



Winu Project Vertebrate Fauna Consolidation Report



Prepared for

Rio Tinto Winu Pty Ltd

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Winu Project Vertebrate Fauna Consolidation Report

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1.0 Executive Summary

Rio Tinto Winu Pty Limited (RTW) plans to develop a new copper-gold mine, referred to as the Winu Project, approximately 320 km east of Port Hedland in the Pilbara region of Western Australia, within both the Nyangumarta and Martu People's Native Title Determination Areas.

Considerable biological survey work has been completed to support the environmental impact assessment (EIA) of the proposal. Biota Environmental Sciences was commissioned to conduct biological surveys to meet EIA expectations, consolidate relevant data and documentation, and provide biological technical support to RTW in relation to the referral and EIA of the proposal. Multiple studies have been undertaken in the Winu Project development envelope (DE), in addition to other studies in the locality which provide relevant reference data for the proposal. This report provides a consolidation and integration of all relevant terrestrial vertebrate fauna data collected in previous and current surveys to support the formal referral of the project to State and Commonwealth regulators.

Five rationalised fauna habitats were defined within the DE; Shrub and spinifex on sandplain, Inland sand dune, Gravelly lateritic rises, Clayey sandplain with termitaria, Ephemeral claypan (plus Disturbed/cleared areas). Across all studies consolidated in this report, a total of 34 significant vertebrate species were returned from the database searches. Eleven of these species were recorded within the Winu DE during the field surveys, a further four significant species were recorded in close proximity and are considered likely to occur, and an additional four significant species may occur within the DE.

Table 1.1: Likelihood of significant vertebrate species occurring within the Winu DE.

Species Name	Common Name	Significance*		Likelihood of Occurrence in DE
		State	C'wealth	
Mammals				
<i>Macrotis lagotis</i>	Bilby, Dalgyte	VU	VU	Recorded
<i>Dasycercus blythi</i>	Brush-tailed Mulgara, Ampurta	P4	-	Recorded
<i>Notoryctes caurinus</i>	Northern Marsupial Mole	P4	-	Recorded
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	P4	-	Recorded
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	EN	Likely to occur
<i>Petrogale lateralis lateralis</i>	Black-footed Rock-wallaby	EN	EN	Likely to occur
<i>Lagorchestes conspicillatus</i>	Spectacled Hare-wallaby	P4	-	Likely to occur
<i>Leggadina lakedownensis</i>	Short-tailed Mouse	P4	-	May occur
Reptiles				
<i>Lerista separanda</i>	Dampierland Plain Slider	P2	-	Recorded
Birds				
<i>Falco hypoleucos</i>	Grey Falcon	VU	VU	Recorded
<i>Anarhynchus veredus</i>	Oriental Plover	MI	MI	Recorded
<i>Gelochelidon [nilotica] macrotarsa</i>	Australian Tern	MI	MI	Recorded
<i>Numenius minutus</i>	Little Curlew	MI	MI	Recorded
<i>Glareola maldivarum</i>	Oriental Pratincole	MI	MI	Recorded
<i>Apus pacificus</i>	Pacific Swift	MI	MI	Recorded
<i>Pezoporus occidentalis</i>	Night Parrot	CR	EN	Likely to occur
<i>Falco peregrinus</i>	Peregrine Falcon	OS	-	May occur
<i>Polytelis alexandrae</i>	Princess Parrot	P4	VU	May occur
<i>Hirundo rustica</i>	Barn Swallow	MI	MI	May occur

* CR = Critically Endangered; EN = Endangered; VU = Vulnerable; MI = Migratory; P = Priority; OS = Other Specially Protected.

2.0 Introduction

2.1 Project Background

Rio Tinto Winu Pty Limited (RTW) plans to develop a new copper-gold mine, referred to as the Winu Project, approximately 320 km east of Port Hedland in the Pilbara region of Western Australia, within both the Nyangumarta and Martu People's Native Title Determination Areas.

Considerable biological survey work has been completed to support the environmental impact assessment (EIA) of the proposal. Biota Environmental Sciences (Biota) was commissioned to conduct biological surveys to meet EIA expectations, consolidate relevant data and documentation, and provide biological technical support to RTW in relation to the referral and EIA of the proposal. This report provides a consolidation and integration of all relevant terrestrial vertebrate fauna data collected in previous and current surveys to support the formal referral of the project to State and Commonwealth regulators. Short-range endemic invertebrate fauna and subterranean fauna are reported on separately.

Multiple studies have been undertaken within and in the vicinity of the Winu development envelope (DE) for the Winu Project, with Biota holding a large proportion of the biological data, having completed all the fauna surveys to date for the project over multiple phases. In addition to this, a portion of the DE was surveyed for a neighbouring project, the Australian Renewable Energy Hub (AREH) (also by Biota), and a data sharing agreement has been reached between Rio Tinto and AREH, enabling the data from those surveys to be utilised here. While the focus of the current scope is on the Winu DE, sampling effort and species recorded from outside the Winu DE for the AREH project (as shown in Figure 2.1), are also discussed as they provide regional context and reference data for the work completed within the Winu DE, particularly in an under-surveyed region such as the Great Sandy Desert.

2.2 Study Scope

2.2.1 Study Area

The DE has historically comprised multiple sections over the course of project development, with each area being surveyed at various times and intensities. This report focuses only on the results occurring inside the current DE (as supplied by RTW on 24th February 2025). The DE covers approximately 23,649 ha and includes the combined areas of the Mine and Infrastructure Area (MIA), the Road Access Corridor (RAC), and the regional borefield (Rimfire) and its associated access tracks and pipelines (see Figure 2.1).

Table 2.1: Key terminology relevant to the Winu Project.

Term	Definition	Area (ha)
The Project	Includes the development of a new below-water table (BWT) copper-silver-gold deposit and associated infrastructure and activities required to access, process and transport ore.	N/A
Development Envelope (DE)	Refers to the combined areas of the mine and infrastructure area, two regional borefield (Rimfire) and all associated access tracks and pipeline corridors. All activities will occur within this area.	23,649
Mine Infrastructure Area (MIA)	Refers to the area containing the mineralised deposit and related infrastructure. This is the Winu mine site.	10,182
Road Access Corridor (RAC)	Refers to the Access Road, which encompasses the entire length of the existing Access Road from Great Northern Highway to the Winu Project Area.	6,647
Rimfire Borefield (Rimfire)	Refers to the regional borefield located at Rimfire (located approximately 31 km from the MIA), and the associated pipeline corridor connecting the borefield to the MIA.	6,820

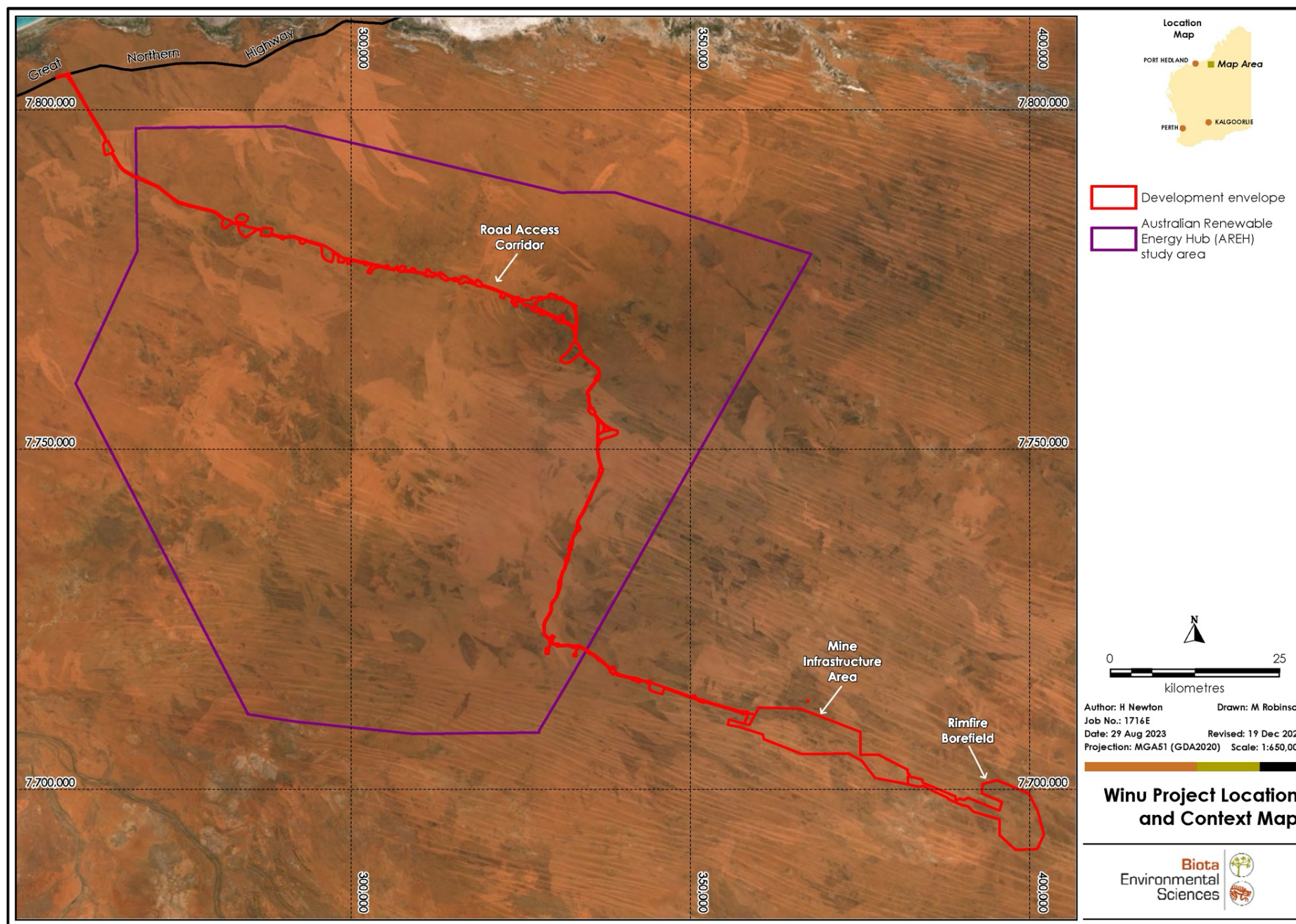


Figure 2.1: Winu Project location map.

2.2.2 Study Objectives

The specific objectives of this study were to consolidate and integrate all terrestrial vertebrate fauna work undertaken for the Winu Project into a report consistent with the framework of the proposal referral. Specifically, this comprised:

- consolidating and summarising all supporting surveys undertaken for the Winu Project and their compliance with relevant policy;
- vetting and auditing all fauna data into single master data set (including any updates to taxonomy or conservation status); and
- generating a consolidated account of all records of fauna of significance across the DE.

This report was undertaken with reference to the following EPA guidance:

- *Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2020); and
- *Environmental Factor Guideline: Terrestrial Fauna* (EPA 2016).

3.0 Methods

3.1 Significance Framework

The framework for formal listing of significant species considered in this study is summarised below and presented in Appendix 1.

Native fauna species that are rare, threatened with extinction, or have high conservation value, are specially protected by law as threatened species under the State *Biodiversity Conservation Act 2016* (BC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Some species are also protected under the EPBC Act as Matters of National Environmental Significance (MNES) for other values, such as representing Migratory or Marine¹ species.

In addition, the State Department of Biodiversity, Conservation and Attractions (DBCA) maintains a list of species that are deemed a priority for conservation, which have not been assigned statutory protection under the BC Act but are still considered to be of conservation or monitoring priority (Priority species).

3.2 Nomenclature

Consistent with EPA (2020), nomenclature for amphibians, reptiles and mammals within this report follows that of the Western Australian Museum (WAM) fauna taxonomic checklist, last revised in November 2024. Avifauna nomenclature is in accordance with the International Ornithological Congress (IOC) world bird list (www.worldbirdnames.org). EPA (2020) suggests using avifauna nomenclature in accordance with the Australian Biological Resources Study Federal Australian Faunal Directory (DCCEEW 2023). This avifauna nomenclature also follows the IOC Bird List. Where the nomenclature under which a species is listed is different to that of standard taxonomies used (typically the common name of birds), the listed taxonomy is indicated in square brackets.

3.3 Database Searches

The following databases have been searched as part of the supporting studies consolidated here to obtain information on species and communities potentially occurring in the DE and surrounding locality. Each of these searches were conducted using buffers ranging from 40 km to 120 km around a central point in the respective survey area.

The most recent searches were conducted with the smaller buffer (40 km). Databases queried comprised:

1. The DBCA NatureMap database. This database was 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. It has now been decommissioned.

¹As the DE does not encompass marine environs, marine-listed species are not included in this report.

2. The EPBC Act Protected Matters Search Tool database. This database includes species and communities considered to be Matters of National Environmental Significance (MNES).
3. The Atlas of Living Australia (ALA) database (<http://www.ala.org.au>): a joint project between academic collecting institutions, private individual collectors and community groups. The atlas contains occurrence records, environmental data, images and the conservation status of species throughout Australia.
4. The Department of Climate Change, Energy, the Environment and Water Species Profiles and Threats (SPRAT) database.
5. Biota's internal database of conservation significant records obtained from surveys in the locality.

3.4 Previous Surveys

The data consolidated in this report were collated from multiple studies undertaken for the purposes of the Winu Project, and for other studies in the locality which are considered relevant to the project. A range of published and unpublished survey reports were used to consolidate data from multiple phases. Key studies included:

- Asian Renewable Energy Hub Terrestrial Fauna and SRE Fauna Survey (Biota 2018a);
- Asian Renewable Energy Hub Migratory Shorebirds and Waterbirds Study (Biota 2022a);
- Asian Renewable Energy Hub Detailed Fauna Assessment (Biota 2022b);
- Winu Project Fauna Assessment (Biota 2021);
- Winu Project Bilby Abundance Study (Biota 2020);
- Winu Project Area Extension Targeted Fauna Survey (Biota 2022c);
- Winu Project Bilby Population Abundance Study (Biota 2023a);
- Winu Project Water Borefield Targeted Fauna Survey (Biota 2023b);
- Winu Project Native Vegetation Clearing Permit Fauna Clearance Survey (Biota 2023c);
- Terrestrial Fauna Gap Closure Survey (Biota 2023d);
- Winu Terrestrial Fauna Interim Consolidation Report (Biota 2023d); and
- Winu Project Bilby Population Abundance Study (Biota 2024a).

Additional surveys to those listed above which have not yet been reported on are also captured in this report.

3.4.1 Survey Teams

All surveys were completed by Biota personnel, as detailed in the individual survey reports cited in Section 3.4 above. Appendix 2 presents a consolidated summary of all team members by individual survey. We gratefully acknowledge the support and assistance of all the traditional owner rangers who also participated in and assisted with surveys on country.

3.4.2 Survey Methodology

Specific methodology details are provided in the relevant supporting reports listed above (Section 3.4). However, in summary, methods used during the field surveys included:

- Systematic sampling (pitfall, funnel and Elliott trapping lines);
- Searches of specific habitats for Schedule and Priority listed fauna species;
- Searching of microhabitats for species not commonly recorded through trapping;

- Avifauna surveys (systematic and unbounded);
- Deployment of ultrasonic sound recorders to detect listed bat species;
- Deployment of autonomous recording units (ARUs) to detect listed bird species;
- Deployment of motion-sensor cameras to detect listed mammal species;
- Targeted Bilby searches (2 ha sign plots and transect searches);
- Marsupial Mole trenching;
- Recording of opportunistic sightings;
- Nocturnal surveys including road spotting and head-torching; and
- Recording and identification of secondary trace signs including tracks, scats and diggings.

3.4.3 Survey Effort

A significant amount of biological survey work has been undertaken by Biota in the Winu DE and the broader locality between 2017 and 2024 for the purposes of EIA undertaken for both the Winu and AREH projects. A detailed review of this consolidated survey effort is presented in Table 3.1, with survey site locations presented in Figure 3.1 - Figure 3.3.

In summary, the consolidated survey effort comprises²:

- A three-phase seasonal detailed fauna survey for the AREH Project (which overlaps with the RAC);
- A targeted fauna survey for AREH;
- Three phases of migratory shorebird and waterbird studies for AREH;
- A two-phase seasonal detailed fauna survey of the MIA;
- Targeted surveys of a Bilby population south of the MIA (2019, 2022 and 2024 censuses); and,
- Six basic and targeted fauna surveys across the MIA, RAC and regional borefield options as the project developed.

² Ongoing acoustic surveys and habitat assessment work for Night Parrot are reported on separately.

Table 3.1: Consolidated survey effort across AREH and Winu projects.

Survey Description	Survey Dates	Scope	Weather, Climate and Fire	Methodology and Effort	Significant Fauna Recorded	Limitations
AREH Detailed Survey (Biota 2022d) Location: RAC	- Phase 1: 24th August - 5th September 2017 - Phase 2: 13th - 21st March 2018 - Phase 3: 8th - 19th March 2021	Three-phase seasonal detailed fauna survey	Conditions during all phases were typical of the region at the time of each survey though significant rainfall events occurred in the months preceding Phase 1 (January and February 2017) and Phase 2 (January and February 2018).	- Combination pitfall/funnel/Elliott trap sites: 46 - Funnel trap sites: 3 - Elliott/ Cage trap sites: 7 - Motion Cameras: 14 - Acoustic Recorders: 14 - Ultrasonic Recorders: 13 - Avifauna Surveys: 42 - General Searches: 12 - Targeted Searches: 78 - Nocturnal Searches: 4	- BC Act and EPBC Act Endangered: Black-footed Rock-wallaby (<i>Petrogale lateralis lateralis</i>), and Northern Quoll (<i>Dasyurus hallucatus</i>). - BC Act and EPBC Act Vulnerable: Bilby (<i>Macrotis lagotis</i>). - BC Act and EPBC Act Migratory: Oriental Pratincole (<i>Glareola maldivarum</i>); Pacific Swift (<i>Apus pacificus</i>); Oriental Plover (<i>Anarhynchus veredus</i>); Little Curlew (<i>Numenius minutus</i>); Australian [Gull-billed] Tern (<i>Gelochelidon [nilotica] macrotarsa</i>) - DBCA Priority 4: Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>), Brush-tailed Mulgara (<i>Dasycercus blythi</i>), and Northern Marsupial Mole (<i>Notoryctes caurinus</i>). - DBCA Priority 3; Spectacled Hare-wallaby (<i>Lagorchestes conspicillatus</i>) - DBCA Priority 2: Dampierland Plain Slider (<i>Lerista separanda</i>). - Range extensions: <i>Lerista separanda</i>, Stimson's Python (<i>Antaresia stimsoni</i> / <i>A. childreni</i>), Perentie (<i>Varanus giganteus</i>), <i>Demansia rufescens</i>, and <i>Diporiphora vescus</i>. - Previously unknown colony of Black-footed Rock-wallaby (<i>Petrogale lateralis lateralis</i>).	Contextual information was limited at time of surveys (lack of past biological survey effort in the locality).
AREH Migratory Shorebirds and Waterbirds Studies (Biota 2018b, 2022a) Location: RAC	2017-18 Season 2020-21 Season 2022-23 Season	Waterbird and shorebird assessments	Walyarta system was in flood during first season.	Acoustic Recorders: 12	BC Act and EPBC Act Migratory: Pacific Swift (<i>Apus pacificus</i>); Oriental Plover (<i>Anarhynchus veredus</i>); Little Curlew (<i>Numenius minutus</i>); Oriental Pratincole (<i>Glareola maldivarum</i>)	Due to bushfire and the lack of maintenance/serviceability checks through the year, some units did not record for full duration.
AREH Targeted Fauna (Biota 2024b) Location: RAC	20th – 29th September 2023	Targeted fauna survey	Weather during the survey was typical for the time of the year; however, the area experienced an extended wet season with high rainfall occurring well into April 2023.	- Motion Cameras: 9 - Acoustic Recorders: 6 - Targeted Searches: 13	- BC Act and EPBC Act Endangered: Black-footed Rock-wallaby (<i>Petrogale lateralis lateralis</i>) - BC Act and EPBC Act Vulnerable: Bilby (<i>Macrotis lagotis</i>) - DBCA Priority 4: Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>)	Higher than average temperatures during survey may have reduced activity of target species.
Winu Detailed Survey (Biota 2021); Bilby Abundance Study (Biota 2020) Location: MIA	- Phase 1: 12th – 20th May 2019 - Phase 2: 18th – 25th September 2019 - Bilby survey: 23rd September 2019	- Two-phase seasonal detailed fauna survey - Targeted survey of Bilby population south of MIA (2019 census)	Phase 1 occurred after an unusually dry wet season (January - March), with much lower rainfall recorded than the long-term medians across each month. Phase 2 (dry-season) survey followed a period of above average temperatures and below average rainfall.	- Combination pitfall/funnel/Elliott trap sites: 20 - Elliott/ Cage trap sites: 2 - Motion Cameras: 20 - Acoustic Recorders: 12 - Ultrasonic Recorders: 11 - Avifauna Surveys: 20 - Targeted Searches: 59 - Nocturnal Searches: 12 - Marsupial Mole Trench: 1	- BC Act and EPBC Act Vulnerable: Bilby (<i>Macrotis lagotis</i>) and Grey Falcon (<i>Falco hypoleucos</i>). - BC Act Migratory and EPBC Act Marine/Migratory: Oriental Plover (<i>Anarhynchus veredus</i>) and Australian [Gull-billed] Tern (<i>Gelochelidon [nilotica] macrotarsa</i>). - DBCA Priority 2: Dampierland Plain Slider (<i>Lerista separanda</i>). - DBCA Priority 4: Northern Marsupial Mole (<i>Notoryctes caurinus</i>) and Brush-tailed Mulgara (<i>Dasycercus blythi</i>). - Range extensions: Pilbara Planigale (<i>Planigale kendricki</i>), <i>Lerista separanda</i>, <i>Demansia calodera</i>, and <i>Anilius endoterus</i>.	- Contextual information was limited at time of surveys. - Higher than average temperatures and lower than average rainfall preceded both phases of survey and may have influenced fauna activity. - Disturbance (fire). - Minor access limitations. - Bilby recapture sample size considered too small for informative Spatially Explicit Capture-Recapture (SECR) population estimation.
Winu Reinjection Borefield and Potential Borrow Source Areas (Biota 2021) Location: MIA and RAC	11th – 20th July 2020	Basic and targeted survey	Weather during the survey was typical for the region at the time of the survey.	Targeted searches: 49	BC Act and EPBC Act Vulnerable: Bilby (<i>Macrotis lagotis</i>)	Nil

Survey Description	Survey Dates	Scope	Weather, Climate and Fire	Methodology and Effort	Significant Fauna Recorded	Limitations
Winu Additional Areas Targeted Surveys - Winu Project Area Extension (Biota 2022c) - Winu Water Borefield (Biota 2023b) - Winu Project Bilby Abundance Study (Biota 2023a) Location: MIA, Rimfire	15th – 22nd July 2022 - Bilby survey 19th and 21st July 2022	- Basic and Targeted survey across multiple areas - Targeted survey of known Bilby population south of MIA (2022 census)	Significantly higher than average rainfall was recorded in the preceding months of March and May 2022.	- Acoustic Recorders: 4 - Targeted Searches: 41 - Marsupial Mole Trench: 11	- BC Act and EPBC Act Vulnerable: Bilby (<i>Macrotis lagotis</i>). - DBCA Priority 4: Northern Marsupial Mole (<i>Notoryctes caurinus</i>) and Brush-tailed Mulgara (<i>Dasymercus blythi</i>).	- Not every section of survey area ground-truthed or sampled, as parts inaccessible by vehicle and helicopter use was limited. - Dune access in some areas restricted due to heritage considerations. - Bilby census not an exhaustive study of Bilby population dynamics.
Winu Project Native Vegetation Clearing Permit Fauna Clearance Survey (Biota 2023c) Location: RAC	19th - 28th July 2023	Targeted fauna survey conducted prior to planned vegetation clearing	Weather during the survey was typical for the time of the year; however, the area experienced an extended wet season with high rainfall occurring well into April 2023.	- General Searches: 163 - Targeted Searches: 10	No significant species detected, however suitable habitat present.	Nil
Winu Borefields Fauna Survey Location: RAC, Rimfire and surrounds	26th February – 4th March 2024 8th - 11th April 2024 6th - 16th May 2024 - Bilby survey 9th to 15th May 2024	- Basic and targeted fauna survey of Winu borefield options - Targeted survey of known Bilby population south of MIA (2024 census)	Months preceding initial survey experienced higher than average rainfall. The area was also significantly burnt.	- Motion Cameras: 3 - Acoustic Recorders: 12 - General Searches: 11	- BC Act Endangered; EPBC Act Critically Endangered: Night Parrot (<i>Pezoporus occidentalis</i>) - BC Act and EPBC Act Vulnerable: Bilby (<i>Macrotis lagotis</i>) - BC Act and EPBC Act Migratory: Little Curlew (<i>Numenius minutus</i>)	- Targeted searches confined to survey area - not the entire extent of the Bilby population in the locality. - Not all collected Bilby scats successfully sequenced - possible additional bilbies present in survey area during survey periods.
Winu Pipeline Corridors Fauna Survey Location: Rimfire and surrounds	8th – 12th July 2024	Basic and targeted fauna survey of Winu borefield pipeline corridor options	Weather during the survey was typical for the region at the time of the survey.	- Acoustic Recorders: 2 - General Searches: 10	BC Act and EPBC Act Vulnerable: Bilby (<i>Macrotis lagotis</i>).	Nil

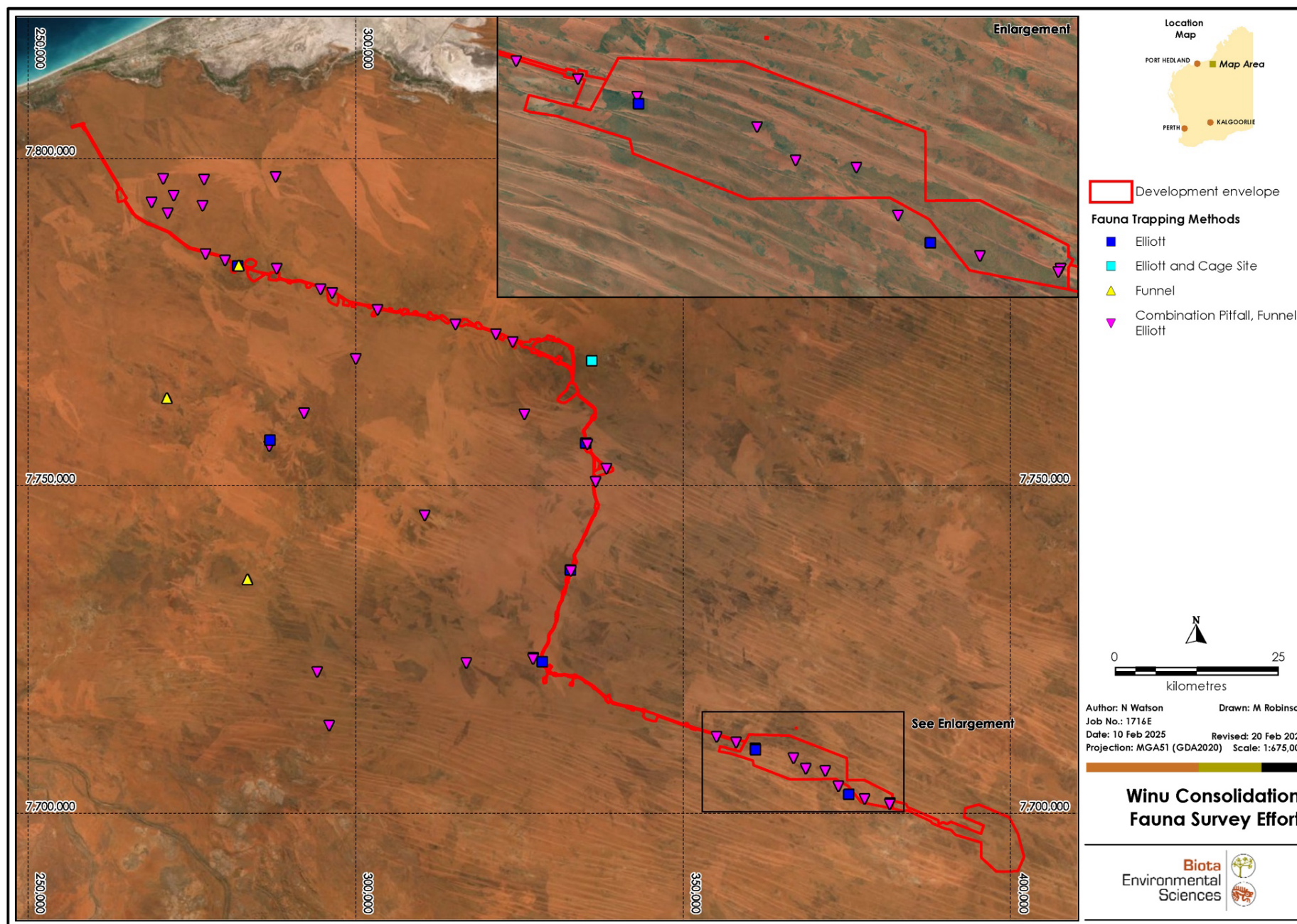


Figure 3.1: Consolidated fauna sampling effort within the DE – systematic trapping.

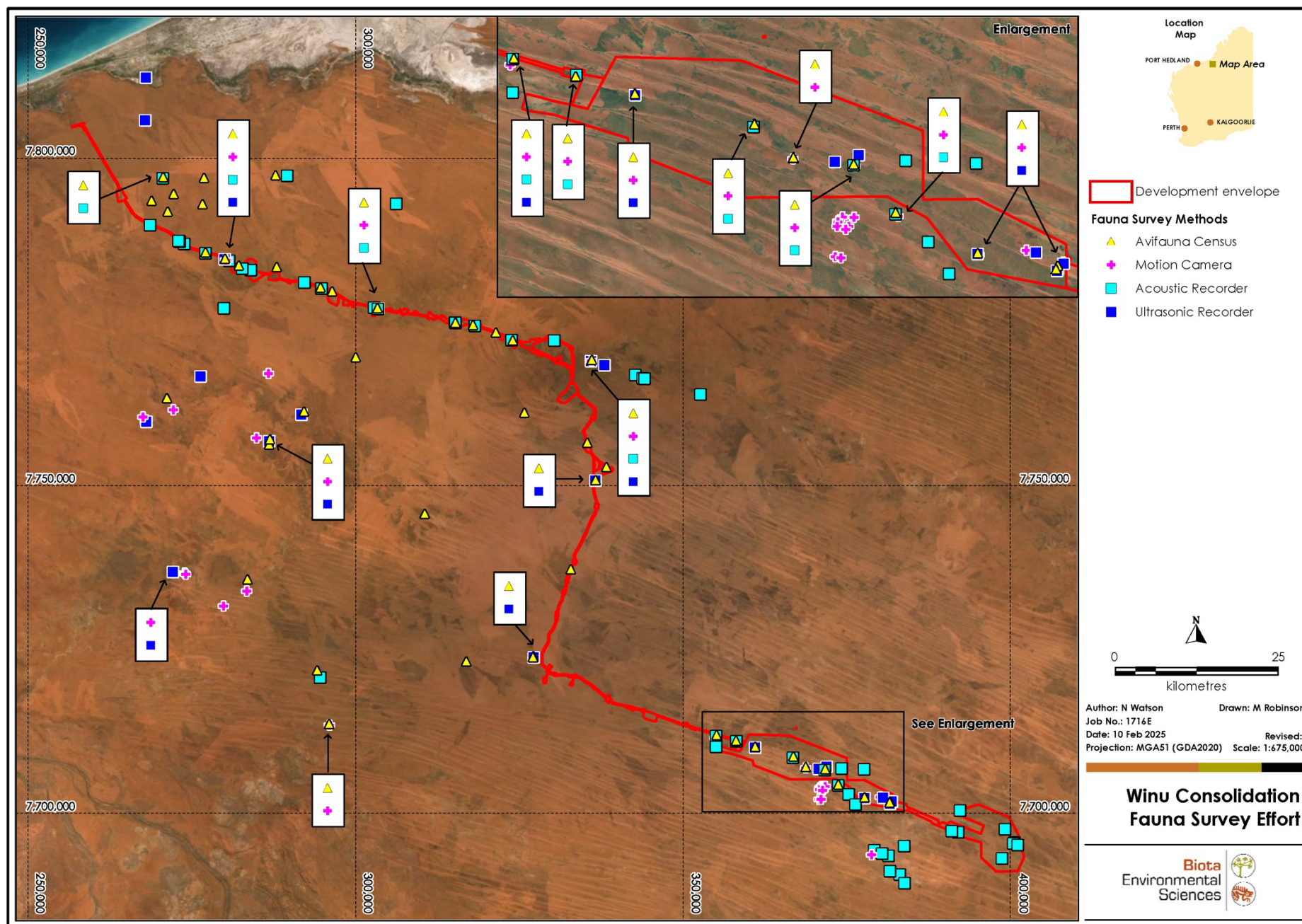


Figure 3.2: Consolidated fauna sampling effort within the DE – targeted sampling.

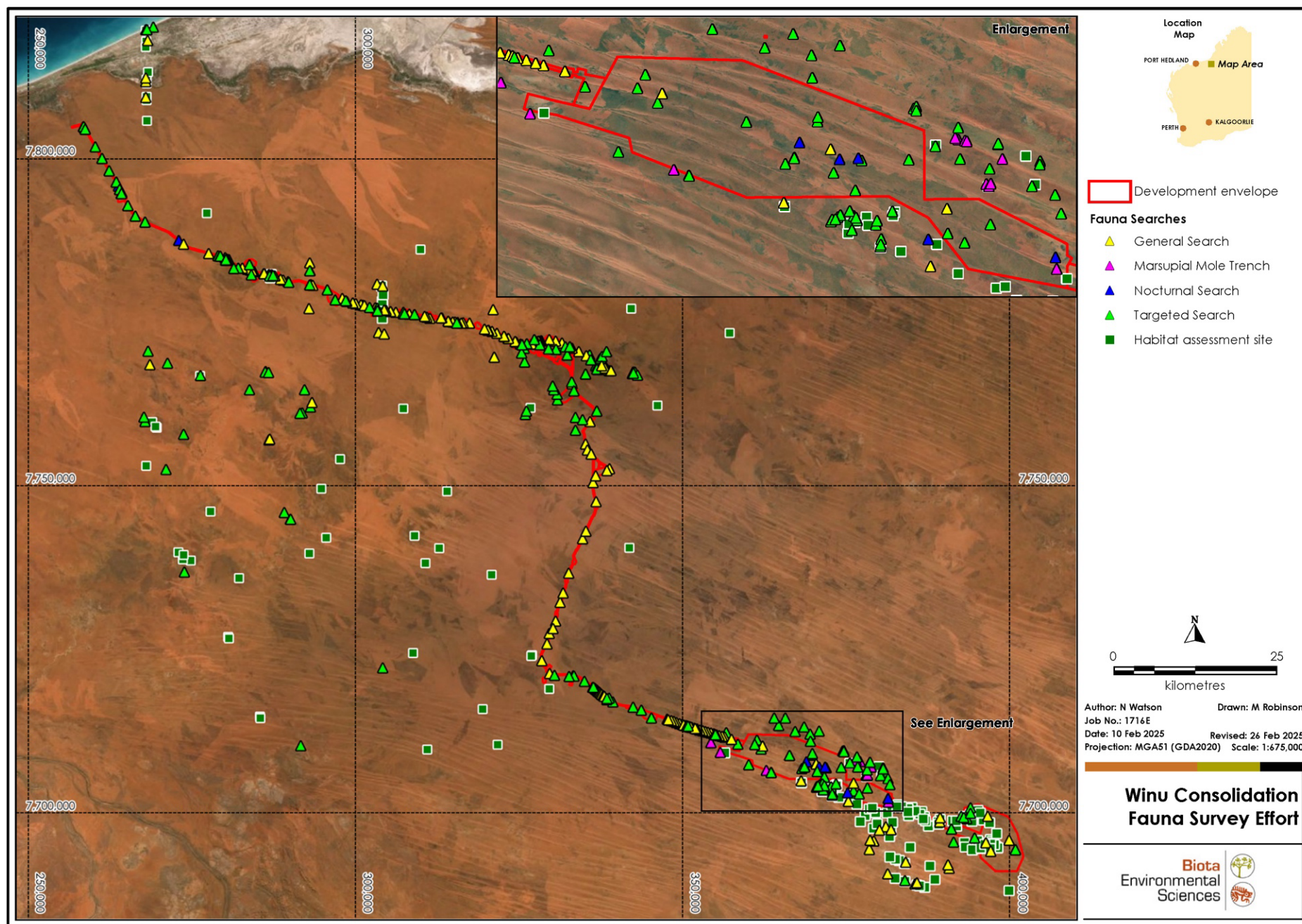


Figure 3.3: Consolidated fauna sampling effort within the DE – targeted searches.

A total of 741 sites were surveyed across the consolidated survey effort, with 398 of these located inside of the DE and 343 located outside (see Figure 3.1-Figure 3.3 for locations). Systematic sampling comprised pitfall, funnel and Elliott trapping, in addition to bird censuses at each of the systematic pitfall sites. Non-systematic sampling techniques comprising motion cameras, acoustic recorders, ultrasonic bat recorders, nocturnal searches and marsupial mole trenches were employed to detect additional fauna species not readily trapped using systematic sampling methods. A detailed breakdown of survey effort inside and outside the Winu DE is provided in Table 3.2. In addition to the survey sites, a total of 145 habitat assessments were undertaken, with 36 inside of the DE and 109 outside (see Figure 3.3 for locations).

Table 3.2: Detailed survey effort relative to DE.

Survey Methodology	Survey Effort	
	Inside DE	Outside DE
Systematic Methods		
Combination pitfall/funnel/Elliott trap sites	38 sites (3,801 trap nights)	28 sites (2,777 trap nights)
Funnel trap sites	-	3 sites (400 nights)
Elliot/Elliott and cage trap sites	6 sites (570 trap nights)	4 sites (800 nights)
Avifauna Surveys	32 sites (1,910 minutes)	30 sites (1,690 minutes)
Non-systematic Methods		
Motion Camera (short and long-term deployments)	12 sites (44 nights)	34 sites (1,702 nights)
Acoustic Recorders (short and long-term deployments)	29 sites (3,123 nights)	33 sites (3,684 nights)
Ultrasonic Recorders	14 sites (21 nights)	10 sites (37 nights)
General Searches	157 searches	39 searches
Targeted Searches	100 searches	150 searches
Nocturnal Searches	9 searches	1 search
Marsupial Mole Trenches	1 site	11 sites
Habitat Assessments	36	109

3.4.4 Survey Conditions

3.4.4.1 Weather and Climate

Weather conditions at the time of each survey are detailed in the individual survey reports cited in Section 3.3 above and are summarised in Table 3.1. It is important to note weather can influence survey findings, particularly the amount of rainfall preceding a survey. Given the remote location of the Winu project, the closest weather station that can provide a robust

dataset of long-term climatic conditions is the Bureau of Meteorology weather station at Telfer Aero (No. 013030), located approximately 115 km southeast of the survey area.

Figure 3.4 depicts the monthly average rainfall, maximum and minimum temperatures with their respective long-term median values (dotted lines and dashed columns) for the years surveys have taken place. Significant high rainfall events occurred in December and January 2017, in March and May 2022, and again in April 2023. Rainfall was much lower than the median across the wet season months in 2019. Both excessive rain and drought can impact the results of field surveys, any limitations due of weather are outlined in the individual survey reports and summarised in Section 3.8.

Generally, average minimum and maximum monthly temperatures hovered close to that of the long-term medians. The year 2019 is the exception, coinciding with the drought; higher maximums and minimum temperatures were recorded, particularly across the early summer months.

3.4.4.2 Fire History

Fire has played a dominant role in shaping many of Australia's ecosystems, particularly our desert landscapes. The DE has been directly impacted by fire multiple times since biological survey work began. Fire occurrences in the DE are described briefly below (Table 3.3) and mapped in Figure 3.5 (data from Northern Australia & Rangelands Fire Information (NAFI)):

Table 3.3: Summary of the fire history of the Winu DE.

Area (ha)	Year burnt	Approximate area burnt (ha)
MIA	2018	6,663
	2022	1,797
	2023	3,035
RAC	2017	836
	2018	2,626
	2019	1,388
	2022	170
	2023	2,923
Rimfire	2018	6,678
	2023	173

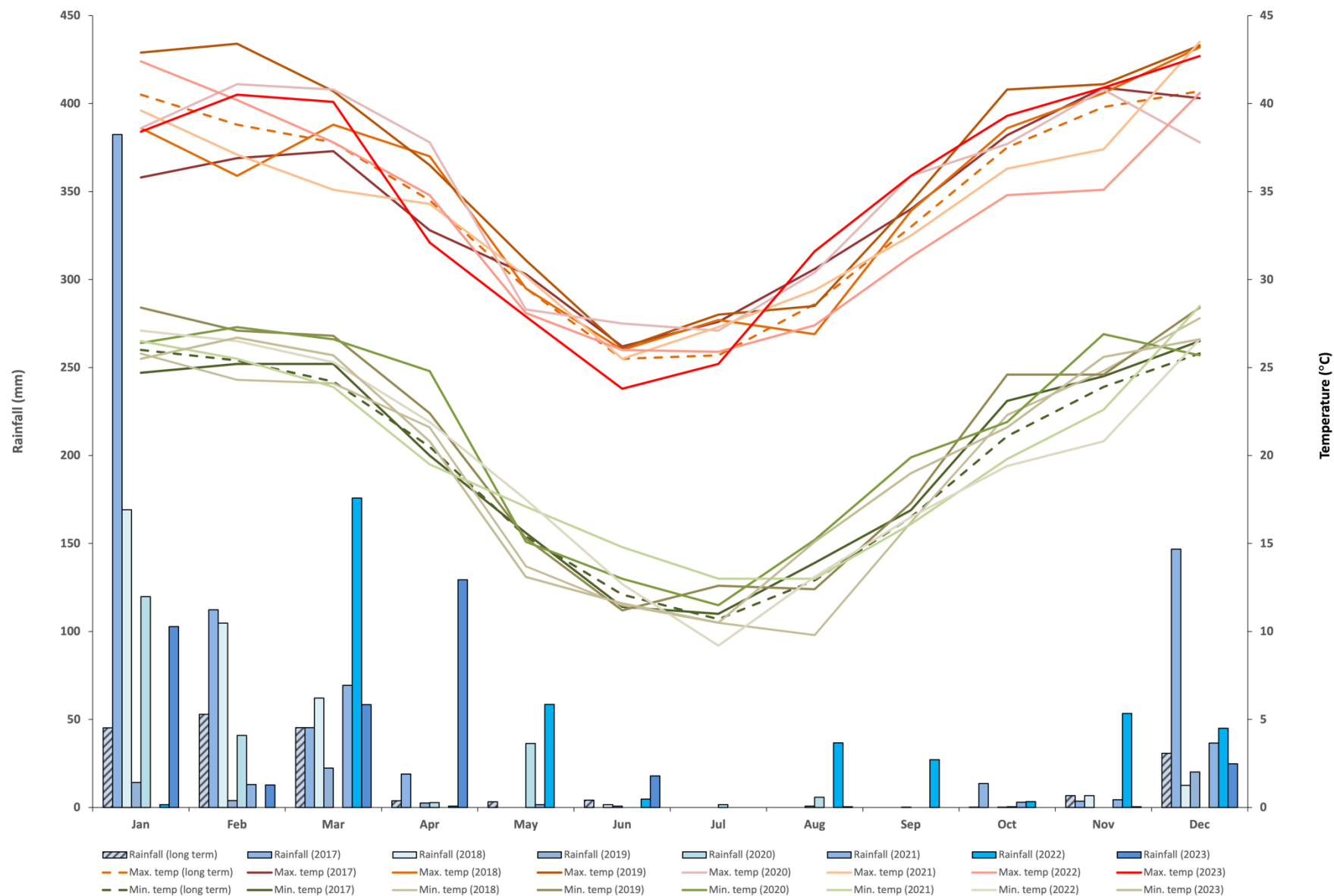


Figure 3.4: Climate graph depicting long-term averages and monthly data for the Telfer Aero (#013030) weather station (data from Bureau of Meteorology) for the years surveys took place in the Winu DE.

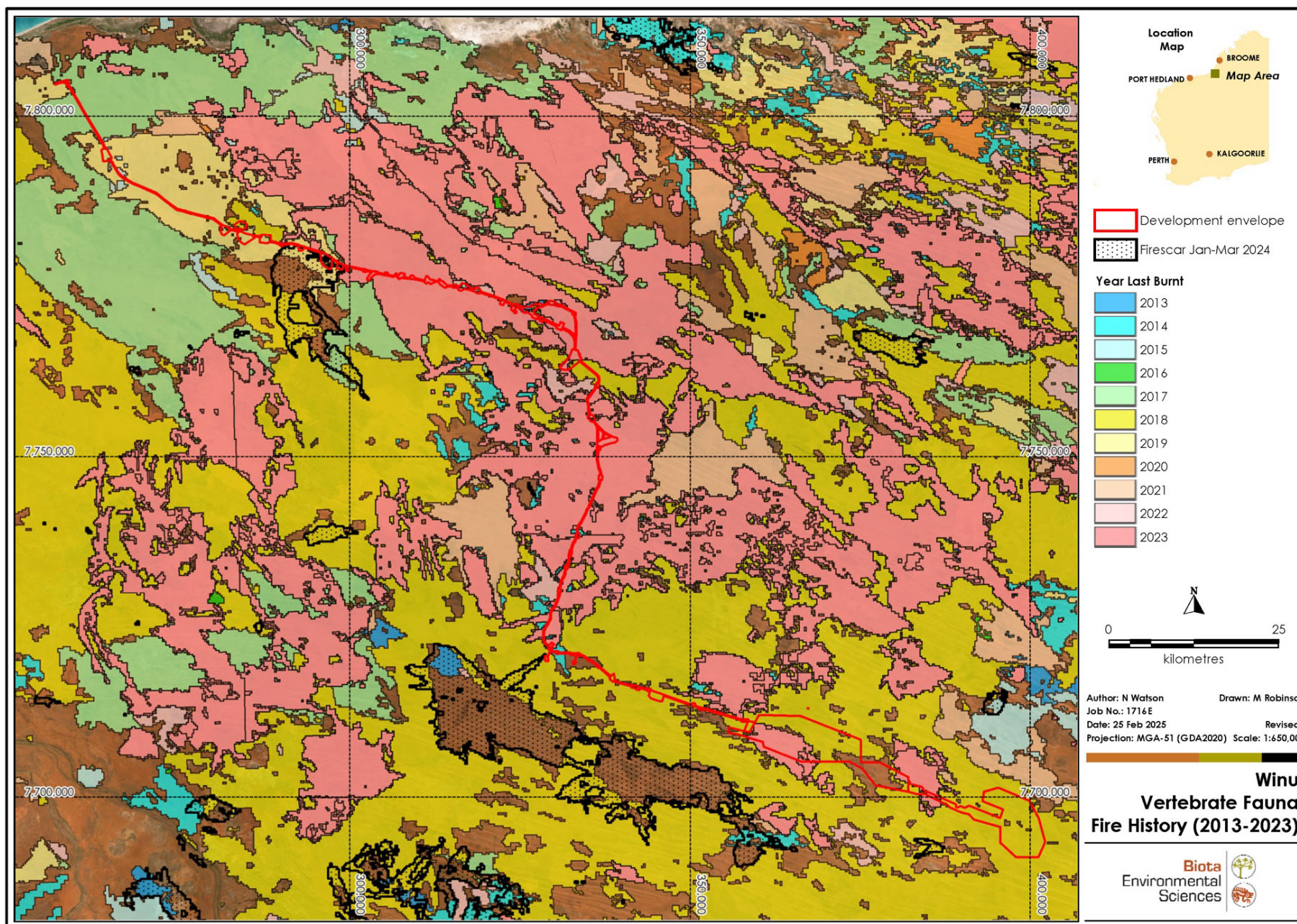


Figure 3.5: Fire scar history of the Winu DE and surrounding locality.

3.5 Fauna Habitat Rationalisation

As the source surveys consolidated in this report were completed in varying spatial settings and by differing field teams and lead report authors, terminology in describing habitat units also varied somewhat from report to report. This is not an uncommon situation that arises with repeated survey effort in the same locality over time whereby what is effectively the same habitat type is described by a slightly different name in different reports.

In completing this consolidation exercise, we have reviewed the landforms, vegetation, photographs, habitat descriptions and aerial imagery of habitats from the various studies completed in the Winu DE and rationalised the terminology used to describe fauna habitats into a consistent framework.

3.6 Likelihood of Occurrence Assessment

For significant species identified from previous surveys, database searches, and the current additional basic and targeted surveys, an assessment of the likelihood of occurrence in their respective survey areas was made prior to the field surveys and was reviewed once they were all completed. The likelihood assessment was based on factors including the proximity of previous records to the survey area, habitat preferences for species, the assessment of the habitats present within the survey and contextual areas made during the field survey, and any records obtained during the field survey.

The likelihood that fauna species of significance would occur in the DE has been assessed here using a set of rankings and criteria (Table 3.4). Through the remainder of this report, the term “close proximity” is defined as being within 20 km of the DE boundary, while the broader “locality” comprises the area up to 40 km from the DE. The likelihood ranking criteria are summarised in Table 3.4.

Table 3.4: Ranking system used to assign the likelihood that a significant species occurs in the DE.

Rank / Likelihood of Occurrence	Criteria
Recorded	1. The species has been recorded in the DE previously.
Likely to occur or “High”	1. There are existing records of the species in close proximity to the DE; and - the species is strongly linked to a specific habitat, which is present in the DE; or - the species has more general habitat preferences, and suitable habitat is present.
May occur or “Moderate”	1. There are existing records of the species from the locality, however - the species is strongly linked to a specific habitat, of which only a small amount is present in the DE; or - the species has more general habitat preferences, but only some suitable habitat is present in the DE. 2. There is suitable habitat in the DE, but the species is recorded infrequently in the locality.
Unlikely to occur or “Low”	1. The species is linked to a specific habitat, which is absent from the DE; 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 DE, however the species is very infrequently recorded in the locality, or the only records are historical (>40 years ago).
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the DE; and/or 2. The species’ range is very restricted and would not include the DE.

3.7 Data Analysis

The combined fauna data set was analysed using PRIMER v6.1 (Clarke and Gorley 2006). Prior to importing the data, the records were screened to remove data with the potential to bias the results, which comprised:

- excluding opportunistic records that represent chance events and are not derived from equivalent sampling methods across sites;
- excluding large body-size species that would not have been adequately sampled by the trapping sites; and
- as the surveys spanned multiple seasons and years, frog species were excluded from the analysis as they are prone to large abundance peaks following wet weather conditions, which can skew site resemblance analyses.

The screened site by species matrix for each of the faunal groups was imported into PRIMER and square-root transformed to reduce the influence of high abundance species on the similarity analyses. 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 similar species composition (SIMPROF was used to assess significant cut-off values at the 5% level; Clarke and Gorley 2006). SIMPROF clusters generally corresponded to a 30% similarity level and this cut level was used to inform assemblage groupings. Habitat parameters for each site were imported into PRIMER as categorical factors for each site, which from broad to fine scale comprised:

- land system (van Vreeswyk et al. 2004);
- habitat type (as documented in the field by the survey zoologists and rationalised here into consistent terminology; Section 4.1); and
- survey timing.

The outputs from the clustering and MDS plots were then coded with these factors to identify any relationships between the factors and the species assemblages defined by the site clusters. PRIMER's BEST routine was then used to identify which of these habitat parameters provided the best explanation for the faunal assemblage groupings (using the step-wise BVSTEP method).

3.8 Limitations

As this report collates data from multiple source studies, the limitations that apply to each of those also apply here. Table 3.5 summarises the limitations faced across these surveys.

Table 3.5: Potential constraints and limitations of the biological surveys that have taken place within the Winu DE.

Potential Constraint	Statement of Limitations
1. Availability of contextual information at a regional and local scale	• Very few surveys had occurred in the Great Sandy Desert bioregion and more specifically within the Winu locality prior to the first survey being completed by Biota in 2017. • Contextual information was considered to be a limitation at the time of some surveys.
2. Competency/ experience of the team carrying out the survey, including experience in the bioregion surveyed	• All field personnel were suitably qualified and experienced. • Competency was not considered to be a limitation.
3. Proportion of species recorded and/or collected, any identification issues	• The scope of surveys varied, with detailed (level 2) and basic and targeted (level 1) surveys being undertaken in various parts of the DE. • Overall, identification and proportion of species recorded was not considered to be a limitation during any of the field surveys.
4. Appropriate area fully surveyed (effort and extent)	• Sampling effort and methods were not equal amongst the consolidated surveys, as survey types varied and spanned a variety of sampling seasons. • Each individual supporting study was adequate to meet relevant policy expectations for the nature of the study.
5. Access restrictions within the survey areas	• Not all parts of the DE have been ground-truthed or systematically sampled, as some parts of the survey areas were inaccessible, so installation and regular trap checking of fauna traps would therefore not have been possible. • Dune access was also restricted during some surveys due to heritage considerations, and as a result, searches for Northern Marsupial Mole were not conducted across all survey areas. • Access was a limitation during some surveys.
6. Survey timing, rainfall, season of survey	• Surveys were undertaken at various sampling times spanning multiple years. Weather can influence the results, particularly the amount of rainfall in the year preceding a survey. • The second phase of the Winu detailed survey (September 2019) may have been impacted by drought, and a basic and targeted survey in 2024 was cut short due to excessive rain.
7. Disturbance that may have affected the results of survey such as fire, flood or clearing	• The Pilbara and Great Sandy Desert bioregions are known to experience wildfires. The Winu DE has been impacted by fire on multiple occasions, with survey results in turn being affected. • Some of the survey area has been impacted by livestock (cattle) and feral vertebrate fauna species (camels, cats). • Disturbance was considered to be a minor limitation.

4.0 Results

4.1 Fauna Habitats

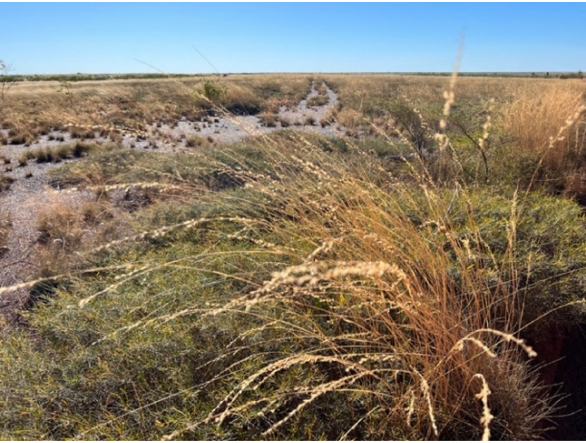
4.1.1 Consolidated Habitat Types

Five rationalised fauna habitats (plus disturbed/cleared areas) were defined within the DE on the basis of the supporting studies consolidated here (see Section 3.5). The rationalised habitats comprise:

- Shrub and spinifex on sandplain;
- Inland sand dune;
- Gravelly lateritic rises;
- Clayey sandplain with termitaria;
- Ephemeral claypan; and
- Disturbed/cleared;

A description of each habitat, an overview of its fauna values and representative photos are provided in Table 4.1, and the habitats are mapped in Figure 4.1 and Figure 4.2. Habitat extents mapped outside the DE as part of supporting surveys are also presented in Figure 4.1 and Figure 4.2. Consolidated survey effort across fauna habitats is provided in Appendix 3.

Table 4.1: Fauna habitats of the Winu DE.

Habitat Description	Example Photographs		Area (ha)	Proportion of DE
Shrub and Spinifex on Sandplain The dominant habitat of the DE. These broad plains comprised pink to red pindan soils. These varied in condition, with some areas having been recently burnt. This habitat supported typical pindan vegetation, comprising occasional trees of species such as <i>Corymbia zygophylla</i> (Broome Bloodwood), <i>Erythrophleum chlorostachys</i> (Ironwood) and <i>Owenia reticulata</i> (Native Walnut) over open to moderately dense mixed shrublands, typically dominated by wattles (<i>Acacia</i> spp.), over hummock grasslands of <i>Triodia schinzii</i> and <i>T. epactia</i> . Some areas recovering from recent fires are currently dominated by successional species such as <i>Eragrostis</i> spp, <i>Scaevola parvifolia</i> and <i>Ptilotus calostachyus</i> , though with time will likely return to the species assemblage described above. Values: Habitat for Bilby and Brush-tailed Mulgara. Supports a diversity of burrowing species, and species with particular associations with spinifex e.g. mammals that forage on seeds or species that utilise shrubs and spinifex for cover and/or foraging. Friable soils for burrowing; shelter in spinifex hummocks.			17,039	72%
Inland Sand Dune Substrate consisted of red loose sand. The vegetation was dominated by <i>Corymbia chippendalei</i> , <i>Erythrophleum chlorostachys</i> and <i>Owenia reticulata</i> low woodland and scattered trees over mixed <i>Acacia</i> low open shrublands over open hummock grasslands dominated by <i>Triodia schinzii</i> . Values: Species associated with this habitat include fossorial species and dune specialists. The fossorial skink, <i>Eremiascincus pallidus</i> , which prefers loose substrates of dunes, was only recorded from the dune sites. The sand slider <i>Lerista vermicularis</i> , endemic to the Great Sandy Desert where it inhabits crests of sand-ridges, was recorded only from the dune sites, where it was abundant. Species such as the Northern Marsupial Mole would also preferentially occupy this habitat type, particularly interconnected dunes that provide dispersal opportunity. Bilby were recorded on sand dunes where <i>Acacia monticola</i> was also present.			3,105	13%
Gravelly Lateritic Rises Patchily distributed habitat type but much of its regional extent occurs within the DE and surrounding locality. Low rises with a surface covering of laterite gravel and pebbles occurred sporadically, supporting open hummock grasslands of <i>Triodia epactia</i> with a low open shrubland of the wattles <i>Acacia hilliana</i> (Hill’s Tabletop Wattle) and <i>A. adoxa</i> var. <i>adoxo</i> (Grey Whorled Wattle); taller shrubs were typically sparse but included species such as <i>Grevillea refracta</i> (Silver-leaf Grevillea) and <i>G. wickhamii</i> (Wickham’s Grevillea). Values: Species with a preference for rocky substrate would be expected to be associated with this habitat type, for example <i>Ctenophorus caudicinctus</i> .			3,116	13%

Habitat Description	Example Photographs		Area (ha)	Proportion of DE
Clayey Sandplain with Termitaria				
The substrate of these plains comprised clayey sand to a loose depth of 2 cm. Vegetation comprising <i>Acacia bivenosa</i> shrubland over <i>Triodia brizoides</i> open hummock grassland. Values: The clayey sand substrate of this habitat type enables construction of termitaria. Species that utilise termitaria as refugia or for foraging purposes would therefore be associated with this habitat, such as <i>Gehyra pilbara</i>, <i>Diplodactylus laevis</i>, <i>Antaresia childreni</i> and <i>Aspidites melanocephalus</i>, which are known to shelter in termite mounds. The termite mounds probably represent a significant microhabitat for these species.		N/A	125	1%
Ephemeral Claypan				
Claypans with <i>Eucalyptus</i> spp. scattered low trees and <i>Acacia</i> spp. very open shrubland represented a very small proportion of the DE. These areas are dominated by <i>Eragrostis</i> sp. grassland and become seasonally inundated. Values: When inundated, this habitat would provide foraging habitat for a number of species including the Migratory Oriental Plover.			49	<1%
Disturbed/cleared				
Areas that have been cleared or disturbed and were largely or entirely devoid of native vegetation. Values: Negligible.			214	<1%

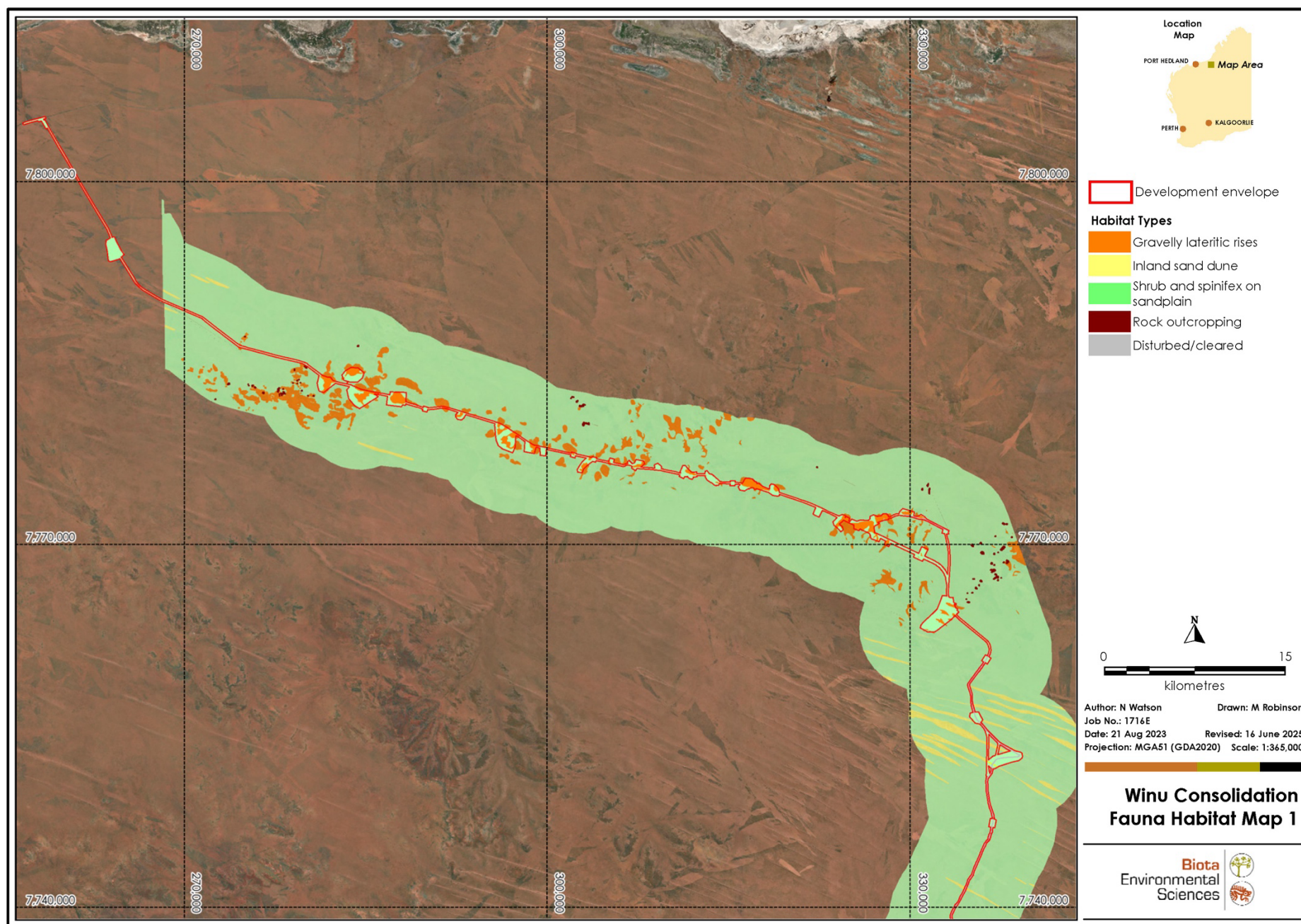


Figure 4.1: Mapping of fauna habitats of the DE (RAC).

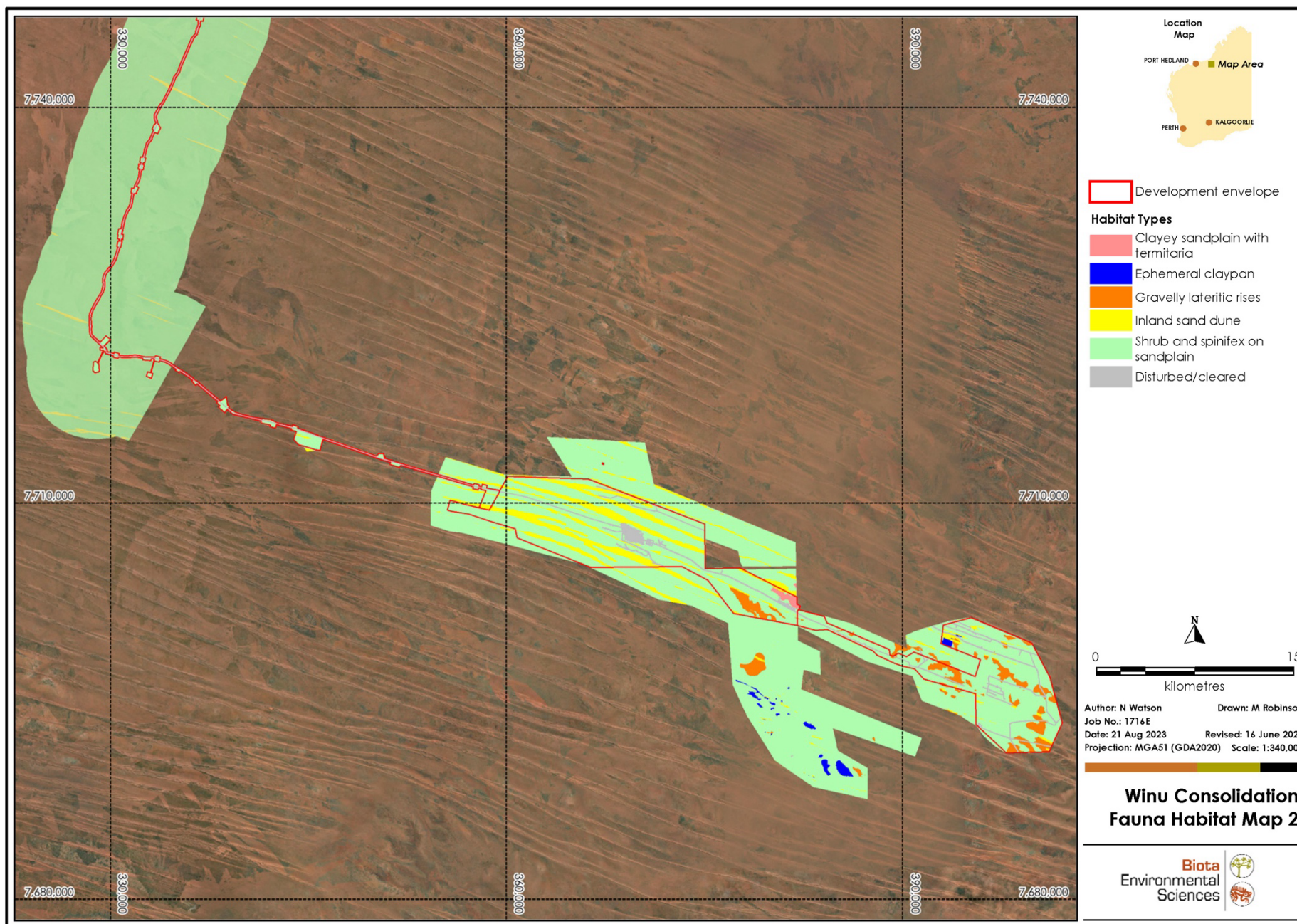


Figure 4.2: Mapping of fauna habitats of the DE (RAC, MIA and Rimfire).

4.1.2 Regional Representation

In order to place the habitat types of the DE into a regional context, the land systems mapping for the Rangelands regions of WA (van Vreeswyk et al. 2004) was utilised. 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. This mapping covers much of the DE, however the mapping boundary ends 11.2 km from the MIA’s western extent, thereby excluding the Rimfire borefield. For these areas east of the MIA, soil-landscape mapping by DPIRD (2018) was instead utilised to characterise the landscape.

Four land systems have been mapped as occurring in the DE (Table 4.2; Figure 4.3). The southern portion of the RAC is dominated by the Little Sandy land system, while the northern section is a mosaic of the Nita and Callawa land systems, with the Buckshot land system being present in two small areas (Figure 4.3). The Callawa land system is relatively restricted to small mosaic patches regionally, of which the RAC intersects a long mosaic stretch of this land system, covering just over 2% of the system’s total extent (Table 4.2). The MIA is nearly entirely represented by the Little Sandy system (Figure 4.3).

In the absence of land system mapping to the east of the MIA, two soil landscape units are represented, AB40 and B30 (DPIRD 2018). AB40 is described as gently undulating plains with longitudinal dunes, and unit B30 as dune fields with areas of clay pans and salt pans (Figure 4.3). A review of the descriptions of these two soil landscape units determined that they are most comparable to land units of the Little Sandy land system (AB40 equivalent to “3. Sandplains” and “2. Sand dunes”; B30 equivalent to “7. Drainage foci”, as per Van Vreeswyk et al. (2004)). Therefore, for the purposes of comparing the fauna habitats within the Winu DE to the broader region, these two soil landscape units were treated as representing the Little Sandy Desert land system (see Table 4.2).

The extent of the land systems present within the DE ranges from <1% to just over 2.85% of their broader extent across the McLarty, Mackay and Pindanland IBRA Subregions combined (Table 4.2). Based on examination of aerial imagery, land systems mapping, soil landscapes mapping and vegetation mapping, the fauna habitats identified within the Winu DE are not restricted to the survey area and are common and widespread in the wider region.

Table 4.2: Relationship between rationalised fauna habitats of the DE (excluding disturbed/cleared) and land systems.

Fauna Habitat	Related Land Unit (after van Vreeswyk et al. 2004)	Land system Description	Area within DE (ha)	Proportion of DE (%)	Extent within McLarty, Mackay and Pindanland IBRA Subregions (ha)	Proportion of Subregional Extent Within DE (%)
Inland sand dune	“2. Linear Sand dunes”	<u>Little Sandy</u> Sandplains with linear and reticulate dunes supporting shrubby hard and soft spinifex grasslands	19,271	74	676,257	2.85
Shrub and spinifex on sandplain	“3. Sandplains and swales”					
Clayey sandplain with termitaria						
Ephemeral claypan	“7. Drainage foci”					
Shrub and spinifex on sandplain	“4. Sandplains”	Nita Sandplains supporting shrubby spinifex grasslands with occasional trees.	2,221	13	1,429,175	<1
Gravelly lateritic rises	“2. Gravelly rises and plains”	Callawa Highly dissected low hills, mesas and gravelly plains of sandstone and conglomerate supporting soft and hard spinifex grasslands	2,060	13	97,793	2.11
	“4. Gravelly sandplains”	Buckshot Gravelly sandplains and occasional sand dunes supporting hard spinifex grasslands	96	<1	79,44	1.21
Total			23,649	100		

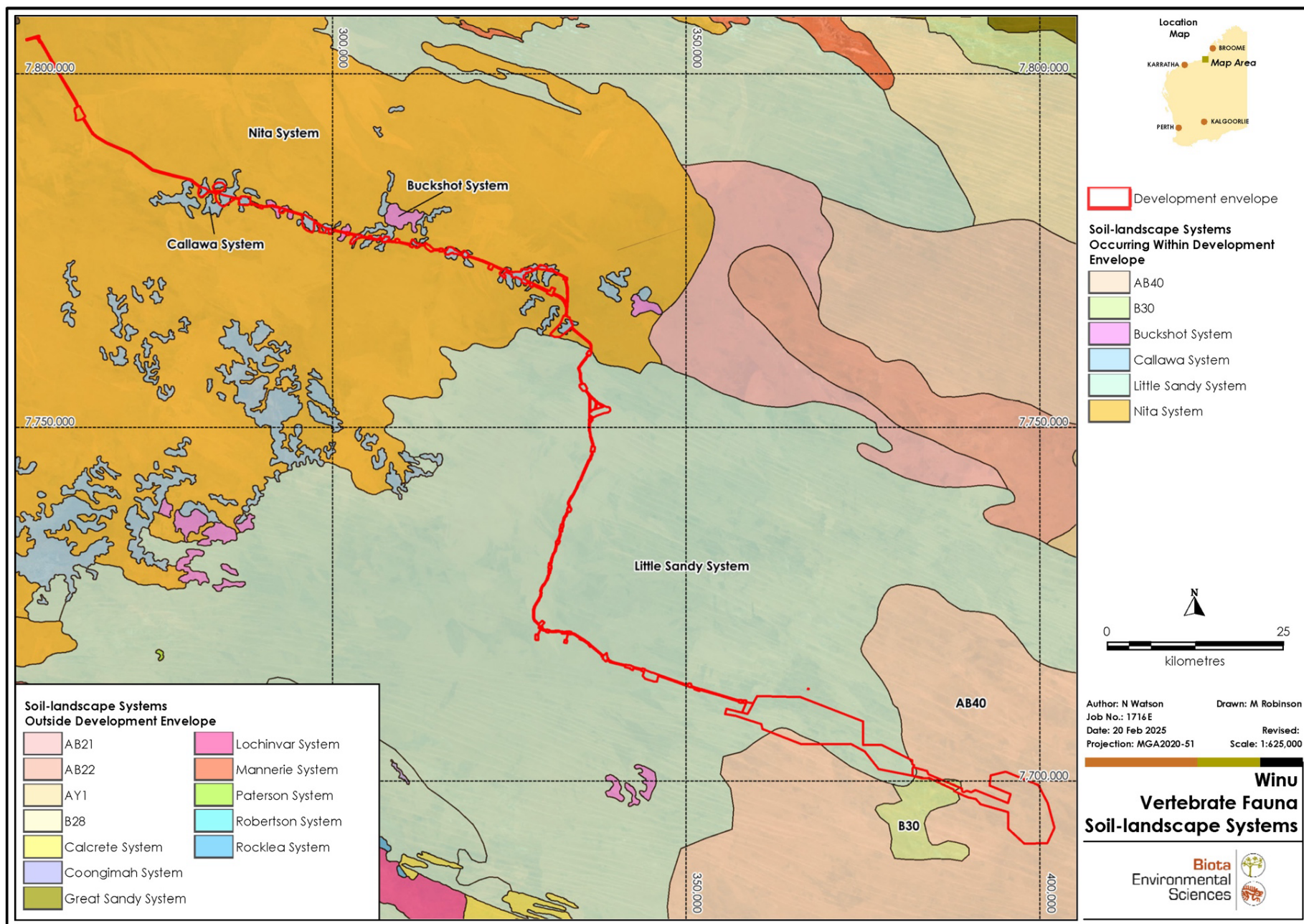


Figure 4.3: Land systems and soil landscapes of the Winu DE and surrounds.

4.2 Fauna Assemblage

4.2.1 Overview

A combined total of 151 vertebrate fauna species were recorded from within the DE as a result of the consolidated survey effort detailed in Section 3.4. This overall assemblage comprises 69 reptile, one amphibian and 56 bird species. The mammal fauna was represented by 25 species, of which 15 were native ground mammal species, five were bat species and five were introduced mammal species (Table 4.3). See Appendix 4 for a consolidated species list detailing all recorded fauna species.

Eleven significant species were recorded within the DE, comprising four native mammal, six bird and one reptile species (Table 4.3). See Section 4.3 for further discussion of significant species.

Table 4.3: Vertebrate fauna recorded from within the DE.

Fauna Group	Status	Number of Species	Number of Conservation Significant Species
Amphibians	Native	1	0
Reptiles	Native	69	1
Ground-dwelling Mammals	Native	15	4
	Introduced	5	0
Bats	Native	5	0
Birds	Native	56	6
Total		151	11

4.2.2 Assemblage Analysis and Locality Representation

The average group linking of sites based on ground fauna similarity produced the dendrogram shown in Figure 4.4. This consolidated the clusters into three groupings of sites that showed similarity in faunal composition at the 30% level (group 1-3 on Figure 4.4). These effectively correspond to three broad ground fauna assemblages.

The analysis indicated that sites from inside and outside of the DE clustered together within the group that accounted for most sites from the combined data set (group 2; Figure 4.4). This includes sites from the two dominant habitats of the locality: Shrub and spinifex on sandplain and Inland sand dune, for which the analysis indicated very similar faunal assemblages. This is a not unexpected result: while there were multiple species recorded that specialise in inland dunes, the majority are not confined to this specific habitat type and will use other sand substrate landforms, so no significant separation of sites from adjoining sandplain habitat sites was observed.

Rather than habitat or land system, Primer's BEST routine indicated that the strongest explanatory factor for the site clusters was the timing of the individual surveys. This evident in the groups in Figure 4.4, with the 'WIN' prefix sites clustered together; all of which were sampled during the detailed fauna survey of the Winu MIA. This was during warm conditions but following periods of little to no rainfall in preceding months (Biota 2021). In contrast, the 'ARE' and 'AHF' prefix sites were also sampled in warm conditions (March 2021; and September 2017 and March 2018, respectively) but importantly: the ARE and AHF sampling followed periods of above average rainfall (Biota 2022b). Rainfall is well recognised as a key factory in survey results and this likely explains the separation of the WIN sites in Figure 4.4. Consistent with these observations, inspection of the raw data indicates that the suite of species recorded from the WIN sites is a subset of those recorded from the locality and does not contain any distinct or significant fauna species not recorded from other sites in the locality.

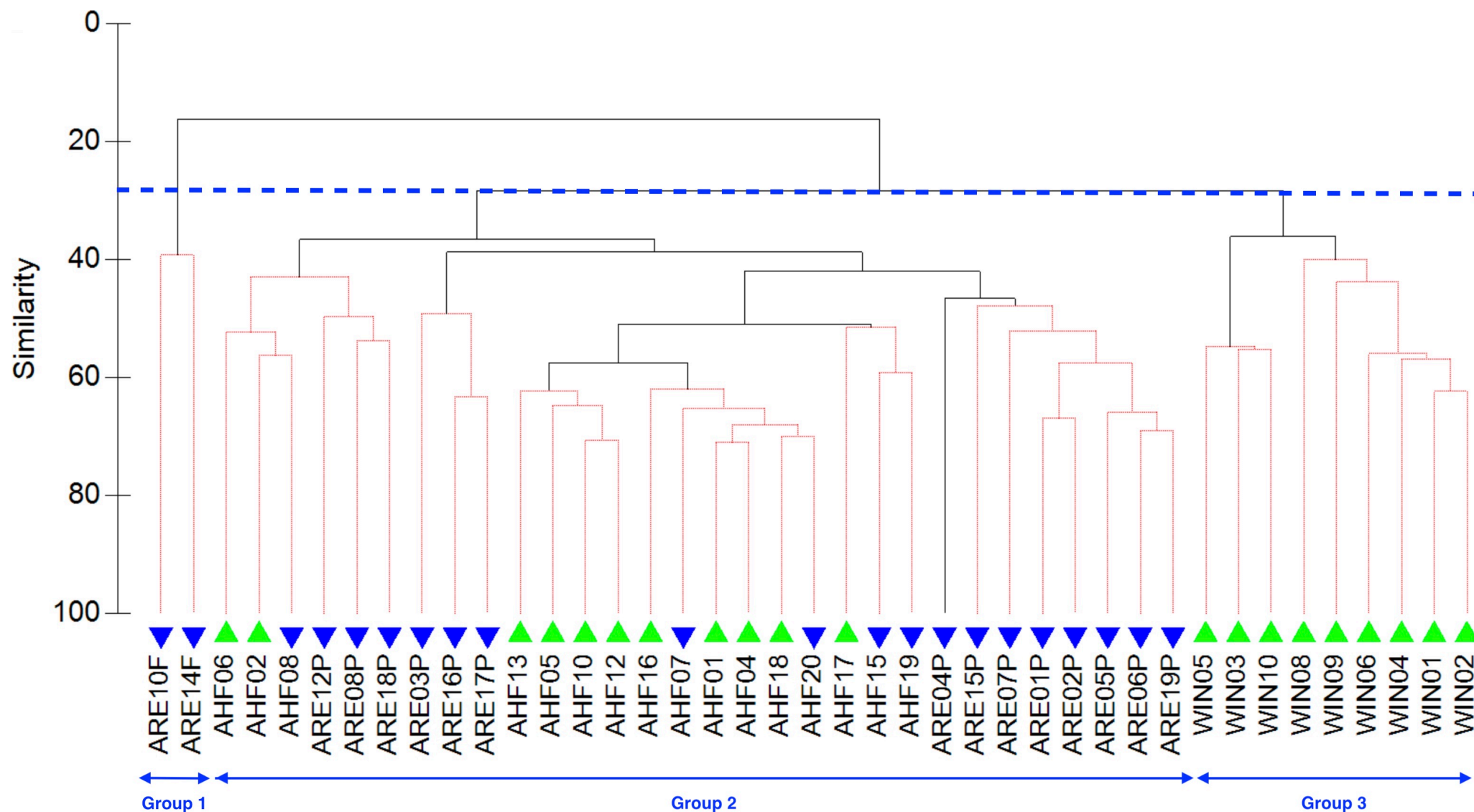


Figure 4.4: Group average similarity dendrogram of all survey sites from the Winu DE and surrounding locality based on ground fauna composition, coded by inside (▲) or outside (▼) the DE (30% similarity slice shown dashed in blue; three 30% clusters grouped into faunal assemblages shown number 1-3 in blue).

4.3 Significant Fauna

Across all studies consolidated in this report, a total of 34 significant vertebrate species were returned from the database searches (Table 4.4). Eleven of these species were recorded within the Winu DE during the field surveys (see Figure 4.5 for locations). These comprised:

- Bilby (*Macrotis lagotis*) – BC Act and EPBC Act Vulnerable;
- Grey Falcon (*Falco hypoleucos*) – BC Act and EPBC Act Vulnerable
- Brush-tailed Mulgara (*Dasymercus blythi*)– DBCA Priority 4;
- Northern Marsupial Mole (*Notoryctes caurinus*)– DBCA Priority 4;
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – DBCA Priority 4;
- Dampierland Plain Slider (*Lerista separanda*) – DBCA Priority 2;
- Oriental Plover (*Anarhynchus veredus*) – BC Act and EPBC Act Migratory;
- Oriental Pratincole (*Glareola maldivarum*) –BC Act and EPBC Act Migratory; and
- Australian Tern (*Gelochelidon [nilotica] macrotarsa*) - BC Act and EPBC Act Migratory;
- Pacific Swift (*Apus pacificus*) – BC Act and EPBC Act Migratory; and
- Little Curlew (*Numenius minutus*) - BC Act and EPBC Act Migratory.

A further four significant species were recorded in close proximity of the DE and are considered likely to occur, and an additional four may occur.

For the recorded species, and those assessed as having a reasonable likelihood of occurrence (i.e. those ‘likely to occur’ or that ‘may occur’), more information on biology, habitat preferences and previous records is provided in Sections 4.3.1, 4.3.2 and 4.3.3, respectively.

No further information has been provided for those species which were assessed as having little likelihood of occurrence (i.e. those that were considered ‘unlikely to occur’ or ‘would not occur’), with the exception of the Great Desert Skink.

The Great Desert Skink (*Liopholis kintorei*) is listed as Vulnerable under the EPBC Act and has been raised previously as potentially occurring in the locality by State regulators. Biota has completed a detailed review specific to this species, provided here as Appendix 5, which demonstrated – while the habitat in the DE is apparently suitable – there is no evidence the species occurs. The DE is considerably outside the species’ confirmed range, with the nearest record being nearly 200 km away; the DE is also considerably outside the EPBC Act modelled range of the species (see Figure 2 of Appendix 5). With the extensive survey effort expended in the DE over a five-year period (Section 3.4.3), there have been no records of the species. We therefore maintain our view that the species is unlikely to occur in the DE (Table 4.4).

4.3.1 Significant Species Recorded

4.3.1.1 Bilby (*Macrotis lagotis*) – BC Act and EPBC Act Vulnerable

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. The species occurs in two separate

geographic areas; one extending from the western deserts region (Tanami, Great Sandy, Gibson) of the Northern Territory and WA north to the Pilbara and Kimberley regions, and the second in southwestern Queensland (Pavey 2006).

Within the previously extensive range of the species, numerous habitats were occupied including grasslands on uplands and hills, mulga or mixed *Acacia* species woodlands/shrublands and hummock grassland growing on sand plains and dunes, drainage systems, salt lake systems and other alluvial areas (Pavey 2006). The Bilby has an opportunistic feeding strategy that enables it to persist in arid regions despite the unpredictable temporal and spatial availability of food resources (Gibson and Hume 2004). A wide range of plant and animal material is consumed with major dietary components varying across both seasons and geographic range (Southgate 1990). Important plant foods include seed from various grasses (particularly *Panicum australiense* and *Dactyloctenium radulans*) and sedges and bulbs such as Bush Onion/Yalka (*Cyperus bulbosus*) and *Wurmbea deserticola*. Major invertebrate prey includes termites, ants, beetles, insect larvae and spiders. The species often occupies only temporary home ranges and relatively rapid changes in distribution have been observed in response to habitat resources. 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.

Secondary evidence of the Bilby was recorded from burrows, scats and diggings at the western and eastern ends of the DE, and in the Rimfire pipeline corridor and south of Rimfire within Shrub and spinifex on sandplain habitat type. Secondary evidence of Bilby was also found in the locality surrounding the DE at multiple locations. Targeted Bilby abundance surveys have been undertaken at a previously known population to the south of the MIA (Biota 2023a), which is provided here as Appendix 6.

4.3.1.2 Grey Falcon (*Falco hypoleucos*) – BC Act and EPBC Act Vulnerable

The Grey Falcon is endemic to Australia and is widespread but rare throughout Australia's arid and semi-arid regions, with a distribution centered primarily on inland drainage systems with an average rainfall <50 mm per annum (Garnett et al. 2011). It inhabits lightly timbered coastal and inland plains, particularly *Acacia* shrublands crossed by tree-lined watercourses (Johnstone and Storr 1998, Garnett et al. 2011). Wetlands where surface water attracts prey may also attract Grey Falcons, but they will hunt over a variety of habitats, even far out over treeless plains (Olsen and Olsen 1986).

The Grey Falcon primarily hunts birds, especially parrots and pigeons, taken using high-speed chases and stoops; reptiles and mammals are also taken. Natural breeding sites are usually in trees, such as eucalypts, typically in the abandoned nests of crows and butcherbirds (Marchant and Higgins 1993, Johnstone and Storr 1998). Telecommunications towers are also used regularly.

A single record of the Grey Falcon was recorded in the MIA. It is likely to occur in the DE as a foraging visitor given the diverse range of habitats utilised, however no suitable nesting habitat (major drainages) is present.

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

The Brush-tailed Mulgara is listed as a Priority 4 species (DBCA 2022). 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 these were distinct species living in partial sympatry (Pavey et al. 2011).

The Brush-tailed Mulgara is known to inhabit spinifex grasslands on sand plains and sandy swales 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 of gibber (rock and pebble-covered flat plains), and is closely associated with gently sloping to flat topographical positions rather than steep-sided sand ridges (Pavey et al. 2011).

Secondary evidence (tracks and diggings) of the Brush-tailed Mulgara was recorded from within the MIA within the Shrub and spinifex on sandplain habitat type. The Mulgara has also been recorded in the locality surrounding the DE through secondary evidence. All records were inferred to belong to Brush-tailed Mulgara (not the Crest-tailed Mulgara *D. cristicauda*) based on habitat and the most recent descriptions of distribution for the species.

4.3.1.4 Northern Marsupial Mole (*Notoryctes caurinus*) – DBCA Priority 4

The Northern Marsupial Mole is a fossorial species with prominent morphological adaptations to its almost entirely subterranean habit, including being blind, lacking ears and the modification of limbs to form paddle-like structures to aid ‘swimming’ through sand (Warburton 2006). 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.

Mole-holes belonging to the Northern Marsupial Mole were recorded from both inside and outside of the DE near the MIA in the Inland sand dune habitat. The species is likely to occur in other areas of suitable habitat within the DE.

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

Once described as endemic to the central and eastern parts of the Pilbara (Menkhorst and Knight 2011), this species is now known to occur much more widely over the entire Pilbara region and into the Gascoyne (based on 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 m² (van Dyck and Strahan 2008). Active mounds are identifiable by features 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. 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.

Western Pebble-mound Mouse mounds were recorded within the western portion of the DE within the RAC from Gravelly lateritic rises habitat, as well as outside of the DE to the immediate southwest.

4.3.1.6 Dampierland Plain Slider (*Lerista separanda*) – DBCA Priority 2

This species was originally described as occurring solely from the Dampier Peninsula, however recent records have extended its distribution to include Warrawagine station (to the west of the survey area) and part of the DE (Doughty et al. 2011, Biota 2018a). The records from the MIA represent a further range extension for this species.

Lerista separanda was recorded within the RAC and MIA within Shrub and spinifex on sandplain habitat. It was also recorded from sites in the locality outside the DE (Biota 2018a).

4.3.1.7 Oriental Plover (*Anarhynchus veredus*) – BC Act and EPBC Act Migratory

The species breeds in Mongolia, northern China and southern Siberia, and is a non-breeding summer migrant to Australia, occurring primarily from September to April (Johnstone and Storr 1998). However, unlike most shorebird species, they are not tied to wetland and coastal habitats while in Australia. Their preferred foraging habitats are sparsely vegetated open areas, including short-grassed or bare plains, bare wetland margins, and recently burnt areas (Johnstone and Storr 1998). This also includes similar man-made habitats, such as sports fields and airfields. The species will also use tidal mudflats, beaches, sewage ponds and freshwater wetland areas, primarily while on migration, or for roosting during the heat of the day (Johnstone and Storr 1998, Menkhorst et al. 2017). They are mobile in response to conditions, and disperse across inland northern Australia during the wet season (Minton et al. 2013).

Oriental Plovers were recorded on four occasions, inside and outside of the MIA section of the DE in Shrub and spinifex on sandplain and Inland sand dune habitats. Additionally, there is some suitable habitat in other parts of the DE, primarily in the Ephemeral claypan and Clayey sandplain with termitaria habitats.

4.3.1.8 Oriental Pratincole (*Glareola maldivarum*) – BC Act and EPBC Act Migratory

The species is a non-breeding migrant to Australia and is typically present from October to May, with the largest numbers present from December to March (Johnstone and Storr 1998, Sitters et al. 2004). The Oriental Pratincole often uses broadly similar foraging habitats to the Oriental Plover, including short-grassed or bare plains, bare wetland margins. However, Oriental Pratincoles take most of their insect prey aerially (Johnstone and Storr 1998), and will forage over a wider range of open habitat types, and occasionally over more wooded areas. Oriental Pratincole will also use tidal mudflats, beaches, sewage ponds and freshwater wetland areas, primarily for roosting during the heat of the day. They are mobile in response to conditions, and disperse across inland northern Australia during the wet season, occasionally gathering in exceptionally high numbers (Sitters et al. 2004).

One Oriental Pratincole was identified from within the DE from an ARU recording and the species has been recorded multiple times in the locality from outside the DE (Biota 2018b). Additionally, suitable foraging habitat exists across most of the DE, primarily in airspace over plains habitats. There is also suitable loafing or roosting habitat in the Ephemeral claypan and Clayey sandplain with termitaria habitats.

4.3.1.9 Australian Tern (*Gelochelidon [nilotica] macrotarsa*) - BC Act and EPBC Act Migratory

There are two populations of Gull-billed Tern in Australia; a resident population, *G. [nilotica] macrotarsa* and a migratory population *G. nilotica affinis*. Most authorities now recognise the resident Australian population as a distinct species; the Australian [Gull-billed] Tern, based on differences in plumage, structure, ecology and genetics (Rogers et al. 2005). However, the Australian [Gull-billed] Tern is still listed as Migratory under the EPBC Act due to a lag in updating the taxonomy of the species. Australian [Gull-billed] Terns are nomadic and occur widely across Australia, including both coastal and inland areas, but generally remain within Australia. They breed colonially on inland wetlands, and forage over sheltered coastal and inland wetlands, and over open grassland and bare ground (Johnstone and Storr 1998).

The Australian [Gull-billed] Tern was recorded within the MIA, however the record was of *G. [nilotica] macrotarsa* rather than representing the actual migratory taxon (*G. nilotica affinis*),

but this record is treated as the Migratory taxon under the current legislation listings (Table 4.4).

4.3.1.10 Little Curlew (*Numenius minutus*) - BC Act and EPBC Act Migratory

The Little Curlew is listed as Migratory under the BC Act and EPBC Act. It is a common non-breeding summer migrant to northern Australia, primarily between mid-September and April, with very few overwintering (Menkhorst et al. 2017). It favours short grassland habitats, including natural short grasslands or recently burnt grasslands, airfields and sports grounds, and less commonly other open habitats such as drying river beds and tidal flats (Johnstone and Storr 1998). The species is generally more common in coastal areas, but disperses further inland following widespread rainfall during the wet season.

Little Curlew calls were identified on four acoustic recording units deployed in and outside of the Rimfire borefield. Calls were detected across four nights and can be attributed to individuals flying over the survey area as Little Curlews primarily call in flight; however, it is possible that they are utilising the ground habitats of the survey area as well.

4.3.1.11 Pacific Swift (*Apus pacificus*) – BC Act and EPBC Act Migratory

It occurs as a non-breeding migrant across much of Australia from September to April, particularly in the northern half of the continent. In general, the species is most common closer to the coast, but occurs over much of the Pilbara and Kimberley. In Australia, the species is entirely aerial in habit, foraging for flying insects and even sleeping on the wing. It is highly mobile, often occurring in association with unsettled weather and low pressure systems (Johnstone and Storr 1998). Occurrence is most likely in association with the passage of low pressure systems or other unsettled weather conditions, but would not be limited to these conditions.

The Pacific Swift has been recorded from within the RAC and also within the locality surrounding the DE (Biota 2022b)(Figure 4.5). No other regional records were identified during the desktop review, but the species occurs widely over the Kimberley and the survey area falls within published distributions of the species (e.g. Johnstone and Storr 1998, Menkhorst et al. 2017). It is likely to occur in the airspace over the DE sporadically between September and April.

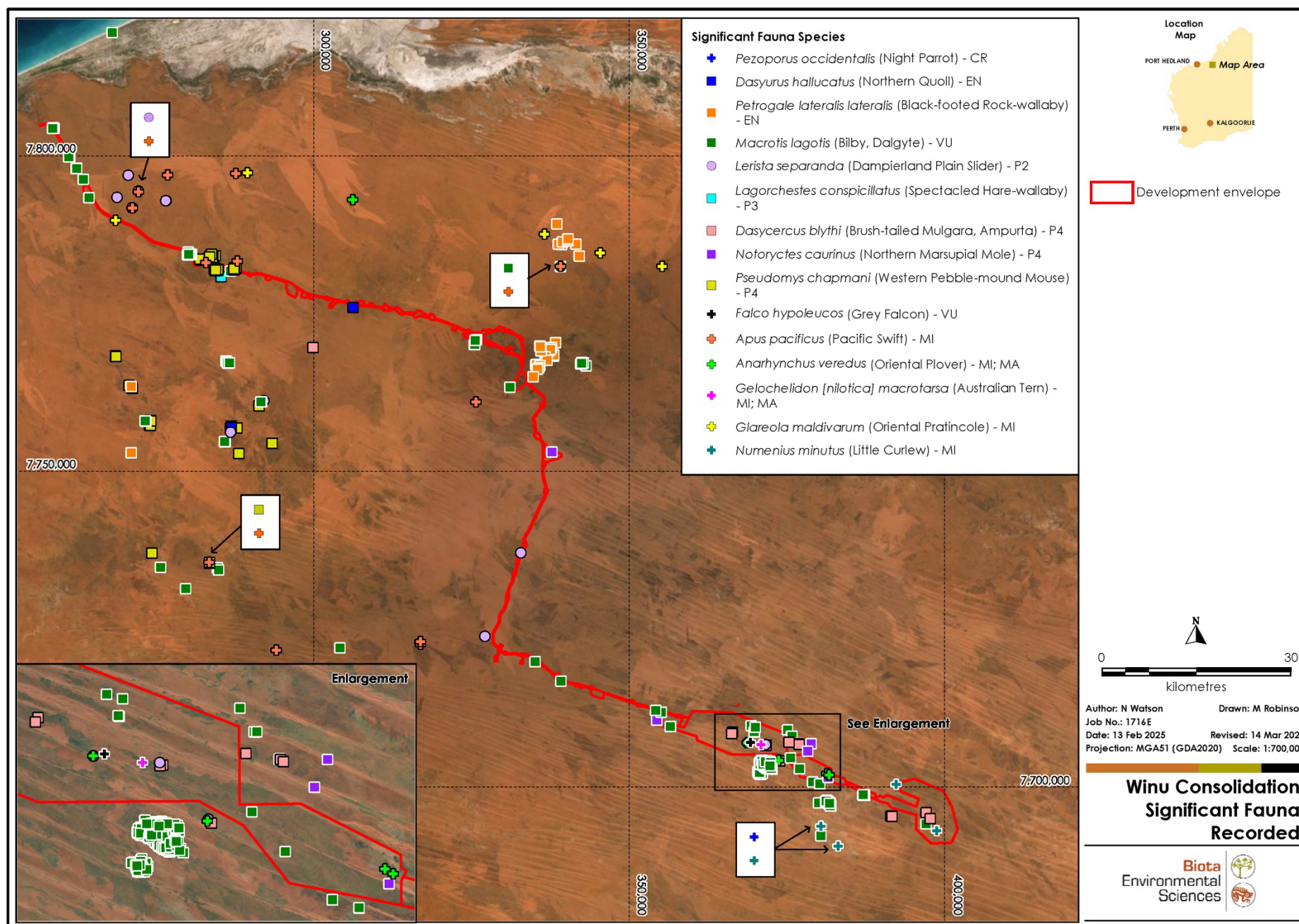


Figure 4.5: Locations of significant fauna records from the DE and surrounding locality.

4.3.2 Significant Species that are Likely to Occur

4.3.2.1 Night Parrot (*Pezoporus occidentalis*) – BC Act Endangered and EPBC Act Critically Endangered

The Night Parrot is a small ground-dwelling Parrot endemic to Australia and occurring in arid to semi-arid regions where it requires dense, low vegetation, under or in which it hides 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) before a hiatus in records of almost 100 years despite considerable search effort. Then in 1990 and 2006 two specimens were collected in south-west Queensland, with the first photographic evidence presented in 2013 (Dooley 2013). In 2017 there was a confirmed record from the Murchison bioregion (Jones 2017) and reports of sightings in an area which straddles the Murchison/Gascoyne bioregions (Hamilton et al. 2017). A small number of confirmed records have also been made in the eastern Pilbara (Higgins 1999) and north of the Fortescue Marsh (approximately 100 km north of Newman, and 250 km east of Brockman) (Davis and Metcalf 2008), along with several unconfirmed sightings.

Night Parrot calls were initially detected on acoustic recording units deployed in one of the borefield options south of the DE in 2024 (Biota 2025a). This borefield option has since been removed from consideration as part of the project. As a result of these initial records, a targeted Night Parrot survey involving long-term passive acoustic recording and detailed habitat mapping was undertaken to further assess the species' status within the DE and surrounding locality (Biota 2025a). Night Parrot calls have now been detected at eight locations in this area (all outside of the DE), but importantly, at none of the locations in the modified DE where recorders have been deployed simultaneously. Night Parrot habitat has been mapped over an area of 2,475.1 ha, with potential roosting habitat accounting for most of that total at 2,167.8 ha, and potential foraging habitat being the remaining 307.3 ha (Biota 2025). Based on this habitat mapping, the DE was amended to exclude all Night Parrot habitat, such that there is none mapped in either the MIA or Rimfire borefield (Biota 2025a).

Potential roosting habitat is present south of the Rimfire pipeline corridor, extending from 200 m south of the DE to approximately 13 km south and covering a distance of approximately 12 km southeast to northwest. Potential foraging habitat is also present within this area. An additional two small areas of potential roosting habitat have been mapped as occurring immediately north of the boundary of the Rimfire pipeline corridor (within 5 m of the DE boundary). Based on the close proximity of mapped potential roosting habitat to the DE and the confirmed record of the species approximately 4 km from the DE, it is considered likely that this species could periodically occur as a foraging visitor or occasionally overfly the Rimfire pipeline corridor. However, its occurrence would be expected to be transitory only and restricted to this southeast portion of the DE, where potential roosting habitat has been mapped to the north and south (predominantly to the south) of the Rimfire pipeline corridor (see Biota (2025a) for more detail). Night Parrots remain a focus of ongoing monitoring in areas of mapped potential habitat, as well as areas of the DE proximal to mapped habitat where they may be expected to visit.

4.3.2.1 Black-footed Rock-wallaby (*Petrogale lateralis lateralis*) – BC Act and EPBC Act Endangered

The Black-footed Rock-wallaby was once widespread but is now widely scattered through ranges in the central and west of Australia, and isolated populations on Barrow Island and Islands in the Recherche Archipelago (Menkhorst and Knight 2011). Rockpiles and other rocky habitat are primary habitat for the Black-footed Rock-Wallaby, providing 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 temperatures and predators. Feeding occurs as close to shelter as possible (especially if predators are present), however if food is not available near an area of shelter, they will move up to several hundred metres away to obtain it ((Eldridge and Pearson 2008) cited in Threatened Species Scientific Committee (2016)).

The Black-footed Rock-wallaby has been recorded from rockpiles immediately northeast of the eastern RAC section of the DE, where the nearest records were approximately 2 km east of the DE boundary (see Figure 4.5). The species is likely to occur within the areas of rocky outcropping habitat found adjacent to this part of the DE and individuals may periodically traverse supporting habitat that falls within the DE. Based on this, the species is considered likely to occur within the DE but only occasionally within the eastern RAC where it is in proximity to the rockpiles outside of the DE. There are no occurrences of rockpiles or rocky outcropping habitat that would be considered critical habitat for the species within the DE itself. Other occurrences of rocky outcropping are mapped along the RAC (see Figure 4.1) and, while these represent potential habitat for the Black-footed Rock-wallaby, there have been no records of the species outside of the rockpiles to the east of the RAC (see Figure 4.5). Thus, the rockpiles to the northeast of the RAC, and additional rockpiles extending northwards outside the DE, represent the only confirmed habitat for the species in the Winu locality.

4.3.2.2 Northern Quoll (*Dasyurus hallucatus*) – BC Act and EPBC Act Endangered

The Northern Quoll is a medium-sized dasyurid marsupial, with adult weight ranging from 300 g to 1,200 g. It is 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 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.

The Northern Quoll was recorded from a scat within rocky outcropping habitat adjacent to the central-RAC portion of the DE (approximately 270 m outside the DE) (see Figure 4.5). No evidence of denning in the form of larger scat piles was recorded, no individuals were trapped and none were recorded on automated cameras. 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. Given the extensive searches of rocky habitat undertaken to target the Black-footed Rock-wallaby outside the DE, the paucity of denning evidence of the Northern Quoll would suggest that it is occurring at most on a transient basis. However, due to the close proximity of the Northern Quoll record to the RAC, the Northern Quoll is considered likely to occur within the DE. Its occurrence within the DE is likely to be only as a transient visitor and/or at low density, as all of the rocky outcropping habitat in the locality occurs outside the DE.

4.3.2.3 Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*) – DBCA Priority 4

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, including drastic declines in the mainland Pilbara region (Ingleby 1991, Burbidge and Johnson 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 and Main 1971). Individuals are mostly solitary, but sometimes feed in groups of up to three (Burbidge and Johnson 2008), and occupy home ranges of about 1.77 km² (McCosker 1997).

Spectacled Hare-wallaby was recorded via tracks from one location approximately 640 m south of the DE. This species can be hard to detect and is most commonly recorded incidentally when flushed from its daytime shelter in spinifex hummocks. Considerable walking of spinifex habitat targeting the Bilby was conducted during multiple surveys for the Winu project, with no more detections made. Fire age is also likely to have an impact, with long unburnt large spinifex clumps preferred by the species. Based on the proximity of the record, the species is considered likely to occur in the DE.

4.3.3 Significant Species that May Occur

4.3.3.1 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 lakedownensis* includes the Pilbara and Kimberley regions (Menkhorst and Knight 2011) although historical 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. 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).

Some areas of mixed grasslands and shrublands occur throughout the undisturbed portions of the RAC, though these are not entirely typical for the species. Given this, a precautionary approach was adopted and the species was assessed as having a small potential to occur ('may occur').

4.3.3.2 Princess Parrot (*Polytelis alexandrae*) – DBCA Priority 4, EPBC Act Vulnerable

Sparsely distributed in the arid regions of Western Australia, the Northern Territory, and South Australia, the Princess Parrot is mainly concentrated in the Great Sandy, Gibson, Tanami and Great Victoria Deserts (Department of the Environment 2016). Large-scale movements and sporadic appearances make changes in distribution hard to determine, with the parrot being an irregular visitor to most sites in its range. Habitat preferences include sand dunes and sand flats, although the bird also occurs in open savanna woodlands and shrublands that usually consist of scattered strands of *Eucalyptus*, *Casuarina* or *Allocasuarina*.

Although the Princess Parrot was not recorded during any of the surveys and there have been no records from the locality, the species may occur in the survey area as there is suitable habitat in the form of sand dunes and sand flats present in the DE and surrounding locality.

4.3.3.3 Barn Swallow (*Hirundo rustica*) – BC Act and EPBC Act Migratory

The Barn Swallow breeds throughout the northern hemisphere in temperate and subtropical regions. They migrate to the southern hemisphere for the boreal winter and reaches northern Australia annually. On the mainland, the Barn Swallow occurs from the Pilbara Region to

Fraser Island in Queensland, and has been irregularly recorded further south in Western Australia, South Australia, and vagrants as far south as Sydney. In Australia, records are known from areas of open country in coastal lowlands often near water.

Although no Barn Swallows were recorded during any of the surveys, suitable habitat in the form of open country, low vegetation and man-made structures is present within the DE, and there are known historical records from the locality, therefore the species may occur in the survey area.

4.3.3.4 Peregrine Falcon (*Falco peregrinus*) – BC Act Other Specially Protected Fauna

The Peregrine Falcon has an almost cosmopolitan distribution, but is absent from most deserts and the Nullarbor Plain (Johnstone and Storr 2004). The species is widespread throughout Australia (Marchant and Higgins 1993) and was not considered to be threatened by Garnett et al. (2011).

Peregrine Falcons occur in 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, but not typically less than 480 ha (Marchant and Higgins 1993). The species typically nests on ledges, 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 a variety of 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).

Regional records are known from the locality, however critical breeding habitat in the form of high cliff faces is absent from the DE. The Peregrine Falcon may occur as a foraging visitor in the DE.

4.4 Introduced Fauna

Four introduced fauna species have been detected in the Winu DE:

- Feral Cat (*Felis catus*);
- Red Fox (*Vulpes vulpes*);
- European Cattle (*Bos primigenius taurus*); and
- Dromedary Camel (*Camelus dromedarius*).

The north-western portion of the Winu DE (the RAC) intersects Wallal Downs Cattle Station. Cattle abundance and presence in the Winu DE will vary over time, though their relevance to the Winu Project is predominantly as a safety risk for personnel travelling to site via vehicle. While cattle can cause grazing pressure on the landscape, and thus negatively impact native fauna species that also utilise grasses as food sources or shelter, their occurrence is limited to a very small proportion of the Winu DE.

Camels are extremely well adapted to the arid landscapes of Australia. A 2010 study estimated a minimum population of 1 million feral camels at an overall density of 0.29 camels/km², noting two significant hotspots of high density, the Simpson Desert and the Great Sandy Desert (Saalfeld and Edwards 2010). Camels or their signs (tracks) have been recorded in all fauna habitats of the Winu DE. Negative environmental impacts of feral

camels include damage to vegetation (via grazing and trampling), suppression of recruitment in some plant species, and competition with native animals for food and shelter.

Predation of native fauna species by introduced predators, red foxes and feral cats is well documented across Australia. Wide-scale habitat modification due to mining operations can impact predator-prey interactions, including by facilitating predator access via the establishment of linear infrastructure such as access tracks (Bradley et al. 2022). Other mining infrastructure such as office and camp establishments can act as predator-prey focal points due to increased availability of shelter and food sources (including human food waste, and small irrigated areas creating attractive natural vegetated patches). There is some evidence of this in the Winu DE with cats and their tracks being frequently observed on vehicle access tracks, and under transportable offices/accommodation units (pers. comms. on site RTW personnel).

4.5 Culturally Significant Fauna

The following significant fauna species are also recognised to be of important cultural significance to Indigenous people across Australia as they are an important part of tjukurrpa (Dreamtime)³:

- Night Parrot;
- Bilby, Dalgyte – historically also acted as a food source and their tails were used for decoration;
- Great Desert Skink, Tjakura – historically also a favoured food resource; and
- Black-footed Rock-wallaby – also hunted for food and fur.

In addition to the species listed above, more abundant ‘game’ species are also recognised as being important as food sources, such as kangaroo/ Euro (*Osphranter* spp.), varanid species (*Varanus* spp.) and bustard (*Aredotis australis*).

³ <https://www.indigenoussdesertalliance.com/what-we-do/desert-projects/significant-species>

Table 4.4: Assessment of the likelihood of significant species to occur within the Winu DE.

		Significance*				
Species Name	Common Name	State	C'wealth	Preferred Habitat	Habitat in DE?	Likelihood of Occurrence in DE
Mammals						
Macrotis lagotis	Bilby, Dalgyte	VU	VU	Acacia shrubland, open tussock grassland.	✓	Recorded: Evidence of Bilby recorded throughout DE and in adjacent MIA extension areas, and Rimfire borefield.
Dasyercus blythi	Brush-tailed Mulgara, Ampurta	P4	-	Spinifex grasslands on sandplains 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.	✓	Recorded: Diggings, tracks and burrows recorded in MIA and RAC. Suitable vegetated sandplain habitats throughout the DE.
Notoryctes caurinus	Northern Marsupial Mole	P4	-	Vast sandy deserts of central Australia.	✓	Recorded: Mole holes observed within the RAC and MIA.
Pseudomys chapmani	Western Pebble-mound Mouse	P4	-	Stony hillsides with hummock grasslands in the central and eastern parts of the Pilbara.	✓	Recorded: Records from northwest section of the DE and additional mounds recorded south of there. Occurs in gravelly lateritic habitat within the area.
Dasyurus hallucatus	Northern Quoll	EN	EN	Rocky areas and tall open coastal eucalypt.	-	Likely to occur: Scats recorded near the central section of the RAC. Rockpiles provide suitable habitat though none are located within the DE. Likely a transitory visitor only.
Petrogale lateralis lateralis	Black-footed Rock-wallaby	EN	EN	Rockpiles and other rocky habitat providing 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 temperatures and predators.	-	Likely to occur: Records are concentrated in two areas outside of the DE in the northeast of the RAC near the diversion. Rockpiles are present near RAC section of the DE. Likely to occur in the DE as a transitory visitor only.
Lagorchestes conspicillatus	Spectacled Hare-wallaby	P4	-	Long unburnt spinifex on sandy or stony plains.	✓	Likely to occur: One record of tracks near the western end of the RAC section of the DE.
Leggadina lakedownensis	Short-tailed Mouse	P4	-	Cracking clay and adjacent habitats.	✓	May occur: Clay habitat available in MIA section of the DE and records from the locality.

Species Name	Common Name	Significance*		Preferred Habitat	Habitat in DE?	Likelihood of Occurrence in DE
		State	C'wealth			
<i>Rhinonictis aurantia</i>	Orange Leaf-nosed Bat	VU	VU	Semi-desert adapted. Critical habitat includes caves or mine adits with stable, very hot and very humid microclimates. Supporting foraging habitat includes <i>Triodia</i> hummock grassland, sparse tree and shrub savannah and riparian vegetation along drainage lines.	-	Unlikely to occur: No suitable roost cave habitat.
<i>Macroderma gigas</i>	Ghost Bat	VU	VU	Range of habitats that provide suitable caves for roost sites. Critical habitat: gorges, gullies, free faces, incised hills. Supporting habitat: drainage systems, alluvial plains and floodplains.	-	Unlikely to occur: No suitable roost cave present.
<i>Antechinomys longicaudata</i>	Long-tailed Dunnart	P4	-	<i>Acacia</i> dominated rocky screes with hummock grasses, tall open shrubland and woodland.	✓	Unlikely to occur: No records from the locality and little suitable habitat present.
<i>Isoodon auratus</i>	Golden Bandicoot	VU	VU	A variety of habitats including sand dunes, sandplains with spinifex or sandplains with <i>Acacia</i> and Eucalypt woodlands, sandstone-spinifex and vine thickets.	✓	Would not occur: No records from the locality and well outside documented distribution.
<i>Phascogale calura</i>	Red-tailed Phascogale	CD	VU	Dense vegetation with Wandoo and Rock Oak.	-	Would not occur: Outside of current documented distribution and no suitable habitat present.
Reptiles						
<i>Lerista separanda</i>	Dampierland Plain Slider	P2	-	Dune crests and sandy areas.	✓	Recorded: Records from RAC and in MIA, both representing a range extension for the species.
<i>Liopholis kintorei</i>	Great Desert Skink	VU	VU	Generally red sandplains and sand ridges. Mosaic vegetation different ages (regenerating vegetation important), usually consisting of hummock grasslands with scattered shrubs and trees. Preferred habitat has at least 50% bare ground.	✓	Unlikely to occur: Suitable habitat available but no records from the locality and outside the documented distribution (see Appendix 5).
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	VU	Rocky areas within the Pilbara, showing a preference for rocky gorges containing water in streams and rock pools.	-	Unlikely to occur: No records from the locality and suitable habitat absent.
<i>Ctenotus uber johnstonei</i>	-	P2	-	Known from a single location in the arid north-eastern interior of WA, from low chenopod shrubs growing on colluvium at the foot of a sandstone hill.	-	Unlikely to occur: The subspecies was described from Balgo in the southern Kimberley, but morphologically similar individuals have been recorded widely within the Pilbara. Nearest records are 214 km SW of the DE.
Birds						

Species Name	Common Name	Significance*		Preferred Habitat	Habitat in DE?	Likelihood of Occurrence in DE
		State	C'wealth			
<i>Anarhynchus veredus</i>	Oriental Plover	MI	MI	Open plains, bare, rolling country, muddy or sandy wastes near inland swamps or tidal mudflats, bare claypans, margins of coastal marshes, grassy airfields, sportsfields, lawns and coastal dune areas.	✓	Recorded: Records from RAC and MIA.
<i>Gelochelidon [nilotica] macrotarsa</i>	Australian Tern	MI	MI	Coastlines and estuaries, esp. with tidal flats, larger permanent and ephemeral wetlands inland, open plains (sometimes far from water).	✓	Recorded: One record from inside the DE in the MIA.
<i>Glareola maldivarum</i>	Oriental Pratincole	MI	MI	Lightly wooded and untimbered lowland plains that are crossed by major watercourses lined with taller trees or isolated manmade structures such as communications towers.	-	Recorded: Observations and audio recordings in RAC with two observations of flocks foraging near RAC.
<i>Pezoporus occidentalis</i>	Night Parrot	CR	EN	Roosting/nesting: widespread long unburnt spinifex with significant structural complexity. Foraging: Floristically diverse run-on areas providing a broad array of grasses and forbs, ranging from small depressions and gilgai formations to large floodplains.	-	Likely to occur: Recorded 4 km east of MIA/south of Rimfire. Potential roosting and foraging habitat mapped in close proximity to Rimfire pipeline corridor.
<i>Numenius minutus</i>	Little Curlew	MI	MI	Utilise a range of marine and freshwater, wetland habitats including tidal mudflats, beaches, estuaries, sewage ponds, dams, salt lakes, creeks and freshwater wetlands.	-	Recorded: Recorded on four acoustic recording units in the Rimfire borefield and south of Rimfire.
<i>Falco hypoleucos</i>	Grey Falcon	VU	VU	Diverse from rainforest to arid shrublands, from coastal heath to alpine, mainly about cliffs along coasts, rivers and ranges and about wooded watercourses and lakes.	✓	Recorded: A single Grey Falcon was observed during sampling for subterranean fauna (Biota 2021b). Suitable foraging habitat present.
<i>Falco peregrinus</i>	Peregrine Falcon	OS	-	Short grassland habitats, including natural short grasslands or recently burnt grasslands, airfields and sports grounds.	✓	May occur: Records from the locality but no critical habitat in the DE. May occur as a foraging visitor.
<i>Apus pacificus</i>	Pacific Swift	MI	MI	Thought to be almost exclusively aerial in Australia.	✓	Recorded: Recorded from within the RAC and the locality surrounding the DE during the AREH (Biota 2022b) survey.
<i>Polytelis alexandrae</i>	Princess Parrot	P4	VU	Sand dunes and sand flats in the arid zone.	✓	May occur: No records from the locality and only a small area of suitable habitat present.
<i>Hirundo rustica</i>	Barn Swallow	MI	MI	Open country with low vegetation, often near manmade structures.	✓	May occur: Suitable habitat present and some historical records within the locality.

Species Name	Common Name	Significance*		Preferred Habitat	Habitat in DE?	Likelihood of Occurrence in DE
		State	C'wealth			
<i>Cuculus optatus</i>	Oriental Cuckoo	MI	MI	Non-breeding habitat only: monsoonal rainforest, vine thickets, wet sclerophyll forest or open <i>Casuarina</i> , <i>Acacia</i> or <i>Eucalyptus</i> woodlands. Frequently at edges or ecotones between habitat types. Riparian forest is favoured habitat in the Kimberley region.	-	Unlikely to occur: No suitable habitat, rare migrant to Western Australia.
28 coastal/ wetland Migratory shorebird species	-	EN; VU; MI	EN; VU; MI	Sandy or muddy fringes of freshwater, wetlands, coastal beaches and inlets.	-	Unlikely to occur: No wetland or coastal habitats included within the DE.
				Utilise a range of marine and freshwater, wetland habitats including tidal mudflats, beaches, estuaries, sewage ponds, dams, salt lakes, creeks and freshwater wetlands.		
<i>Rostratula australis</i>	Australian Painted-snipe	EN	EN	Freshwater wetlands, preferring ephemeral wetlands with a mix of shallow water, exposed mud, and dense fringing vegetation.	-	Unlikely to occur: Wetland habitat absent.
<i>Gelochelidon nilotica</i>	Gull-billed Tern spp.	MI	MI	Coastlines and estuaries, particularly with tidal flats. Occasionally on near-coastal wetlands.	-	Unlikely to occur: Migratory subspecies is a non-breeding migrant to Australia and is more coastal in its habitat.
<i>Pandion haliaetus</i>	Osprey	MI	MI	Littoral and coastal environments as well as terrestrial wetlands. Requires large areas of fresh, brackish or saline water for foraging.	-	Unlikely to occur: No suitable habitat within DE.
<i>Erythrotriorchis radiatus</i>	Red Goshawk	VU	EN	Tall woodlands and forests near coastline.	-	Unlikely to occur: Outside of currently published distribution but potential for dispersal through arid zones.
<i>Motacilla tschutschensis</i>	Eastern Yellow Wagtail	MI	MI	Short grasslands and open margins of water bodies, including human-modified environments such as sports fields and sewage ponds.	-	Unlikely to occur: Common migrant to the Kimberley and coastal Pilbara but no suitable habitat in DE.
<i>Motacilla cinerea</i>	Grey Wagtail	MI	MI	In Australia, near running water in disused quarries, sandy, rocky streams in escarpments and rainforest, sewerage ponds, ploughed fields and airfields.	-	Would not occur: A rare migrant to the Kimberley and vagrant outside of the Kimberley. No preferred habitat.

* CR = Critically Endangered; EN = Endangered; VU = Vulnerable; MI = Migratory; P = Priority; CD = Conservation Dependent; OS = Other Specially Protected.

5.0 Discussion

5.1 Significant Fauna

Across all studies consolidated in this report, a total of 34 significant vertebrate species were returned from the database searches. Eleven of these significant species were recorded within the Winu DE during the field surveys (four mammal, one reptile and six bird species)(Table 5.1). A further four significant species were recorded in close proximity and are considered likely to occur (three mammal and one bird species), and an additional four significant species may occur in the DE (one mammal and three bird species)(Table 5.1).

Table 5.1: Likelihood of significant vertebrate species occurring within the Winu DE.

Species Name	Common Name	Significance*		Likelihood of Occurrence in DE
		State	C'wealth	
Mammals				
<i>Macrotis lagotis</i>	Bilby, Dalgyte	VU	VU	Recorded
<i>Dasycercus blythi</i>	Brush-tailed Mulgara, Ampurta	P4	-	Recorded
<i>Notoryctes caurinus</i>	Northern Marsupial Mole	P4	-	Recorded
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	P4	-	Recorded
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	EN	Likely to occur
<i>Petrogale lateralis lateralis</i>	Black-footed Rock-wallaby	EN	EN	Likely to occur
<i>Lagorchestes conspicillatus</i>	Spectacled Hare-wallaby	P4	VU	Likely to occur
<i>Leggadina lakedownensis</i>	Short-tailed Mouse	P4	-	May occur
Reptiles				
<i>Lerista separanda</i>	Dampierland Plain Slider	P2	-	Recorded
Birds				
<i>Falco hypoleucos</i>	Grey Falcon	VU	-	Recorded
<i>Anarhynchus veredus</i>	Oriental Plover	MI	MI	Recorded
<i>Gelochelidon [nilotica] macrotarsa</i>	Australian Tern	MI	MI	Recorded
<i>Numenius minutus</i>	Little Curlew	MI	MI	Recorded
<i>Glareola maldivarum</i>	Oriental Pratincole	MI	MI	Recorded
<i>Apus pacificus</i>	Pacific Swift	MI	MI	Recorded
<i>Pezoporus occidentalis</i>	Night Parrot	CR	EN	Likely to occur
<i>Falco peregrinus</i>	Peregrine Falcon	OS	-	May occur
<i>Polytelis alexandrae</i>	Princess Parrot	P4	VU	May occur
<i>Hirundo rustica</i>	Barn Swallow	MI	MI	May occur

* CR = Critically Endangered; EN = Endangered; VU = Vulnerable; MI = Migratory; P = Priority; OS = Other Specially Protected.

5.2 Fauna Habitats

This data consolidation exercise has identified five rationalised fauna habitats as occurring within the Winu DE; Shrub and spinifex on sandplain, Inland sand dune, Gravelly lateritic rises, Clayey sandplain with termitaria, and Ephemeral claypan (plus Disturbed/cleared areas).

When assessing the value of habitat in the Winu DE, it is reasonable to determine the critical habitat of individual species of significance. Critical habitat for significant species equates to “habitat critical to the survival of a species” (Department of the Environment 2013). Such habitats include those that are known, or are likely, to be utilised by listed species for key ecological activities such as nesting, roosting, breeding, refugia and important foraging areas.

As a result, it is assumed that some proportion of this habitat must be maintained across the species' range to ensure the persistence of the species in the region. Secondary (supporting) habitats may be used for lesser foraging or on a transitory, dispersing, or occasional basis, but do not represent critical habitat. When considering the faunal value of habitats within the DE, the following criteria can therefore be used to identify areas of higher habitat value. These are habitats that:

- support significant fauna;
- support unique faunal assemblages; and/or
- are uncommon in the region.

In terms of the recorded significant species, results from targeted surveying for the Bilby (*Macrotis lagotis*) indicate that habitat for the species -Shrub and spinifex on sandplain is available throughout the DE, and that the species is present. This habitat type is also important for the Brush-tailed Mulgara (*Dasyurus blythi*) and the Dampierland Plain Slider (*Lerista separanda*).

The Inland sand dune systems (and surrounding sandplains to a lesser extent) provide suitable connective habitat for the Northern Marsupial Mole (*Notoryctes caurinus*). Areas of Gravelly lateritic rises through the RAC are suitable for the Western Pebble-mound Mouse (*Pseudomys chapmani*).

The Grey Falcon (*Falco hypoleucos*), Oriental Plover (*Anarhynchus veredus*), Oriental Pratincole (*Glareola maldivarum*) and Australian [Gull-billed] Tern (*Gelochelidon [nilotica] macrotarsa*) are likely to occur through the MIA and RAC on occasion during appropriate foraging conditions.

Targeted surveys for the Black-footed Rock-wallaby (*Petrogale lateralis lateralis*) revealed a previously unknown colony located outside of the DE, near the RAC. The rock piles that this species was recorded from represent critical and restricted habitat for the species in the region. The rock piles are also likely to represent habitat utilised by the Northern Quoll (*Dasyurus hallucatus*) in a transient capacity. Thus, these two species would likely occur in the DE, but only on a transitory basis as there are no occurrences of critical habitat for the species within the DE.

Table 5.2 summarises the faunal value of habitats occurring within the Winu DE for potentially occurring significant species.

Though currently only recorded outside of the DE, it is likely that the Night Parrot (*Pezoporus occidentalis*) could occur as a foraging visitor or occasionally overfly the Rimfire pipeline corridor. This is based on the close proximity of mapped potential roosting and foraging habitat to the DE and the confirmed record of the species approximately 4 km from the DE. As a dedicated habitat mapping study has been completed for the species at the Winu Project (Biota 2025a), in addition to a species-specific impact assessment (Biota 2025b), habitat significance for Night Parrot is not considered in Table 5.2.

Table 5.2: Fauna habitat classification for significant vertebrate species potentially occurring within the Winu DE⁴.

Common Name	Shrub and spinifex on sandplain 17,039 ha (72%)	Inland sand dune 3,105 ha (13%)	Gravelly lateritic rises 3,116 ha (13%)	Clayey sandplain with termitaria 125 ha (<1%)	Ephemeral claypan 49 ha (<1%)	Disturbed/cleared 214 ha (<1%)
Mammals						
Bilby, Dalgyte	Critical	Critical	-	-	-	-
Brush-tailed Mulgara, Ampurta	Critical	-	Supporting	-	-	-
Northern Marsupial Mole	Supporting	Critical	-	-	-	-
Western Pebble-mound Mouse	-	-	Critical	-	-	-
Northern Quoll	Supporting	-	Supporting	-	-	-
Black-footed Rock-wallaby	Supporting	-	Supporting	-	-	-
Spectacled Hare-wallaby	Critical	-	-	-	-	-
Short-tailed Mouse	Supporting	-		Supporting	-	-
Reptiles						
Dampierland Plain Slider	Critical	-	-	-	-	-
Birds						
Grey Falcon	Supporting	Supporting	Supporting	Supporting	Supporting	-
Oriental Plover	Supporting	-	-	Supporting	Supporting	-
Australian Tern	Supporting	-	-	Supporting	-	-
Little Curlew	Supporting	-	-	Supporting	-	-
Oriental Pratincole	Supporting	-	-	Supporting	Supporting	-
Pacific Swift	Supporting	Supporting	Supporting	Supporting	Supporting	-
Peregrine Falcon	Supporting	Supporting	Supporting	Supporting	Supporting	-
Princess Parrot	Supporting	Supporting	-	-	-	-
Barn Swallow	Supporting	-	Supporting	Supporting	-	Supporting

⁴ For Night Parrot habitat classification see Biota (2025a).

5.3 Conclusions

The consolidated sampling effort provides coverage of both the full spatial extent and the range of habitats present within the Winu DE. The composition and diversity of the fauna assemblage recorded from the DE is similar to that documented for the habitats occurring in the surrounding locality. This is consistent with the nature of the habitats present in the DE, which are also well-represented in the locality and regionally.

The findings from the surveys undertaken for the Winu project have added to the knowledge base of fauna assemblages and habitats in the Great Sandy Desert, a relatively under-surveyed region of Australia. The assessment documented previously unknown occurrences of threatened fauna species, and range extensions for several fauna species that were previously not known from the bioregion. As a result of the detailed surveys undertaken at Winu, minor northerly range extensions were demonstrated for the Children's Python (*Antaresia childreni*), Perentie (*Varanus giganteus*), and Rufous Whipsnake (*Demansia rufescens*). Of note were the significant range extensions to the known distributions of the Pilbara Planigale (*Planigale kendricki*), Dampierland Plain Slider, (*Lerista separanda*), the Black-necked Whipsnake (*Demansia calodera*), the blind snake, (*Anilius endoterus*), and the Northern Pilbara Tree Dragon (*Diporiphora vescus*)(see Figure 5.1).

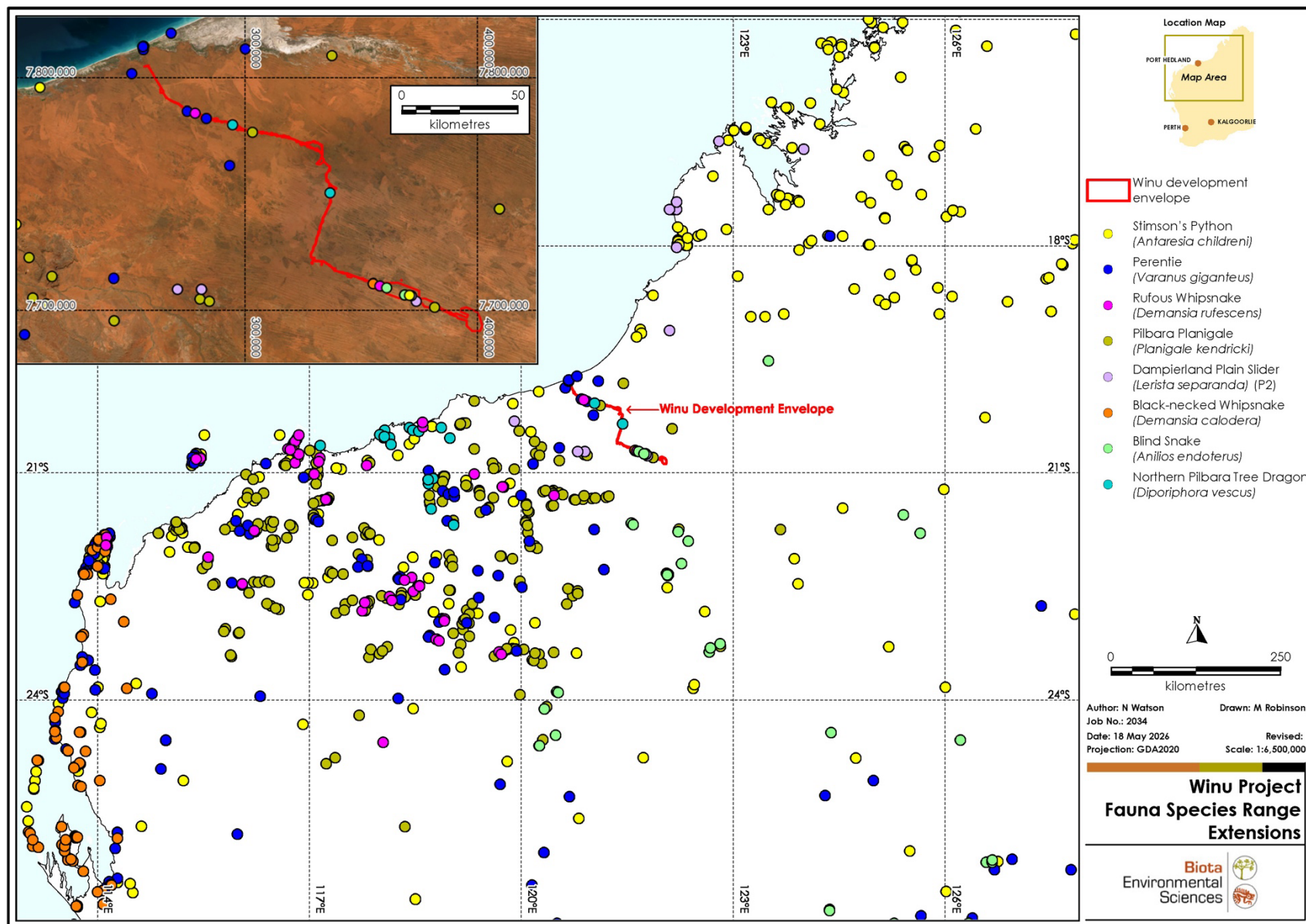


Figure 5.1: Range extensions recorded during Winu surveys.

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Appendix 1 Threatened Fauna Framework

CONSERVATION CODES

For Western Australian Fauna and Flora

Threatened, Extinct and Specially Protected fauna or flora¹ are species² which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species³ under Part 2 of the *Biodiversity Conservation Act 2016*.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T **Threatened species**

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is the species of fauna that are listed as critically endangered, endangered or vulnerable threatened species.

Threatened flora is the species of flora that are listed as critically endangered, endangered or vulnerable threatened species.

The assessment of the conservation status of threatened species is in accordance with the BC Act listing criteria and the requirements of Ministerial Guideline (Number 1) and Ministerial Guideline (Number 2) that adopts the use of the International Union for Conservation of Nature (IUCN) Red List of Threatened Species Categories and Criteria⁴, and is based on the national distribution of the species.

CR **Critically endangered species**

Threatened species considered to be “*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*”.

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines.

Examples of use:

- The western ringtail possum (*Pseudocheirus occidentalis*) is listed as a critically endangered threatened species under the *Biodiversity Conservation Act 2016*.
- Western ringtail possum is listed as critically endangered under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: CR.

EN **Endangered species**

Threatened species considered to be “*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*”.

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines.

Examples of use:

- *Caladenia hopperiana* is listed as an endangered threatened species under the *Biodiversity Conservation Act 2016*.
- *Caladenia hopperiana* is listed as endangered under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: EN.

VU Vulnerable species

Threatened species considered to be “*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*”.

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.

Examples of use:

- The forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*) is listed as a vulnerable threatened species under the *Biodiversity Conservation Act 2016*.
- Forest red-tailed black cockatoo is listed as vulnerable under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: VU.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where “*there is no reasonable doubt that the last member of the species has died*”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Examples of use:

- *Acacia kingiana* is listed as an extinct species under the *Biodiversity Conservation Act 2016*.
- *Acacia kingiana* is listed as extinct under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: EX.

EW Extinct in the wild species

Species that “*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no fauna or flora species listed as extinct in the wild.

SP Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered, or vulnerable) or extinct species under the BC Act cannot also be listed as specially protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Migratory species include birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA)⁵, China (CAMBA)⁶ or The Republic of Korea (ROKAMBA)⁷, and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention)⁸, an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Examples of use:

- The wedge-tailed shearwater (*Ardenna pacifica*) is listed as a specially protected migratory species under the *Biodiversity Conservation Act 2016*.
- Wedge-tailed shearwater is listed as migratory under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: MI.

CD Species of special conservation interest (conservation dependent)

Species of special conservation need that are dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Currently only fauna are listed as species of special conservation interest.

Examples of use:

- The wambenger, south-western brush-tailed phascogale (*Phascogale tapoatafa wambenger*) is listed as a specially protected species of special conservation interest under the *Biodiversity Conservation Act 2016*.
- Wambenger, south-western brush-tailed phascogale, is listed as conservation dependent under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: CD.

OS Species otherwise in need of special protection (other specially protected)

Species otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Currently only fauna are listed as species otherwise in need of special protection.

Examples of use:

- The dugong (*Dugong dugon*) is listed as a specially protected species otherwise in need of special protection under the *Biodiversity Conservation Act 2016*.
- Dugon is listed as other specially protected fauna under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: OS.

P Priority species

Priority is not a listing category under the BC Act.

All fauna and flora are protected in WA following the provisions in Part 10 of the BC Act. The protection applies even when a species is not listed as threatened or specially protected, and regardless of land tenure (State managed land (Crown land), private land, or Commonwealth land).

Species that may possibly be threatened species that do not meet the criteria for listing under the BC Act because of insufficient survey or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of prioritisation for survey and evaluation of conservation status so that consideration can be given to potential listing as threatened.

Species that are adequately known, meet criteria for near threatened, or are rare but not threatened, or that have been recently removed from the threatened species list or conservation dependent or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of priority status is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species - known from few locations, none on conservation lands

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, for example, agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation.

Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under immediate threat from known threatening processes. These species are in urgent need of further survey.

Examples of use:

- *Borya stenophylla* is listed as a Priority 1 species by the Department of Biodiversity, Conservation and Attractions.
- *Borya stenophylla* is listed as Priority 1 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P1.

2 Priority 2: Poorly-known species - known from few locations, some on conservation lands

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, for example, national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation.

Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under threat from known threatening processes. These species are in urgent need of further survey.

Examples of use:

- *Caladenia nivalis* is listed as a Priority 2 species by the Department of Biodiversity, Conservation and Attractions.
- *Caladenia nivalis* is listed as Priority 2 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P2.

3 Priority 3: Poorly-known species - known from several locations

Species that are known from several locations and the species does not appear to be under imminent threat or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat.

Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. These species need further survey.

Examples of use:

- *Acacia nitidula* is listed as a Priority 3 species by the Department of Biodiversity, Conservation and Attractions.
- *Acacia nitidula* is listed as Priority 3 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P3.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as a conservation dependent specially protected species.

(c) Species that have been removed from the list of threatened species or lists of conservation dependent or other specially protected species, during the past five years for reasons other than taxonomy.

(d) Other species in need of monitoring.

Examples of use:

- *Banksia aculeata* is listed as a Priority 4 species by the Department of Biodiversity, Conservation and Attractions.
- *Banksia aculeata* is listed as Priority 4 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P4.

¹ The definition of flora includes algae, fungi, and lichens.

² Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

³ Schedules are not referred to when stating the listing status of threatened, extinct or specially protected species under the BC Act. See the examples provided under each listing category.

⁴ Western Australia has assigned species to threat categories using the *IUCN Red List of Threatened Species Categories and Criteria* since 1996 (referencing all criteria). At the national level, threatened species listings under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) reference only some of the IUCN criteria (<http://www.environment.gov.au/biodiversity/threatened/nominations/forms-and-guidelines>).

⁵ JAMBA - first included in the WA migratory species list in 1980.

⁶ CAMBA - first included in the WA migratory species list in 2010.

⁷ ROKAMBA - first included in the WA migratory species list in 2010.

⁸ Bonn Convention (Birds) - first included in the WA migratory species list in 2015.

Commonwealth *EPBC Act 1999*

Fauna species of national environmental significance are listed under the Commonwealth *EPBC Act*, 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 *Biodiversity Conservation Act 2016*

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 has been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the Biodiversity Conservation Act 2016:

Threatened Species

- **Critically Endangered (CR):** Threatened species considered to be “facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines.
- **Endangered (EN):** Threatened species considered to be “facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines”.
- **Vulnerable (VU):** Threatened species considered to be “facing a high risk of extinction in the wild in the medium term future, as determined in accordance with criteria set out in the ministerial guidelines”.

Extinct Species

- **Extinct Species (EX):** Species where “there is no reasonable doubt that the last member of the species has died”
- **Extinct in the wild (EW):** Species that “is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form”

Specially Protected Species

- **Migratory (MI):** Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth.

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program

- **Species of special conservation interest (conservation dependent fauna) (CD):** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
- **Other specially protected fauna (OS):** Fauna otherwise in need of special protection to ensure their conservation.

Department of Biodiversity, Conservation and Attractions Priority Listing

The DBCA maintains a list of Priority species that have not been assigned statutory protection under the *Biodiversity Conservation Act 2016*. 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 four Priority categories:

Priority 1: Poorly known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

Priority 2: Poorly known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

Priority 3: Poorly known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy. conservation lands.



Appendix 2 Field Survey Personnel

Team member	Role	Years of experience	AREH Terrestrial Fauna (Biota 2018a)	AREH Migratory Shorebirds (Biota 2022a)	AREH Detailed Fauna (Biota 2022b)	Winu Fauna Assessment (Biota 2021)	Winu Bilby Abundance (Biota 2020)	Winu Extension Targeted Fauna (Biota 2022c)	Winu Bilby Population Study (Biota 2023a)	Winu Borefield Targeted Fauna (Biota 2023b)	Winu NVCP Fauna Clearance (Biota 2023c) and Gap Closure (Biota 2023d)	Winu Borefield Basic and Targeted Fauna (this report)	Winu Bilby Population Study (Biota 2024)	Winu Pipeline Corridor Basic Fauna Survey (this report)
Garth Humphreys	Project Director	33	✓	✓	✓	✓			✓		✓			
Roy Teale	Team leader	32	✓			✓	✓							
Stewart Ford	Team leader	20	✓	✓		✓	✓		✓			✓		
Daniel Kamien	Team Leader	20	✓		✓					✓				
Jacinta King	Survey Zoologist	10	✓			✓								
Dave Kierle	Survey Zoologist	15	✓											
Michael Greenham	Survey Zoologist	22	✓		✓						✓	✓	✓	✓
Penny Brooshooft	Survey Zoologist	15	✓			✓	✓							
Sylvie Schmidt	Survey Zoologist	12	✓											
John Graff	Survey Zoologist	12		✓	✓	✓								
Joshua Keen	Survey Zoologist	7			✓	✓	✓	✓	✓	✓				
Nathan Beerkens	Survey Zoologist	7			✓	✓	✓		✓					
Peter Kendrick	Survey Zoologist	40			✓									
Roxanne de Vos	Survey Zoologist	6						✓	✓	✓				
Hayley Newton	Survey Zoologist	3									✓	✓	✓	✓



Appendix 3 Survey Effort over Fauna Habitats



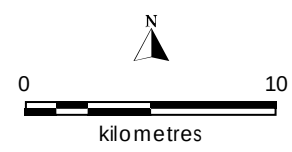
Development envelope

Fauna Searches

- General Search
- Marsupial Mole Trench
- Nocturnal Search
- Targeted Search
- Habitat assessment site

Fauna Habitat Types

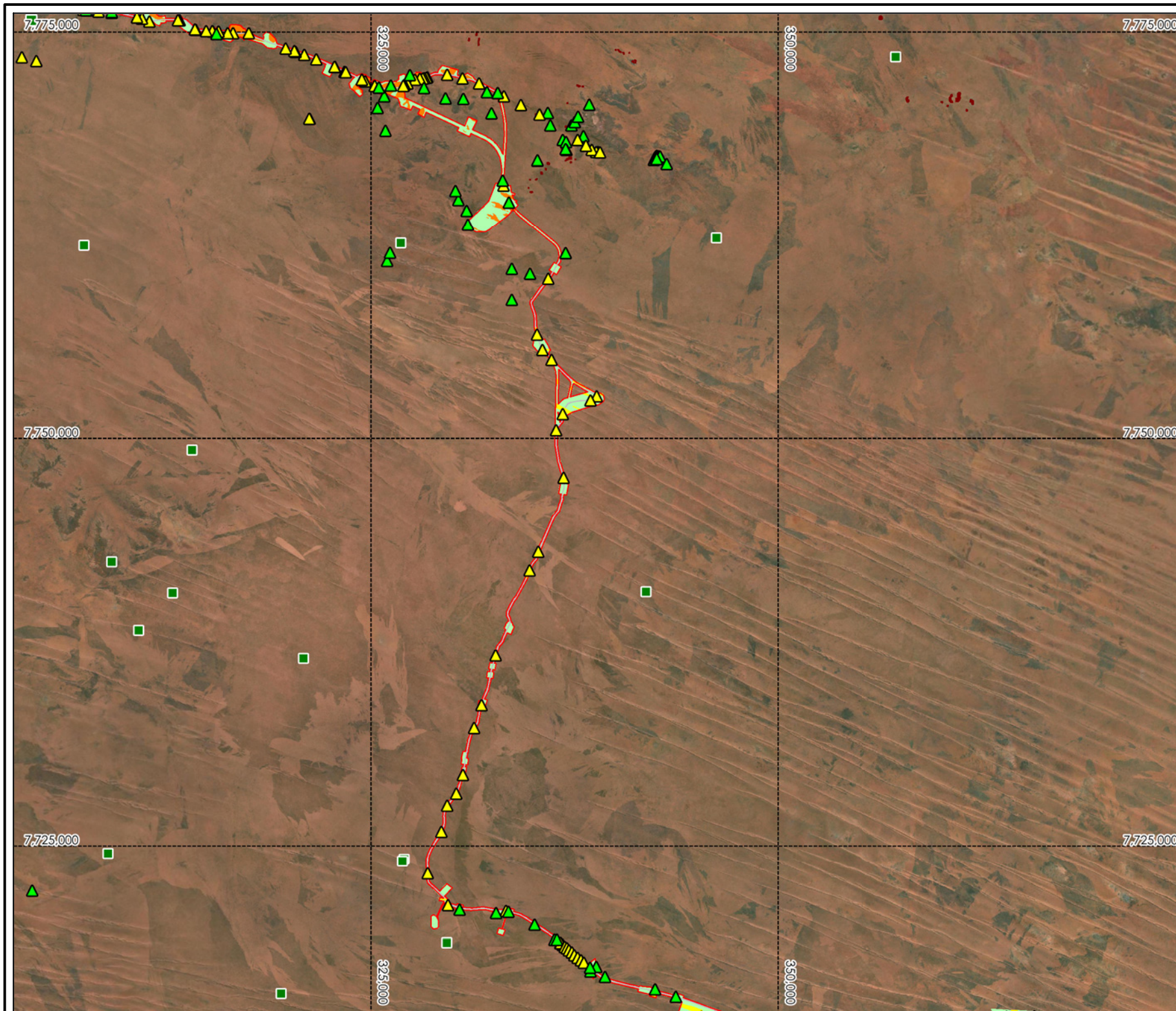
- Gravelly lateritic rises
- Rock outcropping
- Shrub and spinifex on sandplain
- Disturbed/cleared



Author: N Watson Drawn: M Robinson
Job No.: 1716E
Date: 08 May 2026 Revised:
Projection: MGA51 (GDA2020) Scale: 1:300,000

Winu Project
Fauna Survey Effort
Map 1





Location Map

PORT HEDLAND ● Map Area

PERTH ● KALGOORLIE ●

Development envelope

Fauna Searches

- General Search
- Marsupial Mole Trench
- Nocturnal Search
- Targeted Search
- Habitat assessment site

Fauna Habitat Types

- Gravelly lateritic rises
- Inland sand dune
- Rock outcropping
- Shrub and spinifex on sandplain
- Disturbed/cleared

0 10

kilometres

Author: N Watson Drawn: M Robinson

Job No.: 1716E

Date: 08 May 2026 Revised:

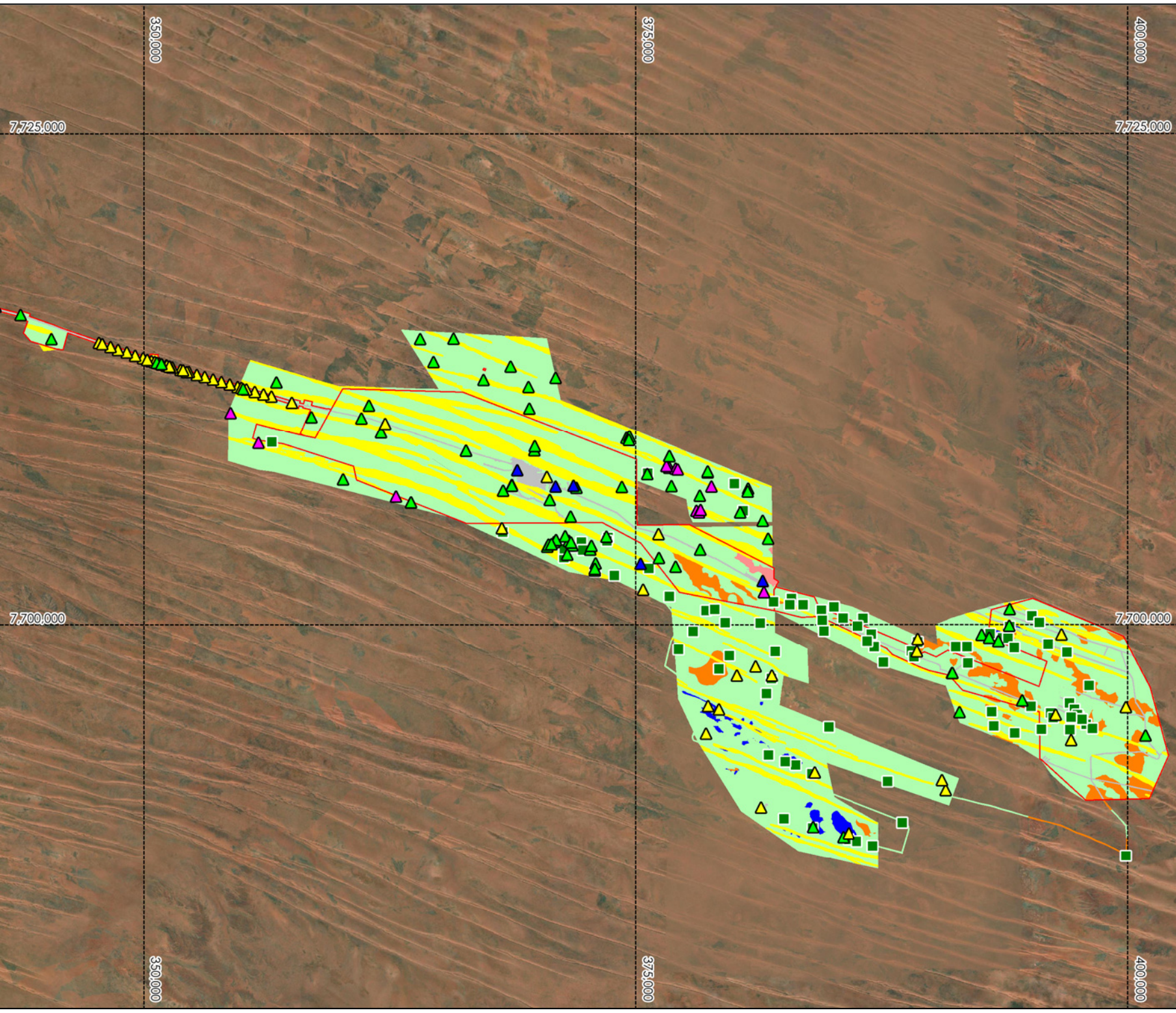
Projection: MGA51 (GDA2020) Scale: 1:300,000

Winu Project

Fauna Survey Effort

Map 2

Biota
Environmental
Sciences



Location Map

PORT HEDLAND ● **Map Area**

PERTH ● KALGOORLIE ●

Development envelope

Development envelope

Fauna Searches

- General Search
- Marsupial Mole Trench
- Nocturnal Search
- Targeted Search
- Habitat assessment site

Fauna Habitat Types

- Clayey sandplain with termitaria
- Ephemeral Claypan
- Gravelly lateritic rises
- Inland sand dune
- Shrub and spinifex on sandplain
- Disturbed/cleared

Scale and Orientation

0 10 kilometres

N

Author: N Watson
Job No.: 1716E
Date: 08 May 2026
Projection: MGA51 (GDA2020)

Drawn: M Robinson
Revised:
Scale: 1:250,000

**Winu Project
Fauna Survey Effort
Map 3**

**Biota
Environmental
Sciences**



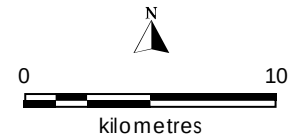
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Fauna Survey Methods

- ▲ Avifauna Census
- ✚ Motion Camera
- Acoustic Recorder
- Ultrasonic Recorder

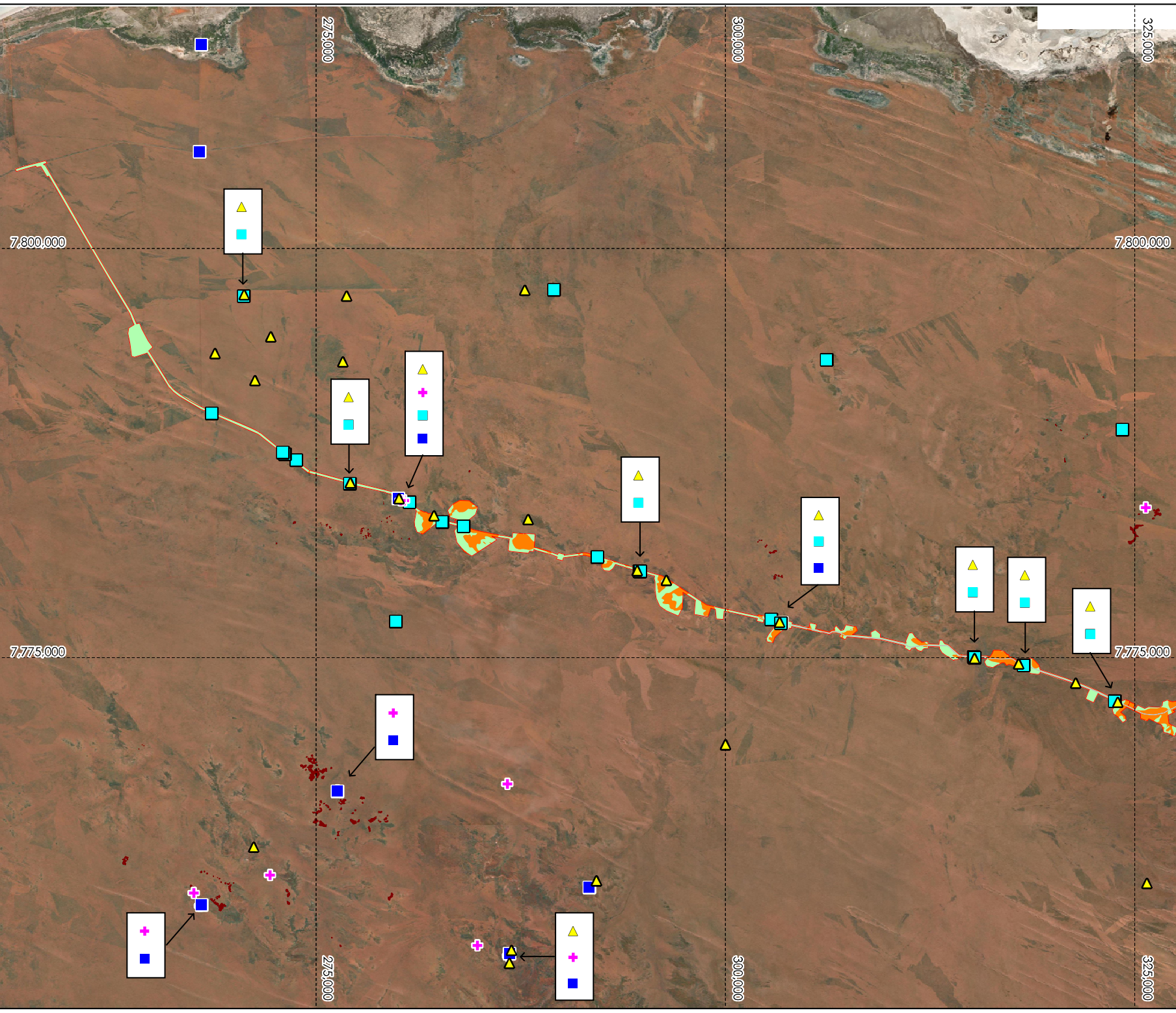
Fauna Habitat Types

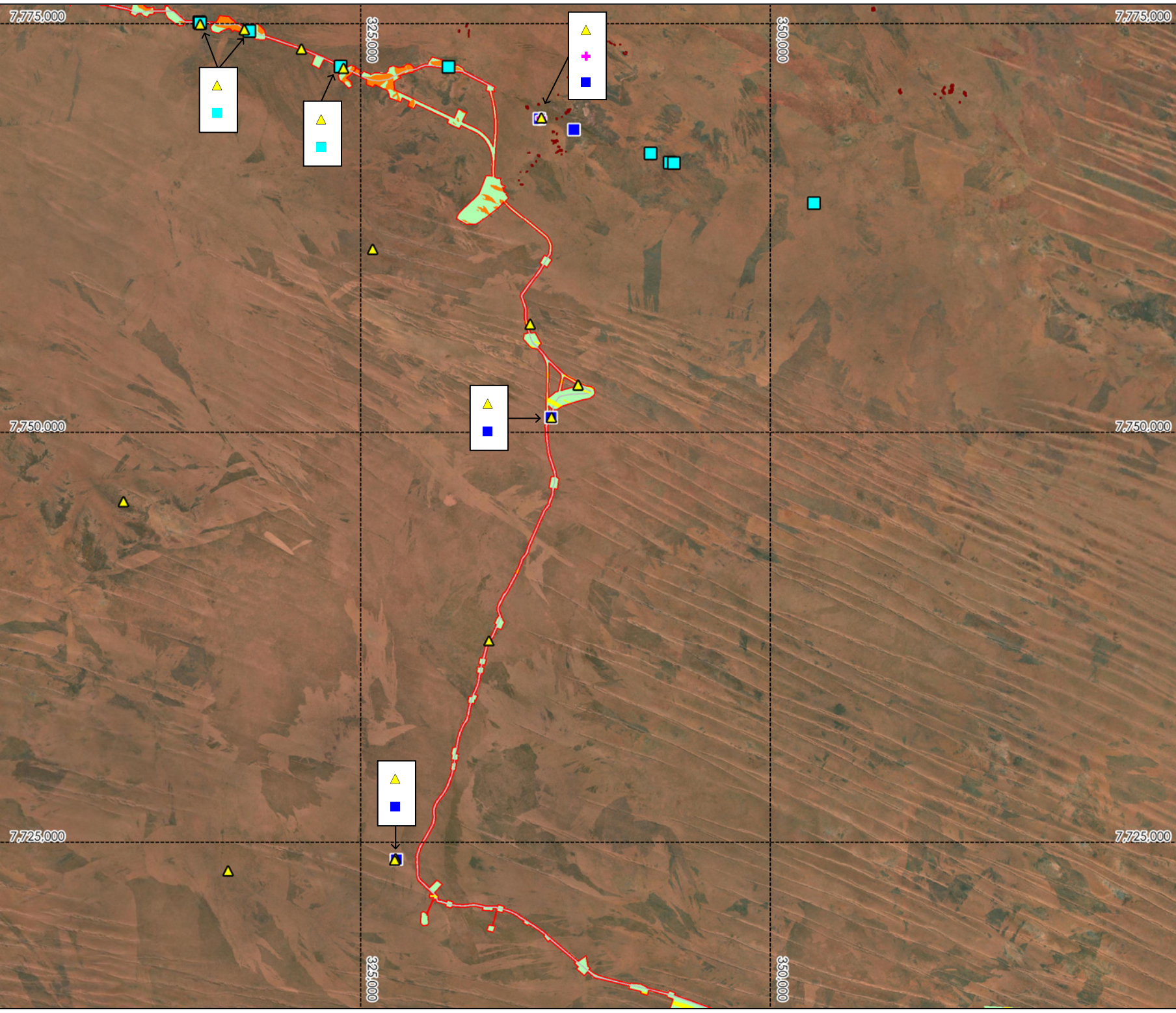
- Gravelly lateritic rises
- Rock outcropping
- Shrub and spinifex on sandplain
- Disturbed/cleared



Author: N Watson Drawn: M Robinson
Job No.: 1716E
Date: 08 May 2026 Revised:
Projection: MGA51 (GDA2020) Scale: 1:300,000

**Winu Consolidation
Fauna Survey Effort
Map 1**

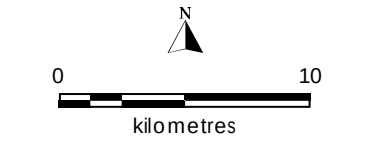




Development envelope

- Fauna Survey Methods**
- Avifauna Census
 - Motion Camera
 - Acoustic Recorder
 - Ultrasonic Recorder

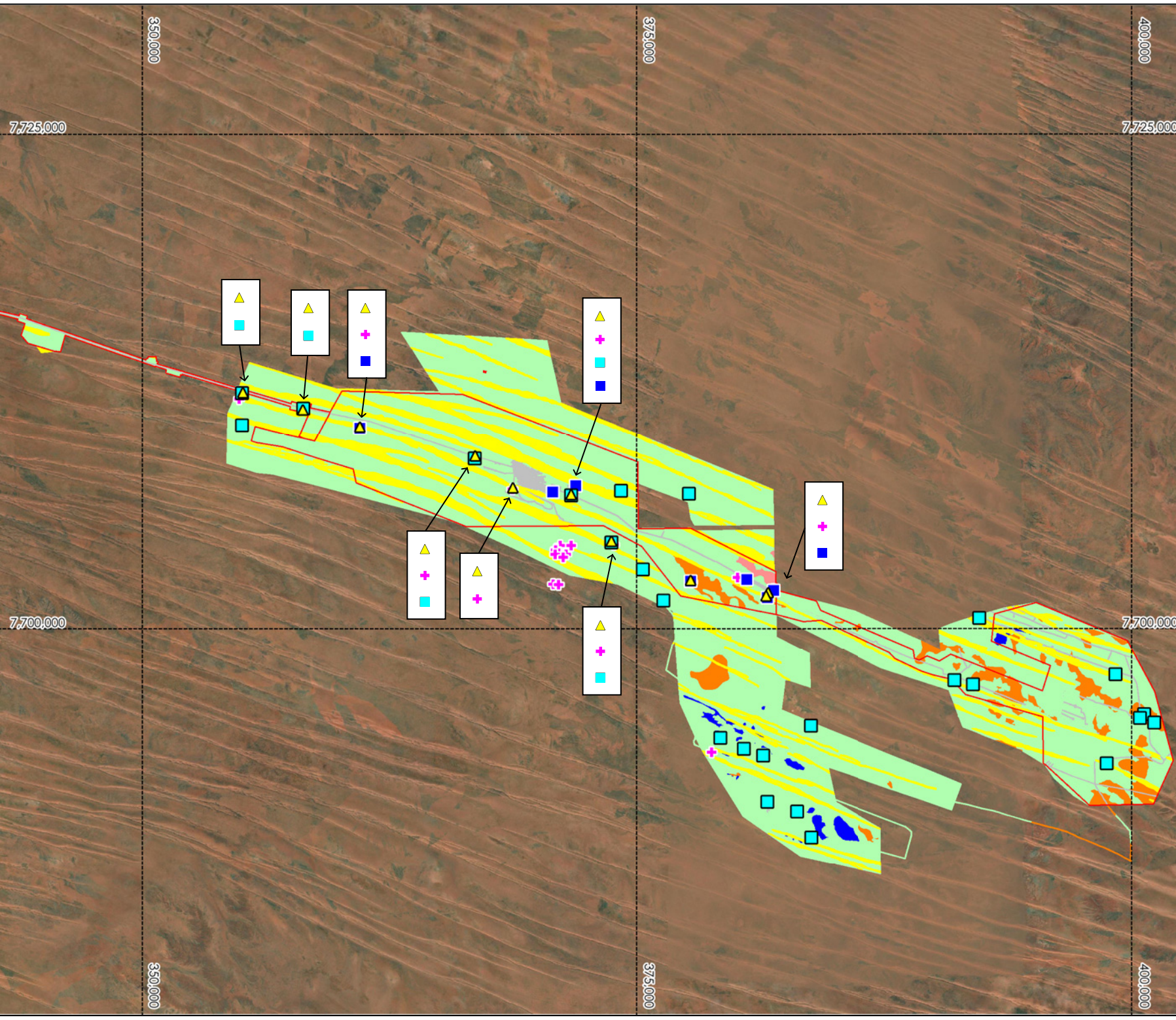
- Fauna Habitat Types**
- Gravelly lateritic rises
 - Inland sand dune
 - Rock outcropping
 - Shrub and spinifex on sandplain
 - Disturbed/cleared



Author: N Watson Drawn: M Robinson
Job No.: 1716E
Date: 08 May 2026 Revised:
Projection: MGA51 (GDA2020) Scale: 1:300,000

**Winu Consolidation
Fauna Survey Effort
Map 2**

Biota
Environmental
Sciences



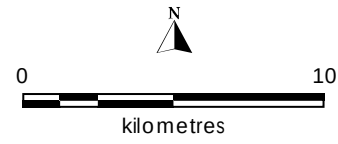
Development envelope

Fauna Survey Methods

- Avifauna Census
- Motion Camera
- Acoustic Recorder
- Ultrasonic Recorder

Fauna Habitat Types

- Clayey sand plain with termitaria
- Ephemeral Claypan
- Gravelly lateritic rises
- Inland sand dune
- Shrub and spinifex on sandplain
- Disturbed/cleared



Author: N Watson Drawn: M Robinson
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Projection: MGA51 (GDA2020) Scale: 1:250,000

**Winu Consolidation
Fauna Survey Effort
Map 3**





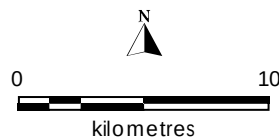
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Fauna Trapping Methods

- Elliott
- Elliott and Cage Site
- Funnel
- Combination Pitfall, Funnel, Elliott

Fauna Survey Methods

- Gravelly lateritic rises
- Rock outcropping
- Shrub and spinifex on sandplain
- Disturbed/cleared

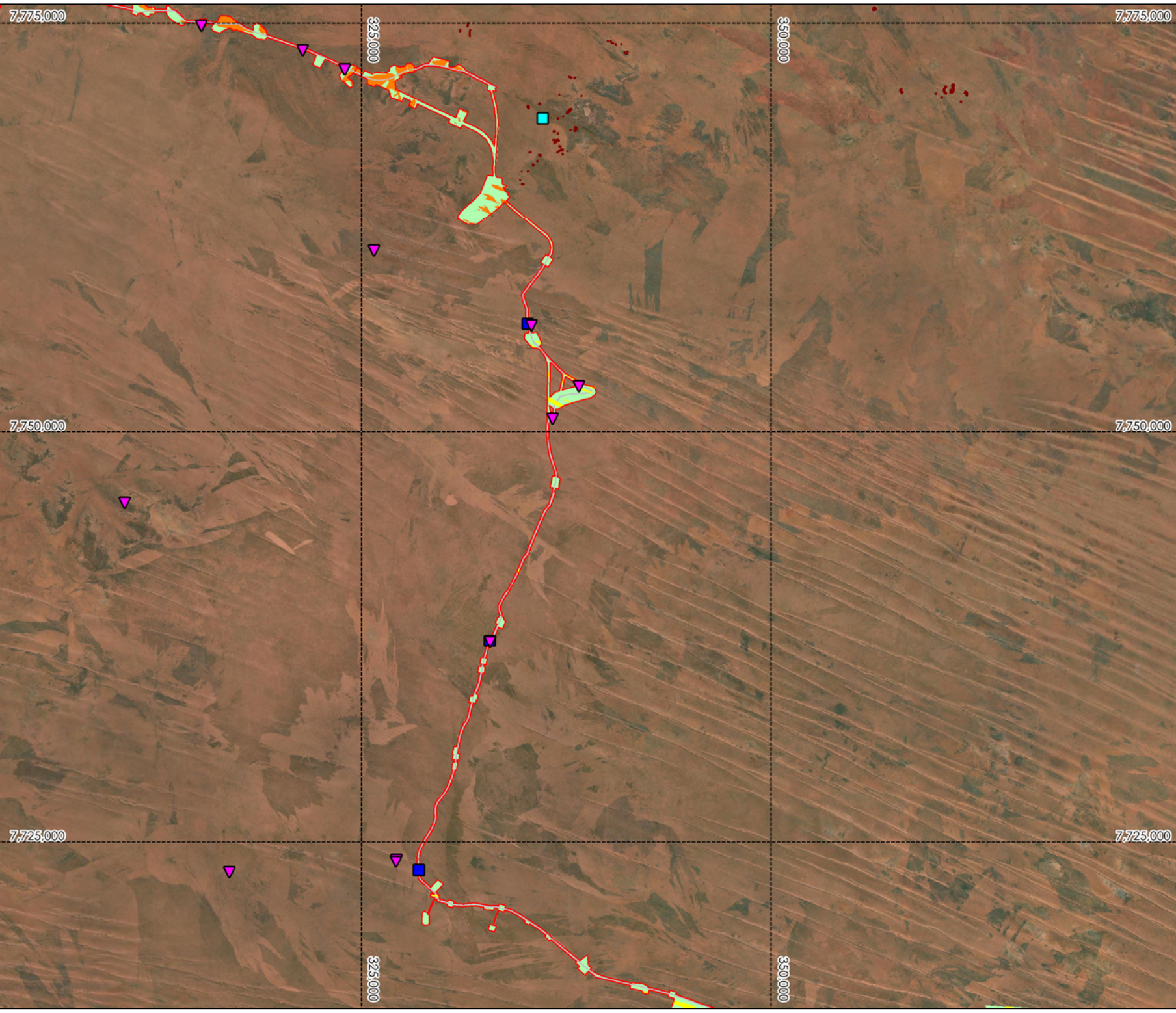


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Date: 08 May 2026 Revised:
Projection: MGA51 (GDA2020) Scale: 1:300,000

Winu Project Fauna Survey Effort Map 1

Biota
Environmental
Sciences





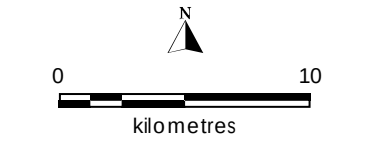
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Fauna Trapping Methods

-  Elliott
-  Elliott and Cage Site
-  Funnel
-  Combination Pitfall, Funnel, Elliott

Fauna Survey Methods

-  Gravelly lateritic rises
-  Inland sand dune
-  Rock outcropping
-  Shrub and spinifex on sandplain
-  Disturbed/cleared



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Winu Project
Fauna Survey Effort
Map 2



Location Map



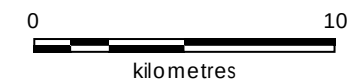
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Fauna Trapping Methods

- Elliott
- Elliott and Cage Site
- Funnel
- Combination Pitfall, Funnel, Elliott

Fauna Survey Methods

- Clayey sandplain with termitaria
- Ephemeral Claypan
- Gravelly lateritic rises
- Inland sand dune
- Shrub and spinifex on sandplain
- Disturbed/cleared



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Date: 08 May 2026 Revised:
Projection: MGA51 (GDA2020) Scale: 1:250,000

Winu Project
Fauna Survey Effort
Map 3





Appendix 4 Consolidated Species List

			Significance*		
Family	Species	Common name	State	C'wealth	Recorded in DE ?
Mammals					
Dasyuridae	<i>Dasyercus blythi</i>	Brush-tailed Mulgara, Ampurta	P4		✓
	<i>Dasykaluta rosamondae</i>	Kaluta			✓
	<i>Dasyurus hallucatus</i>	Northern Quoll	EN	EN	
	<i>Ningau ridei</i>	Wongai Ningau			✓
	<i>Ningau timealeyi</i>	Pilbara Ningau			
	<i>Planigale kendricki</i>	Pilbara Planigale			✓
	<i>Pseudantechinus macdonnellensis</i>	Fat-tailed Pseudantechinus			✓
	<i>Sminthopsis youngsoni</i>	Lesser Hairy-footed Dunnart			✓
Thylacomyidae	<i>Macrotis lagotis</i>	Bilby, Dalgyte	VU	VU	✓
Notoryctidae	<i>Notoryctes caurinus</i>	Northern Marsupial Mole	P4		✓
Macropodidae	<i>Lagorchestes conspicillatus</i>	Spectacled Hare-wallaby			
	<i>Notamacropus agilis</i>	Agile Wallaby			✓
	<i>Osphranter rufus</i>	Red Kangaroo, Marlu			✓
	<i>Petrogale lateralis lateralis</i>	Black-footed Rock-wallaby	EN	EN	
Muridae	<i>Mus musculus</i>	House Mouse			✓
	<i>Notomys alexis</i>	Spinifex Hopping-mouse			✓
	<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	P4		✓
	<i>Pseudomys desertor</i>	Desert Mouse			✓
	<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse			✓
Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tailed Bat			✓
	<i>Taphozous georgianus</i>	Common Sheath-tailed Bat			
Molossidae	<i>Austronomus australis</i>	White-striped Free-tailed Bat			✓
	<i>Chaerephon jobensis</i>	Greater Northern Free-tailed Bat			✓
	<i>Ozimops lumsdenae</i>	Northern Free-tailed Bat			
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat			✓
	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat			
	<i>Scotorepens greyii</i>	Little Broad-nosed Bat			✓
	<i>Vespadelus finlaysoni</i>	Finlayson's Cave-bat			
Canidae	<i>Canis familiaris</i>	Dog/Dingo			✓
	<i>Vulpes vulpes</i>	Red Fox			✓
Felidae	<i>Felis catus</i>	Cat			✓

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Family	Species	Common name	Significance*		Recorded in DE ?
			State	C'wealth	
Camelidae	<i>Camelus dromedarius</i>	Dromedary, Camel			✓
Reptiles					
Agamidae	<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon			✓
	<i>Ctenophorus isolepis</i>	Military Dragon			✓
	<i>Ctenophorus nuchalis</i>	Central Netted Dragon			✓
	<i>Ctenophorus reticulatus</i>	Western Netted Dragon			✓
	<i>Diporiphora paraconvergens</i>	Grey-striped Western Desert Dragon			✓
	<i>Diporiphora pindan</i>	Pindan Dragon			✓
	<i>Diporiphora vescus</i>	Northern Pilbara Tree Dragon			✓
	<i>Gowidon longirostris</i>	Long-nosed Dragon			✓
	<i>Moloch horridus</i>	Thorny Devil			✓
	<i>Pogona minor</i>				✓
Carphodactylidae	<i>Nephrurus laevis</i>				✓
	<i>Nephrurus levis</i>				✓
Diplodactylidae	<i>Diplodactylus laevis</i>	Desert Fat-tailed Gecko			✓
	<i>Lucasium stenodactylus</i>	Western Sandplain Gecko			✓
	<i>Oedura fimbria</i>	Western Marbled Velvet Gecko			
	<i>Rhynchoedura ornata</i>	Western Beaked Gecko			✓
	<i>Strophurus ciliaris</i>				✓
	<i>Strophurus elderi</i>				✓
	<i>Strophurus jeanae</i>				✓
Elapidae	<i>Demansia calodera</i>	Black-necked Whipsnake			✓
	<i>Demansia reticulata</i>	Reticulated Whipsnake			✓
	<i>Demansia rufescens</i>	Rufous Whipsnake			✓
	<i>Furina ornata</i>	Moon Snake			
	<i>Pseudechis australis</i>	Mulga Snake			✓
	<i>Pseudonaja mengdeni</i>	Western Brown Snake			✓
	<i>Pseudonaja modesta</i>	Ringed Brown Snake			✓
	<i>Simoselaps anomalus</i>	Desert Banded Snake			✓
Gekkonidae	<i>Gehyra montium</i>				✓
	<i>Gehyra pilbara</i>				✓
	<i>Gehyra punctata</i>				
	<i>Gehyra purpurascens</i>				✓

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Family	Species	Common name	Significance*		Recorded in DE ?
			State	C'wealth	
	<i>Gehyra variegata</i>				✓
	<i>Heteronotia binoei</i>	Bynoe's Gecko			✓
Pygopodidae	<i>Delma butleri</i>				✓
	<i>Delma desmosa</i>				✓
	<i>Delma nasuta</i>				✓
	<i>Lialis burtonis</i>				✓
	<i>Pygopus nigriceps</i>				✓
Pythonidae	<i>Antaresia childreni</i>	Children's Python			✓
	<i>Aspidites melanocephalus</i>	Black-headed Python			✓
	<i>Aspidites ramsayi</i>	Woma			
Scincidae	<i>Carlia triacantha</i>				✓
	<i>Ctenotus brooksi</i>				✓
	<i>Ctenotus calurus</i>				✓
	<i>Ctenotus dux</i>				✓
	<i>Ctenotus grandis</i>				✓
	<i>Ctenotus helenae</i>				✓
	<i>Ctenotus leae</i>				✓
	<i>Ctenotus pantherinus</i>	Leopard Ctenotus			✓
	<i>Ctenotus piankai</i>				✓
	<i>Ctenotus quattuordecimlineatus</i>				✓
	<i>Ctenotus robustus</i>				
	<i>Ctenotus rufescens</i>				✓
	<i>Ctenotus saxatilis</i>	Rock Ctenotus			
	<i>Ctenotus schomburgkii</i>				✓
	<i>Egernia cygnitos</i>	Western Pilbara Spiny-tailed Skink			
	<i>Eremiascincus musivus</i>	Mosaic Desert Skink			✓
	<i>Eremiascincus pallidus</i>	Western Narrow-banded Skink			✓
	<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer			✓
	<i>Lerista bipes</i>				✓
	<i>Lerista separanda</i>		P2		✓
	<i>Lerista vermicularis</i>				✓
	<i>Menetia greyii</i>				✓
	<i>Morethia ruficauda</i>				✓

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			Significance*		
Family	Species	Common name	State	C'wealth	Recorded in DE ?
	<i>Notoscincus ornatus</i>				✓
	<i>Tiliqua multifasciata</i>	Central Blue-tongue			✓
Typhlopidae	<i>Anilius ammodytes</i>				✓
	<i>Anilius endoterus</i>				✓
	<i>Anilius grypus</i>				✓
	<i>Anilius pilbarensis</i>				
Varanidae	<i>Varanus acanthurus</i>	Spiny-tailed Goanna			✓
	<i>Varanus brevicauda</i>	Short-tailed Pygmy Goanna			✓
	<i>Varanus eremius</i>	Pygmy Desert Goanna			✓
	<i>Varanus giganteus</i>	Perentie			✓
	<i>Varanus gilleni</i>	Pygmy Mulga Goanna			✓
	<i>Varanus gouldii</i>	Bungarra or Sand Goanna			✓
Amphibians					
Limnodynastidae	<i>Notaden nichollsi</i>	Desert Spadefoot			✓
Myobatrachidae	<i>Uperoleia micromeles</i>	Tanami Toadlet			
Pelodyadidae	<i>Cyclorana australis</i>	Giant Frog			
Pelodyadidae	<i>Cyclorana longipes</i>	Long-footed Frog			

			Significance*		
Family	Species	Common name	State	C'wealth	Recorded in DE ?
Avifauna					
Caprimulgidae	<i>Eurostopodus argus</i>	Spotted Nightjar		MA	✓
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth			✓
Apodidae	<i>Apus pacificus</i>	Pacific Swift	MI	MI; MA	
Otididae	<i>Ardeotis australis</i>	Australian Bustard			✓
Cuculidae	<i>Centropus phasianinus</i>	Pheasant Coucal			
	<i>Chalcites basalis</i>	Horsfield's Bronze Cuckoo		MA	
	<i>Heteroscenes pallidus</i>	Pallid Cuckoo		MA	✓
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing			✓
	<i>Ocyphaps lophotes</i>	Crested Pigeon			✓
	<i>Geopelia cuneata</i>	Diamond Dove			✓
Turnicidae	<i>Turnix velox</i>	Little Buttonquail			✓

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Family	Species	Common name	Significance*		Recorded in DE ?
			State	C'wealth	
Charadriidae	<i>Anarhynchus veredus</i>	Oriental Plover	MI	MI; MA	
Scolopacidae	<i>Numenius minutus</i>	Little Curlew	MI	MI; MA	✓
Glareolidae	<i>Glareola maldivarum</i>	Oriental Pratincole	MI	MI; MA	✓
Laridae	<i>Gelochelidon [nilotica] macrotarsa</i>	Australian Tern	MI	MI; MA	✓
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron			
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican		MA	✓
Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite			
	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard			✓
	<i>Hieraaetus morphnoides</i>	Little Eagle			✓
	<i>Aquila audax</i>	Wedge-tailed Eagle			
	<i>Tachyspiza fasciata</i>	Brown Goshawk		MA	✓
	<i>Tachyspiza cirrocephala</i>	Collared Sparrowhawk			✓
	<i>Circus assimilis</i>	Spotted Harrier			✓
	<i>Milvus migrans</i>	Black Kite			✓
	<i>Haliastur sphenurus</i>	Whistling Kite		MA	✓
Alcedinidae	<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher			✓
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater		MA	✓
Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel		MA	✓
	<i>Falco longipennis</i>	Australian Hobby			✓
	<i>Falco berigora</i>	Brown Falcon			✓
Cacatuidae	<i>Calyptorhynchus banksii</i>	Red-tailed Black Cockatoo			✓
	<i>Nymphicus hollandicus</i>	Cockatiel			✓
	<i>Eolophus roseicapilla</i>	Galah			✓
Psittaculidae	<i>Pezoporus occidentalis</i>	Night Parrot	CR	EN	
	<i>Melopsittacus undulatus</i>	Budgerigar			✓
Maluridae	<i>Malurus assimilis</i>	Purple-backed Fairywren			
	<i>Malurus leucopterus</i>	White-winged Fairywren			✓
Meliphagidae	<i>Epthianura tricolor</i>	Crimson Chat			✓
	<i>Certhionyx variegatus</i>	Pied Honeyeater			✓
	<i>Sugomel nigrum</i>	Black Honeyeater			✓
	<i>Lichmera indistincta</i>	Brown Honeyeater			✓
	<i>Purnella albifrons</i>	White-fronted Honeyeater			✓
	<i>Gavicalis virescens</i>	Singing Honeyeater			✓

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Family	Species	Common name	Significance*		Recorded in DE ?
			State	C'wealth	
	<i>Ptilotula keartlandi</i>	Grey-headed Honeyeater			✓
	<i>Manorina flavigula</i>	Yellow-throated Miner			✓
Psophodidae	<i>Psophodes occidentalis</i>	Chiming Wedgebill			✓
Artamidae	<i>Artamus personatus</i>	Masked Woodswallow			
	<i>Artamus cinereus</i>	Black-faced Woodswallow			✓
	<i>Cracticus nigrogularis</i>	Pied Butcherbird			✓
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckooshrike		MA	✓
	<i>Lalage tricolor</i>	White-winged Triller			✓
Oreoicidae	<i>Oreoica gutturalis</i>	Crested Bellbird			✓
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler			✓
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail			✓
Corvidae	<i>Corvus orru</i>	Torresian Crow			
	<i>Corvus bennetti</i>	Little Crow			✓
Petroicidae	<i>Melanodryas cucullata</i>	Hooded Robin			✓
Alaudidae	<i>Mirafrja javanica</i>	Singing Bush Lark			✓
Hirundinidae	<i>Cheramoeca leucosterna</i>	White-backed Swallow			✓
	<i>Petrochelidon ariel</i>	Fairy Martin			✓
Locustellidae	<i>Poodytes carteri</i>	Spinifexbird			
	<i>Cincloramphus cruralis</i>	Brown Songlark			✓
	<i>Cincloramphus mathewsi</i>	Rufous Songlark			✓
	<i>Heteromunia pectoralis</i>	Pictorella Mannikin			✓
Estrildidae	<i>Emblema pictum</i>	Painted Finch			✓
	<i>Taeniopygia castanotis</i>	Australian Zebra Finch			✓
Motacillidae	<i>Anthus australis</i>	Australian Pipit		MA	✓

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Appendix 5 Great Desert Skink Likelihood of Occurrence



5 February 2025

Scott Young
Senior Specialist Environment
Rio Tinto Copper
Winu
Via email

Dear Scott

Revisiting the Likelihood of Occurrence of the Great Desert Skink at Winu

1. Background

Rio Tinto Winu Pty Limited (RTW) plans to develop a new copper-gold mine, referred to as the Winu Project, approximately 320 km east of Port Hedland in the Great Sandy Desert bioregion (DCCEEW 2024) of Western Australia. Considerable biological survey work has been completed to support the environmental impact assessment (EIA) of the proposal (Biota 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2022c, 2023a, 2023b). Part of this work involved the assessment of the likelihood of occurrence of significant fauna species within the Development Envelopment (DE). To date, nine significant species have been recorded from within the DE, an additional three species have been recorded from the surrounding locality and are considered likely to occur within the DE, and a further seven may occur (Biota In prep.).

One species considered unlikely to occur is the Great Desert Skink, Tjakura (*Liopholis kintorei*) (Vulnerable under the EPBC Act¹ and BC Act²). A detailed review of its likelihood of occurrence within the Winu DE was provided to RTW in 2020 (Biota 2020c). Since then, the Winu DE has changed and now encompasses additional areas. The current document serves to update the previous review, incorporating additional survey effort, along with an up-to-date desktop study of previous records of the species including database searches and a review of relevant literature. In addition, the *National Recovery Plan for the Great Desert Skink 2023-2033* (Indigenous Desert Alliance 2022) has been released since the previous review, providing its own review of all known records as of 2022, which has been utilised here.

2. Ecology

The Great Desert Skink (*Liopholis kintorei*) is a large skink, growing to 44 cm in length and weighing up to 350 g (McAlpin 2001). The species constructs large burrow systems which can be as deep as 1 m and extend over 10 m in diameter. These systems may start as a single tunnel, with new tunnels added progressively, or may be appropriated and adapted from burrows of other species (McAlpin 2001). The skinks themselves are crepuscular and nocturnal, so these burrow systems are an effective means of identifying their presence in

¹ Environment Protection and Biodiversity Conservation Act 1999

² Biodiversity Conservation Act 2016

an area. Active burrow systems are identifiable by the presence of at least one communal latrine on the surface (McAlpin 2001).

3. Distribution

Historically, the Great Desert Skink occurred “across a large area of inland Australia from the Broome region in the northwest across the Great Sandy and Tanami Deserts to Tennant Creek in the north-east, to Wiluna in the southwest and east across the Gibson and Great Victoria Deserts to north-western SA” (Indigenous Desert Alliance 2022). A review of the species distribution in 2017 described 12 known regional subpopulations occurring over an area of approximately 500,000 km², this has since been extended to a known range of 770,000 km², with the discovery of additional subpopulations (Indigenous Desert Alliance 2022).

4. Previous Records

To review previous records of the Great Desert Skink, searches were undertaken of State and Federal Government databases (the Department of Biodiversity, Conservation and Attractions (DBCA), and the EPBC Protected Matters Search Tool (EPBC PMST)), as well as the Atlas of Living Australia³ (ALA), an open access database of Australian biodiversity data. A search of the DBCA database of threatened fauna records using a 100 km radial buffer around a central point within the DE returned no records of *Liopholis kintorei*. The closest records identified from the ALA database were 274 km northeast of the Winu DE at Godfreys Tank, recorded in 1968 and within a location accuracy of 50 km. However, despite no longer being shown in the ALA database, additional records are also known from Karlamilyi National Park (formerly Rudall River National Park), approximately 150 km southeast of the DE, from 2014. Previous records of the Great Desert Skink sourced from the ALA database are presented in Figure 1.

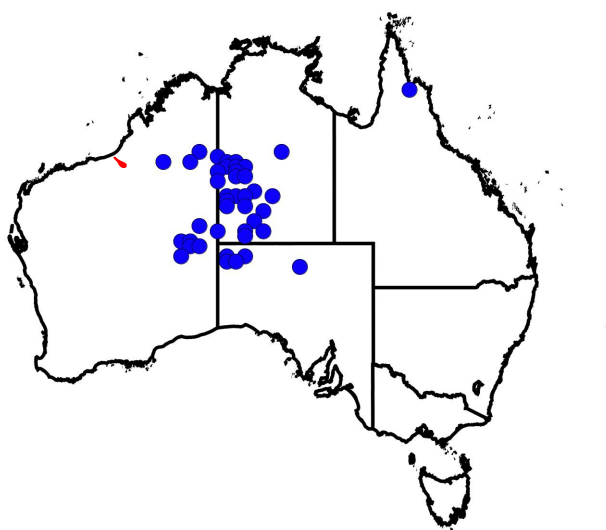


Figure 1: ALA records of the Great Desert Skink (approximate location of the DE shown in red).

The modelled habitat⁴ for the Great Desert Skink, utilised by Department of Climate Change, Energy, the Environment and Water (DCCEEW) to support decision-making under the EPBC Act, is reproduced in Figure 2 with the Winu DE also shown. Two likelihood categories are mapped:

1. The species or species habitat may occur, and
2. The species or species habitat is likely to occur.

The EPBC PMST categorised the likelihood of the Great Desert Skink as “species or species habitat may occur” within the Winu DE (see Figure 2).

³ <https://www.ala.org.au/>

⁴ Species of National Public Significance dataset from www.DCCEEW.gov.au

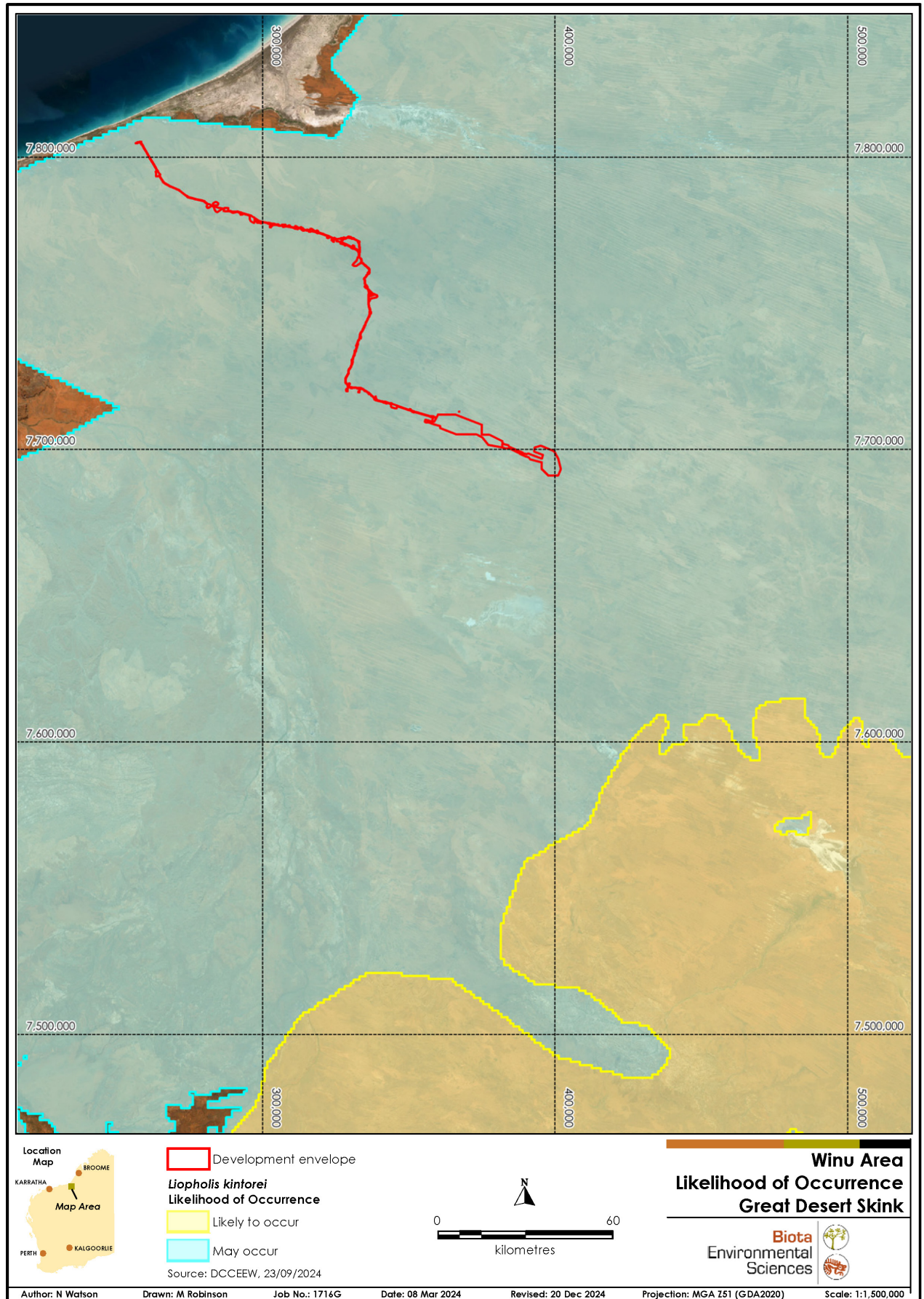


Figure 2: Great Desert Skink Modelled Habitat (source: DCCEEW).

The National Recovery Plan for the Great Desert Skink has identified three broad “priority survey areas” to better determine the distribution of the Great Desert Skink, targeting areas around the edge of their known range and in key gaps of their distribution. The Winu DE is located within one of these priority areas, however it is also noted in relation to that region that, “there have been no recent records across this northern part of the range (from WA/NT border across the northern Great Sandy Desert to Broome)” (Indigenous Desert Alliance 2022).

5. Habitat

The species “occupies a variety of environments across their distribution from hard spinifex gravelly plains and sandplains to semi-saline soft spinifex sandplains, and even non-spinifex mulga (*Acacia aneura*) woodland. A common feature of occupied habitat appears to be a more benign fire regime where fire size and/ or frequency is limited by either regular burning by Aboriginal people or other land managers, or an inherent patchiness in fuels (due to presence of bare salt pan or rock outcropping... in parts of the Great Sandy Desert (including Newhaven Wildlife Sanctuary, Lake Mackay and Punmu subpopulations), Tjakura also inhabits palaeodrainage country featuring slightly saline depressions or chains of dry salt lakes” (Indigenous Desert Alliance 2022).

6. Habitat Suitability at Winu

Potentially suitable habitat for the Great Desert Skink exists across much of the DE. The most suitable habitat type is likely to be the Shrub and spinifex on sandplain habitat, which is the most common habitat in the DE, comprising ~72% of its extent. However, based on the range of habitats occupied by other populations of the Great Desert Skink, it is also possible that the Gravelly lateritic rise (13% of DE) and the Clayey sand plain with termitaria (0.5% of DE) habitats are also suitable. The National Recovery Plan states that “*Tjakura commonly occurs on open spinifex sandplains and adjacent dune field swales but rarely in extensive dune fields or rocky outcrops*” (Indigenous Desert Alliance 2022), therefore we consider the sand dune habitat less suitable for the species.

7. Search Effort at Winu

Targeted searches were undertaken specifically for the Great Desert Skink as part of survey work at Winu. In addition to these, all of the targeted Bilby and Brush-tailed Mulgara searches, and other generalised searches that have been undertaken were also suitable for detecting the Great Desert Skink, due to their shared habitat preferences and the Great Desert Skinks' distinctive burrow systems. The targeted survey effort expended at Winu and in the locality of Winu (for the Winu Project and the Australian Renewable Energy Hub Project (AREH) combined) using methods capable of detecting the Great Desert Skink totals 194 targeted searches in habitat types suitable for the Great Desert Skink. A further 196 general searches and 10 nocturnal searches (six at Winu and four at AREH) were also undertaken across all habitats across both projects. Further detail on these searches and their locations are provided in Biota (In prep.).

No evidence of the species was recorded inside or outside of the DE despite this considerable search effort.

8. Likelihood of Occurrence

Based on the above information, and utilising the criteria detailed in Attachment 1, we consider the likelihood of the Great Desert Skink occurring within the DE as “Unlikely/Low”, as its current status meets the following criteria:

- Suitable habitat is present, but there are no existing records of the species from the locality despite reasonable previous search effort in suitable habitat; and,
- There is some suitable habitat in the DE, but the species is very infrequently recorded in the locality, or the only records are historical (>40 years ago).

In arriving at this conclusion, we note recent records of Great Desert Skink from outside of its previously documented distribution (i.e. Lake Wells (Western Wildlife 2019)). In the case of Winu, the targeted search methods for other threatened fauna known or considered likely to occur (i.e. Bilby, Bush-tailed Mulgara) were focused on habitat suitable for Great Desert Skink and would have also detected the species if it were present, improving confidence in our findings.

Please contact me should you have any queries in regard to the above.

Yours sincerely,

Biota Environmental Sciences Pty Ltd

Dr. Nicola Watson
Principal Zoologist

Attachment 1: Likelihood of Occurrence Assessment Criteria

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Attachment 1:**Likelihood of Occurrence Assessment**

For significant species identified from previous surveys and database searches, an assessment of their likelihood of occurrence within the DE is made prior to the field surveys, and then is reviewed once completed. The likelihood assessment is based on factors including the proximity of previous records to the survey area, habitat preferences for species, the assessment of habitats present within the survey and contextual areas made during the field survey, and any records obtained during the field survey.

The likelihood that fauna species of significance would occur in the DE is assessed using a set of rankings and criteria (Table 1). The term "close proximity" is defined as being within 20 km of the DE boundary, while the broader "locality" comprises the area up to 40 km from the DE.

Table 1: Ranking system used to assign the likelihood that a significant species occurs in the DE.

Rank / Likelihood of Occurrence	Criteria
Recorded	1. The species has been recorded in the DE previously.
Likely to occur or "High"	1. There are existing records of the species in close proximity to the DE; and - the species is strongly linked to a specific habitat, which is present in the DE; or - the species has more general habitat preferences, and suitable habitat is present.
May occur or "Moderate"	1. There are existing records of the species from the locality, however - the species is strongly linked to a specific habitat, of which only a small amount is present in the DE; or - the species has more general habitat preferences, but only some suitable habitat is present in the DE. 2. There is suitable habitat in the DE, but the species is recorded infrequently in the locality.
Unlikely to occur or "Low"	1. The species is linked to a specific habitat, which is absent from the DE; 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 DE, however the species is very infrequently recorded in the locality, or the only records are historical (>40 years ago).
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the DE; and/or 2. The species' range is very restricted and would not include the DE.



Appendix 6 Bilby Population Abundance Study



Winu Project Bilby Abundance Study 2025



Prepared for

Rio Tinto Winu Pty Ltd

May 2026

Biota
Environmental
Sciences



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Bilby Abundance Study 2025

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1.0 Executive Summary

Rio Tinto Winu Pty Limited (RTW) plans to develop a new copper-gold mine, referred to as the Winu Project, approximately 320 km east of Port Hedland in the Pilbara region of Western Australia, within both the Nyangumarta and Martu Peoples' Native Title Determination Areas.

A significant amount of biological survey work has been undertaken by Biota in the Winu DE and the broader locality between 2017 and 2024 for the purposes of environmental impact assessment. Effort summaries and previous Bilby results provide a contextual understanding of Bilby occurrence in the broader locality.

RTW referred the Winu Project to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and were issued a request for further information (RFI). RTW commissioned Biota Environmental Sciences (Biota) to undertake a targeted Bilby study to address the DCCEEW RFI. The purpose of this study was to conduct an updated census of the number of individual bilbies known to inhabit the areas of suitable habitat in the vicinity of the Winu Development Envelope (DE).

The survey work at Winu was undertaken by two suitably qualified and experienced zoologists from the 9th – 15th October 2025. The targeted Bilby survey comprised strip transect traverses to record sign evidence of the Bilby (tracks, scats, diggings and/or burrows). Habitat assessments were also undertaken at all sites to determine the suitability of the areas in supporting bilbies.

Since 2019, bilbies have occupied (at discrete points in time) four disjunct areas in the vicinity of the Winu DE. No recent Bilby signs were recorded in any of the areas surveyed in the current study. However, additional evidence showing signs of ageing (debris in diggings, crusted spoil piles, and very dry scat) were recorded. Four scat samples were collected and submitted to Helix Molecular Solutions for molecular analysis and genotyping. Two were successfully genotyped; one aligned with an individual identified during the 2024 survey, whilst the other represented a new individual. Despite the latest two records being collected and analysed in 2025, the condition of the scat samples upon collection and the absence of other recent evidence (fresh diggings, active burrows and/or tracks) in the survey area, strongly suggest that the bilbies are not currently utilising the survey area.

Given bilbies' known propensity to move around in response to resource availability, it is likely the population still exists and is currently occupying areas outside of the current scope of this study.

2.0 Introduction

2.1 Project Background

Rio Tinto Winu Pty Limited (RTW) plans to develop a new copper-gold mine, referred to as the Winu Project, approximately 320 km east of Port Hedland in the Pilbara region of Western Australia, within both the Nyangumarta and Martu Peoples' Native Title Determination Areas.

Multiple studies have been undertaken within and in the vicinity of the Winu development envelope (DE) for the Winu Project, with Biota Environmental Sciences (Biota) holding a large proportion of the biological data, having completed all the fauna surveys to date for the project over multiple phases. In addition to this, a portion of the DE was surveyed for a neighbouring project, the Australian Renewable Energy Hub (AREH) (also by Biota), and a data sharing agreement has been reached between Rio Tinto and AREH, enabling the data from those surveys to be utilised here. While the focus of the current scope is on the Bilby population in the vicinity of the Winu DE, sampling effort and Bilby records from outside the Winu DE for the AREH project are presented as they provide regional context and reference data for the work completed within the Winu DE, particularly in an under-surveyed region such as the Great Sandy Desert.

2.1.1 Summary of Consolidated Survey Effort

A significant amount of biological survey work has been undertaken by Biota in the Winu DE and the broader locality between 2017 and 2024 for the purposes of environmental impact assessment for both the Winu and AREH projects (summarised in Biota (2025a)). In summary, the following surveys included effort targeting bilbies:

- A three-phase seasonal detailed fauna survey for the AREH Project (which overlaps with the Winu Road Access Corridor, RAC) (Biota 2018, 2022a);
- A targeted fauna survey for AREH (Biota 2024a);
- A two-phase seasonal detailed fauna survey of the Mine and Infrastructure Area, MIA (Biota 2021);
- Targeted surveys of a Bilby population south of the MIA (2019, 2022 and 2024 censuses) (Biota 2020, 2023a, 2024b) and,
- Six basic and targeted fauna surveys across the MIA, RAC and regional borefield options as the project developed (Biota 2022b, 2023b, 2023c, 2023d).

Survey methodology employed across these surveys includes:

- Targeted searches for secondary evidence in highly suitable habitat;
- General searches for secondary evidence in broadly suitable habitat;
- 2 ha sign plots;
- Nocturnal surveys;
- Deployment of motion cameras; and
- Searches on transect in areas known to support bilbies.

A detailed breakdown of survey effort inside and outside the Winu DE is provided in Table 2.1 with site locations mapped in Figure 2.1.

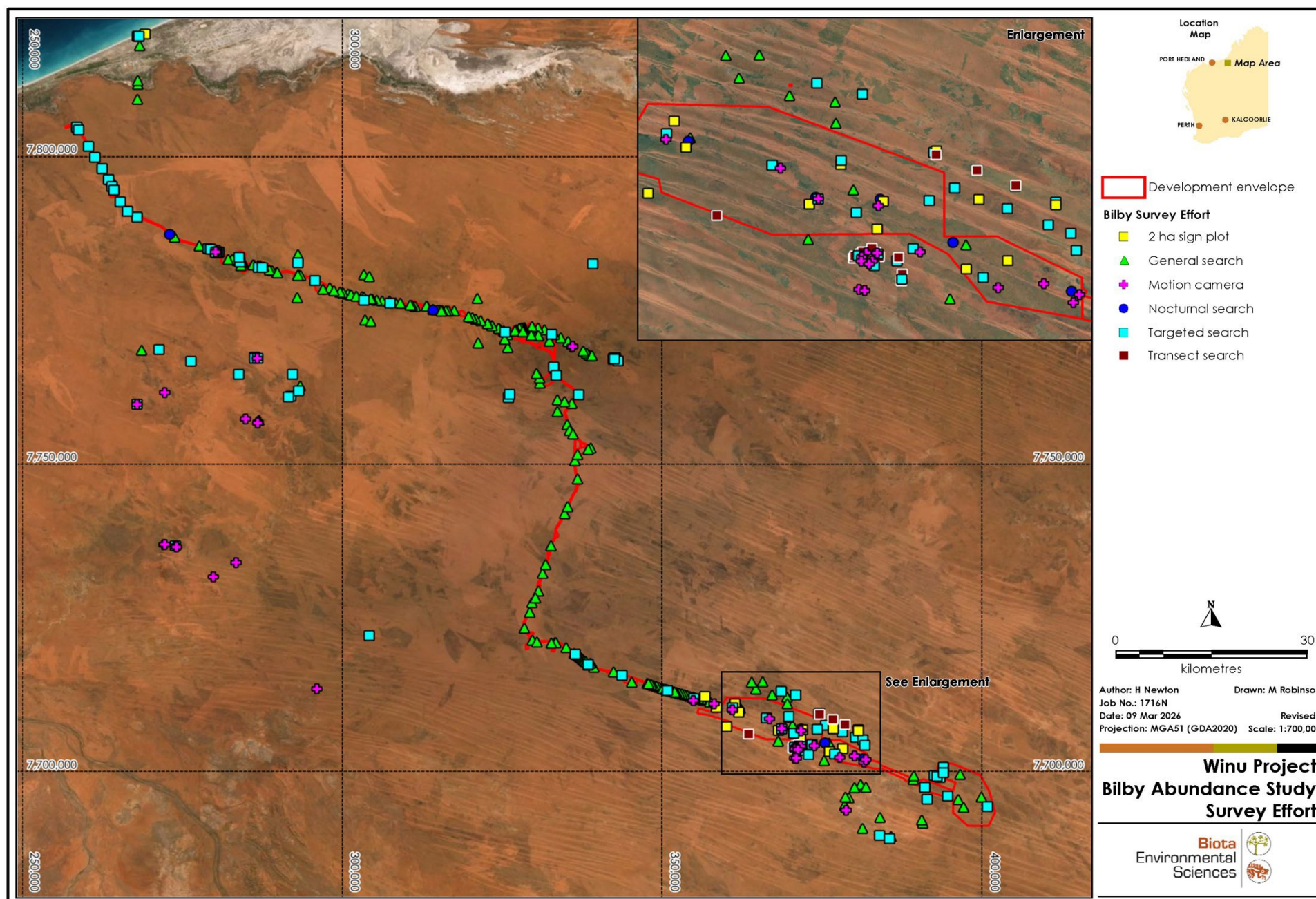


Figure 2.1: Consolidated Bilby survey effort in the Winu DE and surrounding locality.

Table 2.1: Bilby survey effort relative to Winu DE.

Survey Methodology	Survey Effort		
	Inside DE	Outside DE	Total
Targeted searches	67 searches	71 searches	138
General searches	178 searches	59 searches	237
2 ha sign plot	9	6	15
Nocturnal searches	9 searches	1 search	10
Motion camera (short and long-term deployments)	12 sites (44 nights)	31 sites (1,340 nights)	43
Transect searches	-	14	14

2.1.2 Summary of Consolidated Survey Findings

As a result of the extensive survey effort detailed in Section 2.1.1, sign evidence of Bilby indicating past use (inactive burrows, old tracks and scats) was recorded at numerous locations along the RAC and MIA, as well as found in the locality surrounding the DE (Biota 2021, 2022a). Evidence of active use was also recorded for both the Winu (Biota 2020, 2023a, 2024b) and AREH (Biota 2024a) projects. The areas with active, or recently active Bilby sign evidence recorded in proximity to the Winu DE, form the focus of this study.

In early 2019, Biota completed a targeted survey of what was previously referred to as the Winu Project Area (now Mine Infrastructure Area, MIA), resulting in the detection of a population of Bilby (Biota 2021). The area known to support the Bilby population encompassed approximately 344.1 ha of highly prospective Bilby habitat. Following the initial detection of the population, Biota conducted three Bilby abundance surveys within this extent (Phase 1 in 2019, Phase 2 in 2022 and Phase 3 in 2024). Bilbies were recorded here during Phase 1 and 2. In July 2023, the DE boundary was amended, resulting in the area supporting the Bilby population being excised from the DE. Then, after the occurrence of a fire in 2023, RTW advised that much of this area had been burnt and that previously active burrows were now inactive. During Phase 3 (May 2024), the original area was re-surveyed and an additional two areas (Additional Area 1 and 2), located within the vicinity of the area that previously supported bilbies (but outside of the extent of the fire) were also surveyed. The Phase 3 survey recorded recent evidence of Bilby activity within Additional Area 2 (AA2) in the form of tracks, scats, diggings and burrows. No evidence of recent Bilby activity was found in the original survey area or in Additional Area 1 (AA1). Subsequent to these three phases of Bilby abundance surveys, in July 2024, recently active signs of bilbies were recorded during basic fauna surveys of the borefield options at the easternmost end of the DE. Consolidated records of Bilby sign evidence (comprising evidence of both current use and past use) from the Winu and AREH projects from 2017-2024 are presented in Figure 2.2.

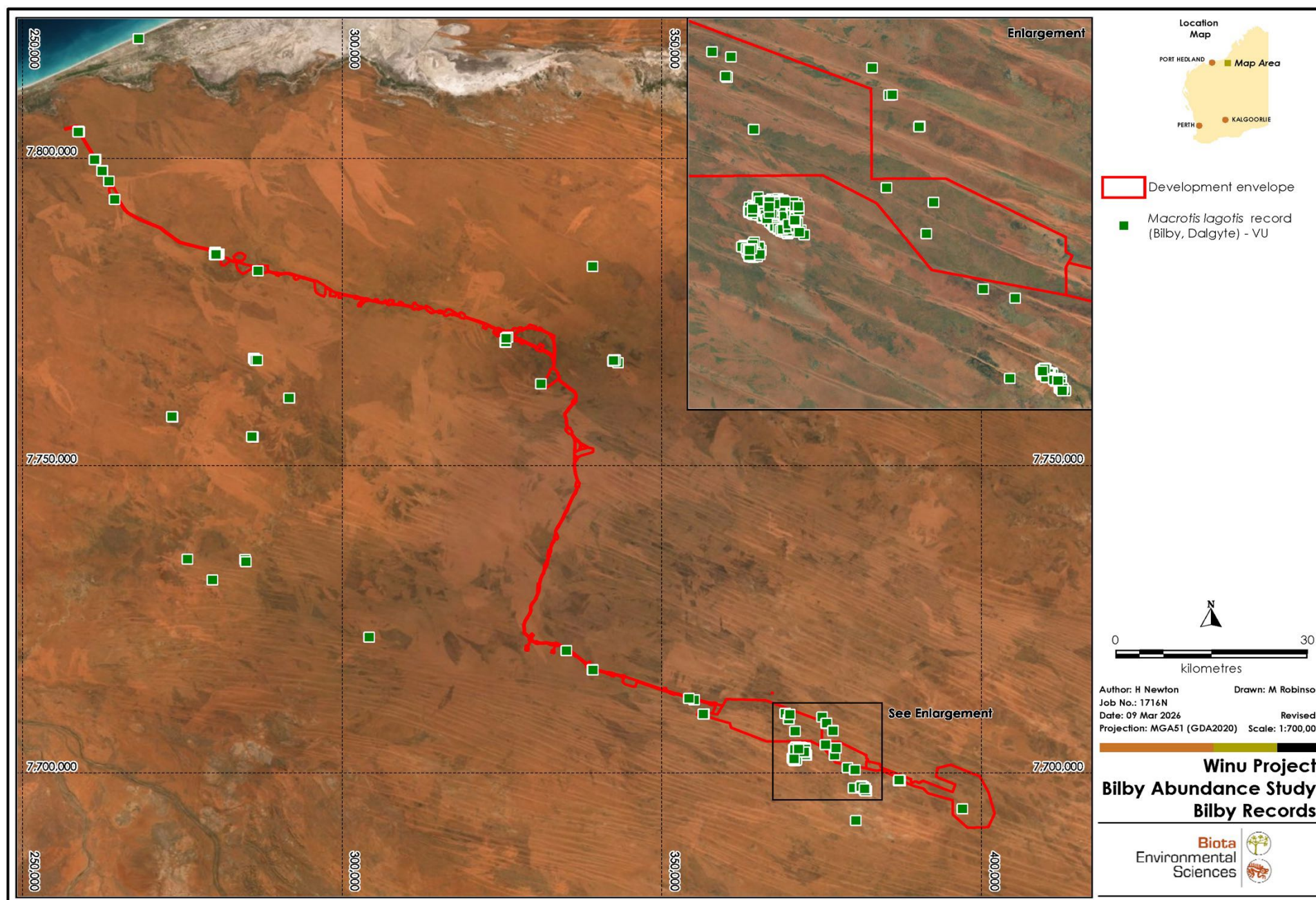


Figure 2.2: Consolidated Bilby records in the Winu DE and surrounding locality.

2.2 Scope of Current Work

RTW referred the Winu Project to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and were issued a request for further information (RFI), under s95A(2) of the EPBC Act. Section 2 of the RFI requests:

- *“the results of an updated targeted Greater Bilby survey and impact assessment¹ for the development envelope, including the areas not surveyed following the 2023 fire along with the result of the areas surveyed in July 2024 within Rimfire and surrounding areas;*
- *to detail any evidence of use by the Bilby, including burrows, tracks, scats and diggings along with evidence of predator scats;*
- *include evidence and mapping that demonstrates the location of the 4,878 ha of ‘suitable habitat’ for the species that is located within the development envelope; and,*
- *include maps that depict the local and/or regional context for habitat availability for the Greater Bilby”.*

RTW commissioned Biota to undertake a targeted Bilby study to address the DCCEEW RFI requests.

2.3 Study Objectives

The purpose of this study was to conduct an updated census of the number of individual bilbies known to inhabit the areas of suitable habitat in the vicinity of the Winu Development Envelope (DE). The study aims were to:

- conduct targeted Bilby transect searches;
- collect scats (where located) on each transect;
- identify individual bilbies via genotyping of scats;
- consolidate data obtained in 2019, 2022, 2024 and 2025;
- map the current extent of the Bilby population;
- determine robustness of data with the view to conducting spatially-explicit capture-recapture (SECR) analysis (Efford 2004, Efford and Fewster 2012), if valid within the limitations of the data; and,
- address all points relating to Greater Bilby (*Macrotis lagotis*) as set out in Section 2 of the DCCEEW RFI.

¹ Impact assessment addressed within Environmental Review Document.

2.4 Study Area

The study area comprises five disjunct areas in proximity to the Winu DE, including four areas where active Bilby burrows and fresh scats, tracks and diggings have been recorded (Biota 2020, 2023a, 2024b). In addition to these four areas, a fifth area that has not been shown to support bilbies (AA1), constitute the study area of the current scope (Table 2.2, Figure 2.3).

The first area known to support bilbies was identified in early 2019 and at the time, consisted entirely of highly prospective Bilby habitat. A fire in 2023 significantly impacted the area, resulting in a loss of approximately 50% of the suitable habitat. This area, previously referred to as the ‘survey area’ (Biota 2023a), will henceforth be referred to as Area 0 (A0). In May 2024, Biota zoologists censused two additional areas in the vicinity of A0 but outside the extent of the fire; Additional Area 1 and 2 (AA1 and AA2). The two remaining areas known to recently support bilbies were identified during surveys undertaken in July 2024 and are hereafter referred to as Additional Area 3 and 4 (AA3 and AA4). All five areas were surveyed in October 2025 as part of the current study.

Table 2.2: Survey area name, extent and years surveyed.

Area	Extent (hectares)	Years surveyed
Area 0 (A0)	344.1	September 2019, July 2022, May 2024, October 2025
Additional Area 1 (AA1)	131.7	May 2024, October 2025
Additional Area 2 (AA2)	68.9	May 2024, October 2025
Additional Area 3 (AA3)	129.7	July 2024, October 2025
Additional Area 4 (AA4)	39.8	July 2024, October 2025

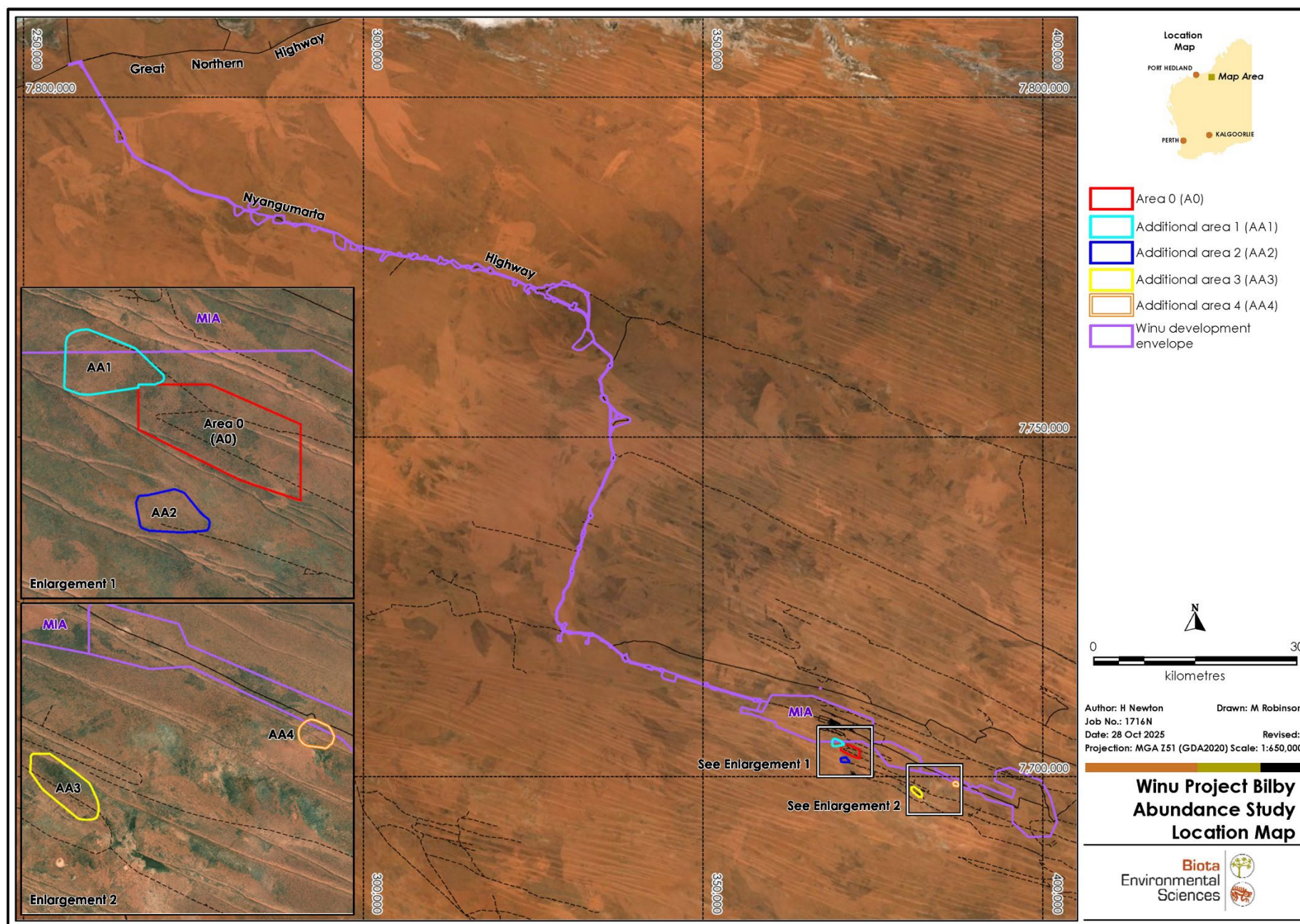


Figure 2.3: Location of study area and Winu DE.

3.0 Methodology

A targeted Bilby survey was undertaken in accordance with relevant Federal and State policy, including:

- Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2020);
- Guidelines for Surveys to Detect the Presence of Bilbies, and Assess the Importance of Habitat in Western Australia (DBCA 2017a); and,
- Survey Guidelines for Australia’s Threatened Mammals (DSEWPaC 2011).

The targeted Bilby survey comprised strip transect traverses to record sign evidence of the Bilby (tracks, scats, diggings and/or burrows). Habitat mapping was also undertaken (see Section 3.3).

The survey work at Winu was undertaken by Michael Greenham (Senior Zoologist) and Hayley Newton (Zoologist) from the 9th – 15th October 2025. Biota acknowledges the effort and guidance provided by RTW Environmental Advisor, Lily Deveroux and Martu Rangers (JYAC), Louis Janawana and Dion Billycan, during the 2025 survey.

3.1 Search Effort

A summary of the total search effort expended for the current Bilby abundance study is presented in Table 3.1 and Figure 3.1. Appendix 1 maps the combined survey effort of all targeted Bilby abundance surveys completed by Biota for the Winu Project. For details specific to past surveys, please refer to Biota (2020, 2023a, 2024b).

Table 3.1: Summary of targeted search effort from the current survey.

Area	Date	Personnel	Traverse Distance (km) ¹
Area 0 (A0)	12 th Oct 2025	Hayley Newton Michael Greenham Lily Deveroux (RTW) Louis Janawana (JYAC) Dion Billycan (JYAC)	21.5
Additional Area 1 (AA1)	11 th Oct 2025		18.3
Additional Area 2 (AA2)	10 th Oct 2025		9.6
Additional Area 3 (AA3)	10 th -11 th Oct 2025		12.5
Additional Area 4 (AA4)	9 th Oct 2025		5.2

¹Excludes the distances covered by the Martu Rangers.

In addition to the survey effort detailed above, an additional non-systematic targeted search was undertaken in a previously unsurveyed area approximately 1 km south of AA2. This search was undertaken opportunistically as the vegetation was recognised as *Acacia* shrubland with *A. monticola* as a dominant species (a key food source plant for Bilby) (Western Botanical 2025)). Approximately 6 km was traversed during this search (Figure 3.1).

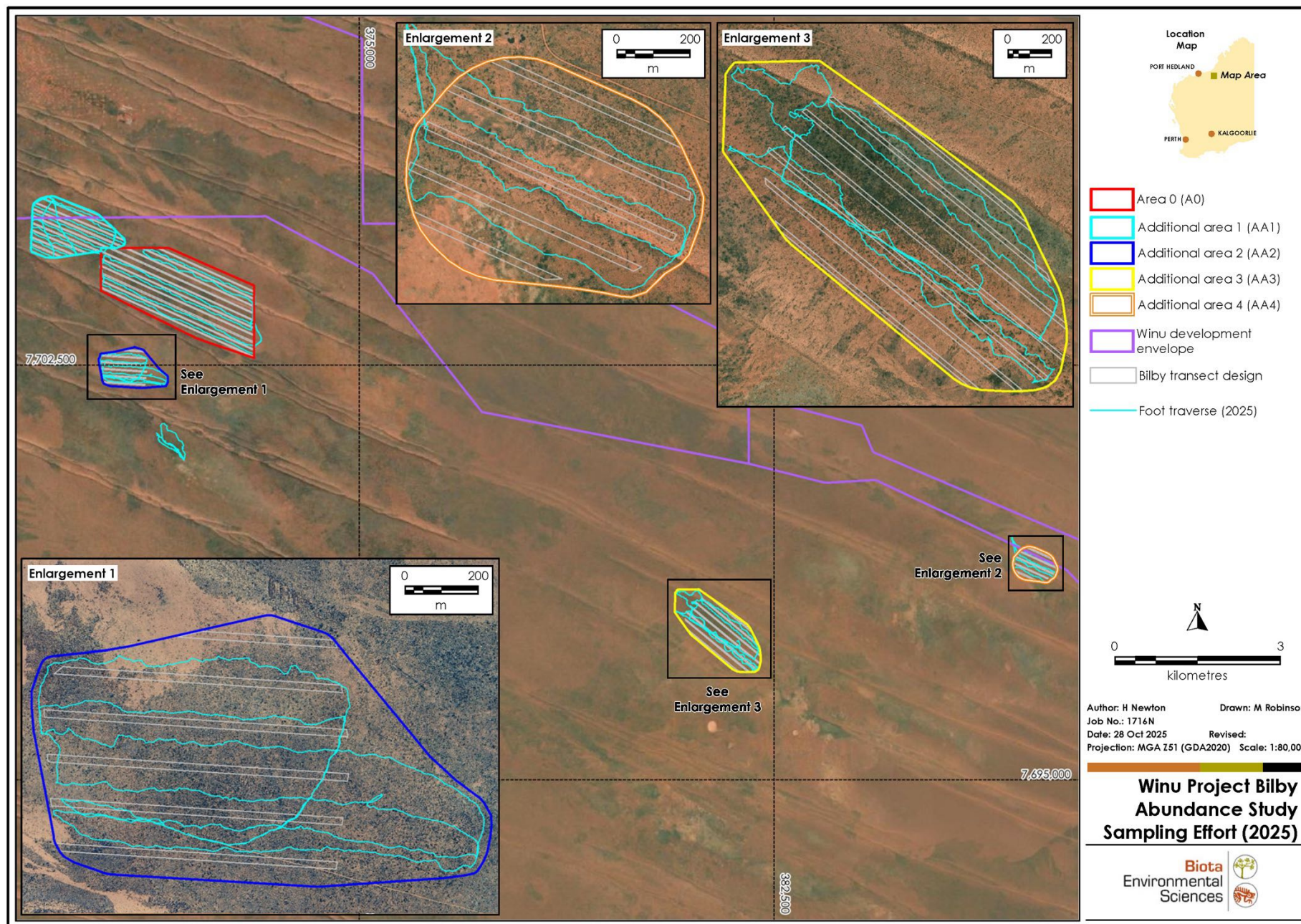


Figure 3.1: Targeted Bilby search effort from the current study.

3.2 Weather and Climate

Weather conditions can influence survey findings, particularly the amount of rainfall preceding a survey. Given the remote location of the Winu project, the closest weather station that can provide a robust dataset of long-term climatic conditions is the Bureau of Meteorology weather station at Telfer Aero (#013030), located approximately 115 km southeast of the survey area.

Figure 3.2 depicts the monthly average rainfall, maximum and minimum temperatures with their respective long-term median values for the years targeted Bilby surveys have taken place. Rainfall in the wet season months of 2019 were much lower than the long-term medians. January and February of 2022 also recorded very little (<3 mm) rain, however March recorded 176 mm, nearly 4-times the monthly long-term median. Rainfall for the remainder of 2022 was generally higher each month compared to the long-term medians. Significant high rainfall events occurred in April 2023, in February and March 2024, and in December 2024 and February 2025.

Generally, average minimum and maximum monthly temperatures hovered close, though slightly higher, than those of the long-term medians (Figure 3.2).

With the exception of the first survey undertaken in September 2019, all other surveys took place in years that recorded significant rainfall in the wet-seasons month, with no significant deviations from long-term maximum and minimum temperatures recorded.

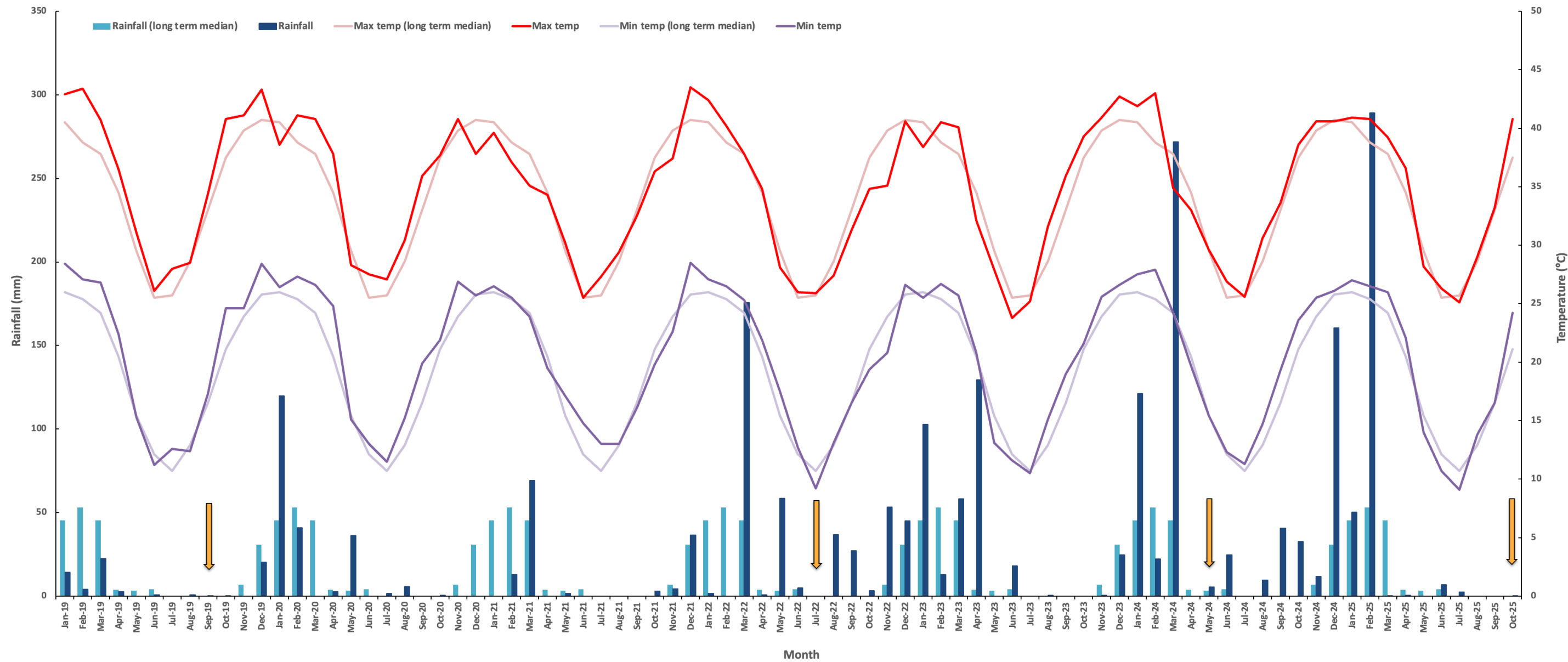


Figure 3.2: Climate graph depicting long-term averages and monthly data for the Telfer Aero (#013030) weather station for the years between the first and most recent Bilby survey.

(data from Bureau of Meteorology; arrows indicate survey timing).

3.3 Habitat Mapping

Although there are many factors which may determine the habitat preferences of Bilby (Cramer et al. 2016), the approach adopted by this study recognises that Bilby presence is strongly linked to the availability of food resources, which are intrinsically dependent on fire history (Southgate 2005).

Bilbies have been recorded in habitats spanning a wide range of fire-ages, including recently burnt (1-2 years), unburnt (3-6 years) and long unburnt (>6 years) areas (Southgate 2005, Southgate and Carthew 2007, DBCA 2017a), with each providing different food resources. For example, recent fire (and subsequent rainfall) promotes regeneration of some short-lived species such as the grass *Yakirra australiensis*, the seeds of which form dominant components of the Bilby diet when available (Southgate 2005, Liddle 2016). Fire also promotes the growth of other short-lived species such as *Senna notabilis*, the roots of which host larvae, another key component in the Bilby diet (Liddle 2016, DBCA 2018). Conversely, fire kills long-lived larvae host species, such as *Acacia hilliana* (Liddle 2016). These long-lived species only develop hosting capacity for larvae after the plant reaches a certain age (Liddle 2016), suggesting that unburnt stands of these species are important from the dietary perspective for the Bilby. The nomadic habit of bilbies allows them to exploit a range of food resources in the landscape.

Considering the above, Biota has developed a set of criteria to aid in determining the prospectivity of Bilby habitat (Table 3.2). Habitats were mapped primarily based on field notes, but mapping was informed by North Australia and Rangelands Fire Information mapping (Charles Darwin University 2022), and vegetation mapping of the area (Western Botanical 2025). The mapping produced is representative of the habitat at the time of writing: many biotic and abiotic factors determine suitability of Bilby habitat, and temporal changes in these factors influence Bilby presence. The habitat map should therefore be viewed as a guide to delineate areas that may currently be of importance to the Bilby, in the absence of significant change in influencing factors (e.g. post-survey fires and rainfall, or increase in prevalence of introduced predators).

Table 3.2: Criteria used to assess prospective Bilby habitat.

Habitat Prospectivity	Criteria
High	1. Sandy habitat supporting long-lived shrubs or forbs known to contain root-dwelling larvae and other important food source plants in unburnt and long unburnt areas (e.g. <i>Acacia monticola</i>, <i>A. eriopoda</i>, <i>A. dictyophleba</i>, <i>A. melleodora</i>, <i>A. stellaticeps</i>, <i>A. hilliana</i>, <i>Senna notabilis</i> and <i>Indigofera georgei</i>), and/or; 2. Sandy habitat supporting short-lived shrubs or forbs known to contain root-dwelling larvae and other important food source plants in recently burnt areas (e.g. <i>Senna notabilis</i> and <i>Yakirra australiensis</i>).
Moderate	1. Sandy habitat supporting plant species that are broadly typical of suitable Bilby habitat in the Great Sandy Desert or Little Sandy Desert (e.g. other <i>Acacia</i> spp., <i>Melaleuca</i> spp. and <i>Triodia</i> grasslands), but with no mapped records of important food source plant species.
Low	1. Habitat does not meet any of the criteria listed above.

3.4 Sign Evidence

3.4.1 Tracks

Bilby foot imprints are distinctive when fresh, and readily distinguished from other species that have an otherwise similar track pattern and gait (Southgate et al. 2019). Hind foot imprints are noticeably longer than front foot imprints and bear few conspicuous indentations, while front foot imprints have three distinct parallel lines produced by the toes and claws (Moseby et al. 2012, Southgate et al. 2019). Other species with similar tracks include the rabbit, bandicoot, dasyurids and rodents, however these can be distinguished from the Bilby based on differences in shape, size and toe and claw prints (Southgate et al. 2019).

The gait of the Bilby is a quadrupedal bounding overstep, which produces a pattern of parallel hind foot imprints and slightly offset or in-line front foot imprints (Moseby et al. 2012, Southgate et al. 2019). This gait pattern is consistent with other similar-sized mammals, including quolls, mulgara, bandicoots, rabbits, rats and occasionally possums (Southgate et al. 2019). As tracks and gait patterns have the potential to be confused with species other than the Bilby, a set of certainty criteria was applied when assessing track evidence in the field (Table 3.3).

Table 3.3: Criteria used to assess certainty of Bilby tracks.

Certainty	Criteria
High	1. Track imprints and gait pattern are clear and consistent with those produced by the Bilby; or 2. Resolution of hind feet and front feet imprints is poor despite a gait pattern consistent with that of the Bilby, however they may be attributed to the Bilby as other species producing similar tracks and gait patterns do not occur, or are unlikely to occur in the survey area.
Low	1. Resolution of hind feet and front feet imprints is poor despite a gait pattern consistent with that of the Bilby, and they cannot reliably be attributed to the Bilby as other species producing similar tracks and gait patterns occur, or are likely to occur in the survey area.

3.4.2 Diggings

Bilbies forage for food at the soil surface, or dig in the subsoil for beetles, termites, root-dwelling larvae, seeds and bulbs (Southgate et al. 2019). Where the Bilby has foraged, diggings are generally conspicuous and distinctive, especially where they occur at the base of shrubs or forbs known to contain root-dwelling larvae, as the Bilby is the only species in mainland Australia that forages for root-dwelling larvae in plant roots (Southgate et al. 2019). Within the Great Sandy Desert bioregion, plant species known to contain root-dwelling larvae include: *Acacia monticola*, *A. dictyophleba*, *A. melleodora*, *A. stellaticeps*, *A. hilliana*, *Senna notabilis* and *Indigofera georgei* (DBCA 2018, Southgate et al. 2019).

Diggings of the Bilby can be of different size and shape, but are typically:

- shallow, 5-10 cm in depth, with the spoil pile evenly distributed around the dig;
- deep conical or cylindrical digs, usually less than 50 cm deep; or
- large ploughed areas of multiple shallow diggings around termite nests.

Other species such as varanids, echidnas, rabbits, wallabies, bandicoots, mulgara and mice can produce diggings that are similar to the Bilby. Varanid diggings can sometimes superficially appear to belong to the Bilby, but can be distinguished by their notable crescent shape, presence of a distinct mid-ridge at the base of the digging and spoil pile often on one

side (Moseby et al. 2012, Southgate et al. 2019). Given that diggings may be confused with species other than the Bilby, a set of criteria was applied when assessing digging evidence in the field (Table 3.4).

Table 3.4: Criteria used to assess certainty of Bilby diggings.

Certainty	Criteria
High	1. Single or multiple diggings at the base of shrubs or forbs known to contain root-dwelling larvae; and/or, 2. Confirmed Bilby scats detected within spoil piles of diggings; and/or, 3. Other sign, including clear tracks, scats and burrows, recorded in association with diggings.
Moderate	1. Size and shape of diggings are consistent with known characteristics of Bilby diggings, but occur in isolation of other sign; and/or 2. Isolated diggings occur in habitat supporting plant species suitable for foraging, and the Bilby has been recorded historically from the locality.
Low	1. Diggings exhibit some characteristics typical of the Bilby, however they cannot reliably be attributed to the Bilby due to age, location within the landscape (i.e. not at the base of shrubs or forbs), and/or absence of other positive sign.

3.4.3 Burrows

The Bilby constructs burrows that typically have a single round entrance, readily distinguishable from varanids and other reptiles that construct crescent shaped burrows (Southgate et al. 2019). Bilby burrows usually have an apron of excavated sand at the entrance, and are often found under logs, at the base of trees, spinifex tussocks, termite mounds or sand mounds (Triggs 1996, Moseby et al. 2012, Southgate et al. 2019). It is common to observe multiple burrows within an established foraging area, and ‘warrens’ with multiple burrow entrances can sometimes occur (Southgate et al. 2019).

Inactive Bilby burrows can be utilised by a range of other species, including cats, foxes, varanids, echidnas, hopping mice and mulgara, potentially making them appear active (Southgate et al. 2019). Where burrow evidence was detected, a set of criteria was applied to assess the certainty that they were active (or inactive) Bilby burrows (Table 3.5).

Table 3.5: Criteria used to assess certainty of Bilby burrows.

Certainty	Criteria
High (Active)	1. Fresh, confirmed Bilby tracks detected on/surrounding apron in front of burrow entrance; and/or 2. Fresh, confirmed Bilby scats detected on/surrounding apron in front of burrow entrance; and/or, 3. Fresh, confirmed Bilby diggings detected in a foraging area surrounding the burrow entrance; and/or 4. Multiple burrow entrances detected in a foraging area, displaying evidence from 1-3 above.
Low (Inactive)	1. Burrow entrance exhibits characteristics of the Bilby, and some other sign evidence with longevity persists (e.g. scats/diggings), however it cannot reliably be attributed to the Bilby due to age and absence of fresh, positive signs.

3.4.4 Scat Collection

The Bilby produces scats with distinctive characteristics unmatched by any other species on mainland Australia (Southgate et al. 2019). Bilbies produce scats that are oblong in shape, longer than they are wide, firm, usually contain a mixture of sand, plant and invertebrate material, have a smooth coating and rounded ends, and are typically deposited in a group of two to five pellets (Southgate et al. 2019). Scats are most commonly found in association with digging activity, deposited on top of or within spoil piles of diggings, and sometimes at burrow entrances (Southgate et al. 2019).

Molecular analysis of epithelial cell DNA obtained from scats was undertaken to genotype individuals. This method is non-invasive and enables accurate determination of the number of individuals (DBCA 2017b). The technique also has specific application to field situations, as Bilby scats are relatively easy to detect, identify and collect, and DNA can reliably be obtained from scats deposited up to two weeks prior to collection (DBCA 2017b).

To reduce DNA degradation and optimise the likelihood of obtaining a useable molecular sequence, we followed the storage protocol recommended by the DBCA (2017b). Scats were stored in 30 ml vials filled with 10 ml of silica gel beads and placed in between two balls of cotton wool that acted as buffers to movement. Singular scats were stored in unique vials, unless it could be determined with certainty that scats came from one animal (i.e. scats were deposited in a pile and stuck together).

3.4.5 Estimating Age of Signs

Bilbies are often found to occur in low densities, show low site fidelity, and are highly mobile in response to resource availability and habitat modification (DBCA 2021). Therefore, it is not unusual for Bilby signs to be detected in areas they are not currently occupying. Bilby signs can persist in the environment for extended periods of time, with burrows being the most durable. Burrows are generally deemed to be active if there is fresh soil around the entrance and footprints in the soil (Thompson and Thompson 2008). Tracks are the first sign that disappear from the landscape, with other animals or wind altering their appearance after just a few days. The softness and size of a digging spoil pile can be used to estimate age, with recent diggings generally having larger piles of soft sand, and older diggings being flatter and having a crusty layer. Debris in diggings can also be used as an estimator for age, with leaf litter accumulations suggesting diggings have been present for some time (Thompson and Thompson 2008). Bilby scats are difficult to age based solely on appearance, however the age of scats can be assessed by examining decomposition of diggings which are typically associated with scat deposition (DBCA 2018). It is important to consider weather and climate when aging signs as well, with heavy rains and winds altering digging and burrow appearances, and extreme heat likely to dry out scat.

3.5 DNA Extraction and Genotyping

To identify individual bilbies, attempts were made to amplify and sequence seven microsatellite loci for each collected scat. DNA from 59 scat specimens (all Bilby scats collected by Biota since 2019) were extracted using the QIAGEN QIAamp Fast DNA Stool mini kit (Qiagen, Hilden, Germany). Samples were washed in buffer as per Carpenter and Dziminski (2017) and eluted as per manufacturer's protocols. Seven microsatellite loci for *Macrotis lagotis* were amplified using the QIAGEN Multiplex PCR kit in triplicate. PCR products were analysed on an ABI3730XL Sequencer using Genescan-500 LIZ internal standard and scored using GeneMarker V1.91. A genotype accumulative curve was performed, and results revealed that the minimum number of loci to distinguish individuals was five to six (Appendix 2). Examination of genotypes amongst all individual scat specimens was undertaken.

3.6 Survey Limitations

The following limitations should be recognised regarding this study:

- The targeted searches were confined to the five previously identified areas (A0, AA1-AA4) and one additional site. These would not encompass the entire extent of the Bilby population in the locality, but were identified as the areas supporting an active population after extensive survey work throughout the DE.
- Not all collected Bilby scats were successfully sequenced. It is therefore possible that additional bilbies were present in the survey areas during the survey periods.
- The study provides a census snapshot from four occasions (spatially and temporally) and is not an exhaustive study of Bilby population dynamics.

4.0 Field Survey Results

4.1 Habitat Prospectivity

4.1.1 Area 0

Based on the criteria outlined in Section 3.3, 53.5% (184.1 ha) of A0 was assessed as highly prospective Bilby habitat (High prospectivity), mainly due to the presence *Acacia monticola* (a key food source plant). Any areas that were burnt during the fire in 2023 or contained suitable habitat but with few or no food source plants, were assessed as Moderate prospectivity (45.4%, 156.2 ha). *Acacia monticola* has started to grow back in the areas previously burnt, however, are currently too young to harbour the ground-dwelling larvae bilbies favour. The tracks and cleared areas (3.8 ha, 1.1 %) within A0 have been mapped as Low prospectivity habitat (Figure 4.1).

4.1.2 Additional Area 1

The majority (98.3%, 129.5 ha) of AA1 was assessed as Moderate prospectivity as it contained suitable habitat, but with few or no food source plants and no history of recorded Bilby activity (Figure 4.1). All lay-down pads and associated tracks within AA1 were assessed as Low prospectivity (1.7 %, 2.2 ha).

4.1.3 Additional Area 2

Most of AA2 was assessed as High prospectivity (95.3%, 65.6 ha; Figure 4.1); the exceptions being the access track (0.3%, 0.2 ha) and a small area that had been recently burnt (4.4%, 3.0 ha). The area was dominated by *Acacia ancistrocarpa* and *Acacia monticola*, the latter a long-lived forb known to contain root-dwelling larvae favoured by bilbies.

4.1.4 Additional Area 3

Just under half of AA3 is High prospectivity Bilby habitat (41.3 ha, 31.9%, Figure 4.2). The area is dominated by the food source plant *Acacia monticola*, with Bilby foraging activity ceasing in line with the extent of this plant species in the landscape. The remaining area does not contain food source plants though is still broadly suitable for bilbies and is hence assigned a prospectivity rating of Moderate (87.7 ha, 67.6%).

4.1.5 Additional Area 4

A small proportion of AA4 is mapped as High prospectivity habitat (5.9 ha, 14.7%, Figure 4.2), the remaining is Moderate prospectivity habitat (33.9 ha, 85.3%). Given the extent of High prospectivity habitat is quite minimal, we have deduced that AA4 likely represents a temporary area of occupancy for dispersing individuals, rather than core habitat for a small population like A0, AA2 and AA3.

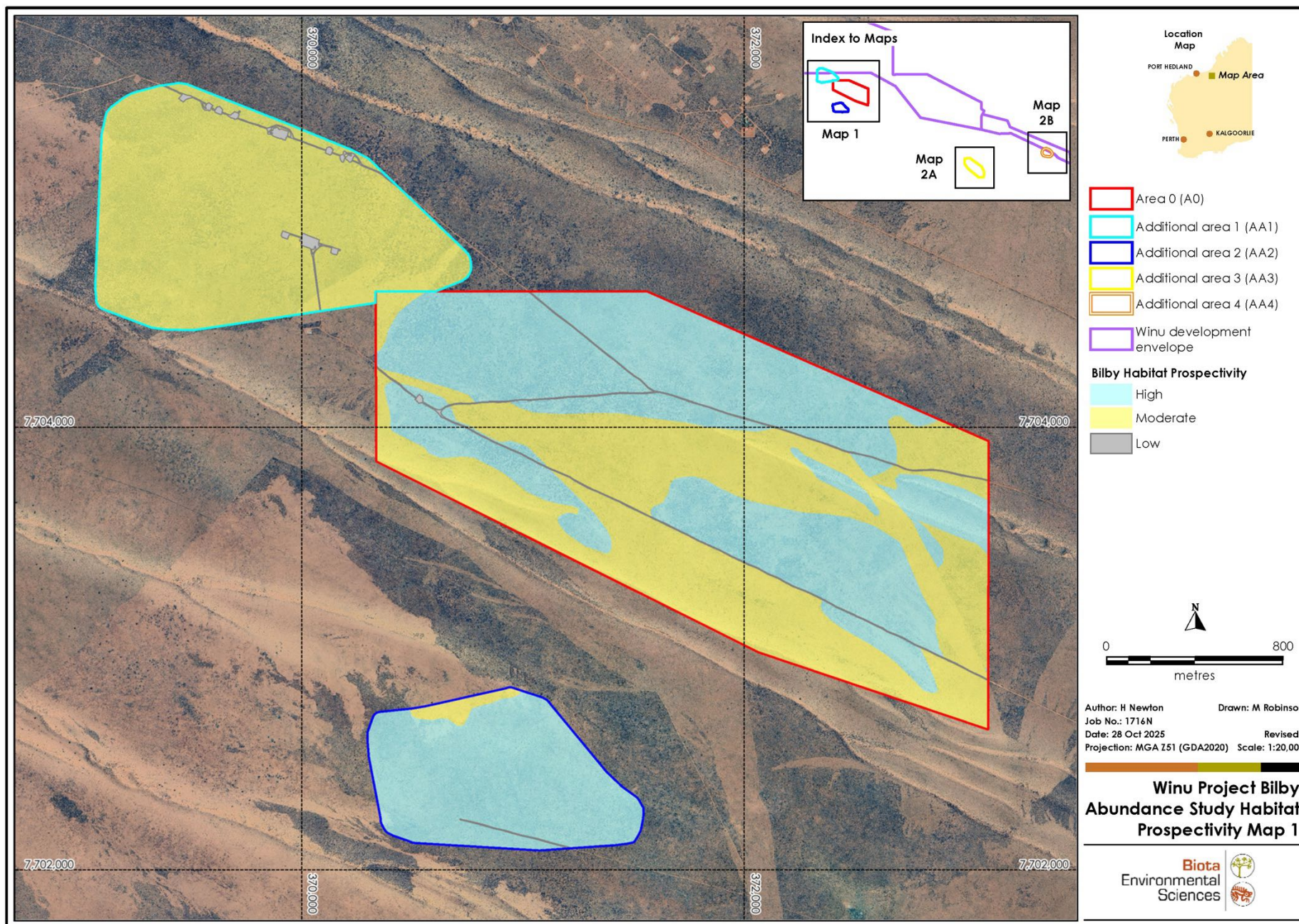


Figure 4.1: Bilby habitat prospectivity in A0, AA1 and AA2.

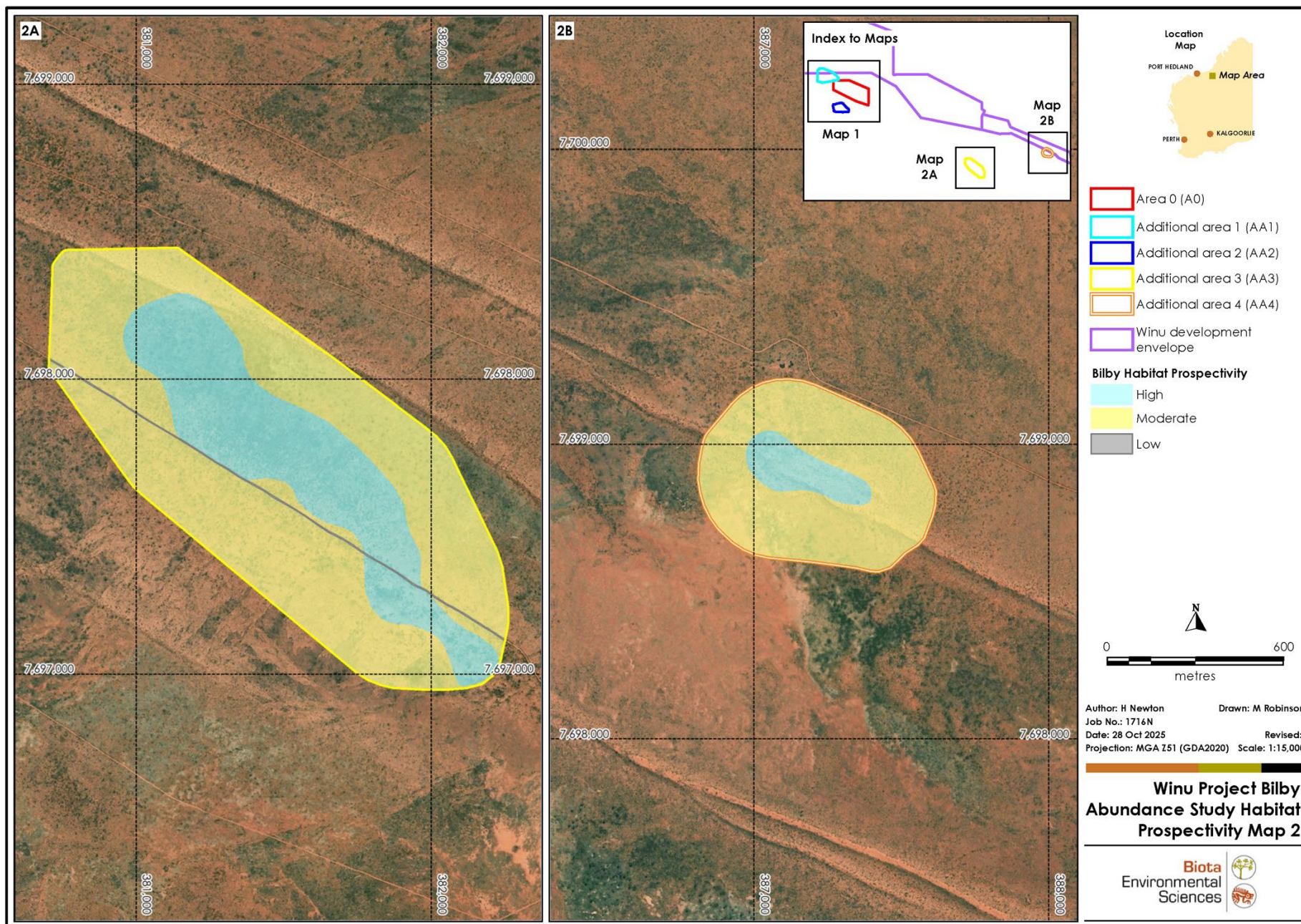


Figure 4.2: Bilby habitat prospectivity in AA3 and AA4.

4.2 Bilby Signs

4.2.1 Area 0

Active Bilby signs were recorded during the 2019 and 2022 searches of A0 (Biota 2020, 2023a) (Figure 4.4). During the third and fourth (current) survey (May 2024, October 2025), no recent Bilby activity was documented in A0.

4.2.2 Additional Area 1

AA1 is situated immediately west of A0; no signs of Bilby activity were recorded at this site in 2024 or 2025.

4.2.3 Additional Area 2

AA2 is located approximately 2 km south of A0 (separated by a longitudinal dune), numerous fresh signs were recorded during the 2024 survey (Biota 2024b). Additional evidence was recorded during the current study, including a single scat sample, though none appeared to be from recent activity (Plate 4.1, Figure 4.3).



Plate 4.1: Example burrow recorded in AA2 during the October 2025 survey; entrance full of debris and lack of tracks or soft soil around entrance indicating it is aged and currently unused.

A targeted search in an area less than 1 km south of AA2 (separated by a longitudinal dune), that consists of highly prospective Bilby habitat, did not return any evidence of the species.

4.2.4 Additional Area 3

AA3 is an area located approximately 9-10 km east of A0 and AA2. Over 50 diggings and 11 burrows were recorded during the 2024 survey (Biota 2024b). Additional signs were recorded during the current survey, including scats diggings and burrows. However, most signs showed evidence of ageing, with diggings filled in with leaves and spoil piles having a layer of crust (Figure 4.3, Plate 4.2). A single burrow on the western edge of AA3 had tracks in the burrow

entrance and a few diggings in the vicinity that appeared to be more recent than all other signs in the area (soft spoil piles, no debris in the digging). However, given the low number of active signs, we have assumed these are the remnants of the last individual that occupied the area.



Plate 4.2: Example scat sample collected from AA3 during the October 2025 survey highlighting the low quality (aged) scat and debris in the associated digging.

4.2.5 Additional Area 4

AA4 is located within the Rimfire pipeline corridor; in 2024 two burrows, one scat sample and ten diggings were recorded here (Figure 4.4). Additional sign evidence was recorded during the 2025 survey, though all were aged, likely attributable to the same period of activity as the records from the 2024 survey (Figure 4.3).

4.2.6 Summary

Since 2019, bilbies have occupied (at discrete points in time) four disjunct areas in the vicinity of the Winu DE. At the time of the current study, it appears as though the Bilby population has moved beyond the bounds of the previously occupied areas into unsurveyed territory (Table 4.1).

Table 4.1: Summary of Bilby presence in the study area.

Area	September 2019	July 2022	May & July 2024	October 2025
A0	Present	Present	Absent	Absent
AA1	-	-	Absent	Absent
AA2	-	-	Present	Absent
AA3	-	-	Present	Absent
AA4	-	-	Present	Absent

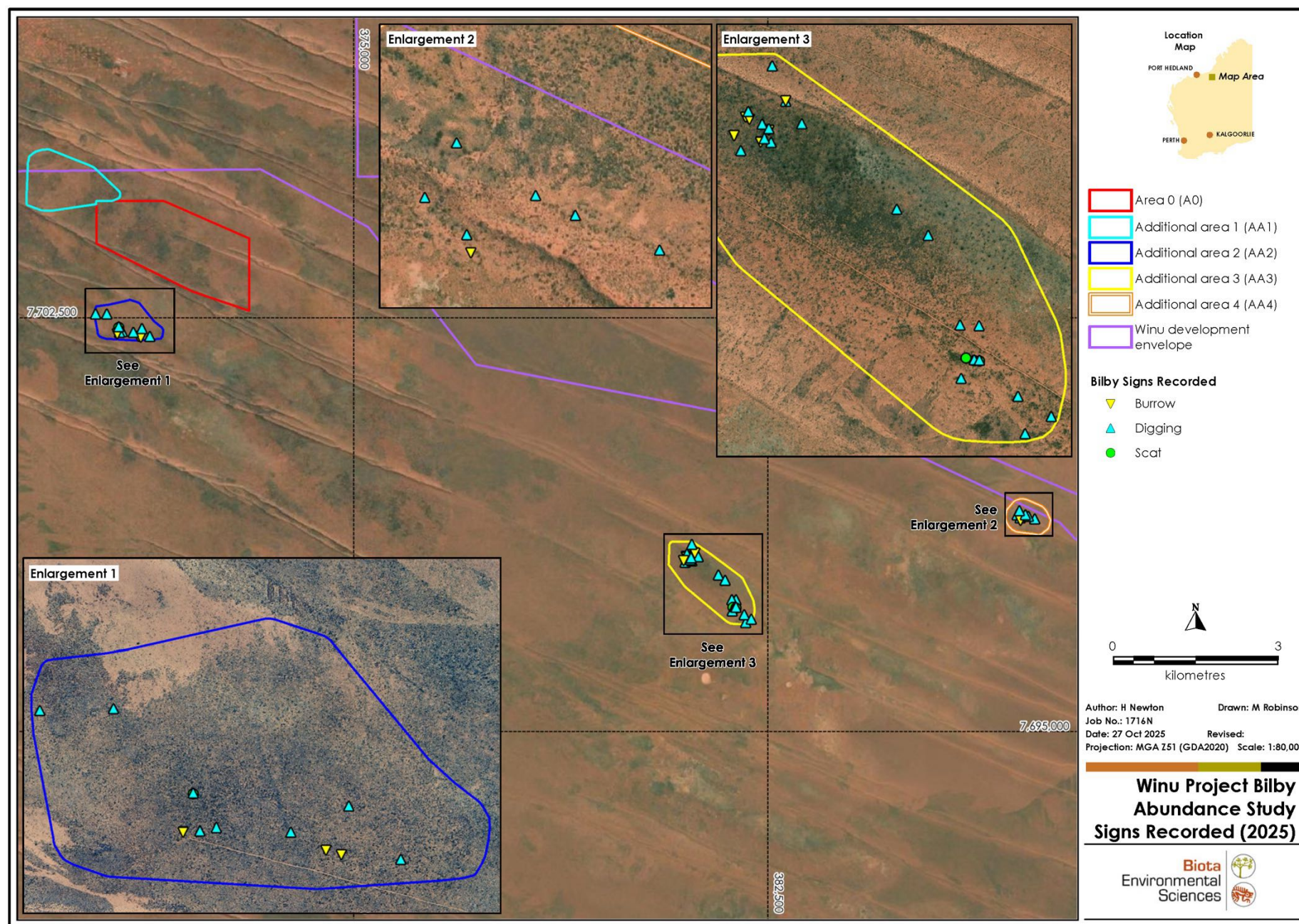


Figure 4.3: Bilby signs recorded during the current survey.

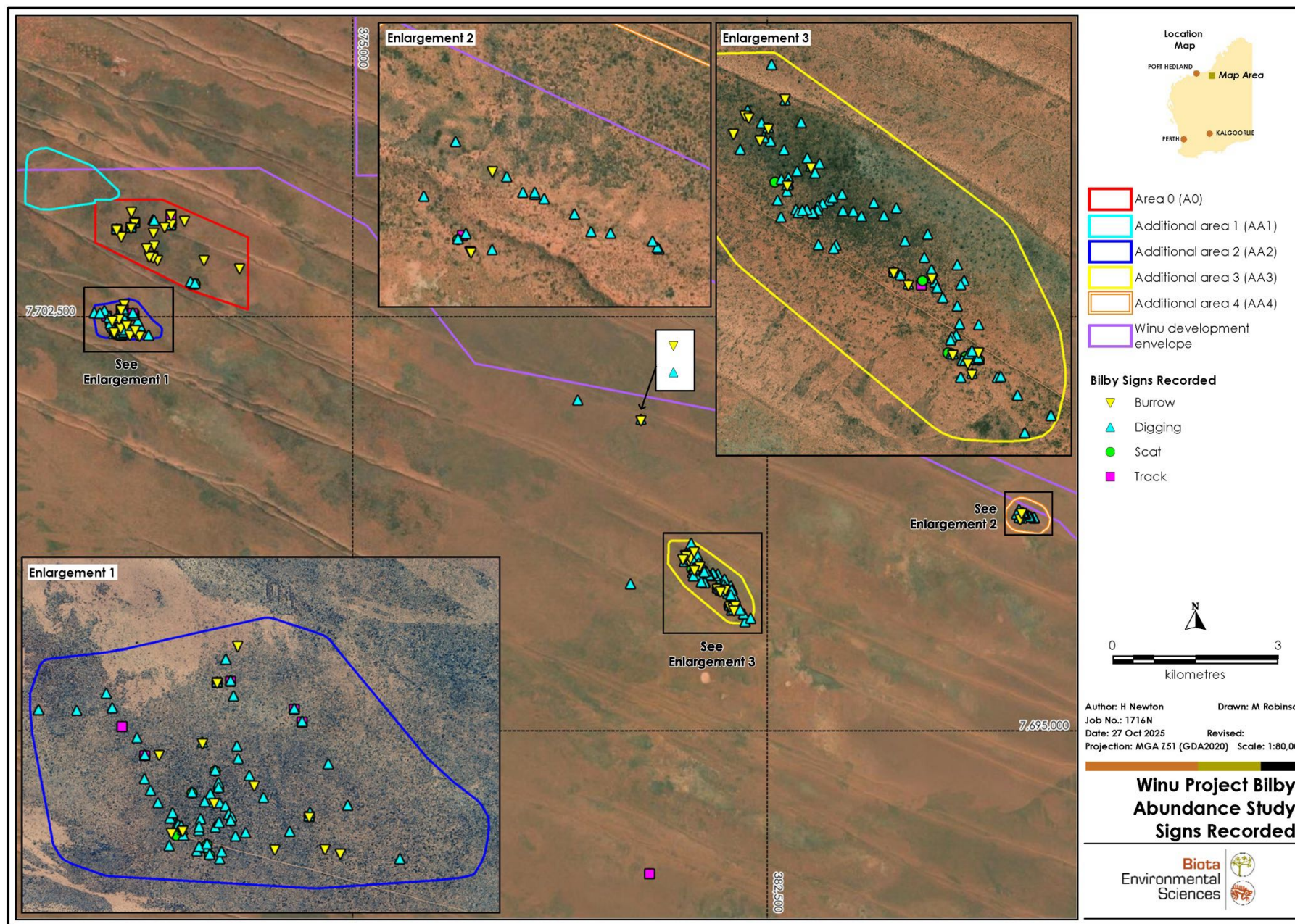


Figure 4.4: Compilation of Bilby signs recorded between 2019-2025.

4.3 Bilby Census

4.3.1 Genotyping of Individuals

A combined total of 59 Bilby scats have been collected within and near to the Winu DE over four years of surveying. Thirty-four of these were successfully genotyped, corresponding to ten individual bilbies (Table 4.2, Figure 4.5; Appendix 2).

Table 4.2: Scat analysis breakdown.

Area	Year	Number of scats collected	Number successfully genotyped
Area 0	2019	20	9
	2022	18	13
	2024	0	-
	2025	0	-
Additional Area 1	2024	0	-
	2025	0	-
Additional Area 2	2024	9	5
	2025	1	1
Additional Area 3	2024	7	4
	2025	3	1
Additional Area 4	2024	1	1
	2025	0	-
Total		59	34

The additional scat samples and improvements in data analysis techniques provides an updated census of the Winu Bilby population. Individual genotype groupings of scat samples are presented in Appendix 2 and displayed below (Figure 4.5). In this study, a ‘detection’ refers to a single scat sample, e.g. 12 scat samples belonging to individual A were recorded in Area 0 across two years. Locations of each individual detection are presented in Figure 4.6 and Figure 4.7.

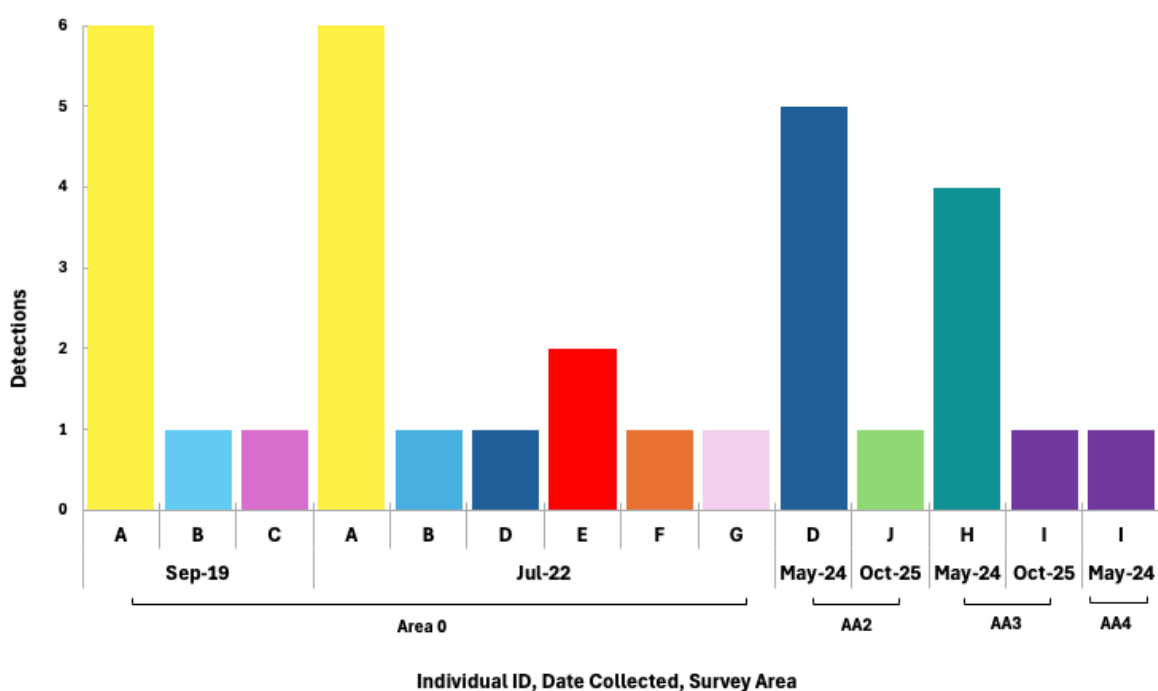


Figure 4.5: Bilby detections across survey years grouped by survey area.

4.3.2 SECR Analysis

A minimum of 10 recaptures are generally required for robust density estimation using SECR, with at least 20 cited as a more realistic minimum². During the combined surveys, only four of the ten individuals were 'recaptured' (detected again from scats collected on a subsequent phase), and only one was recaptured enough times to meet the suggested minimum (Individual A; Figure 4.5). SECR analysis has therefore not been utilised here, as the data obtained in this study is not reliable for the analysis and the findings would be uninformative. In such instances, and where a robust sampling approach is followed, the sequence data can be considered representative of a census only. In this case, the sequencing identified three different individuals from within A0 in 2019, six individuals from within A0 in 2022 (four new, two recaptures), three individuals from three different areas in 2024 (two new and one recapture), and two individuals in 2025 (one new in AA2 and one recapture in AA3) (Figure 4.6, Figure 4.7).

² (<http://www.phidot.org/forum/>).

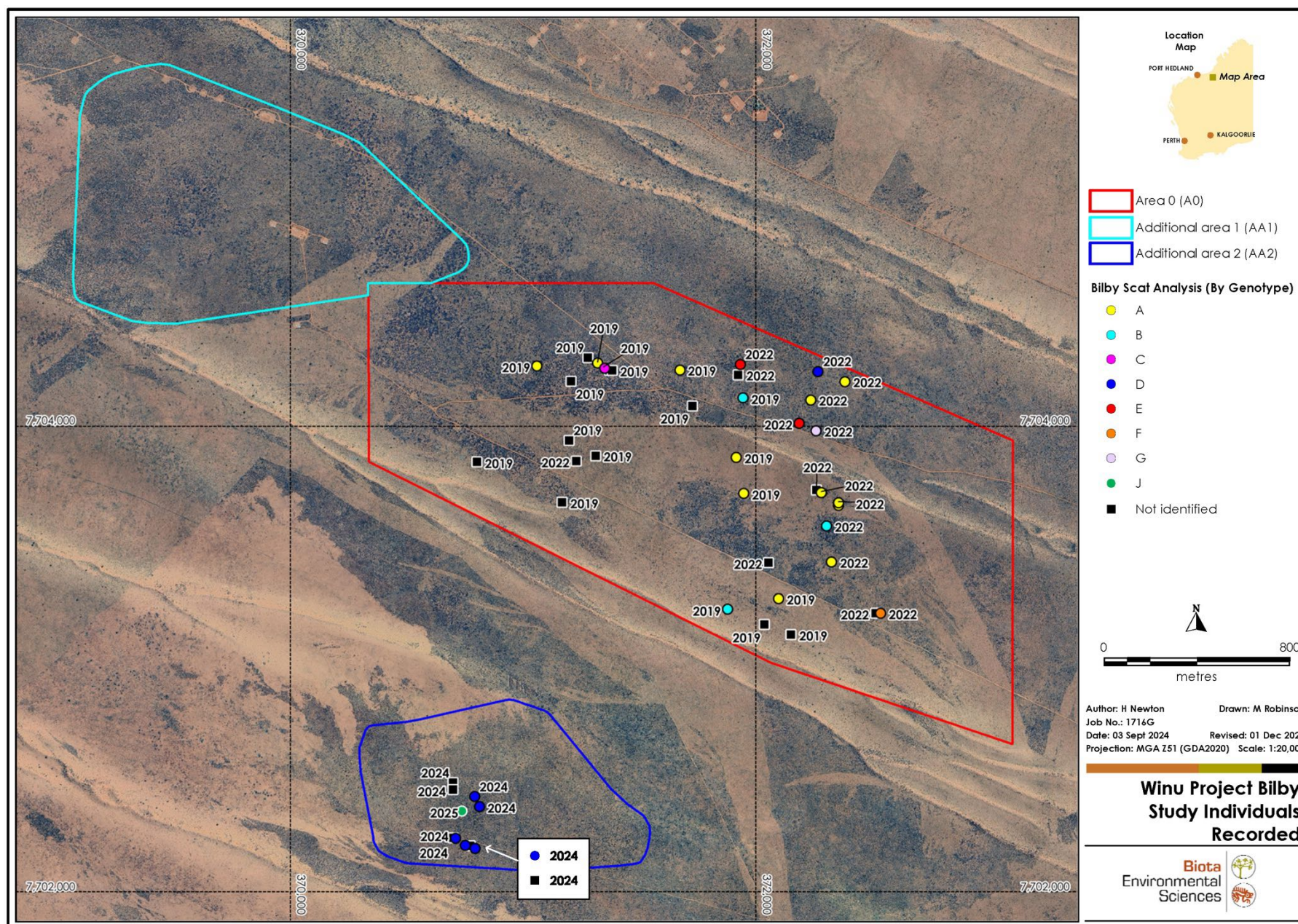


Figure 4.6: Bilby individuals recorded as determined through molecular genotyping - Map 1 of 2.

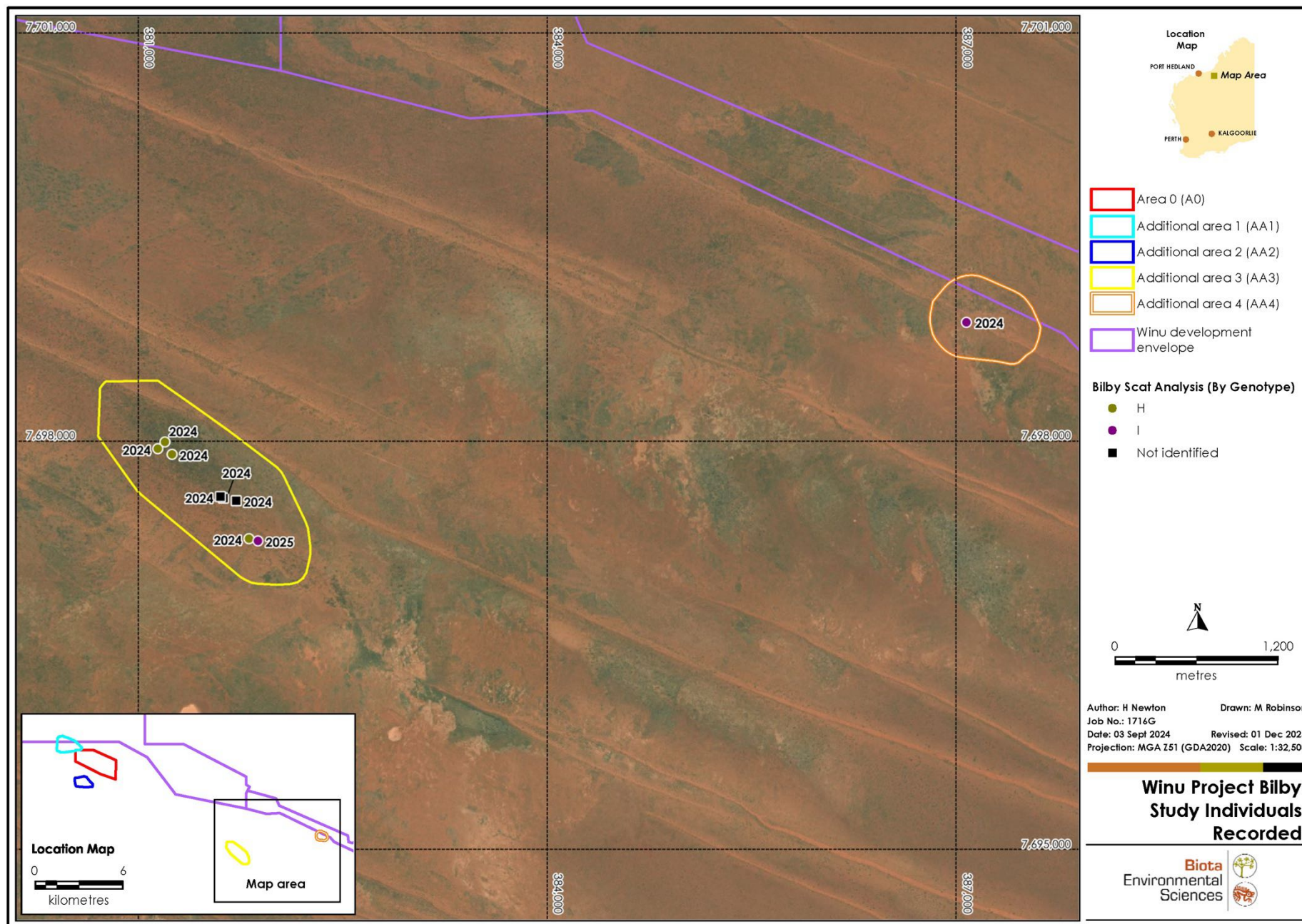


Figure 4.7: Bilby individuals recorded as determined through molecular genotyping - Map 2 of 2.

4.4 Feral Predators

Evidence of feral predators in the Winu DE and the current study area is common and not restricted to specific fauna habitats. Tracks attributable to both feral domestic cats (*Felis catus*) and red foxes (*Vulpes vulpes*) (and the similar tracks of dogs/dingos) are seen in the landscape frequently. No scats of either species or fox dens were recorded in the study area, and there were no obvious signs of the feral predator species occupying abandoned Bilby burrows.

Mining infrastructure such as office and camp establishments can act as predator-prey focal points due to increased availability of shelter and food sources (including human food waste, and small irrigated areas creating attractive natural vegetated patches). There is evidence of this in the Winu DE with cats and foxes being frequently observed on vehicle access tracks, and under transportable offices/accommodation units (pers. comms. on site RTW personnel). Furthermore, a recent trapping initiative undertaken by Animal Pest Management Services captured six foxes in the Winu DE (October 2025, pers. comm. RTW environmental advisor). The Winu Project Felixer trial has begun; one unit has been placed just north of Winu Camp, and the other in A0. At the time of writing, the trial was still in the 'photo only' mode (i.e. no targeted bait firing was occurring).

5.0 Discussion

5.1 Local Habitat Assessment

Five rationalised fauna habitats (plus disturbed/cleared areas) have been mapped as occurring in the Winu DE (Biota 2025a), comprising:

- Shrub and spinifex on sandplain;
- Inland sand dune;
- Gravelly lateritic rises;
- Clayey sandplain with termitaria;
- Ephemeral claypan; and
- Disturbed/cleared;

Two of these include potential areas of core habitat for Bilby; Shrub and spinifex on sandplain and Inland sand dune. The sandy soils provide the appropriate substrate to support burrows and host foraging plant species bilbies are known to favour. Gravelly lateritic rises may provide supporting habitat for the species, particularly if food source plants such as *Acacia hilliana* (Hill's Tabletop Wattle) are present.

The current Winu disturbance footprint constitutes an area of approximately 4,878 ha, 3,682 ha of this is mapped as Shrub and spinifex on sandplain (75.5%), and 815 ha is mapped as Inland sand dune (16.7%) (Figure 5.1, Figure 5.2). Whilst these fauna habitats can provide critical habitat for bilbies, previous surveys of the DE did not reveal any prominent areas of Bilby activity, with evidence of the species being most prevalent south of the DE. The current Winu disturbance footprint also encompasses areas already highly disturbed, with numerous tracks dissecting the area leading to bores, laydowns, and camp infrastructure.

Furthermore, the Winu Bilby population very closely aligns with the presence of *Acacia monticola* in the landscape, showing a clear preference for areas that contain large swathes of this plant species with an understory of *Triodia* spp. The Winu mine area is predominately mapped as Shrub and spinifex on sandplain, but the dominant shrub species here are *Acacia platycarpa*, *A. tumida* var. *kulparn*, *A. sabulosa*, and *Grevillea wickhamii* subsp. *hispidula* (Western Botanical 2025).

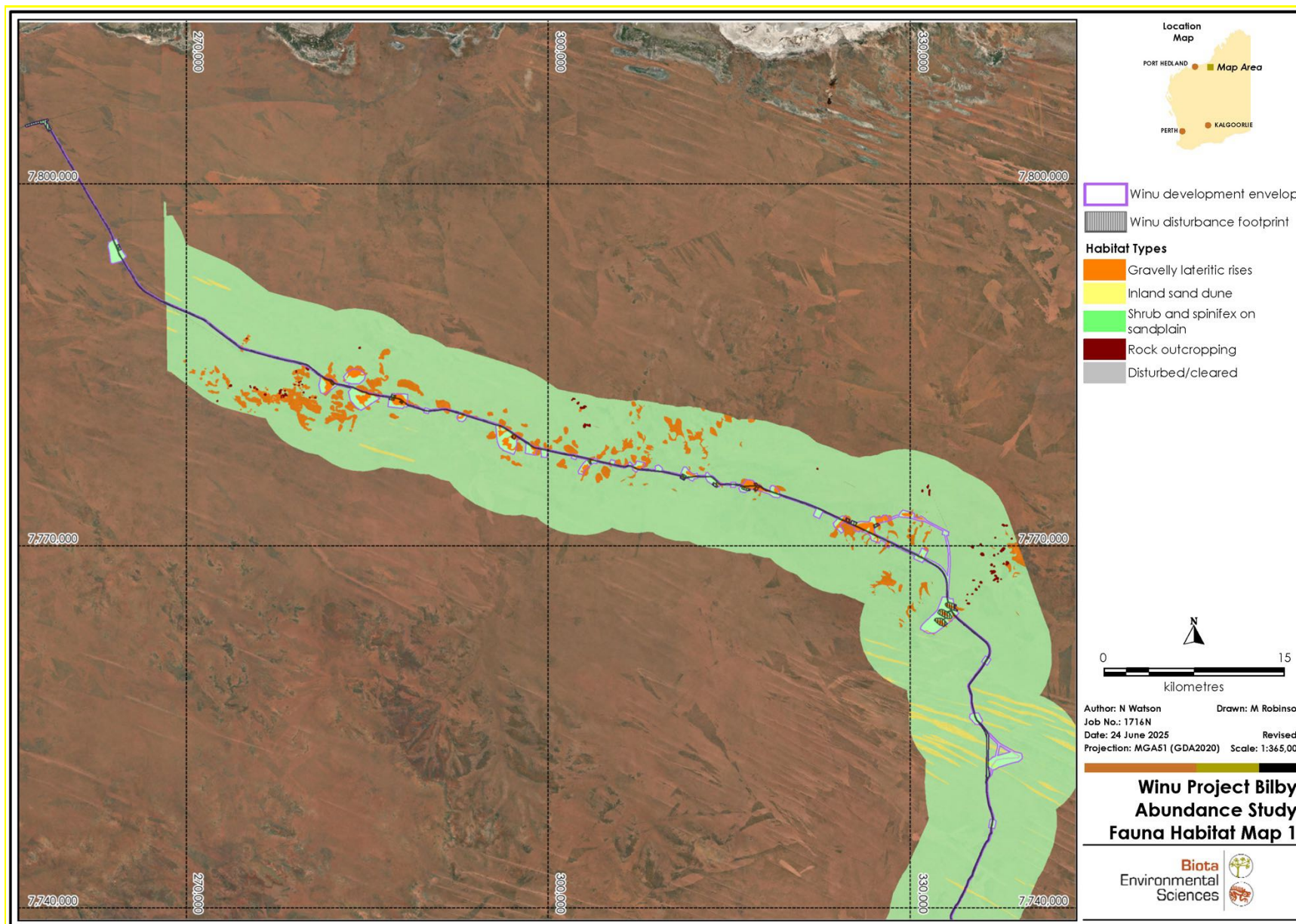


Figure 5.1: Rio Tinto Winu clearing footprint (as of October 2025) overlaid onto fauna habitats (Map 1 of 2).

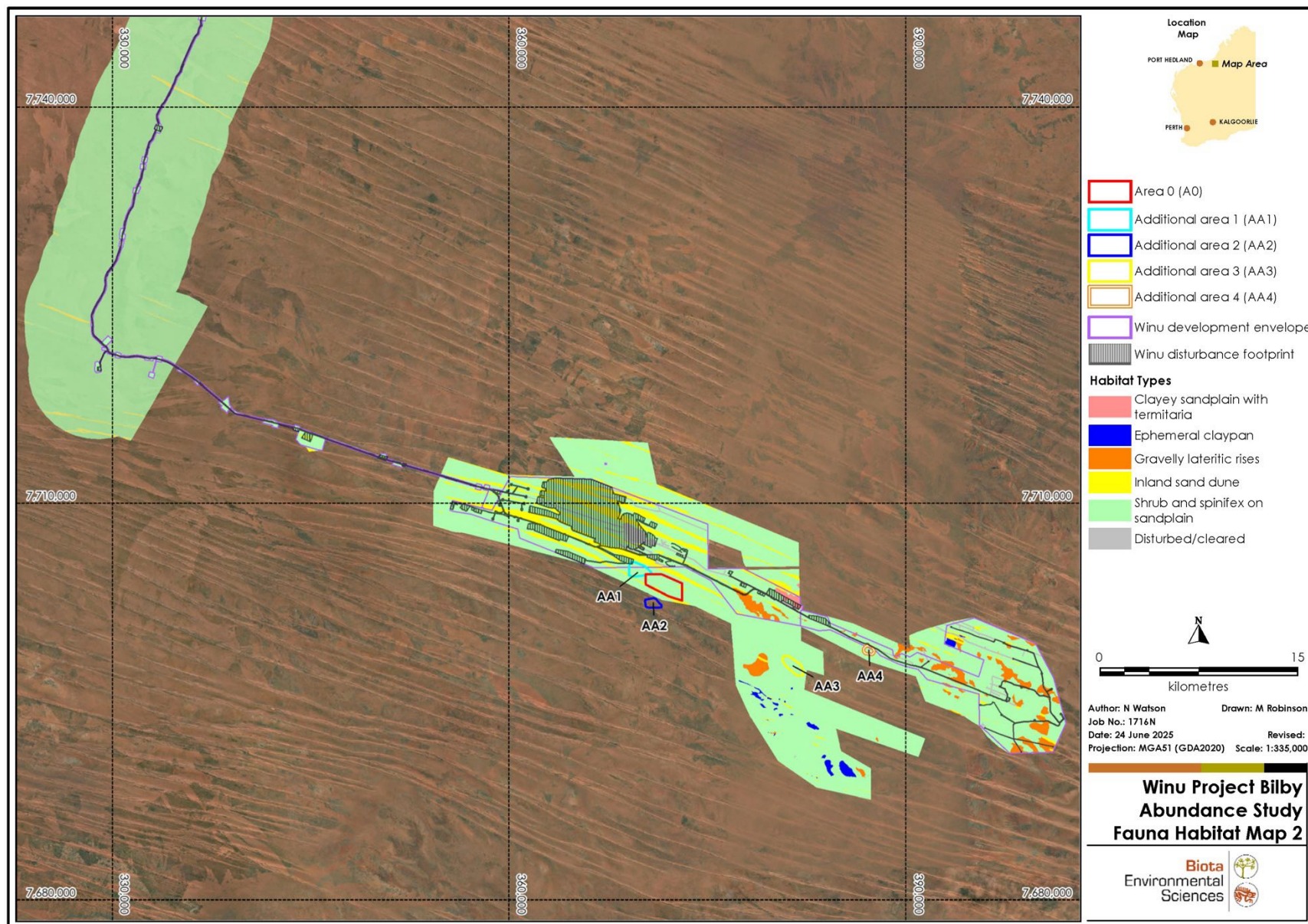


Figure 5.2: Rio Tinto Winu clearing footprint (as of October 2025) overlaid onto fauna habitats (Map 2 of 2).

5.2 Regional Habitat Assessment

5.2.1 Land Systems and Soil Landscapes

As described in Biota (2025), both land systems mapping for the Rangelands regions of WA (van Vreeswyk et al. 2004) and soil-landscape mapping by DPIRD (2018) were examined in order to place the fauna habitats of the Winu DE into a regional context. Four land systems have been mapped as occurring in the DE; Little Sandy, Nita, Callawa and Buckshot, and in the absence of land system mapping to the east of the MIA, two soil landscape units are represented, AB40 and B30 (Figure 5.3). A review of the descriptions of these two soil landscape units determined that they are most comparable to land units of the Little Sandy land system.

Two of the land systems encompass the areas containing suitable habitat for bilbies; Little Sandy and Nita, with each characterised by sandplains and linear and reticulate dunes supporting shrubby (hard and soft) spinifex grasslands, with occasional trees. The extent of these land systems present within the DE ranges from <1% to just over 2.85% of their broader extent across the McLarty, Mackay and Pindanland IBRA Subregions combined (Biota 2025a), indicating that habitat suitable for bilbies is not restricted to the Winu DE, rather is common and widespread in the broader region.

Our consolidated survey findings support this, with evidence of Bilby occurrence recorded at numerous sites in the surrounding locality (see Figure 2.2).

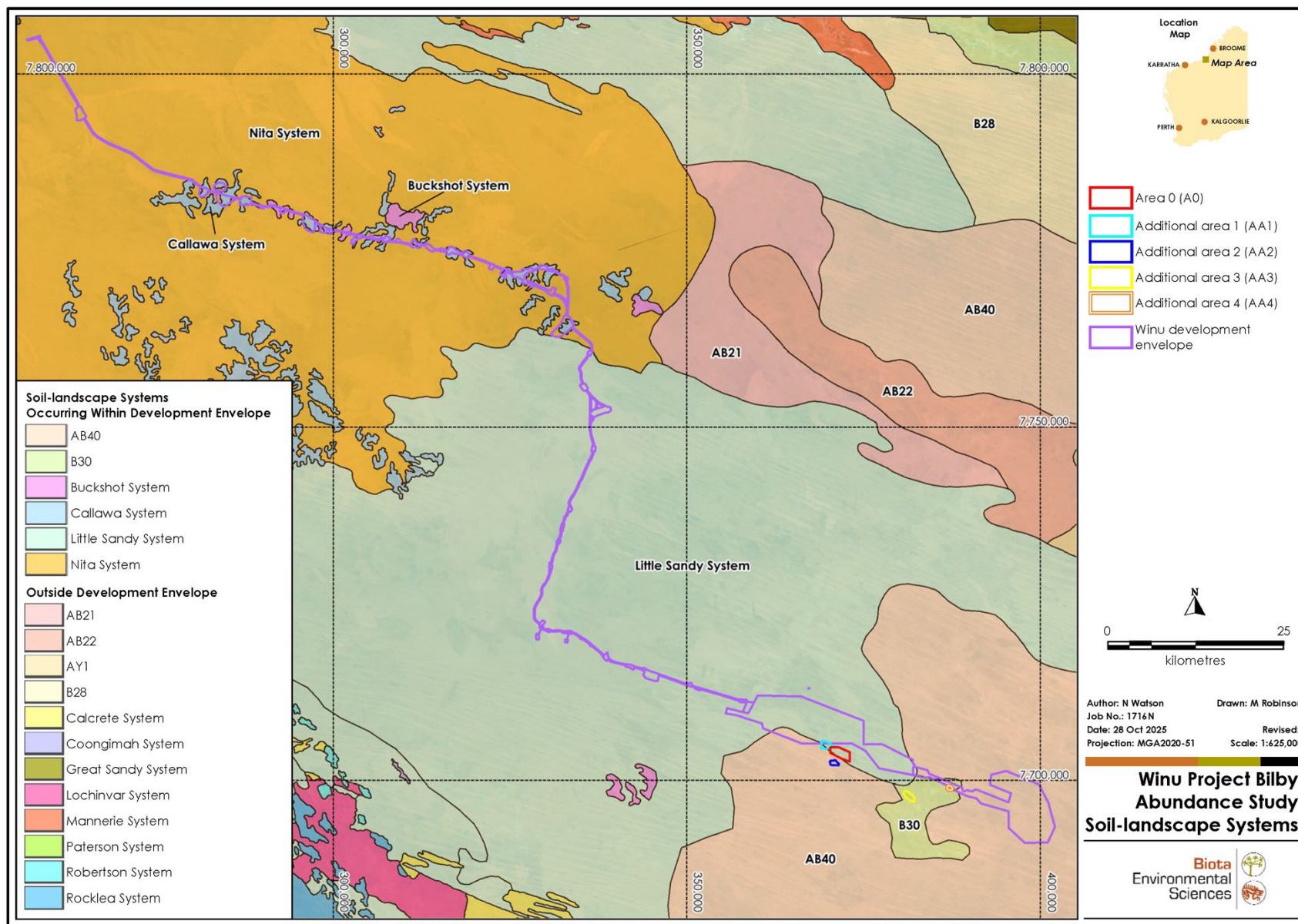


Figure 5.3: Soil-landscape systems occurring within the Winu DE.

5.2.2 Fire History

Fire has played a dominant role in shaping many of Australia’s ecosystems, particularly our desert landscapes. The Winu DE has been directly impacted by fire multiple times prior to, and since biological survey work began. Fire occurrences in the DE are summarised in Table 5.1 and mapped in Figure 5.4.

Table 5.1: Summary of the fire history of the Winu DE.

Area (ha)	Year burnt	Approximate area burnt (ha)
Mine Infrastructure Area	2018	6,663
	2022	1,797
	2023	3,035
Road Access Corridor	2017	836
	2018	2,626
	2019	1,388
	2022	170
	2023	2,923
Rimfire	2018	6,678
	2023	173

Due to their small and isolated nature, Bilby populations in the Pilbara and Great Sandy Desert are highly susceptible to the impacts of fire; large intense wildfires can lead to local extirpations, and lack of fire can lead to reduced habitat quality (Bradley et al. 2015, Northover et al. 2024). The relationship between Bilby occurrence and fire is complex, some studies indicate long-unburnt areas are preferred by the species (DCCEEW 2023, Moore et al. 2024), and others found areas with more homogenous vegetation, such as the Tanami Desert, have a positive relationship between Bilby occurrence and fire frequency (Southgate et al. 2007), likely due to the high availability of fire-promoted food plants (Southgate and Carthew 2007). A recent study found fire frequency to be the most important predictor in contemporary (2000-2022) ecological niche models, indicating that bilbies have contracted to areas with higher fire frequencies (Geyle et al. 2025).

The Winu Bilby population has demonstrated resilience to fire, with evidence of the species persisting in the landscape less than 2 km from where a fire event occurred in 2023 (Biota 2024b).

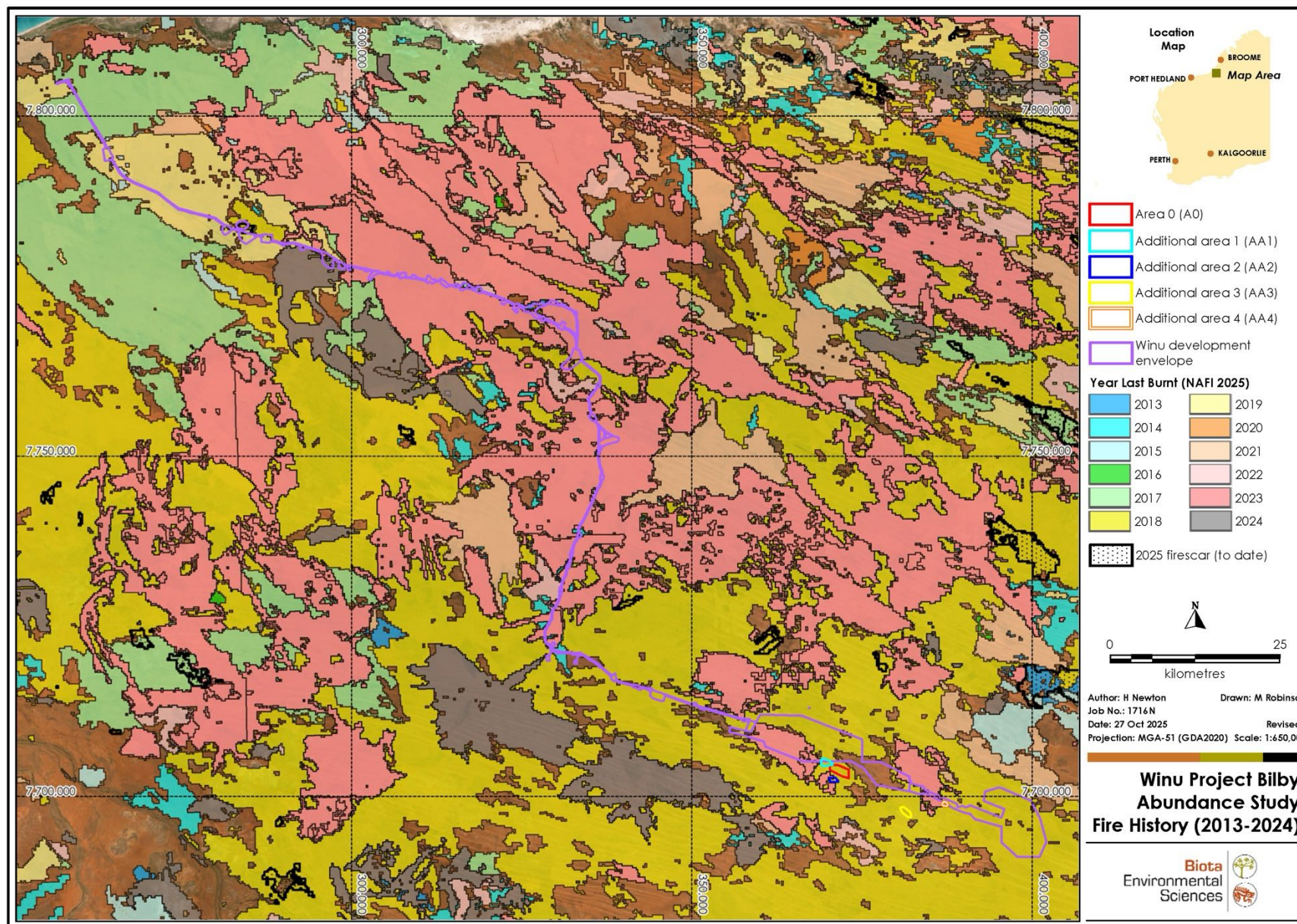


Figure 5.4: Fire history of the Winu DE (data from Northern Australia & Rangelands Fire Information).

5.3 Winu Bilby Population

Targeted surveys to detect signs of bilbies in the vicinity of the Winu DE have been undertaken on four occasions; initially in September 2019, followed by July 2022, May 2024 and lastly, in October 2025. Each survey phase was at different times of the year under varying climatic and environmental conditions (see Figure 3.2). The first targeted abundance survey took place towards the end of the dry season after the locality experienced below than average rainfall. The second survey was undertaken just over a month after a significant rainfall event occurred (May 2022). In 2023, a fire occurred in the locality, impacting around 50% of the suitable habitat in A0. The third survey was undertaken soon after a particularly wet, wet season and the current survey was undertaken at the end of the dry season.

The number of molecularly identified individuals across survey phases is 3, 6, 3 and 2, respectively. During the first three surveys, active burrows and recent diggings were recorded along with finding scat samples, indicating the individuals identified were likely occupying the survey area at the time of the surveys. In contrast, no active signs were recorded during the current survey (October 2025), with the scat collected being dry and aged. We conclude that no bilbies were using the study area at the time of the current survey. However, the recording of additional sign evidence and scat samples suggests bilbies were still utilising the study area for some time after the May 2024 survey.

5.3.1 Population Significance

Under Federal significant impact guidelines (Department of the Environment 2013), nationally threatened species populations are considered important if they:

1. represent key source populations either for breeding or dispersal;
2. are necessary for maintaining genetic diversity; and/or
3. are near the limit of the species' range.

Considered in isolation, the Winu Bilby population would not represent a key source population for breeding or dispersal within the Great Sandy Desert due to its low to moderate abundance, nor is it a population near the limit of the species' range. However, it likely represents a population necessary for maintaining genetic diversity in the bioregion. In this context, the Winu Bilby population is considered important.

5.3.2 Regional Population Comparison

Comparing the Winu Bilby population against regional data allows for a rudimentary comparison of population size. Bilby population abundance monitoring has been undertaken within at least 11 populations in the Pilbara (Dziminski et al. 2020). Monitoring has also been conducted in the Gascoyne, Gibson Desert and Dampierland bioregions (DBCA 2017b, 2018, 2021). Regional population estimates for 21 locations across these regions are summarised in Table 5.2.

The largest population recorded to date was at Anna Plains in 2017, with 44 (± 7) individuals (though this is considered an outlier population) (Table 5.2). The populations at Matuwa (Gascoyne) were also large, however these populations were in an area that has benefited from predator control, stock exclusion and fire management for more than 12 years (DBCA 2017b). By contrast, the remaining Pilbara, Gibson Desert and Dampierland populations for which abundance estimates are available, are largely unmanaged (DBCA 2017b). Bilby populations are generally small and geographically isolated, with most comprising fewer than 10 individuals (Northover et al. 2024). The findings of the Winu abundance study align, with an average of 3.5 individuals being recorded across four years of surveying (Table 5.2).

Table 5.2: Regional population abundance estimates for the Bilby.

	Pilbara													Gascoyne		Gibson Desert	Dampierland					
Monitoring Year	Turner River	Hillside	Nullagine	Yarrie	Warralong	Callawa	MvPhee Creek	Pardoo	Warralong Congan	Warralong River	Warralong O’Grady Well	Rail	Winu	Matuwa (Possum Lake)	Matuwa (New Market)	Kiwirrkurra	Anna Plains	Nita Downs	Thangoo	Yarri Yarri	Kurlku	Bawoorrooga
2013	-	-	-	-	-	-	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	2	3	2	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-
2015	1	-	5	10	-	8	1	0	-	-	-	1	-	26	-	-	-	-	-	-	-	-
2016	2	-	8	2	6	-	0	0	6	-	-	2	-	29	21	4	-	-	-	-	-	-
2017	-	3	-	-	-	-	0	-	-	-	-	1	-	-	-	-	44	10	2	-	-	-
2018	-	-	-	-	-	-	-	-	3	7	-	2	-	-	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-	-	-	4	-	-	3	-	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	4	13
2021	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-	5	2	-	-	6	-	-	-	-	-	-	-	-	-
2023	-	-	-	-	-	-	-	-	12	3	-	-	-	-	-	-	-	-	-	-	-	-
2024	-	-	-	-	-	-	-	-	4	0	3	-	3	-	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Average Abundance	1.7	3.0	5.0	6.0	6	8	0.75	1.8	6.0	3.2	3	1.6	3.5	27.5	21	4	44	10	2	6	4	13

Shaded columns indicate managed populations. Feral cat baits were deployed in the Warralong Bilby Land Management Area between 2022-2024 (Harrison et al. 2025).

6.0 Conclusion

The results of the current field survey revealed no recent Bilby activity in the four areas previously known to support the species. A search in an additional area of suitable habitat further south of the Winu DE did not reveal any sign evidence either. Molecular analysis of the four scat samples collected during the current survey had a 50% success rate, with two being successfully genotyped. One record is attributable to an individual identified in the 2024 survey, the other is a previously unidentified individual. The condition of the scat samples upon collection and the absence of other recent evidence in the survey area (fresh diggings, active burrows and/or tracks), strongly suggest that no bilbies were occupying the study area at the time of the survey. Rather, these are representative of individuals occupying the area sometime between the previous survey (May 2024) and the current (October 2025) survey.

Given bilbies' known propensity to move in response to resource availability and environmental variables, it is likely the population still exists and is currently occupying areas outside of the current scope of the study. The alternative hypothesis is that the population has been extirpated; whilst predators are known to occur within the area, the population has persisted since 2019 (and likely for years prior to this), and given no unusually extreme weather events have occurred in the past year, we do not think this to be the case. Future monitoring of the areas of High prospectivity habitat would allow us to verify if the Winu Bilby population returns. Educating on-site personnel on the importance of recording any Bilby sightings is recommended.

7.0 References

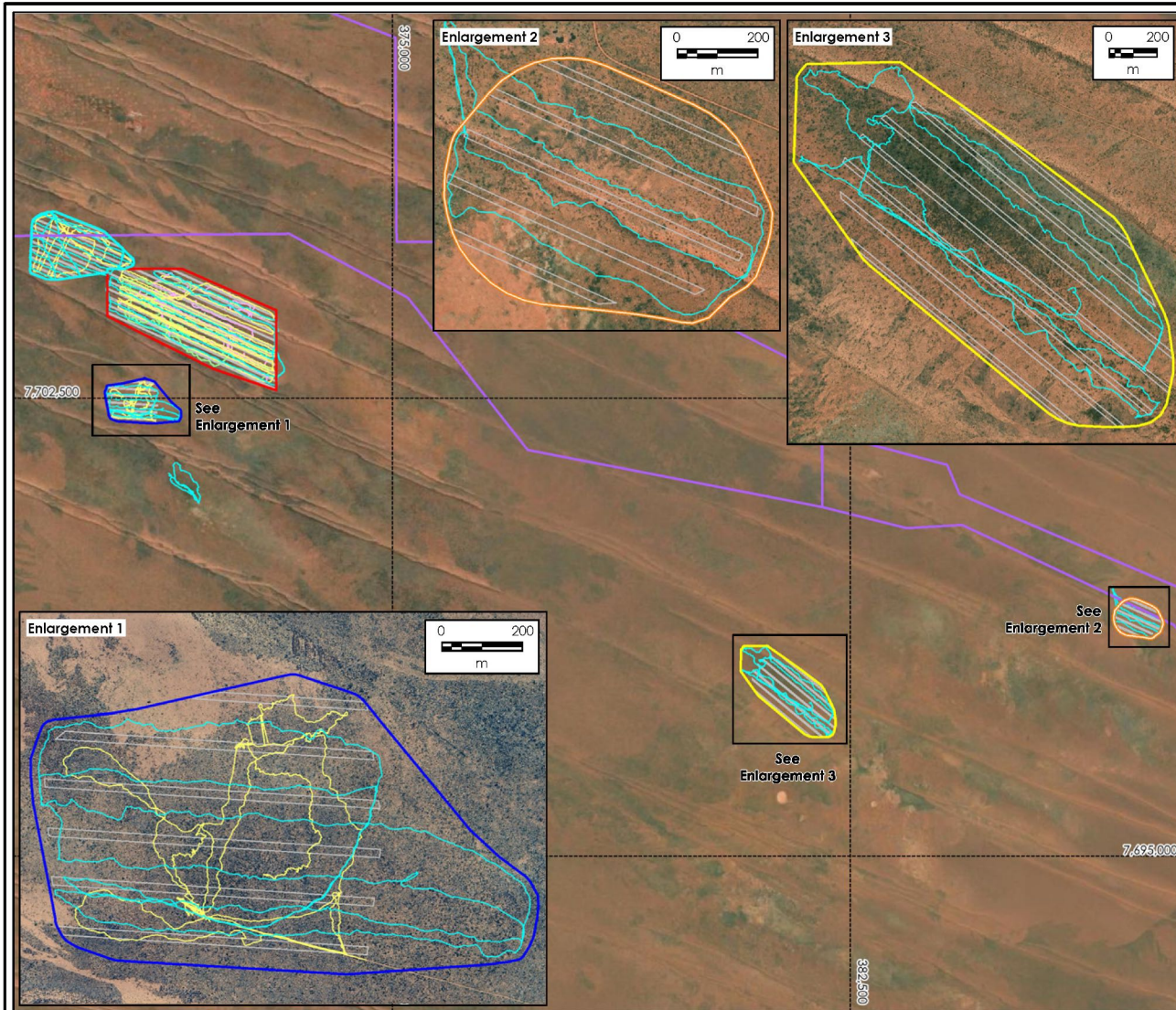
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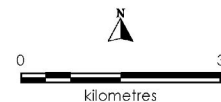
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Appendix 1 All Years Survey Effort Mapping



- Area 0 (A0)
- Additional area 1 (AA1)
- Additional area 2 (AA2)
- Additional area 3 (AA3)
- Additional area 4 (AA4)
- Winu development envelope
- Bilby transect design
- Foot traverse (2025)
- Foot traverse (2024)
- Foot traverse (2022)
- Foot traverse (2019)



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Winu Project Bilby Abundance Study Sampling Effort



Appendix 2 Genotyping Bilby Scat Samples from Winu – Helix Molecular Solutions

Helix

Molecular
Solutions



Genotyping Bilby (*Macrotis lagotis*) Scat Samples from the Winu Project



Prepared for

Biota Environmental
Sciences

November 2025



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Genotyping Winu Bilby (*Macrotis lagotis*) Scat Samples

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1.0 Executive Summary

Helix Molecular Solutions (Helix) was engaged by Biota Environmental Sciences (Biota) to perform DNA extraction, microsatellite amplification and individual genotype identification using faecal (scat) samples suspected to belong to the Greater Bilby (*Macrotis lagotis*).

Suspected bilby scats were collected during a targeted survey in the Winu Project area, where bilby scats have been collected in previous years. The objective of this investigation was to identify unique individuals based on their multilocus genotypes and determine whether these individuals had been detected during previous surveys, or whether they represent 'new' / 'previously undetected' individuals.

DNA was extracted from four separate bilby scat samples, two of which produced DNA of sufficient quality and quantity to yield a clean genotype that was suitable for individual discrimination. Resulting genotypes were assigned to two distinct identity groups, each representing a unique individual.

One individual was new and previously undetected, whilst the other had previously been detected by Helix during the Biota 2024 survey at the Winu Project area (Helix and Biota, 2024). Throughout the four survey phases over the six years (2019, 2022, 2024, 2025), there have been a total of ten individual bilbies (unique genotypes) detected.

2.0 Introduction

2.1 Study Scope

Biota Environmental Sciences (Biota) engaged Helix Molecular Solutions (Helix) to determine the minimum number of individual Bilby (*Macrotis lagotis*) that were represented amongst scat samples collected from the Winu Project area during a single sampling period (10th – 15th October 2025).

This was undertaken by performing DNA extractions on the submitted scat samples, followed by genotyping those that yielded high quality DNA.

3.0 Methods

Scat samples submitted to Helix were stored in a sterile vial in silica-based desiccant to preserve DNA through the provision of a dry environment. These scat samples were medium to large in size and were moderately to very dry in condition upon receipt. Two to three scats (dependent on size and moisture level) were selected from each sample collection for DNA extraction. DNA was extracted and amplified from the four submitted scat samples suspected to belong to the Greater Bilby (*Macrotis lagotis*) (Table 1).

During analysis, reference genetic data were included from previous Biota collections within the Winu Project area to determine if the same individuals were detected across different phases of the survey (see Table 2 - Table 4).

Table 1. **October 2025 Winu Project area Bilby scat sample identification and collection details.**
Shaded cells represent samples that did not produce a useable genotype.

Scat ID	Helix ID	Collection date	Latitude	Longitude
1716N_20251010_AA3_HN-02	WC01	2025-10-10	-20.82083765	121.8651132
1716N_20251010_AA3_HN-03	WC02	2025-10-10	-20.82073872	121.8648234
1716N_20251010_AA3_HN-01	WC03	2025-10-10	-20.82084325	121.8653177
1716N_20251010_AA2_HN-01	WC04	2025-10-10	-20.7741618	121.7581648

Table 2. **Previously genotyped Winu Project area Bilby scat sample identification and collection details from May and July 2024.**
Shaded cells represent samples that did not produce a useable genotype.

Scat ID	Helix ID	Collection date	Latitude	Longitude
1716G.20240514.Scat01MG	TQ01	2024-05-14	-20.773988	121.758867
1716G.20240514.Scat02MG	TQ02	2024-05-14	-20.773596	121.758724
1716G.20240514.Scat03MG	TQ03	2024-05-14	-20.775514	121.758485
1716G.20240514.Scat04MG	TQ04	2024-05-14	-20.775498	121.758322
1716G.20240514.Scat05MG	TQ05	2024-05-14	-20.775205	121.757751
1716G.20240514.Scat06MG	TQ06	2024-05-14	-20.775212	121.757936
1716G.20240515.Scat01OKK	TQ07	2024-05-15	-20.773056	121.7577778
1716G.20240515.Scat02OKK	TQ08	2024-05-15	-20.773333	121.7577778
1716G.20240515.Scat01HN	TQ09	2024-05-15	-20.775612	121.758661
WPC07DS_MG-04	TQ10	2024-07-11	-20.81807396	121.8632568
WPC07DS_MG-03	TQ11	2024-07-11	-20.81790049	121.8624395
WPC07DS_MG-02	TQ12	2024-07-11	-20.81779267	121.8621782
WPC07DS_MG-01	TQ13	2024-07-11	-20.82060455	121.8641743

Scat ID	Helix ID	Collection date	Latitude	Longitude
WPC05DS_MG-01	TQ14	2024-07-10	-20.8145902	121.8578083
WPC02DS_HN-01	TQ15	2024-07-10	-20.80655146	121.9148679
WPC05DS_OKK-01	TQ16	2024-07-10	-20.814964	121.8587919
WPC05DS_OKK-02	TQ17	2024-07-10	-20.8141317	121.8582939

Table 3. Previously genotyped Winu Project area Bilby scat sample identification and collection details from July 2022.

Shaded cells represent samples that did not produce a useable genotype.

Scat ID	Helix ID	Collection date	Latitude	Longitude
S20220719_WAA03BT-01	SA01	2022-07-19	-20.7646475	121.7709263
S20220719_WAA03BT-02	SA02	2022-07-19	-20.766584	121.7753205
S20220719_WAA03BT-03	SA03	2022-07-19	-20.7665963	121.7754804
S20220719_WAA04BT-01	SA04	2022-07-19	-20.7645582	121.7735061
S20220719_WAA06BT-01	SA05	2022-07-19	-20.7618465	121.7729333
S20220719_WAA06BT-02	SA06	2022-07-19	-20.76192697	121.7731446
S20220719_WAA08BT-01	SA07	2022-07-19	-20.7591905	121.772217
S20220719_WAA08BT-02	SA08	2022-07-19	-20.7594693	121.7728629
S20220719_WAA09BT-02	SA09	2022-07-19	-20.7568523	121.7697594
S20220719.WAABT09-01	SA10	2022-07-19	-20.7583271	121.7727307
S20220719_WAA10BT-01	SA11	2022-07-19	-20.757588	121.7740931
S20220719_WAA10BT-02	SA12	2022-07-19	-20.7572303	121.7730023
S20220721.WAABO_rdv01-01	SA13	2022-07-21	-20.7632194	121.7732889
S20220721.WAABOPP_jke-01	SA14	2022-07-21	-20.7624495	121.773845
S20220721.WAABOPP_jke-02	SA15	2022-07-21	-20.7623018	121.7738011
S20220719.WAABTopp02-01	SA16	2022-07-19	-20.7572932	121.7696761
S20220719.WAABTopp03-01	SA17	2022-07-19	-20.75256241	121.8050556
S20220719.WAAopp-01_01.	SA18	2022-07-19	-20.76060883	121.763003

Table 4. Previously genotyped Winu Project area Bilby scat sample identification and collection details from September 2019.
Shaded cells represent samples that did not produce a useable genotype.

Scat ID	Helix ID	Collection date	Latitude	Longitude
S20190923.WINWBT07-01	PM12	2019-09-23	-20.7566412	121.7634752
S20190923.WINWBT07-02	PM13	2019-09-23	-20.7568333	121.7639071
S20190923.WINWBT07-03	PM14	2019-09-23	-20.7569615	121.7642162
S20190923.WINWBT07-04	PM15	2019-09-23	-20.7570847	121.764444
S20190923.WINWBT07-05	PM16	2019-09-23	-20.7570938	121.7645487
S20190923.WINWBT07-06	PM17	2019-09-23	-20.7585271	121.7678107
S20190923.WINWBT08-01	PM18	2019-09-23	-20.7582497	121.769879
S20190923.WINWBT08-02	PM19	2019-09-23	-20.7570561	121.7673443
S20190923.WINWBT01-01	PM20	2019-09-23	-20.7673683	121.7717549
S20190923.WINWBT01-02	PM21	2019-09-23	-20.7669568	121.7707239
S20190923.WINWBT01-03	PM22	2019-09-23	-20.7663859	121.7692259
S20190923.WINWBT02-01	PM23	2019-09-23	-20.7606075	121.75888
S20190923.WINWBT02-02	PM24	2019-09-23	-20.7621728	121.7623916
S20190923.WINWBT02-03	PM25	2019-09-23	-20.7659524	121.7712529
S20190923.WBT06-01	PM26	2019-09-23	-20.7604802	121.7695682
S20190923.WBT06-02	PM27	2019-09-23	-20.75747578	121.7628321
S20190923.WBT06-03	PM28	2019-09-23	-20.75686129	121.761419
S20190923.WBT05-01	PM29	2019-09-23	-20.76185487	121.7699319
S20190923.WBT04-01	PM30	2019-09-23	-20.7603867	121.7637985
S20190923.WBT04-02	PM31	2019-09-23	-20.7598171	121.7627399

3.1 DNA Extraction, PCR Amplification and Fragment Sizing

All scat samples submitted to Helix were extracted using the QIAGEN QIAamp Fast DNA Stool mini kit (Qiagen, Hilden, Germany, cat. no. 51604). Samples were washed in buffer as per Carpenter et al. (2017), followed by an incubation in the buffer solution overnight to allow for the maximum recovery of DNA, and then eluted as per the manufacturer's protocols ("Isolation of DNA from Stool for Pathogen Detection" (Qiagen, Feb 2020)).

Seven microsatellite loci (Moritz et al., 1997 and Smith et al., 2009, see Table 5) were amplified using the QIAGEN Multiplex PCR kit in triplicate. Polymerase Chain Reaction (PCR) products were analysed on an ABI3730XL Sequencer using Genescan-500 LIZ internal standard and scored using the software Geneious Prime® version 2024.0.7. Individual genotypes were based on molecular weights.

Table 5. Summary information for the seven microsatellite loci used on the bilby scat samples in all project phases.
T optimal annealing temperature, *B_p* allele size range.

Loci	Repeat bases	Primer sequences (5' - 3')	<i>T</i>	<i>B_p</i>
B22	(CA) ₁₆	F: GGT ATG AGG AAT TAG AAT TAC AGG	55	183-197
		R: CGG TAT TAA ATG GGC TAT GGA GT		
B63	(CA) ₁₄	F: CTT AGG CAA ATA GGG TGA AGT GG	55	232-268
		R: CAG AAC CAT TAG GAA GGA GTT TC		
B41	(CA) ₁₄	F: TGA CTT TCT TTT GCT ACA ACA ACC	55	171-191
		R: GGA AAA GTT TTT AGC CTA ATA GTG G		
B55	(CA) ₂₄	F: GCA CCA ACC TAT CCT CTT CAT TC	55	184-196
		R: CTA CAA GTC TGA TAA TTC CAG GC		
B02	(CA) ₁₇	F: GCA TGT ACT TAA CCC CCT TTG CC	55	170-183
		R: CCC GAC AAT CCA GCC TGT TAT TC		
B17	(CA) ₁₆	F: AGC CTG TGT GTC TTA AAA TGC	55	212-229
		R: CTC CAA TTC ACT TTT CCT GAG AC		
B56	(CA) ₂₃	F: CACACTTATACATACACGTACACG	55	157-170
		R: CAC TAA CAA ATA TGC TTG GGA AAG G		

3.2 Genetic Diversity Analyses

Genotype discrimination was performed using *R* software (R core team, 2022). The *R* package ‘poppr’ (Kamvar et al. 2014) was used to construct an accumulative genotype curve to assess whether the number of loci was sufficient to differentiate unique ‘multilocus genotypes’ (MLGs) from the genetic data of unknown individuals. Loci were randomly sampled until $n - 1$ loci (n being the total number of loci) and the number of observed genotypes were counted with each iteration. A distribution for each locus was generated by resampling 10,000 times without replacement. A plateau point in the curve indicated that the corresponding loci are sufficient to accurately describe the number of MLGs in the data (Kamvar et al. 2015). The ‘allelematch’ (Galpern et al., 2012) package was then used to discriminate between the identified MLGs and assign them to ‘genotype identity groups’, each of which equates to an individual animal. Assignment was confirmed through manual appraisal of the genetic data.

Verification of data quality and basic population genetic statistics were generated using *R* software (R core team, 2022) and the Excel add-in GenAlEx version 6.5 (Peakall and Smousse, 2006, 2012). All unique individuals collected across the four sampling years were included in the following analyses and any duplicate individuals were excluded:

- the *R* package ‘PopGenReport’ (Adamack and Gruber, 2017) was used to assess the data quality in the form of ‘null alleles’, with the frequency of null alleles determined per locus using the method of Brookfield (1996);
- departures from Hardy-Weinberg equilibrium (*HWE*) were assessed for each locus and each sampling year with the *R* package ‘pegas’ (Paradis, 2010), using an exact test with 1,000 Monte Carlo permutations and $\alpha = 0.05$;
- the *R* package ‘poppr’ (Kamvar et al. 2014) was used to evaluate the level of missing data; and
- GenAlEx (Peakall and Smousse, 2006; 2012) was used to calculate the number of alleles (N_A), number of effective alleles (N_E), observed and unbiased expected heterozygosities (H_O and uH_E respectively), the Information index (I) and the inbreeding coefficient (F_{IS}).

4.0 Results

Seven loci were successfully amplified in two of the four scat samples. Genotyping fails were associated with those samples of a 'dry and crumbly' consistency - a presentation likely resulting from extended exposure to the DNA degradative effects of the sun's ultraviolet radiation. The two resulting (successful) sample genotypes were combined with those generated during prior collections for analysis.

All seven loci were polymorphic and conformed to Hardy-Weinberg equilibrium. No null alleles were detected. The genotype accumulation curve indicated five loci were sufficient to accurately discriminate the number of unique individuals in this dataset (Figure 1); as such, sample genotypes of less than five loci were excluded from all further analyses (see Table 1 - Table 4).

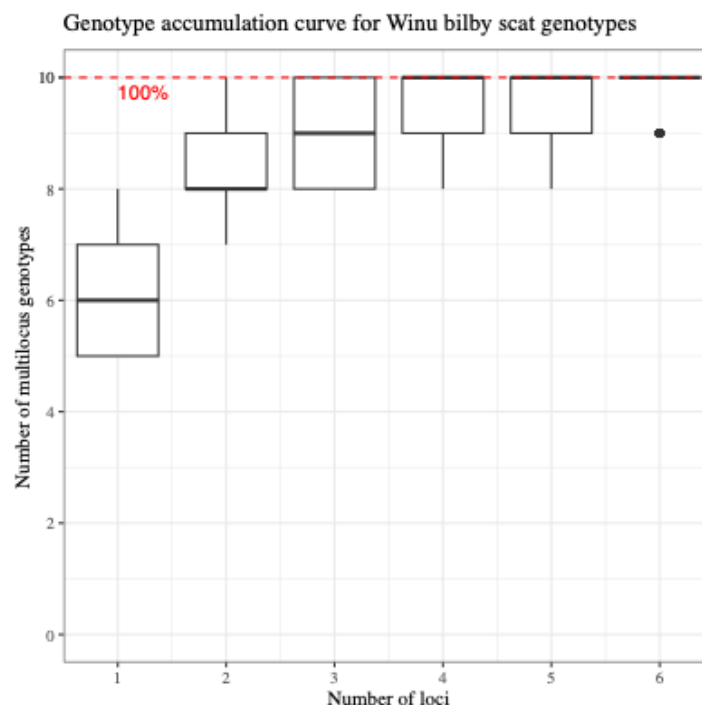


Figure 1. Multilocus genotype curve used to determine the required number of loci for identification of unknown individuals from scat samples. Dotted line (---) depicts 100% discrimination of genotypes.

Missing data was insignificant and averaged 5% due to the inclusion of two individuals missing data from two loci (PM14, TQ17). The number of alleles (N_A) observed across the seven loci ranged from four to seven and averaged 5.71 (± 0.36) alleles (see Table 6). The number of effective alleles was relatively lower, ranging from 2.71 (locus 'B41') – 4.17 (locus 'B55') with an average of 3.52 (± 0.23) effective alleles (N_E) (see Table 6).

The information index (I) was moderate and averaged 1.42 (± 0.06) across loci (see Table 6). Observed (H_o) and unbiased expected (uH_e) heterozygosity's were similar and high, averaging approximately 75% (mean $H_o = 0.76 \pm 0.05$, mean $uH_e = 0.74 \pm 0.02$). No inbreeding was detected, exemplified by an inbreeding coefficient (F_{IS}) estimate close to zero (mean $F_{IS} = -0.07 \pm 0.06$).

Table 6. Genetic diversity statistics generated from the seven microsatellite loci for the unique Bilby genotypes ($n = 10$), collected by Biota from the Winu Project area.
 N_A – number of alleles, N_E – number of effective alleles, I – information index, F_{IS} – inbreeding coefficient, H_o – observed heterozygosity, uH_e – unbiased expected heterozygosity.

Loci	N_A	N_E	I	F_{IS}	H_o	uH_e
B55	6.00	4.17	1.57	-0.20	0.91	0.80
B22	6.00	2.80	1.32	0.09	0.58	0.67
B63	7.00	3.77	1.56	0.18	0.60	0.77
B41	6.00	2.72	1.24	-0.19	0.75	0.66
B02	4.00	3.17	1.21	-0.22	0.83	0.71
B17	6.00	4.00	1.54	-0.20	0.90	0.79
B56	5.00	4.03	1.49	0.03	0.73	0.79
Mean	5.71 ± 0.36	3.52 ± 0.23	1.42 ± 0.06	-0.07 ± 0.06	0.76 ± 0.02	0.74 ± 0.02

The two genotyped samples from the current October 2025 collection were assigned to two separate genotype identity groups, each representing a unique individual (Table 7). One genotype was newly detected and assigned the genotype identity ‘J’ (Table 7). The other, genotype ‘I’, had previously been detected in the 2024 collection and has now been detected a total of two times (Table 7).

When all four survey phases (2019, 2022, 2024 and 2025) for the project area are considered, a total of ten individual bilbies have been identified from the total 59 scat samples. Three individuals are unique to the 2019 collection (genotype IDs ‘E’, ‘F’ and ‘G’), two are unique to the 2024 collection (genotype IDs ‘C’ and ‘H’) and the newly detected genotype ID ‘J’ is unique to the 2025 collection (see Table 7). Genotypes detected across multiple phases indicate the persistence of individuals and encompass genotype IDs ‘A’ and ‘B’ in 2019 and 2022, genotype ID ‘D’ in 2022 and 2024, and genotype ID ‘I’ in 2024 and 2025 (Table 7).

Table 7 Bilby scat identifiers, number of genotyped loci and genotype identity group assignment for scat samples collected across the Winu Project area during four sampling phases (2019, 2022, 2024, 2025).

Scat Vial ID	Latitude	Longitude	Helix ID	Genotyped loci	Genotype ID
1716N_20251010_AA3_HN-02	-20.8208	121.8651	WC01	0	-
1716N_20251010_AA3_HN-03	-20.8207	121.8648	WC02	7	I
1716N_20251010_AA3_HN-01	-20.8208	121.8653	WC03	0	-
1716N_20251010_AA2_HN-01	-20.7742	121.7582	WC04	7	J
1716G.20240514.Scat01MG	-20.7740	121.7589	TQ01	7	D
1716G.20240514.Scat02MG	-20.7736	121.7587	TQ02	7	D
1716G.20240514.Scat03MG	-20.7755	121.7585	TQ03	3	-
1716G.20240514.Scat04MG	-20.7755	121.7583	TQ04	7	D
1716G.20240514.Scat05MG	-20.7752	121.7578	TQ05	0	-
1716G.20240514.Scat06MG	-20.7752	121.7579	TQ06	7	D
1716G.20240515.Scat01OKK	-20.7731	121.7578	TQ07	0	-
1716G.20240515.Scat02OKK	-20.7733	121.7578	TQ08	0	-
1716G.20240515.Scat01HN	-20.7756	121.7587	TQ09	7	D
WPC07DS_MG-04	-20.8181	121.8633	TQ10	0	-

Scat Vial ID	Latitude	Longitude	Helix ID	Genotyped loci	Genotype ID
WPC07DS_MG-03	-20.8179	121.8624	TQ11	0	-
WPC07DS_MG-02	-20.8178	121.8622	TQ12	3	-
WPC07DS_MG-01	-20.8206	121.8642	TQ13	7	H
WPC05DS_MG-01	-20.8146	121.8578	TQ14	7	H
WPC02DS_HN-01	-20.8066	121.9149	TQ15	7	I
WPC05DS_OKK-01	-20.8150	121.8588	TQ16	7	H
WPC05DS_OKK-02	-20.8141	121.8583	TQ17	5	H
S20220719_WAA03BT-01	-20.7646	121.7709	SA01	0	-
S20220719_WAA03BT-02	-20.7666	121.7753	SA02	6	-
S20220719_WAA03BT-03	-20.7666	121.7755	SA03	7	F
S20220719_WAA04BT-01	-20.7646	121.7735	SA04	7	A
S20220719_WAA06BT-01	-20.7618	121.7729	SA05	1	-
S20220719_WAA06BT-02	-20.7619	121.7731	SA06	7	A
S20220719_WAA08BT-01	-20.7592	121.7722	SA07	7	E
S20220719_WAA08BT-02	-20.7595	121.7729	SA08	7	G
S20220719_WAA09BT_JK-01	-20.7569	121.7698	SA09	7	E
S20220719.WAABT09-01	-20.7583	121.7727	SA10	6	A
S20220719_WAA10BT-01	-20.7576	121.7741	SA11	7	A
S20220719_WAA10BT-02	-20.7572	121.7730	SA12	7	D
S20220721.WAABO_rdv01-01	-20.7632	121.7733	SA13	7	B
S20220721.WAABOPP_jke-01	-20.7624	121.7738	SA14	7	A
S20220721.WAABOPP_jke-02	-20.7623	121.7738	SA15	7	A
S20220719.WAABTopp02-01	-20.7573	121.7697	SA16	0	-
S20220719.WAABTopp03-01	-20.7526	121.8051	SA17	7	D
S20220719.WAAopp-01_01.	-20.7606	121.7630	SA18	0	-
S20190923.WINWBT07-01	-20.7566	121.7635	PM12	0	-
S20190923.WINWBT07-02	-20.7568	121.7639	PM13	7	A
S20190923.WINWBT07-03	-20.7570	121.7642	PM14	5	C
S20190923.WINWBT07-04	-20.7571	121.7644	PM15	4	-
S20190923.WINWBT07-05	-20.7571	121.7645	PM16	4	-
S20190923.WINWBT07-06	-20.7585	121.7678	PM17	4	-
S20190923.WINWBT08-01	-20.7582	121.7699	PM18	7	B
S20190923.WINWBT08-02	-20.7571	121.7673	PM19	7	A
S20190923.WINWBT01-01	-20.7674	121.7718	PM20	0	-
S20190923.WINWBT01-02	-20.7670	121.7707	PM21	0	-
S20190923.WINWBT01-03	-20.7664	121.7692	PM22	7	B
S20190923.WINWBT02-01	-20.7606	121.7589	PM23	3	-
S20190923.WINWBT02-02	-20.7622	121.7624	PM24	5	-
S20190923.WINWBT02-03	-20.7660	121.7713	PM25	7	A

Scat Vial ID	Latitude	Longitude	Helix ID	Genotyped loci	Genotype ID
S20190923.WBT06-01	-20.7605	121.7696	PM26	7	A
S20190923.WBT06-02	-20.7575	121.7628	PM27	0	-
S20190923.WBT06-03	-20.7569	121.7614	PM28	7	A
S20190923.WBT05-01	-20.7619	121.7699	PM29	7	A
S20190923.WBT04-01	-20.7604	121.7638	PM30	0	-
S20190923.WBT04-02	-20.7598	121.7627	PM31	0	-

5.0 Discussion

Scat DNA extraction and genotype assignment has proven successful for determining the minimum number of unique bilby individuals detected from secondary evidence (scat samples) from the Winu Project area.

Genotyping was based on seven variable and informative loci. Analyses determined that at least five loci are required for accurate discrimination between individual genotypes, due to the genetic diversity of the bilby individuals and the variability of the microsatellite loci. Two of the four submitted scat samples produced good quality genomic DNA with a high amplification success rate of all seven loci.

Two unique individuals were detected and assigned the genotype identification codes '*I*' and '*J*'. Individual '*I*' had been previously detected from the 2024 samples from the project area, while Individual '*J*' is new and not previously detected. When all ten unique individuals detected across the four project phases are considered, genetic diversity of the sampled bilby population is high and inbreeding is negligible.

6.0 References

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