitats in the study area and tend to occur in close geographic association. Most of the remaining land system mapping represents coastal or near-coastal habitats: the Anna, Eighty Mile and Mannerie land systems together comprise 0.006% of the study area and are only intersected by the transmission cable corridor. A small portion of the final land system, Robertson (0.03% of the study area), is intersected along the southern edge of the study area.

The study area encompasses a small proportion of the total mapped extent of the Anna, Eighty Mile, Mannerie and Robertson land systems across the McLarty, Mackay and Pindanland subregions, but contains substantial proportions of the Buckshot, Callawa, Little Sandy and Nita land systems, including 88.1% of Buckshot. The Buckshot land system does also exist outside of the McLarty, Mackay and Pindanland subregions, with the majority of its extent occurring to the south within the Trainor subregion of the Little Sandy Desert. The Buckshot land system has a total mapped extent of 279,157 ha when all subregions are included; approximately 2.5% of this total mapped extent occurs within the study area. The Little Sandy land system similarly has a broad distribution further south within the Trainor subregion, and the extent within the current study area represents 18.6% of the total 1,359,914.4 ha mapped across all subregions. In contrast, the distribution of the Callawa and Nita land systems is centred on the McLarty, Mackay and Pindanland subregions, meaning that the substantial proportions within the current study area are realistic.

3.4 Beard's Regional Vegetation Mapping

Broad-scale vegetation mapping for the locality has been prepared at the 1:1,000,000 scale based on the work of J.S. Beard for the Pilbara (Beard 1975) and Great Sandy Desert (Beard 1968). The study area includes 11 of Beard's "vegetation system associations", however as some of these are essentially the same unit mapped in adjacent areas, the study area actually contains only seven broad vegetation types (see Table 3.2 and Figure 3.3). The majority of the study area was mapped by Beard as hummock grasslands with sparse to open shrublands.

The pre-European and current extents of Beard's vegetation system associations have been calculated using interpretation of imagery to determine areas that have been cleared (see Shepherd et al. 2002, and Government of Western Australia 2018). According to this, none of Beard's vegetation system associations have been substantially cleared, and the study area contains substantial proportions of three broad system associations: 51.8% of 80.1, 34.3% of 101.1 and 25.5% of 117.1 (see Table 3.2 and Figure 3.3).

Table 3.1: Description and extent of land systems in the study area.

Land System	Area within Study Area (ha)	% of Study Area	Extent within McLarty, Mackay and Pindanland Subregions (ha)	% of Subregional Extent Within Study Area	Description
Nita	364,535.00	55.2%	1,429,175.4	25.5	Sandplains supporting shrubby spinifex grasslands with occasional trees.
Little Sandy	253,483.60	38.4%	676,256.8	37.5	Sandplains with linear and reticulate dunes supporting shrubby hard and soft spinifex grasslands.
Callawa	35,539.80	5.4%	97,792.8	36.3	Highly dissected low hills, mesas and gravelly plains of sandstone and conglomerate supporting soft and hard spinifex grasslands.
Buckshot	6,995.90	1.1%	7,943.9	88.1	Gravelly sandplains and occasional sand dunes supporting hard spinifex grasslands.
Robertson	177.5	0.03%	3,361.2	5.3	Hills and ranges of sedimentary rocks supporting hard spinifex grasslands.
Anna	25.1	<0.01%	149,250.5	0.02	Paleo-tidal coastal plains with saline soils supporting tussock grasslands and halophytic low shrublands
Eighty Mile	7.6	<0.01%	42,259.1	0.02	Beach foredunes, longitudinal coastal dunes and sandy plains with tussock grasslands and spinifex grasslands.
Mannerie	9.5	<0.01%	61,304.8	0.02	Seepage areas on inland margins of paleo-tidal plains (adjacent to sand plain land systems) supporting melaleuca thickets and halophytic low shrublands.

Table 3.2: Description and extent of Beard's broad vegetation units in the study area (Source: Department of Primary Industries and Regional Development).

Beard's Vegetation Unit	Association Code	Area (ha)	% of Study Area	Description
Mandora Coastal Plain 73	73.2	28.4	<0.01	Grasslands, short bunch grass savanna, grass; salt water grassland (*Sporobolus virginicus*)
Mandora Coastal Plain 41	41.3	15.7	<0.01	Shrublands; teatree scrub
Pindan 32	32.1	41.8	<0.01	Shrublands, pindan; Acacia shrubland with scattered low trees over Triodia spp.
Mandora - East 80	80.1	152,538.8	23.1	Hummock grasslands, low tree steppe; desert walnut over soft spinifex between sandridges
Mandora - East 117	117.1	30,209.4	4.6	Hummock grasslands, grass steppe; soft spinifex
Mandora - West 117	117.1	29,866.4	4.5	
Great Sandy Desert 117	117.0	1,098.1	0.2	
Mandora - East 101	101.1	117,960.2	17.9	Hummock grasslands, shrub steppe; *Acacia pachycarpa* over soft spinifex
Mandora - West 101	101.1	77,356.6	11.7	
Great Sandy Desert 101	101.2	8,874.9	1.3	
Great Sandy Desert 134	134.1	242,642.9	36.7	Mosaic: Hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex on sandhills / Hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills

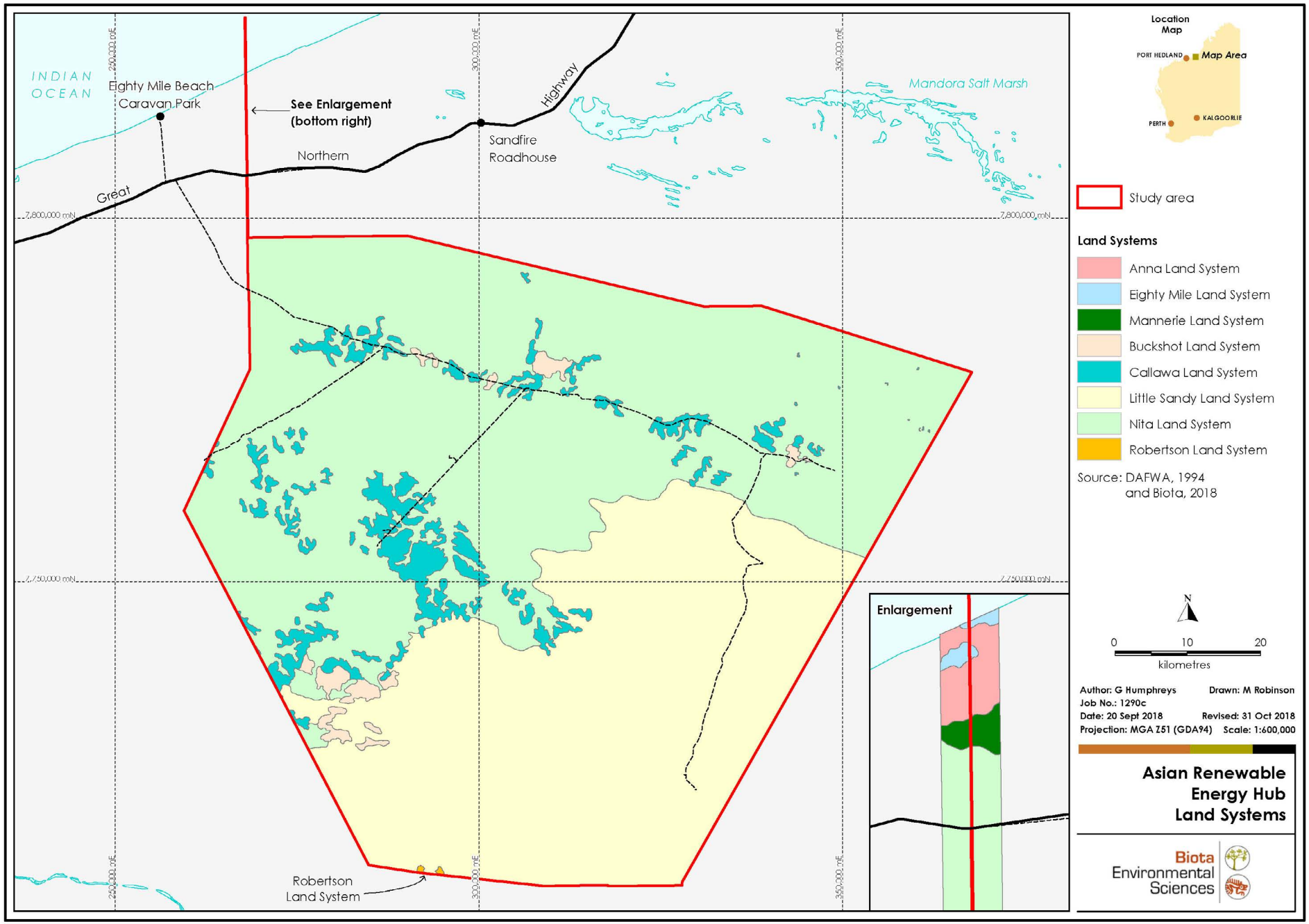


Figure 3.2: Land systems of the study area.

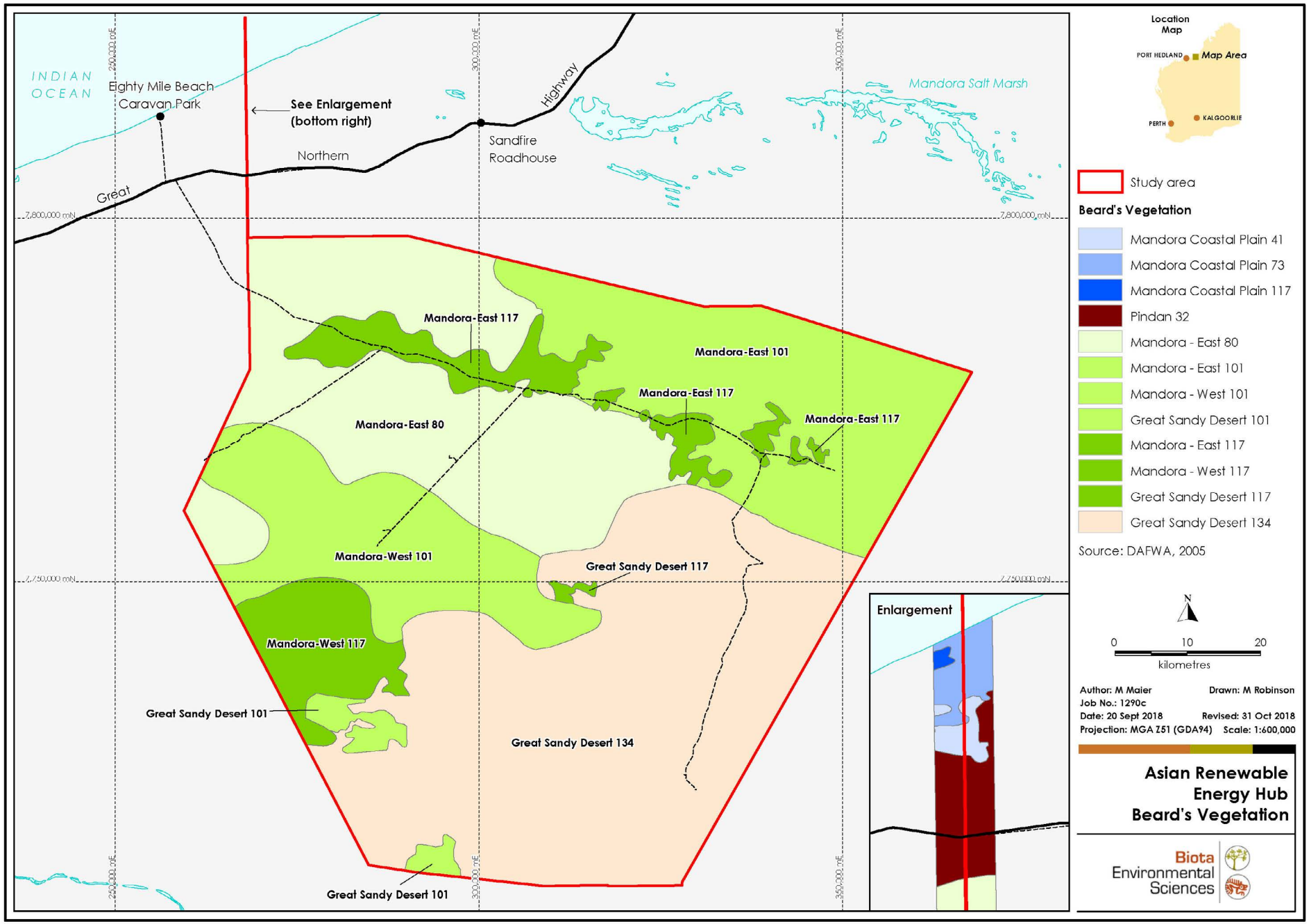


Figure 3.3: Beard's vegetation associations for the study area.

4.0 Methods

4.1 Desktop Review

4.1.1 Literature Review

Table 4.2 summarises the literature reviewed to compile the potential faunal assemblage of the study area. The species recorded in these previous studies have been consolidated with the database search results and are presented in Appendix 1.

It is expected that the records from these studies (with the possible exception of the WA Museum Great Sandy Desert survey conducted in the late '70s and early '80s (Burbidge and McKenzie 1983)) would exist within the NatureMap database. However, considering the studies individually also enables interpretation of how frequently species are recorded and in what area, and consequently, which past studies share habitats with the current study area.

The location of the study area, spanning the northern edge of the Pilbara to the southern extremities of the Kimberley, has been subject to relatively few comprehensive fauna surveys. As a result, the records returned from the NatureMap database were considered unlikely to represent the full potential fauna assemblage due to the lack of survey effort underpinning the database.

4.1.2 Database Searches

To inform the potential vertebrate fauna assemblage of the study area, the following databases were queried:

- **Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap database**: this database represents the most comprehensive source of information on the distribution of Western Australia's fauna, comprising records from the Fauna Survey Returns Database and WA Threatened Fauna database (both of the DBCA), the WA Museum specimen database, and the Birds Australia Atlas. The search was conducted by using co-ordinates at four corners of the study area and adding a 35 km search buffer:
  - NW corner: 120.957222 E, 20.100278 S;
  - NE corner: 121.418611 E, 20.179444 S;
  - SE corner: 121.183056 E, 20.552222 S; nad
  - SW corner: 120.815833 E, 20.427222 S.
- **EPBC Act Protected Matters Search Tool:** which contains records and modeled distributions of species listed as Matters of National Environmental Significance (MNES). This was searched using a 65 km buffer around the central coordinate (121.09472 E, 20.29018 S) (Appendix 2).

4.1.3 Assessment of Likelihood of Conservation Significant Fauna Occurring

In order to determine which species of conservation significance had the potential to occur in the study area, the results of the database searches and previous surveys in the locality were examined while considering the known habitat preferences for the species. Habitats were defined prior to the field survey according to the landforms apparent on aerial imagery, and taking into account existing information regarding the environment and results from previous surveys (Section 4.1.1).

The likelihood that species of conservation significance would occur in the study area was then assessed as part of the desktop review using a set of rankings and criteria (Table 4.1). The term "close proximity" has been defined as being within 20 km of the study area, while the "locality" comprises the area up to 40 km from the study area.

Table 4.1: Ranking system used to assign the likelihood that a species would occur in the study area.

Rank	Criteria
Recorded	1. The species has been previously recorded in the study area.
Likely to occur	1. There are past records of the species in close proximity to the study area (within 20 km); and: • the species is strongly linked to a specific habitat, which is present in the study area; or • the species has more general habitat preferences, and suitable habitat is present.
May potentially occur	1. There are existing records of the species from the locality (within 40 km), however: • the species is strongly linked to a specific habitat, of which only a small amount is present in the study area; or • the species has more general habitat preferences, but only some suitable habitat is present; • the records are more than 20 years old. 2. There is suitable habitat in the study area, but the species is recorded infrequently in the locality.
Unlikely to occur	1. The species is linked to a specific habitat, which is absent from the study area; or 2. Suitable habitat is present, however there are no existing records of the species from the locality despite reasonable previous search effort in suitable habitat; or 3. There is some suitable habitat in the study area, however the species is very infrequently recorded in the locality.
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the study area; and/or 2. The species' range is very restricted and would not include the study area.

4.2 Habitat Definition

To ensure that survey effort encompassed all fauna habitats present in the study area, the following sources of information were used to delineate indicative broad fauna habitats of the study area before field-work commenced:

- aerial imagery;
- elevation modelling in Google Earth;
- Beard (1968, 1975, 1979) vegetation mapping; and,
- Land System mapping (van Vreeswyk et al. 2004).

Following the survey, fauna habitats were refined based on on-site descriptions and vegetation mapping conducted by Biota's botanical team (Biota 2018b). This process supported defining habitats along the same lines as the Land System mapping (van Vreeswyk et al. 2004) but with some additional delineation of microhabitats within each Land System. Using the Land System mapping to define habitats is beneficial as it can provide a much broader context for the occurrence of each habitat outside the study area.

A limitation of any habitat classification system is that it is not specific to any one species. Rather, the classification provides a convenient framework to summarise species occurrence. When considering habitat for individual species of elevated conservation significance, the habitat availability within the study area has been compared to a wider area using a scale appropriate to the species. For example, where these species are widely occurring and have broad habitat requirements, land system mapping may represent an appropriate scale, while for species with more constrained habitat requirements, finer scale mapping has been attempted.

The following criteria were used to define a significant fauna habitat:

1. it is uncommon;
2. supports a unique faunal assemblage;
3. supports fauna of elevated conservation significance or
4. any combination of these three factors.

Table 4.2: Literature reviewed in relation to the study area.

Report/Survey	Shortened title in Appendix 1 table	Description of Report/Survey	Dates of Survey	Location Relative to the Study Area
Goldsworthy Extension Project Phase 2: Consultative Environmental Review Report for BHP Billiton Iron Ore Pty Ltd by Dames & Moore Pty Ltd (1992)	"Gold'w Lvl1"	Level 1 fauna survey	2-5 October 1992	26 km south-west
Goldsworthy Extension Project - Biological Assessment Survey Report for BHP Billiton Iron Ore Pty Ltd by ecologia Environment (2005)	"Gold'w Lvl2"	A collation of several Level 2 fauna surveys	3-9 June 1998 0-21 December 2004 2-17 November 2004 22 November - 6 December, 2004	Yarrie: 30 km south-west Cattle Gorge: 34 km south-west Nimingarra: 60 km west Sunrise Hill: 45 km west
Biota of the Mandora System, Western Australia: - Mammals by Start, Kendrick and McKenzie (2008)	"Mandora Marsh"	Pit trapping, mist netting and Elliott trapping	12-17 August 1983 12-21 October 1999	30 km north
Assessment of the Bilby *Macrotis lagotis* on Wallal Downs Station; Homestead and Chirup project areas by Bamford Consultants (2016)	N/A	Level 1 targeted survey	17 - 18 August 2016	Homestead: 28 km Northwest Chirup: 40 km Northwest
Wildlife of the Great Sandy Desert, Western Australia by Burbidge and McKenzie (1983)	"GSD WAM"	Comprehensive and broad ranging survey by the Western Australian Museum. Survey effort included a total of 5633 metal trap-nights and 190 pit-fence nights.	Five survey phases between 1976 and 1980	Sites ranged over much of the Great Sandy Desert.

4.3 Vertebrate Fauna Field Survey

4.3.1 Survey Timing and Weather Conditions

Phase 1 of the terrestrial fauna survey was carried out from the 24th August – 5th September 2017 and Phase 2 from the 13th – 21st March 2018. Weather observations during the survey and long-term averages were sourced from data collected at Mandora Station (Bureau of Meteorology weather station number 004019) (Table 4.3).

Mean annual rainfall at Mandora is 377 mm and during the five years preceding the survey average annual rainfall ranged from below to well above the mean (262 – 750 mm) with an average 422 mm. On this basis, productivity in the landscape was not considered a limitation to the fauna survey.

Conditions during the year preceding Phase 1 of the study were typical with slightly above average Summer rainfall and slightly lower than average Autumn and Winter rainfall. Phase 1 of the study was conducted in late Winter/early Spring and weather conditions were warm to hot and dry. Daily maximum temperatures ranged from 29.5 - 39.6°C while overnight temperatures were generally cool. This timing was conducive to the trapping of reptiles and mammals. Conditions were also favourable for the recording of birds, particularly in the cool early mornings.

Phase 2 of the study was conducted in early Autumn following a summer with considerably higher than average rainfall (Figure 4.1). Conditions during the second phase were hot and minor rainfall was recorded on two days. While the warmer overnight temperatures were particularly conducive to the recording of nocturnal reptiles, it was necessary to consider the welfare of animals in this trapping programme such that the use of trap types that subject animals to dehydration (particularly Elliott traps) was reduced to a number that could be checked and emptied before becoming too hot.

Table 4.3: Weather conditions during the field survey (data from BOM, Mandora Station 004019).

	Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
Phase 1	24/08/17	14.7	39.6	0
	25/08/17	17.4	37.5	0
	26/08/17	17.9	34.4	0
	27/08/17	13.9	34.7	0
	28/08/17	15.5	33.3	0
	29/08/17	10.6	33.3	0
	30/08/17	11	34.8	0
	31/08/17	11.8	32.8	0
	1/09/17	11.6	29.5	0
	2/09/17	16.4	31.3	0
	3/09/17	15.1	34.5	0
	4/09/17	19.1	35.3	0
	5/09/17	19.3	36	0
	Avg./Total	**14.9**	**34.4**	**0.0**
Phase 2	13/03/18	26.9	39.8	0
	14/03/18	23.4	38.6	0
	15/03/18	21.2	37.9	0
	16/03/18	21.6	38.7	0
	17/03/18	24.8	36.8	0.2
	18/03/18	22.6	41.5	0
	19/03/18	24.7	40.4	0
	20/03/18	27.6	36.3	0
	21/03/18	25	36.8	6.8
	Avg./Total	**24.2**	**38.5**	**7.0**

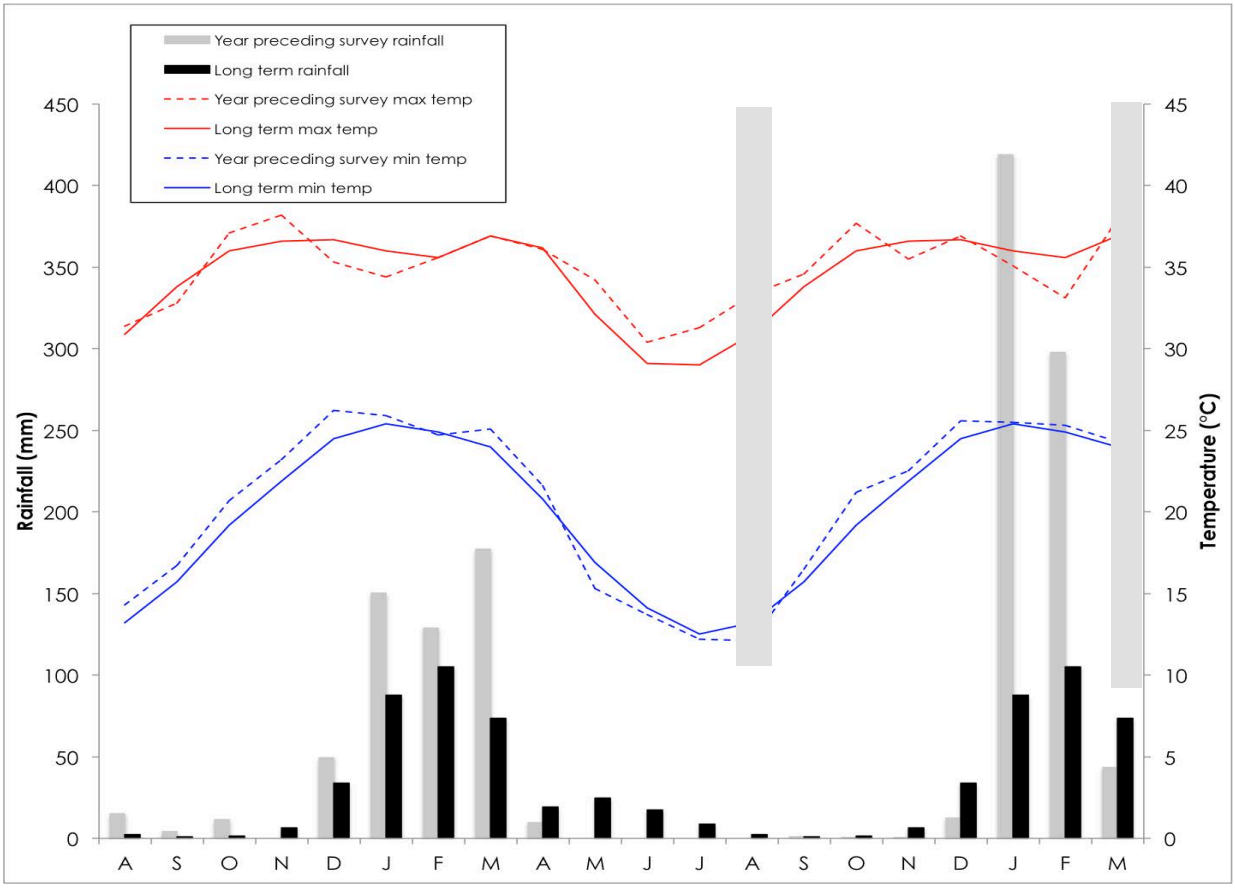


Figure 4.1: **Weather observations in the year preceding the survey (August 2016 – March 2018) compared to long-term (1913 – 2018) climatological averages** (data from the Bureau of Meteorology Mandora Station 004019).

4.3.2 Survey Team

The fauna survey was conducted under Regulation 17 "Licence to Take Fauna for Scientific Purposes" Permit No. 08-000993-4 issued by the DBCA to Mr Daniel Kamien (Appendix 3).

The survey team comprised Mr Garth Humphreys, Mr Roy Teale, Mr Dan Kamien, Dr Stewart Ford, Mr Michael Greenham, Ms Penny Brooshooft, Ms Jacinta King, Dr Sylvie Schmidt, and Mr David Keirle (all of Biota). All team members are qualified and experienced zoologists, with at least six years experience as a consulting zoologist in the arid zone, with specialist experience in a range of areas including ornithology, mammals, reptiles and short-range endemic fauna.

We also gratefully acknowledge various Nyangumarta Traditional Owners for their assistance with this study, including for granting permission for the survey team to access the area, and members of the Nyangumarta Ranger Group for their assistance during the field surveys.

4.3.3 Sampling Effort

An overview of the field sampling effort deployed within the study area is provided in Figure 4.2. Systematic and non-systematic sampling methods were used to sample the terrestrial fauna at a combined total of 190 sites, distributed across the study area (Figure 4.2). A detailed account of the effort and methods for each sampling techniques follows in Sections 4.3.4 to 4.3.7.

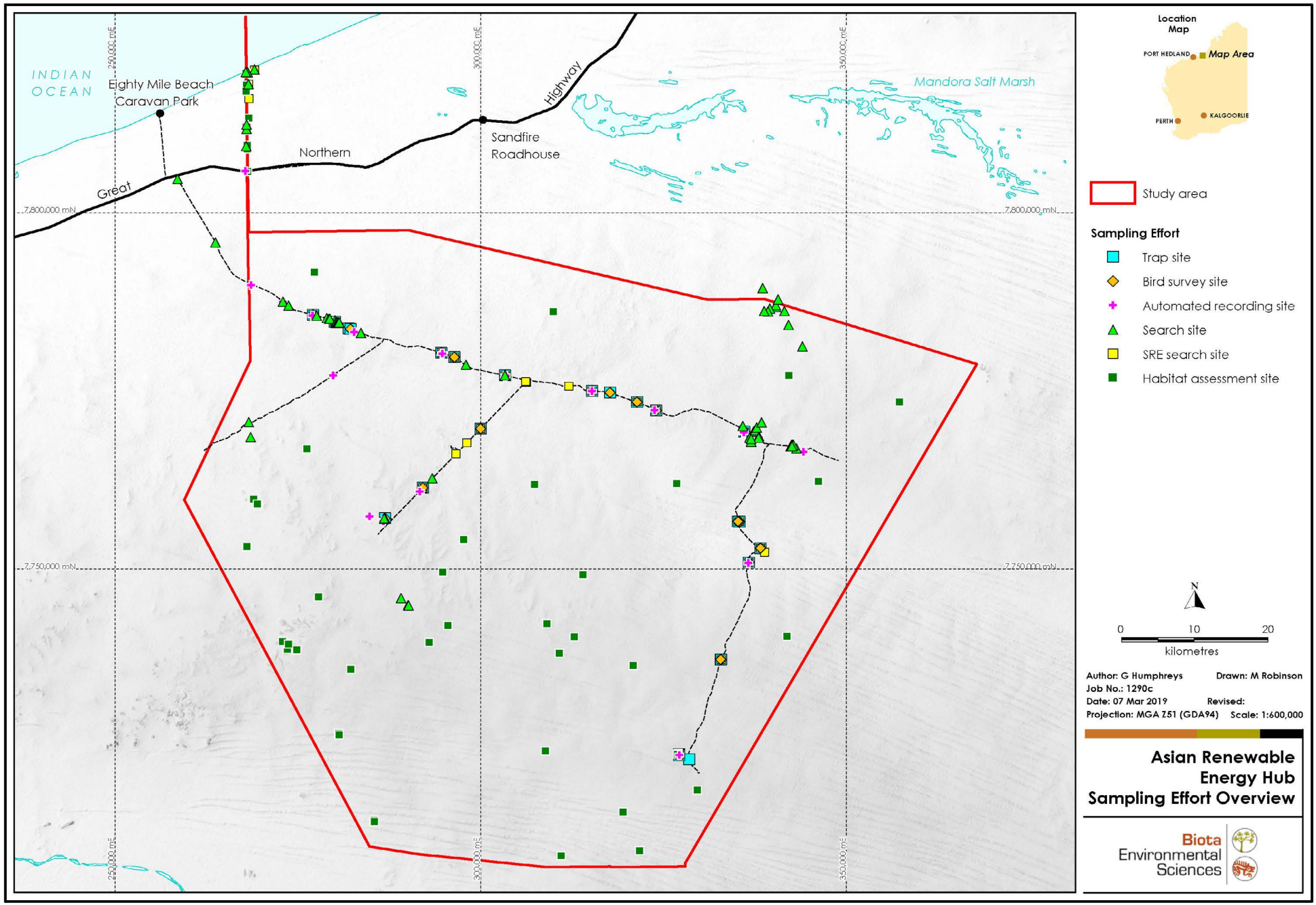


Figure 4.2: Overview of fauna sampling effort within the study area (see Figures 4.3 to 4.7 for more detail on each sampling method).

4.3.4 Trapping Effort

Indicative trapping sites were identified based on the results of the desktop review and preliminary habitat assessment, and were subsequently ground-truthed during a reconnaissance site visit (6th – 9th August 2017), following which the final location of fauna sampling sites were chosen. The reconnaissance also include an aerial over-flight and ground-truthing of the range of habitats within the study area via helicopter.

A total of 22 fauna trapping sites were installed with the aim of trapping as many species from the potential vertebrate assemblage as possible. Sites were distributed to representatively sample the range of fauna habitats in the study area, while giving consideration to access and ensuring traps could be checked in a timely manner each morning to meet fauna sampling ethics requirements.

The locations of the sites are illustrated in Figure 4.3, and are further detailed in Table 4.4 and Table 4.5. The trapping sites comprised the following:

- Sixteen pitfall and funnel trapping transects, consisting of 10 pitfall traps arranged as alternating 20 litre buckets and PVC tubes (diameter: 150 mm, depth: 700 mm) connected by a 110 m long, 30 cm high fly wire fence. One pair of funnel traps was also set at each end. These sites were run during both survey phases.
- One funnel trapping transect, consisting of 20 funnel traps, arranged in pairs and distributed along a 110 m length of 30 cm high fly wire drift fence. This site was run during the first phase only, as hotter temperatures during Phase 2 raised concern for the welfare of potentially trapped animals at this site, which was located in rocky habitat (see Table 4.5).
- Five Elliott and cage trapping sites were also deployed. The number of Elliott and cage traps set at each site varied depending on the habitat and target taxa, which included specific conservation significant mammal species such as the Northern Quoll, Bilby, Brush-tailed Mulgara, Western Pebble-mound Mouse and Black-flanked Rock-wallaby. Two of these sites were also run during Phase 2.

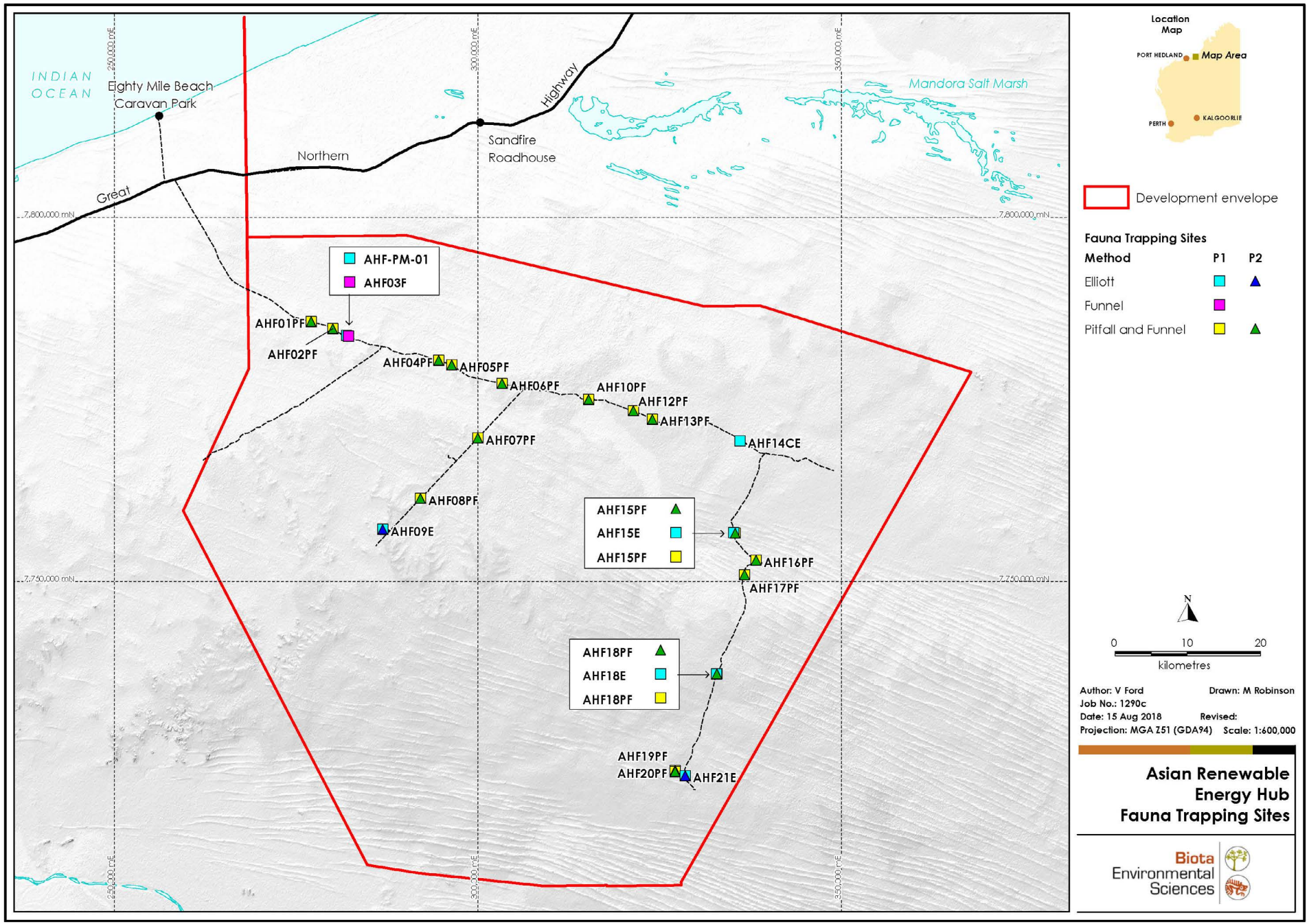


Figure 4.3: Location of fauna trapping sites within the study area.

Table 4.4: Details of trap site locations and sampling effort (trap-nights) per phase.

					Phase 1			Phase 2			
Site ID	**Method**	**Line Location**	**Latitude**	**Longitude**	**Start**	**End**	**Trap nights**	**Start**	**End**	**Trap nights**	**Total**
AHF01PF	10 Pitfall, 4 Funnel	Start End	-20.01249 -20.011732	120.869162 120.869383	28/08/17	4/09/17	P: 70 F: 28	13/03/18	21/03/18	P: 80 F: 32	P: 150 F: 60
AHF02PF	10 Pitfall, 4 Funnel	Start End	-20.021538 -20.020868	120.897614 120.897457	28/08/17	4/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56
AHF03F	20 Funnel	Start End	-20.031228 -20.031835	120.917786 120.917462	29/08/17	4/09/17	F: 120	*not run			F: 120
AHF04PF	10 Pitfall, 4 Funnel	Start End	-20.062857 -20.063596	121.036155 121.035942	28/08/17	4/09/17	P: 70 F: 28	13/03/18	20/03/18	P: 70 F: 28	P: 140 F: 56
AHF05PF	10 Pitfall, 4 Funnel	Start End	-20.068389 -20.067508	121.053044 121.053323	28/08/17	4/09/17	P: 70 F: 28	13/03/18	20/03/18	P: 70 F: 28	P: 140 F: 56
AHF06PF	10 Pitfall, 4 Funnel	Start End	-20.092331 -20.091659	121.11885 121.119381	28/08/17	4/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56
AHF07PF	10 Pitfall, 4 Funnel	Start End	-20.159488 -20.160098	121.086371 121.086912	28/08/17	4/09/17	P: 70 F: 28	13/03/18	20/03/18	P: 70 F: 28	P: 140 F: 56
AHF08PF	10 Pitfall, 4 Funnel	Start End	-20.233738 -20.234212	121.010161 121.01069	29/08/17	4/09/17	P: 60 F: 24	13/03/18	20/03/18	P: 70 F: 28	P: 130 F: 52
AHF09E	25 medium Elliott, 10 large Elliott	Start End	-20.271538 -20.270458	120.959911 120.960073	2/09/17	4/09/17	E: 70	15/03/18	20/03/18	E: 175	E: 145
AHF10PF	10 Pitfall, 4 Funnel	Start End	-20.113576 -20.112878	121.232507 121.232449	27/08/17	4/09/17	P: 80 F: 32	13/03/18	20/03/18	P: 70 F: 28	P: 150 F: 60
AHF12PF	10 Pitfall, 4 Funnel	Start End	-20.127737 -20.127032	121.291481 121.29175	27/08/17	4/09/17	P: 70 F: 28	13/03/18	20/03/18	P: 70 F: 28	P: 140 F: 56
AHF13PF	10 Pitfall, 4 Funnel	Start End	-20.138511 -20.139188	121.315972 121.315665	27/08/17	4/09/17	P: 70 F: 28	13/03/18	20/03/18	P: 70 F: 28	P: 140 F: 56
AHF14CE	40 medium Elliott, 20 large Elliott, 5 Cage	Start End	-20.166872 -20.166906	121.431171 121.431151	28/08/17	4/09/17	E: 420 C: 35	*not run			E: 420 C: 35
AHF15PF	10 Pitfall, 4 Funnel	Start End	-20.280832 -20.281003	121.423455 121.424132	26/08/17	3/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56
AHF15E	10 Elliott	Start End	-20.280415 -20.28066	121.421374 121.422771	28/08/17	3/09/17	E: 60	*not run			E: 60
AFH16PF	10 Pitfall, 4 Funnel	Start End	-20.314623 -20.315103	121.450957 121.450132	27/08/17	3/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56
AHF17PF	10 Pitfall, 4 Funnel	Start End	-20.332338 -20.332656	121.435382 121.436049	27/08/17	3/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56

					Phase 1			Phase 2			
Site ID	**Method**	**Line Location**	**Latitude**	**Longitude**	**Start**	**End**	**Trap nights**	**Start**	**End**	**Trap nights**	**Total**
AHF18PF	10 Pitfall, 4 Funnel	Start End	-20.455252 -20.45475	121.39752 121.396541	27/08/17	3/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56
AHF18E	15 medium Elliott	Start End	-20.455129 -20.454449	121.397321 121.39706	28/08/17	3/09/17	E: 90	*not run			E: 90
AHF19PF	10 Pitfall, 4 Funnel	Start End	-20.574697 -20.574346	121.341528 121.340935	27/08/17	3/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56
AHF20PF	10 Pitfall, 4 Funnel	Start End	-20.575968 -20.575807	121.341206 121.34042	27/08/17	3/09/17	P: 70 F: 28	14/03/18	21/03/18	P: 70 F: 28	P: 140 F: 56

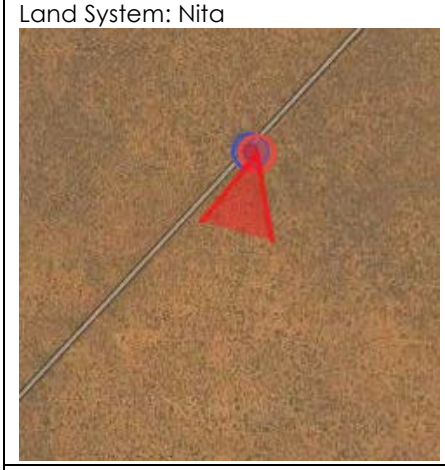
Pit-trap effort (trap-nights)	**2,250**
Funnel-trap effort (trap-nights)	**900**
Elliott-trap effort (trap-nights)	**715**
Total trap effort (trap-nights)	**4,065**

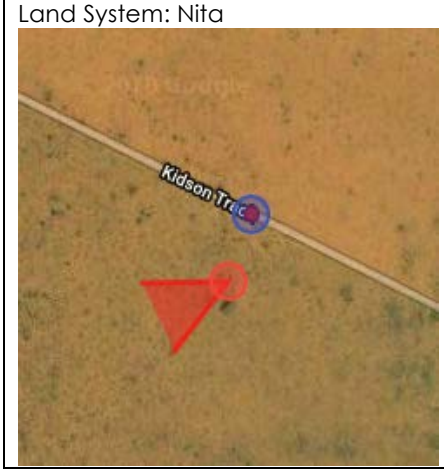
*not run due to temperature constraints

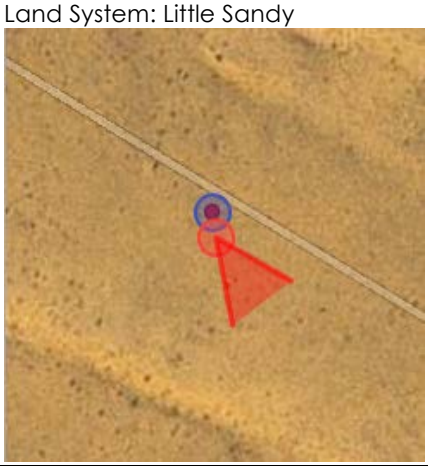
Table 4.5: Trapping site descriptions and photographs.

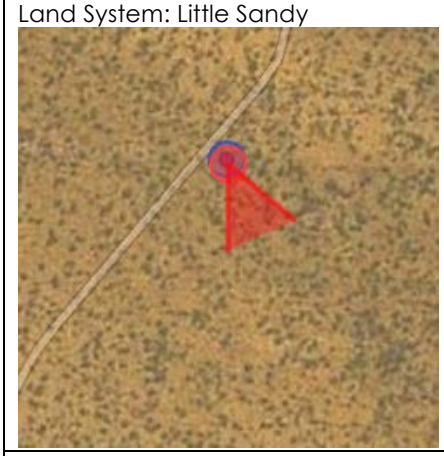
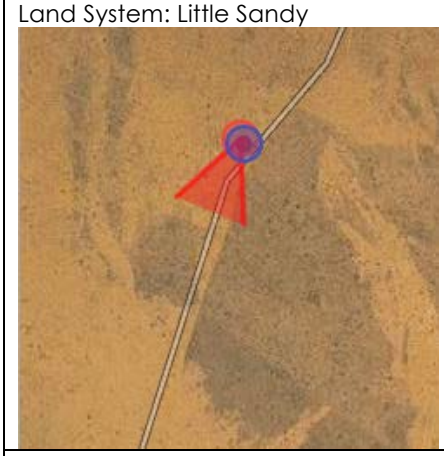
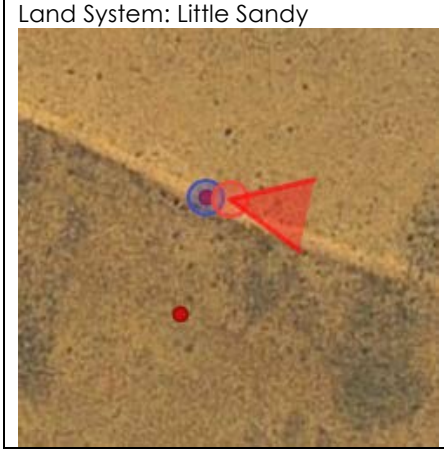
Site Description	Site Photograph
AHF01 Pitfall trapping, Funnel trapping FLATS: Sandplain Scattered low trees and shrubs 1 – 2 m over hummock grassland Land System: Nita 	
AHF02 Pitfall trapping, Funnel trapping FLATS: Sandplain Scattered low trees over closed hummock grassland Land System: Callawa 	
AHF03 Funnel trapping HILLS AND SLOPES: Gradual hill slope Scattered low shrubs over low open hummock grassland Land System: Callawa 	

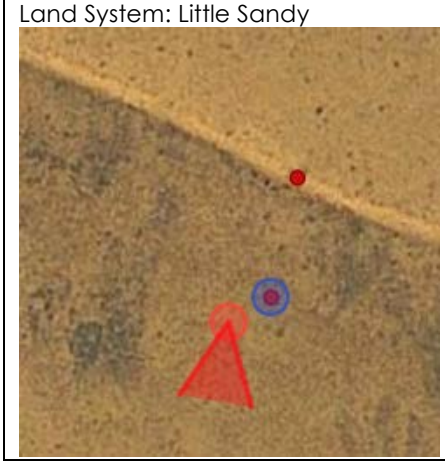
Site Description	Site Photograph
AHF04 Pitfall trapping, Funnel trapping FLATS: Sandplain Scattered ironwood trees, open shrubs 1 - 2 m over hummock grassland (small hummocks) Land System: Nita 	
AHF05 Pitfall trapping, Funnel trapping FLATS: Sandplain Open hummock grassland (hummocks moderate in size) Land System: Callawa 	
AHF06 Pitfall trapping, Funnel trapping FLATS: Sandplain Scatttered tall shrubs (>2 m) and low shrubs (1-2 m) over open hummock grassland Land System: Nita 	

Site Description	Site Photograph
AHF07 Pitfall trapping, Funnel trapping FLATS: Sandplain Open shrubland over hummock grassland Land System: Nita 	
AHF08 Pitfall trapping, Funnel Trapping HILLS AND SLOPES: Gentle rocky hill slope Scattered low shrubs and tall shrubs over low hummock grassland Land System: Callawa 	
AHF09E Elliott trapping HILLS AND SLOPES: Free Face Scattered low trees, open low shrubland over open hummock grassland Land System: Callawa 	

Site Description	Site Photograph
AHF10 Pitfall trapping, Funnel trapping FLATS: Sandplain Scattered tall and low shrubs over open hummock grassland Land System: Nita 	
AHF12 Pitfall trapping, Funnel trapping FLATS: Sandplain Scattered tall and low shrubs over open hummock grassland Land System: Nita 	
AHF13 Pitfall trapping, Funnel trapping FLATS: Sandplain Scattered tall and low shrubs over hummock grassland Land System: Nita 	

Site Description	Site Photograph
AHF14E Cage and Elliott trapping HILLS AND SLOPES: Rock Hill slope Scattered Ficus and Acacia shrubs over open hummock grassland Land system: Nita 	
AHF15 Pitfall trapping, Funnel trapping, Elliott trapping DUNES: Longitudinal dune ridge Scattered tall shrubs, low open shrubland and very open tussock grassland Land System: Little Sandy 	
AHF16 Pitfall trapping, Funnel trapping FLATS: Sandplain Scattered trees over low shrubland over very open tussock grass Land System: Little Sandy 	

Site Description	Site Photograph
AHF17 Pitfall trapping, Funnel trapping FLATS: Sandplain Open woodland over open shrubland over very open hummock grassland Land System: Little Sandy 	
AHF18 Pitfall trapping, Funnel trapping, Elliott trapping FLATS: Sandplain Scattered trees over scattered tall shrubs over hummock grassland Land System: Little Sandy 	
AHF19 Pitfall trapping, Funnel trapping DUNES: Longitudinal dune Scattered tall shrubs over low open shrubland over open hummock grassland Land System: Little Sandy 	

Site Description	Site Photograph
AHF20 FLATS: Sandplain Shrubs of *Erythrophleum*, *Eucalyptus* and *Acacia* over open Triodia hummock grassland. Land System: Little Sandy 	

4.3.5 Bird Surveys

Birds were recorded using the following techniques:

- unbounded area searches (30 minutes in duration) conducted within defined habitats at the 16 pitfall and funnel trapping transect sites (shown on Figure 4.4);
- unbounded area searches conducted at opportunistic locations containing habitats or microhabitats likely to support previously unrecorded species (see Figure 4.3);
- opportunistic observations of birds whilst traversing the study area; and
- automated recordings (see Section 4.3.6).

A total of 23.2 hours were dedicated to avifauna census across both survey phases at the pitfall and funnel trapping sites (Table 4.6). As conditions were hot during the second phase, birds ceased calling early in the morning limiting productive birding opportunities.

A number of species were also recorded opportunistically within the study area by ornithologists conducting work targeting migratory species outside of the two seasonal phases (Biota 2018a). These species have been added to the overall inventory in this report.

Automated recorders were also deployed to target both the Night Parrot and shorebirds (see Section 4.3.6.3) but the calls of terrestrial bird species were also collated while analysis the recordings. Water birds and migratory shorebirds are the subject of a concurrent dedicated study, reported separately (Biota 2018a).

Table 4.6: Avifauna census times at each trapping site (minutes).

	Phase 1								Phase 2		
	28/08/17	**29/08/17**	**30/08/17**	**31/08/17**	**1/09/17**	**2/09/17**	**3/09/17**	**Total**	**15/03/18**	**Total**	**Grand Total**
AHF01		20	20	20	20	20		100	30	30	130
AHF02		20	20	20	20			80	30	30	110
AHF03			20	20	20			60			60
AHF04		20	20	20				60	30	30	90
AHF05		20	20	20				60			60
AHF06			20					20			20
AHF07			20		40			60	20	20	80
AHF08					20			20	20	20	40
AHF09							20	20			20
AHF10		20		20	40	20		100	20	20	120
AHF11				20				20			20
AHF12		20	20	20	20	20		100			100
AHF13		20	20	20	20	20		100			100
AHF14E		20	20	40	40			120			120
AHF15	40							40			40
AHF16	20	20						40			40
AHF17	20	20						40			40
AHF18	20	20	20		20			80			80
AHF19		20	20	20				60			60
AHF20		20	20	20				60			60
								1,240		**150**	**1,390**

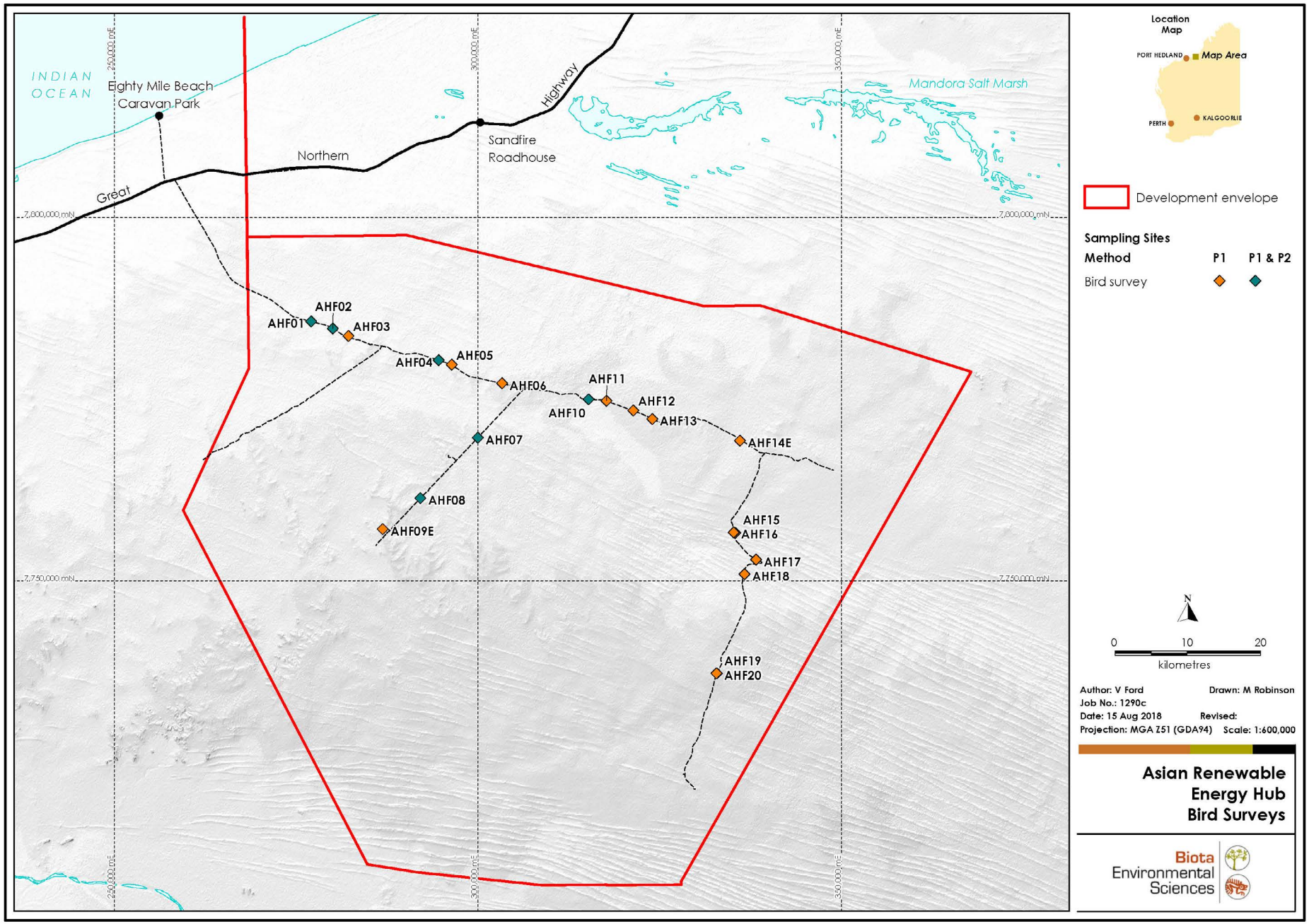


Figure 4.4: Locations of systematic bird census sites.

4.3.6 Automated Recorders

4.3.6.1 Motion Cameras

Infrared motion cameras (Bushnell Trophy Cam) were primarily used to target the Northern Quoll, Black-footed Rock-wallaby and Bilby, and as such were placed in rocky habitats and at entrances of apparently active Bilby burrows. Details of infrared cameras sites and trap effort are provided in Table 4.7, and locations are shown in Figure 4.5.

Table 4.7: Motion camera sites.

	Site ID	Latitude	Longitude	Start	End	Nights
P1	AHF14E-MC-01	-20.167298	121.429874	29/8/17	3/9/17	5
	AHF14E-MC-02	-20.166507	121.430589	29/8/17	3/9/17	5
	AHFCAM026-01	-20.022127	120.900598	30/08/17	2/09/17	3
	AHFCAM015-02	-20.022196	120.900574	31/08/17	3/09/18	3
	AHFCAM015-01	-20.021757	120.8985	28/08/17	31/08/17	3
P2	AHF09E-MC-P2-01	-20.27295457	120.9585567	17/03/18	22/03/18	5
	AHF09E-MC-P2-02	-20.274116	120.958064	17/03/18	22/03/18	5
	AHFCAM08-01	-20.268047	120.940056	15/03/18	22/03/18	7
					Total Nights	**36**

4.3.6.2 Ultrasonic Sound Recorders

Bats were surveyed using SongMeter (SM2BAT and SM4BAT) units, which detect and record ultrasonic echolocation calls emitted by bats during flight. The selectable filters and triggers, jumper and audio settings used followed the manufacturer's recommendations for bat detection (Wildlife Acoustics 2010). Bat sampling effort is detailed in Table 4.8 and the locations of recorders shown in Figure 4.5. Bat echolocation call analysis was conducted by Mr Dan Kamien of Biota using Kaleidoscope Pro software (version 4.3.2), and following methods recommended by the Australasian Bat Society (2006) in conjunction with available reference data (Churchill 2008, McKenzie and Bullen 2009). Only sequences containing good quality search phase calls were considered for identification.

Table 4.8: Bat-call recording sites.

	Site ID	Latitude	Longitude	Start	End	Nights
P1	AHF897-1	-20.021	120.897	29/08/17	31/08/17	2
	AHF827-1	-20.092	121.120	29/08/17	1/09/17	3
	AHF4654-02	-20.237	121.006	1/09/17	3/09/17	2
	CAM654-14E	-20.167	121.430	29/08/17	2/09/17	4
	AHF1169-02	-20.173	121.450	1/09/17	3/09/17	2
	AHFBat1169-01	-20.332	121.435	29/08/17	31/08/17	2
	AHF897-02	-20.575	121.342	1/09/17	3/09/17	2
				Phase 1 Total		**17**
P2	AHF04195-01	-20.272979	120.958622	15/03/18	17/03/18	2
	AHF04195-02	-19.769224	120.785736	17/03/18	22/03/18	5
	AHFSM2827	-19.828062	120.783763	18/03/18	22/03/18	4
				Phase 2 Total		**11**
					Total Nights	**28**

4.3.6.3 Recording in the Audible Range

The Interim guideline for preliminary surveys of the Night Parrot (*Pezoporus occidentalis*) (DBCA 2017a) recommends passive acoustic surveys as an effective low impact survey method. Therefore, SongMeter SM4BAT units were set to record in the audible range at 12 sites (Figure 4.5). At six of these sites recorders were set for 56 consecutive days while at the remaining sites recorders were maintained for 11 months (Table 4.9); site locations are shown in Figure 4.5.

Audio files were analysed by Mr Dan Kamien of Biota using a combination of visual scanning of spectrograms using Kaleidoscope Pro software (version 4.3.2) followed by manual confirmations. Spectrograms of reference calls of the Night Parrot from both western Queensland and Western Australia[1] were imported into the software for comparison.

[1] https://nightparrot.com.au/index.php/resources/night-parrot-calls

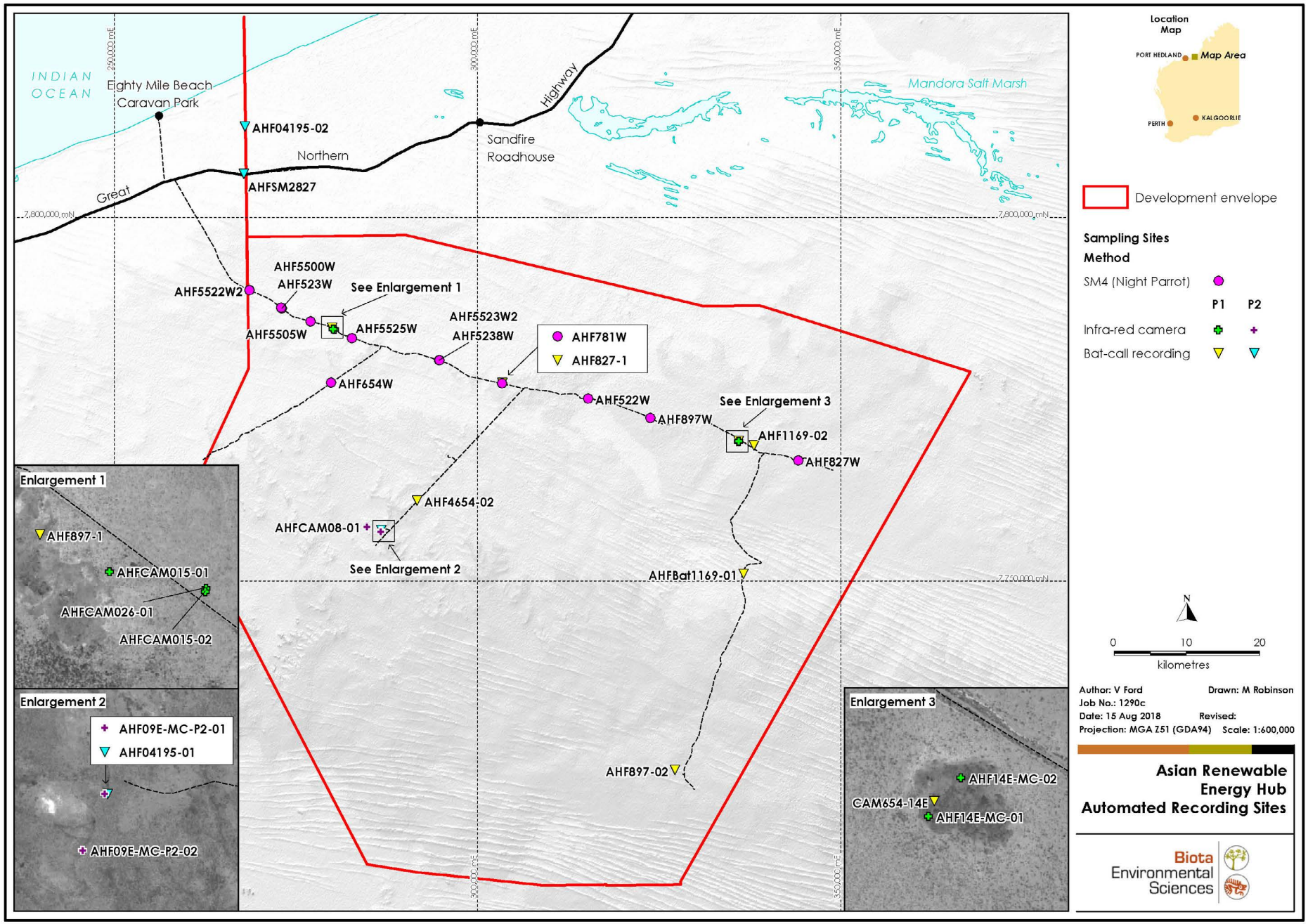


Figure 4.5: Locations of automated recording units.

Table 4.9: Details of SM4 units deployed to record in the audible range.

Unit	Set	Collected	Days	Latitude	Longitude
AHF522W	4/09/17	30/10/17	56	-20.11252286	121.2325648
AHF654W	4/09/17	30/10/17	56	-20.088908	120.894758
AHF781W	4/09/17	30/10/17	56	-20.09235502	121.1196803
AHF827W	4/09/17	30/10/17	56	-20.19193761	121.5081527
AHF897W	4/09/17	30/10/17	56	-20.13723002	121.3142784
AHF523W	4/09/17	30/10/17	56	-19.99582113	120.83136
AHF5238W	4/09/17	3/08/18	334	-20.06277654	121.0372213
AHF5500W	4/09/17	3/08/18	334	-19.99493958	120.8301003
AHF5505W	4/09/17	3/08/18	334	-20.01244669	120.8689437
AHF5522W2	4/09/17	3/08/18	334	-19.97268356	120.788973
AHF5523W2	4/09/17	3/08/18	334	-20.06286272	121.0377932
AHF5525W	4/09/17	3/08/18	334	-20.03426177	120.9225773
		Total:	**2,340**		

4.3.7 Search Sites, Habitat Assessments and Opportunistic Records

Numerous transect searches and point searches were undertaken to more comprehensively characterise the habitats of the study area and to supplement the fauna trapping inventory (Figure 4.6 and Table 4.10). The types of searches and non-systematic assessments were as follows:

- General searches were carried out on foot in areas of habitat with the potential to support species of conservation significance. Areas that might represent habitat of interest were chosen using aerial photography and thematic layers such as land systems mapping.
- Searching for Bilby evidence was undertaken via 32 transect walks. Transect sites were selected on the basis of habitat quality or following incidental detection of sign. During transect walks burrows, tracks, scats and diggings of bilbies were recorded. Details of type of sign, location, personnel, date, general habitat and a photograph were taken with each record. The work targeting the Bilby within the study area was intended to supplement a larger study conducted by the DBCA, which incorporated the search of 2 ha sign plots as described in DBCA (2017b).
- General searches for fauna (Figure 4.6) generally involved either diurnal searching for species that are not readily trapped or within habitats that were not accessible for the installation of traps.
- Twenty-one diurnal search sites targeted rocky habitat as potential habitat for the conservation significant Northern Quoll and Black-footed Rock-wallaby.
- Forty-two habitat assessments were conducted via helicopter jointly with the Biota (2018b) flora and vegetation survey (Figure 4.6). Data on substrate, vegetation structure and habitat type were collected at these sites. The purpose of this was two-fold: to validate the assumption that the systematic trapping sites were representative of the range of habitats in areas not accessible by vehicle, and to identify if any new or significantly different habitats were present.
- Nocturnal searches via road spotting (driving very slowly and spotting animals from the car) or on foot. Nocturnal searching was conducted on two nights of each of the survey phases, generally for 2.5 – 3 hours immediately following sunset. Nocturnal searches often add a number of new species to the inventory, most commonly snakes that are not easily trapped, and nocturnal birds such as owls, owlet-nightjars, frogmouths and nightjars.

Table 4.10: Summary of vertebrate fauna search effort.

	Date	BFRW & NQ Targeted	Bilby Transect	Bilby 2 ha Plot Search	General Search	Nocturnal Road Spot	Habitat Assessment	Nocturnal Foot Search
Phase 1	**28/08/17**	-	-	-	1	-	-	-
	29/08/17	-	3	-	3	-	-	-
	30/08/17	3	1	-	-	-	-	1
	31/08/17	-	1	-	-	-	-	-
	1/09/17	7	-	-	-	1	-	-
	2/09/17	-	16	-	3	-	-	-
	3/09/17	-	7	-	-	-	-	-
	4/09/17	-	-	-	1	-	-	-
Phase 2	**15/03/18**	6	2	-	3	-	6	-
	16/03/18	-	-	-	2	1	7	-
	17/03/18	-	2	-	3	-	6	-
	18/03/18	-	-	-	-	-	7	
	19/03/18	5	-	1	-	-	8	-
	22/03/18	-	-	-	-	1	8	-
	Total:	**21**	**32**	**1**	**16**	**3**	**42**	**1**

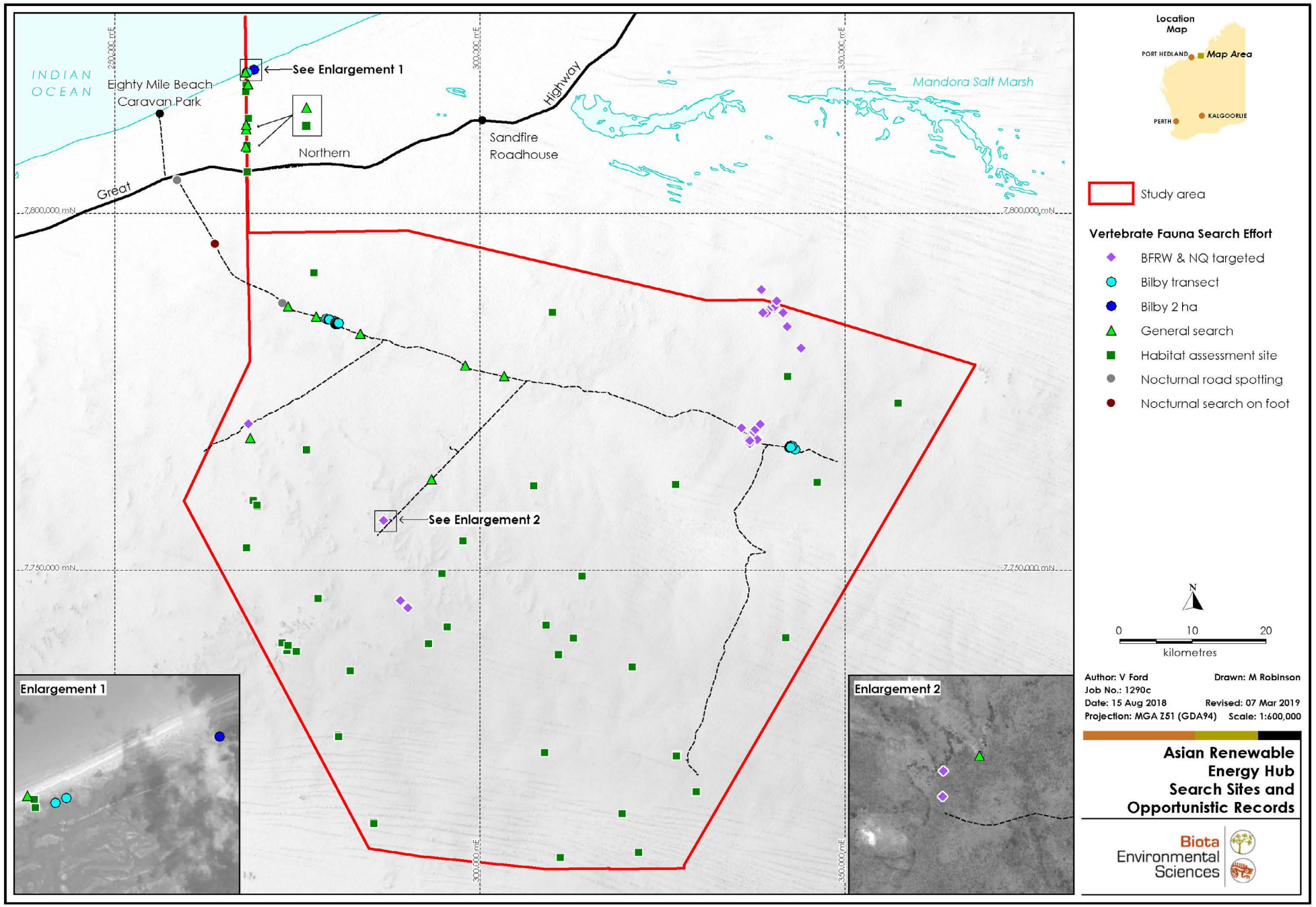


Figure 4.6: Location of search and habitat assessment sites.

4.4 SRE Fauna Survey

4.4.1 Sampling

Sampling of potential short-range endemic (SRE) invertebrate fauna targeted taxonomic groups known to contain SRE species as identified in EPA Guidance Statement 20 (EPA 2016c).

A combination of dry pitfall trapping (i.e. the pitfall trapping sites also used to sample for vertebrate fauna) and active searching was employed. A summary of the methods used and groups targeted is provided in Table 4.11. Details of the dry pitfall sites are provided in Section 4.3.2 and a summary of the targeted search sites for invertebrate fauna is provided in Table 4.12, with locations of sampling sites depicted in Figure 4.7 and habitats illustrated in Plate 4.1 to Plate 4.10.

Search effort was focused on microhabitats most likely to support potential SREs, which included on the south-west side of trees, amongst exposed roots in sheltered locations, and under the southern side of rockpiles, and clay-rich plains which all have more mesic microhabitats suitable for SRE fauna. In loose soil around the base of large trees, the surface layer of dirt was removed to reveal any camouflaged mygalomorph burrows as part of active searchges.

Collected specimens were preserved in 100% ethanol for later genetic analysis by Helix Molecular Solutions (Helix) (see Section 4.4.2).

Table 4.11: Summary of methods used to sample for short-range endemic invertebrate fauna.

	Dry Pitfall	Burrow Search	Under Rocks	Raking Soil and Leaf Litter	Sieving Soil and Leaf Litter
Mygalomorphae (trapdoor spiders)	•	•	•	•	
Pseudoscorpiones (pseudoscorpions)				•	•
Scorpiones (scorpions)	•	•	•	•	
Diplopoda (millipedes)	•		•	•	•
Pulmonata (land snails)			•	•	•

Table 4.12: Search sites targeting potential SRE invertebrate fauna.

Site ID	Latitude	Longitude	Method	Date
AHFSRE01	-20.16698271	121.4310645	Rock turning	29/08/17
AHFSRE02	-20.31955002	121.4562845	Burrow search	30/08/17
AHFSRE03	-20.10151849	121.1468678	Burrow search	1/09/17
AHFSRE03	-20.10028901	121.1459284	Burrow search	1/09/17
AHFSRE04	-20.1774758	121.0679128	Burrow search	3/09/17
AHFSRE05	-20.19130003	121.0535735	Burrow search	3/09/17
AHFSRE06	-20.23408412	121.0093232	Burrow search	3/09/17
AHFSRE07	-20.10725393	121.2021695	Burrow search	3/09/17
AHFSRE08	-19.71908859	120.7889261	Hummock turning; Rock turning	17/03/18
AHFSRE09	-19.701021	120.797262	Vegetation and leaf litter search	19/03/18
AHFSRE10	-19.737334	120.78926	Vegetation and leaf litter search	19/03/18

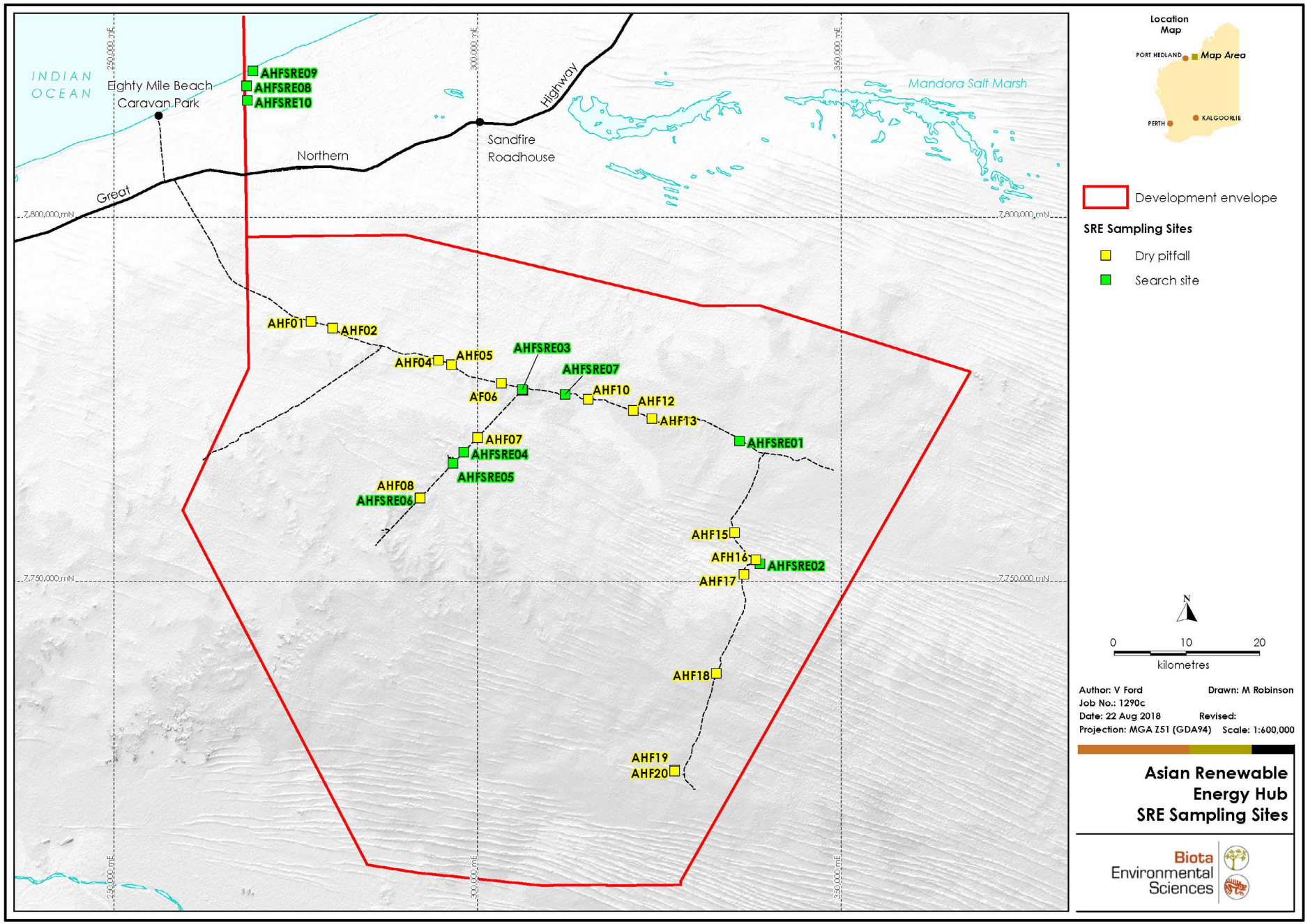


Figure 4.7: Locations of potential SRE invertebrate fauna sampling sites.

Plate 4.1: AHFSRE01.

Plate 4.2: AHFSRE02.

Plate 4.3: AHFSRE03.

Plate 4.4: AHFSRE04.

Plate 4.5: AHFSRE05.

Plate 4.6: AHFSRE06.

Plate 4.7: AHFSRE07.

Plate 4.8: AHFSRE08.

Plate 4.9: AHFSRE09.

Plate 4.10: AHFSRE10.

4.4.2 Molecular Analysis

All specimens collected were identified to species level through molecular (DNA) methods by Helix (Helix 2018). The Helix (2018) report, including detailed methods, is attached as Appendix 4, with only a summary of the methodology used presented here. Invertebrate fauna specimens were sequenced for variation at the mitochondrial cytochrome oxidase subunit I gene (COI). The resulting molecular sequences were then used in a phylogenetic analysis to determine the number of taxa present and place the study area taxa into context with reference sequences publically available on GenBank, within Helix's database or via collaboration with the WA Museum.

Molecular methods of identification were used to overcome limitations associated with using morphological methods alone to identify specimens within the target taxonomic groups for the study, which include:

- **Land snails**: morphological variation is not well correlated with phylogenetic distance: a single species can show broad variation in shell morphology while in other groups convergent evolution has led to consistent shell morphologies between species.
- **Scorpions**: for the largest family of scorpions, the Buthidae, morphological taxonomy is limited in differentiating and defining species boundaries, with findings that several currently recognised species are actually species groups comprising multiple undescribed taxa.
- **Trapdoor spiders**: identification of species has traditionally been performed using morphological techniques, however, only males can be used in identification, as both females and juveniles lack the diagnostic characters required for species level identification. Additionally, extensive molecular work has been conducted on the trapdoor spider fauna of Western Australia by Helix and the WA Museum, and this data set offers a molecular framework that can be used to provide regional context to study area taxa.

4.4.2.1 Determining SRE Status

The SRE status of species is primarily based on their geographic distributions, which are described by two summary statistics. The first is the 'maximum spanning distance', which is the maximum linear distance between two records. The second statistic is the 'minimum spanning area', which is the area of the smallest polygon that can be drawn around all of the records. The minimum spanning area can be used as a means for objectively establishing SRE status by comparison against the 10,000 km^2 criterion established by Harvey (2002). Table 4.13 details the criteria used to determine the SRE status of putative species for the purposes of this report.

Table 4.13: Criteria used to determine SRE status.

SRE Status	Defining Criteria
Known SRE	• Species, morphotype or genetic type has a documented range of <10,000 km^2. • Species, morphotype or genetic type is well collected with numerous specimens typed and habitat preference understood.
Potential SRE	• Species, morphotype or genetic type has a documented range of <10,000 km^2 but is poorly sampled. • Specimen may not be formally described or assigned to a morphotype / genetic type. • Short-range endemism may be common in genus or family. • May have been collected from restricted, refugial or isolated habitats.
Unlikely to be an SRE	• Species, morphotype or genetic type has a documented range of <10,000 km^2 but is poorly sampled. • Specimen may not be formally described or assigned to a morphotype / genetic type. • Short-range endemism is not common in genus or family. • Taxon was not collected from restricted, refugial or isolated habitats. • Few other individuals of the taxon collected, but records are separated by long distances (>100 km).
Not an SRE	• Specimen formally described or assigned to a morphotype / genetic type. • Species, morphotype or genetic type has a documented range of >10,000 km^2.
Undetermined	• Taxa where there is insufficient taxonomic framework available to provide any informed comment on the species-level distribution of the fauna or, therefore, the risk of small-scale spatial restrictions.

4.5 Nomenclature

Consistent with EPA Guidance (EPA 2016b), species nomenclature used in this report for vertebrate fauna follows that of the Western Australian Museum checklist for reptiles, amphibians and mammals, and that of Christidis and Boles (2008) for birds. Nomenclature for invertebrates follows that of the WA Museum.

Distributional information refers only to Western Australia unless otherwise stated.

4.6 Data Analysis

4.6.1 Vertebrate Fauna Assemblage Analysis

Similarity in fauna assemblage amongst trapping sites was analysed by Bray-Curtis similarity matrices, calculated in PRIMER v6.1, where were then represented as CLUSTER dendrograms (Clarke and Gorley 2006). Sites with similar assemblages were then further examined to assess whether this related to landscape units.

A screened site-by-species matrix for each fauna group, including abundance data, was imported into PRIMER and square-root transformed to reduce the influence of high abundance species on the similarity analyses (Clarke and Gorley 2006).

A resemblance matrix was then constructed using the Bray-Curtis similarity index, which produces a similarity value for all pairs of sites based on species representation and transformed abundances. The resultant resemblance matrix was then run through PRIMER's CLUSTER routine, using group average linkage to construct a dendrogram, grouping the survey sites into clusters based on similarity of species composition. Lastly, PRIMER's similarity profile (SIMPROF) permutation tests were applied to the outputs to determine if any of the groups were significantly different.

4.6.2 Species Accumulation Curves

Species accumulation curves graph the detection of new species as a function of increasing sampling effort. When a survey has sampled a high proportion of the fauna assemblage, and few new species are added with additional sampling, the curve will plateau and approach an asymptote. In this way, the species accumulation curve can provide an indication of survey adequacy. In addition, nonparametric estimators can be used to estimate the total species richness based on the frequency of singletons (species only recorded from one individual) and doubletons in the sampling data, that is, the total number of species, including those that may be present but have not yet been detected. EstimateS version 9.1.0 (Colwell 2009) was used to calculate smoothed rarefaction curve based on 500 random permutations of the species data, using each day's sampling across the suite of sites as the sampling unit (n = 16), for comparison with observed actual species . The Chao 1 richness estimator was selected as most appropriate to the data set, as it contained a number of rarely recorded species (nine species of the 69 trapped ground species recorded as singletons and 11 of 44 bird species).

Records from the 16 systematic trapping sites with equal trap effort were included in the analysis. Species recorded using targeted trapping methodologies (e.g. bat targeted trapping and targeted use of Elliott traps) were excluded from the analysis given the limited scope of these methodologies to capture species other than those targeted. Opportunistic fauna records were also removed from the data given the unpredictable nature of such records that are not derived from equivalent sampling methods across sites.

4.7 Survey Limitations

As required by EPA Surveys (2016d), the following limitations to survey and this report are identified for the reader's information:

- Systematic fauna sampling was completed in all fauna habitats, but it was not possible to ground-truth every part of the study area; and nor was it necessary with the very small proportion of the study area that will actually be affected by the project. Some areas were inaccessible by vehicle, so installation and regular checking of fauna traps in these areas was not possible. This limitation applied primarily to the southern-most extent of the study area, which was largely inaccessible by vehicle, but this limitation was addressed by means of helicopter ground-truthing to confirm the habitats sampled systematically were representative of inaccessible areas.
- Many potential SRE taxa are difficult to sample adequately (e.g. mygalomorph spiders are difficult to locate, and morphological identification requires adult male specimens, which are often in low abundance and only emerge from their burrow during selective, specific conditions). While this is a common limitation of these types of surveys, the most prospective microhabitats of the study area were targeted and personnel experienced in SRE sampling undertook the work.
- There is a general lack of past biological survey effort in the locality, which may have limited some assessments of potential wider distributions (e.g. for SRE taxa and where range extensions for some species have been identified in this report).

Despite the above limitations, the overall study still provides an adequate assessment suitable to inform consideration of the project under Section 38 of the *Environmental Protection Act 1986*.

4.8 Legislation and Policy Conformance

All surveys were completed as far as practicable in accordance with relevant State and Commonwealth policy, and to a standard that would provide adequate information to assess the proposal against principals and environmental aims relating to the environmental factor 'Terrestrial Fauna' (EPA 2016a). Table 4.14 provides a summary of the most important and relevant legislation, policy and guidelines relating to this study.

Table 4.14: State and Commonwealth legislation, policy and guidelines of most relevance to this study.

Legislation, Guideline or Policy	Application to this Study	Regulating Authority
Commonwealth		
Environment Protection and Biodiversity Conservation Act 1999	The Australian Government's central piece of environmental legislation.	Department of Environment and Energy
Western Australia		
Environmental Factor Guideline: Terrestrial Fauna (EPA 2016a).	Overall aim of the study is to provide adequate information to assess the proposal against the objective of the environmental factor Terrestrial Fauna, stated to be "To protect terrestrial fauna so that biological diversity and ecological integrity are maintained".	Environmental Protection Authority
Technical Guide – Sampling Methods for Terrestrial Fauna (EPA 2016b)	Provides the State's advice on fauna sampling techniques and methodologies for the analysis, interpretation and reporting requirements for environmental impact assessment.	Environmental Protection Authority
Technical Guide - Terrestrial Fauna Surveys (EPA 2016d)	The State's central guideline on scope and methods for vertebrate fauna inventory.	Environmental Protection Authority
Technical Guide - Sampling of Short Range Endemic Invertebrates (EPA 2016c).	The State's central guideline as to what constitutes SRE invertebrate fauna and how to sample them.	Environmental Protection Authority

Legislation, Guideline or Policy	Application to this Study	Regulating Authority
Interim guideline for preliminary surveys of Night Parrot *Pezoporus occidentalis* in Western Australia (DBCA 2017a).	Targeted survey methodology for Night Parrots.	Department of Biodiversity Conservation and Attractions
Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia (DBCA 2017b).	Targeted survey methodology for bilbies.	Department of Biodiversity Conservation and Attractions

This page intentionally blank.

5.0 Results

5.1 Fauna Habitats

The fauna habitats defined for the study area broadly aligned with the land systems present, with the further delineation of some prominent landforms that occur over multiple land systems but support a distinct assemblage and so were defined as a separate habitat (Table 5.1 and Figure 5.1). Example photographs of each habitat type are presented in Plate 5.1 - Plate 5.6.

Sand dunes and plains were differentiated into coastal and inland habitat types, while the gravelly lateritic rises and rock outcropping habitats only present in the inland areas (see Table 5.1 and Figure 5.1).

Plate 5.1: Shrub and spinifex on sandplain.

Plate 5.2: Gravelly lateritic rises.

Plate 5.3: Inland sand dune.

Plate 5.4: Rock outcropping.

Plate 5.5: Beach and foredunes.

Plate 5.6: Paleo-tidal coastal plains.

Table 5.1: Fauna habitats of the study area and the survey sites at which they were sampled.

Habitat	Land System	Notes	Area (ha)
Shrub and spinifex on sandplain	Primarily Nita but also Little Sandy where the inter-dune distance is large	The dominant habitat of the study area. These broad plains comprised pink to red pindan soils. These were in Excellent condition and supported typical pindan vegetation, comprising occasional trees of species such as *Corymbia zygophylla* (Broome Bloodwood), *Erythrophleum chlorostachys* (Ironwood) and *Owenia reticulata* (Native Walnut) over open to moderately dense mixed shrublands, typically dominated by wattes (*Acacia* spp.), over hummock grasslands of *Triodia schinzii* and *T. epactia*. **Survey sites:** AHF01, AHF02, AHF04, AHF05, AHF06, AHF07, AHF10, AHF12, AHF13, AHF16, AHF17, AHFSRE03, AHFSRE04, AHFSRE05	60,5647.7
Gravelly lateritic rises	Primarily Buckshot but also occurs within Nita	Patchily distributed habitat type but much of its regional extent occurs within the study area. Low rises with a surface covering of laterite gravel and pebbles occurred sporadically through the study area. These supported open hummock grasslands of *Triodia epactia* with a low open shrubland of the wattles *Acacia hilliana* (Hill's Tabletop Wattle) and *A. adoxa* var. *adoxa* (Grey Whorled Wattle); taller shrubs were typically sparse but included species such as *Grevillea refracta* (Silver-leaf Grevillea) and *G. wickhamii* (Wickham's Grevillea). **Survey sites:** AHF03, AHF08, AHFSRE06, AHFSRE07	31,001.4
Inland sand dunes	Primarily Little Sandy and a small number of dunes within Nita	Dominant within the south-eastern portion of the study area. The sand dunes in inland areas had a pink to red pindan sand substrate, and were typically long linear dunes trending east-west. These were dominated by mixed open shrublands over open hummock grasslands of *Triodia schinzii* (Feathertop Spinifex). **Survey sites:** AHF15, AHF18, AHF19, AHF20, AHFSRE02	23,577.1
Rock outcropping	Callawa	Patchily distributed and occurs as rock piles, rocky ridges and breakaway landforms. These rocky areas supported some species that were not found in any other habitats in the study area, including *Ficus brachypoda* (Rock Fig), *Mallotus nesophilus* (Yellow Ball Flower), *Trichosanthes cucumerina* (Snake Gourd) and *Triumfetta incana*. **Survey sites:** AHF09E, AHF14E, AHFSRE01	387.2
		Inland habitats subtotal:	**660,613.3**
Beach and foredunes	Eighty Mile	Small extent within the study area, occurring where indicative cable route meets the coast. The primary dunes and associated swales had a white sand substrate, and occupied the areas closest to the coast. These were dominated by hummock grasslands of *Spinifex longifolius* (Beach Spinifex) and *Triodia epactia* (Humpback Spinifex) and would comprise part of the "Eighty Mile Land System" PEC (Biota 2018b). **Survey sites:** AHFSRE09	42.6
Paleo-tidal coastal plains	Anna and Mannerie	Small extent within the study area, occurring where cable route meets the coast. Low-lying habitat located between the coastal dunes and inland plains. The plains near the coast had a grey silty loam to light clay substrate, and were extensively degraded through weed invasion and heavy grazing by cattle. These areas would presumably once have supported hummock grasslands of *Triodia epactia*, which were now replaced by tussock grasslands of **Cenchrus ciliaris* (Buffel Grass) and **C. setiger* (Birdwood Grass). **Survey sites:** AHFSRE08, AHFSRE10	39.8
		Coastal habitats subtotal:	**82.4**
		Total:	**660,695.7**

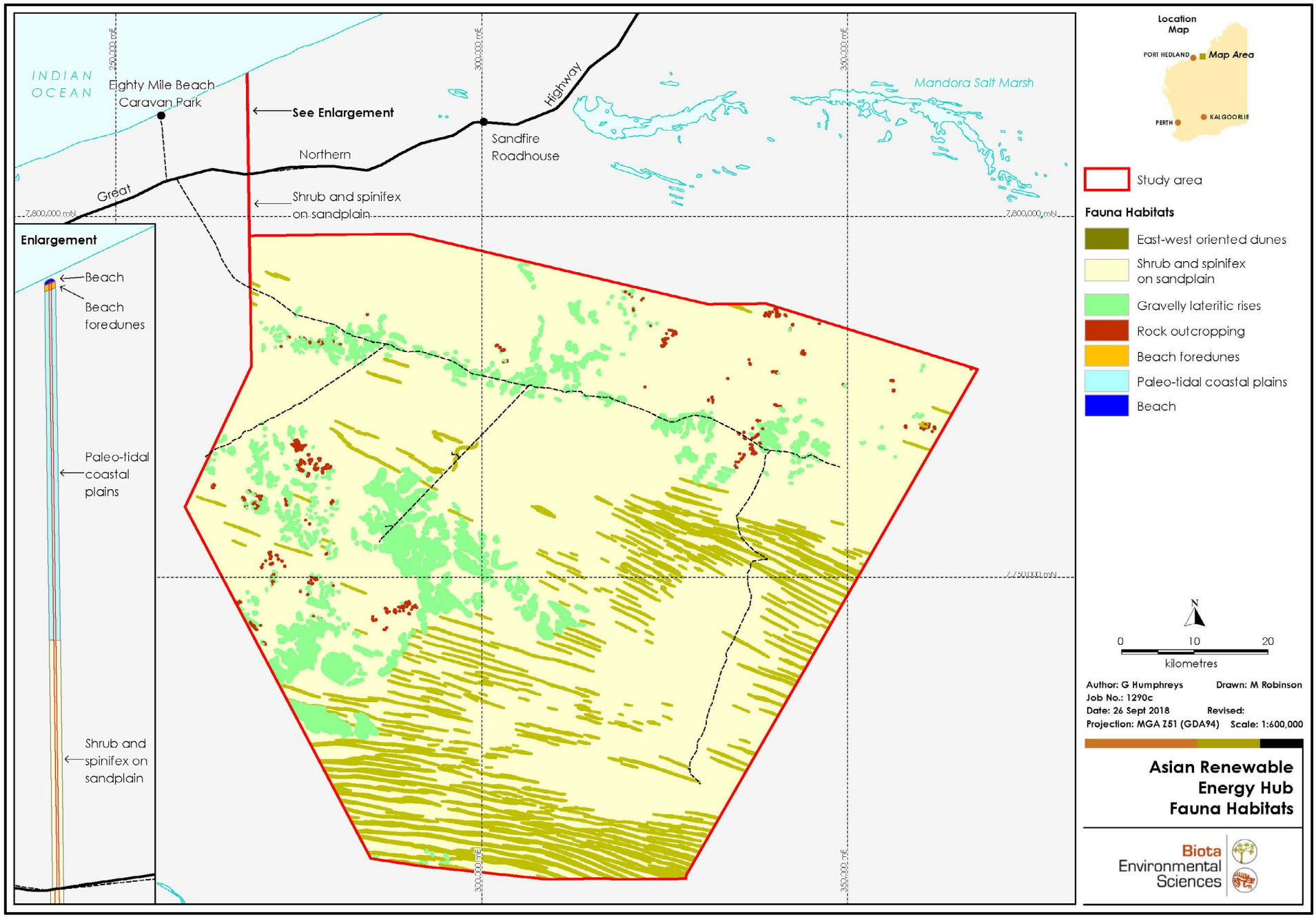


Figure 5.1: Fauna habitats defined within the study area.

5.2 Desktop Review

5.2.1 Potential Faunal Assemblage

The desktop review returned 364 species, comprising 55 mammals (27 native non-volant, 15 bats and 13 non-native), 183 birds (53 of which are largely reliant on freshwater or marine habitats), 116 reptiles and 10 amphibians.

Tables summarising the full lists of species returned from each desktop review source are presented in Appendix 1.

5.2.2 Fauna of Conservation Significance

Species returned from the desktop review were considered to be of elevated conservation significance if they have a formal conservation ranking under the EPBC Act, *Wildlife Conservation Act 1950* (WC Act) or are listed as a DBCA priority species. Appendix 5 details categories of conservation significance recognised under these three frameworks.

An assessment of the likelihood of occurrence of each species of conservation significance was made based on availability of suitable habitat, whether it is core or secondary, as well as records of the species during the current or past studies included in the desktop review (Table 5.2). Some species returned during the desktop review were confidently assessed as unlikely to occur due to an absence of specific habitat requirements within the study area or a well-defined distribution that does not include the study area. When conducting the desktop review to ascertain the conservation significant species that may occur, a conservative approach was taken that included studies in the wider region such as those at Goldsworthy and Yarrie. This broader approach was taken due to the lack of local survey data on which to draw.

A large number of migratory bird species were returned from the desktop review reflecting the proximity of the study area to the Mandora Marsh and coastline. These species are the subject of a separate specialist study and as such the current study incorporated minimal effort targeting such species. Therefore, their likelihood of occurrence has been noted here, but further detail on their occurrence has been reported separately (Biota 2018a).

Table 5.2 details the likelihood assessment for each conservation significant species. Due to a lack of past biological survey in the study area, no fauna species of conservation significance had been recorded at the time of the desktop review.

Those that were considered likely to occur in the study area, or may potentially occur, were targeted during the field survey, and details on those recorded as a result of this are provided in Sections 6.1 to 6.3. Section 6.4 also provides a review of the species that were assessed as likely to occur in the desktop review, but for which there was no evidence of their presence recorded during the survey.

Table 5.2: Conservation significant fauna returned from the desktop review with their likelihood of occurrence.

Species Name	Common Name	Conservation Status (State; Commonwealth)	EPBC	NatureMap	ALA	WAM GSD (1983)	Gold'w Lvl1 (1995)	Gold'w Lvl2 (2005)	Mandora Mammals (2008)	Notes
Mammals										
Likely to occur										
Dasyurus hallucatus	Northern Quoll	Schedule 2; Endangered	✓				✓	✓		Records from the locality and suitable habitat in southwest of study area
Macrotis lagotis	Bilby	Schedule 3; Vulnerable	✓	✓		✓	✓		✓	Multiple records from locality and habitat suitable.
Notoryctes caurinus	Northern Marsupial Mole	Priority 4; N/A				✓				Records from the locality and suitable habitat present
Pseudomys chapmani	Western Pebble-mound Mouse	Priority 4; N/A		✓			✓	✓		Records from the locality and suitable habitat present
Dasycercus blythi	Brush-tailed Mulgara	Priority 4; N/A								Habitat available and records from the locality
Leggadina lakedownensis	Short-tailed Mouse	Priority 4; N/A		✓				✓		Habitat available and records from the locality
Unlikely to occur										
Petrogale lateralis lateralis	Black-footed Rock-wallaby	Schedule 2; Endangered								No records from the locality
Lagorchestes hirsutus	Rufous Hare-wallaby	Schedule 2; Endangered				✓				No recent records and study area well outside documented distribution
Macroderma gigas	Ghost Bat	Schedule 3; Vulnerable	✓		✓		✓			No suitable cave habitat
Isoodon auratus	Golden Bandicoot	Schedule 3; Vulnerable				✓				No records from the locality and well outside documented distribution
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat	Schedule 3; Vulnerable	✓				✓	✓		No suitable cave habitat for roosting
Phascogale calura	Red-tailed Phascogale	Schedule 6; Vulnerable				✓				Outside documented distribution but continuous with central desert habitats
Dasycercus cristicauda[2]	Crest-tailed Mulgara	Priority 4; Vulnerable				✓	✓	✓		Habitat available but no vouchered records from locality[2]
Lagorchestes conspicillatus	Spectacled Hare-wallaby	Priority 3; N/A								Habitat available but no records from locality
Sminthopsis longicaudata	Long-tailed Dunnart	Priority 4; N/A					✓			No records from the locality and little suitable habitat present
Birds										
Likely to occur										
Glareola maldivarum	Oriental Pratincole	Schedule 5; Marine, Migratory	✓	✓	✓					Previous records from the locality, records during shorebird study relating to this project (Biota 2018a) and utilises plains habitats
Apus pacificus	Fork-tailed Swift	Schedule 5; Marine, Migratory	✓	✓	✓					Records from the locality and suitable habitat present, but largely aerial, does not rely on terrestrial habitats
Falco peregrinus	Peregrine Falcon	Schedule 7; N/A		✓	✓	✓				Records from the locality and some core habitat in the form of breakaways in south of study area
Numenius minutus	Little Curlew	Schedule 5; Marine, Migratory	✓	✓	✓					Previous records from the locality, and records during shorebird study relating to this project (Biota 2018a) and utilises plains habitats
Charadrius veredus	Oriental Plover	Schedule 5; Marine, Migratory	✓	✓	✓					Previous records from the locality, and records during shorebird study relating to this project (Biota 2018a) and utilises plains habitats
Unlikely to occur										
Pezoporus occidentalis	Night Parrot	Schedule 1; Endangered	✓							Difficult to assess such a rarely recorded species but no records from the locality and study area does not contain accepted preferred habitat of old spinifex in proximity to varied foraging habitat plants or saline grasslands.
Polytelis alexandrae	Princess Parrot	Priority 4; Vulnerable	✓			✓				No records from the locality and only a small area of suitable habitat present
Reptiles										
Likely to occur										
Natator depressus	Flatback Turtle	Schedule 3; Vulnerable, Marine, Migratory								Known nesting activity on Eighty Mile Beach.
Aspidites ramsayi	Woma	Priority 1; N/A		✓		✓				Records from the locality and suitable habitat present
Lerista separanda	Dampierland Plain Slider	Priority 2; N/A		✓	✓					Records from the locality and suitable habitat present
May potentially occur										
Liopholis kintorei	Great Desert Skink	Schedule 3; Vulnerable				✓				Habitat available in the study area but no recent records from the locality

[2] Past records from historical surveys most likely to be *Dasycercus blythi*, based on recent WA Museum re-determinations of vouchered material.

Species Name	Common Name	Conservation Status (State; Commonwealth)	EPBC	NatureMap	ALA	WAM GSD (1983)	Gold'w Lvl1 (1995)	Gold'w Lvl2 (2005)	Mandora Mammals (2008)	Notes
Unlikely to occur										
Caretta caretta	Loggerhead Turtle	Schedule 2; Endangered, Marine, Migratory								No nesting activity recorded anywhere within Eighty Mile Beach Marine Park.
Chelonia mydas	Green Turtle	Schedule 3; Vulnerable, Marine, Migratory								No nesting activity recorded anywhere within Eighty Mile Beach Marine Park.
Eretmochelys imbricata	Hawksbill Turtle	Schedule 3; Vulnerable, Marine, Migratory								No nesting activity recorded anywhere within Eighty Mile Beach Marine Park.
Liasis olivaceus barroni	Pilbara Olive Python	Schedule 3; Vulnerable	✓				✓	✓		No records from the locality and preferred habitat absent
Ctenotus angusticeps	-	Priority 3; Vulnerable	✓							Outside known distribution and only a very small amount coastal habitat within study area

5.3 Recorded Assemblage

5.3.1 Overview

The combined trapping and search effort over the two phases recorded a total of 177 species (Table 5.3). Across all trap sites (including targeted trapping) 2,803 individuals were trapped (including 2,489 reptiles, 95 amphibians and 219 mammals) and 820 bird individuals were observed. A further 587 individuals (462 birds, 82 reptiles, 21 amphibians and 22 mammals) were observed either opportunistically or during searches. Nineteen species (five mammals, 12 reptiles and two amphibians) were recorded by methods other than trapping (e.g. point searches, walking transect and nocturnal searches) while 10 bird species were recorded opportunistically only. The use of automated recorded units added seven additional species to the inventory that were not recorded by any other method.

Each phase of the study recorded an equal number of species, although the second phase of survey added 31 species not recorded during the first phase.

Table 5.3: Overview of vertebrate fauna recorded from the study area.

Faunal Group	Number of Species			Total Number of Species
	Phase 1	Phase 2	Biota (2018a)*	
Native non-volant mammals	15	10	-	18
Introduced ground-dwelling mammals	4	4	-	5
Bats	8	4	-	9
Birds	41	38	40	68
Reptiles	55	64	-	73
Amphibians	1	4	-	4
Totals	**124**	**124**	**40**	**177**

* waterbirds and migratory shorebirds study

The study area is situated in the interzone between the Pilbara and Kimberley regions, but the faunal assemblage shared greater similarity with that of the Pilbara and very few species with Kimberley distributions were recorded.

A number of species recorded in this study have well understood distributions in the Pilbara but had not previously been recorded as far north as the current study area. Specific examples within each class of fauna are provided in Sections 5.3.2 to 5.3.5 below.

5.3.2 Mammals

5.3.2.1 Non-Volant Mammals

Nine small to medium weight-range mammal species (including eight native and the introduced House Mouse) were recorded from the trapping sites (Table 5.4). Few were abundant; the tiny dasyurid Long-tailed Planigale (*Planigale ingrami*) and the Sandy Inland Mouse (*Pseudomys hermannsburgensis*) were the most common and were recorded at five sites (Table 5.4). Three of the species were uncommonaly recorded, comprising the Kaluta (*Dasykaluta rosamondae*), Rory's Pseudantechinus (*Pseudantechinus roryi*) and the Desert Mouse (*Pseudomys desertor*), which were only recorded from a single site on one day of the trapping (Table 5.4).

A single individual of the Black-footed Rock-wallaby (*Petrogale lateralis lateralis* - Schedule 2; Endangered) was recorded via cage trap at a site targeting the species in rocky habitat (Table 5.4). The species was further recorded from scats and video footage.

An additional four mammal species of elevated conservation significance were recorded from their distinctive burrow formations (Table 5.4). These were the Western Pebble-mound Mouse (*Pseudomys chapmani* – Priority 4), Bilby (*Macrotis lagotis* – Schedule 3; Vulnerable), Brush-tailed Mulgara (*Dasycercus blythi* – Priority 4) and the Northern Marsupial Mole (*Notoryctes caurinus* – Priority 4). The Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti* – Priority 4) was recorded once via tracks.

Further detail of these conservation significant mammal species recorded during the survey is presented in Section 6.1.

Seven non-volant mammal species were observed opportunistically only and included the following native species: Agile Wallaby (*Notamacropus agilis*), Red Kangaroo (*Osphranter rufus*) and Dingo (*Canis dingo*), in addition to the following introduced species: Dog (*Canis lupus*), Red Fox (*Vulpes vulpes*), Cat (*Felis catus*) and Camel (*Camelus dromedarius*) (Table 5.4).

5.3.2.2 Bats

Nine bat species were identified from ultrasonic call recordings (Table 5.5). None of the species recorded were of elevated conservation significance.

Table 5.4: Non-volant mammals recorded during the survey.

Family Species	Common Name	State°	Commonwealth°	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF10	AHF12	AHF13	AHF14	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	AHF E22	AHF-PM-01	AHFCAM26-01	Trace^	Hand capture or observation
Dasyuridae																										
Dasycercus blythi	Brush-tailed Mulgara, Ampurta	P4																								1
Dasykaluta rosamondae	Kaluta													1												
Dasyurus hallucatus	Northern Quoll	S2	EN																							2
Ningaui timealeyi	Pilbara Ningaui															3										
Planigale ingrami	Long-tailed Planigale				4		2		6		5									1						
Pseudantechinus roryi	Rory's Pseudantechinus								1																	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart											1	1	1					1		1					
Thylacomyidae																										
Macrotis lagotis	Bilby, Dalgyte	S3	VU																					1	1	28
Notoryctidae																										
Notoryctes caurinus	Northern Marsupial Mole	P4																							1	
Macropodidae																										
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby	P4																							1	
Notamacropus agilis	Agile Wallaby																									5
Osphranter rufus	Red Kangaroo, Marlu																									1
Petrogale lateralis lateralis	Black-footed Rock-wallaby	S2	EN												1										72	13
Muridae																										
*Mus musculus**	House Mouse						1													1	1		1			
Notomys alexis	Spinifex Hopping-mouse										1					1	1		4							1
Pseudomys chapmani	Western Pebble-mound Mouse	P4																							2	6
Pseudomys desertor	Desert Mouse						1																			
Pseudomys hermannsburgensis	Sandy Inland Mouse							1				1	2	3					1			5				
Canidae																										
Canis dingo	Dingo																									1
*Canis lupus**	Dog																									1
*Vulpes vulpes**	Red Fox																								1	
Felidae																										
*Felis catus**	Cat																								2	6
Camelidae																										
*Camelus dromedarius**	Dromedary, Camel																								2	1
	Total Number of Species:			**0**	**1**	**0**	**3**	**1**	**2**	**0**	**2**	**2**	**2**	**3**	**1**	**2**	**1**	**0**	**3**	**2**	**2**	**1**	**1**	**1**	**8**	**12**

* Introduced species

°P4 = Priority 4, S2 = Schedule 2, S3 = Schedule 3, VU = Vulnerable, EN = Endangered

^ Trace includes sign evidence such as tracks, scats or burrows

Table 5.5: Bats recorded during the survey.

Family *Species*	Common Name	State	Commonwealth	Cam-654-14E	AHF897-1	AHFBat1169-01	AHF827-1	AHF897-02	AHF1169-02	AHF654-02	AHF04195-01	AHF04195-02	AHFSM2827	Trace	Observation
Emballonuridae															
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat					•			•			•			
Taphozous georgianus	Common Sheath-tailed Bat			•					•				•	•	•
Molossidae															
Austronomus australis	White-striped Free-tailed Bat					•			•						
Chaerephon jobensis	Greater Northern Free-tailed Bat								•						
Ozimops lumsdenae	Northern Free-tailed Bat								•						
Vespertilionidae															
Chalinolobus gouldii	Gould's Wattled Bat			•		•			•						
Nyctophilus geoffroyi	Lesser Long-eared Bat								•						
Scotorepens greyii	Little Broad-nosed Bat			•		•			•			•			
Vespadelus finlaysoni	Finlayson's Cave-bat										•				
	Total Number of Species:			**3**	**0**	**4**	**0**	**0**	**8**	**0**	**1**	**2**	**1**	**1**	**1**

5.3.3 Birds

The terrestrial bird assemblage recorded within the study area largely comprised species commonly recorded in the Pilbara, although the overall species richness was relatively low. The dominance of open plain habitat and scarcity of dense tree and shrub layers or water sources that are typically areas of avifauna diversity are likely contributors to the lack of species richness.

Sixty-eight species from 26 families were recorded from 1,798 individuals (Table 5.6). Birding at trapping sites yielded 44 species while 44 species were recorded opportunistically, 15 of which had not been recorded at the trap sites (Table 5.6). Thirty-eight species were recorded by the automated recording units, of which eight had not been recorded by other means (Table 5.6).

The most species-rich families recorded were the Accipitridae (all diurnal raptors except falcons and kestrels) with eight species, and Meliphagidae (honeyeaters and chats), with eight species (Table 5.6). The most abundant bird species were the Singing Honeyeater (*Lichenostomus virescens*) and the Crimson Chat (*Epthianura tricolor*), which accounted for 26% and 18% respectively of all individual bird species recorded from the study area (Table 5.6).

There are no bird species endemic to the Great Sandy or Little Sandy Deserts and the only species to be confined to deserts in Western Australia is the Princess Parrot, which was not recorded during this survey (Burbidge and McKenzie 1983). Two conservation significant bird species were recorded within the study area: the Oriental Pratincole (*Glareola maldivarum* - Schedule 5; Migratory) and the Rainbow Bee-eater (*Merops ornatus* - Marine) (Table 5.6). Further detail of these latter two species is provided below in Section 6.2.

5.3.4 Reptiles

The recorded reptiles assemblage of 73 species included one turtle, 16 species of gecko, five legless lizards, nine dragons, 24 skinks, six goannas, three blind snakes, two pythons and seven elapid snake species (Table 5.7). The recorded assemblage included a large proportion of that known from the Great Sandy Desert (Burbidge and McKenzie 1983), and was dominated by species with Eremean distributions with almost no Kimberley representatives. *Gehyra kimberleyi* represented the only real exception, but this is also a recently described species (Doughty et al. 2012b) so the full extent of its distribution may not yet have been ascertained.

The records of *Antaresia stimsoni* (Stimson's Python), *Demansia psammophis* (Yellow-faced Whipsnake), *Varanus giganteus* (Perentie) and *Demansia rufescens* (Rufous Whipsnake), all represent minor northerly extensions to the species, distributions as currently described using NatureMap records (Table 5.7).

The DBCA Priority 2 species *Lerista separanda* (Dampierland Plain Slider) was a notable record given how rarely it has been recorded to date (Table 5.7). Originally described solely from the Dampier Peninsula, records from this study and the Pilbara Biological Survey where it was recorded from Warrawagine (Doughty et al. 2011) indicate it has a considerably broader distribution. Only one other species recorded during the survey has a restricted northern Pilbara distribution: *Diporiphora vescus*, which was first described in 2012 (Doughty et al. 2012a).

Two skink species recorded during the survey, *Lerista vermicularis* and *Lerista ips* (Table 5.7), represent perhaps the only two vertebrate species endemic to the Great Sandy Desert.

5.3.5 Amphibians

Four frog species were recorded; two species via trapping and an additional two species opportunistically (Table 5.8). The trapped species, *Notaden nichollsi* and *Uperoleia russelli* typically burrow in red dune habitats, and often burrow together (Cartledge et al. 2006)

While 10 species were returned from the desktop review (Appendix 1), it is common to record relatively few desert frogs during surveys due to their tendency to aestivate and remain cryptic during dry conditions. They are typically recorded opportunistically following rainfall.

Table 5.6: Birds recorded within the study area.

Family *Species*	Common Name	State	Commonwealth	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF09E	AHF10	AHF11	AHF12	AHF13	AHF14	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	Opportunistic	Trapped	Automated recorders
Casuariidae																										
Dromaius novaehollandiae	Emu																									
Phasianidae																										
Coturnix ypsilophora	Brown Quail																									•
Columbidae																										
Phaps chalcoptera	Common Bronzewing							1																		
Ocyphaps lophotes	Crested Pigeon			6	1		2																	19		•
Geopelia cuneata	Diamond Dove				1		1			1	2							2								
Podargidae																										
Podargus strigoides	Tawny Frogmouth																							3		
Eurostopodidae																										
Eurostopodus argus	Spotted Nightjar																							5		
Pelecanidae																										
Pelecanus conspicillatus	Australian Pelican						5																	3		
Ardeidae																										
Ardea pacifica	White-necked Heron						1																	1		
Nycticorax caledonicus	Nankeen Night-Heron																									•
Accipitridae																										
Elanus axillaris	Black-shouldered Kite				1																					
Hamirostra melanosternon	Black-breasted Buzzard																							2		
Haliastur sphenurus	Whistling Kite			1																	1			1		
Accipiter fasciatus	Brown Goshawk																			1				1		
Accipiter cirrocephalus	Collared Sparrowhawk																							1		
Circus assimilis	Spotted Harrier						1			1							1				1			1		
Aquila audax	Wedge-tailed Eagle																							1		
Hieraaetus morphnoides	Little Eagle																							1		
Falconidae																										
Falco cenchroides	Nankeen Kestrel									1			1		1		1					1		6		
Falco berigora	Brown Falcon																							4		
Falco longipennis	Australian Hobby																				1			1		
Otididae																										
Ardeotis australis	Australian Bustard			1	1								1		1	1								8		
Charadriidae																										
Elseyornis melanops	Black-fronted Dotterel																									•
Vanellus miles	Masked Lapwing																									•
Turnicidae																										
Turnix velox	Little Button-quail			2	1	1	3	3		1		1	1		1	1	3	1			1		2	2	7	
Glareolidae																										
Glareola maldivarum	Oriental Pratincole	S5	MI																							•
Cacatuidae																										
Calyptorhynchus banksii samuelli	Red-tailed Black-Cockatoo			5																				13		•
Eolophus roseicapillus	Galah			2								1														•
Nymphicus hollandicus	Cockatiel																							53		•

Family *Species*	Common Name	State	Commonwealth	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF09E	AHF10	AHF11	AHF12	AHF13	AHF14	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	Opportunistic	Trapped	Automated recorders
Psittacidae																										
Melopsittacus undulatus	Budgerigar			1	2					2						13				13		2		28		•
Cuculidae																										
Centropus phasianinus	Pheasant Coucal																2									
Chalcites basalis	Horsfield's Bronze-Cuckoo									2									1							
Chalcites osculans	Black-eared Cuckoo																									•
Cacomantis pallidus	Pallid Cuckoo			1																						•
Tytonidae																										
Tyto javanica	Eastern Barn Owl																									•
Halcyonidae																										
Todiramphus pyrrhopygius	Red-backed Kingfisher			1						2			1					2						3		•
Meropidae																										
Merops ornatus	Rainbow Bee-eater		Ma										1			3			2					11		•
Maluridae																										
Malurus leucopterus	Black and White Fairy-wren																							3		
Malurus lamberti	Variegated Fairy-wren				1		3	4		5							6		3				4	3		•
Amytornis striatus	Striated Grasswren				1																					
Meliphagidae																										
Certhionyx variegatus	Pied Honeyeater																							3		•
Lichenostomus virescens	Singing Honeyeater			5	5	6	6	2	4	23	9		16		11	21	16	17	2	8	48	14	25	5		•
Lichenostomus keartlandi	Grey-headed Honeyeater											2								2				1		•
Manorina flavigula	Yellow-throated Miner			11	1	3				2	1		2				1	2	2		14	2	1	3		•
Acanthagenys rufogularis	Spiny-cheeked Honeyeater																									•
Epthianura tricolor	Crimson Chat									2								14	47	3		7	57	81		•
Sugomel niger	Black Honeyeater																							1		•
Lichmera indistincta	Brown Honeyeater												1		1			1				2		3		•
Eupetidae																										
Psophodes occidentalis	Chiming Wedgebill																	3	7	1		1		1		
Campephagidae																										
Coracina novaehollandiae	Black-faced Cuckoo-shrike				1												1				1			1		•
Lalage sueurii	White-winged Triller									1								1	12	1	2	3	6	4		
Pachycephalidae																										
Pachycephala rufiventris	Rufous Whistler																					1				•
Oreoica gutturalis	Crested Bellbird									4					1			5		1		1				•
Artamidae																										
Artamus personatus	Masked Woodswallow						1																	653		•
Artamus cinereus	Black-faced Woodswallow			1			9	4					1		1	3	1	8	6		1		4	3		•
Cracticus nigrogularis	Pied Butcherbird			1	7	1				1	1						2							2		•
Rhipiduridae																										
Rhipidura leucophrys	Willie Wagtail			1	2			2		2			1				5	1	2							•
Corvidae																										
Corvus bennetti	Little Crow																							29		•
Corvus orru	Torresian Crow														1											•

Family *Species*	Common Name	State	Commonwealth	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF09E	AHF10	AHF11	AHF12	AHF13	AHF14	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	Opportunistic	Trapped	Automated recorders
Alaudidae																										
Mirafra javanica	Horsfield's Bushlark					5	2	1	4		1													1		
Megaluridae																										
Cincloramphus mathewsi	Rufous Songlark												2								2	1				
Cincloramphus cruralis	Brown Songlark														5	1					1			7		
Eremiornis carteri	Spinifexbird																									•
Hirundinidae																										
Petrochelidon ariel	Fairy Martin																							14		•
Estrildidae																										
Taeniopygia guttata	Zebra Finch						15			18	9		6				4							3		•
Emblema pictum	Painted Finch				1		1						2											24		•
Heteromunia pectoralis	Pictorella Mannikin																							3		
Motacillidae																										
Anthus novaeseelandiae	Australasian Pipit													1												•
	Total number of species:			**14**	**14**	**5**	**13**	**7**	**2**	**16**	**6**	**3**	**13**	**1**	**9**	**7**	**12**	**12**	**10**	**8**	**11**	**11**	**7**	**44**	**1**	**38**

° S5 = Schedule 5, Mi = Migratory, Ma = Marine

Table 5.7: Reptiles recorded during the survey.

Family *Species*	Common Name	State	Commonwealth	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF10	AHF12	AHF13	AHF14	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	AHFCAM015-01	AHFCAM08-01	Trace	Hand Captures and Opp. Sightings
Cheloniidae																									
Natator depressus	Flatback Turtle	S3	VU, Ma, Mi																					1	
Carphodactylidae																									
Nephrurus laevissimus																	1			14	2			1	
Nephrurus levis								1		1				2			1		1						
Diplodactylidae																									
Diplodactylus laevis	Desert Fat-tailed Gecko			7	3		11	14	14	26	6	21	16	8					3	3	14				
Lucasium stenodactylum				6	1		4	4		1		2	6	7		3	11	28	3	3	2				
Oedura fimbria	Western Marbled Velvet Gecko																							1	2
Rhynchoedura ornata	Western Beaked Gecko			3	1		1		1	2		14	9	3		3	1	6	3		1				1
Strophurus ciliaris				2		2	8	13	9	5		1	2	1		5		1	6	3	8				1
Strophurus elderi														2		1		1		5	1				
Strophurus jeanae				2			1					1									1				
Gekkonidae																									
Gehyra kimberleyi	Robust Termitaria Gecko								1																
Gehyra montium							1		1																1
Gehyra pilbara									3																2
Gehyra punctata																									1
Gehyra purpurascens				1													1		1						

Family *Species*	Common Name	State	Commonwealth	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF10	AHF12	AHF13	AHF14	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	AHFCAM015-01	AHFCAM08-01	Trace	Hand Captures and Opp. Sightings
Gehyra variegata				1			1					2					1	1	1	1	2				
Heteronotia binoei	Bynoe's Gecko							2	9	1				2				1	1	4					
Pygopodidae																									
Delma butleri				1	4			5	2				1	2						1					
Delma desmosa				2	9	1	3	4	3	1	1	1	2	3		1			3	7	2				
Delma nasuta													5							1	1				
Lialis burtonis				3	3		4	1				1	1				1		1	6	3				
Pygopus nigriceps				1			1		2	3		4													1
Agamidae																									
Ctenophorus caudicinctus	Ring-tailed Dragon																								5
Ctenophorus isolepis	Military Dragon			26	9	2	34	37	23	21	1	35	39	49		28	28	69	44	37	25				
Ctenophorus nuchalis	Central Netted Dragon								3			1				1		7		1					1
Diporiphora paraconvergens	Grey-striped Western Desert Dragon						2		1	1								1	1	4	2				
Diporiphora pindan	Pindan Dragon			1			4	1								3	1		2	3					1
Diporiphora vescus	Northern Pilbara Tree Dragon						1											1							
Gowidon longirostris	Long-nosed Dragon																	1							
Moloch horridus	Thorny Devil																								1
Pogona minor				1	2		2	3	3	3										4	1				1
Scincidae																									
Carlia triacantha				1	1	4	1	1		1		3	6												
Ctenotus brooksi																				7					
Ctenotus calurus										1															
Ctenotus grandis				2			2				2	3		1		1		1	3						
Ctenotus helenae							1						1			4	1	2	5	1	1				
Ctenotus pantherinus	Leopard Ctenotus			7	7	6	12	14	4	5	1	2	11	21		5	2	6	28	8	12	1			
Ctenotus piankai				1	4		1	1	2		3	1	1	2			2		1	1	1				
Ctenotus quattuordecimlineatus							2			1			1			1	5		2	2	4				
Ctenotus rufescens					5		1	1										2		1					
Ctenotus saxatilis	Rock Ctenotus				2	8					2														1
Ctenotus schomburgkii					5			1	11	1	9	1	1												
Egernia cygnitos	Western Pilbara Spiny-tailed Skink																								3
Eremiascincus isolepis																									1
Eremiascincus musivus	Mosaic Desert Skink			2						5			2	1		1	2	6	3	1					
Eremiascincus pallidus	Western Narrow-banded Skink			1						1			1	2		15	1	4	3	1	1				
Eremiascincus richardsonii	Broad-banded Sand Swimmer						1																		
Lerista bipes				6	49		39	32	22	64	2	32	15	5		56	58	77	56	39	56				
Lerista clara																									1
Lerista separanda	Dampierland Plain Slider	P2									1								1	1					
Lerista vermicularis																4	1			87					
Menetia greyii				1						2				2											
Morethia ruficauda				2			1	1		2			5	2			1		4	1					1

Family *Species*	Common Name	State	Commonwealth	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF10	AHF12	AHF13	AHF14	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	AHFCAM015-01	AHFCAM08-01	Trace	Hand Captures and Opp. Sightings
Notoscincus ornatus				1			1	2	4	5	2	11	8	1			1	1	2	1	2				
Tiliqua multifasciata	Central Blue-tongue					1	1	3		1	1	2													1
Varanidae																									
Varanus acanthurus	Spiny-tailed Goanna				2			1		1	2						1				1			1	1
Varanus brevicauda	Short-tailed Pygmy Goanna			1			2							1						2	3				
Varanus eremius	Pygmy Desert Goanna			2			1	4	2	2		4	3	7		2	1		2	4	2				
Varanus giganteus	Perentie																						2		4
Varanus gilleni	Pygmy Mulga Goanna																	2	1						
Varanus gouldii	Bungarra or Sand Goanna					1		1					1	2		1			1		2				1
Typhlopidae																									
Anilios ammodytes				1	9		5	1	3		4	3	1	2		3									
Anilios grypus							1			1							1	4	1		6				
Anilios pilbarensis																				1					
Pythonidae																									
Antaresia stimsoni	Stimson's Python				2																				
Aspidites melanocephalus	Black-headed Python																								1
Elapidae																									
Demansia psammophis	Yellow-faced Whipsnake																								2
Demansia rufescens	Rufous Whipsnake																								1
Furina ornata	Moon Snake										1														
Pseudechis australis	Mulga Snake							1							1										2
Pseudonaja mengdeni	Western Brown Snake						2	1		2															
Pseudonaja modesta	Ringed Brown Snake				1	1	1	2	5	1	1								1		1				2
Simoselaps anomalus	Desert Banded Snake			4			3	2	1	9				1		29	3	9	4	6	3				
	Total Number of Species:			**28**	**19**	**9**	**34**	**28**	**23**	**29**	**16**	**21**	**23**	**24**	**1**	**20**	**23**	**22**	**30**	**33**	**28**	**1**	**1**	**4**	**26**

Table 5.8: Amphibians recorded during the survey.

Family *Species*	Common Name	State	Commonwealth	AHF01	AHF02	AHF03	AHF04	AHF05	AHF06	AHF07	AHF08	AHF10	AHF12	AHF13	AHF14E	AHF15	AHF16	AHF17	AHF18	AHF19	AHF20	Trace	Hand Captures and Opp. Sightings
Hylidae																							
Cyclorana australis	Giant Frog																						3
Cyclorana longipes	Long-footed Frog																						14
Limnodynastidae																							
Notaden nichollsi	Desert Spadefoot			6			2			4		1				41	2	6	3	5	7		4
Myobatrachidae																							
Uperoleia russelli	Northwest Toadlet															5				13			
	Total Number of Species:			**1**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**2**	**1**	**1**	**1**	**2**	**1**	**0**	**3**

5.4 Survey Adequacy

As a broad gauge of survey adequacy, the number of taxa recorded during this survey was compared with historical data for the locality from databases (NatureMap and Atlas of Living Australia (ALA)) which incorporate the results of several surveys, as well as the results of two individual Level 2 style studies (Burbidge and McKenzie 1983, ecologia 2005) which comparable effort to that of the current survey (Figure 5.2).

The current study recorded more reptile species than any other individual study or the consolidated list returned from database searches, more mammals species than all but one source reviewed and as many amphibians. The number of terrestrial birds recorded was on par with the number returned from NatureMap and the Goldsworthy Level 2 survey (ecologia 2005), but notably less than returned from the ALA database and the study of the WA Museum survey of the Great Sandy Desert (Burbidge and McKenzie 1983). Given the substantial effort applied to the recording of birds during this study (23 hours of dedicated bird census and considerable opportunistic effort, together with 2,340 days of automated recordings scanned by an ornithologist), we assume that the recorded bird assemblage is relatively complete for the study area. The lower species richness recorded is more likely to reflect a lack of diversity in habitat availability. For example, the WA Museum Great Sandy Desert (Burbidge and McKenzie 1983) study included wetland fringing habitats including samphire as well as woodland habitat; these habitats were absent from the current study area and are well known to support high bird diversity in arid areas.

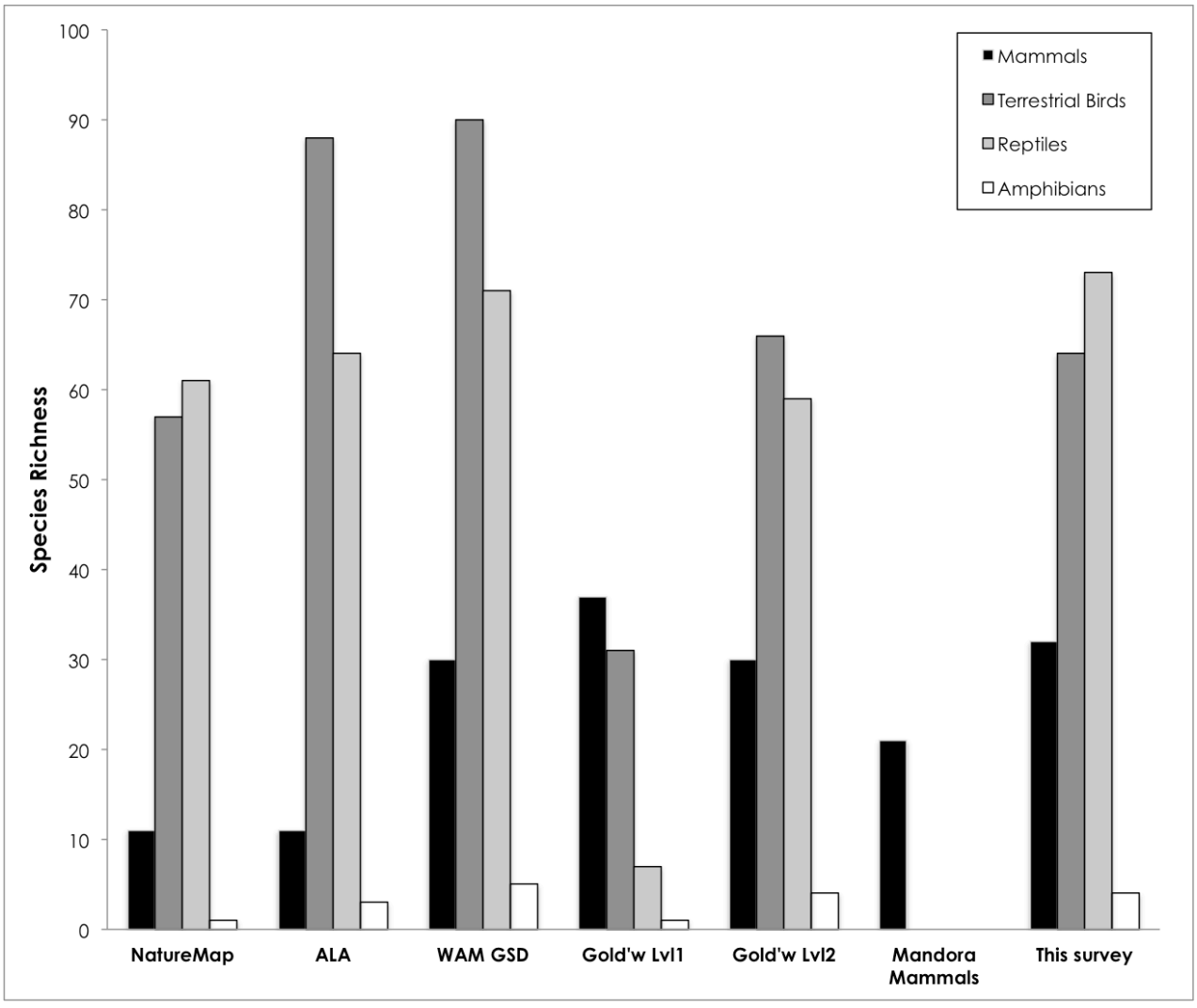


Figure 5.2: Species richness returned from database searches and other surveys in the region relative to the current study.

5.5 Species Accumulation

5.5.1 Ground Fauna

Seventy-two species of ground fauna were recorded from the sites trapped with a consistent trapping methodology and equal effort (pitfall and funnel transects, n = 16). Figure 5.3 displays both the actual accumulation of species with each day of trapping at these sites as well as the randomised rarefaction curve. Both show a relatively rapid initial increase in species recorded which flattens toward an asymptote, suggesting adequate sampling (Figure 5.3).

The Chao1 estimator predicts a maximum species richness of 78.2 species based on the data set (shown dashed in Figure 5.3), again indicating that the actual tally of 72 species from the survey has recorded the majority of the ground fauna assemblage.

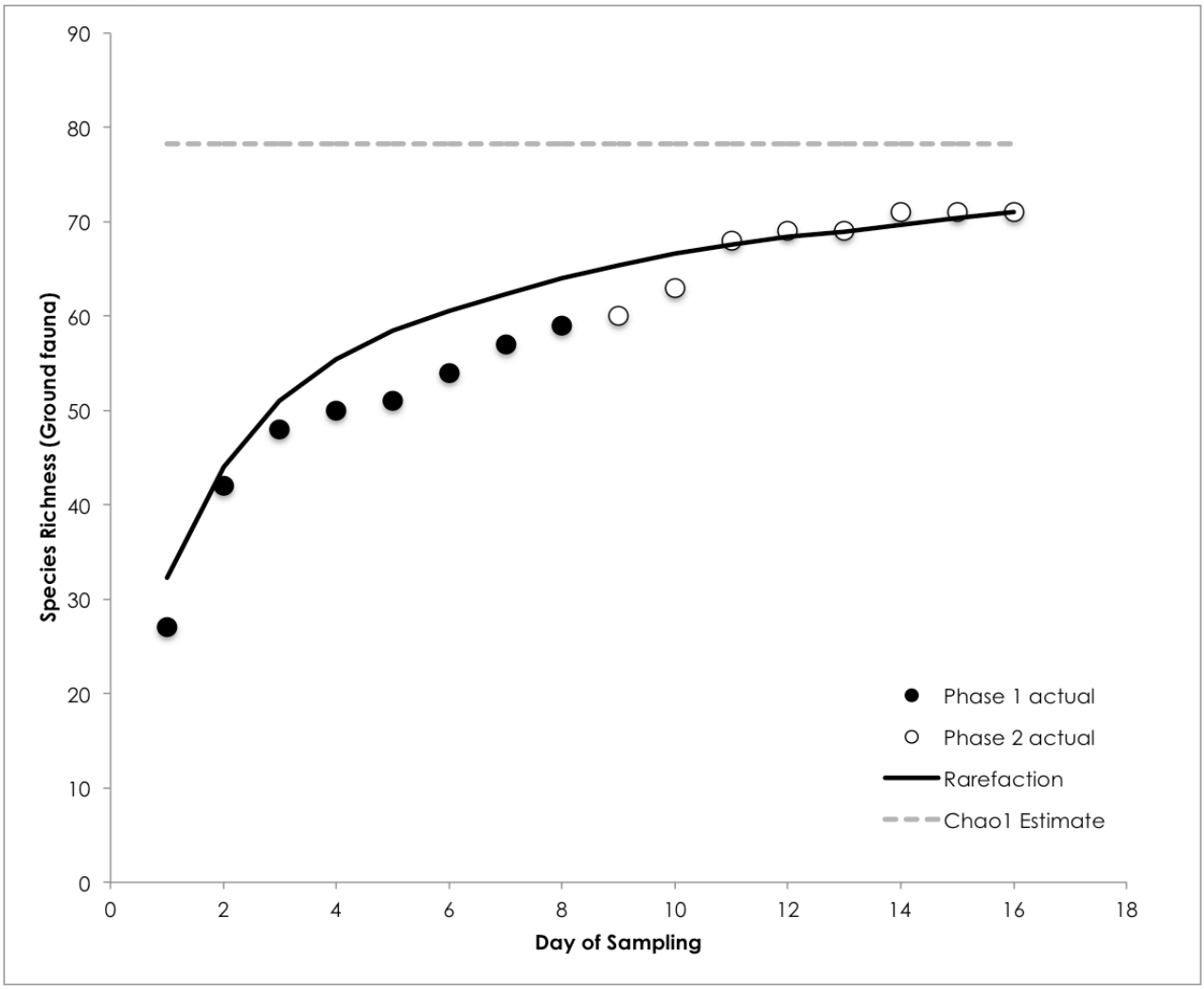


Figure 5.3: Rarefaction curve, actual species accumulation and estimated species richness (Chao1) for ground fauna species recorded at the 16 systematic trapping sites.

5.5.2 Birds

Forty-four bird species were recorded across 816 individuals during the bird censuses conducted at trapping sites, which represent the data included in the species accumulation analysis. The number of species approached a plateau relatively quickly which was sustained through considerable further effort. However, the addition of five new species in the last day of the first phase, and the relatively high proportion of species recorded as singletons (11 of 44), would indicate that further bird survey effort may have yielded more species (Figure 5.4). The rarefaction constructed from these data was consistent with this, which, while flattening somewhat were not as strongly asymptotic as the ground fauna accumulation (Figure 5.4).

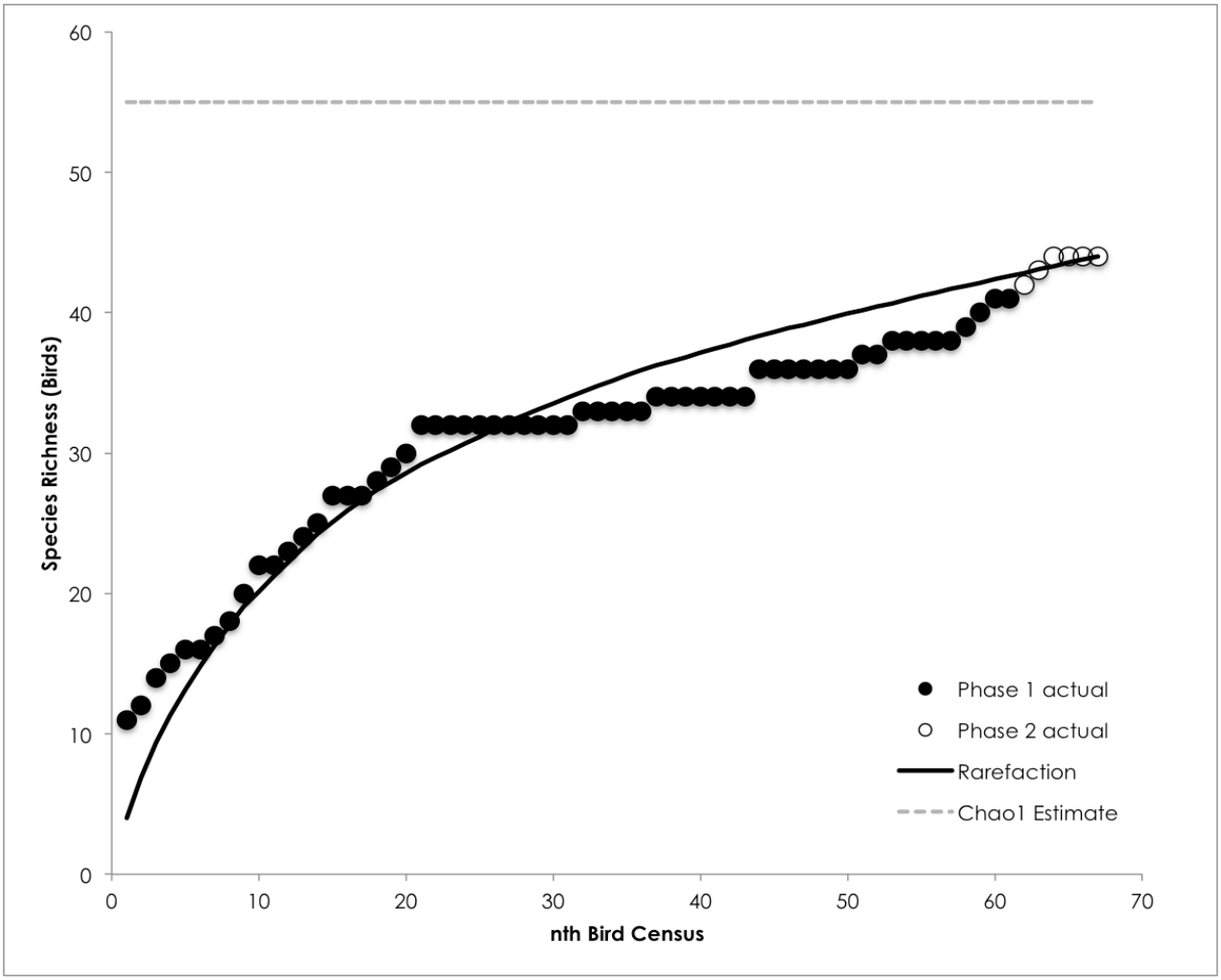


Figure 5.4: Rarefaction curve and estimated species richness (Chao1) for bird species recorded via dedicated bird census at the systematic sampling sites.

The Chao1 estimator predicted a maximum species richness of 55 species (Figure 5.4). It is important to note, however, that in addition to bird surveys at trap sites, birds were also surveyed in during targeted censuses in other habitats during the survey, often recorded opportunistically, and via the use of automated recording units. Together these latter methods added 24 species to the avifauna inventory, bringing it to 68 species, exceeding the species richness predicted by the nonparametric estimator.

5.6 Faunal Assemblage Analysis

The ground fauna species composition was compared across the systematic sampling sites using Bray-Curtis measure of similarity. The analysis was run twice, once with abundance of each species included and once using presence/absence data only. Both analyses yielded very similar results. Similarity with abundance data included, is displayed as a dendrogram in Figure 5.5.

Four groupings were statistically significant different (illustrated by the black dendrogram branches in Figure 5.5). Relationships between site habitat type and land system were investigated, but little correlations with the four groupings, with sites from different habitats within the same cluster and no consistent grouping of a single habitat type within any of the four groups (Figure 5.5). This may indicate that there is little distinction in the ground faunal assemblages across the survey area between the habitat types as defined.

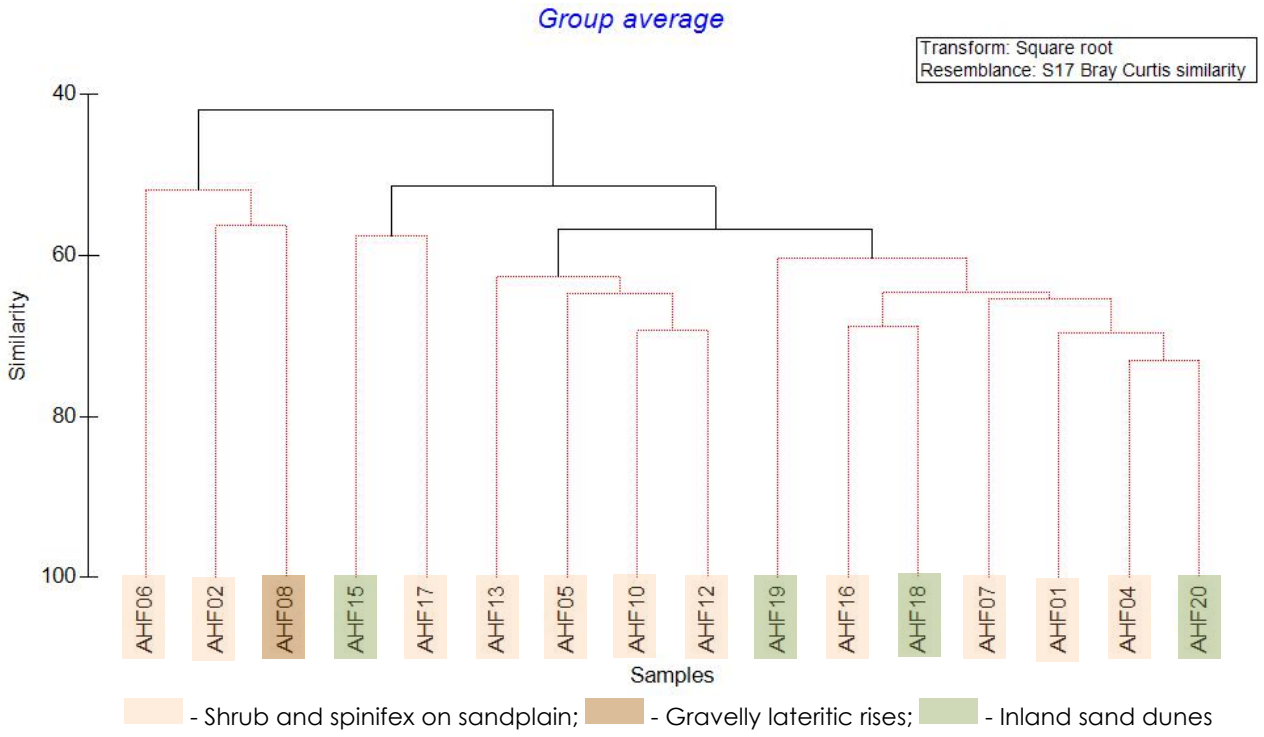


Figure 5.5: Dendrogram display of Bray-Curtis Similarity between systematic sites and the habitats that they sampled (ground fauna only).

6.0 Conservation Significant Vertebrate Fauna

Eleven vertebrate species of conservation significance were recorded in the study area during the survey, comprising:

- Northern Quoll (*Dasyurus hallucatus*) – Schedule 2; Endangered;
- Black-footed Rock-wallaby (*Petrogale lateralis lateralis*) – Schedule 2; Endangered;
- Bilby (*Macrotis lagotis*) – Schedule 3; Vulnerable;
- Flatback Turtle (*Natator depressus*) – Schedule 3; Vulnerable, Marine, Migratory;
- Oriental Pratincole (*Glareola maldivarum*) - Schedule 5; Migratory;
- Rainbow Bee-eater (*Merops ornatus*) - Marine
- Dampierland Plain Slider (*Lerista separanda*) – Priority 2;
- Spectacled Hare-wallaby *Lagorchestes conspicillatus* – Priority 3;
- Brush-tailed Mulgara (*Dasycercus blythi*) – Priority 4;
- Northern Marsupial Mole (*Notoryctes caurinus*) – Priority 4; and
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – Priority 4.

The location at which each conservation significant species was recorded during this study are shown in Figure 6.1, with a detailed account of each species following Sections 6.1 to 6.3. Two of the species above, the Black-footed Rock Wallaby and the Spectacled Hare-wallaby, were considered unlikely to occur on the basis of the desktop review (Section 5.2.2; Table 5.2); highlighting the value of the field survey effort invested in this previously unsurveyed study area.

Previous records and habitat availability reviewed during the desktop review (Section 5.2; Appendix 1), indicate a further five conservation significant species are Likely to occur, but no evidence of their presence was recorded during the survey. Section 6.4 provides an overview of the ecology and status of these latter species and an assessment of their likelihood of occurrence. The five species were:

- Fork-tailed Swift (*Apus pacificus*) - Schedule 5; Marine, Migratory;
- Little Curlew (*Numenius minutus*) - Schedule 5; Marine, Migratory;
- Oriental Plover (*Charadrius veredus*) - Schedule 5; Marine, Migratory;
- Peregrine Falcon (*Falco peregrinus*) - Schedule 7; and
- Short-tailed Mouse (*Leggadina lakedownensis*) - Priority 4.

Three of the conservation significant species that were assessed as Unlikely to occur in the study area (Section 5.2.2) and were not recorded during the survey but are difficult to detect, were given additional consideration in the interests of a precautionary assessment. Appendix 6 discusses these three species, which comprise:

- Night Parrot (*Pezoporus occidentalis*) - Schedule 1; Endangered;
- Great Desert Skink (*Liopholis kintorei*) - Schedule 3, Vulnerable; and
- Princess Parrot (*Polytelis alexandrae*) - Priority 4; Vulnerable.

No evidence that any of these latter species currently occur in the study area was recorded, as discussed in Appendix 6.

6.1 Mammals

6.1.1 Northern Quoll (*Dasyurus hallucatus)* - WC Act Schedule 2; EPBC Act Endangered

Two records of the Northern Quoll were confirmed during the survey, both of which came from rocky habitat in the central study area (Figure 6.1).

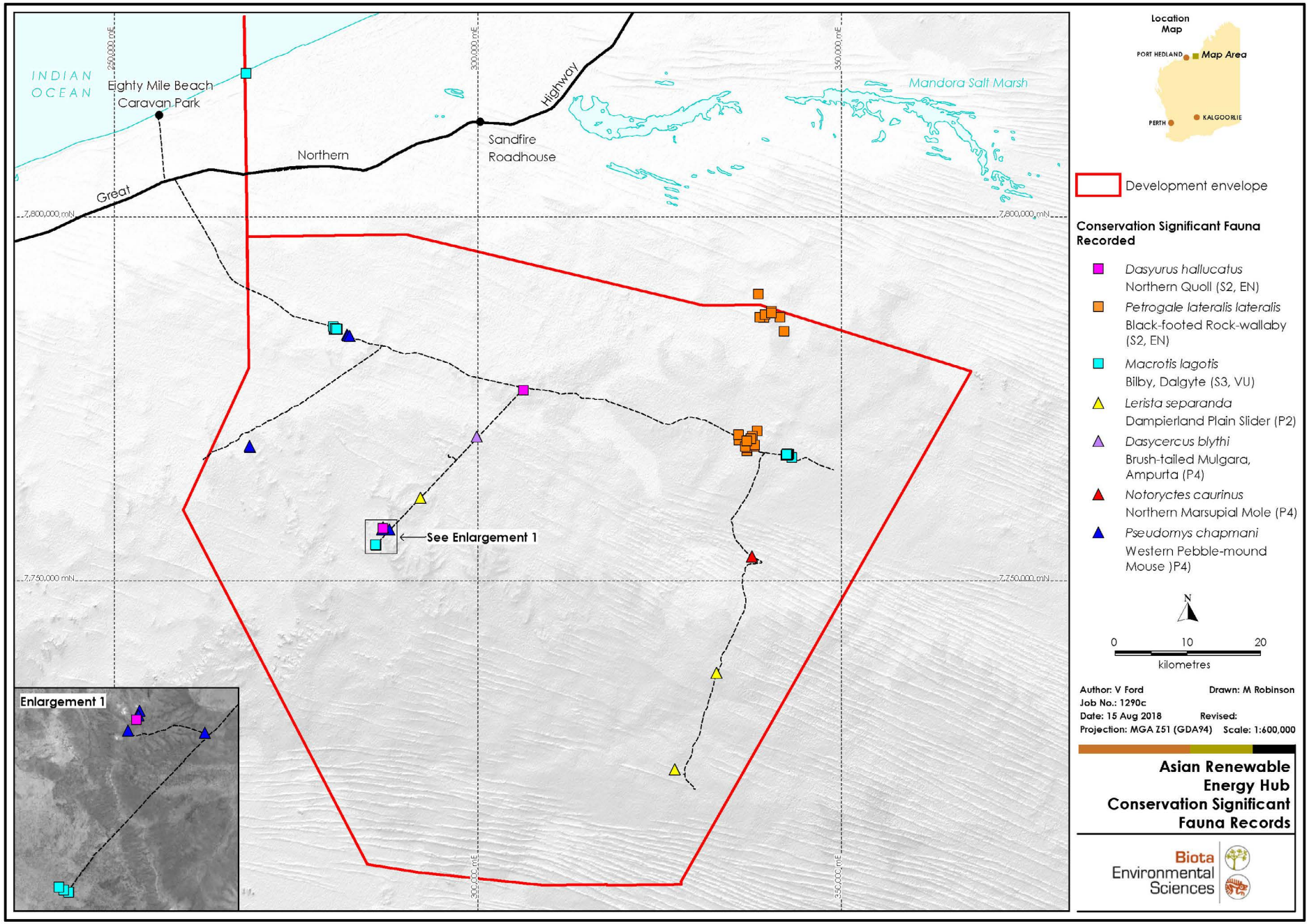


Figure 6.1: Records of conservation significant vertebrate fauna from this study.

The Northern Quoll is a medium-sized dasyurid marsupial, with adult weight ranging from 300 to 1,200 g. It is considered a partially arboreal and aggressive carnivore, preying on a varied diet of small invertebrates and vertebrates, including lizards, birds, snakes, small mammals and frogs (Oakwood 2008). It is also known to feed on fleshy fruit and carrion. The Northern Quoll is mostly nocturnal, although crepuscular (dusk and dawn) activity also occurs. The species makes a den in spaces amongst rocks or in log and tree hollows. Many records from the Pilbara bioregion have come from mesa and breakaway features abutting large creeks (Biota 2010) and from boulder tors of the Abydos-Woodstock Plain (How et al. 1991).

The Northern Quoll is a short-lived mammal, with both sexes maturing at 11 months. Females reproduce only once each year and all males die shortly after reproducing (Dickman and Braithwaite 1992, Oakwood 2000). The discrete male cohorts that arise within populations can make quolls more susceptible to local population extinctions. If no juvenile male quolls survive to adulthood, there will be no males available for mating the following year and the local population will rapidly go extinct (Braithwaite and Griffiths 1994, Oakwood 2000). Therefore, any factor that results in significant increases in mortality rates of female and juvenile quolls could result in the loss of local populations.

Two single scats of the species were found but no evidence of denning in the form of larger scat piles was recorded, no individuals were trapped and none were recorded on automated cameras. On the mainland of Western Australia, the species is generally described as occurring within the Pilbara and the north-west Kimberley, and as such the records of the species within the study area represents one of the most northerly occurring of the Pilbara records.

Given the extensive search of rocky habitat undertaken to target the Black-footed Rock-wallaby within the study area, the paucity of denning evidence of the Northern Quoll would seem to indicate that it is occurring at most on a transient. Areas utilised intensively by Northern Quolls are readily identified by the presence of latrines, at their dens, which remain in the landscape for many years even when the dens cease to be used.

6.1.2 Black-footed Rock-wallaby (*Petrogale lateralis lateralis)* - WC Act Schedule 2; EPBC Act Endangered

Multiple records of the Black-footed Rock-wallaby were recorded from rock pile habitat in the northeast of the study area (Figure 6.1). The species is known from a series of isolated, patchily distributed populations in Western Australia and the Northern Territory (Pearson 2013, Woinarski et al. 2014). The records of the species within the study area are significant not only due to the conservation significance of the species overall, but also because it appears to represent the only recent record of the species from the Great Sandy Desert, and was a previously unknown colony prior to the completion of this study (Section 5.2.2).

This nocturnal species requires shelter in the form of caves, cliffs and boulder screes during the day. Habitat critical to survival requires sufficient cave and crevice development to provide shelter from extremes of temperature and predators (Pearson 2013). Free water is usually not required unless the animals are occupying sub-optimal habitat that has inferior thermal refuges (Pearson 2013). The species is susceptible to predation by foxes and cats and habitat degradation by introduced herbivores.

Most effort targeting this species was directed at recording its presence via secondary signs to maximise the amount of prospective rocky habitat that could be searched. Rocky habitat in the form of breakaways and rock piles (Plate 6.1 and Plate 6.2) was searched, yielding numerous scat and track records (Plate 6.3 and Plate 6.4). In addition, two individuals were recorded in cage traps and on motion cameras (Figure 6.1), and individuals were also sighted on the rock piles just after dawn. Records were concentrated in two areas in the northeast of the study area (Figure 6.1), but it is possible that other similar rock pile habitat occurs in the study area, which may also be utilised by the species.

Plate 6.1: **Typical Black-footed Rock-wallaby habitat within the study area.**

Plate 6.2: **Typical Black-footed Rock-wallaby habitat within the study area.**

Plate 6.3: **Black-footed Rock-wallaby shelter and scat piles within the study area.**

Plate 6.4: **Black-footed Rock-wallaby tracks within the study area.**

6.1.3 Bilby (*Macrotis lagotis)* - WC Act Schedule 3; EPBC Act Vulnerable

Effort recording the species focused on finding burrows via walking linear transects in line with DBCA Guideline (2017). Evidence of Bilby presence, in the form of recent diggings, burrows (Plate 6.5) and tracks, was found in three general locations within the study area (Figure 6.1), and the species was also recorded via motion camera (Plate 6.6).

Plate 6.5: Bilby burrow in Shrub and spinifex on sandplain habitat.

Plate 6.6: Bilby record from automatic camera.

The Bilby is a medium sized ground mammal, ranging in weight from 1.0-2.5 kg. The species is apparently strictly nocturnal and constructs a substantial burrow system, which may be up to 3 m in length (Flannery et al. 1990). The former range of the Bilby included most of the semi-arid areas of mainland Australia, however it is now confined to *Triodia* hummock grassland and *Acacia* scrub across parts of northern Australia.

Similar to the Mulgara (*Dasycercus cristicauda*), the species has been documented as showing temporary home ranges and relatively rapid changes in distribution in response to variation in habitat resources (Johnson 1995). While fox and cat predation and the effect of rabbits and stock are thought to be the principal factors in the decline of this species, fire has also been suggested as an important factor in maintaining habitat diversity for this species (Johnson 1995).

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

Tracks of the Spectacled Hare-wallaby were recorded at a single location in the west of the study area during the survey (Figure 6.1).

There are scattered records of this species from the Kimberley and Pilbara regions of Western Australia. It has declined in numbers over most of its range, and has declined drastically and is rare in the Pilbara region (Ingleby 1991, van Dyck and Strahan 2008). While abundant on Barrow Island, it was eliminated from the Montebello group of islands (located just to the north of Barrow Island) prior to 1950, most likely as a result of predation by feral cats (Burbidge 1971). Mostly solitary, but sometimes feeding in groups of up to three (van Dyck and Strahan 2008), mainland individuals occupy home ranges of about 1.77 km^2 (McCosker 1997). The species prefer large spinifex (*Triodia*) clumps in which to shelter during the day.

The species can be hard to detect, and is most commonly recorded incidentally when flushed from its daytime hummock shelter. As a result, it is difficult to assess the distribution of the Spectacled Hare-wallaby within the study area, but areas supporting large spinifex hummocks, which are common in the study area and wider locality, represent suitable habitat.

6.1.5 Brush-tailed Mulgara (*Dasycercus blythi*) - DBCA Priority 4

The Brush-tailed Mulgara is currently listed as a Priority 4 species (DBCA 2017c). It was recognised as a separate species to the Crest-tailed Mulgara (*Dasycercus cristicauda*) based on a morphological study by Woolley (2005). Molecular analyses later confirmed that the two species were separate species living in partial sympatry (Pavey et al. 2011).

This species is known to inhabit spinifex grasslands on sand plains and sandy swale between low dunes from south-western Queensland across the Simpson, Tanami, and Great Sandy Deserts of southern and central Northern Territory and central Western Australia. It is also known to inhabit areas on gibber (rock and pebble covered flat plains), and is closely associated with gently sloping to flat topographic positions rather than steep-sided sandridges (Pavey et al. 2011).

A single burrow of what is inferred to be Brush-tailed Mulgara (i.e. not the Crest-tailed Mulgara *D. cristicauda*) based on habitat and most recent descriptions of distribution was recorded (Plate 6.7 and Plate 6.8).

Plate 6.7: Mulgara burrow within typical habitat.

Plate 6.8: Mulgara burrow.

6.1.6 Northern Marsupial Mole (*Notoryctes caurinus*) - DBCA Priority 4; EPBC Act Vulnerable

The fossorial (burrowing) species has prominent morphological adaptations to its almost entirely subterranean habit, including being blind, without ears and the modification of limbs to form paddle-like structures to aid 'swimming' through sand (Warburton 2006).

The species occurs in the Great Sandy, Little Sandy and the northern Gibson Deserts of Western Australia, and probably in the western Tanami Desert of Western Australia and western Northern Territory. Marsupial Moles inhabit sand dunes and, to a lesser extent, adjacent swales where there is suitable deep, loose sand. There is no robust estimate of population size (Department of the Environment and Energy 2018) likely due to their cryptic nature.

Recorded via "trenching" dunes within study area represent habitat.

6.1.7 Western Pebble-mound Mouse *(Pseudomys chapmani)* - DBCA Priority 4

The species was detected via five mounds at three locations during the survey, all of which were in Gravelly lateritic rise habitat (Figure 6.1).

Once described as endemic to the central and eastern parts of the Pilbara (Menkhorst and Knight 2011), this species is now much more widely known over the entire Pilbara region and into the Gascoyne (NatureMap records). This species is typically found on stony hillsides with hummock grasslands (Menkhorst and Knight 2011) and is common to very common in suitable habitat within the Hamersley and Chichester subregions of the Pilbara bioregion. The Western Pebble-mound Mouse is well known for its behaviour of constructing extensive mounds of small stones covering areas from 0.5 to 9.0 m^2 (van Dyck and Strahan 2008). This mound formation is most common on spurs and gentle slopes where suitably sized stones are present. Habitat destruction and altered fire regimes that remove old growth habitat constitute the main threatening processes for this species.

The occurrence of the species in the study area was notable as it falls north of where the species has typically been recorded, probably reflecting a lack of survey given the conspicuous nature of the mounds. Active mounds are discernible by factors such as the presence of maintained turrets and lack of debris in the turrets. Inactive mounds generally display a more flattened and consolidated appearance due to the lack of routine maintenance and pebble movement. These parameters are generally used when determining likely mound status. One mound recorded during the survey was classified as active (Plate 6.9) while the remainder were inactive.

Plate 6.9: Active Western Pebble-mound Mouse mound.

6.2 Birds

6.2.1 Oriental Pratincole (*Glareola maldivarum)* - WC Act Schedule 5; EPBC Act Migratory

Oriental Pratincole were recorded via three observations and an audio-recording of Pratincole within or near the study area in February and March 2018, two of which involved foraging flocks (Biota 2018a).

A medium-sized tern-like shorebird with short legs, very long pointed wings and short decurved bill (Geering et al. 2007). Gregarious, found in small to very large flocks on open plains, bare grounds and around the margins of wetalnds and on mudlats. Most often seen hunting in flight, capturing insects with aerobatic manoeuvres. (Geering et al. 2007).

6.2.2 Rainbow Bee-eater (*Merops ornatus)* - EPBC Act Marine

The Rainbow Bee-eater was recorded from 17 individuals at four locations (Section 5.3.3), but is likely to be widespread in the study area on a transitory basis.

This species occurs through the majority of the western third of Western Australia, usually where free water is readily available. Some individuals migrate northward during winter, either within Australia or as far as Indonesia (Johnstone and Storr 1998), however most birds residing in Western Australia do not migrate outside of the country. Rainbow Bee-eaters forage aerially for insects and nest in burrows in the ground (Johnstone and Storr 1998). The species occurs in a variety of habitats that are generally well watered, lightly wooded with suitable (sandy) soil for nesting and a tall stratum of vegetation for perching.

The Rainbow Bee-eater has a very large range, population size appears stable and under no substantiated threat (Department of the Environment 2015).

6.3 Reptiles

6.3.1 Flatback Turtle (*Natator depressus)* - WC Act Schedule 3; EPBC Act Vulnerable, Marine, Migratory

This species is the only sea turtle restricted to Australian waters between the Pilbara and east coast of Queensland (Wilson and Swan 2017) and one of only two sea turtles without a global distribution. In Western Australia, Eighty Mile Beach is a recognised nesting location (Hale and Butcher 2009).

A track belonging to the species was recorded on Eighty Mile Beach where the northernmost part of the study area intersects the beach. As a marine species, the occurrence of the Flatback Turtle is discussed in more detailed in the marine environmental impact assessment undertaken by BMT (2018).

6.3.2 Dampierland Plain Slider (*Lerista separanda)* - DBCA Priority 2

Records of this small burrowing skink were obtained from three locations within the study area (Figure 6.1). The species has four well-developed limbs (Plate 6.10) and a preference for sandy substrates (Wilson and Swan 2017), consistent with the records from the current study. The records of this species from this study represent a range extension on its previously known distribution, which was generally described as the southern Kimberley coast, between Kimbolton and Nita Downs. However the NatureMap database does include records of the species from Warrawagine Homestead (Doughty et al. 2011) located approximately 30 km south of the study area.

Plate 6.10: ***Lerista separanda*** **specimen from the survey vouchered with the WA Museum.**

6.4 Conservation Significant Fauna Likely to Occur but Not Recorded

6.4.1 Mammals

6.4.1.1 Short-tailed Mouse (*Leggadina lakedownensis)* – DBCA Priority 4

Prior to 1997, only two specimens of this species had been collected, however the number of records of this species has increased substantially since this time (Cooper et al. 2003). In Western Australia the distribution of *Leggadina lakedownesis* includes the Pilbara and Kimberley regions (Menkhorst and Knight 2011) although NatureMap records also place it within the Great Sandy Desert. Regional records suggest that the primary mainland habitat comprises areas of cracking clay and adjacent habitats. Consistent with this habitat description, Biota records include trapping the species on cracking clay communities from Cape Preston (60 km west of Dampier) in the west, to the northern flanks of the Fortescue Marshes in the east (Halpern Glick Maunsell et al. 2001). However, other sources provide a more diverse picture of habitat utilisation that includes areas of open tussock and hummock grassland, *Acacia* shrubland and savannah woodland, sandy soils as well as cracking clays (Morris et al. 2008).

The study area is mostly dominated by Triodia hummock grasslands, which are not preferred by the species, and while the species was not recorded during the survey, areas of more suitable mixed grasslands and shrublands do occur.

6.4.2 Birds

6.4.2.1 Peregrine Falcon (*Falco peregrinus*), WC Act Schedule 7

The Peregrine Falcon has an almost cosmopolitan distribution, but is absent from most deserts and the Nullarbor Plain (Johnstone and Storr 2004). The only subspecies in Australia (*macropus*) is widespread throughout Australia (Marchant and Higgins 1993) and is not considered as threatened by Garnett et al. (2011).

This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country (Pizzey and Knight 2007). Home ranges are probably defended year round and are variable in size, though not typically less than 480 ha (Marchant and Higgins 1993). The species typically nests on ledges in cliffs, granite outcrops and quarries, but also in hollow trees and in old nests constructed by other species such as Wedge-tailed Eagles and Ravens (Johnstone and Storr 2004). Breeding typically occurs between August and November (Johnstone and Storr 2004). Their diet consists almost exclusively of birds such as pigeons, parrots and passerines, which are captured in flight (Johnstone and Storr 2004). Mammals such as possums and rabbits have also been recorded as prey items (Marchant and Higgins 1993).

Some core habitat in the form of breakaways was available in the south of the study area, but species or nests were not recorded during the field survey.

6.4.2.2 Fork-tailed Swift (*Apus pacificus*), WC Act Schedule 5; EPBC Act Marine, Migratory

The Fork-tailed Swift is most often observed following thunderstorms and cyclonic weather patterns and the associated emergence of invertebrate fauna, which are a food source for this species (Johnstone et al. 2013). Fork-tailed Swifts are thought to be exclusively aerial in Australia as they breed in the northern hemisphere, migrating south to the Australasian region from October to April. The species is an irregular summer visitor to the Pilbara during November to early April (Johnstone et al. 2013). Fork-tailed Swifts do not rely on terrestrial habitats, but may overfly the study area episodically.

6.4.2.3 Oriental Plover *(Charadrius veredus)* and Little Curlew *(Numenius minutus)* - WC Act Schedule 5; EPBC Act Marine, Migratory

Migratory shorebirds have been the subject of a separate report focussed on Eighty Mile Beach and the Mandora Marsh (Biota 2018a) so the details of the large majority of migratory species restricted to marine habitats have not been reported here.

However, two species listed under the WC Act as Schedule 5 and EPBC Act as Migratory and Marine warrant special consideration because they are likely to utilise terrestrial habitats within the study area: Oriental Plover (*Charadrius veredus*) and Little Curlew (*Numenius minutus*), which forage in large numbers on and over the plains inland from Eighty Mile Beach and Broome (Sitters et al. 2004, Piersma and Hassell 2010). On this basis, both are considered likely to occur within the study area, even though they were not recorded during the current survey or the parallel Biota (2018a) targeted migratory bird survey.

7.0 Invertebrate Fauna

In total, 63 invertebrate fauna samples were collected from a combination of dry pitfall trapping and targeted searching of microhabitats likely to support SRE taxonomic groups.

The collected samples comprised 29 spiders from 10 sampling locations, 10 scorpions from four locations and 24 snails from four sampling locations. All specimens were sequenced by Helix to assign them to species level taxa and place them into regional context (Appendix 4).

7.1.1 Spiders

7.1.1.1 Mygalomorphae

All of the specimens collected belonged to the family Nemesiidae and genus *Aname*. By applying the 9.5% sequence divergence 'cut-off' that was tested by Castalanelli et al. (2014), the levels of sequence divergence recorded among the specimens indicates that they belong to four distinct nemesiid species. These species are all undescribed, and three of the species are likely to be newly recorded taxa. The fourth species, which one of which as was associated with a previously collected species from 245 km away, suggesting it belongs to a widespread species (Helix 2018) (Appendix 4).

The remaining three putative species showed no affinities to previously collected trapdoor spiders and should be conservatively treated as potential SREs (Biota 2018c).

7.1.1.2 Araneomorphae

Nine of the sequenced spider specimens were placed within the Araneomorphae sub-order of spiders (modern spiders) on the basis of the sequence data. As no groups within the Aranaemorphae are known to include SRE species, no further analysis was conducted on these specimens.

7.1.2 Scorpions

7.1.2.1 Buthidae

Nine of the ten specimens of buthid scorpions were successfully sequenced for the COI gene. Due to limitations on publicly available genetic sequences, Helix Molecular Solutions sought assistance from the WA Museum (Helix 2018). Collaboration with Dr. Joel Huey, a researcher at the WA Museum, enabled more accurate placement of the buthid scorpions (Appendix 4).

The specimens were included in a phylogenetic analysis with a more extensive collection of sequences, which placed them into a species clade with specimens identified as *Lychas annulatus* by Lorenzo Prendini (American Museum of Natural History). This species is also recognised as *Hemilychas alexandrinus,* which has a distribution extending across the Australia arid zone ,and the species is therefore not considered to be an SRE.

7.1.3 Snails

7.1.3.1 Camaenidae

All snails collected were identified as belonging to the family Camaenidae and the genus *Rhagada*; the most species-rich genus of land snails in Australia's semi-arid Pilbara region (Johnson et al. 2004, Hamilton 2015).

Twenty-four specimens of camaenid *Rhagada* land snails from the development envelope were sequenced and assessed for variation at the COI mtDNA gene (Helix 2018) (Appendix 4). The molecular data were then placed into an existing molecular taxonomic framework for *Rhagada*, using publicly available COI sequences, which indicated that all specimens collected from the development envelope represented the same recently described species: *Rhagada karajarri* (Helix 2018).

The records from the development envelope extend the distribution of the species by approximately 180 km, suggesting that it is not an SRE.

7.1.4 Potential SRE Taxa and Habitats

Three potential SRE taxa, all trapdoor spiders, were recorded from the study area, with the remaining fourth trapdoor spider taxon, and the scorpion and land snail species recorded, demonstrated to be more widespread and not SREs.

This latter result is generally consistent with the overall character of the landscape of the study area, which is strongly dominated by very extensive and contiguous sandplain and interconnected linear dune habitats. These landforms have few obvious geographic barriers to dispersal that might restrict gene flow and promote short range endemism (EPA 2016c).

While the three newly recorded trapdoor spiders have been conservatively treated here as potential SREs, it is possible that they are also more widely distributed. While all were recorded from only one or two specimens, which hampers a true assessment of distribution and potential short-range endemism: all three came from widely-connected sandplain habitats with no barriers to dispersal, within the very widespread Nita and Little Sandy land systems. The risk that these species are restricted to very small distributions is therefore likely to be low.

8.0 Conclusions

A total of 177 vertebrate fauna species were recorded from the study area during the seasonal survey. While the study area is situated on the boundary of the Pilbara and Kimberley, the faunal assemblage showed a strong association with the Pilbara bioregion and very few species with typical Kimberley distributions were recorded. The locality has been subject to little previous fauna survey effort and the records of a number of species represented northerly extensions to their previously known distributions.

Eleven vertebrate species of conservation significance were recorded in the study area during the survey, comprising:

- Bilby (*Macrotis lagotis*) – Schedule 3; Vulnerable;
- Black-footed Rock-wallaby (*Petrogale lateralis lateralis*) – Schedule 2; Endangered;
- Northern Quoll (*Dasyurus hallucatus*) – Schedule 2; Endangered;
- Flatback Turtle (*Natator depressus*) – Schedule 3; Vulnerable, Marine, Migratory;
- Oriental Pratincole (*Glareola maldivarum*) - Schedule 5; Migratory;
- Rainbow Bee-eater (*Merops ornatus*) - Marine
- Dampierland Plain Slider (*Lerista separanda*) – Priority 2;
- Spectacled Hare-wallaby *Lagorchestes conspicillatus* – Priority 3;
- Brush-tailed Mulgara (*Dasycercus blythi*) – Priority 4;
- Northern Marsupial Mole (*Notoryctes caurinus*) – Priority 4; and
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – Priority 4.

Most of the above species were expected for the study area, but the discovery of a previously unknown colony of the Black-footed Rock-wallaby was a significant outcome from the field survey.

Six major fauna habitats were identified within the study area. The mapping of fauna habitats was conducted using aerial photography and existing thematic layers such as land systems but was also extensively ground-truthed by zoologists and during the Biota (2018b) flora and vegetation survey, where a helicopter was utilised to ensure all landforms and habitats of the study area were identified and that the systematic sampling sites adequately represented the range of habitats present in the overall study area. As a result we are confident that the habitat mapping is a true reflection of the range of habitats present and they results of the systematic sampling sites reported here are representative of the faunal assemblage of the study area.

Several measures of adequacy indicate a thorough survey has been conducted:

- The current study recorded more reptile species than any individual study or database search reviewed, more mammals than all but one source reviewed, and as many amphibians. The number of terrestrial birds recorded was less than some sources (the ALA database and the WAM survey of the GSD) but these sources include much higher effort and a greater diversity of habitats preferable to birds.
- Species accumulation and nonparametric estimators for ground fauna suggest that 92% of the assemblage was recorded.
- The desktop review indicated that up to 14 conservation significant species were Likely to occur within the study area, and 11 species of conservation significance were recorded during the survey.

Of the six fauna habitats occurring within the study area, one warrants further consideration based on the criteria defined in Section 4.2: Rocky outcropping. The areas of more significant rock outcropping in the study area were found to support two species listed as Endangered at both the state and Commonwealth level; the Black-footed Rock-wallaby (Schedule 2; Endangered) and based on the finding of two scats, occasionally also by the Northern Quoll (Schedule 2; Endangered).

Geographically, this habitat type occurs as isolated patches in the landscape, and the conservation significant species utilising it are strongly associated with it, making it a habitat type that warrants specific consideration during environmental impact assessment.

9.0 Glossary

ARU	Automated Recording Unit
Biota	Biota Environmental Sciences
Conservation significant	A species listed under the EPBC Act, WC Act or as a DBCA priority
DBCA	Department of Parks and Wildlife, Western Australia (formerly the Department of Environment and Conservation)
Elliott trap	A collapsible aluminium box trap
EPA	Environmental Protection Authority, Western Australia.
EPBC Act	Federal *Environment Protection and Biodiversity Conservation Act 1999*
Fauna habitat	A collection of similar landforms likely to a discrete assemblage.
IBRA	Interim Biogeographic Regionalisation for Australia
Land System	A system of land classification. This system divides the region into broad units, each consisting of a series of "land units" that occur on characteristic physiographic types within the land system.
Opportunistic record	Recorded by non-systematic sampling methods
Study area	The area in which the fauna study was conducted, corresponding to the project development envelope
Systematic sampling	Sampling using trapping (including pitfall traps, Elliott traps and/or funnel traps) installed in a defined habitat.
WC Act	Western Australian *Wildlife Conservation Act 1950*

This page intentionally blank.

10.0 References

Australasian Bat Society (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australian Bat Society Newsletter* 27:6–9.

Bamford Consulting Ecologists (2016). Assessment of the Bilby *Macrotis lagotis* on Wallal Downs Station; Homestead and Chirup project areas. Report for Granleigh Pty Ltd, Bamford Consulting Ecologists.

Beard, J. S. (1968). Vegetation Survey of Western Australia 1:1,000,000 Vegetation Series. Map Sheet 2 - Great Sandy Desert. University of Western Australia Press, Western Australia.

Beard, J. S. (1975). Vegetation Survey of Western Australia 1:1,000,000 Vegetation Series. Map Sheet 5 - Pilbara. University of Western Australia Press, Western Australia.

Beard, J. S. (1979). *Vegetation Survey of Western Australia : Kimberley. 1:1,000,000 Vegetation Series : Explanatory Notes to Sheet 1*. University of Western Australia.

Biota (2010). Yandicoogina Expansion Northern Quoll Position Paper. Unpublished report prepared for Rio Tinto Iron Ore, April 2010, Biota Environmental Sciences, Western Australia.

Biota (2018a). Asian Renewable Energy Hub Specialist Fauna Studies: Waterbirds and Migratory Shorebirds. Unpublished report being prepared for InterContinental Energy, Biota Environmental Sciences, Western Australia.

Biota (2018b). Asian Renewable Energy Hub Vegetation and Flora Survey. Unpublished report being prepared for InterContinental Energy, Biota Environmental Sciences, Western Australia.

Biota (2018c). Asian Renewable Energy Hub Fauna Survey. Unpublished report being prepared for InterContinental Energy, Biota Environmental Sciences, Western Australia.

BMT (2018). Asian Renewable Energy Hub: Marine State Waters Environmental Impact Assessment. Western Australia.

Braithwaite, R. W., and A. D. Griffiths (1994). Demographic variation and range contraction in the northern quoll, *Dasyurus hallucatus* (Marsupialia: Dasyuridae). *Wildlife Research* 21(2):203–217.

Burbidge, A. A., and N. L. McKenzie (1983). Wildlife of the Great Sandy Desert, Western Australia. Page 127. Wildlife Research Bulletin No. 12, Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife.

Cartledge, V. A., P. C. Withers, K. A. McMaster, G. G. Thompson, and S. D. Bradshaw (2006). Water balance of field-excavated aestivating Australian desert frogs, the cocoon forming *Neobatrachus aquilonius* and the non-cocooning *Notaden nichollsi* (Amphibia: Myobatrachidae). *The Journal of Experimental Biology* 209:3309–3321.

Castalanelli, M. A., R. Teale, M. G. Rix, J. Kennington, and M. S. Harvey (2014). Barcoding of mygalomorph spiders (Araneae: Mygalomorphae) in the Pilbara bioregion of Western Australia reveals highly diverse fauna. *Invertebrate Systematics* 28:375–385.

Christidis, L., and W. E. Boles (2008). *Systematics and Taxonomy of Australian Birds*. CSIRO Publishing, Melbourne.

Churchill, S. K. (2008). *Australian Bats*, 2nd edition. Allen and Unwin, Australia.

Clarke, K., and R. Gorley (2006). *Primer v6 : User Manual/Tutorial.* PRIMER-E Ltd, Plymouth, UK.

Colwell, R. K. (2009). EstimateS: Statistical Estimation of Species Richness and Shared Species from Samples. Version 8.2.0. Users guide User's Guide and application published at: http://purl.oclc.org/estimates, . Retrieved from http://purl.oclc.org/estimates.

Cooper, N. K., M. Adams, C. Anthony, and L. H. Schmitt (2003). Morphological and genetic variation in *Leggadina* (Thomas, 1910) with special reference to Western Australian populations. *Records of the Western Australian Museum* 21:333–351.

Dames & Moore (1992). Goldsworthy extension project Phase 2: Consultative Environmental Review. Report for BHP Billiton Iron Ore, Dames & Moore Pty Ltd.

DBCA (2017a). Interim guideline for preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia. Department of Biodiversity, Conservation and Attractions.

DBCA (2017b). Guidelines for Surveys to Detect the Presence of Bilbies, and Assess the Importance of Habitat in Western Australia. Department of Biodiversity, Conservation and Attractions.

DBCA (2017c). Threatened and Priority Fauna List, 6 January 2017. Department of Parks and Wildlife.

Department of the Environment (2015). *Merops ornatus* — Rainbow Bee-eater SPRAT Profile [WWW Document]. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=670.

Department of the Environment (2017). *Environment Protection and Biodiversity Conservation Act 1999* Protected Matters Search Tool [WWW Document]. Retrieved from http://www.environment.gov.au/epbc/pmst/index.html.

Department of the Environment and Energy (2018). *Notorcytes caurinus* — Kakarratul, Karrkaratul, Northern Marsupial Mole SPRAT Profile [WWW Document]. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=295.

Dickman, C. R., and R. W. Braithwaite (1992). Postmating mortality of males in the Dasyurid Marsupials, *Dasyurus* and *Parantechinus*. *Journal of Mammalogy* 73:143–147.

Doughty, P., L. Kealley, and J. Melville (2012a). Taxonomic assessment of *Diporiphora* (Reptilia: Agamidae) dragon lizards from the western arid zone of Australia. *Zootaxa* 3518:1–24.

Doughty, P., R. Palmer, M. Sistrom, A. M. Bauer, and S. Donnellan (2012b). Two new species of Gehyra (Squamata: Gekkonidae) geckos from the north-west Kimberley region of Western Australia. *Records of the Western Australian Museum* 27:117–134.

Doughty, P., J. K. Rolfe, A. H. Burbidge, D. J. Pearson, and P. G. Kendrick (2011). Herpetological assemblages of the Pilbara biogeographic region Western Australia: ecological associations, biogeographic patterns and conservation. *Records of the Western Australian Museum* 78:315–341.

Ecologia (2005). Goldsworthy Extension Project - Biological Assessment Survey. Report for BHP Billiton Iron Ore Pty Ltd, .

Environment Australia (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and development of Version 6.1, Summary Report. Environment Australia, Canberra.

EPA (2016a). *Environmental Factor Guideline: Terrestrial Fauna*. Environmental Protection Authority, Western Australia.

EPA (2016b). *Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna*. Environmental Protection Authority, Western Australia.

EPA (2016c). *Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna*. Environmental Protection Authority, Western Australia.

EPA (2016d). *Technical Guidance: Terrestrial Fauna Surveys*. Environmental Protection Authority, Western Australia.

Flannery, T., P. Kendall, and K. Wynn-Moylan (1990). *Australia's Vanishing Mammals Endangered and Extinct Native Species*. RD Press.

Geering, A., L. Agnew, and S. Harding (2007). *Shorebirds of Australia*. CSIRO Publishing, Melbourne.

Government of Western Australia (2018). *2017 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of December 2017*. Department of Biodiversity, Conservation and Attractions, Government of Western Australia, Perth, Western Australia.

Graham, G. (2003a). Dampierland 2 (DL2 - Pindanland subregion). Pages 179–187 *in* J. E. May and N. L. McKenzie, editors. *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions*. Department of Conservation and Land Management, Western Australia.

Graham, G. (2003b). Great Sandy Desert 1 (GSD1 - McLarty subregion). Pages 326–331 *in* J. E. May and N. L. McKenzie, editors. *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions*. Department of Conservation and Land Management, Western Australia.

Hale, J., and R. Butcher (2009). Ecological Character Description of the Eighty-mile Beach Ramsar Site. ECD, Department of Environment and Conservation, Perth, WA.

Halpern Glick Maunsell, Biota, and M.E. Trudgen & Associates (2001). Austeel Biological Survey, Phase I. Unpublished report ES974691A100 prepared for Austeel Pty Ltd, February 2001, Halpern Glick Maunsell with Biota Environmental Sciences and M.E. Trudgen & Associates, Western Australia.

Hamilton, Z. R. (2015). DNA barcoding reveals a contact zone in cryptic lineages of *Rhagada* land snails (Pulmonata: Camaenidae) in an ancient landscape. *in prep*.

Harvey, M. S. (2002). Short-Range Endemism Among the Australian Fauna: Some Examples from Non-Marine Environments. *Invertebrate Systematics* 16:555–570.

Helix (2018). Report on the molecular systematics of the targeted SRE invertebrates from the Asian RE Hub Fauna survey. Unpublished letter report prepared for Biota Environmental Sciences, 9 August 2018, Helix Molecular Solutions.

How, R. A., J. Dell, and N. K. Cooper (1991). Vertebrate fauna of the Abydos-Woodstock Reserve, northeast Pilbara. *Records of the Western Australian Museum* Supplement 37:78–125.

Ingleby, S. (1991). Distribution and status of the spectacled hare-wallaby, *Lagorchestes conspicillatus*. *Wildlife Research* 18:501–519.

Johnson (1995). The Bilby *Macrotis lagotis*. Page *in* R. Strahan, editor. *The Mammals of Australia*. Australian Museum/Reed Books.

Johnson, M. S., Z. R. Hamilton, C. E. Murphy, C. A. MacLeay, B. Roberts, and P. G. Kendrick (2004). Evolutionary genetics of island and mainland species of *Rhagada* (Gastropoda: Pulmonata) in the Pilbara Region, Western Australia. *Australian Journal of Zoology* 52:341–355.

Johnstone, R. E., A. H. Burbidge, and J. C. Darnell (2013). Birds of the Pilbara region, including seas and offshore islands, Western Australia: distribution, status and historical changes. *Records of the Western Australian Museum* Supplement 78:343–441.

Johnstone, R. E., and G. M. Storr (1998). *Handbook of Western Australian Birds Volume I - Non-Passerines (Emu to Dollarbird)*. Western Australian Museum, Perth.

Johnstone, R. E., and G. M. Storr (2004). *Handbook of Western Australian Birds*.

Kendrick, P. (2003). Great Sandy Desert 2 (GSD2 - Mackay subregion). Pages 332–342 *in* J. E. May and N. L. McKenzie, editors. *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions*. Department of Conservation and Land Management, Western Australia.

Marchant, S., and P. J. Higgins (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings*. Oxford University Press, Melbourne.

McCosker, J. C. (1997). The ecology and conservation of spectacled hare-wallabies *Lagorchestes conspicillatus* in central Queensland. Unpublished MSc Thesis, University of Queensland, Brisbane.

McKenzie, N. L., and R. Bullen (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum* Supplement 78:123–155.

Menkhorst, P., and F. Knight (2011). *A Field Guide to the Mammals of Australia*, 3rd edition. Oxford University Press, Australia.

Morris, K., J. Woinarski, and K. Aplin (2008). *Leggadina lakedownensis* [WWW Document]. Retrieved June 13, 2012, from http://www.iucnredlist.org/apps/redlist/details/11384/0.

Oakwood, M. (2000). Reproduction and demography of the northern quoll, *Dasyurus hallucatus*, in the lowland savanna of northern Australia. *Australian Journal of Zoology* 48:519–539.

Oakwood, M. (2008). Northern Quoll. Pages *57–59 in* S. van Dyck and R. Strahan, editors. *The Mammals of Australia*, 3rd edition. Reed New Holland, Chatswood Australia.

Pavey, C. R., C. E. M. Nano, J. B. Cooper, J. R. Cole, and P. J. McDonald (2011). Habitat use, population dynamics and species identification of mulgara, *Dasycercus blythi* and *D. cristicauda*, in a zone of sympatry in central Australia. *Australian Journal of Zoology* 59:156–169.

Payne, A. L., and S. Schoknecht (2011). *Technical Bulletin No. 98: Land Systems of the Kimberley Region, Western Australia.* Department of Agriculture and Food, Western Australia.

Pearson, D. (2013). Recovery plan for five species of rock wallabies: Black-footed rock wallaby (*Petrogale lateralis*), Short-eared rock wallaby (*Petrogale brachyotis*), Monjon (*Petrogale burbidgei*), Nabarlek (*Petrogale concinna*), Rothschild rock wallaby (*Petrogale rothschildi*). Department of Parks and Wildlife.

Pizzey, G., and F. Knight (2007). *The Field Guide to the Birds of Australia*. Page (P. Menkhorst, Ed.), 8th edition. Harper Collins Publishers, Sydney.

Shepherd, D. P., G. R. Beeston, and A. J. M. Hopkins (2002). Native vegetation in Western Australia: Extent, Type and Status. Technical Report 249, Department of Agriculture and Food, Western Australia, Perth.

Start, A. N., P. Kendrick, and N. L. McKenzie (2008). Biota of the Mandora System, Western Australia: - Mammals. *Journal of the Royal Society of Western Australia* 91:209–217.

State of Western Australia (2017). Wildlife Conservation (Specially Protected Fauna) Notice 2016. *Western Australian Government Gazette*:76–89.

van Dyck, S., and R. Strahan (Eds.) (2008). *The Mammals of Australia*, 3rd edition. Reed New Holland, Sydney.

van Vreeswyk, A. M. E., A. L. Payne, K. A. Leighton, and P. Hennig (2004). *Technical Bulletin No. 92: An inventory and condition survey of the Pilbara region, Western Australia*. Department of Agriculture, South Perth WA.

Warburton, N. (2006). Functional morphology of marsupial moles (Marsupialia: Notoryctidae). *Verh. naturwissenschaftlicher Verlag Hamburg* NF (42):39–142.

Wildlife Acoustics (2010). *Song Meter User Manual, Model SM2, with Song Meter SM2BAT 192kHz Stereo or 384kHz Mono Ultrasonic Recorders addendum.*

Wilson, S., and G. Swan (2017). *A Complete Guide to Reptiles of Australia*, 5th edition. New Holland.

Woinarski, J. C. Z., A. A. Burbidge, and P. L. Harrison (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing, Victoria.

Woolley, P. A. (2005). The species of *Dasycercus* Peters 1875 (Marsupialia: Dasyuridae). *Memoirs of Museum Victoria* 62:213–221.

Appendix 1

Desktop Review Results

A1: Mammals

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	Mandora Mammals	This survey
Tachyglossus aculeatus	Short-beaked Echidna						•	•		
Dasycercus blythi	Brush-tailed Mulgara	P4								•
Dasycercus cristicauda	Crest-tailed Mulgara	P4; VU					•	•		
Dasykaluta rosamondae	Little Red Kaluta			•	•	•	•	•		•
Dasyurus hallucatus	Northern Quoll	S2; EN	•				•	•		•
Ningaui ridei	Wongai Ningaui					•				
Ningaui timealeyi	Pilbara Ningaui			•	•		•	•		•
Planigale ingrami	Long-tailed Planigale					•	•			•
Planigale maculata	Common Planigale						•		•	
Pseudantechinus macdonnellensis	Fat-tailed Pseudantechinus					•	•			
Pseudantechinus roryi	Rory's Pseudantechinus			•	•					•
Sminthopsis longicaudata	Long-tailed Dunnart	P4					•			
Sminthopsis macroura	Stripe-faced Dunnart					•	•	•	•	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart			•	•	•		•	•	•
Macrotis lagotis	Bilby	S3; VU	•	•		•	•		•	•
Notoryctes caurinus	Northern Marsupial Mole	P4				•				•
Notamacropus agilis	Agile Wallaby								•	•
Osphranter robustus	Euro				•		•	•	•	
Osphranter rufus	Red Kangaroo, Marlu					•	•	•	•	•
Petrogale lateralis lateralis	Black-footed Rock-wallaby	S2; VU								•
Petrogale rothschildi	Rothschild's Rock-wallaby						•	•		
Leggadina lakedownensis	Short-tailed Mouse	P4						•		
Mus musculus	House Mouse		•	•	•	•	•	•	•	
Notomys alexis	Spinifex Hopping-mouse					•	•		•	•
Pseudomys chapmani	Western Pebble-mound Mouse	P4		•			•	•		•
Pseudomys delicatulus	Delicate Mouse					•	•	•		
Pseudomys desertor	Desert Mouse			•	•			•	•	•
Pseudomys hermannsburgensis	Sandy Inland Mouse			•	•	•	•	•	•	•
Pseudomys nanus	Western Chestnut Mouse					•			•	
Rattus rattus	Black Rat		•							
Zyzomys argurus	Common Rock-rat						•	•		
Oryctolaug cuniculus	European Rabbit					•				
Pteropus scapulatus	Little Red Flying-fox					•				
Rhinonicteris aurantia (Pilbara Form)	Pilbara Leaf-nosed Bat	S3; VU	•				•	•		
Macroderma gigas	Ghost Bat	S3; VU	•		•		•			
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat					•	•	•	•	•
Taphozous georgianus	Common Sheath-tailed Bat			•	•		•	•		•

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	Mandora Mammals	This survey
Taphozous hilli	Hill's Sheath-tailed Bat					•	•	•		
Austronomus australis	White-striped Free-tailed Bat					•				•
Chaerephon jobensis	Greater Northern Free-tailed Bat					•	•	•	•	•
Ozimops lumsdenae	Northern Free-tailed Bat					•				•
Chalinolobus gouldii	Gould's Wattled Bat					•	•	•		•
Nyctophilus geoffroyi	Lesser Long-eared Bat					•	•	•	•	•
Scotorepens balstoni	Inland Broad-nosed Bat					•				
Scotorepens greyii	Little Broad-nosed Bat						•	•		•
Vespadelus baverstocki	Inland Forest-bat							•		
Vespadelus finlaysoni	Finlayson's Cave Bat			•	•		•	•		•
Canis dingo	Dingo					•	•	•	•	•
Canis lupus	Dog		•							•
Vulpes vulpes	Red Fox		•				•		•	•
Felis catus	Cat		•			•	•	•	•	•
Equus asinus	Donkey		•				•		•	
Equus caballus	Horse		•				•			
Sus scrofa	Pig		•							
Camelus dromedarius	Camel		•			•	•		•	•
Bos taurus	European Cattle							•	•	
Capra hircus	Goat						•			
TOTAL				**11**	**11**	**27**	**37**	**30**	**21**	**30**

A2. Birds

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Dromaius novaehollandiae	Emu					•			•
Coturnix ypsilophora	Brown Quail			•	•	•		•	•
Pavo cristatus	Indian Peafowl				•				
Dendrocygna eytoni	Plumed Whistling-Duck			•	•				
Stictonetta naevosa	Freckled Duck				•				
Cygnus atratus	Black Swan				•	•			
Tadorna tadornoides	Australian Shelduck				•	•			
Chenonetta jubata	Australian Wood Duck				•	•			
Malacorhynchus membranaceus	Pink-eared Duck			•	•	•			
Anas gracilis	Grey Teal			•	•	•	•	•	
Anas superciliosa	Pacific Black Duck		•		•			•	

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Aythya australis	Hardhead			•	•	•		•	
Tachybaptus novaehollandiae	Australasian Grebe				•	•	•		
Poliocephalus poliocephalus	Hoary-headed Grebe					•			
Phaps chalcoptera	Common Bronzewing					•		•	•
Ocyphaps lophotes	Crested Pigeon			•	•	•		•	•
Geophaps plumifera	Spinifex Pigeon			•	•	•	•	•	
Geopelia cuneata	Diamond Dove			•	•	•		•	•
Geopelia striata	Peaceful Dove			•	•	•		•	
Geopelia humeralis	Bar-shouldered Dove				•				
Podargus strigoides	Tawny Frogmouth								•
Eurostopodus argus	Spotted Nightjar			•	•	•	•	•	•
Aegotheles cristatus	Australian Owlet-nightjar			•	•	•		•	
Apus pacificus	Fork-tailed Swift	S5; Ma, Ml	•		•				
Anhinga novaehollandiae	Australasian Darter			•		•			
Microcarbo melanoleucos	Little Pied Cormorant							•	
Phalacrocorax sulcirostris	Little Black Cormorant							•	
Pelecanus conspicillatus	Australian Pelican			•		•		•	•
Ephippiorhynchus asiaticus	Black-necked Stork				•			•	
Ardea pacifica	White-necked Heron			•	•	•	•	•	•
Ardea modesta	Eastern Great Egret		•		•	•		•	
Ardea intermedia	Intermediate Egret				•				
Ardea ibis	Cattle Egret		•						
Egretta novaehollandiae	White-faced Heron				•	•		•	
Egretta garzetta	Little Egret				•				
Nycticorax caledonicus	Nankeen Night-Heron			•	•	•			•
Plegadis falcinellus	Glossy Ibis	S5; Ma, Ml			•			•	
Threskiornis molucca	Australian White Ibis				•				
Threskiornis spinicollis	Straw-necked Ibis			•	•	•		•	
Platalea regia	Royal Spoonbill		•	•				•	
Platalea flavipes	Yellow-billed Spoonbill		•	•				•	
Pandion cristatus	Eastern Osprey	S5; Ma						•	
Elanus axillaris	Black-shouldered Kite				•	•		•	•
Hamirostra melanosternon	Black-breasted Buzzard			•	•	•			•
Haliaeetus leucogaster	White-bellied Sea-Eagle		•						
Haliastur sphenurus	Whistling Kite			•	•	•	•	•	•
Milvus migrans	Black Kite			•	•	•			
Accipiter fasciatus	Brown Goshawk				•	•		•	•
Accipiter cirrocephalus	Collared Sparrowhawk					•			•

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Circus assimilis	Spotted Harrier			•	•	•		•	•
Circus approximans	Swamp Harrier				•	•			
Aquila audax	Wedge-tailed Eagle			•	•	•	•	•	•
Hieraaetus morphnoides	Little Eagle			•	•	•		•	•
Falco cenchroides	Nankeen Kestrel			•	•	•		•	•
Falco berigora	Brown Falcon			•	•	•	•	•	•
Falco longipennis	Australian Hobby			•	•	•		•	•
Falco subniger	Black Falcon					•			
Falco peregrinus	Peregrine Falcon	S7		•	•	•			
Grus rubicunda	Brolga				•	•			
Porphyrio porphyrio	Purple Swamphen				•				
Gallirallus philippensis	Buff-banded Rail				•			•	
Porzana pusilla	Baillon's Crake				•				
Porzana fluminea	Australian Spotted Crake							•	
Tribonyx ventralis	Black-tailed Native-hen					•			
Fulica atra	Eurasian Coot				•	•			
Ardeotis australis	Australian Bustard			•	•	•		•	•
Burhinus grallarius	Bush Stone-curlew							•	
Himantopus himantopus	Black-winged Stilt			•		•			
Recurvirostra novaehollandiae	Red-necked Avocet					•			
Charadrius ruficapillus	Red-capped Plover			•		•		•	
Charadrius veredus	Oriental Plover	S5; Ma, MI	•						
Charadrius australis	Inland Dotterel					•			
Elseyornis melanops	Black-fronted Dotterel					•		•	•
Erythrogonys cinctus	Red-kneed Dotterel					•		•	
Vanellus miles	Masked Lapwing								•
Rostratula australis	Australian Painted Snipe	S2; EN	•						
Numenius madagascariensis	Eastern Curlew	S3&S5; CR, Ma, MI	•						
Actitis hypoleucos	Common Sandpiper	S5; Ma, MI	•			•		•	
Tringa nebularia	Common Greenshank	S5; Ma, MI	•		•	•		•	
Tringa stagnatilis	Marsh Sandpiper	S5; Ma, MI						•	
Tringa glareola	Wood Sandpiper	S5; Ma, MI					•	•	
Calidris canutus	Red Knot	EN, Ma, MI	•						
Calidris ruficollis	Red-necked Stint	S5; Ma, MI		•		•			
Calidris fuscicollis	White-rumped Sandpiper			•					
Calidris melanotos	Pectoral Sandpiper	S5; Ma, MI	•						
Calidris acuminata	Sharp-tailed Sandpiper	S5; MI	•						
Calidris ferruginea	Curlew Sandpiper	S3&S5; CR&MI	•						

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Turnix velox	Little Button-quail			•	•	•		•	•
Glareola maldivarum	Oriental Pratincole	S5; MI	•		•				•
Stiltia isabella	Australian Pratincole				•	•			
Gelochelidon nilotica	Gull-billed Tern	S5; MI				•			
Hydroprogne caspia	Caspian Tern	S5; MI				•			
Chlidonias hybrida	Whiskered Tern				•	•			
Chlidonias leucopterus	White-winged Black Tern	S5; MI			•				
Chroicocephalus novaehollandiae	Silver Gull					•			
Calyptorhynchus banksii	Red-tailed Black-Cockatoo				•				•
Lophochroa leadbeateri	Major Mitchell's Cockatoo					•			
Eolophus roseicapillus	Galah			•	•	•	•	•	•
Cacatua sanguinea	Little Corella			•	•	•	•	•	
Nymphicus hollandicus	Cockatiel			•	•	•			•
Polytelis alexandrae	Princess Parrot	P4; VU	•			•			
Barnardius zonarius	Australian Ringneck			•	•			•	
Melopsittacus undulatus	Budgerigar			•	•	•			•
Pezoporus occidentalis	Night Parrot	S1; EN	•						
Centropus phasianinus	Pheasant Coucal				•			•	•
Chalcites basalis	Horsfield's Bronze-Cuckoo				•	•		•	•
Chalcites osculans	Black-eared Cuckoo								•
Cacomantis pallidus	Pallid Cuckoo			•	•	•	•		•
Cuculus optatus	Oriental Cuckoo	S5; MI	•						
Ninox novaeseelandiae	Southern Boobook				•	•		•	
Tyto javanica	Eastern Barn Owl								•
Dacelo leachii	Blue-winged Kookaburra					•	•	•	
Todiramphus pyrrhopygius	Red-backed Kingfisher			•	•	•		•	•
Todiramphus sanctus	Sacred Kingfisher				•	•		•	
Merops ornatus	Rainbow Bee-eater	MA	•	•	•	•	•	•	•
Ptilonorhynchus maculatus	Spotted Bowerbird			•	•				
Ptilonorhynchus guttatus	Western Bowerbird							•	
Malurus leucopterus	White-winged Fairy-wren			•	•	•		•	•
Malurus lamberti	Variegated Fairy-wren			•	•	•		•	•
Stipiturus ruficeps	Rufous-crowned Emu-wren					•			
Amytornis striatus	Striated Grasswren						•	•	•
Calamanthus fuliginosus	Striated Fieldwren					•			

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Pyrrholaemus brunneus	Redthroat				•				
Smicrornis brevirostris	Weebill					•			
Gerygone fusca	Western Gerygone			•	•	•			
Acanthiza apicalis	Inland Thornbill					•			
Aphelocephala nigricincta	Banded Whiteface				•	•			
Pardalotus rubricatus	Red-browed Pardalote					•	•	•	
Pardalotus striatus	Striated Pardalote					•		•	
Certhionyx variegatus	Pied Honeyeater			•	•	•			•
Lichenostomus virescens	Singing Honeyeater				•	•	•	•	•
Lichenostomus unicolor	White-gaped Honeyeater				•				
Lichenostomus keartlandi	Grey-headed Honeyeater				•	•	•	•	•
Lichenostomus ornatus	Yellow-plumed Honeyeater							•	
Lichenostomus plumulus	Grey-fronted Honeyeater							•	
Lichenostomus penicillatus	White-plumed Honeyeater				•	•	•	•	
Purnella albifrons	White-fronted Honeyeater			•	•	•			
Manorina flavigula	Yellow-throated Miner			•	•	•	•	•	•
Acanthagenys rufogularis	Spiny-cheeked Honeyeater			•	•	•			•
Epthianura tricolor	Crimson Chat			•	•	•			•
Epthianura aurifrons	Orange Chat				•	•			
Sugomel niger	Black Honeyeater				•	•			•
Lichmera indistincta	Brown Honeyeater			•	•	•	•	•	•
Melithreptus gularis	Black-chinned Honeyeater			•	•	•		•	
Pomatostomus temporalis	Grey-crowned Babbler					•		•	
Pomatostomus superciliosus	White-browed Babbler					•			
Psophodes occidentalis	Chiming Wedgebill			•	•	•			•
Coracina novaehollandiae	Black-faced Cuckoo-shrike			•	•	•	•	•	•
Lalage sueurii	White-winged Triller				•	•		•	•
Pachycephala rufiventris	Rufous Whistler			•	•	•		•	•
Colluricincla harmonica	Grey Shrike-thrush			•	•	•	•		
Oreoica gutturalis	Crested Bellbird			•	•	•			•
Artamus leucorynchus	White-breasted Woodswallow			•	•				

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Artamus personatus	Masked Woodswallow			•	•	•			•
Artamus superciliosus	White-browed Woodswallow			•	•				
Artamus cinereus	Black-faced Woodswallow			•	•	•	•	•	•
Artamus minor	Little Woodswallow					•	•	•	
Cracticus nigrogularis	Pied Butcherbird			•	•	•	•	•	•
Cracticus tibicen	Australian Magpie			•	•				
Rhipidura leucophrys	Willie Wagtail			•	•	•	•	•	•
Corvus bennetti	Little Crow				•		•		•
Corvus orru	Torresian Crow			•	•	•	•	•	•
Grallina cyanoleuca	Magpie-lark			•	•	•	•	•	
Microeca fascinans	Jacky Winter			•	•				
Petroica goodenovii	Red-capped Robin			•	•	•			
Melanodryas cucullata	Hooded Robin			•	•				
Mirafra javanica	Horsfield's Bushlark			•	•	•		•	•
Acrocephalus australis	Australian Reed-Warbler				•	•			
Cincloramphus mathewsi	Rufous Songlark				•			•	•
Cincloramphus cruralis	Brown Songlark				•	•		•	•
Eremiornis carteri	Spinifexbird				•	•	•	•	•
Cheramoeca leucosterna	White-backed Swallow					•			
Hirundo rustica	Barn Swallow	S5; MI	•						
Petrochelidon ariel	Fairy Martin				•	•	•	•	•
Petrochelidon nigricans	Tree Martin				•	•		•	
Dicaeum hirundinaceum	Mistletoebird					•		•	
Taeniopygia guttata	Zebra Finch			•	•	•	•	•	•
Neochmia ruficauda	Star Finch							•	
Emblema pictum	Painted Finch				•	•	•	•	•
Heteromunia pectoralis	Pictorella Mannikin							•	•
Anthus novaeseelandiae	Australasian Pipit				•	•	•	•	•
Motacilla tschutschensis	Yellow Wagtail	S5; MI	•						
Motacilla cinerea	Grey Wagtail	S5; MI	•						
TOTAL (includes water birds)				72	116	120	35	90	68
TOTAL (Terrestrial)				**55**	**84**	**87**	**30**	**64**	**60**

A3: Reptiles

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Chelodina steindachneri	Flat-shelled Turtle							•	
Nephrurus laevissimus				•	•	•			•
Nephrurus levis				•	•	•		•	•
Crenadactylus ocellatus								•	
Diplodactylus conspicillatus	Fat-tailed Gecko			•	•	•		•	
Diplodactylus laevis	Desert Fat-tailed Gecko			•					•
Diplodactylus savagei	Southern Pilbara Beak-faced Gecko							•	
Lucasium stenodactylum				•	•	•		•	•
Lucasium wombeyi				•	•			•	
Oedura fimbria	Marbled Velvet Gecko			•	•	•			•
Rhynchoedura ornata	Western Beaked Gecko			•	•	•		•	•
Strophurus ciliaris				•	•	•		•	•
Strophurus elderi				•	•	•			•
Strophurus jeanae						•			•
Gehyra pilbara				•	•	•			•
Gehyra punctata				•	•			•	•
Gehyra purpurascens				•	•	•		•	•
Gehyra variegata				•	•	•	•	•	•
Hemidactylus frenatus	Asian House Gecko				•				
Heteronotia binoei	Bynoe's Gecko			•	•	•		•	•
Heteronotia spelea	Pilbara Cave Gecko							•	
Delma borea						•			
Delma butleri	Delma haroldi				•				•
Delma desmosa				•	•				•
Delma elegans								•	
Delma nasuta				•	•	•			•
Delma pax				•				•	
Delma tincta								•	
Lialis burtonis				•	•	•		•	•
Pygopus nigriceps				•		•			•
Ctenophorus caudicinctus	Ring-tailed Dragon			•	•	•	•	•	•
Ctenophorus clayi	Collared Dragon					•			
Ctenophorus isolepis	Crested Dragon			•	•	•	•	•	•
Ctenophorus nuchalis	Central Netted Dragon				•	•	•	•	•
Diporiphora paraconvergens	Grey-striped Western Desert Dragon			•	•				•
Diporiphora pindan	Pindan Dragon			•	•	•			•
Diporiphora vescus	Northern Pilbara Tree Dragon								•

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Gowidon longirostris	Long-nosed Dragon			•		•		•	•
Lophognathus gilberti	Ta-Ta or Gilbert's Dragon			•	•				
Moloch horridus	Thorny Devil			•	•	•			•
Pogona minor	Dwarf Bearded Dragon			•	•	•		•	•
Carlia munda								•	
Carlia triacantha	Desert Rainbow Skink			•	•	•		•	•
Cryptoblepharus plagiocephalus						•	•	•	
Ctenotus angusticeps		P3; VU	✓						
Ctenotus ariadnae						•			
Ctenotus brooksi				•	•	•			
Ctenotus calurus				•	•	•			•
Ctenotus colletti						•			
Ctenotus duricola				•	•				
Ctenotus dux						•			
Ctenotus grandis				•		•			•
Ctenotus hanloni						•			
Ctenotus helenae				•	•	•		•	•
Ctenotus inornatus					•				
Ctenotus leonhardii						•			
Ctenotus nasutus				•	•	•			
Ctenotus pantherinus	Leopard Ctenotus			•				•	•
Ctenotus piankai				•	•	•		•	•
Ctenotus quattuordecimlineatus				•	•	•			•
Ctenotus rubicundus								•	
Ctenotus rufescens									•
Ctenotus saxatilis	Rock Ctenotus			•		•		•	•
Ctenotus schomburgkii					•				•
Ctenotus tanamiensis						•			
Cyclodomorphus melanops	Slender Blue-tongue			•	•			•	
Egernia cygnitos	Western Pilbara Spiny-tailed Skink					•		•	•
Eremiascincus isolepis					•	•			•
Eremiascincus musivus	Mosaic Desert Skink			•	•				•
Eremiascincus pallidus	Western Narrow-banded Skink			•	•	•			•
Eremiascincus richardsonii	Broad-banded Sand Swimmer					•			•
Lerista bipes				•	•	•		•	
Lerista clara					•				•

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Lerista ips				•	•	•			
Lerista jacksoni								•	
Lerista separanda	Dampierland Plain Slider	P2		•	•				•
Lerista verhmens				•	•				
Lerista vermicularis						•		•	
Liopholis kintorei	Great Desert Skink	S3; VU				•			
Liopholis striata	Night Skink					•			
Menetia greyii				•	•	•		•	•
Morethia ruficauda				•	•	•		•	
Notoscincus ornatus				•		•			•
Proablepharus reginae				•		•			
Tiliqua multifasciata	Central Blue-tongue			•	•	•			•
Varanus acanthurus	Spiny-tailed Monitor			•		•		•	•
Varanus brevicauda	Short-tailed Pygmy Monitor			•	•	•			•
Varanus caudolineatus						•		•	
Varanus eremius	Pygmy Desert Goanna					•		•	•
Varanus giganteus	Perentie							•	•
Varanus gilleni	Pygmy Mulga Goanna					•			•
Varanus gouldii	Bungarra or Sand Monitor			•	•	•	•	•	•
Varanus panoptes	Yellow-spotted Goanna							•	
Varanus pilbarensis	Northern Pilbara Rock Goanna							•	
Varanus tristis	Racehorse Goanna					•		•	
Anilios ammodytes					•				•
Anilios endoterus						•			
Anilios grypus					•	•		•	•
Anilios hamatus					•				
Anilios pilbarensis					•				•
Antaresia perthensis	Pygmy Python			•	•	•		•	
Antaresia stimsoni	Stimson's Python							•	•
Aspidites melanocephalus	Black-headed Python			•	•				•
Aspidites ramsayi	Woma	P1		•		•			
Liasis olivaceus barroni	Pilbara Olive Python	S3; VU	•				•	•	
Acanthophis pyrrhus	Desert Death Adder				•			•	
Brachyurophis approximans								•	
Brachyurophis fasciolatus	Narrow-banded Shovel-nosed Snake			•	•				
Demansia psammophis	Yellow-faced Whipsnake							•	•
Demansia rufescens	Rufous Whipsnake							•	•
Furina ornata	Moon Snake				•	•		•	•

Species Name	Common Name	Conservation Status (State; C'w)	EPBC PMST	Nature Map	ALA	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Pseudechis australis	Mulga Snake			•	•	•		•	•
Pseudonaja mengdeni	Western Brown Snake				•				•
Pseudonaja modesta	Ringed Brown Snake			•	•	•		•	•
Pseudonaja nuchalis	Gwardar; Northern Brown Snake							•	
Simoselaps anomalus	Desert Banded Snake			•	•	•		•	•
TOTAL				**61**	**64**	**70**	**7**	**59**	**70**

A4: Amphibians

Species Name	Common Name	Conservation Status (State; C'w)	Nature Map	ALA	EPBC PMST	WAM GSD	Gold'w Lvl1	Gold'w Lvl2	This survey
Cyclorana australis	Giant Frog			•		•			•
Cyclorana longipes	Long-footed Frog								•
Cyclorana maini	Sheep Frog					•		•	
Cyclorana occidentalis	Water Holding Frog								
Litoria rubella	Little Red Tree Frog					•		•	
Neobatrachus aquilonius	Northern Burrowing Frog		•	•					
Notaden nichollsi	Desert Spadefoot			•		•			•
Platyplectrum spenceri	Centralian Burrowing Frog					•		•	
Uperoleia glandulosa	Glandular Toadlet							•	
Uperoleia micromeles	Tanami Toadlet								•
Uperoleia russelli	Northwest Toadlet						•		
TOTAL			**1**	**3**	**0**	**5**	**1**	**4**	**4**

Appendix 2

Database Search Results

Australian Government
Department of the Environment and Energy

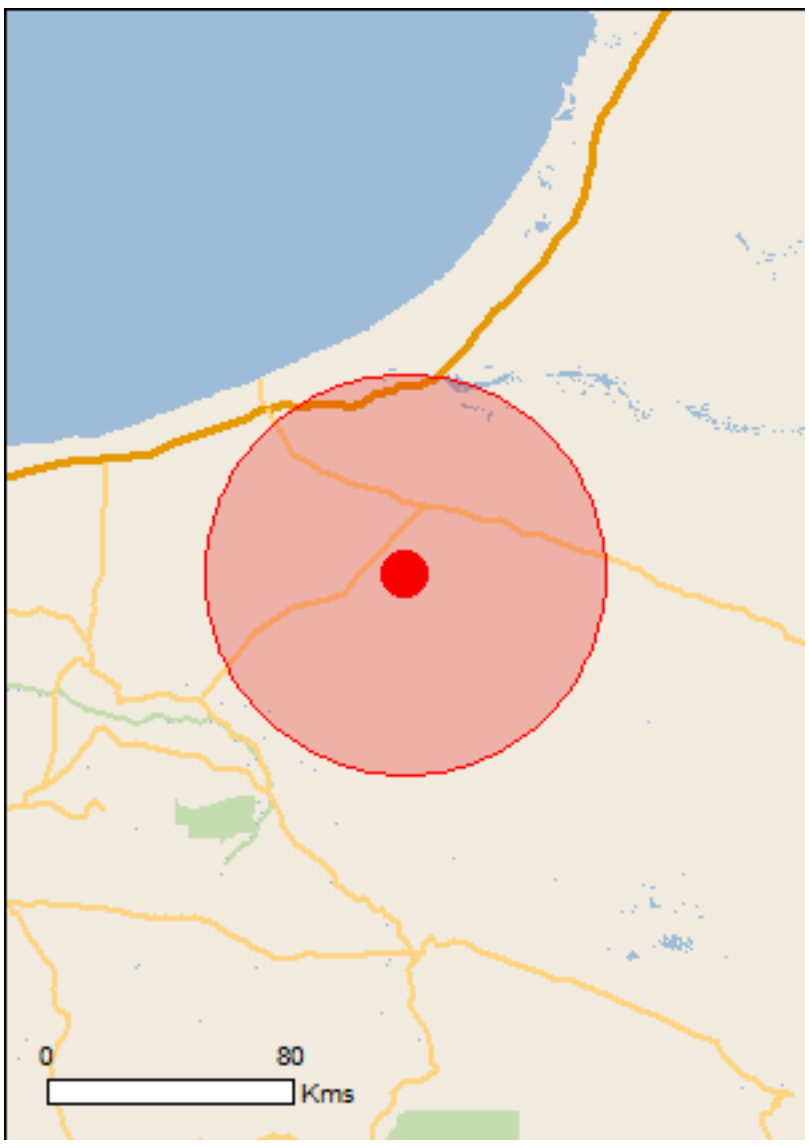
EPBC Act Protected Matters Report

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

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

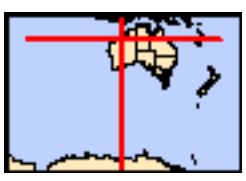
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 15/08/17 16:50:00



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

Coordinates
Buffer: 65.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	12
Listed Migratory Species:	15

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	20
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Eighty-mile beach	Within Ramsar site

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis		
Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Polytelis alexandrae		
Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Mammals		
Dasyurus hallucatus		
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas		
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Ctenotus angusticeps		
Airlie Island Ctenotus [25937]	Vulnerable	Species or species habitat may occur within area
Liasis olivaceus barroni		
Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]		
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Nyangumarta Warrarn	WA

Invasive Species	[Resource Information]

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

Name	Status	Type of Presence
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-20.29018 121.09472

Acknowledgements

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

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

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

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

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Jacinta King on 15/08/2017

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	121° 25' 07" E,20° 10' 46" S
Buffer	35km
Group By	Species Group

Species Group	Species	Records
Bird	33	106
Reptile	15	44
TOTAL	**48**	**150**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Bird					
1.	24285	*Aquila audax (Wedge-tailed Eagle)*			
2.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
3.	24356	*Artamus personatus (Masked Woodswallow)*			
4.	24357	*Artamus superciliosus (White-browed Woodswallow)*			
5.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
6.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	
7.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
8.	24289	*Circus assimilis (Spotted Harrier)*			
9.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
10.	25701	*Coturnix ypsilophora (Brown Quail)*			
11.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
12.	24570	*Epthianura tricolor (Crimson Chat)*			
13.	24368	*Eurostopodus argus (Spotted Nightjar)*			
14.	25621	*Falco berigora (Brown Falcon)*			
15.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
16.	24401	*Geopelia cuneata (Diamond Dove)*			
17.	47965	*Hieraaetus morphnoides (Little Eagle)*			
18.	25661	*Lichmera indistincta (Brown Honeyeater)*			
19.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
20.	24583	*Manorina flavigula (Yellow-throated Miner)*			
21.	24736	*Melopsittacus undulatus (Budgerigar)*			
22.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
23.	25693	*Microeca fascinans (Jacky Winter)*			
24.	24742	*Nymphicus hollandicus (Cockatiel)*			
25.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
26.	24618	*Oreoica gutturalis (Crested Bellbird)*			
27.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
28.	24390	*Psophodes occidentalis (Western Wedgebill, Chiming Wedgebill)*			
29.	42344	*Purnella albifrons (White-fronted Honeyeater)*			
30.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
31.	30870	*Taeniopygia guttata (Zebra Finch)*			
32.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
33.	24851	*Turnix velox (Little Button-quail)*			
Reptile					
34.	25320	*Aspidites melanocephalus (Black-headed Python)*			
35.	24876	*Ctenophorus isolepis subsp. isolepis (Crested Dragon, Military Dragon)*			
36.	25045	*Ctenotus helenae*			
37.	25064	*Ctenotus pantherinus subsp. ocellifer (Leopard Ctenotus)*			
38.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
39.	24896	*Diporiphora pindan (Pindan Dragon)*			
40.	24956	*Gehyra pilbara*			
41.	24957	*Gehyra purpurascens*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
42.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
43.	24967	*Nephrurus levis subsp. levis*			
44.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
45.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
46.	24924	*Strophurus ciliaris subsp. aberrans*			
47.	25202	*Tiliqua multifasciata (Central Blue-tongue)*			
48.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			

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

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

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Jacinta King on 15/08/2017

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	120° 57' 26" E,20° 06' 01" S
Buffer	35km
Group By	Species Group

Species Group	Species	Records
Bird	41	143
Mammal	3	9
Reptile	24	69
TOTAL	**68**	**221**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Bird					
1.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
2.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
3.	24610	*Ardeotis australis (Australian Bustard)*			
4.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
5.	25567	*Artamus leucorynchus (White-breasted Woodswallow)*			
6.	24356	*Artamus personatus (Masked Woodswallow)*			
7.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
8.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
9.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
10.	25593	*Corvus orru (Torresian Crow)*			
11.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
12.	25595	*Cracticus tibicen (Australian Magpie)*			
13.		*Eolophus roseicapillus*			
14.	24570	*Epthianura tricolor (Crimson Chat)*			
15.	25621	*Falco berigora (Brown Falcon)*			
16.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
17.	25623	*Falco longipennis (Australian Hobby)*			
18.	25585	*Geopelia striata (Zebra Dove)*			
19.	24271	*Gerygone fusca subsp. fusca (Western Gerygone)*			
20.	24443	*Grallina cyanoleuca (Magpie-lark)*			
21.	24295	*Haliastur sphenurus (Whistling Kite)*			
22.	24297	*Hamirostra melanosternon (Black-breasted Buzzard)*			
23.	25661	*Lichmera indistincta (Brown Honeyeater)*			
24.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
25.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
26.	24583	*Manorina flavigula (Yellow-throated Miner)*			
27.	47997	*Melanodryas cucullata (Hooded Robin)*			
28.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
29.	25693	*Microeca fascinans (Jacky Winter)*			
30.	25542	*Milvus migrans (Black Kite)*			
31.	25545	*Mirafra javanica (Horsfield's Bushlark, Singing Bushlark)*			
32.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
33.	24742	*Nymphicus hollandicus (Cockatiel)*			
34.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
35.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
36.	24659	*Petroica goodenovii (Red-capped Robin)*			
37.	42344	*Purnella albifrons (White-fronted Honeyeater)*			
38.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
39.	30870	*Taeniopygia guttata (Zebra Finch)*			
40.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
41.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
Mammal					

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
42.	24168	*Macrotis lagotis (Bilby, Dalgyte)*		T	
43.	24175	*Taphozous georgianus (Common Sheath-tailed Bat)*			
44.	24205	*Vespadelus finlaysoni (Finlayson's Cave Bat)*			

Reptile

45.	30831	*Amphibolurus gilberti (Ta-ta, Gilbert's Dragon)*			
46.	30833	*Amphibolurus longirostris (Long-nosed Dragon)*			
47.	25236	*Aspidites ramsayi (Woma)*			
48.	42374	*Brachyurophis fasciolatus subsp. fasciatus (Narrow-banded Shovel-nosed Snake)*			
49.	24876	*Ctenophorus isolepis subsp. isolepis (Crested Dragon, Military Dragon)*			
50.	25461	*Ctenotus brooksi*			
51.	25045	*Ctenotus helenae*			
52.	25064	*Ctenotus pantherinus subsp. ocellifer (Leopard Ctenotus)*			
53.	25062	*Ctenotus piankai*			
54.	25073	*Ctenotus saxatilis (Rock Ctenotus)*			
55.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
56.	24896	*Diporiphora pindan (Pindan Dragon)*			
57.	41409	*Eremiascincus musivus (Mosaic Desert Skink)*			
58.	24956	*Gehyra pilbara*			
59.	24957	*Gehyra purpurascens*			
60.	24959	*Gehyra variegata*			
61.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
62.	24904	*Moloch horridus (Thorny Devil)*			
63.	24966	*Nephrurus laevissimus*			
64.	24967	*Nephrurus levis subsp. levis*			
65.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
66.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
67.	24924	*Strophurus ciliaris subsp. aberrans*			
68.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			

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

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

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Jacinta King on 15/08/2017

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	121° 10' 59" E,20° 33' 08" S
Buffer	35km
Group By	Species Group

Species Group	Species	Records
Bird	1	1
Invertebrate	3	3
Mammal	7	11
Reptile	26	51
TOTAL	**37**	**66**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Bird					
1.	24613	*Colluricincla harmonica subsp. rufiventris (Grey Shrike-thrush)*			
Invertebrate					
2.		*Aname ellenae*			
3.		*Morebilus diversus*			
4.		*Xestaspis linnaei*			
Mammal					
5.	24091	*Dasykaluta rosamondae (Little Red Kaluta)*			
6.	24223	*Mus musculus (House Mouse)*	Y		
7.	24105	*Pseudantechinus roryi (Rory's Pseudantechinus)*			
8.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse, Ngadji)*		P4	
9.	24235	*Pseudomys desertor (Desert Mouse)*			
10.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
11.	24120	*Sminthopsis youngsoni (Lesser Hairy-footed Dunnart)*			
Reptile					
12.	30833	*Amphibolurus longirostris (Long-nosed Dragon)*			
13.	25017	*Carlia triacantha (Desert Rainbow Skink)*			
14.	24865	*Ctenophorus caudicinctus subsp. caudicinctus (Ring-tailed Dragon)*			
15.	24876	*Ctenophorus isolepis subsp. isolepis (Crested Dragon, Military Dragon)*			
16.	25032	*Ctenotus calurus*			
17.	25036	*Ctenotus duricola*			
18.	25057	*Ctenotus nasutus*			
19.	25064	*Ctenotus pantherinus subsp. ocellifer (Leopard Ctenotus)*			
20.	25090	*Cyclodomorphus melanops subsp. melanops (Slender Blue-tongue)*			
21.	30830	*Delma desmosa*			
22.	25001	*Delma nasuta*			
23.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
24.	24896	*Diporiphora pindan (Pindan Dragon)*			
25.	41409	*Eremiascincus musivus (Mosaic Desert Skink)*			
26.	24958	*Gehyra punctata*			
27.	24959	*Gehyra variegata*			
28.	25125	*Lerista bipes*			
29.	25170	*Lerista separanda (Dampierland Plain Slider, skink)*		P2	
30.	30925	*Lerista verhmens*			
31.	25005	*Lialis burtonis*			
32.	30933	*Lucasium stenodactylum*			
33.	30934	*Lucasium wombeyi*			
34.	24904	*Moloch horridus (Thorny Devil)*			
35.	25194	*Morethia ruficauda subsp. ruficauda*			
36.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
37.	25199	*Proablepharus reginae*			

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

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

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

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Jacinta King on 15/08/2017

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	120° 48' 57" E,20° 25' 38" S
Buffer	35km
Group By	Species Group

Species Group	Species	Records
Amphibian	1	2
Bird	52	73
Invertebrate	58	60
Mammal	9	19
Reptile	48	165
TOTAL	**168**	**319**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Amphibian					
1.	25422	*Neobatrachus aquilonius (Northern Burrowing Frog)*			
Bird					
2.	24312	*Anas gracilis (Grey Teal)*			
3.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
4.	24341	*Ardea pacifica (White-necked Heron)*			
5.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
6.	24318	*Aythya australis (Hardhead)*			
7.		*Barnardius zonarius*			
8.	25716	*Cacatua sanguinea (Little Corella)*			
9.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
10.	24785	*Calidris fuscicollis (White-rumped Sandpiper)*			Y
11.	24377	*Charadrius ruficapillus (Red-capped Plover)*			
12.	24289	*Circus assimilis (Spotted Harrier)*			
13.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
14.	24613	*Colluricincla harmonica subsp. rufiventris (Grey Shrike-thrush)*			
15.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
16.	24363	*Coracina novaehollandiae subsp. subpallida (Black-faced Cuckoo-shrike)*			
17.	25593	*Corvus orru (Torresian Crow)*			
18.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
19.	24325	*Dendrocygna eytoni (Plumed Whistling Duck)*			
20.		*Eolophus roseicapillus*			
21.	24570	*Epthianura tricolor (Crimson Chat)*			
22.	25621	*Falco berigora (Brown Falcon)*			
23.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
24.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
25.	24401	*Geopelia cuneata (Diamond Dove)*			
26.	24404	*Geophaps plumifera (Spinifex Pigeon)*			
27.	24271	*Gerygone fusca subsp. fusca (Western Gerygone)*			
28.	24443	*Grallina cyanoleuca (Magpie-lark)*			
29.	24295	*Haliastur sphenurus (Whistling Kite)*			
30.	47965	*Hieraaetus morphnoides (Little Eagle)*			
31.	25734	*Himantopus himantopus (Black-winged Stilt)*			
32.	25661	*Lichmera indistincta (Brown Honeyeater)*			
33.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
34.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
35.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
36.	24583	*Manorina flavigula (Yellow-throated Miner)*			
37.	24589	*Melithreptus gularis subsp. laetior (Black-chinned Honeyeater)*			
38.	24736	*Melopsittacus undulatus (Budgerigar)*			
39.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
40.	25542	*Milvus migrans (Black Kite)*			
41.	25545	*Mirafra javanica (Horsfield's Bushlark, Singing Bushlark)*			
42.	24742	*Nymphicus hollandicus (Cockatiel)*			
43.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
44.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
45.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
46.	24659	*Petroica goodenovii (Red-capped Robin)*			
47.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
48.	24842	*Platalea regia (Royal Spoonbill)*			
49.	24757	*Ptilonorhynchus maculatus subsp. guttatus (Western Bowerbird)*			
50.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
51.	30870	*Taeniopygia guttata (Zebra Finch)*			
52.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
53.	24851	*Turnix velox (Little Button-quail)*			

Invertebrate

54.		*'Amphitritecandona' 'prima'(pss)*			
55.		*Acariformes sp.*			
56.		*Achnanthidium minutissima (Kütz.) Czarnecki*			
57.		*Alona rectangula novaezealandiae*			
58.		*Aname ellenae*			
59.		*Anisops canaliculatus*			
60.		*Anisops elstoni*			
61.		*Anisops nasuta*			
62.		*Anisops stali*			
63.		*Anomoeoneis styriaca (Grun.) Hust.*			
64.		*Bennelongia barangaroo*			
65.		*Boeckella triarticulata*			
66.		*Calamoecia baylyi (Cue form) (ex nr lucasi CB)*			
67.		*Cloeon sp.*			
68.		*Conchostraca (unident.)*			
69.		*Copelatus nigrolineatus*			
70.		*Craticula cuspidata (Grun. ex. Van Heurck) Mann*			
71.		*Cypretta seurati*			
72.		*Cypricercus salinus*			
73.		*Daphnia projecta*			
74.		*Diaphanosoma unguiculatum*			
75.		*Enochrus deserticola*			
76.		*Eretes australis*			
77.		*Euchlanis sp.*			
78.		*Eunotia pectinatus (Dillw.) Rabh.*			
79.		*Halacaridae sp.*			
80.		*Hantzschia virgata*			
81.		*Helochares foveicollis*			Y
82.		*Hemicordulia tau*			
83.		*Hydroglyphus basalis var fuscolineatus*			Y
84.		*Hydroglyphus grammopterus (=trilineatus)*			
85.		*Hydrophilus brevispina*			
86.		*Hydrovatus rufoniger*			
87.		*Hyphydrus lyratus*			
88.		*Ilyocypris australiensis*			
89.		*Ischnura aurora aurora*			
90.		*Lecane cf. spenceri (PSW)*			
91.		*Limnocytheridae n.gen. sp 419 (CB)*			
92.		*Mesocyclops notius*			
93.		*Micronecta virgata*			
94.		*Morebilus diversus*			
95.		*Navicula molestiformis Hust.*			
96.		*Navicula subrhynchocephala Hust.*			
97.		*Nitzschia calida Grun.*			
98.		*Nitzschia filiformis (W. Sm.) Van Heurck*			
99.		*Nitzschia palea (Kütz.) W. Sm.*			
100.		*Nitzschia umbonata (Ehr.) Lange-Bertalot*			
101.		*Oecetis sp.*			
102.		*Pentaneurini sp.*			
103.		*Polypedilum leei*			
104.		*Procladius Pilbara sp. 1 (PSW)*			
105.		*Regimbartia attenuata*			
106.		*Stauroneis anceps Ehr.*			
107.		*Tamopsis facialis*			
108.		*Testudinella cf. elliptica (PSW)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
					Y
109.		*Thermocyclops decipiens*			
110.		*Xestaspis linnaei*			Y
111.		*Zonocypretta kalimna*			
Mammal					
112.	24091	*Dasykaluta rosamondae (Little Red Kaluta)*			
113.	24095	*Ningaui timealeyi (Pilbara Ningaui)*			
114.	24105	*Pseudantechinus roryi (Rory's Pseudantechinus)*			
115.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse, Ngadji)*		P4	
116.	24235	*Pseudomys desertor (Desert Mouse)*			
117.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
118.	24120	*Sminthopsis youngsoni (Lesser Hairy-footed Dunnart)*			
119.	24175	*Taphozous georgianus (Common Sheath-tailed Bat)*			
120.	24205	*Vespadelus finlaysoni (Finlayson's Cave Bat)*			
Reptile					
121.	30833	*Amphibolurus longirostris (Long-nosed Dragon)*			
122.	25318	*Antaresia perthensis (Pygmy Python)*			
123.	25017	*Carlia triacantha (Desert Rainbow Skink)*			
124.	25459	*Ctenophorus isolepis (Crested Dragon, Military Dragon)*			
125.	24876	*Ctenophorus isolepis subsp. isolepis (Crested Dragon, Military Dragon)*			
126.	25461	*Ctenotus brooksi*			
127.	25032	*Ctenotus calurus*			
128.	25036	*Ctenotus duricola*			
129.	25462	*Ctenotus grandis*			
130.	25045	*Ctenotus helenae*			
131.	25057	*Ctenotus nasutus*			
132.	25463	*Ctenotus pantherinus (Leopard Ctenotus)*			
133.	25064	*Ctenotus pantherinus subsp. ocellifer (Leopard Ctenotus)*			
134.	25066	*Ctenotus quattuordecimlineatus*			
135.	25073	*Ctenotus saxatilis (Rock Ctenotus)*			
136.	30830	*Delma desmosa*			
137.	25002	*Delma pax*			
138.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
139.	47934	*Diplodactylus laevis (Desert Fat-tailed Gecko)*			Y
140.	42401	*Diporiphora paraconvergens (Grey-striped Western Desert Dragon)*			
141.	24896	*Diporiphora pindan (Pindan Dragon)*			
142.	41409	*Eremiascincus musivus (Mosaic Desert Skink)*			
143.	43381	*Eremiascincus pallidus (Western Narrow-banded Skink, Narrow-banded Sand Swimmer)*			
144.	24956	*Gehyra pilbara*			
145.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
146.	25125	*Lerista bipes*			
147.	25142	*Lerista ips*			
148.	25170	*Lerista separanda (Dampierland Plain Slider, skink)*		P2	
149.	30933	*Lucasium stenodactylum*			
150.	25184	*Menetia greyii*			
151.	24904	*Moloch horridus (Thorny Devil)*			
152.	25495	*Morethia ruficauda*			
153.	25194	*Morethia ruficauda subsp. ruficauda*			
154.	24966	*Nephrurus laevissimus*			
155.	25499	*Notoscincus ornatus*			
156.		*Oedura fimbria*			Y
157.	24976	*Oedura marmorata (Marbled Velvet Gecko)*			
158.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
159.	24908	*Pogona minor subsp. mitchelli (Dwarf Bearded Dragon)*			
160.	25261	*Pseudechis australis (Mulga Snake)*			
161.	25009	*Pygopus nigriceps*			
162.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
163.	25305	*Simoselaps anomalus (Desert Banded Snake)*			
164.	24924	*Strophurus ciliaris subsp. aberrans*			
165.	24927	*Strophurus elderi*			
166.	25209	*Varanus acanthurus (Spiny-tailed Monitor)*			
167.	25210	*Varanus brevicauda (Short-tailed Pygmy Monitor)*			
168.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			

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

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

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

Scientific Name	Taxon Concept	Taxon Rank	Kingdom	Phylum	Class	Order	Family	Number of records
Acanthophis pyrrhus	Boulenger, 1898	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	2
Acanthophis rugosus	Loveridge, 1948	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	2
Anilios ammodytes	(Montague, 1914)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	TYPHLOPIDAE	5
Anilios grypus	(Waite, 1918)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	TYPHLOPIDAE	1
Anilios hamatus	(Storr, 1981)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	TYPHLOPIDAE	2
Anilios pilbarensis	(Aplin & Donnellan, 1993)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	TYPHLOPIDAE	4
Antaresia perthensis	(Stull, 1932)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	PYTHONIDAE	3
Aspidites melanocephalus	(Krefft, 1864)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	PYTHONIDAE	1
Aspidites ramsayi	(Macleay, 1882)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	PYTHONIDAE	2
Brachyurophis fasciolatus fasciatus	(Sterling & Zietz, 1893)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	1
Carlia triacantha	(Mitchell, 1953)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	3
Ctenophorus caudicinctus caudicinctus	(GÃ¼nther, 1875)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	2
Ctenophorus caudicinctus	(GÃ¼nther, 1875)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	1
Ctenophorus isolepis isolepis	(Fischer, 1881)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	27
Ctenophorus isolepis	(Fischer, 1881)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	3
Ctenophorus nuchalis	(De Vis, 1884)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	2
Ctenotus brooksi	(Loveridge, 1933)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	3
Ctenotus calurus	Storr, 1969	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	1
Ctenotus duricola	Storr, 1975	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	4
Ctenotus helenae	Storr, 1969	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	4
Ctenotus inornatus	(J.E. Gray, 1845)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	7
Ctenotus nasutus	Storr, 1969	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	4
Ctenotus pantherinus ocellifer	(Boulenger, 1896)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	5
Ctenotus piankai	Storr, 1969	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	1
Ctenotus quattuordecimlineatus	(Sternfeld, 1919)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	3
Ctenotus schomburgkii	(Peters, 1863)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	1
Cyclodomorphus melanops melanops	(Stirling & Zietz, 1893)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	2
Delma desmosa	Maryan, Aplin & Adams, 2007	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	PYGOPODIDAE	8
Delma haroldi	Storr, 1987	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	PYGOPODIDAE	1
Delma nasuta	Kluge, 1974	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	PYGOPODIDAE	4
Diplodactylus conspicillatus	Lucas & Frost, 1897	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	7
Diporiphora paraconvergens	Doughty, Kealley & Melville, 2012	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	2
Diporiphora pindan	Storr, 1979	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	9
Eremiascincus isolepis	(Boulenger, 1887)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	1
Eremiascincus musivus	Mecke, Doughty & Donnellan, 2009	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	7
Eremiascincus pallidus	(GÃ¼nther, 1875)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	6
Furina ornata	(J.E. Gray, 1842)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	2
Gehyra pilbara	Mitchell, 1965	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	GEKKONIDAE	6
Gehyra punctata	(Fry, 1914)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	GEKKONIDAE	4
Gehyra purpurascens	Storr, 1982	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	GEKKONIDAE	3
Gehyra variegata	(DumÃ©ril & Bibron, 1836)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	GEKKONIDAE	3
Hemidactylus frenatus	DumÃ©ril & Bibron, 1836	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	GEKKONIDAE	1
Heteronotia binoei	(J.E. Gray, 1845)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	GEKKONIDAE	6
Lerista bipes	(Fischer, 1882)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	22
Lerista clara	Smith & Adams, 2007	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	1
Lerista ips	Storr, 1980	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	9
Lerista separanda	Storr, 1976	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	9
Lerista verhmens	Smith & Adams, 2007	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	2
Lialis burtonis	J.E. Gray, 1835	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	PYGOPODIDAE	2
Lophognathus gilberti	J.E. Gray, 1842	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	1
Lucasium stenodactylum	Boulenger, 1896	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	3
Lucasium wombeyi	(Storr, 1978)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	1
Menetia greyii	J.E. Gray, 1845	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	4
Moloch horridus	J.E. Gray, 1841	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	4
Morethia ruficauda ruficauda	(Lucas & Frost, 1895)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	5
Nephrurus laevissimus	Mertens, 1958	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	CARPHODACTYLIDAE	6
Nephrurus levis levis	De Vis, 1886	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	CARPHODACTYLIDAE	2
Notoscincus ornatus ornatus	(Broom, 1896)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	2
Oedura marmorata	J.E. Gray, 1842	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	10
Pogona minor minor	Sternfeld, 1919	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	3
Pogona minor mitchelli	(Badham, 1976)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	AGAMIDAE	2
Pseudechis australis	(J.E. Gray, 1842)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	1
Pseudonaja mengdeni	Wells & Wellington, 1985	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	2
Pseudonaja modesta	(GÃ¼nther, 1872)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	3
Rhynchoedura ornata	GÃ¼nther, 1867	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	1
Simoselaps anomalus	(Sternfeld, 1919)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	ELAPIDAE	3
Strophurus ciliaris aberrans	(Glauert, 1952)	subspecies	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	33
Strophurus ciliaris	(Boulenger, 1885)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	2
Strophurus elderi	(Stirling & Zietz, 1893)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	DIPLODACTYLIDAE	3
Tiliqua multifasciata	Sternfeld, 1919	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	SCINCIDAE	1
Varanus brevicauda	Boulenger, 1898	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	VARANIDAE	1
Varanus gouldii	(J.E. Gray, 1838)	species	ANIMALIA	CHORDATA	REPTILIA	SQUAMATA	VARANIDAE	3

Scientific Name	Taxon Concept	Taxon Rank	Kingdom	Phylum	Class	Order	Family	Number of records
Dasykaluta rosamondae	(Ride, 1964)	species	ANIMALIA	CHORDATA	MAMMALIA	DASYUROMORPHIA	DASYURIDAE	5
Macroderma gigas	(Dobson, 1880)	species	ANIMALIA	CHORDATA	MAMMALIA	CHIROPTERA	MEGADERMATIDAE	9
Mus musculus	Linnaeus, 1758	species	ANIMALIA	CHORDATA	MAMMALIA	RODENTIA	MURIDAE	1
Ningaui timealeyi	Archer, 1975	species	ANIMALIA	CHORDATA	MAMMALIA	DASYUROMORPHIA	DASYURIDAE	2
Osphranter robustus robustus	(Gould, 1841)	subspecies	ANIMALIA	CHORDATA	MAMMALIA	DIPROTODONTIA	MACROPODIDAE	1
Pseudantechinus roryi	Cooper, Aplin & Adams, 2000	species	ANIMALIA	CHORDATA	MAMMALIA	DASYUROMORPHIA	DASYURIDAE	1
Pseudomys desertor	Troughton, 1932	species	ANIMALIA	CHORDATA	MAMMALIA	RODENTIA	MURIDAE	8
Pseudomys hermannsburgensis	(Waite, 1896)	species	ANIMALIA	CHORDATA	MAMMALIA	RODENTIA	MURIDAE	4
Sminthopsis youngsoni	McKenzie & Archer, 1982	species	ANIMALIA	CHORDATA	MAMMALIA	DASYUROMORPHIA	DASYURIDAE	4
Taphozous georgianus	Thomas, 1915	species	ANIMALIA	CHORDATA	MAMMALIA	CHIROPTERA	EMBALLONURIDAE	4
Vespadelus finlaysoni	(Kitchener, Jones & Caputi, 1987)	species	ANIMALIA	CHORDATA	MAMMALIA	CHIROPTERA	VESPERTILIONIDAE	4

Scientific Name	Taxon Concept	Taxon Rank	Kingdom	Phylum	Class	Order	Family	Number of records
Cyclorana australis	(Gray, 1842)	species	ANIMALIA	CHORDATA	AMPHIBIA	ANURA	HYLIDAE	7
Neobatrachus aquilonius	Tyler, Davies & Martin, 1981	species	ANIMALIA	CHORDATA	AMPHIBIA	ANURA	LIMNODYNASTIDAE	2
Notaden nichollsi	Parker, 1940	species	ANIMALIA	CHORDATA	AMPHIBIA	ANURA	LIMNODYNASTIDAE	2

Scientific Name	Taxon Concept	Taxon Rank	Kingdom	Phylum	Class	Order	Family	Vernacular Name	Number of records
Acanthagenys rufogularis	Gould, 1838	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		2
Accipiter (Leucospiza) fasciatus	(Vigors & Horsfield, 1827)	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE		6
Acrocephalus (Acrocephalus) australis	(Gould, 1838)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ACROCEPHALIDAE	Australian reed warbler	2
Aegotheles (Aegotheles) cristatus	(Shaw, 1790)	species	ANIMALIA	CHORDATA	AVES	APODIFORMES	AEGOTHELIDAE		1
Anas (Anas) superciliosa	Gmelin, 1789	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE		4
Anas (Nettion) gracilis	Buller, 1869	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Grey teal	19
Anthus (Anthus) novaeseelandiae	(Gmelin, 1789)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MOTACILLIDAE	Australian Pipit	13
Aphelocephala nigricincta	(North, 1895)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ACANTHIZIDAE		1
Apus (Apus) pacificus	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	APODIFORMES	APODIDAE	Fork-tailed swift	1
Aquila (Uroaetus) audax	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE		4
Ardea (Ardea) pacifica	Latham, 1801	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	Pacific Heron	16
Ardea (Casmerodius) modesta	J.E. Gray, 1831	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	Great white egret	14
Ardea (Mesophoyx) intermedia intermedia	Wagler, 1829	subspecies	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	Intermediate Egret	3
Ardeotis australis	(J.E. Gray, 1829)	species	ANIMALIA	CHORDATA	AVES	GRUIFORMES	OTIDIDAE		11
Artamus (Angroyan) cinereus cinereus	Vieillot, 1817	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE		28
Artamus (Artamus) leucorynchus	(Linnaeus, 1771)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE		2
Artamus (Campbellornis) personatus	(Gould, 1841)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE	Masked woodswallow	21
Artamus (Campbellornis) superciliosus	(Gould, 1837)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE	White-browed woodswallow	1
Aythya (Nyroca) australis	(Eyton, 1838)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE		8
Barnardius zonarius	(Shaw, 1805)	species	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	PSITTACIDAE		1
Cacatua (Licmetis) sanguinea sanguinea	Gould, 1843	subspecies	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	CACATUIDAE		10
Cacomantis (Vidgenia) pallidus	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	CUCULIFORMES	CUCULIDAE	Pallid Cuckoo	11
Calyptorhynchus (Calyptorhynchus) banksii	(Latham, 1790)	species	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	CACATUIDAE		4
Centropus (Polophilus) phasianinus	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	CUCULIFORMES	CENTROPODIDAE		1
Certhionyx (Certhionyx) variegatus	Lesson, 1830	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		13
Chenonetta jubata	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Australian wood duck	1
Chlidonias (Chlidonias) leucopterus	(Temminck, 1815)	species	ANIMALIA	CHORDATA	AVES	CHARADRIIFORMES	LARIDAE	White-winged Black Tern	1
Chlidonias (Pelodes) hybrida	(Pallas, 1811)	species	ANIMALIA	CHORDATA	AVES	CHARADRIIFORMES	LARIDAE	Whiskered Tern	17
Chrysococcyx basalis	(Horsfield, 1821)	species	ANIMALIA	CHORDATA	AVES	CUCULIFORMES	CUCULIDAE		10
Cincloramphus (Cincloramphus) cruralis	(Vigors & Horsfield, 1827)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MEGALURIDAE		8
Cincloramphus (Maclennania) mathewsi	Iredale, 1911	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MEGALURIDAE		5
Circus approximans	Peale, 1848	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE	Australasian harrier	4
Circus assimilis	Jardine & Selby, 1828	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE		12
Colluricincla (Colluricincla) harmonica rufiventris	Gould, 1841	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PACHYCEPHALIDAE		1
Colluricincla (Colluricincla) harmonica	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PACHYCEPHALIDAE		2
Coracina (Coracina) novaehollandiae subpallida	Mathews, 1912	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	CAMPEPHAGIDAE		1
Coracina (Coracina) novaehollandiae	(Gmelin, 1789)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	CAMPEPHAGIDAE	Black-faced cuckoo-shrike	11
Corvus bennetti	North, 1901	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	CORVIDAE		2
Corvus orru orru	Bonaparte, 1850	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	CORVIDAE		12
Coturnix (Synoicus) ypsilophora	Bosc, 1792	species	ANIMALIA	CHORDATA	AVES	GALLIFORMES	PHASIANIDAE	Brown quail	1
Cracticus nigrogularis	(Gould, 1837)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE		15
Cracticus tibicen	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ARTAMIDAE	Australian Magpie	3
Cygnus (Chenopis) atratus	(Latham, 1790)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Black Swan	10
Dendrocygna (Leptotarsis) eytoni	(Eyton, 1838)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE		2
Egretta garzetta	(Linnaeus, 1766)	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	Little Egret	8
Egretta novaehollandiae	(Latham, 1790)	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	White-faced heron	5
Elanus axillaris	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE		1
Emblema pictum	Gould, 1842	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ESTRILDIDAE		1
Eolophus roseicapillus	(Vieillot, 1817)	species	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	CACATUIDAE	Galah	2
Ephippiorhynchus (Ephippiorhynchus) asiaticus	(Latham, 1790)	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	CICONIIDAE		1
Epthianura (Aurepthianura) aurifrons	Gould, 1838	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		1
Epthianura (Parepthianura) tricolor	Gould, 1841	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		18
Eremiornis carteri	North, 1900	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MEGALURIDAE		1
Eurostopodus (Eurostopodus) argus	(Hartert, 1892)	species	ANIMALIA	CHORDATA	AVES	CAPRIMULGIFORMES	CAPRIMULGIDAE		3
Falco (Falco) longipennis longipennis	Swainson, 1838	subspecies	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	FALCONIDAE		2
Falco (Hierofalco) peregrinus	Tunstall, 1771	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	FALCONIDAE		1
Falco (Ieracidea) berigora berigora	Vigors & Horsfield, 1827	subspecies	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	FALCONIDAE		18
Falco (Tinnunculus) cenchroides	Vigors & Horsfield, 1827	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	FALCONIDAE	Nankeen kestrel	26
Fulica atra	Linnaeus, 1758	species	ANIMALIA	CHORDATA	AVES	GRUIFORMES	RALLIDAE	Australasian coot	7
GALLIFORMES		order	ANIMALIA	CHORDATA	AVES			Game Birds and Allies	2
Gallirallus philippensis	(Linnaeus, 1766)	species	ANIMALIA	CHORDATA	AVES	GRUIFORMES	RALLIDAE	Banded Rail	1
Gavicalis virescens	(Vieillot, 1817)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		47
Geopelia cuneata	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	COLUMBIFORMES	COLUMBIDAE		9
Geopelia humeralis	(Temminck, 1821)	species	ANIMALIA	CHORDATA	AVES	COLUMBIFORMES	COLUMBIDAE		4
Geopelia striata placida	Gould, 1844	subspecies	ANIMALIA	CHORDATA	AVES	COLUMBIFORMES	COLUMBIDAE		3
Geopelia striata	(Linnaeus, 1766)	species	ANIMALIA	CHORDATA	AVES	COLUMBIFORMES	COLUMBIDAE		3
Geophaps (Lophophaps) plumifera plumifera	Gould, 1842	subspecies	ANIMALIA	CHORDATA	AVES	COLUMBIFORMES	COLUMBIDAE		1
Gerygone fusca fusca	(Gould, 1838)	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ACANTHIZIDAE		3
Glareola (Glareola) maldivarum	J.R. Forster, 1795	species	ANIMALIA	CHORDATA	AVES	CHARADRIIFORMES	GLAREOLIDAE	Oriental Pratincole	3
Grallina cyanoleuca	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MONARCHIDAE		36
Grus (Mathewsia) rubicunda	(Perry, 1810)	species	ANIMALIA	CHORDATA	AVES	GRUIFORMES	GRUIDAE		10
Haliastur sphenurus	(Vieillot, 1818)	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE		28
Hamirostra melanosternon	(Gould, 1841)	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE		5
Hieraaetus (Hieraaetus) morphnoides	(Gould, 1841)	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE		5
Lalage (Lalage) sueurii	(Vieillot, 1818)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	CAMPEPHAGIDAE	Australian White-winged Triller	17
Lichmera (Lichmera) indistincta	(Vigors & Horsfield, 1827)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		11
Malacorhynchus membranaceus	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Pink-eared duck	2
Malurus (Leggeornis) lamberti assimilis	North, 1901	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MALURIDAE		1
Malurus (Leggeornis) lamberti lamberti	Vigors & Horsfield, 1827	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MALURIDAE		18
Malurus (Musciparus) leucopterus leucopterus	Dumont, 1824	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MALURIDAE		8
Manorina (Myzantha) flavigula	(Gould, 1840)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		43
Melanodryas (Melanodryas) cucullata	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PETROICIDAE		1
Melithreptus (Eidopsarus) gularis laetior	Gould, 1875	subspecies	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		1
Melopsittacus undulatus	(Shaw, 1805)	species	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	PSITTACIDAE		15
Merops (Merops) ornatus	Latham, 1801	species	ANIMALIA	CHORDATA	AVES	CORACIIFORMES	MEROPIDAE		20
Microeca (Microeca) fascinans	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PETROICIDAE		1
Milvus migrans	(Boddaert, 1783)	species	ANIMALIA	CHORDATA	AVES	FALCONIFORMES	ACCIPITRIDAE	Black kite	16
Mirafra (Mirafra) javanica	Horsfield, 1821	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ALAUDIDAE		11
Ninox (Ninox) novaeseelandiae boobook	(Latham, 1801)	subspecies	ANIMALIA	CHORDATA	AVES	STRIGIFORMES	STRIGIDAE		1
Nycticorax caledonicus	(Gmelin, 1789)	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	ARDEIDAE	Nankeen night heron	3
Nymphicus hollandicus	(Kerr, 1792)	species	ANIMALIA	CHORDATA	AVES	PSITTACIFORMES	CACATUIDAE		4
Ocyphaps lophotes	(Temminck, 1822)	species	ANIMALIA	CHORDATA	AVES	COLUMBIFORMES	COLUMBIDAE		15
Oreoica gutturalis	(Vigors & Horsfield, 1827)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	OREOIDIDAE		1
Pachycephala (Alisternornis) rufiventris	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PACHYCEPHALIDAE		10
Pavo cristatus	Linnaeus, 1758	species	ANIMALIA	CHORDATA	AVES	GALLIFORMES	PHASIANIDAE	Peafowl	6
Petrochelidon (Hylochelidon) nigricans	(Vieillot, 1817)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	HIRUNDINIDAE	Tree martin	6
Petrochelidon (Petrochelidon) ariel	(Gould, 1842)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	HIRUNDINIDAE	Fairy martin	2
Petroica (Petroica) goodenovii	(Vigors & Horsfield, 1827)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PETROICIDAE		5
Plegadis falcinellus	(Linnaeus, 1766)	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	THRESKIORNITHIDAE	Glossy ibis	3
Porphyrio (Porphyrio) porphyrio melanotus	Temminck, 1820	subspecies	ANIMALIA	CHORDATA	AVES	GRUIFORMES	RALLIDAE	Pukeko	1
Porzana (Porzana) pusilla	(Pallas, 1776)	species	ANIMALIA	CHORDATA	AVES	GRUIFORMES	RALLIDAE	Marsh Crake	1
Psophodes (Sphenostoma) occidentalis	(Mathews, 1912)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PSOPHODIDAE		1
Ptilonorhynchus maculatus	Gould, 1837	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	PTILONORHYNCHIDAE		1
Ptilotula keartlandi	(North, 1895)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		5

Ptilotula penicillata	(Gould, 1837)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		5
Purnella albifrons	(Gould, 1841)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		2
Pyrrholaemus brunneus	Gould, 1841	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ACANTHIZIDAE		1
Rhipidura (Sauloprocta) leucophrys	(Latham, 1801)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	RHIPIDURIDAE	Willie Wagtail	25
Stictonetta naevosa	(Gould, 1841)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE		1
Stiltia isabella	(Vieillot, 1816)	species	ANIMALIA	CHORDATA	AVES	CHARADRIIFORMES	GLAREOLIDAE		7
Stomiopera unicolor	(Gould, 1843)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		1
Sugomel niger	(Gould, 1838)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	MELIPHAGIDAE		8
Tachybaptus novaehollandiae	(Stephens, 1826)	species	ANIMALIA	CHORDATA	AVES	PODICIPEDIFORMES	PODICIPEDIDAE		4
Tadorna (Casarca) tadornoides	(Jardine & Selby, 1828)	species	ANIMALIA	CHORDATA	AVES	ANSERIFORMES	ANATIDAE	Australian Shelduck	1
Taeniopygia guttata	(Vieillot, 1817)	species	ANIMALIA	CHORDATA	AVES	PASSERIFORMES	ESTRILDIDAE		25
Threskiornis molucca	(Cuvier, 1829)	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	THRESKIORNITHIDAE	White Ibis	6
Threskiornis spinicollis	(Jameson, 1835)	species	ANIMALIA	CHORDATA	AVES	CICONIIFORMES	THRESKIORNITHIDAE	Straw-necked ibis	26
Todiramphus (Cyanalcyon) pyrrhopygius	(Gould, 1840)	species	ANIMALIA	CHORDATA	AVES	CORACIIFORMES	ALCEDINIDAE		10
Todiramphus (Todiramphus) sanctus	(Vigors & Horsfield, 1827)	species	ANIMALIA	CHORDATA	AVES	CORACIIFORMES	ALCEDINIDAE	Sacred kingfisher	2
Tringa (Glottis) nebularia	(Gunnerus, 1767)	species	ANIMALIA	CHORDATA	AVES	CHARADRIIFORMES	SCOLOPACIDAE	Greenshank	3
Turnix (Alphaturnia) velox	(Gould, 1841)	species	ANIMALIA	CHORDATA	AVES	TURNICIFORMES	TURNICIDAE		5

Appendix 3

Regulation 17 Licence

DEPARTMENT OF PARKS AND WILDLIFE

Department of Parks and Wildlife

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: https://wildlifelicensing.dpaw.wa.gov.au
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

Wildlife Conservation Act 1950

REGULATION 17

Regulation 17 – Licence to take fauna for scientific purposes (Regulation 17 - Standard)

The undermentioned person may take fauna for research or other scientific purposes and where authorised, keep it in captivity, subject to the following and attached conditions, which may be added to, suspended or otherwise varied as considered fit.

Director General

Conditions

1 The licensee shall comply with the provisions of the Wildlife Conservation Act 1950, Wildlife Conservation Regulations 1970 and any Notices in force under this legislation.

2 The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.

3 Unless specifically authorised in the conditions of this Licence or otherwise in writing by the Director General, species of fauna declared as likely to become extinct, rare or otherwise in need of special protection shall not be taken.

4 Any by-catch of fauna, which is declared to be rare, likely to become extinct, or otherwise in need of special protection shall be released immediately at the point of capture. Where such fauna taken under this licence is injured or deceased, the licensee shall contact the Department's Wildlife Licensing Section for advice on disposal. Records must be kept of any such fauna so captured and details are to be included in the report required under further condition below.

5 Any interaction involving Gazetted Threatened Fauna that may be harmful to the fauna and/or invasive may require approval from the Commonwealth Department of the Environment ph 02 6274 1111. Interaction with such species is controlled by the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and Environment Protection and Biodiversity Conservation Regulations 2000 as well as the Wildlife Conservation Act 1950 and Wildlife Conservation Regulations 1970.

6 No fauna shall be taken in areas where it would impinge on pre-existing scientific research programs.

7 Except in the case of approved lethal traps, the licensee shall ensure that measures are taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and inspected at regular intervals throughout each day of their use. At the conclusion of research all markers used, and signs and structures erected by the licensee shall be removed and the environment returned to its original condition.

8 Not more than ten specimens of any one protected species of fauna shall be taken and removed from any location less than 20km apart. Where exceptional circumstances make it necessary to take a larger number of specimens from a particular location in order to obtain adequate statistical data, the collector must proceed with circumspection and justify their actions to the Director General in advance.

9 The licensee shall not release any fauna or their progeny in any area where it does not naturally occur, nor hand such fauna over to any other person or authority unless approved by the Director General, nor dispose of the remains of such fauna in any manner likely to confuse the natural or present day distribution of the species.

10 Bioprospecting involving the removal of sample aquatic and terrestrial organisms for chemical extraction and bioactivity screening shall not be conducted without specific written approval by the Director General.

11 No fauna shall be taken from any CALM land, as defined in the Conservation and Land Management Regulations 2002, without prior written approval of the Director General. No fauna shall be taken from any public land without the prior written approval of the Government Authority managing that land.

12 The licensee shall not enter upon any private property or pastoral lease for the purposes of this licence, nor take any fauna from any private land or pastoral lease without the prior consent in writing of the owner or occupier. Similarly, in the case of Aboriginal lands, the licensee must not enter upon or take fauna from such lands without the written approval of the Department of Aboriginal Affairs and/or the relevant native title holders or applicants.

13 Copies of this licence and any written approval or consent required by conditions of this licence must be carried by the licensee and any person/s authorised under the licence at all times when conducting activities relevant to the licence

Department of Parks and Wildlife

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: https://wildlifelicensing.dpaw.wa.gov.au
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

and must be presented to an authorised officer of the Department upon request.

14 All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range shall upon request be donated to the Western Australian Museum.

15 To prevent any unnecessary collecting in this State, all specimens and material taken and retained under the authority of this license shall, upon request, be loaned to the Western Australian Museum. Any unused portion or portions of any specimen collected under the authority of this license shall be offered to the Western Australian Museum for inclusion in its collection or made available to other scientific workers if so required.

16 Within one month of the expiration of this licence, the holder shall submit an electronic return into the department's Wildlife Licensing System, detailing the locality, site, geocode, date and number of each species of fauna captured, sighted or vouchered during the currency of the licence. A copy of any paper, report or thesis resulting from the research shall upon completion be lodged with the Director General.

Purpose

Level 1 reconnaissance survey by opportunistic observation; and a Level 2 fauna survey using cage, Elliott, dry pit and funnel traps, hand foraging, and via spotlighting/head torching, secondary signs/evidence and habitat assessment; and a Targeted conservation significant fauna survey for bilby (Macrotis lagotis) by active searching, secondary signs/evidence and habitat assessment; and a Short Range Endemic (SRE) invertebrate fauna survey by foraging (raking, sieving and excavation); and a Targeted wader (shorebirds and migratory birds) survey by visual observation, secondary signs/evidence and habitat assessment. Captured vertebrate fauna will be release at capture site and collected invertebrate fauna may be retained as specimens. For the Asian Renewable Energy Hub Terrestrial Environmental Impact Assessment

Locations

Pilbara Region, near the southwest boundary of the Kimberley region, approximately 30km inland from Eighty Mile Beach and extending east onto the margin of the Great Sandy Desert.

Authorised Person

Surname	Given name(s)
Humphreys	Garth
Teale	Roy
Ford	Stewart
Greenham	Michael
Keirle	David
Sawers	Paul
Traditional Landowners	rangers
King	Jacinta

DEPARTMENT OF PARKS AND WILDLIFE

Department of
Parks and Wildlife

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: https://wildlifelicensing.dpaw.wa.gov.au
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

Date of Issue 15/08/2017
Valid From 15/08/2017
Date of Expiry 23/08/2018

Licensee: Mr Daniel Kamien
Address Biota Environmental Sciences Pty Ltd
PO Box 155
Leederville WA 6903
Australia

Issued by a Wildlife Licensing Officer of the Department of Parks and Wildlife under delegation from the Minister for Environment pursuant to section 133(1) of the Conservation and Land Management Act 1984.

DEPARTMENT OF PARKS AND WILDLIFE

Department of Parks and Wildlife

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: https://wildlifelicensing.dpaw.wa.gov.au
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

Wildlife Conservation Act 1950

REGULATION 17

Regulation 17 – Licence to take fauna for scientific purposes (Regulation 17 - Standard)

The undermentioned person may take fauna for research or other scientific purposes and where authorised, keep it in captivity, subject to the following and attached conditions, which may be added to, suspended or otherwise varied as considered fit.

Director General

Conditions

1 The licensee shall comply with the provisions of the Wildlife Conservation Act 1950, Wildlife Conservation Regulations 1970 and any Notices in force under this legislation.

2 The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.

3 Unless specifically authorised in the conditions of this Licence or otherwise in writing by the Director General, species of fauna declared as likely to become extinct, rare or otherwise in need of special protection shall not be taken.

4 Any by-catch of fauna, which is declared to be rare, likely to become extinct, or otherwise in need of special protection shall be released immediately at the point of capture. Where such fauna taken under this licence is injured or deceased, the licensee shall contact the Department's Wildlife Licensing Section for advice on disposal. Records must be kept of any such fauna so captured and details are to be included in the report required under further condition below.

5 Any interaction involving Gazetted Threatened Fauna that may be harmful to the fauna and/or invasive may require approval from the Commonwealth Department of the Environment ph 02 6274 1111. Interaction with such species is controlled by the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and Environment Protection and Biodiversity Conservation Regulations 2000 as well as the Wildlife Conservation Act 1950 and Wildlife Conservation Regulations 1970.

6 No fauna shall be taken in areas where it would impinge on pre-existing scientific research programs.

7 Except in the case of approved lethal traps, the licensee shall ensure that measures are taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and inspected at regular intervals throughout each day of their use. At the conclusion of research all markers used, and signs and structures erected by the licensee shall be removed and the environment returned to its original condition.

8 Not more than ten specimens of any one protected species of fauna shall be taken and removed from any location less than 20km apart. Where exceptional circumstances make it necessary to take a larger number of specimens from a particular location in order to obtain adequate statistical data, the collector must proceed with circumspection and justify their actions to the Director General in advance.

9 The licensee shall not release any fauna or their progeny in any area where it does not naturally occur, nor hand such fauna over to any other person or authority unless approved by the Director General, nor dispose of the remains of such fauna in any manner likely to confuse the natural or present day distribution of the species.

10 Bioprospecting involving the removal of sample aquatic and terrestrial organisms for chemical extraction and bioactivity screening shall not be conducted without specific written approval by the Director General.

11 No fauna shall be taken from any CALM land, as defined in the Conservation and Land Management Regulations 2002, without prior written approval of the Director General. No fauna shall be taken from any public land without the prior written approval of the Government Authority managing that land.

12 The licensee shall not enter upon any private property or pastoral lease for the purposes of this licence, nor take any fauna from any private land or pastoral lease without the prior consent in writing of the owner or occupier. Similarly, in the case of Aboriginal lands, the licensee must not enter upon or take fauna from such lands without the written approval of the Department of Aboriginal Affairs and/or the relevant native title holders or applicants.

13 Copies of this licence and any written approval or consent required by conditions of this licence must be carried by the licensee and any person/s authorised under the licence at all times when conducting activities relevant to the licence

Department of Parks and Wildlife

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: https://wildlifelicensing.dpaw.wa.gov.au
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

and must be presented to an authorised officer of the Department upon request.

14 All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range shall upon request be donated to the Western Australian Museum.

15 To prevent any unnecessary collecting in this State, all specimens and material taken and retained under the authority of this license shall, upon request, be loaned to the Western Australian Museum. Any unused portion or portions of any specimen collected under the authority of this license shall be offered to the Western Australian Museum for inclusion in its collection or made available to other scientific workers if so required.

16 Within one month of the expiration of this licence, the holder shall submit an electronic return into the department's Wildlife Licensing System, detailing the locality, site, geocode, date and number of each species of fauna captured, sighted or vouchered during the currency of the licence. A copy of any paper, report or thesis resulting from the research shall upon completion be lodged with the Director General.

Purpose

Level 1 reconnaissance survey by opportunistic observation; and a Level 2 fauna survey using cage, Elliott, dry pit and funnel traps, hand foraging, and via spotlighting/head torching, secondary signs/evidence and habitat assessment; and a Targeted conservation significant fauna survey for bilby (Macrotis lagotis) by active searching, secondary signs/evidence and habitat assessment; and a Short Range Endemic (SRE) invertebrate fauna survey by foraging (raking, sieving and excavation); and a Targeted wader (shorebirds and migratory birds) survey by visual observation, secondary signs/evidence and habitat assessment. Captured vertebrate fauna will be release at capture site and collected invertebrate fauna may be retained as specimens. For the Asian Renewable Energy Hub Terrestrial Environmental Impact Assessment

Locations

Pilbara Region, near the southwest boundary of the Kimberley region, approximately 30km inland from Eighty Mile Beach and extending east onto the margin of the Great Sandy Desert, wader and waterbird surveys at Walyarta (Mandora Marsh) and nearby areas of 80 mile beach.

Authorised Person

Surname	Given name(s)
Humphreys	Garth
Teale	Roy
Ford	Stewart
Greenham	Michael
Keirle	David
Sawers	Paul
Traditional Landowners	Nyangumarta Rangers
King	Jacinta
Graff	John

DEPARTMENT OF PARKS AND WILDLIFE

Department of
Parks and Wildlife

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: https://wildlifelicensing.dpaw.wa.gov.au
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

Date of Issue 11/10/2017
Valid From 11/10/2017
Date of Expiry 23/08/2018

Licensee: Mr Daniel Kamien
Address Biota Environmental Sciences Pty Ltd
PO Box 155
Leederville WA 6903
Australia

Issued by a Wildlife Licensing Officer of the Department of Parks and Wildlife under delegation from the Minister for Environment pursuant to section 133(1) of the Conservation and Land Management Act 1984.

Appendix 4

Helix Molecular Solutions Report

Helix
Molecular
Solutions

School of Animal Biology The University of Western Australia
Hackett Entrance No. 4 Hackett Drive Crawley WA 6009

PO Box 155
Leederville WA 6903

t: (08) 6488 4509 | f: (08) 6488 1029 | abn: 32 133 230 243 | w: www.helixsolutions.com.au

9 August 2018

Garth Humphreys
Biota Environmental Sciences
Level 1 / 228 Carr Place
Leederville WA 6007

Via email

Re. Report on the molecular systematics of the targeted SRE invertebrates from the Asian Hub RE Fauna survey.

Dear Garth,

Following is a summary of the results of the invertebrate molecular investigation we have completed for the Asian Hub Re Fauna survey. Results suggest that all camaenid snail specimens belong to the described *Rhagada karajarri* and these records extend the species distribution substantially. Nine of the ten buthid scorpions were successfully sequenced and belong to two clades of *Lychas annulatus* (also recognised as *Hemilychas alexandrinus*) and show mean sequence divergence of 7.8 % from one another. Amongst the 29 spider specimens, 15 belonged to four distinct species of nemesiid mygalomorphs and belonging to a single genus *Aname*, three of the species haven't been recorded previously. Nine specimens of spiders were found to be Araneomorphae with their family placement uncertain. A further five spider specimens were unsuccessful during the sequencing process. All twenty-four specimens of camaenid snails sequenced belonged to the recently described *R. karajarri* species and these records markedly increase the distribution of the species.

Thanks once again for collaborating on this project with Helix. We hope we can continue to provide you with useful information, and feel free to contact us if you have any questions or would like to discuss the results in detail.

Sincerely,

Dr. Zoë Hamilton, Dr. Terrie Finston and Yvette Hitchen
Helix Molecular Solutions

Background and Objective

Sixty-three specimens of invertebrate fauna belonging to four taxonomic groups (Camaenidae, Buthidae, Araneae, Araneomorphae) from the Asian Hub RE Fauna Survey area in the Great Sandy Desert and Dampierland biogeographic Regions were sequenced for variation at the mitochondrial cytochrome oxidase subunit I gene (*COI*). The resulting molecular sequences were then assessed to determine the number of taxa present and compare these results to those sequences publically available on GenBank and those already in Helix's database for context.

Executive summary

- Twenty-four specimens of camaenid *Rhagada* land snails from the survey area were sequenced and assessed for variation at the *COI* mtDNA gene. The molecular data were then placed within an existing molecular taxonomic framework for *Rhagada*, using *COI* mtDNA sequences from GenBank in order to accurately determine what species the Asian Hub camaenids showed affinity to. A single species *Rhagada karajarri* was recorded.
- Two divergent clades of buthid scorpions were sequences for *COI* mtDNA. Preliminary analyses with sequences available on GenBank found two divergent lineages with mean divergence of 7.8%. Collaboration with Dr. Joel Huey from the WA Museum enabled more accurate resolution of these specimens. These specimens show affinity to the *Lychas annulatus* species clade (also recognised as *Hemilychas alexandrinus*), this species has an extensive distribution across the arid interior of Australia. There was substantial divergence between the clades, the significance of which cannot be resolved until the buthid phylogenetic relationships and taxonomy have been revised.
- Four species of nemesiid mygalomorph spiders all Belonging to the genus *Aname* were amongst the fifteen successfully sequenced mygale specimens. Three of these have not been recorded previously.
- Nine spider specimens sequenced belonged to the Araneomorphae infraorder and family placement was undetermined with the sequence data available.

Methods

Twenty-four specimens of camaenid land snails from four sampling locations all belonging to the genus *Rhagada,* along with ten specimens of buthid scorpions from four sampling locations, and twenty-nine suspected mygalomorph spiders from ten sampling locations were sequenced for variation at the cytochrome oxidase subunit I gene (*COI*) using primers LCOI & HCO2 (Folmer *et al*., 1994)

All resulting sequences were edited using SEQUENCHER software (Gene Codes Corporation, Ann Arbor, MI, USA). Alignment was performed with CLUSTAL W (Thompson *et al*., 1994) using default parameters. DNA nucleotide sequences were translated into protein sequences to ensure that the amplified sequences corresponded to the target mtDNA. The translated protein sequences were then checked for the presence of stop codons. All sequences were 'BLAST'ed (Basic Local Alignment Search Tool) with the NCBI (National Centre for Biotechnology Information). This program compares DNA nucleotide sequences with a library of sequences and identifies sequences within the database that resemble the query sequences above a certain threshold. Genetic distances between unique genetic sequences (haplotypes) were measured using uncorrected p-distances (total percentage of nucleotides different between sequences). To account for polymorphism within lineages, the net genetic diversity of Nei (1987) was calculated to give a 'corrected' distance between lineages.

For phylogenetic analysis, likelihood ratio tests using the Bayesian Information Criterion were calculated in MEGA 6.06 (Tamura *et al*., 2013) to determine the best-fit model of evolution. Maximum Likelihood was used to construct the phylogenetic tree, incorporating the best-fit model of evolution. Details of analyses are described for each taxonomic group.

Results

Camaenidae

The camaenid genus *Rhagada* is the most species-rich genus of land snails in Western Australia's semi-arid Pilbara region, where it shows both morphological conservatism within and among species over large distances (Solem, 1997; Johnson *et al*., 2012; Hamilton & Johnson, 2015), and extreme morphological diversification of shell traits over relatively small areas (Stankowski, 2011, 2013, 2015; Stankowski & Johnson, 2014; Johnson *et al.,* 2016). This contrasting pattern of morphological variation in the genus, in addition to repeated incidences of convergent shell morphologies between distinct cryptic taxa (Hamilton, in prep), and the occurrence of narrow hybrid zones with morphological intermediates between distinct taxa (Hamilton & Johnson, 2015) highlights the need for the use of molecular markers in addition to morphological taxonomy for species diagnosis.

Reference specimens and outgroups

A number of reference samples of *Rhagada* were obtained from GenBank for the purposes of providing a taxonomic framework in which the specimens from the survey could be accurately placed. These included all described species from the Pilbara region, previously examined in tests of species taxonomy (Johnson *et al*., 2012; 2016), plus several species from the Kimberley region, from which the Pilbara lineages were derived (Köhler & Criscione, 2013; Burghardt & Köhler, 2014). GenBank accession numbers are shown in parenthesis for the samples used in the analyses and included *Rhagada convicta* (KF151996; JQ362681.1; KF151996.1; JQ362679.1; JQ362696.1; JQ362689.1; JQ362682.1), *R. capensis* (JQ362694.1; JQ362693.1), *R. barrowensis* (KC617888.1; KC617889.1), *R. torulus* (JQ362699.1; JQ362700.1), *R. globosa* (JQ362697.1; JQ362698.1), *R. richardsonii* (JQ362675.1; JQ362676.1; KC703158.1), *R*. sp. 'Pannawonica' (KM405439.1; KM405441.1; KM405442.1), *R. radleyi* (JQ362687.1; JQ362688.1; JQ362685.1; JQ362686.1), *R. pilbarana* (JQ362683.1; JQ362684.1), *R. ngurrana* (JQ362717.1; JQ362718.1), *R. elachystoma* (KP085400.1), *R. dampierana* (KP085399.1), *R. minima* (KF152059.1), *R. dringi* (JQ362674.1; JQ362673.1), *R. karajarri* (KC703133.1; [WAM S49582a]; KC703134.1 [WAM S49582b]), *R. warora* (KC703111.1 [WAM S49580a]), *R. kessneri* (KC703109.1[WAM S37678a]), *R. harti* (KC703143.1 [WAM S49576]), and *R. biggeana* (KC703112.1 [WAM S36739a]).

A *COI* sequence belonging to the land snail *Baudinella tuberculata* (HQ245450.1 [WAM S37063]) was used as the outgroup for all analyses, owing to its relationship with *Rhagada* within the Camaenidae (Johnson *et al*., 2012).

Phylogenetic Analysis

Phylogenetic analyses were calculated in MEGA 6.06 (Tamura *et al*., 2013) using maximum likelihood (ML) with 1000 bootstrap replicates, based on the genetic distances with T92 + G + I as the best-fit model of evolution (Tamura Nei, with gamma distribution and invariant sites). The parameter for the gamma distribution was 0.89. The phylogenetic analysis, which included the fifteen camaenid snail specimens from the survey area, as well as fifty-one reference *Rhagada* specimens obtained from GenBank, placed the Asian Hub *Rhagada* specimens within the *R. karajarri* lineage (Figure 2).

Differentiation within and between lineages

Of the fifteen Asian hub *Rhagada* specimens examined (Table 1), six had shared haplotypes, the remaining nine all had unique haplotypes. Amongst these *Rhagada* specimens from the study area, there was 0.0 % to 5.9 % molecular variation at *COI* (Table 2). The mean sequence divergence between the *Rhagada* specimens from the Asian Hub sample sites, and specimens of *R. karajarri,* the species to which they showed most affinity was 6.1 %. The *R. karajarri* specimens were from Port Smith around 185 km to the north (Table 3). This contrasts the vast amount of differentiation (17.3 %, Table 3) found between the Asian Hub *Rhagada* specimens and *R. dringi*, just 40 km to the north-east. This is a remarkable result as the sample localities for the Asian hub *Rhagada* place these specimens well within the distribution of the described distribution of *R. dringi* according to Solem (1997). However, the molecular results imply that a revision of this species' distribution is required. The results reveal that *Rhagada* from the study area form a strongly supported group with the recently described *R. karajarri* (Burghardt & Köhler, 2014). This extends the distribution of this species significantly, and furthermore suggests that what Solem (1997) described as *R. dringi* (from morphological characters only) may well be

the *R. karajarri* species, and what we have interpreted previously as *R. dringi* (Johnson *et al*., 2012; Burghardt & Köhler, 2014) is in fact an undescribed *Rhagada* species with an extremely limited distribution.

Buthidae

The Buthidae are the largest family of scorpions with 1053 species known under 92 genera (Rein, 2015). Few molecular investigations of phylogenetic relationships in the family Buthidae are available (Gantenbein *et al*., 2000; 2003; Fet *et al*., 2003; Gantenbein & Largiadèr, 2003; Mirshamsi *et al*., 2010; Sousa *et al*., 2010, 2011; Suranse *et al*., 2017). Nevertheless, all these studies agree that morpho-taxonomy has limitations in differentiating and defining species boundaries, with findings that several currently recognized species are species groups comprising undescribed taxa. Morphological variability in buthids within taxa, along with morphological similarity between taxa, has led to taxonomic confusion and underscores the value of the inclusion of molecular data for species delineation in scorpions (Yamashita & Rhoads, 2013).

Summary

Nine of the ten specimens of buthid scorpions were successfully sequenced for *COI* (Table 4). Phylogenetic analyses including the limited available buthid GenBank specimens imply that two clades exist amongst the collected specimens with up to 8.00 % sequence divergence between them (7.8 % mean divergence between clades) (Table 5 & 6)). Collaboration with Dr. Joel Huey, a researcher at the WA Museum, enabled more accurate placement of the buthid scorpions in question. The nine specimens were included in a subsequent phylogenetic analysis by Dr. Joel Huey with his more extensive collection of sequences, which are not yet publically available. This analysis placed the Asian Hub specimens in a species clade along with specimens identified as *Lychas annulatus* by Lorenzo Prendini (American Museum of Natural History). This species is also recognised as *Hemilychas alexandrinus,* which according to the Atlas of Living Australia has a large distributional range across the arid zone of Australia.

Reference specimens and outgroups

Four haplotypes were among the nine successfully sequenced specimens from the Asian Hub study area, one of which was shared amongst five individuals. These sequences were analysed along with reference scorpion specimens belonging to the family Buthidae. These included one specimen of *Mesobuthus martensii* (GenBank accession # JF700146.1), one specimen of *Lychas tricarinatus* (GenBank accession # KT716037.1), three specimens of *Lychas mucronatus* (GenBank accession # JN018211.1, JN018153.1, & JN018210.1) and one specimen of *Centruroides vittatus* (GenBank accession # EU404114.1). The *Mesobuthus* and *Centuroides* sequences were used at outgroups in the analysis.

Phylogenetic analysis

Phylogenetic analyses were calculated in MEGA 6.06 (Tamura *et al*., 2013) using maximum likelihood (ML) with 1000 bootstrap replicates, based on the genetic distances with Tamura-Nei with gamma distribution as the best-fit model of evolution (TN93 + G). The parameter for the gamma distribution was 0.17. The preliminary phylogenetic analysis, which included the nine specimens from the survey area, as well as the four reference specimens obtained from GenBank, revealed two distinct and strongly supported clades of Asian Hub specimens (Figure 2). Subsequent analysis performed by Dr. Joel Huey (WA Museum) with the use of his extensive collection of Australian buthid sequences that are not yet publicly available place the two clades of buthid scorpions within the *Lychas annulatus* clade. This species is also recognised as *Hemilychas alexandrinus.*

Differentiation within and between lineages.

The two lineages of *Lychas annulatus* (Dr. Joel Huey pers. comm.) from the Asian Hub study area showed sequence divergence from one another by a mean of 7.8 %. Each lineage showed a mean within divergence of 0.00 % (0.00 - 0.00)(clade A) and 0.10 % (0.9 – 1.2)(clade B).

Family undetermined

Nine of the sequenced spider specimens did not belong to the Mygalomorphae infraorder (Table 7). Instead a 'megablast' search places them within the Araneomorphae. Their family assignment is unresolved as numerous identity assignments were found including the families Deinopidae, Mesysmaucheniidae, Dictynidae, Salticidae, Sparassidae, and Phyxelididae with 88% similarity (see appendix 1 –'megaBLAST' results).

Araneae

The infraorder of Arachnida, Mygalmomorphae, includes trapdoor spiders and their kin, and they are frequently identified as short-range endemics (SREs)(e.g. Harvey *et al*., 2011; Castalanelli *et al*., 2014). Identification of species has traditionally been performed using morphological techniques, however, only males can be used in identification, as both females and juveniles lack the diagnostic characters used in identification, and furthermore there is a large backlog of undescribed taxa. DNA barcoding with the use of *COI* mtDNA has become a rapid, objective method aiding mygalomorph species identifications and their distributions, and is recognised as providing important information that regulatory authorities can use to assess environmental impacts of large-scale developments (Harvey *et al*., 2008; Environmental Protection Authority, 2009; Castalanelli *et al*., 2014). Extensive molecular work has been conducted on the trap-door spider fauna of Western Australia (Helix, 2009a &b, 2010, 2011a - k, 2012a - h, 2013a & b, 2014a - d, 2015a - e). The resulting dataset provides a molecular framework that can be used to provide regional context for localised sampling.

Reference specimens and outgroups

A number of reference specimens (n = 460) were used including in preliminary analyses to determine the family placement of the mygale specimens. This included 71 Barychelidae samples, 37 Ctenizidae samples, 115 Idiopidae samples, 207 Nemesiidae samples, and 30 Actinopidae samples. Preliminary analyses placed the Asian hub mygale specimens within the Nemesiidae family (Table 7), subsequent analyses therefore included only nemesiid specimens that were within 15 % sequence divergence.

The family Nemesiidae is one of the most diverse and species-rich mygalomorph families in Australia, with 15 genera and 99 named species (Castalanelli *et al*., 2014; 2017). Representative specimens from four other myaglomorph families were used as outgroups (T112080 Synothele MYG127 BBW from Barychelidae; T96581-Conothele MYG059 CAN from Ctenizidae; T96336 Aganippe MYG017 IDI 173 from Idiopidae; T96308 Missulena MYG049 A2 from Actinopidae).

*Phylogenetic anal*ysis

Phylogenetic analyses were calculated in MEGA 6.06 (Tamura *et al*., 2013) using maximum likelihood (ML) with 1000 bootstrap replicates, based on the genetic distances with Tamura-Nei with Gamma distribution as the best-fit model of evolution (TN93 + G). The parameter for the gamma distribution was 0.23. The phylogenetic analysis, which included the thirteen haplotypes for the fifteen specimens from the survey area, as well as the forty-six nemesiid reference specimens within 15% sequence divergence obtained both from Helix's database and from GenBank. Fifteen nemesiid mygale specimens were amongst the samples collected from the Asian Hub survey. Phylogenetic analyses found four distinct clades of nemesiid mygalomorph spiders amongst these specimens.

Differentiation within and between lineages

Thirteen haplotypes existed amongst the fifteen nemesiid specimens (Table 8). None of the specimens sequenced match haplotypes on our molecular database, or on GenBank. The mygale specimens belonged to four separate clades (N7, N138, N139, N140). These clades showed mean divergences of 3.2 % (N7) & 0.4 % (N140) within and substantial between clade divergences with mean divergence ranging from 12.1 % to 19.2 % (Tables 8 & 9). By applying the 9.5 % sequence divergence 'cut-off' that was tested by Castalanelli *et al*., (2014), these levels of sequence divergence indicate that the specimens belong to four distinct nemesiid species. One clade showed associations with reference specimens with individuals showing between 3.8 % to 6.3 % sequence divergence from the 'KJ744648' individual from Genbank, 4.8 % to 5.8 % from the KJ744648 GenBank specimen, and 4.6 % to 6.3 % divergence from the

NBT_N7_AD748. These reference specimens (KJ744649, KJ744648, & NBT_N7_AD748) were collected between 245 km & 300 km to the south-west of the Asian Hub specimens from the same lineage(see Appendix 2 for genetic p-distance between all specimens). This result implies this species has a large distribution. The remaining three clades are only distantly associated with reference specimens (Table 9), with sequence divergences of 10.9 % ('NN35' & KJ745288) to the closest related samples for clade N138, and sequence divergences of 17.0 % for clade N139 ('NN29' & KJ744688), and 14.5 % for clade N140 ('NN32' with individuals JQ772139, KJ45375, NBC_N6_AD577), and are therefore likely to be new species (see Appendix 2 for genetic p-distances between all specimens).

Conclusions

The mtDNA gene cytochrome oxidase 1 (*COI*) is widely considered to show suitable variation to distinguish species (Hebert *et al*., 2003a), and the use of this gene can be extremely effective for 'DNA barcoding' in taxa where clear differentiation exists between intra and interspecific levels of divergence (e.g. Hebert *et al*., 2004a; 2004b). In a comparison of *COI* sequences for over 13,000 pairs of taxa, Hebert *et al* (2003b) found a mean of 11.1% sequence divergence between distinct species. Nearly 80% of these comparisons found that species pairs differed from one another by greater than 8% sequence divergence. Despite its merits in barcoding however, a taxon by taxon approach, examining the amount of phylogenetic variation within and between taxa is the most widely accepted method of delineating species and their distributions, especially in areas where rapidly expanding mining operations outpace taxonomic treatment of unresolved taxa.

Camaenidae

The *Rhagada* land snail specimens undoubtedly belong to the recently described *R. karajarri* species, and extend its distribution markedly (by 180 km). This result also calls for a revision of the *R. dringi* species and its apparently very limited distribution. Morphological similarities between the species have led to taxonomic confusion with a perceived extensive distribution for *R. dringi* according to Solem (1997) based on morphological characters alone.

Buthidae

Two distinct clades of were evident amongst the buthid specimens sequenced. These appear to be two divergent clades belonging to *Lychas annulatus*. The significance of the divergent clades cannot be resolved until the buthid phylogenetic relationships and taxonomy have been revised.

Araneae

Four distinct undescribed species of nemesiid mygales were apparent, all from the genus *Aname* three of which are likely to be newly recorded species.

References

Australian Faunal Directory. Australian Government, Department of Sustainability, Environment, Water, Population and Communities http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/index.html

Brower AVZ. 1994. Rapid morphological radiation and convergence among races of the butterfly Heliconius erato inferred from patterns of mitochondrial DNA evolution. *Proceedings of the National Academy of Sciences USA*. **91**: 6491-6495.

Burghardt I, Köhler F. 2014. *Rhagada* revisited: on the taxonomy of species from the Kimberley and Dampierland, Western Australia (Pulmonata, Camaenidae). *Molluscan Research* **35**: 37-50.

Castalanelli MA, Huey JA, Hillyer MJ, Harvey MS. 2017. Molecular and morphological evidence for a new genus of small trapdoor spiders from arid Western Australia (Araneae: Mygalomorphae: Nemesiidae: Anaminae). *Invertebrate Systematics* **31**: 492-505.

Environmental Protection Authority 2009. Sampling if short range endemic invertebrate fauna for environmental impact assessment in Western Australia. In 'Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986). Vol. No. 20'. pp. 1-31.

Fet V, Gantenbein B, Gromov AV, Lowe G, Lourenço WR. 2003. The first molecular phylogeny of Buthidae (Scorpiones). *Euscorpius*. **4**: 1–10.

Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R. 1994. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology* **3**: 294-299.

Gantenbein B, Kropf C, Largiadèr CR, Scholl A. 2000. Molecular and mor- phological evidence for the presence of a new buthid taxon (Scorpiones: Buthidae) on the island of Cyprus. *Revue Suisse Zoologie*. **107**: 213–232.

Gantenbein B, Fet V, Gromov AV. 2003. The First DNA phylogeny of four species of *Mesobuthus* (Scorpiones, Buthidae) from Eurasia. *Journal of Arachnology*. **31**: 412–420.

Gantenbein B, Largiadèr CR. 2003. The phylogeographic importance of the Strait of Gibraltar as a gene flow barrier in terrestrial arthropods: a case study with the scorpion *Buthus occitanus* as model organism. *Molecular Phylogenetics and Evolution* **28**: 119–130.

Hamilton ZR, Johnson MS. 2015. Hybridization between genetically and morphologically divergent forms of *Rhagada* (Gastropoda: Camaenidae) snails at a zone of secondary contact). *Biological Journal of the Linnean Society* **114**: 348-362.

Harvey MS, Berry O, Edward KL, Humphreys G. 2008. Molecular and morphological systematics of hypogean schizomids (Schizomida: Hubbardiidae) in semiarid Australia. *Invertebrate Systematics* **22**: 167-194.

Harvey MS, Rix MG, Framenau VW, Hamilton ZR, Johnson MS, Teale RJ, Humphreys G, Humphreys WF. 2011. Protecting the innocent: studying short-range endemic taxa enhances conservation outcomes. *Invertebrate Systematics* **25**: 1-10.

Hebert PDN, Cywinska A, Ball SL, deWaard JR. 2003a. Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London B* **270**: 313-321.

Hebert PDN, Ratnasingham S, deWaard JR. 2003. Barcoding animal life: cytochrome c oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society of London B (supplement)* **270**, S96-S99.

Hebert, P.D.N., Penton EH, Burns JM, Janzen DH, Hallwachs W. 2004a. Ten species in one: DNA barcoding reveals cryptic species in the neotropical skipper butterfly *Astraptes fulgerator*. *PNAS* **101**: 14812-14817.

Hebert PDN, Stoeckle MY, Zemiak TS, Francis CM 2004b. Identification of birds through DNA barcodes. *PLoS Biology* **2**: 1657–1663.

Helix 2009a. Report on the molecular systematics of *Aganippe castellum*. Unpublished report for Biota Environmental Sciences.

Helix 2009b. Report on the molecular systematics of wishbone spider *Aname*. Unpublished report for BHP Billiton.

Helix 2010. Report on the molecular systematics of mygalomorph spiders from Forestania. Unpublished report for Biota Environmental Sciences.

Helix 2011a. Report on the molecular systematics of *Galeosoma* from Forestania. Unpublished report for Biota Environmental Sciences.

Helix 2011b. Report on the molecular systematics of Mygalomorphae from Forrestania. Unpublished report for Biota Environmental Sciences.

Helix 2011c. Report on the molecular systematics of Mygalomorphae from Deception. Unpublished report for Biota Environmental Sciences.

Helix 2011d. Report on the molecular systematics of Mygalomorphae from South Parmelia. Unpublished report for Biota Environmental Sciences.

Helix 2011e. Report on the molecular systematics of Mygalomorphae from Jinidi. Unpublished report for Biota Environmental Sciences.

Helix 2011f. Report on the molecular systematics of Mygalomorphae from Southern Flank. Unpublished report for Biota Environmental Sciences.

Helix 2011g. Report on the molecular systematics of Mygalomorphae from Area C to Yandi. Unpublished report for Biota Environmental Sciences.

Helix 2011h. Report on the molecular systematics of Mygalomorphae from Hammersley Irrigation. Unpublished report for Biota Environmental Sciences.

Helix 2011i. Report on the molecular systematics of Mygalomorphae from Mudlark. Unpublished report for Biota Environmental Sciences.

Helix 2011j. Report on the molecular systematics of Mygalomorphae from Marillana. Unpublished report for Biota Environmental Sciences.

Helix 2011k. Report on the molecular systematics of Mygalomorphae from Jinidi to Manline. Unpublished report for Biota Environmental Sciences.

Helix 2011l. Report on the molecular systematics of Mygalomorphae from Eastern Deviation. Unpublished report for Biota Environmental Sciences.

Helix 2012a. Report on the molecular systematics of Mygalomorphae from the Pilbara. Unpublished report for Biota Environmental Sciences, 31 January.

Helix 2012b. Report on the molecular systematics of Mygalomorphae from West Turner Syncline. Unpublished report for Biota Environmental Sciences.

Helix 2012. Report on the molecular systematics of Mygalomorphae from Southern Flank to Jinidi. Unpublished report for Biota Environmental Sciences.

Helix 2012c. Report on the molecular systematics of Mygalomorphae from Koodaideri West Corridor. Unpublished report for Biota Environmental Sciences.

Helix 2012d. Report on the molecular systematics of Mygalomorphae from Koodaideri phase IV and Koodaideri South. Unpublished report for Biota Environmental Sciences.

Helix 2012e. Report on the molecular systematics of Mygalomorphae from Cape Lambert. Unpublished report for Biota Environmental Sciences.

Helix 2012f. Report on the molecular systematics of Mygalomorphae from Marra Mamba. Unpublished report for Biota Environmental Sciences.

Helix 2012g. Report on the molecular systematics of Mygalomorphae from Mt Richardson. Unpublished report for Biota Environmental Sciences.

Helix 2012h. Report on the molecular systematics of Mygalomorphae from West Turner Extension. Unpublished report for Biota Environmental Sciences.

Helix 2013a. Report on the molecular systematics of Mygalomorphae from Mt Richardson phase I and II. Unpublished report for Biota Environmental Sciences.

Helix 2013b. Report on the molecular systematics of mygalomorphae from Koodaideri rail corridor. Unpublished report for Biota Environmental Sciences.

Helix 2014a. Molecular systematics of mygalomorphae from Kundip. Unpublished report for Biota Environmental Sciences.

Helix 2014b. Molecular systematics of mygalomorphae from Koodaideri northern extension. Unpublished report for Biota Environmental Sciences.

Helix 2014c Molecular Systematics of mygalomorphae from Yandi Billiards. Unpublished report for Biota Environmental Sciences.

Helix 2014d. Molecular systematics of mygalomorphae from Yandi Billiards phase 2. Unpublished report for Biota Environmental Sciences.

Helix 2015a. Report on the molecular systematics of mygalomorphae from Bungaroo Valley. Unpublished report for Biota Environmental Sciences.

Helix 2015b. Report on the molecular systematics of mygalomorphae form Baby Hope Downs. Unpublished report for Biota Environmental Sciences.

Helix 2015c. Molecular systematics of mygalomorphae from Yandi Oxbow. Unpublished report for Biota Environmental Sciences.

Helix 2015d. Molecular systematics of mygalopmorphae from Red Hill. Unpublished report for Biota Environmental Sciences.

Helix 2015e. Molecular systematics of mygalomorphae from the Buckland Hills Level 2 fauna survey. Unpublished report for Biota Environmental Sciences.

Johnson MS, Hamilton ZR, Teale R, Kendrick PG. 2012. Endemic evolutionary radiation of *Rhagada* land snails (Pulmonata: Camaenidae) in a continental archipelago in northern Western Australia. *Biological Journal of the Linnean Society* **106**: 316-327.

Johnson MS, Stankowski S, Kendrick PG, Hamilton ZR, Teale RJ. 2016. Diversity, complementary distributions and taxonomy of *Rhagada* land snails (Gastropoda: Camaenidae) on the Burrup Peninsula, Western Australia. *Invertebrate Systematics* **30**: 323-334.

Köhler F, Criscione F. 2013. Small snails in a big place: a radiation in the semi-arid rangelands in northern Australia (Eupulmonata, Camaenidae, *Nanotrachia* gen. nov.). *Zoological Journal of the Linnean Society* **169**: 103-123.

Mirshamsi O, Sari A, Elahi E, Hosseinie S. 2010. Phylogenetic relationships of *Mesobuthus eupeus* (CL Koch, 1839) inferred from COI sequences (Scorpiones: Buthidae). *Journal of Natural History* **44**: 2851–2872.

Nei M. 1987. DNA polymorphism within and between populations. In: *Molecular Evolutionary Genetics*. pp.254-286. Columbia University Press New York, NY.

Rein JO. 2015. Scorpion files. Species List. Buthidae. [Cited 2015 October 7]. Available from: http://www.ntnu.no/ub/scorpion-files/buthidae.php.

Simon C, Fratl F, Beckenbach A, Crespi, B, Liu H, Flook P. 1996. Evolution, weighting, and phylogenetic utility of mitochondrial gene sequences and a compilation of conserved polymerase chain reaction primers. *Annals of the Entomological Society* **87**: 651-701.

Solem A. 1997. Camaenid land snails from Western and Central Australia (Mollusca: Pulmonata: Camaenidae): VII. Taxa from Dampierland through the Nullarbor. *Records of the Western Australian Museum Supplement* **50**: 1461– 1906.

Sousa P, Froufe E, Alves PC, Harris DJ. 2010. Genetic diversity within scorpions of the genus *Buthus* from the Iberian Peninsula: mitochondrial DNA sequence data indicate additional distinct cryptic lineages. *Journal of Arachnology*. **38**: 206–211.

Stankowski S. 2011. Extreme, continuous variation in an island snail: local diversification and association of shell form with the current environment. *Biological Journal of the Linnean Society* **104**: 756-769.

Stankowski S. 2013. Ecological speciation in an island snail: evidence for the parallel evolution of a novel ecotype and maintenance by ecologically dependent postzygotic selection. *Molecular Ecology* **22**: 2726-2741.

Stankowski S. 2015. Layers of contingency shroud pervasive ecological divergence in a local radiation of land snails. *Biological Journal of the Linnean Society* **116**: 267-276.

Stankowski S, Johnson MS. 2014. Biogeographic discordance of molecular phylogenetic and phenotypic variation in a continental archipelago radiation of land snails. *BMC Evolutionary Biology* **14**: 1-12.

Suranse V, Sawant NS, Paripatyadar SV, Krutha K, Paingankar MS, Padhye AD, Bastawade DB, Dahanukar N. 2017. First molecular phylogeny of scorpions of the family Buthidae from India. *Mitochondrial DNA Part A* **28**: 606-611.

Tamura K, Peterson D, Peterson N, Stecher G, Nei M, Kumar S. 2011. MEGA 5: Molecular Evolutionary Genetic Analysis Version 6. *Molecular Biology and Evolution* **28**: 2731 – 2739.

Tamura K, Stecher G, Peterson D, Filipski A, Kumar S. 2013. MEGA 6: Molecular Evolutionary Genetic Analysis using Maximum Likelihood, evolutionary distance, and Maximum Parsimony methods. *Molecular Biology and Evolution* **30**: 2725 – 2729.

Thompson J, Higgins D, Gibson T. 1994. CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research* **22**, 4673–4680. doi:10.1093/nar/ 22.22.4673

Yamashita T, Rhoads DD. 2013. Species delimitation and morphological divergence in the scorpion *Centroides vittatus* (Say, 1821): Insights from phylogeography. *PLoS One* **8**: e68282.

Table 1. Camaenid *Rhagada* snail specimens used in the present study, and the genetic lineage to which they belong.

Biota Specimen ID	Helix Lab ID	Genetic Lineage/ Taxonomic ID
Cable track site 2-01	NN40	*Rhagada karajarri*
Cable track site 2-02	NN41	*Rhagada karajarri*
Cable track site 2-03	NN42	*Rhagada karajarri*
Cable track site 2-04	NN43	*Rhagada karajarri*
Cable track site 2-05	NN44	*Rhagada karajarri*
Cable track site 2-06	NN45	*Rhagada karajarri*
Opp North Beach-01	NN46	*Rhagada karajarri*
Opp North Beach-02	NN47	*Rhagada karajarri*
Opp North Beach-03	NN48	*Rhagada karajarri*
Paddock-01	NN49	*Rhagada karajarri*
Paddock-02	NN50	*Rhagada karajarri*
Paddock-03	NN51	*Rhagada karajarri*
Paddock-04	NN52	*Rhagada karajarri*
Paddock-05	NN53	*Rhagada karajarri*
Paddock-06	NN54	*Rhagada karajarri*
Paddock-07	NN55	*Rhagada karajarri*
Paddock-08	NN56	*Rhagada karajarri*
Paddock-09	NN57	*Rhagada karajarri*
Inland Dunes-01	NN58	*Rhagada karajarri*
Inland Dunes-02	NN59	*Rhagada karajarri*
Inland Dunes-03	NN60	*Rhagada karajarri*
Inland Dunes-04	NN61	*Rhagada karajarri*

Table 2. Genetic p-distance (below) and the associated standard error (above) between camaenid haplotypes of *Rhagada* from the Asian Hub area as shown in Figure 1. Specimens identified with '*' are those representing shared haplotypes. Un-corrected p-distances do not account for mutational saturation, which results from back mutations, and therefore provide a conservative estimate of genetic distance.

	NN40	**NN41**	**NN45***	**NN46***	**NN48**	**NN50**	**NN51***	**NN56***	**NN57***	**NN58**	**NN61***
NN40		0.003	0.003	0.009	0.003	0.003	0.003	0.003	0.002	0.002	0.008
NN41	0.009		0.002	0.009	0.002	0.002	0.002	0.003	0.003	0.003	0.009
NN45*	0.007	0.004		0.009	0.002	0.002	0.001	0.002	0.002	0.003	0.009
NN46*	0.056	0.059	0.057		0.009	0.009	0.009	0.009	0.009	0.009	0.003
NN48	0.007	0.004	0.003	0.054		0.002	0.001	0.002	0.002	0.003	0.008
NN50	0.007	0.004	0.003	0.057	0.003		0.001	0.002	0.002	0.003	0.009
NN51*	0.006	0.003	0.001	0.056	0.001	0.001		0.001	0.002	0.002	0.009
NN56*	0.007	0.004	0.003	0.054	0.003	0.003	0.001		0.002	0.003	0.008
NN57*	0.003	0.006	0.004	0.056	0.004	0.004	0.003	0.004		0.001	0.008
NN58	0.004	0.007	0.006	0.056	0.006	0.006	0.004	0.006	0.001		0.008
NN61*	0.054	0.057	0.056	0.004	0.053	0.056	0.054	0.053	0.054	0.054	

Table 3. Mean between group distances (below) and standard error (s.e.) (above) for 22 lineages of camaenid snails utilised in analyses.

	Asian Hub *Rhagada*	*Baudinella*	*R. barrowensis*	*R. capensis*	*R. convicta*	*R. elachystoma*	*R. dringi*	*R. globosa*	*R. ngurrana*	*R. pilbarana*	*R. radleyi*	*R. richardsonii*	*R. sp. Pannawonica*	*R. torulus*	*R. karajarri*	*R. biggeana*	*R. harti*	*R. kessneri*	*R. setzeri*	*R. waroora*
ian Hub *agada*		0.017	0.015	0.015	0.014	0.015	0.014	0.014	0.016	0.015	0.014	0.015	0.015	0.015	0.009	0.015	0.015	0.015	0.016	0.016
udinella	0.214		0.017	0.018	0.015	0.015	0.017	0.016	0.016	0.016	0.016	0.016	0.017	0.016	0.018	0.017	0.016	0.016	0.017	0.017
arrowensis	0.182	0.202		0.016	0.011	0.015	0.014	0.015	0.015	0.014	0.012	0.013	0.015	0.015	0.016	0.017	0.016	0.016	0.016	0.016
capensis	0.192	0.195	0.172		0.014	0.014	0.015	0.012	0.015	0.015	0.015	0.015	0.015	0.012	0.016	0.017	0.015	0.017	0.016	0.017
convicta	0.185	0.193	0.118	0.165		0.013	0.011	0.013	0.014	0.011	0.010	0.012	0.014	0.014	0.015	0.015	0.014	0.015	0.015	0.015
achystoma	0.181	0.185	0.173	0.143	0.158		0.014	0.013	0.011	0.014	0.014	0.014	0.014	0.014	0.016	0.015	0.015	0.015	0.014	0.016
dringi	0.173	0.180	0.139	0.163	0.124	0.154		0.014	0.015	0.014	0.013	0.014	0.014	0.015	0.015	0.016	0.015	0.016	0.015	0.017
globosa	0.164	0.176	0.159	0.096	0.154	0.137	0.149		0.015	0.014	0.015	0.015	0.014	0.011	0.015	0.016	0.015	0.016	0.016	0.017
ngurrana	0.199	0.186	0.173	0.158	0.169	0.102	0.157	0.156		0.015	0.015	0.015	0.015	0.015	0.016	0.017	0.016	0.017	0.016	0.017
pilbarana	0.199	0.210	0.131	0.177	0.115	0.166	0.154	0.155	0.163		0.012	0.012	0.014	0.015	0.016	0.016	0.014	0.016	0.016	0.018
radleyi	0.175	0.193	0.109	0.159	0.095	0.147	0.129	0.155	0.159	0.104		0.013	0.015	0.015	0.015	0.016	0.015	0.016	0.016	0.016
hardsonii	0.183	0.188	0.124	0.165	0.117	0.155	0.143	0.165	0.169	0.108	0.110		0.015	0.015	0.016	0.016	0.015	0.016	0.016	0.017
sp. *nnawonica*	0.195	0.192	0.171	0.147	0.164	0.143	0.146	0.138	0.148	0.165	0.165	0.161		0.014	0.016	0.017	0.015	0.017	0.017	0.017
torulus	0.183	0.189	0.174	0.107	0.168	0.146	0.156	0.089	0.164	0.159	0.162	0.165	0.141		0.015	0.016	0.015	0.017	0.016	0.017
karajarri	0.061	0.220	0.185	0.195	0.186	0.181	0.166	0.177	0.199	0.195	0.180	0.179	0.197	0.181		0.017	0.016	0.016	0.017	0.016
biggeana	0.208	0.196	0.192	0.194	0.192	0.186	0.186	0.190	0.199	0.200	0.178	0.188	0.194	0.189	0.207		0.015	0.015	0.017	0.018
harti	0.193	0.181	0.168	0.171	0.169	0.183	0.152	0.155	0.186	0.167	0.163	0.168	0.172	0.162	0.190	0.155		0.016	0.016	0.017
kessneri	0.193	0.205	0.181	0.204	0.182	0.163	0.186	0.189	0.181	0.181	0.165	0.176	0.179	0.202	0.180	0.143	0.183		0.017	0.017
setzeri	0.188	0.185	0.171	0.169	0.176	0.154	0.168	0.161	0.170	0.180	0.164	0.175	0.172	0.173	0.184	0.199	0.185	0.197		0.018
waroora	0.198	0.210	0.205	0.213	0.201	0.205	0.207	0.207	0.181	0.210	0.193	0.203	0.216	0.223	0.199	0.214	0.190	0.214	0.212	
solorensis	0.185	0.186	0.178	0.176	0.176	0.161	0.165	0.156	0.156	0.169	0.165	0.186	0.151	0.164	0.187	0.198	0.177	0.192	0.129	0.214
setzeri auroensis	0.203	0.201	0.182	0.175	0.186	0.164	0.174	0.173	0.175	0.190	0.174	0.189	0.180	0.181	0.195	0.206	0.187	0.198	0.039	0.222

Table. Mean within group p-distances for the twenty-two clades of *Rhagada* and the associated variance (s.e.), representing the seventy-three individuals of camaenid snails utilised in analyses. n/a= not applicable

	Species	p-distance	s.e.
80-mile Beach	**Asian Hub *Rhagada***	0.027787934	0.004473486
Dampierland	***R. karajarri***	0.007312614	0.002986689
Pilbara Mainland	***R. dringi***	0.003656307	0.002449676
	R. convicta	0.070647979	0.006588534
	R. pilbarana	0.010968921	0.00419212
	R. radleyi	0.012797075	0.004568103
	R. richardsonii	0.009140768	0.004057425
	R. sp. Pannawonica	0.002437538	0.001670985
	R. barrowensis	0.007312614	0.003402982
Shark Bay Region	***R. capensis***	0.001828154	0.001733956
	R. torulus	0.020109689	0.005928764
	R. globosa	0.016453382	0.005209184
Pilbara Islands	***R. ngurrana***	0	0
	R. elachystoma	0.0511883	0.007477044
Kimberley Region	***R. waroora***	n/a	n/a
	R. biggeana	n/a	n/a
	R. harti	n/a	n/a
	R. kessneri	n/a	n/a
	***Baudinella* (outgroup)**	n/a	n/a
Lesser Sundas	***R. setzeri***	n/a	n/a
	R. solorensis	0.001828154	0.001792877
	R. setzeri atauroensis	0.010603291	0.002637137

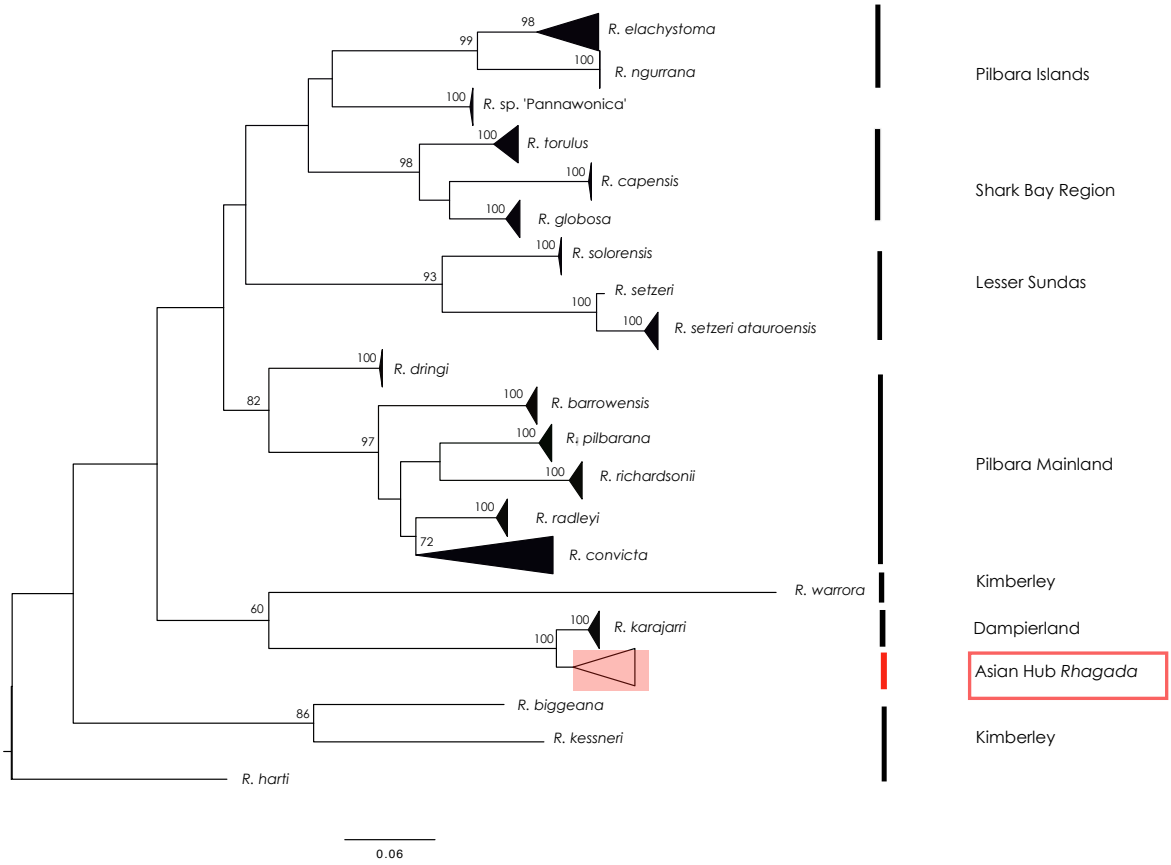


Figure 1. Maximum likelihood analysis of *Rhagada COI* mtDNA sequences, showing the placement of the Asian Hub *Rhagada* within the current taxonomic framework of *Rhagada* species from the Pilbara, Dampierland, Kimberley and Lesser Sundas. Terminal nodes are collapsed. Numbers on nodes indicate nodal support by means of maximum likelihood (ML) bootstrap values. Bootstrap values <60 are not shown. Scale indicates inferred evolutionary distance (substitutions/site).

Table 4. Buthid scorpion specimens used in the present study, and the species and genetic lineage to which they belong. Highlighted specimens were unsuccessful during the PCR process.

Biota Specimen ID	Helix Lab ID	Taxonomic ID	Genetic lineage
Sc20170828AHF16-2	NN01	*Lychas annulatus*	B
Sc20170828AHF15-1	NN02	PCR unsuccessful	n/a
Sc20170828AHF19-2	NN03	*Lychas annulatus*	B
Sc20170939AHF16-1	NN04	*Lychas annulatus*	B
Sc20170828AHF19-2	NN05	*Lychas annulatus*	B
Sc20170828AHF19-3	NN06	*Lychas annulatus*	A
Sc20170828AHF19-1	NN07	*Lychas annulatus*	A
Sc20170828AHF19-1	NN08	*Lychas annulatus*	A
Sc20170828AHF18-1	NN09	*Lychas annulatus*	B
Sc20170828AHF19-4	NN10	*Lychas annulatus*	B

Table 5. Genetic p- distance (below) and associated standard error (above) between haplotypes of buthid specimens of *Lychas annulatus* as shown in Figure 2. Specimens identified with '*' represent shared haplotypes. Un-corrected p-distances do not account for mutational saturation, which results from back mutations, and therefore provide a conservative estimate of genetic distance.

	NN01 B	**NN09 B**	**NN04 B**	**NN03 A**
NN01 B		0.004	0.003	0.010
NN09 B	0.012		0.003	0.010
NN04 B	0.009	0.009		0.010
NN03 * A	0.082	0.076	0.076	

Table 6. Genetic p-distance (below) and associated standard error (above) between Asian Hub buthid specimens and reference buthid specimens obtained from GenBank

	NN01	**NN03**	**NN04**	**NN05**	**NN06**	**NN07**	**NN08**	**NN09**	**NN10**	**KT716037.1 *Lychas tricarinatus***	**JN018211.1 *Lychas mucronatus***	**JN018153.1 *Lychas mucronatus***	**JN018210.1 *Lychas mucronatus***	**EU404114.1 *Centruroides vittatus***	**JF700146.1 *Mesobuthus martensii***
NN01		0.012	0.004	0.012	0.012	0.012	0.012	0.005	0.012	0.016	0.016	0.015	0.016	0.016	0.017
NN03	0.084		0.011	0.000	0.000	0.000	0.000	0.012	0.000	0.015	0.016	0.014	0.015	0.016	0.017
NN04	0.008	0.076		0.011	0.011	0.011	0.011	0.005	0.011	0.016	0.016	0.015	0.016	0.016	0.017
NN05	0.084	0.000	0.076		0.000	0.000	0.000	0.012	0.000	0.015	0.016	0.014	0.015	0.016	0.017
NN06	0.084	0.000	0.076	0.000		0.000	0.000	0.012	0.000	0.015	0.016	0.014	0.015	0.016	0.017
NN07	0.084	0.000	0.076	0.000	0.000		0.000	0.012	0.000	0.015	0.016	0.014	0.015	0.016	0.017
NN08	0.084	0.000	0.076	0.000	0.000	0.000		0.012	0.000	0.015	0.016	0.014	0.015	0.016	0.017
NN09	0.014	0.078	0.010	0.078	0.078	0.078	0.078		0.012	0.016	0.015	0.015	0.016	0.016	0.017
NN10	0.084	0.000	0.076	0.000	0.000	0.000	0.000	0.078		0.015	0.016	0.014	0.015	0.016	0.017
KT716037.1 *Lychas tricarinatus*	0.162	0.138	0.154	0.138	0.138	0.138	0.138	0.152	0.138		0.017	0.016	0.015	0.016	0.017
JN018211.1 *Lychas mucronatus*	0.152	0.160	0.156	0.160	0.160	0.160	0.160	0.150	0.160	0.158		0.012	0.016	0.018	0.018
JN018153.1 *Lychas mucronatus*	0.148	0.126	0.142	0.126	0.126	0.126	0.126	0.144	0.126	0.166	0.088		0.015	0.016	0.016
JN018210.1 *Lychas mucronatus*	0.154	0.148	0.154	0.148	0.148	0.148	0.148	0.152	0.148	0.156	0.170	0.154		0.016	0.018
EU404114.1 *Centruroides vittatus*	0.162	0.182	0.162	0.182	0.182	0.182	0.182	0.166	0.182	0.166	0.202	0.180	0.166		0.016
JF700146.1 *Mesobuthus martensii*	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.184	0.182	0.182	0.200	0.172	0.182	0.164	

Table 7. Mean within group distances for the two lineages of *Lychas annulatus*.

	distance	s.e.
A	0.000	0.000
B	0.010	0.003

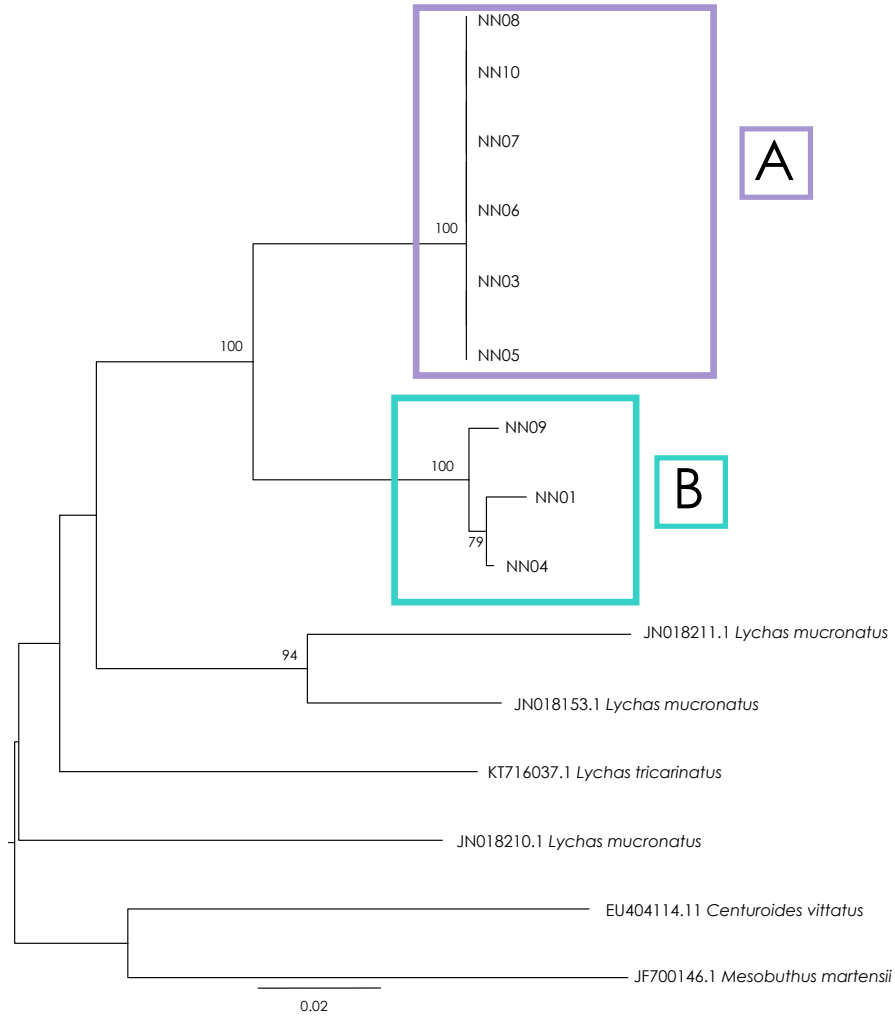


Figure 2. Maximum Likelihood analysis of *COI* haplotypes of buthid scorpion specimens of *Lychas annulatus* from the Asian Hub study area. Numbers on nodes correspond to bootstrap support. Bootstrap < 65 not shown. Lineages are labelled A and B, as referred to in the text and Tables 5 and 7. Scale bar = number of substitutions per site.

Table 8. Mygalomorph specimens used in the present study, and the genetic lineage to which they belong. Grey shading represents either unsuccessful sequencing, or non-mygalomorph lineages. Coloured shading corresponds to colour-coding of species represented in Figure 3.

Biota Specimen ID	Helix Lab ID	Taxonomic ID	Genetic lineage	Species
M20170831.AHF01-01	NN11	Nemesiidae	NRF	N7
M20170904.AHF01-01	NN15	Nemesiidae	NRG	N7
M20170903.AHF06-01	NN16	Nemesiidae	NRH	N7
M20170830.AHF07-01	NN17	Nemesiidae	NRI	N7
M20170830.AHF07-02	NN18	Nemesiidae	NRJ	N7
M20170903.AHF07-01	NN19	Nemesiidae	NRI	N7
M20170830.AHF10-01	NN20	Nemesiidae	NRK	N7
M20170904.AHF10.SRE-01	NN21	Nemesiidae	NRL	N7
M20170901.AHF.SRE03-01	NN29	Nemesiidae	NRR	N139
M20170901.AHF.SRE03-02	NN30	Nemesiidae	NRR	N139
M20170830.AHF.SRE02-02	NN32	Nemesiidae	NRS	N140
M20170829.AHF13.SRE-01	NN35	Nemesiidae	NRP	N138
M20170904.AHF13.SRE-01	NN36	Nemesiidae	NRQ	N138
M20170904.AHF12.SRE-01	NN37	Nemesiidae	NRM	N7
M20170904.AHF??.Bary-02	NN38	Nemesiidae	NRO	N7
M20170828.AHF12-01	NN25			Unusable sequence
M20170902.AHF13-01	NN26			Unusable sequence
M20170902.AHF13-02	NN27			Unusable sequence
M20170903.AHF13-01	NN28			Unusable sequence
M20170830.AHF.SRE02-01	NN31			Failed PCR
M20170903.AHF01-01	NN12			Not mygalmorph
M20170903.AHF01-02	NN13			Not mygalmorph
M20170903.AHF01-03	NN14			Not mygalmorph
M20170904.AHF10.SRE-03	NN22			Not mygalmorph
M20170904.AHF10.SRE-04	NN23			Not mygalmorph
M20170904.AHF10.SRE-05	NN24			Not mygalmorph
M20170904.AHF07.SRE-01	NN33			Not mygalmorph
M20170904.AHF07.SRE-01b	NN34			Not mygalmorph
M20170904.AHF07.SRE-02	NN39			Not mygalmorph

Table 9. Genetic p-distance (below) and the associated variance (s.e. – above) between the 13 haplotypes (lineages) representing the 15 sequenced specimens of nemesiid mygalomorphs, as shown in Figure 3. Shading in distance matrix corresponds to colour-coding of lineages in Figure 3.Un-corrected p-distances do not account for mutational saturation, which results from back mutations, and therefore provide a conservative estimate of genetic distance.

		N7									N138		N139	N140
		NRF_N7_NN11	NRG_N7_NN15	NRH_N7_NN16	NRI_N7_NN17	NRJ_N7_NN18	NRK_N7_NN20	NRL_N7_NN21	NRM_N7_NN37	NRO_N7_NN38	NRP_N138_NN35	NRQ_N138_NN36	NRR_N139_NN29	NRS_N140_NN32
N7	NRF_N7_NN11		0.004	0.005	0.004	0.005	0.007	0.007	0.008	0.006	0.012	0.012	0.015	0.013
	NRG_N7_NN15	0.012		0.006	0.005	0.005	0.007	0.007	0.008	0.007	0.011	0.011	0.014	0.012
	NRH_N7_NN16	0.022	0.025		0.004	0.004	0.007	0.007	0.009	0.007	0.012	0.012	0.015	0.013
	NRI_N7_NN17	0.015	0.018	0.013		0.003	0.007	0.007	0.008	0.007	0.011	0.011	0.015	0.013
	NRJ_N7_NN18	0.015	0.018	0.010	0.009		0.007	0.007	0.008	0.006	0.011	0.011	0.015	0.013
	NRK_N7_NN20	0.034	0.040	0.038	0.037	0.037		0.002	0.008	0.004	0.012	0.012	0.015	0.013
	NRL_N7_NN21	0.034	0.040	0.038	0.037	0.037	0.003		0.008	0.004	0.012	0.012	0.015	0.013
	NRM_N7_NN37	0.047	0.050	0.055	0.050	0.050	0.052	0.055		0.009	0.012	0.013	0.015	0.013
	NRO_N7_NN38	0.032	0.038	0.034	0.035	0.032	0.010	0.010	0.056		0.012	0.012	0.015	0.013
N138	NRP_N138_NN35	0.117	0.112	0.122	0.115	0.115	0.124	0.124	0.128	0.125		0.003	0.014	0.013
	NRQ_N138_NN36	0.119	0.115	0.121	0.117	0.117	0.127	0.127	0.131	0.128	0.004		0.014	0.013
N139	NRR_N139_NN29	0.193	0.190	0.196	0.190	0.192	0.187	0.184	0.206	0.186	0.190	0.195		0.014
N140	NRS_N140_NN32	0.146	0.149	0.152	0.150	0.152	0.150	0.150	0.164	0.149	0.165	0.170	0.162	

Table 10. Mean within group distances for the four lineages of nemesiid mygalomorph spiders. n/a= not applicable.

	Mean Within group p-dist	s.e.
N7	0.042259657	0.004966469
N112	0.012475278	0.00288803
N6	0.048504211	0.004855819
N5	0.016430853	0.00274486
N4	0	0
MYG182	0	0
MYG030	0	0
N138	0.004792332	0.00268387
N139	n/a	n/a
N140	n/a	n/a

Table 11. Mean between group (species) p-distances (below) and associated variance (s.e. – above). Species names correspond to those depicted in Figure 3.

	N7	N112	N6	N5	N4	MYG182	MYG030	N138	N139	N140
N7		0.009	0.011	0.011	0.012	0.012	0.012	0.012	0.014	0.013
N112	0.093		0.011	0.012	0.012	0.013	0.012	0.012	0.015	0.014
N6	0.122	0.126		0.012	0.012	0.013	0.012	0.011	0.015	0.013
N5	0.131	0.130	0.133		0.013	0.013	0.013	0.013	0.015	0.014
N4	0.139	0.141	0.164	0.159		0.014	0.012	0.013	0.016	0.014
MYG182	0.141	0.135	0.167	0.160	0.145		0.014	0.013	0.015	0.015
MYG030	0.151	0.141	0.150	0.140	0.137	0.152		0.014	0.016	0.014
N138	0.127	0.121	0.114	0.139	0.161	0.147	0.148		0.015	0.014
N139	0.201	0.196	0.200	0.200	0.214	0.196	0.195	0.200		0.014
N140	0.163	0.172	0.172	0.174	0.184	0.176	0.168	0.178	0.171	

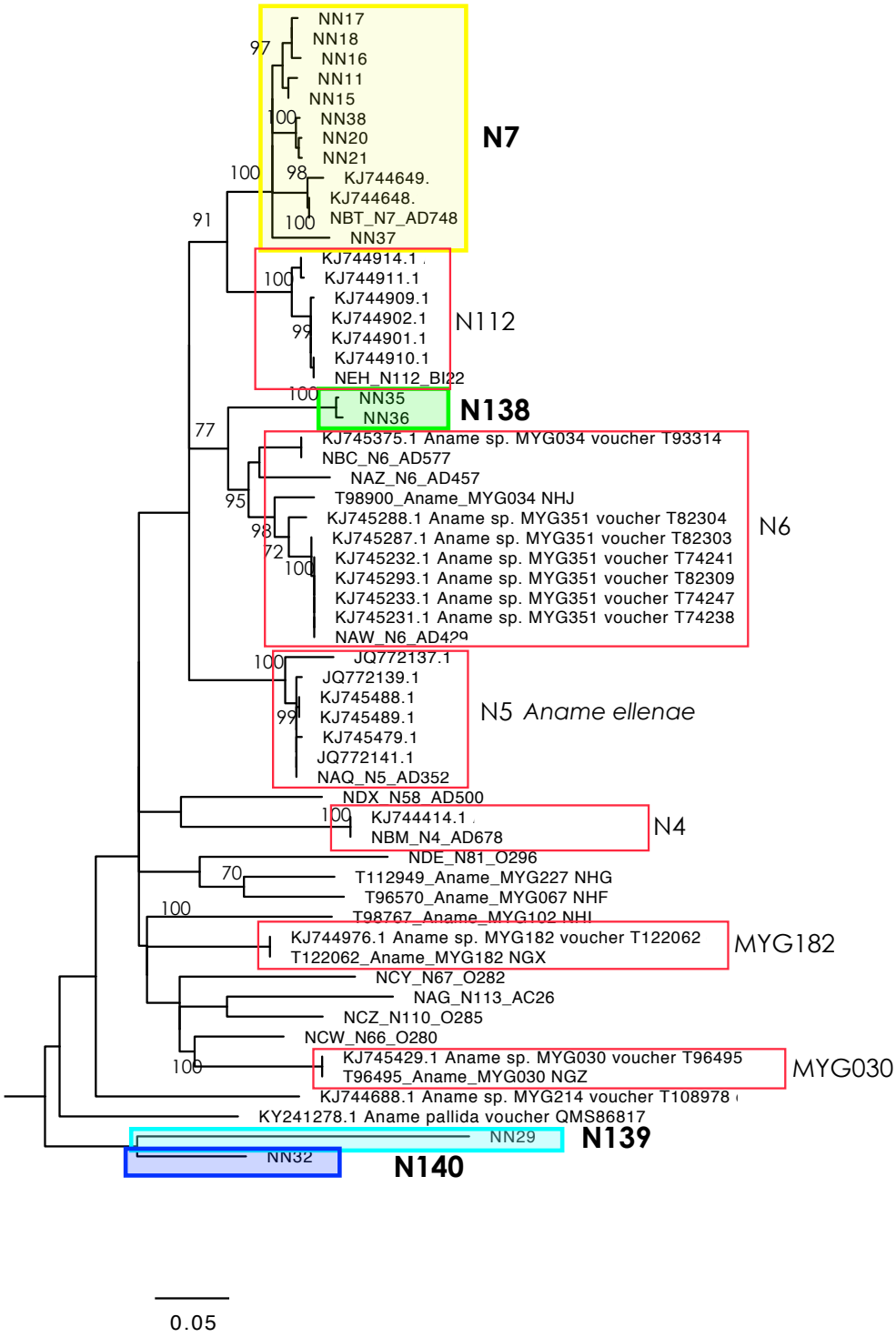


Figure 3. Maximum likelihood analysis of *COI* haplotypes of mygalomorph spider specimens from the Asian Hub area along with reference nemesiid lineages within15 % sequence divergence. Numbers on nodes correspond to posterior probabilities. Numbers on nodes represent bootstrap support. Support < 65 not shown. Scale bar = number of substitutions per site.

Appendix 1. 'megaBLAST' search results for Aranemorph specimen 'NN12'.

Query sample	Sequence ID of reference specimen	Identity (%)	Maximum Score
NN12	KY017668.1	88.113	797
NN12	KY017666.1	87.982	793
NN12	MF467716.1	88.316	787
NN12	KY017865.1	87.892	785
NN12	KP209084.1	88.244	784
NN12	KP209083.1	88.244	784
NN12	KP209044.1	88.244	784
NN12	KP209064.1	87.994	776
NN12	JN817103.1	87.225	774
NN12	KP209067.1	87.897	773
NN12	KP209040.1	87.86	773
NN12	LC310806.1	87.389	771
NN12	KY017626.1	88.438	771
NN12	KY017896.1	87.332	769
NN12	MF811495.1	87.709	767
NN12	KX537030.1	87.709	767
NN12	KX536941.1	87.709	767
NN12	KP209089.1	87.786	767
NN12	KP209042.1	87.746	767
NN12	JF886125.1	87.709	767
NN12	JF886119.1	87.709	767
NN12	LC310805.1	87.24	765
NN12	KP253809.1	87.69	765
NN12	KF442792.1	88	765
NN12	JF411100.1	87.69	765
NN12	FJ525318.1	87.709	765
NN12	KP271816.1	87.221	763
NN12	KM244672.1	86.95	763
NN12	MG816011.1	87.519	760
NN12	KY018010.1	87.164	760
NN12	KY017931.1	87.145	758
NN12	KP209075.1	87.481	756
NN12	JN817216.1	86.676	756
NN12	JN308800.1	87.405	756
NN12	KY018006.1	87.988	754
NN12	KY017776.1	86.924	754
NN12	KY017677.1	86.996	754
NN12	KX537443.1	87.405	754
NN12	KX536876.1	87.405	754
NN12	JN817253.1	86.569	754
NN12	JN817244.1	86.569	754
NN12	JN817199.1	86.745	754
NN12	KY778983.1	87.771	752
NN12	KY018062.1	86.905	752
NN12	KY017920.1	86.924	752
NN12	KY017816.1	86.924	752
NN12	KP646410.1	87.462	752
NN12	JF411084.1	87.273	750
NN12	KY018047.1	86.756	749
NN12	KY017863.1	86.866	749
NN12	KM831538.1	87.234	749
NN12	JF884504.1	87.234	749
NN12	HQ924668.1	87.215	749
NN12	KY017715.1	87.234	747
NN12	KY017671.1	86.846	747
NN12	KP646571.1	87.309	747
NN12	JN817081.1	86.423	747
NN12	KY778930.1	87.695	745
NN12	KU875804.1	87.082	745
NN12	KX762063.1	87.102	745
NN12	KP209090.1	87.141	745
NN12	KP209041.1	87.121	745
NN12	KP651040.1	87.121	745
NN12	JF884514.1	87.082	745
NN12	KY017593.1	86.716	743
NN12	KY268627.1	87.062	743
NN12	LN887155.1	86.736	743

Query sample	Sequence ID of reference specimen	Identity (%)	Maximum Score
NN12	KP650494.1	87.062	743
NN12	KM825530.1	87.082	743
NN12	KM507783.1	86.277	743
NN12	JN817198.1	86.451	743
NN12	JF411087.1	87.102	743
NN12	JF884507.1	87.082	743
NN12	JF884494.1	87.082	743
NN12	GU682805.1	87.062	743
NN12	FJ263794.1	86.297	743
NN12	MF812590.1	86.97	741
NN12	KY778791.1	87.422	741
NN12	KY017688.1	86.587	741
NN12	KY017672.1	86.677	741
NN12	KY017559.1	86.607	741
NN12	KP648977.1	87.156	741
NN12	KT174686.1	87.009	741
NN12	KT174685.1	87.102	741
NN12	KT174684.1	87.009	741
NN12	JN018132.1	87.956	741
NN12	GU682857.1	87.043	741
NN12	KY017695.1	86.567	739
NN12	KY269287.1	86.95	739
NN12	KY268719.1	86.93	739
NN12	KY268704.1	86.95	739
NN12	KY268308.1	86.95	739
NN12	KX537479.1	86.93	739
NN12	KX537432.1	86.95	739
NN12	KX537196.1	86.95	739
NN12	GU682908.1	87.062	739
NN12	LC310804.1	86.558	737
NN12	KY017787.1	86.567	737
NN12	KY268430.1	86.93	737
NN12	KX537314.1	86.91	737

Appendix 5

Conservation Significance Framework

Commonwealth EPBC Act

Fauna species of national environmental significance are listed under the Commonwealth EPBC Act (Department of the Environment 2017), and may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'lower risk', which are consistent with IUCN categories.

Critically Endangered (CR): a taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

Endangered (EN): a taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

Vulnerable (VU): a taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

Lower Risk (LR): a taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

1. **Conservation Dependent (CD).** Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. **Near Threatened (NT).** Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
3. **Least Concern (LC).** Taxa which do not qualify for Conservation Dependent or Near Threatened.

Migratory species are also protected under the EPBC Act as species of national environmental significance. Migratory species are those animals that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations. The list of migratory species consists of those species listed under the following international conventions:

1. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
2. China-Australia Migratory Bird Agreement (CAMBA);
3. Japan-Australia Migratory Bird Agreement (JAMBA); and,
4. Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Marine species are also protected under the EPBC Act, and are listed to ensure the long-term conservation of the species. Marine species include all Australian sea snakes, seals, crocodiles, dugongs, marine turtles, seahorses and seabirds that naturally occur in the Commonwealth marine area.

Western Australian *Wildlife Conservation Act 1950*

Classification of rare and endangered fauna under the state *Wildlife Conservation (Specially Protected Fauna) Notice 2016* (State of Western Australia 2017), recognises seven distinct schedules of taxa:

Schedule 1: fauna that are rare or likely to become extinct as critically endangered fauna (CR).

Schedule 2: fauna that are rare or likely to become extinct as endangered fauna (EN).

Schedule 3: fauna that are rare or likely to become extinct as vulnerable fauna (VU).

Schedule 4: fauna presumed to be extinct (EX).

Schedule 5: birds that are subject to an agreement between the government of Australia and the governments of Japan, China and the Republic of Korea relating to the protection of migratory birds, and birds in danger of extinction, which are declared to be fauna in need of special protection.

Schedule 6: fauna that is of special conservation need as conservation dependent fauna (CD). This category of species contains those taxa that do not meet the criteria for listing as threatened, but which are being maintained by specific management programs.

Schedule 7: Other specially protected fauna (OS). This category contains those taxa that are at risk from harvesting, or other human interactions, which have potential to affect their conservation status if not appropriately managed.

Department of Biodiversity, Conservation and Attractions Priority Fauna

In addition, the Department of Biodiversity, Conservation and Attractions maintains a list of Priority species that have not been assigned statutory protection under the *Wildlife Conservation Act 1950* (DBCA 2017c). Species on this list are considered to be of conservation priority because there is insufficient information to make an assessment of their conservation status or they are considered to be rare but not threatened and are in need of monitoring. Under this list, species are classified according to five Priority categories:

Priority One: Taxa with few, poorly known populations on threatened lands
Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Two: Taxa with few, poorly known populations on conservation lands
Taxa that are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Three: Taxa with several, poorly known populations, some on conservation lands
Taxa that are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Four: Taxa in need of monitoring
Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.

Priority Five: Taxa in need of monitoring
Taxa that are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix 6

Conservation Significant Species Considered Unlikely to Occur

Fauna of Conservation Significance Assessed as Unlikely to Occur but are Challenging to Detect

Night Parrot *(Pezoporus occidentalis)* - WC Act Schedule 1; EPBC Act Endangered

The Night Parrot is a small ground-dwelling parrot endemic to Australia, occurring in arid to semi-arid regions where it requires dense, low vegetation, under or in which they hide during the day. Historical records indicate that the Night Parrot was once widespread and relatively common in the arid zone until late in the 19th Century (Murphy et al. 2017) but then a hiatus in records of almost 100 years followed, despite considerable search effort. Then in 1990 and 2006, two specimens were collected in southwest Queensland with the first photographic evidence presented in 2013 (Dooley 2013). In March 2017 there was a confirmed record from the Murchison (Jones 2017). A published article also details a number of sightings in the Lorna Glen and Millrose Station area, which straddles the Murchison/Gascoyne bioregions (Hamilton et al. 2017).

The current descriptions of the species' habitat preferences are broad, reflecting the wide variety of habitats the species was historically known from. The Department of Biodiversity, Conservation and Attractions Guideline (2017a) details old-growth spinifex (*Triodia* spp.) as habitat for roosting and nesting as has been recorded in western Queensland (Murphy et al. 2017). Foraging habitats are broadly described as grasses and herbs that may or may not contain shrubs or low trees. Johnstone and Storr (1998) mention sparsely-wooded *Triodia* spp. near water as the habitat preferred by this species, while Pizzey and Knight (2007) list the following additional habitats: seeding spinifex on stony rises, breakaway country, sandy lowlands, shrubby glasswort, chenopods, succulents on flats around salt lakes, flooded claypans, saltbush, bluebush and bassia associations.

The following potential threats have been suggested for the decline of the species: predation by feral cats and foxes, degradation of habitat due to fire, grazing or rabbits, reduction in the availability of water due to consumption by feral camels and reduced maintenance of waterholes (Department of the Environment 2016).

The current survey incorporated 2,340 days of automated acoustic recording over 10 sites, which did not detect the species and would have included seasonal improvements in foraging habitat. The study of Murphy et. al. (2017) describes three nests each consisting of a hollow chamber ranging in size from 20 – 28 cm in a spinifex hummock with each chamber leading to the outside via a tunnel of length 20 – 33 cm. The size of the hummocks was not stated but we infer that they must have been at least 40 - 50 cm in size. We assume, based on this information, that the structural elements of a chamber and tunnel are required for nest success and although perhaps the tunnel and chamber size may be tailored somewhat to the size of hummock, a minimum size of hummocks of 40 – 50 cm diameter seems reasonable. The dominance of spinifex on sandplain throughout the study area is likely to support hummocks of a size potentially suitable for nesting, though the current high frequency of major fires reduces the suitability of this aspect of the habitat (by removing large and mature hummocks form the landscape). Preferred nesting habitat is also likely to be in proximity to favourable feeding habitat, which can at times represent seeding *Triodia,* but sources of more constant feeding plants such as chenopod have been coincident with most recent records. This type of habitat may be available north of the study area fringing the Mandora Marsh but does not occur within the study area.

Great Desert Skink (*Liopholis kintorei)* - WC Act Schedule 3, EPBC Act Vulnerable

This species is patchily distributed in the Great Sandy Desert, Gibson Desert and Tanami Desert. *Liopholis kintorei* occurs in a variety of desert habitats on sandy, clay and loamy soils (Storr et al. 1999). Although poorly documented, it is known to inhabit burrow complexes.

Suitable habitat for this species is available throughout the study area, but warrens of this large skink species are distinctive (especially when latrines are present) but were not detected during transect walks. Furthermore, the study occurs outside the range of records to date, however, given the availability of habitat within the study area and lack of previous survey work in the area it must be considered possible that it occurs.

Princess Parrot (*Polytelis alexandrae)* - DBCA Priority 4; EPBC Act Vulnerable

This species occupies the eastern deserts of Western Australia, extending into South Australia. There are records from as far west as Wiluna, Wanjarri Nature Reserve, Sandstone and Laverton.

This highly nomadic species prefers lightly wooded habitat including open mallee/spinifex and open marble gum woodlands (Johnstone and Storr 2004). Its diet includes *Triodia* and wattle seeds, and it has also been observed feeding from *Hakea* and *Grevillea* (Johnstone and Storr 1998).

NatureMap records indicate that the species has not been recorded within 40 km of the study area and the eucalypt-dominated woodlands preferred by the species for roosting and nesting are absent from the study area. Princess Parrots are, however, highly nomadic and they could occasionally utilise spinifex seeding events for foraging on a transient basis.