Bennelongia
Environmental Consultants

Woodie Woodie Short-Range Endemic Invertebrates

Prepared for:

Consolidated Minerals Pty Ltd

February 2022

Final Report

Short-Range Endemics I Subterranean Fauna

Waterbirds I Wetlands

Woodie Woodie Short-Range Endemic Invertebrates

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EXECUTIVE SUMMARY

The Woodie Woodie Mine and associated Woodie Continued Operations Project is owned and operated by Pilbara Manganese Pty Ltd, a wholly owned subsidiary of Consolidated Minerals Pty Ltd (CML). The Project involves the extension of the current approved operational boundary (Active Mining Area) to the north, south and west, increasing the current Clearing Permit Boundary area from 7,589 hectares (ha) to create a Development Envelope of 12,708 ha. The Project is located approximately 160 km southeast of Marble Bar, in the Eastern Pilbara region of Western Australia. The mine is currently operational with approved activities set to continue until 2028.

The Environmental Protection Authority requires that CML considers the risk of the Project to short-range endemic invertebrates (SREs). This report provides the results of desktop and field surveys to determine the conservation values of SREs, as well as other conservation-listed terrestrial invertebrates, that may occur in the vicinity of the Study Area. An assessment is made of the potential impacts of the Project on SRE or listed terrestrial invertebrate species.

For the purposes of the current work the 'Study Area' refers to an area surrounding planned developments within a Development Envelope. Woodie Woodie is an existing mine comprising active pits, dumps, hauls roads and associated infrastructure. Planned developments are collectively referred to as the 'Indicative Footprint'. The Development Envelope also contains non-disturbance areas, and is smaller than the total Study Area.

The desktop assessment of SRE fauna and habitats in the vicinity of Woodie Woodie found a paucity of terrestrial invertebrate collections, but showed that prospective habitat for SREs exists in the Study Area - gorges and rocky outcrops.

A detailed survey was undertaken and recorded 76 species belonging to SRE groups of which 51 species are recorded for the first time in this study. Pseudoscorpions were the most abundant group, followed by isopods/slaters, then snails (mostly represented by dead shells), millipedes, mygalomorph spiders, centipedes, scorpions and selenopid and hersiliid araneomorph spiders. Twenty-two species are not SREs, 18 new species are unlikely to be SREs due to their family biology and occurrence in habitats that are not prospective for SREs, and 36 species are potential SREs.

Habitat assessments in conjunction with collections across Woodie Woodie identified six habitat types of which two typical SRE habitats (gorges and rocky outcrops) are present. The Indicative Footprint proposes to remove 25.6 ha (6.16% of what occurs in the Study Area) of this habitat type, which should not significantly threaten the persistence of any species that utilise it.

One of the 36 potential SRE species was initially collected only from within the Indicative Project Footprint. This species, Chernetidae `BPS364`, was first found in a creekline that is connected to major creeklines towards the northwest of the Study Area. The vegetation type at the site where this species was first collected consists of mid sparse shrubland of mixed species dominated by *Acacia arida* over low sparse shrubland of mixed species and open hummock grassland dominated by *Triodia wiseana*. When this vegetation type intersects creeklines, isolated trees of *Corymbia* are present, and Chernetidae `BPS364` was originally collected from peeling the bark of one of these trees. Targeted sampling in other areas in the Development Envelope, specifically where the vegetation type described above intersects creeklines, was done between the 8th and 15th of October 2021. This resulted in the collection of two additional specimens of Chernetidae `BPS364` (confirmed genetically) in habitat outside the Indicative Footprint of the Project, demonstrating that the distribution of this species extends towards the northwest of the Study Area, as predicted.

The other 35 species of potential SREs all have at least some occurrences outside the proposed mine pits and mine infrastructure.

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1. INTRODUCTION

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2. SRE FRAMEWORK

SRE species are defined as having an overall range of less than 10,000 km^2 (Harvey 2002). They tend to exhibit patchy distributions within their range, slow growth, low fecundity and poor dispersal capabilities. The assessment of SRE invertebrates in Western Australia, as prescribed by the Environmental Protection Authority (EPA 2016a, b), typically focuses on a number of taxonomic groups (the SRE Groups) that are known to contain high proportions of SRE species. These include land snails (Gastropoda); millipedes (Diplopoda); centipedes (Chilopoda); pseudoscorpions (Pseudoscorpiones); scorpions (Scorpiones); spiders [Araneae, mainly Mygalomorphae (trapdoor spiders), but also some modern spider families such as Lycosidae and Selenopidae]; slaters (Isopoda) and harvestmen (Opiliones). Some other groups, such as velvet worms (Onychophora) and earthworms (Oligochaeta), also contain high proportions of SRE species but are restricted to mesic environments and so are not considered here.

Species with restricted ranges also occur in groups mostly containing species that are widespread due to high vagility, ecological plasticity or xeric adaptation (Framenau *et al.* 2008; Rix *et al.* 2015) and, conversely, many species belonging to SRE Groups are in fact widespread. Determining whether or not a species belonging to an SRE Group actually has a significantly restricted range (notionally <10,000 km^2) is often difficult. However, the distribution of an SRE Group species is likely to be confined to the extent of its preferred or obligate habitat(s), so that species that are only found in restricted or patchy habitats usually have smaller ranges than those collected from extensive or common habitats. Most SRE species occur in habitats that have patchy occurrences. An additional constraint is that in some groups there may be some species turnover, often linked to climatic gradients, in widespread habitats that results in a species occupying only part of a widespread habitat and, therefore, being an SRE (Rix *et al.* 2015).

Determination of the SRE status of the species listed in this desktop review is based on the SRE classification system of the Western Australian Museum (WAM; Section 2.1). For example, detailed habitat information is not always available for species in WAM databases, so habitat information cannot always be used to predict distributions. The factors considered when evaluating the SRE status of each species in this report were the known range of the species, habitat(s) at the collection location(s) and the spatial extent and connectivity of these habitats.

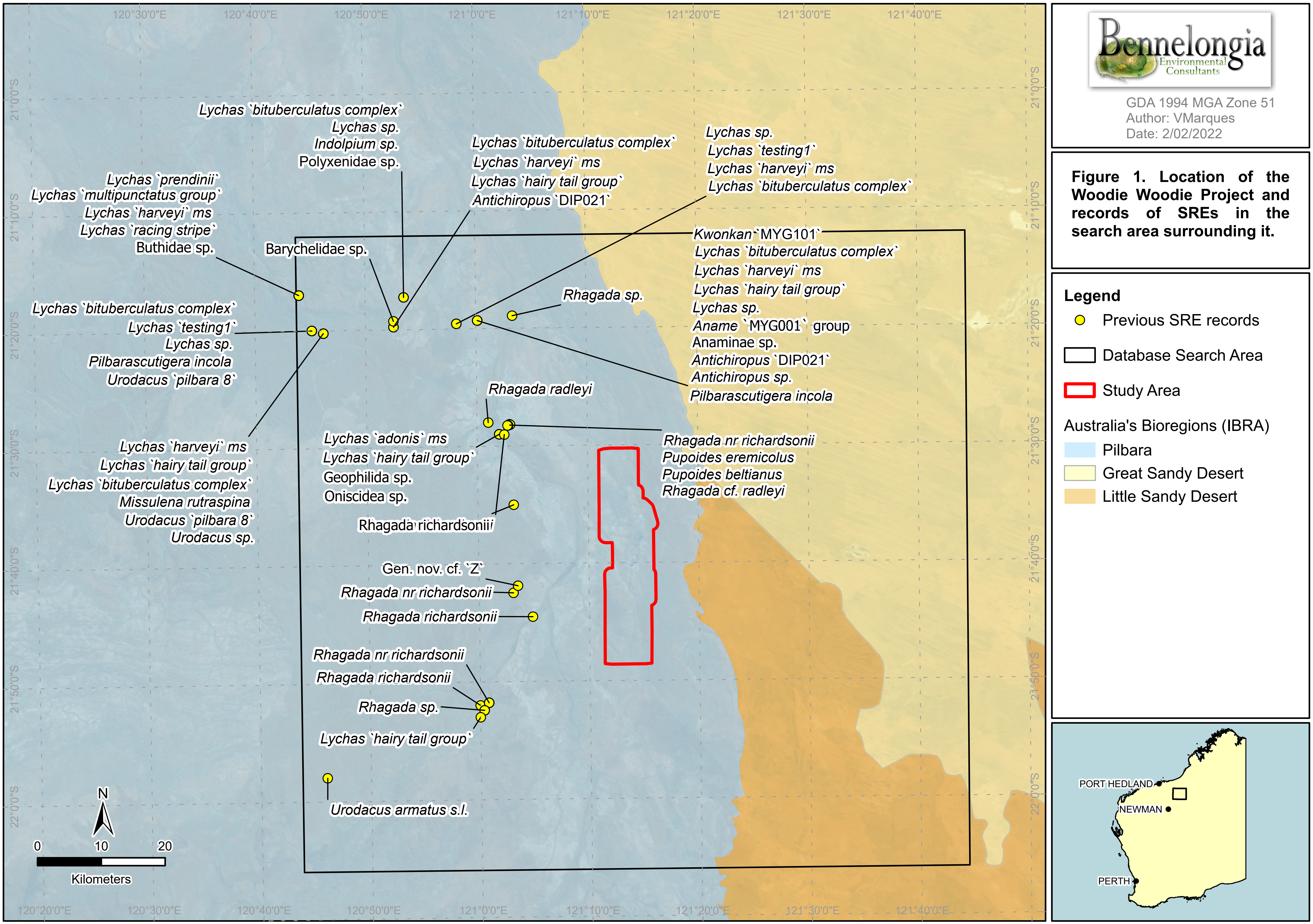


Figure 1. Location of the Woodie Woodie Project and records of SREs in the search area surrounding it.

Species are considered 'widespread' if their known, or likely range, exceeds 10,000 km^2. However, even restricted species may be locally widespread around a project area. Thus, identifying SRE species is only the first part of a filtering process used to determine whether species may be threatened by a development. The actual level of threat to an SRE species depends on its range relative to the development footprint rather than SRE status alone. Determining the likely level of threat to a species requires consideration of the extent of the species' preferred habitat, both locally and regionally, as well as the area of disturbance.

2.1. Classifying SRE Species

A five-tier classification scheme for SRE species was used that is a modification of the system used by the Western Australian Museum (WAM):

Confirmed SREs are species with a well surveyed range of <10,000 km^2.

Potential SREs are species with imperfectly understood ranges because sampling has been patchy. In some cases, the uncertainty about range is compounded by an incomplete taxonomic framework.

Unlikely SRE species includes potentially new species that do not possess the traits of a SRE species (i.e. biological or habitat factors). For example, this subcategory may include species recorded during a survey from one or more habitat types that have low prospectivity for SREs or species possessing very few morphological features typical of SREs.

Not SRE species have a known range of >10,000 km^2. The taxonomy of such species should be well understood, so as not to include the ranges of multiple closely related species in the range estimate.

Unknown taxa are usually higher-level identifications (possibly due to immature specimens) or identifications of species complexes where there have been recent revisions that make it unclear what species was originally collected.

The museum divides Potential SREs into five sub-categories that provide some information about why the species is treated as a Potential SRE (definitions are paraphrased here). The categories are:

1. Data deficient: There are insufficient data available to determine SRE status, because of few collecting records (and a belief sampling for the species has been geographically restricted) or uncertain identifications;
2. Habitat Indicators: The status of a species as an SRE (or not) may be inferred using its association with a particular habitat;
3. Morphological Indicators: The status of a species may be inferred using its morphological characteristics;
4. Molecular Evidence: DNA sequence data may reveal patterns congruent or incongruent with SRE status for a species; and
5. Research & Expertise: Available research data and/or WAM expertise may suggest the species is likely (or not) to be an SRE.

3. DESKTOP REVIEW

The desktop component of this report reviewed previous records of terrestrial invertebrates and habitat information, including geology and vegetation mapping, to examine the possibility of SRE or conservation listed invertebrate species occurring in the vicinity of the Study Area and to assess the requirement for field survey.

3.1. SRE Fauna of the Pilbara

The Pilbara is one of the oldest land surfaces on earth (Pillans 2007) and supports very diverse communities of SRE fauna (e.g. Castalanelli *et al.* 2014; Harvey 2002; Rix *et al.* 2017b). Knowledge of these communities is derived in part from surveys undertaken as part of environmental impact assessments and biological studies in the Pilbara, primarily the Pilbara Biodiversity Survey, a systematic, broad-scale survey for ground-dwelling terrestrial fauna that included four groups of invertebrates (ants, beetles, scorpions and spiders) in addition to mammals, birds, reptiles and aquatic fauna (Gibson *et al.* 2015). The general richness of the Pilbara is thought to derive from the formation of the Australian arid zone during the Neogene, which resulted in extinctions or range contractions of mesic-adapted fauna and diversification and range expansion of arid-adapted taxa (Rix *et al.* 2017a). The Pilbara Biodiversity Survey found the pattern of turnover of terrestrial fauna most strongly related to environmental variables associated with regolith, followed by landform/hydrologic and then by climate/biotic variables. Scorpions and beetles showed strong relationships with soil attributes (Gibson *et al.* 2015) and Gollan *et al.* (2009) identified soil parameters as important predictors of invertebrate assemblages in the Pilbara. Some so-called relictual groups persist only in local refugia but several other groups have undergone extensive radiations and are highly diverse at the species level (Car and Harvey 2013; Car *et al.* 2013).

Six diverse families of trapdoor spiders reliably occur in the Chichester subregion of the Pilbara (where Woodie Woodie is located), including Actinopodidae, Barychelidae, Halonoproctidae, Idiopidae, Anamidae, and Theraphosidae. Many of the recorded species are known only from very few specimens and localities, and have small distributions with high levels of endemism (Castalanelli *et al.* 2014; Harms and Framenau 2013; Main 1983, 1986, 2008; Raven 1994). Although a few trapdoor species appear to have ranges beyond 100 km^2, cryptic speciation is evident (Castalanelli *et al.* 2014) and all species should be treated as potential SREs, until there is evidence for more widespread distributions. Some of the idiopid and barychelid genera (e.g. *Idiosoma* and *Synothele*) include dozens of species, most of which are currently undescribed (e.g. Rix *et al.* 2017b). Wall-crab spiders of the family Selenopidae are also diverse, and endemic species have been collected from under rocks in isolated BIF formations and rocky ridges (Crews and Harvey 2011; Crews 2013).

The myriapod (millipede and centipede) fauna is diverse, with two genera being of conservation significance. All described species of *Antichiropus* and *Boreohersperus* are SRE species and have ranges of less than 10,000 km^2 (Car and Harvey 2013; Car *et al.* 2013). The centipede fauna is poorly known but the families Geophilidae and Cryptopidae are collected frequently during invertebrate surveys and contain at least some potential SREs.

Terrestrial slaters are common in woodlands, BIF formations and creekline habitats. Genera such as *Buddelundia* are megadiverse at a species level, although there is no taxonomic framework for terrestrial slaters in Western Australia, so the assessment of ranges is extremely difficult (Judd and Horwitz 2003). Slaters are collected in almost every invertebrate fauna survey in the WA and are one of the prime target groups in SRE assessments.

Terrestrial snails are also collected frequently during fauna surveys in the Pilbara. Genera from the Pupillidae family (*Gastrocopta* and *Pupoides*) contain widespread species (Whisson and Köhler 2013), but the families Camaenidae and Bothriembryontidae (the latter with many undescribed species) are extremely diverse at the species level and comprise mostly SREs (Breure and Whisson 2012; Hamilton and Johnson 2015; Köhler and Criscione 2015; Solem 1997; Stankowski and Johnson 2014; Whisson and Kirkendale 2014b). The snail genus *Bothriembryon,* in particular, is currently the focus of systematic study and it appears that there is major diversity and endemism in this fauna. The Succineidae also occur in the Pilbara, but little is known about species ranges.

Harvestmen, pseudoscorpions and scorpions occur throughout the Pilbara. Amongst scorpions, the genus *Urodacus* includes a moderately high proportion of potential SRE species because there are a number of species living under rocks that may be restricted to specific BIF ranges and have patchy distributions within these habitats. In contrast, the genus *Lychas* predominantly comprises widespread species on plains and open woodlands. The pseudoscorpion genera *Synsphyronus* and *Feaella* include many range restricted species (all in the case of *Feaella*) and they live under rocks on BIFs, rocky outcrops and granites, with species of *Synsphyronus* collected from tree bark currently considered more widespread (Harvey 1987, 2012; Harvey *et al.* 2016; Harvey *et al.* 2015). Genera such as *Austrochthonius*, *Austrohorus* and *Amblyolpium* are thought to include at least some SRE species. Olpiidae pseudoscorpions are not usually regarded as SREs because they are good dispersers (Cosgrove *et al.* 2016; i.e. phoresy with flying insects) and Pilbara species appear to be highly arid adapted. Not much is known about harvestmen in the Pilbara, but based on biological characteristics (moisture-dependence, restriction to leaf litter habitats), this fauna will probably include SREs (Harvey 2002).

3.2. Previously Recorded Species near the Study Area

Previous records of SREs in the vicinity of the Study Area were collated and evaluated to clarify the likelihood of SRE species occurring in and around the Study Area. Records were obtained from Bennelongia's internal database, within a search area of approximately 100 km x 100 km encompassing the Study Area (defined by 21.20°S 120.73°E and 22.10°S 121.74° E). Published research papers (Car *et al.* 2019; Car *et al.* 2013; Castalanelli *et al.* 2014; Crews and Harvey 2011; Crews 2013; Hamilton and Johnson 2015; Harms and Framenau 2013; Harvey 1987, 1991, 2010, 2012; Harvey *et al.* 2016; Harvey *et al.* 2020; Judd and Horwitz 2003; Raven 1994; Rix *et al.* 2017a; Rix *et al.* 2015; Rix *et al.* 2017b; Whisson and Kirkendale 2014a), available environmental reports and online resources such as the Atlas of Living Australia (ALA 2017) and the Australian Faunal Directory (ABRS 2009) were also reviewed. The search area included areas that are geologically analogous to the Study Area.

Approximately 25 species from SRE Groups have been recorded in the search area (Table 1 and Figure 1). The number of species is approximate because some listed taxa may belong to the same species, while others may consist of multiple species. A portion of the recorded species are described, whilst many are morphospecies, unpublished manuscript names and higher-order identifications. Higher-order identifications that do not appear likely to comprise a unique species were not included in the final list of recorded species and are instead outlined in Appendix 9.1. The SRE Groups recorded were mygalomorph spiders, pseudoscorpions, scorpions, centipedes, millipedes, land snails and slaters. Figure 1 illustrates the distribution of previously recorded species.

Three species considered to be SREs at the time of collection are known only from the desktop search area. *Lychas `prendinii`* and *Lychas `racing stripe`* have both have been recorded from a single location. The third species, *Antichiropus `DIP021`*, has a linear range of 13 km.

Table 1. Previously recorded species from SRE groups within a search area surrounding the Study Area. The species with pink highlight are only known from the search area.

Higher Classification	Lowest Identification	No. of Records	Distribution
ARTHROPODA			
Arachnida			
Araneae			
Actinopodidae	*Missulena rutraspina*	1	Pilbara
Barychelidae	Barychelidae sp.	1	n/a, higher order identification
Anamidae	*Aname* `MYG001` group	1	Pilbara
	Kwonkan `MYG101`	1	Pilbara
Pseudoscorpiones			
Olpiidae	*Indolpium* sp.	1	n/a, higher order identification
Scorpiones			
Buthidae	*Lychas* `adonis` ms	7	WA
	Lychas `bituberculatus complex`	9	Pilbara

Higher Classification	Lowest Identification	No. of Records	Distribution
	Lychas `hairy tail group`	6	Pilbara
	Lychas `harveyi` ms	11	Pilbara, Gascoyne
	Lychas `multipunctatus group`	1	Pilbara
	Lychas `prendinii`	3	Known only from search area
	Lychas `racing stripe`	1	Known only from search area
	Lychas `testing1`	3	Pilbara
Urodacidae	*Urodacus* `pilbara 8`	3	Pilbara
	Urodacus armatus s.l.	1	n/a, species complex
Chilopoda			
Geophilida	Geophilida sp.	1	n/a, higher order identification
Scutigeromorpha			
Scutigeridae	*Pilbarascutigera incola*	6	WA
Diplopoda			
Polydesmida			
Paradoxosomatidae	*Antichiropus* `DIP021`	4	Known only from search area
Polyxenida			
Polyxenidae	Polyxenidae sp.	1	n/a, higher order identification
Malacostraca			
Isopoda	Oniscidea sp.	1	n/a, higher order identification
MOLLUSCA			
Gastropoda			
Camaenidae	Gen. nov. cf. `Z`	1	n/a, unknown taxon
	Rhagada radleyi	1	West Pilbara
	Rhagada richardsonii	4	West Pilbara
Pupillidae	*Pupoides beltianus*	1	Central Australia
	Pupoides eremicolus	1	Central Australia

3.2.1. Potential SRE species only known from the search area

The taxonomy of scorpions in Australia is currently very poor and it is very difficult to have confidence in the distributional information for most species, so it is unknown whether the two *Lychas* species only known from the search area are actually SREs. Both species were collected at the same location in a gorge located 56 km north-west of the Study Area and were classified as SREs at the time of collection. The millipede genus *Antichiropus* contains a high proportion of SREs. *Antichiropus* `DIP021` is only known from two locations 13 km apart; the nearest record to the Study Area is 32 km north-west. This species was collected in a minor creekline and breakaway and was considered to be an SRE when collected. All three species are considered moderately likely to occur in the Study Area, as similar habitats are present. But if they were to occur in the Study Area, that would extend their known distribution enough that they would be unlikely to be true SREs.

3.2.2. Listed Invertebrate Species from the search area

There are no TECs or PECs listed based on terrestrial SREs in the Pilbara. There are no terrestrial invertebrate species listed as threatened in the Pilbara, although there are 10 priority species that include two dragonflies (*Antipodogomphus hodgkini* and *Nososticta pilbara*), seven undescribed millipedes of the genus *Antichiropus* and a single, charopid land snail (*Dupucharopa millestriata*). The type location of both dragonflies is Millstream Spring but *Antipodogomphus hodgkini* has also been recorded near Mardie Station and along the De Grey River (Pinder *et al.* 2010), with a linear range of 363 km. *Nososticta pilbara* is known from near Onslow through to Millstream Chichester National Park (linear range of 232 km) with no records inside the desktop search area (ALA 2017; Pinder *et al.* 2010). The six undescribed millipedes from the genus *Antichiropus* have been recorded in the central and eastern Pilbara at the following locations - Roy Hill, Abydos (near Marble Bar), Mining Area C, Cloudbreak and Mt Bruce (Karijini National Park). The land snail is only known from Depuch Island, east-northeast of Roebourne (Solem 1984) and outside the search area. All listed, invertebrate species in the Pilbara are most unlikely to occur in the Study Area and they will not be discussed further.

3.3. Habitat in the Study Area

Habitats known to harbour SRE species include relict, isolated, sheltered and moist habitats, as well as rocky outcrops and scree piles. Isolated or patchy habitats are generally considered to be more prospective for SRE species than widespread, well-connected ones. The presence and extent of typical SRE habitats were the focus of the desktop assessment.

Geology and Soils

Based on the Interim Biogeographic Regionalisation of Australia, Woodie Woodie lies within the Chichester subregion (PIL1) of the Pilbara region. The area has a semi-desert-tropical climate receiving 300 mm of rainfall annually (mostly in the wet season; Kendrick and McKenzie 2001). The subregion is characterised by undulating Archaean granite and basalt plains supporting a shrub steppe of typically *Acacia inaequilatera* over hummock grasslands and snappy gum tree steppes on the ranges. There are three broad soil types in the Study Area: two units (Fa19 and Gf1) cover most of the area and comprise stony hills and ranges of metamorphosed basic and ultrabasic rocks or steep ranges of basic lavas along with dolomites, tuff, banded iron formation and dolerite dykes (Isbell 2002). The soils in these units are generally shallow and stony with extensive areas lacking soil cover and consist of shallow stony earthy loams or brown loams, usually occurring on the pediments, plains, lower slopes and valley floors (Figure 2). The third unit (MM17) covers a small area of the Study Area and comprises alluvial plains with occasional stony residuals of basic and ultrabasic rocks, with deep cracking clay soils.

Vegetation and Vertebrate Fauna Surveys

Umwelt-Australia (2021) undertook a detailed vegetation survey that identified 23 vegetation communities in the Study Area. Five communities occur along major or minor watercourses, three on drainage areas associated with watercourses, five on clayey soils of low lying areas, three on rocky outcrops and the remaining on slopes, hills and undulating terrain. The report suggests none of these vegetation communities are unique in the broader area. The vegetation condition ranged from excellent to good, due to the presence of weeds (buffel and kapok bush), and historic and current grazing, which degraded areas generally associated with watercourses or low lying terrain, facilitating moisture dependent introduced species.

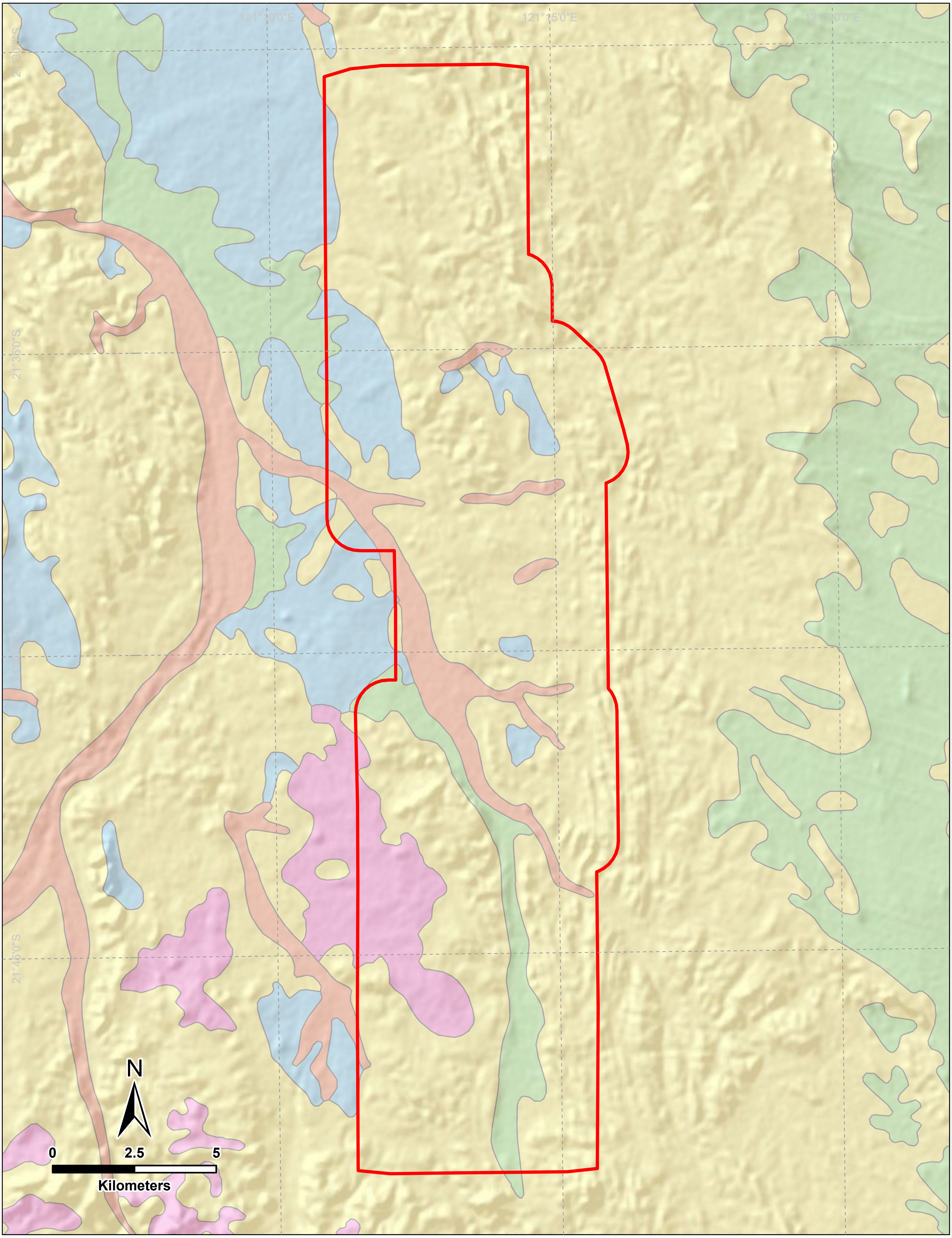
The fauna assessment by Western Wildlife (2021) consolidated the vegetation communities into five fauna habitats – rocky outcrops and breakaways, spinifex stony hills, spinifex flats and major and minor creeklines.

Invertebrate Habitats

Review of geological, vegetation and fauna habitat mapping, and aerial imagery of Woodie Woodie showed the presence of typical SRE habitats - rocky outcrops, gorges and gullies. Other habitat types noted were spinifex stony hills and flats and major to minor creeklines.

3.3.1. Implications of Desktop Review

A Detailed field survey was recommended to provide adequate coverage in the Study Area and its vicinity, due to the general paucity of invertebrate collections in the search area, presence of typical SRE habitat and to verify the desktop review of SRE habitats.



Bennelongia Environmental Consultants

GDA 1994 MGA Zone 51
Author: VMarques
Date: 2/02/2022

Legend
- Study Area
- Alluvium
- Colluvium
- Exposed
- Ferruginous, siliceous, and calcareous duricrust
- Sandplain

Figure 2. Mapped surficial geology in and around the Study Area.

4. TARGETED SURVEY METHODS

A two-season Detailed field survey of SRE invertebrate fauna was undertaken between 20-27 August 2019 and 3-8 October 2019 (Round 1) and between 26-31 March and 14-17 May 2021 (Round 2). Additional sampling, targeting pseudoscorpions under tree bark, was conducted in five sites between the 8th and 15th of October 2021. The specific aims of the surveys were to:

1. *Characterise SRE invertebrates in the Study Area;*
2. *Provide further information on the potential SRE habitats of the Study area and its surrounds; and*
3. *Assess the SRE status of species and the likelihood of their confinement to the Indicative Project Footprint.*

The survey approach and methods used were based on *Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2016b). The survey was designed to target species from invertebrate groups known to contain a high proportion of range-restricted species: land snails (Gastropoda), millipedes (Diplopoda), centipedes (Chilopoda), pseudoscorpions (Pseudoscorpiones), scorpions (Scorpiones), spiders (Mygalomorphae and Selenopidae), harvestmen (Opiliones) and slaters (Isopoda). Earthworms (Megadrilacea) and velvet worms (Onychophora) were not targeted because they are restricted to high-rainfall areas (Blakemore 2000; Reid 2002).

The survey was conducted primarily within the Study Area, with 11 sites (11.8%) located in representative habitats outside the Study Area in order to validate the extent of habitats beyond the Study Area and provide some regional context.

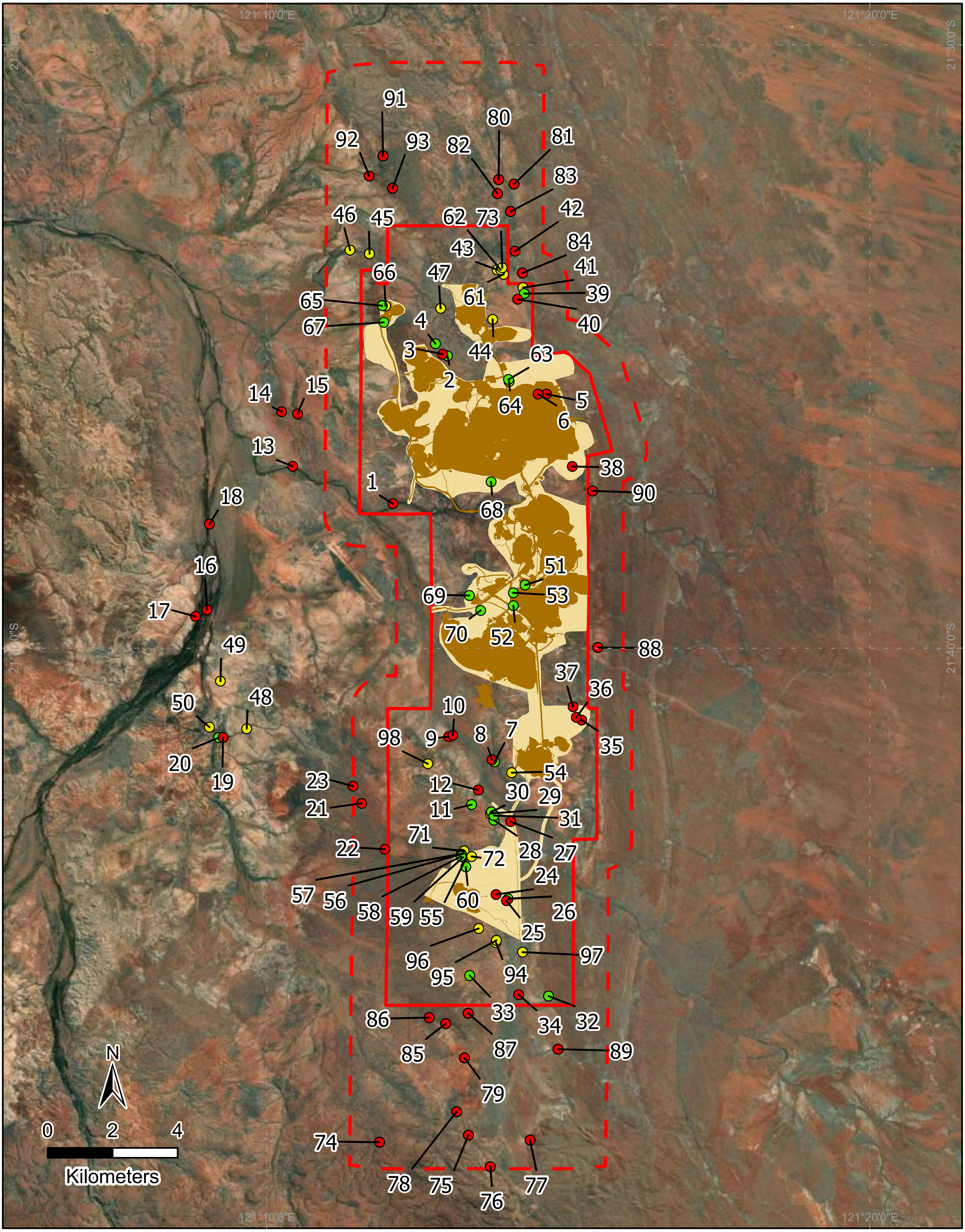
4.1. Field and Laboratory Methods

A total of 98 sites were sampled across Woodie Woodie and surrounds (Figure 3 and Figure 4). A detailed description of all sample sites, including coordinates, information on landforms, vegetation, litter and sample effort, is given in Appendices 9.2 and 9.3. Photographs were taken of each site and are compiled in Appendix 9.4.

In general, up to three methods were applied to each site – wet trapping (T), foraging (F) and litter collection (L) (Table 2). At 48 sites all three methods were employed, whereas at 24 sites there was no trapping and at 26 sites there was no trapping or litter collection. The following sections contain detailed descriptions of each different methodology. Sites where three methods were employed are viewed as comprehensively surveyed, whilst those without trapping are partially surveyed. All sites were sampled once, with the exception of four (sites 2, 19, 25 and 43) that were sampled a second time during trap retrieval.

Table 2. Numbers of sampling sites according to different combinations of collection methods (T = wet trapping; F = foraging; L = litter collection).

Sample Method	Impact	Reference	Total
TFL	9	39	48
FL	13	11	24
F	7	19	26
Total	**29**	**69**	**98**



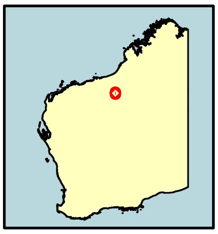
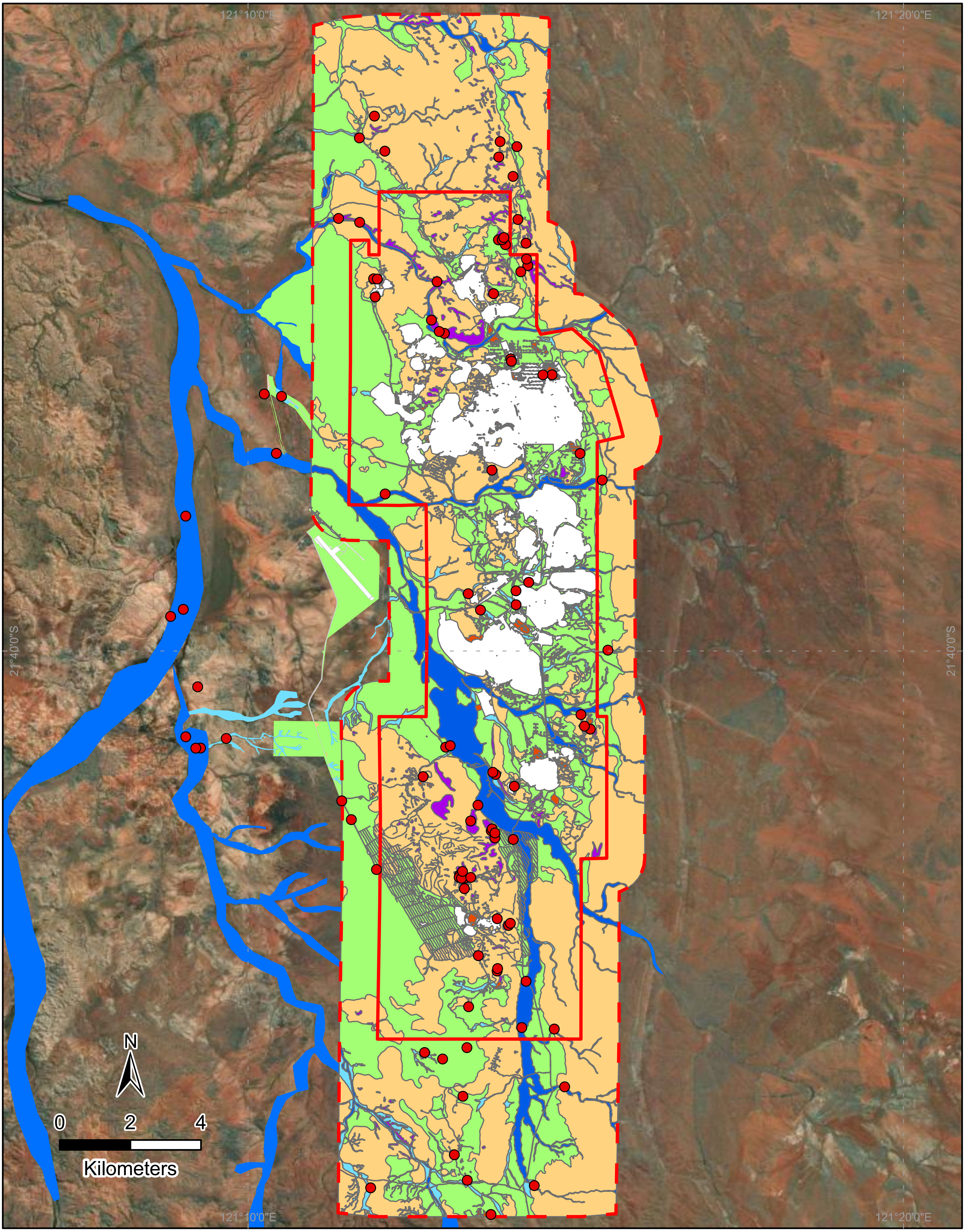


Figure 3. SRE sample sites in the first and second rounds of the survey, and the Indicative Footprint of Woodie Woodie.



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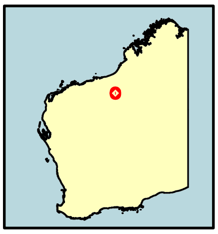
GCS GDA 1994
Author: VMarques
Date: 2/02/2022



Legend

- Study Area
- Development Envelope
- SRE sampling sites

Habitat types

- Rehabilitation
- Cleared
- Spinifex stony hills
- Major creeklines
- Minor creeklines
- Spinifex plains
- Rocky outcrops and breakaways

Figure 4. SRE sample sites in the first and second rounds of the survey, and the habitat types at Woodie Woodie.

Foraging

Thorough active searches were performed at all sites and invertebrates from target groups were collected. Searches were conducted at all prospective microhabitats present, including leaf litter, under logs, in the soil and bark at the base of large trees, under large debris, in rock piles and foliated rock across a 1 to 2-hour time period by two staff. A breakdown of the number of sites where different methods were employed is shown in Table 3, noting that the ability to perform the various methods was dependent on availability of specific substrates. Collection notes were taken to document the microhabitats where important specimens were found.

Table 3. Breakdown of foraging methods used at Woodie Woodie.

<table>
<tr><th>Forage method</th><th>No. of Sites</th><th>Forage method</th><th>No. of Sites</th></tr>
<tr><td>Rock turn</td><td>62</td><td>Log turn</td><td>26</td></tr>
<tr><td>Bark peel</td><td>46</td><td>Leaf blow</td><td>17</td></tr>
<tr><td>Burrow dig</td><td>18</td><td rowspan="2">Night spotlight using white and UV light</td><td rowspan="2">20</td></tr>
<tr><td>Litter sieve</td><td>57</td></tr>
</table>

While searching across all sites, detecting the presence of burrows was prioritised. Seventeen sites comprised of areas of moderate to heavy leaf litter which were searched for burrows by using a leaf blower to reveal any burrow lids or entrances. At 18 sites, representative burrows (scorpions and mygalomorphs) were excavated. Scorpion burrows were observed at six sites where a total of 27 cup traps were left over several nights at the entrance of scorpion burrows in an attempt to catch them upon leaving the burrow.

Comprehensive light and UV spotlighting was undertaken at 20 sites by three persons (includes Brett Bouwer and Luke Barrett of CML) at night to collect nocturnally active species, e.g. night hunting spiders of the family Selenopidae, or animals that fluoresce under ultraviolet light making them easily detectable (scorpions and opilionids).

Animals collected in the field were preserved directly in 100% ethanol and identified morphologically using dissecting and compound microscopes and the available taxonomic literature, unpublished keys, and reference collections by Bruno Buzatto, Michael Curran and Jane McRae at the Bennelongia laboratory.

At all sites, detailed site habitat assessments were undertaken. These metrics comprise shade and litter cover, fire and stock impact, soil types, landscape forms and dominant vegetation.

Wet Pit Trapping

'Wet' pit traps were deployed at 48 sites to capture wandering or foraging invertebrates. A total of 163 traps were deployed with variations in the number of traps able to be deployed within each habitat (between one and six traps depending on the ease of digging traps). Each trap consisted of a 1 L plastic jar, half-filled with propylene glycol as a preservative, inside a 30 cm deep PVC collar embedded into and flush with the ground surface. In difficult-to-dig terrain, only the 1 L jar was dug into the ground rather than the PVC collar. Trap holes were excavated with a motorised posthole digger or by trowel and shovel. A circular lid mounted on brackets was attached to a collar to reduce vertebrate bycatch and collection of rain and excess debris. Lead netting was not used in an effort to further reduce vertebrate bycatch. The traps were left in situ for approximately six-weeks, after which time they were retrieved and transported back to the laboratory.

Soil-Leaf Litter Collection

Two composite samples of approximately 1 L of leaf litter and underlying soil were collected from 71 sites and placed in calico bags. The samples were kept cool and out of direct light, transported back to the laboratory and placed in Tullgren funnels to collect invertebrates using absolute ethanol as a preservative. Subsequently, the substrate was also sorted under dissecting microscopes to collect any remaining specimens.

4.2. Molecular analyses

Molecular analyses were used to confirm morphological identification and delimitate species boundaries for cryptic species or species represented by females, juveniles or fragmented individuals that could not be morphologically identified to species level, and yet had the potential to represent SRE groups. DNA sequencing was attempted on 35 specimens from the study area. Depending on the size of the specimens, legs or whole animals were used for DNA extractions using a Qiagen DNeasy Blood & Tissue kit (Qiagen 2006). Elute volumes varied from 40 µL to 200 µL depending on the quantity of material. Primer combinations used for PCR amplifications were LCO1490:HCO2198 and C1J1718:HC02198, targeting the MT-CO1 gene (Folmer *et al.* 1994; Simon *et al.* 1994). Next, dual-direction, sanger sequencing was undertaken for PCR products by the Australian Genome Research Facility (AGRF). Sequences returned were aligned in Geneious (Kearse *et al.* 2012) and neighbour-joining phylogenetic trees were estimated using 1,000 bootstraps. Genetic distances (using the Tamura-Nei method) between sequences were measured as uncorrected p-distances (total percentage of nucleotide differences between sequences). Sequences on GenBank and in the grey literature were included in phylogenetic analysis to provide a framework for assessing intra- and interspecific variation, as well as to document the levels of intraspecific differentiation in described species across their geographic ranges.

4.3. Staff

Michael Curran led the 2019 survey, supported by Louis Masarei (trip 1) and Huon Clark (trip 2). Jacqui Roberts and Brett Bouwer (both of CML) assisted in all aspects of field work during that survey. Bruno Buzatto led the 2021 survey, supported by Vitor Marques (trip 1) and William Fleming (trip 2). Kaylee Prince and Luke Barrett (both of CML) assisted in all aspects of field work during the 2021 survey.

4.4. Survey Limitations

In the 2019 survey, the Study Area and surrounds were evidently quite dry at the time of surveying as all surface litter was dry underneath. Digging around the base of large trees, mainly eucalypts and melaleucas, close to major creeklines across the surveyed area showed that moisture was present in certain circumstances. At the nearest Bureau of Meteorology sites (Marble Bar, Telfer Aero, Noreena Downs and Meentheena) minimal rainfall was recorded in the months of July, August and September 2019, when the largest rainfall event recorded a maximum of 0.6 mm. This limitation was not applicable for the 2021 survey, since cyclonic rain brought over 80 mm of rain (recorded at Marble Bar) to the Study Area in February, (Figure 5) although most of this rainfall occurred in early February, and the survey started in late March. Another total of 16.8 mm of rain occurred through March, closer to the start of the survey, but more importantly, a significant rain event (34.6 mm recorded in Marble Bar) occurred on April 14th, while the wet pitfall traps were active (Figure 5).

Pastoral activities are prominent throughout the surveyed areas. These activities have had, and continue to have, significant impact on the landscape. Creeklines have been impacted on most significantly, with buffelgrass well established across substantial areas and cattle presence detected in every creekline. Evidence of fires occurring prior to survey was also prominent across sites, and fire impact on sampling locations was severe in some cases, with no unburnt vegetation within the area.

The above conditions can have detrimental impacts on the availability of SRE groups, and in combination can make detection exceedingly difficult. The results of the survey suggest, however, that most species likely to occur were collected.

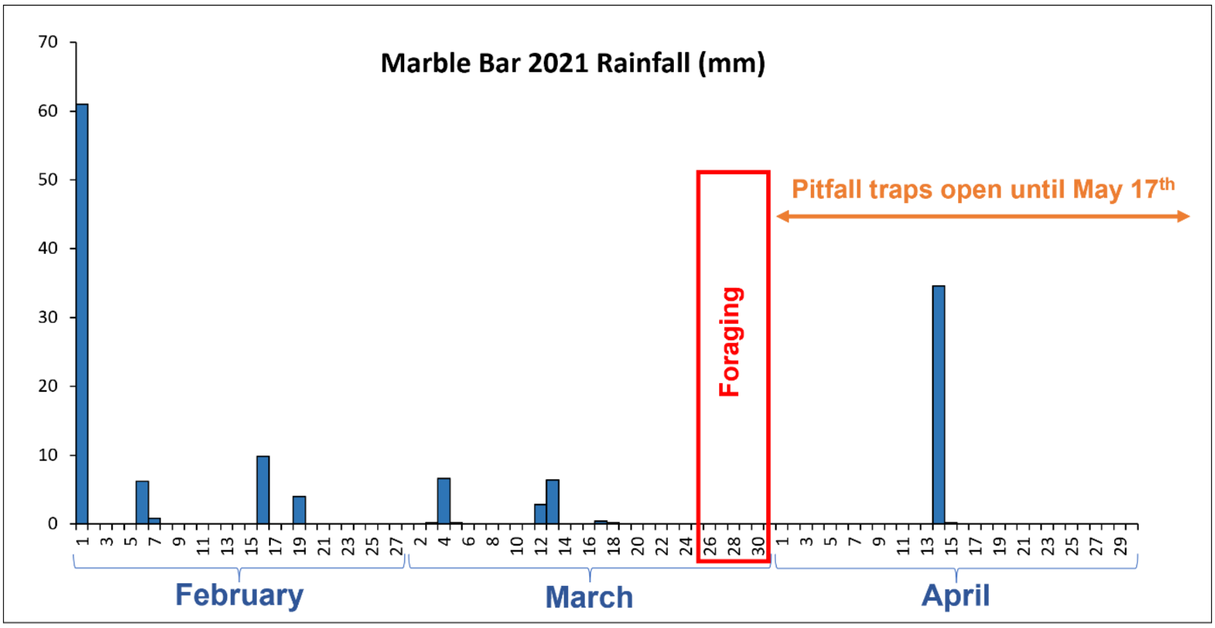


Figure 5. Rainfall recorded at Marble Bar, near the Study Area, between February and April 2021.

5. SURVEY RESULTS

5.1. Habitat Assessment

Six habitat types were identified at Woodie Woodie (Table 4) and all were sampled for terrestrial SREs. One site was also sampled at an artificial rocky outcrop that was created as a result of clearing for mining. A large portion of the survey effort was utilised surveying the rocky features in the Study Area, which are classed as typical SRE habitats – gorges and rocky outcrops. Twenty-one creeklines were sampled and of note, many contained numerous rocky features. Only five of the six habitat types could be practically mapped, with gorges falling within the 'rocky outcrop' habitat type (Figure 4). On some occasions, the habitat type determined for a sampling site (see Appendix 9.3 and 9.4) diverges from the habitat mapped (Figure 4). This is a result of the microhabitats observed in the field and sampled, which provide a better description of the habitat where the animals were found. A detailed description of each habitat type and its prospectivity for terrestrial SREs is provided below and a plate of the habitat types is shown in Figure 5.

Table 4. Sampling methods used by primary landform.

	Sample Method				SRE	Mapped
Primary Landform	**TFL**	**FL**	**F**	**Total**	**Prospectivity**	**Name**
Stony hill			2	2	None	Stony hill
Rocky Outcrop	7	9	12	28	Moderate	Rocky outcrop
Rocky Outcrop (Artificial)			1	1	None	Rocky outcrop
Gorge	1	6	3	10	High	Rocky outcrop
Plain/Floodplain	10	4	3	17	Low	Plain
Minor Creekline	21	5	4	30	Low	Minor Creekline
Major Creekline	9		1	10	Low	Major Creekline
Total	**48**	**24**	**26**	**98**		

Stony hills

The 250K surface geology mapping at Woodie Woodie shows large areas of exposed rock, and fieldwork found this is largely the case. Much of the Study Area comprises rocky ground with minimal cover (spinifex), either in areas of low undulating hills or atop large hills. These areas provide very little support for retention of moisture and establishment of microhabitats (e.g. litter beds). This habitat type is not prospective for SREs. Members of SRE groups may be encountered in this habitat at very low abundances – mygalomorphs of the family Anamidae and pseudoscorpions of the family Olpiidae; both families contain species that are adapted to very harsh environments across Australia. Two sites (29 and 66) were sampled in this habitat type at Woodie Woodie but no taxa from SRE groups were recorded.

Rocky outcrops

Numerous rocky outcrops or breakaways occur throughout the Study Area. They vary in size and comprise one of two types of dolomite – older & flakey or elephant-hide. A third type of outcrop comprising calcrete was found outside the Study Area to the west. The dolomite outcrops contain piles of flaky rock and numerous overhangs of varying size. This habitat type can comprise a variety of habitats and there can be a large range in its capacity for moisture retention. The rock piles provide ideal habitat for senelopid spiders, slaters and pseudoscorpions. Several of the rocky outcrops host *Ficus* and deep litter beds or scattered trees (snappygums or *Corymbia*) that offer microhabitats for a variety of small invertebrates. This habitat type is mostly unsuitable for mygalomorph spiders because there is usually very little soil, which is also quite friable. The suitability of this habitat for SREs was variable in the Study Area and correlates with their aspect, geology and landscape position. For example, some are very subdued or face north (extremely exposed) and many comprise rock piles. Due to the variability, this habitat type ranges from highly prospective to not prospective, so on average it is ranked as moderately prospective for SREs. Of note, the calcareous outcrops outside the Study Area to the west are highly prospective for SREs as all supported dense and abundant populations of SRE land snails from the family Camaenidae. Finally, an artificial rocky outcrop, which resulted from clearing for mining, was also sampled (site 54) to check for the presence of selenopid spiders and slaters, but no SREs were found there.

Gorges

The gorges share many features with the rocky outcrops, except for the fact that they are positioned lower in the landscape, adjacent a creekline, and have steep cliffs. These factors generally allow for greater moisture retention that can promote the development and establishment of large trees (ficus, white gums, corymbia), which provide shade and litter. The gorges resemble refugia in the Pilbara and are highly prospective for both specialist and relict SREs because they are topographically diverse and include a number of very suitable microhabitats, such as south-facing gullies, water-runoffs, rocky breakaways, accumulations of scree and associated vegetation that differ from those in the surrounding habitats (creeklines, plains, stony hills). Specialist SRE fauna collected from this habitat type included land snails of the genus *Basedowena* and *Rhagada*, pseudoscorpions of the genus *Synsphyronu*s, wall-crab spiders of the genus *Karaops* and a fragment of the millipede genus *Antichiropus*. The gorges are connected in the landscape in the Study Area by the creeklines and rocky hills, and the species found here are likely to be shared throughout the local area.

Plains

This is the most common and widespread habitat in the survey area and extends well beyond the Study Area. It is a highly exposed habitat type with hummock grassland interspersed by occasional shrubs over stony sands or silts. There are extensive stretches of grasslands that lack complex vegetation associations and contain a lot of exposed substrate. Organic matter is least frequent compared to other habitats in the Study Area and the plains have a low microhabitat diversity. This habitat type has a low prospectivity for SREs, with the groups most likely to occur being robust and arid adapted - mygalomorph spiders (in particular the family Anamidae), pseudoscorpions of the family Olpiidae and scorpions of the genus *Lychas*. Moisture-dependent SRE groups, such as snails and millipedes, are less likely to occur. Species in SRE Groups occurring in Sandy Plains are expected to be relatively widespread because of good habitat connectivity.

Major and minor creeklines

The creeklines generally comprise a sandy, rocky creekbed flanked by shrubs, trees and clayey sand. The major creeklines are a good source of shade and moisture in an otherwise extremely exposed landscape. The minor creeklines are less sheltered than their larger counterparts, having scattered trees accompanied by shrubs and hummock grassland. Microhabitats within the creeklines are diverse, because vegetation associations are complex, organic matter can be accumulated over long periods of time (although washed away periodically), and the underlying geologies are diverse. It is expected that relictual SRE groups, such as terrestrial slaters and some snails, will occur here. The field survey found most of the creeklines in the Study Area were degraded by cattle and weeds. This habitat type in the Study Area has a low suitability for SRE fauna. The habitat is widespread in the Study Area and extends well beyond the Project Development Envelope. It is anticipated that most species in SRE Groups collected in this habitat type will be widespread locally.

Table 5. Areas historically cleared, mapped habitats and proposed clearing.

Area Type	Existing (ha)	Inside Indicative Footprint (ha)	Proportion of habitat in the Study Area proposed to be cleared
Cleared			
Historically cleared	2585.3	n/a	n/a
Rehabilitated	237.0	n/a	n/a
Uncleared			
Stony hill	11487.4	854.6	7.44%
Major Creeklines	1377.9	84.4	6.12%
Minor Creeklines	630.2	70.16	11.13%
Plain	8135.6	1088.4	13.38%
Rocky Outcrop (incl. gorges)	416.1	25.6	6.16%
Total Uncleared Habitat	**22047.1**	**2123.1**	**9.63%**

5.2. Invertebrates

The survey collected 3,454 animals belonging to SRE groups, representing at least 76 species (Table 8 and Table 9). All groups expected to occur within the survey area were represented. Pseudoscorpions were by far the most diverse with 34 species, with other groups containing between 5 and 10 species. At a single reference site, the exuvia of an *Antichiropus* millipede was collected. Highly moisture dependent groups, such as *Antichiropus* millipedes and to a lesser extent camaenid snails and isopods, are likely to be somewhat underrepresented in the 2019 survey results due to the dry conditions.

Most of the 76 species collected are new (51), and nine species initially considered potentially new were genetically and/or morphologically matched to morphospecies previously collected elsewhere in the Pilbara by the WAM or Bennelongia (including Atemnidae BPS270, *Synsphyronus* sp. PSE093, *Synsphyronus* sp. PSE128, *Lychas* sp. SCO046, *Lychas* sp. SCO024 and *Lychas* \`BSCO051\`). Fourteen species collected are described, and thirteen of them have large ranges (Pilbara through to Australia). The remaining two species were unique higher order identifications (cannot represent any other species in the list; *Antichiropus* sp. and Scutigeridae sp.). Combining the results from the 2019 and 2021 surveys (including the targeted survey), pseudoscorpions were the most abundant group (1012 specimens), followed by slaters (947), then snails (791; mostly represented by dead shells), millipedes (294, primarily polyxenids), mygalomorphs (136, includes some burrow observations), centipedes (151), scorpions (77) and selenopid and hersiliid araneomorphs (46). All hersiliids and selenopids (with one exception) were collected via foraging, followed closely by mygalomorphs, snails and to a lesser degree scorpions. Trapping collected most millipedes, isopods, centipedes, pseudoscorpions, and some scorpions and mygalomorphs. Litter collection accounted for a small portion of pseudoscorpions, snails and millipedes. In the case of pseudoscorpions, which are the most species rich and the most abundant, each of the three methods collected unique and shared species, although trapping contributed the greatest number of unique species.

SRE Status

All 76 species passed through the five-tier classification scheme for SREs. The status of 22 species as widespread (not SREs) was clear because they are either described species or recognized morphospecies that are known to have large ranges (Pilbara to Australia). Of the 51 new species, 18 were ranked as unlikely to be SREs largely owing to their habitat preferences. Thirteen of these were considered unlikely SREs because they are 'generalists' (this name might not fully represent their ecology), as they appeared to lack tight associations to specific habitat types. Meanwhile, two others (*Urodacus* `BSCO029` and *Austrohorus* `BPS221`) were considered unlikely SREs because they were collected in sandy plains, the most common and widespread habitat in the survey area, and which extends beyond the Study Area.

Table 6. Richness of SRE groups in the Study Area.

Group	Richness
Araneomorphae	2
Mygalomorphae	3
Pseudoscorpiones	34
Scorpiones	10
Isopoda	10
Chilopoda	8
Diplopoda	4
Gastropoda	5

Table 7. Richness according to habitat preference.

Habitat Preference	Richness
Generalists	24
Possible Specialists:	
Creeklines	32
Plains	6
Rocky features (gorges, rocky Creeklines, outcrops)	14

Thirty-six species were classed as potential SREs, mainly because they have habitat preferences for rocky features, which primarily comprises gorges and rocky outcrops, but also some creeklines that contain significant rocky features. These 36 species comprise 34 new species, one higher order identification (*Antichiropus* sp.) and one described species (*Rhagada richardsonii*). All potential SRE species are either known from outside or both inside and outside the Indicative Footprint and are not at risk from the proposed development.

Potential SREs

The species of potential SREs include one selenopid spider (*Karaops* `BAR119`), 22 pseudoscorpions (from the families Atemnidae, Chernetidae, Olpiidae and Sternophoridae), two scorpions (*Lychas* `BSCO027` and *Urodacus* `BSCO069`), one centipede (Scolopendridae `BSCOL077`), one millipede (*Antichiropus* sp.), seven slaters (*Buddelundia* `BIS351`, *B.* `BIS355`, *B.* `BIS360`, *B.* `BIS363`, *B.* `BIS440`, *B.* `BIS439` and *Pseudodiploexochus* `BIS441`) and two snails (*Basedowena* `BGA043` and *Rhagada richardsonii*).

Potential SRE spiders

Spiders of the family Selenopidae, also known as wall crab spiders or flatties, are exceptionally fast moving and extremely flattened dorsoventrally (Crews and Harvey 2011). The genus *Karaops* is restricted to Australia, where many species are still only known from a single specimen. There is a large diversity of species in the Pilbara, and the distribution of many of these seem restricted (Crews 2013). 44 specimens of a new species of this genus, *Karaops* `BAR119` were recorded from a variety of rocky habitats in the Study Area, mostly in reference sites, and the species is so far known to have a linear distribution of at least 23 km (Figure 7).

Stony hill

Rocky outcrop

Plain

Creekline

Gorge

Figure 6. Plate of habitat types at Woodie Woodie.

Potential SRE pseudoscorpions

Epigean pseudoscorpions species are generally considered to have widespread distributions and it has been suggested that few species are SREs (Harvey 2002). Notably, however, some species have limited distributions and are normally restricted to specialist habitats including granite outcrops (Harvey 2010, 2012; Harvey 2018; Harvey *et al.* 2015). While phoresy (dispersal by means of attachment to a host organism; White *et al.* 2017) has been documented for many families of pseudoscorpion, including those from Lake Way (Jhasser Martínez *et al.* 2018; Lira and Tizo-Pedroso 2017; Muchmore 1972), pseudoscorpion taxonomy is poorly resolved, largely due to high diversity and thus range determination can be difficult. Nineteen of the 22 pseudoscorpions classed as potential SREs belong to the family Olpiidae. The taxonomy of this family in WA is very poor, but in the Pilbara (and much of WA) this family primarily contains species that appear to be very robust and adapted to the arid conditions. Generally, these species would not be classed as potential SREs, but in a precautionary approach we do not rule out their potential to be SREs. Importantly, *Xenolpium* `BPS213`, *Euryolpium* `BPS245`, *Indolpium* `BPS359` and *Austrohorus* `BPS358` are only known from gorges and rocky features, which are less connected in the wider landscape than creeklines, and are therefore more likely than the other 15 olpiids to be true SREs (Figure 7). The remaining three pseudoscorpions considered potential SREs are Atemnidae `BPS218`, Chernetidae `BPS364` and *Afrosternophorus* `BPS363`. Two of these species, Atemnidae `BPS218` and *Afrosternophorus* `BPS363`, are each known from a single reference site, and are therefore not under threat from proposed developments.

The pseudoscorpion Chernetidae `BPS364` was initially collected only in the Indicative Project Footprint. However, additional sampling was undertaken in October 2021, targeting the recollection of the species in reference areas. This targeted survey produced two more specimens morphologically consistent with Chernetidae `BPS364`, but in different developmental stages. All three individuals collected were sequenced for the Mt-COI gene, and the results compared to 13 other sequences obtained from GenBank (via a BLAST) and from the Bennelongia Database. All three individuals were confirmed as conspecifics, identical (no divergence) in 470 base pairs of the Mt-COI gene. The closest relative to these specimens was a specimen from Lake Rebecca (in the Goldfields) named Chernetidae `BPS351`, but the two species are still 15.3% divergent in the Mt-COI gene, which is more consistent with interspecific, rather than intraspecific divergence. In comparison, sequences of conspecifics, such as for a species identified as Chernetidae `BPS343` (from Lake Rebecca; Bennelongia Database) are no more than 0.9% divergent in that gene. The other pseudoscorpions recorded during the targeted survey were identified only to higher-order level as they do not belong to the Chernetidae family. As a result, these specimens have not been included in the main species list (Table 8) but are shown separately in Table 9.

Potential SRE scorpions

The framework for scorpion identification in Australia needs revisions, so that determining the distribution of morphospecies of the genera *Lychas* and *Urodacus* requires comparison with a range of specimens from the region. Molecular information may also assist in clarifying morphological identifications. Only one species of the genus *Urodacus* (burrowing scorpions) was considered a potential SRE in the current survey, *Urodacus* `BSCO069`. Similarly, only one species in the genus *Lychas*, *L.* `BSCO027`, was considered a potential SRE in the current survey. Each species is known from a single reference site on the eastern edge of the Study Area, just outside the Development Envelope (Figure 7).

Potential SRE centipede

Only one species of centipede collected in the current survey was considered a potential SRE, Scolopendridae `BSCOL077`. This family does not typically contain SRE species, which are more common in the families Cryptopidae and in the order Geophilida. However, given that the Scolopendridae `BSCOL077` could not be assigned to a described genus using the current taxonomic framework for centipedes, we are not ruling out its potential to be an SRE. This species is so far only known from one reference site in the southern end of the Study Area (Figure 8).

Potential SRE millipede
A single exuvia of a millipede from the genus *Antichiropus* was collected from a gorge site outside the Indicative Footprint in the Development Envelope. Currently, all species from this genus in WA are regarded as SREs (Car *et al.* 2019), although some have fairly large distributions. With this being the only record of this genus during the survey, there is insufficient information to determine its range or whether it is an actual SRE, but using a precautionary approach we have not ruled out its potential as an SRE.

Potential SRE slaters/isopods
In Australia, the order Isopoda contains a largely undescribed and diverse group of terrestrial epigean crustaceans (suborder Oniscidae) that, due to poor dispersal capabilities and specific habitat preferences, are often SREs (Judd 2004; Judd and Horwitz 2003; Judd and Tati 2011). Seven species of slaters recorded in the Study Area were considered potential SREs, all in the family Armadillidae, and in the genera *Buddelundia* (six species) and *Pseudodiploexochus* (*P*. `BIS441`). Four of these species were only known from one reference site, and the remaining species were known from at least two reference sites (Table 8, Figure 8). Buddelundia `BIS360` was fairly widespread in the Study Area, and was recorded in 17 different sites (16 of which are outside the Indicative Footprint). Given its locally widespread distribution, this species is the least likely of all slaters in the Study Area to be a true SRE.

Potential SRE snails
The described snail *R. richardsonii* was flagged as a potential SRE for several reasons. Although *R. richardsonii* has a large documented distribution (Solem 1997), the taxonomy of many Australian camaenids is out of date. During the survey, this species was recorded at many sites from all habitat types and would appear to be a 'generalist'; however, its wide occurrence was documented through dead shells (which is why DNA sequencing was not possible with this species). The only live animals were found at the gorges or calcareous outcrops. Camaenid land snails are a typical SRE group, and this species appears to inhabit the relictual habitats and disperse from them during favourable conditions. The same observations were noted for *Basedowena* `BGA043`. These two species were locally widespread in the Study Area, especially in the reference sites on creeklines to the west of the Study Area, and in the northern part of the Development Envelope (Figure 8).

6. ASSESSMENT OF THREATS

The SRE surveys conducted in 2019 and 2021 in the Study Area and surrounds have documented the occurrence of no listed invertebrate species, 22 species that are not SREs, 18 species that are unlikely to be SREs and 36 potential SREs. All potential SRE species occur outside, or both inside and outside the Indicative Footprint. These species are therefore not likely to be threatened by the Proposal and are not likely to be of conservation significance.

Modification to habitats
Six habitat types were identified in the Study Area and surrounds – stony hills, major and minor creeklines, plains, rocky outcrops and gorges. Rocky outcrops and Gorges were considered highly prospective for SREs, whereas major and minor creeklines were considered moderate to highly prospective for SREs. The Indicative Footprint encompasses proposed clearing of 2123.1 ha (9.6% of habitats in the Study Area). The area of proposed clearing under the Indicative Footprint primarily encompasses three habitat types – plains, stony hills and minor creeklines. That is, the removal of 1088.4 ha of plains (13.38% of this type of habitat in the Study Area), 854.6 ha of stony hills (7.44% of this habitat in the Study Area), and 70.2 ha of minor creeklines (11.13% of this habitat in the Study Area). The plains and stony hills are not prospective for SREs and both extend widely within and beyond the Study Area. Minor creeklines are moderate to highly prospective for SREs, but these habitats are extensive and well connected beyond the Study Area, meaning that the removal of this type of habitat might have only a small effect on potential SREs.

Table 8. Species and their abundances in impact and reference sites at Woodie Woodie.
Numbers out of parentheses indicate number of specimens; numbers within parentheses indicate the number of sites from which individuals were collected. Grey denotes higher order identifications that might belong to other listed species (not always viewed as unique species). *Indicates species for which molecular work was used to confirm morphological identification and delimitate species boundaries for cryptic species or species represented by females, juveniles or fragmented individuals that could not be morphologically identified to species level, and yet had the potential to represent SRE groups. Rocky features include gorges, major/minor creeklines and rocky outcrops. #Indicates specimens collected during additional targeted survey in October 2021.

Higher Taxonomy	Lowest Identification	Imp.	Ref.	Taxonomy and distribution	Recorded Habitat(s)	Habitat Preference	SRE Status
ARTHROPODA							
ARACHNIDA							
Araneae							
Araneomorphae							
Hersiliidae	*Tamopsis* cf. *fitzroyensis*	0 (0)	2 (2)	Described species, but considerable range expansion	Major and Minor Creeklines	Creeklines	Widespread
Selenopidae	*Karaops* `BAR119`	5 (3)	39 (19)	New species	Gorge, Rocky Outcrop, Major and Minor Creeklines	Rocky features	**Potential SRE**
Mygalomorphae							
Anamidae	*Aname* `BMYG155`	2 (2)	80 (6)	New species	Plain, Rocky Outcrop and Minor Creekline	Generalist	Unlikely SRE
	Aname sp.	2 (2)	28 (3)	Possibly conspecific of above species		Uncertain	Uncertain
Barychelidae	*Synothele* `BMYG153`	2 (2)	3 (3)	New species	Plain, Rocky Outcrop and Minor Creekline	Generalist	Unlikely SRE
Euagridae	*Cethegus* `BMYG154`	0 (0)	19 (2)	New species	Plain and Minor Creekline	Generalist	Unlikely SRE
Pseudoscorpiones							
Atemnidae	Atemnidae `BPS218`*	0 (0)	1 (1)	New species; singleton	Major Creekline	Creeklines	**Potential SRE**
	Atemnidae `BPS270`*	0 (0)	9 (2)	Genetically matched a morphospecies known from Western Ridge, near Newman (250 km SW).	Major Creekline	Creeklines	Widespread
	Atemnidae sp.	1 (1)	1 (1)	Possibly conspecific of above species		Uncertain	Uncertain
Chernetidae	Chernetidae `BPS364`*	1 (1)	2 (1) #	New species	Minor Creekline	Creeklines	**Potential SRE**
Garypidae	*Synsphyronus* `PSE093, 8/1 Pilbara`*	0 (0)	11 (3)	Genetically matched a morphospecies widespread in the Pilbara (western most record near Onslow; 630 km W).	Plain and Major/Minor Creekline	Generalist	Widespread
	Synsphyronus `PSE128`*	0 (0)	2 (1)	Genetically matched a morphospecies known from Wodgina Mine area (270 km WNW).	Minor Creekline	Creeklines	Widespread
	Synsphyronus `BPS226`	14 (3)	31 (3)	Genetics failed, but specimens suspected to be conspecific with *Synsphyronus* `PSE093, 8/1 Pilbara`	Minor Creekline and Gorge	Rocky features	Unlikely SRE

Higher Taxonomy	Lowest Identification	Imp.	Ref.	Taxonomy and distribution	Recorded Habitat(s)	Habitat Preference	SRE Status
	Synsphyronus `BPS225`	0 (0)	1 (1)	Genetics failed, but species suspected to be conspecific with *Synsphyronus* `PSE128`	Minor Creekline	Creeklines	Unlikely SRE
	Synsphyronus sp.	0 (0)	7 (2)	Possibly conspecific of above species		Uncertain	Uncertain
Olpiidae	*Austrohorus* `BPS219`*	0 (0)	61 (10)	New species	Plain, Gorge, Rocky Outcrop and Minor/Major Creeklines	Generalist	Unlikely SRE
	Austrohorus `BPS220`*	0 (0)	1 (1)	New species; singleton	Minor Creekline	Creeklines	**Potential SRE**
	Austrohorus `BPS221`	0 (0)	1 (1)	New species; singleton	Plain	Plains	Unlikely SRE
	Austrohorus `BPS231`	0 (0)	1 (1)	New species; singleton	Minor Creekline	Creeklines	**Potential SRE**
	Austrohorus `BPS232`	0 (0)	4 (1)	New species; from one location only	Major Creekline	Creeklines	**Potential SRE**
	Austrohorus `BPS233`	0 (0)	5 (1)	New species; from one location only	Major Creekline	Creeklines	**Potential SRE**
	Austrohorus `BPS358`	0 (0)	1 (1)	New species; singleton	Rocky Outcrop	Rocky outcrops	**Potential SRE**
	Austrohorus `BPS365`*	0 (0)	5 (1)	New species; from one location only	Major Creekline	Creeklines	**Potential SRE**
	Austrohorus sp.	0 (0)	20 (7)	Possibly conspecific of above species		Uncertain	Uncertain
	Beierolpium 8/2 `BPS236`	3 (2)	10 (6)	New species	Plain, Rocky Outcrop and Minor/Major Creeklines	Generalist	Unlikely SRE
	Beierolpium 8/3 `BPS241`	0 (0)	11 (3)	New species	Major Creekline	Creeklines	**Potential SRE**
	Beierolpium 8/3 `BPS362`	0 (0)	1 (1)	New species; singleton	Minor Creekline	Creeklines	**Potential SRE**
	Beierolpium 8/4 `BPS224`*	56 (4)	16 (5)	Genetically synonymised with `BPS234`; new species	Plain, Gorge and Minor Creeklines	Generalist	Unlikely SRE
	Beierolpium 8/4 `BPS235`*	3 (1)	5 (2)	Genetics failed; new species	Minor Creekline	Creeklines	**Potential SRE**
	Beierolpium 8/4 `BPS239`*	0 (0)	8 (2)	Genetics failed; new species	Minor Creekline	Creeklines	**Potential SRE**
	Beierolpium 8/4 `BPS240`*	0 (0)	2 (1)	New species, confirmed genetically	Minor Creekline	Creeklines	**Potential SRE**
	Beierolpium sp.	8 (3)	28 (8)	Possibly conspecific of above species		Uncertain	Uncertain
	Euryolpium `BPS245`	10 (1)	13 (6)	New species	Gorge, Rocky Outcrop and Minor Creeklines	Rocky features	**Potential SRE**
	Euryolpium sp.	0 (0)	1 (1)	Possibly conspecific of above species		Uncertain	Uncertain
	Indolpium `BPS214`*	118 (7)	316 (36)	Genetically synonymised with `BPS242 and 243`; new species	Gorge, Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Unlikely SRE
	Indolpium `BPS215`*	1 (1)	2 (2)	New species, confirmed genetically	Gorge, Plain, and Minor Creekline	Generalist	Unlikely SRE
	Indolpium `BPS244`	0 (0)	2 (1)	New species; from one location only	Minor Creekline	Creeklines	**Potential SRE**
	Indolpium `BPS346`	0 (0)	4 (3)	New species	Major and Minor Creeklines	Creeklines	**Potential SRE**
	Indolpium `BPS359`	0 (0)	2 (1)	New species; from one location only	Rocky Outcrop	Rocky outcrops	**Potential SRE**
	Indolpium `BPS360`*	0 (0)	2 (2)	New species, confirmed genetically	Major and Minor Creeklines	Creeklines	**Potential SRE**

Higher Taxonomy	Lowest Identification	Imp.	Ref.	Taxonomy and distribution	Recorded Habitat(s)	Habitat Preference	SRE Status
	Indolpium sp.	11 (7)	26 (16)	Possibly conspecific of above species		Uncertain	Uncertain
	Xenolpium `BPS213`	0 (0)	8 (2)	New species	Gorge	Gorges	**Potential SRE**
	Xenolpium `BPS237`	0 (0)	6 (1)	New species; from one location only	Major Creekline	Creeklines	**Potential SRE**
	Xenolpium `BPS361`	0 (0)	3 (1)	New species; from one location only	Minor Creekline	Creeklines	**Potential SRE**
	Xenolpium sp.	0 (0)	3 (2)	Possibly conspecific of above species		Uncertain	Uncertain
	Olpiidae sp.	4 (2)	24 (14)	Possibly conspecific of above species		Uncertain	Uncertain
Sternophoridae	*Afrosternophorus* `BPS223`	26 (5)	16 (4)	New species	Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Unlikely SRE
	Afrosternophorus `BPS363`	0 (0)	1 (1)	New species; from one location only	Major Creekline	Creeklines	**Potential SRE**
	Afrosternophorus sp.	0 (0)	4 (2)	Possibly conspecific of above species		Uncertain	Uncertain
Unknown family	Pseudoscorpiones sp.	1 (1)	2 (2)	Possibly conspecific of above species		Uncertain	Uncertain
Scorpiones							
Buthidae	*Lychas* `BSCO027`*	0 (0)	1 (1)	New species; from one location only	Minor Creekline	Creeklines	**Potential SRE**
	Lychas `BSCO051`*	0 (0)	13 (7)	Genetically matched a morphospecies known from Sheila Valley (~400 km WSW).	Plain and Major/Minor Creeklines	Generalist	Widespread
	Lychas `BSCO059*`	0 (0)	1 (1)	Genetically matched a morphospecies known from Glacier Valley (230 km WNW).	Gorge	Gorges	Widespread
	Lychas `SCO024`*	3 (2)	26 (15)	Genetically matched a morphospecies known from Mulga Downs (265 km WSW).	Gorge, Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Widespread
	Lychas `SCO046`*	0 (0)	3 (1)	Genetically matched a morphospecies known from Mulga Downs (265 km WSW).	Plain	Plains	Widespread
	Lychas sp.	0 (0)	3 (3)	Possibly conspecific of above species		Uncertain	Uncertain
Urodacidae	*Urodacus* `BSCO026`*	2 (2)	6 (5)	New species in the "*Urodacus butleri* species complex"; genetically unique	Plain and Minor Creekline	Generalist	Unlikely SRE
	Urodacus `BSCO029`*	0 (0)	4 (3)	New species; genetically unique	Plain	Plains	Unlikely SRE
	Urodacus `BSCO069`*	0 (0)	5 (1)	Genetically split from above; New species; from one location only	Major Creekline	Creeklines	**Potential SRE**
	Urodacus `Pilbara 2`*	0 (0)	2 (1)	Morphospecies recognized by WAM	Plain	Plains	Widespread
	Urodacus `Pilbara 8`*	0 (0)	6 (5)	Morphospecies recognized by WAM	Plain and Major/Minor Creeklines	Generalist	Widespread
	Urodacus sp.	0 (0)	2 (2)	Possibly conspecific of above species		Uncertain	Uncertain
CHILOPODA							

Higher Taxonomy	Lowest Identification	Imp.	Ref.	Taxonomy and distribution	Recorded Habitat(s)	Habitat Preference	SRE Status
Geophilida							
Ballophilidae	*Ballophilus australiae*	0 (0)	1 (1)	Described species	Major Creekline	Creeklines	Widespread
Scolopendrida							
Cryptopidae	*Cryptops spinipes*	0 (0)	5 (4)	Described species	Plain and Major/Minor Creeklines	Generalist	Widespread
Scolopendridae	*Arthrorhabdus ?paucispinus*	0 (0)	12 (3)	Described species, but minor differences in morphology	Minor Creekline	Creeklines	Widespread
	Colobopleurus ?inopinatus	0 (0)	2 (1)	Described species, but minor differences in morphology and considerable range expansion	Minor Creekline	Creeklines	Widespread
	Cormocephalus turneri	1 (1)	0 (0)	Described species	Plain	Plains	Widespread
	Scolopendra morsitans	2 (2)	94 (32)	Described species	Gorge, Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Widespread
	Scolopendra sp.	0 (0)	2 (2)	Possibly conspecific of above species		Uncertain	Uncertain
	Scolopendridae `BSCOL077`	0 (0)	1 (1)	New species; from one location only	Major Creekline	Creeklines	**Potential SRE**
Unknown family	Scolopendrida sp.	0 (0)	1 (1)	Possibly conspecific of above species		Uncertain	Uncertain
Scutigeromorpha							
Scutigeridae	Scutigeridae sp.	1 (1)	24 (10)	Higher order identification; the group does not usually contain SREs	Rocky Outcrop and Major/Minor Creeklines	Rocky features	Unlikely SRE
Unknown family	Scutigeromorpha sp.	0 (0)	5 (3)	Possibly conspecific of above species		Uncertain	Uncertain
DIPLOPODA							
Polydesmida							
Paradoxosomatidae	*Antichiropus* sp.	0 (0)	1 (1)	Higher order identification	Gorge	Gorges	**Potential SRE**
Polyxenida							
Lophoproctidae	*Lophoturus madecassus*	2 (1)	0 (0)	Described species	Plain	Plains	Widespread
Polyxenidae	*Unixenus mjoebergi*	17 (2)	18 (8)	Described species	Plain and Major/Minor Creeklines	Generalist	Widespread
	Unixenus sp.	0 (0)	8 (5)	Possibly conspecific of above species		Uncertain	Uncertain
Synxenidae	*Phryssonotus novaehollandiae*	60 (6)	187 (30)	Described species	Gorge, Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Widespread
Unknown family	*Polyxenida* sp.	0 (0)	1 (1)	Possibly conspecific of above species		Uncertain	Uncertain
MALACOSTRACA							
Isopoda							
Armadillidae	*Buddelundia* `BIS351`	0 (0)	2 (1)	New species; from one location only	Rocky Outcrop	Rocky features	**Potential SRE**
	Buddelundia `BIS355`	0 (0)	101 (3)	New species	Major Creekline	Creeklines	**Potential SRE**

Higher Taxonomy	Lowest Identification	Imp.	Ref.	Taxonomy and distribution	Recorded Habitat(s)	Habitat Preference	SRE Status
	Buddelundia \`BIS360\`	1 (1)	39 (16)	New species	Rocky Outcrop and Major/Minor Creeklines	Rocky features	**Potential SRE**
	Buddelundia \`BIS361\`	1 (1)	12 (4)	New species	Plain and Minor Creekline	Generalist	Unlikely SRE
	Buddelundia \`BIS362\`	1 (1)	40 (7)	New species	Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Unlikely SRE
	Buddelundia \`BIS363\`	0 (0)	2 (1)	New species; from one location only	Minor Creekline	Creeklines	**Potential SRE**
	Buddelundia \`BIS364\`	147 (8)	589 (26)	New species	Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Unlikely SRE
	Buddelundia \`BIS439\`	0 (0)	5 (2)	New species	Minor Creekline	Creeklines	**Potential SRE**
	Buddelundia \`BIS440\`	0 (0)	4 (1)	New species; from one location only	Rocky Outcrop	Rocky outcrops	**Potential SRE**
	Buddelundia sp.	0 (0)	1 (1)	Possibly conspecific of above species		Uncertain	Uncertain
	Pseudodiploexochus \`BIS441\`	0 (0)	1 (1)	New species; from one location only	Minor Creekline	Creeklines	**Potential SRE**
	Armadillidae sp.	0 (0)	1 (1)	Possibly conspecific of above species		Uncertain	Uncertain
MOLLUSCA							
GASTROPODA							
Stylommatophora							
Camaenidae	*Basedowena* \`BGA043\`	0 (0)	206 (4)	New species	Gorge, Rocky Outcrop and Minor Creekline	Generalist	**Potential SRE**
	Rhagada richardsonii	12 (3)	483 (16)	Described species	Gorge, Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	**Potential SRE**
Pupillidae	*Gastrocopta mussoni*	0 (0)	27 (5)	Described species	Gorge, Rocky Outcrop and Minor Creekline	Rocky features	Widespread
	Pupoides beltianus	6 (3)	30 (13)	Described species	Gorge, Plain, Rocky Outcrop and Major/Minor Creeklines	Generalist	Widespread
	Pupoides contrarius	4 (1)	19 (7)	Described species	Gorge and Rocky Outcrop	Rocky features	Widespread
	Pupillidae sp.	0 (0)	3 (3)	Possibly conspecific of above species		Uncertain	Uncertain
Unknown family	Gastropoda sp.	0 (0)	1 (1)	Possibly conspecific of above species		Uncertain	Uncertain

Table 9. Higher order identifications of pseudoscorpions collected in reference sites during additional targeted survey at Woodie Woodie.
Numbers out of parentheses indicate number of specimens; numbers within parentheses indicate the number of sites from which individuals were collected.

Higher Taxonomy	Lowest Identification	Ref.	Taxonomy and distribution	Recorded Habitat(s)	Habitat Preference	SRE Status
ARTHROPODA						
ARACHNIDA						
Pseudoscorpiones						
Garypidae	Garypidae sp.	34 (3)	Higher order identification	Major and Minor Creeklines	Creeklines	Uncertain
Olpiidae	Olpiidae sp.	41 (5)	Higher order identification	Major and Minor Creeklines	Creeklines	Uncertain

The gorges and rocky outcrops (gorges mapped as rocky outcrop) are the highest value habitats for SREs in the Study Area and cover approximately 416.1 ha; both habitats are represented outside of the Study Area. The Indicative Footprint proposes to remove 25.6 ha (6.16% of what occurs in the Study Area) of this habitat type. This level of clearing to rocky outcrops or gorges should not significantly threaten the persistence of species that utilise them.

7. CONCLUSION

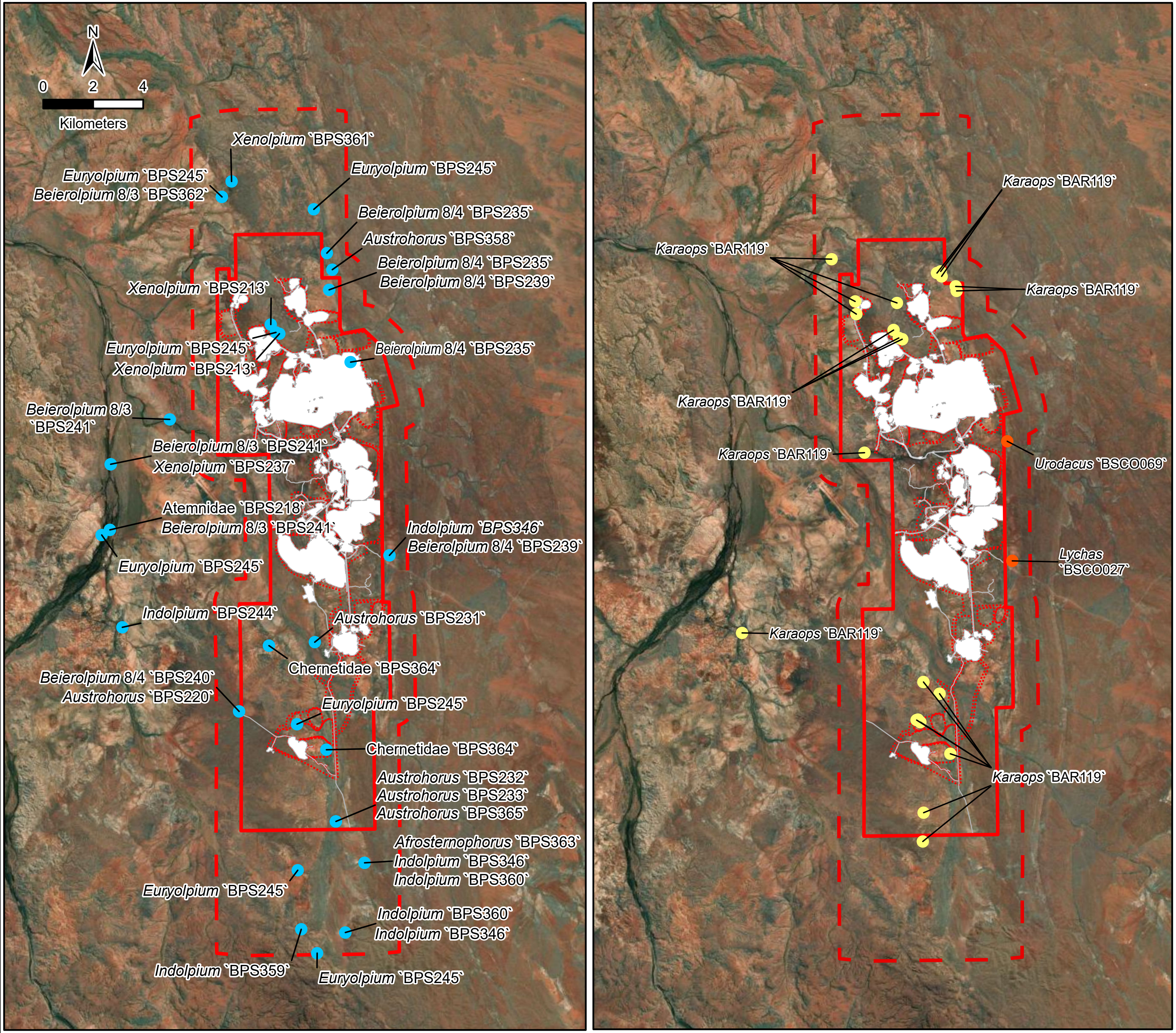
The desktop assessment of SRE fauna and habitats in the vicinity of Woodie Woodie found a paucity of terrestrial invertebrate collections, but showed that prospective habitat for SREs exists in the Study Area - gorges and rocky outcrops.

A Detailed survey was undertaken and recorded 76 species belonging to SRE groups of which 51 species are recorded for the first time in this study. Pseudoscorpions were the most abundant group, followed by isopods/slaters, then snails (mostly represented by dead shells), millipedes, mygalomorphs, centipedes, scorpions and selenopid and hersiliid araneomorphs. Twenty-two species are not SREs, 15 new species are unlikely to be SREs due to their family biology and occurrence in habitats that are not prospective for SREs, and 36 species are potential SREs.

Habitat assessments in conjunction with collections across Woodie Woodie identified six habitat types of which two typical SRE habitats (gorges and rocky outcrops) are present. The Indicative Project Footprint proposes to remove 25.6 ha (6.16% of what occurs in the Study Area) of these two habitat types, which should not significantly threaten the persistence of any species that utilise it.

Only one of the 36 potential SRE species was initially collected only from within the Indicative Project Footprint. This species, Chernetidae \`BPS364\`, was first found in a creekline that is connected to major creeklines towards the northwest of the Study Area. The vegetation type at the site where this species was first collected consists of mid sparse shrubland of mixed species dominated by *Acacia arida* over low sparse shrubland of mixed species and open hummock grassland dominated by *Triodia wiseana*. When this vegetation type intersects creeklines, isolated trees of *Corymbia* are present, and Chernetidae \`BPS364\` was originally collected from peeling the bark of one of these trees. Targeted sampling in other areas in the Development Envelope, specifically where the vegetation type described above intersects creeklines, was done between the 8th and 15th of October. This resulted in the collection of two additional specimens of Chernetidae \`BPS364\` (confirmed genetically) in habitat outside the Indicative Footprint of the Project, demonstrating that the distribution of this species extends towards the northwest of the Study Area, as predicted.

The other 35 species of potential SREs all have at least some occurrences outside the proposed mine pits and mine infrastructure.



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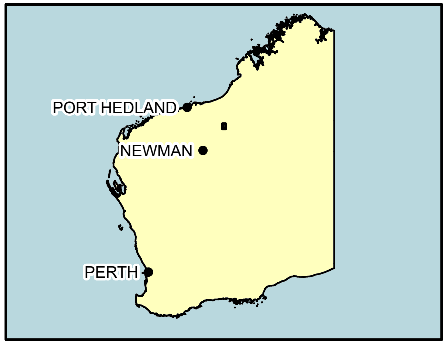
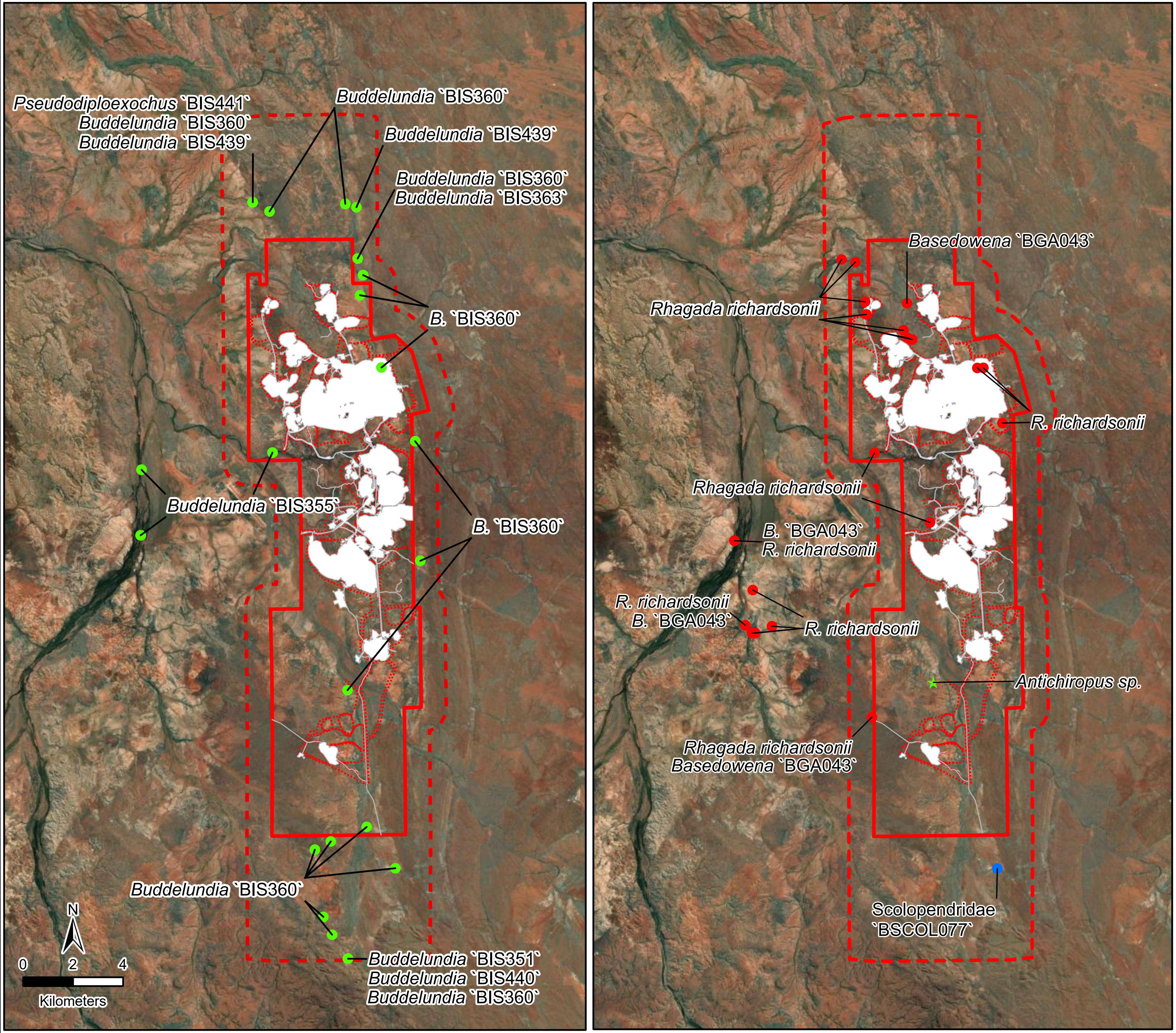
GDA 1994 MGA Zone 51
Author: VMarques
Date: 2/02/2022

Figure 7. Species of Potential SREs collected at Woodie Woodie. The left panel shows pseudoscorpions (most speciose group in the Study Area), whereas the right panel shows the other arachnid groups.

Legend
- Study Area
- Development Envelope
- Indicative Project Footprint
- Historic clearing

Potential SRE groups
- Spiders
- Scorpions
- Pseudoscorpions





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Author: VMarques
Date: 2/02/2022

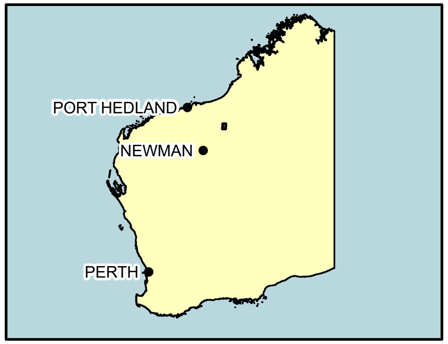
Figure 8. Species of Potential SREs collected at Woodie Woodie. The left panel shows the potential SRE isopods (most abundant group in the Study Area), whereas the right panel shows potential SRE millipedes, centipedes and snails.

Legend

- Study Area
- Development Envelope
- Indicative Project Footprint
- Historic clearing

Potential SRE groups

- Millipedes
- Centipedes
- Snails
- Isopods



8. REFERENCES

ABRS, 2009. Australian Faunal Directory. Australian Biological Resources Study, Canberra.

ALA, 2017. Atlas of Living Australia. National Research Infrastructure for Australia, Canberra.

Blakemore, R.J. (2000) Native Earthworms (Oligochaeta) from Southeastern Australia, with the Description of Fifteen New Species. *Records of the Australian Museum* **52**(2): 187-222.

Breure, A., and Whisson, C. (2012) Annotated type catalogue of Bothriembryon (Mollusca, Gastropoda, Orthalicoidea) in Australian museums, with a compilation of types in other museums. *ZooKeys* **194**(0): 41-80.

Car, C.A., and Harvey, M.S. (2013) A review of the Western Australian keeled millipede genus Boreohesperus (Diplopoda, Polydesmida, Paradoxosomatidae). *ZooKeys* **290**: 1-19.

Car, C.A., Harvey, M.S., Hillyer, M.J., and Huey, J.A. (2019) The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 3: species of the Pilbara bioregion of Western Australia. *Zootaxa* **4617**(1): 1-71.

Car, C.A., Wojcieszek, J.M., and Harvey, M.S. (2013) The millipede genus Antichiropus (Diplopoda: Polydesmida: Paradoxosomatidae), part 1: redefinition of the genus and redescriptions of existing species. *Records of the Western Australian Museum* **28**: 83-118.

Castalanelli, M.A., Teale, R., Rix, M.G., Kennington, W.J., and Harvey, M.S. (2014) Barcoding of mygalomorph spiders (Araneae : Mygalomorphae) in the Pilbara bioregion of Western Australia reveals a highly diverse biota. *Invertebrate Systematics* **28**(4): 375-385.

Cosgrove, J.G., Agnarsson, I., Harvey, M.S., and Binford, G.J. (2016) Pseudoscorpion diversity and distribution in the West Indies: sequence data confirm single island endemism for some clades, but not others. *Journal of Arachnology* **44**: 15.

Crews, S., and Harvey, M.S. (2011) The spider family Selenopidae (Arachnida, Araneae) in Australia and Asia. *ZooKeys* **99**(0): 1-103.

Crews, S.C. (2013) Thirteen new species of the spider genus Karaops (Araneae: Selenopidae) from Western Australia. *Zootaxa* **3647**: 443-469.

EPA (2016a) Environmental Factor Guideline - Terrestrial Fauna. Environmental Protection Authority, Perth, WA, 5 pp.

EPA (2016b) Technical Guidance - Sampling of short range endemic invertebrate fauna. Environmental Protection Authority, Perth, WA, 35 pp.

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

Framenau, V.W., Moir, M.L., and Harvey, M.S. (2008) Terrestrial invertebrates of the south coast NRM region of Western Australia: short-range endemics in Gondwanan relictual habitats.

Gibson, L.A., Williams, K.J., Pinder, A.M., Harwood, T.D., McKenzie, N.L., Ferrier, S., Lyons, M.N., Burbidge, A.H., and Manion, G. (2015) Compositional patterns in terrestrial fauna and wetland flora and fauna across the Pilbara biogeographic region of Western Australia and the representativeness of its conservation reserve system. *Records of the Western Australian Museum* **Supplement 78**: 515-545.

Gollan, J.R., Ashcroft, M.B., Cassis, G., Donnelly, A.P., and Lassau, S.A. (2009) Testing common habitat-based surrogates of invertebrate diversity in a semi-arid rangeland. *Biodiversity and Conservation* **18**(5): 1147-1159.

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

Harms, D., and Framenau, V.W. (2013) New species of mouse spiders (Araneae: Mygalomorphae: Actinopodidae: Missulena) from the Pilbara region, Western Australia. *Zootaxa* **3637**(5): 521-540.

Harvey, M.S. (1987) A revision of the genus Synsphyronus Chamberlin (Garypidae : Pseudoscorpionida : Arachnida). *Australian Journal of Zoology* **Supplementary Series No. 126**: 1-99.

Harvey, M.S. (1991) Notes on the genera Parahya Beier and Stenohya Beier (Pseudoscorpionida: Neobisiidae). *Bulletin of the British Arachnological Society* **8**: 288-292.

Harvey, M.S. (2002) Short-range endemism amongst the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* **16**(4): 555-570.

Harvey, M.S. (2010) Two new species of Synsphyronus (Pseudoscorpiones: Garypidae) from southern Western Australian granite landforms. *Records of the Western Australian Museum* **26**: 11-22.

Harvey, M.S. (2012) A new species of Synsphyronus (Pseudoscorpiones: Garypidae) from Western Australia. *Records of the Western Australian Museum* **27**: 55-61.

Harvey, M.S. (2018) Balgachernes occultus, a new genus and species of pseudoscorpion (Pseudoscorpiones: Chernetidae) associated with balga (Xanthorrhoea preissii) in south-western Australia, with remarks on Austrochernes and Troglochernes. *Records of the West Australian Museum* **33**: 115-130.

Harvey, M.S., Abrams, K.M., Beavis, A.S., Hillyer, M.J., and Huey, J.A. (2016) Pseudoscorpions of the family Feaellidae (Pseudoscorpiones : Feaelloidea) from the Pilbara region of Western Australia show extreme short-range endemism. *Invertebrate Systematics* **30**(5): 491-508.

Harvey, M.S., Abrams, K.M., and Burger, M.A.A. (2015) A new species of the pseudoscorpion genus Synsphyronus (Pseudoscorpiones: Garypidae) from Barrow Island, Western Australia. *Records of the Western Australian Museum* **30**: 137-143.

Harvey, M.S., Gruber, K., Hillyer, M.J., and Huey, J.A. (2020) Five new species of the open-holed trapdoor spider genus *Aname* (Araneae: Mygalomorphae: Anamidae) from Western Australia, with a revised generic placement for *Aname armigera*. *Records of the Western Australian Museum* **35**(1).

Isbell, R.F., 2002. The Australian Soil Classification, Revised Edition ed. CSIRO Publishing, Melbourne.

Jhasser Martínez, R., Isabel Quirós, D., Emmen, D., and Bedoya Roqueme, E. (2018) First report of phoresy of Pseudoscorpiones (Arachnida: Cheiridiidae) with Panstrongylus geniculatus (Latreille, 1811) (Hemiptera: Reduviidae). *Revista Iberica de Aracnologia* **32**: 127-130.

Judd, S. (2004) Terrestrial isopods (Crustacea: Oniscidea) and biogeographical patterns from south-western Australia. B. Sc. (Hons.), Edith Cowan University, Joondalup, WA

Judd, S., and Horwitz, P. (2003) Diversity and biogeography of terrestrial isopods (Isopoda, Oniscidea) from southwestern Australia: organic matter and microhabitat utilization in seasonally dry landscapes. *Crustaceana Monographs* **2**: 191-215.

Judd, S., and Tati, S. (2011) Preliminary taxonomy and biogeography of the subfamily Buddelundiinae Vandel (Armadillidae) in Western Australia. In 'Proceedings of 8th International Symposium of Terrestrial Isopod Biology, 19-23 June 2011, Bled, Slovenia.')

Kearse, M., Moir, R., Wilson, A., *et al.* (2012) Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* **28**: 1647-1649.

Kendrick, P., and McKenzie, N., 2001. Pilbara 1 (PIL1 – Chichester subregion), A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002, pp. 547-558.

Köhler, F., and Criscione, F. (2015) A molecular phylogeny of camaenid land snails from north-western Australia unravels widespread homoplasy in morphological characters. *Molecular Phylogenetcis and Evolution* **83**: 44-55.

Lira, A., and Tizo-Pedroso, E., 2017. Report of Sphenochernes camponoti (Beier, 1970) (Pseudoscorpiones, Chernetidae) in phoresy on Fanniidae (Diptera).

Main, B.Y. (1983) Further studies on the systematics of Australian Diplurinae (Chelicerata: Mygalomorphae: Dipluridae): Two new genera from south western Australia. *Journal of Natural History* **17**(6): 923-949.

Main, B.Y. (1986) Further Studies on the Systematics of Australian Diplurinae (Araneae: Mygalomorphae: Dipluridae): A New Genus from South-western Australia. *Records of the Western Australian Museum* **12**(4): 8.

Main, B.Y. (2008) A new species of the mygalomorph spider genus Yilgarnia from the Western Australian wheatbelt (Araneae : Nemesiidae). *Records of the Western Australian Museum* **24**: 4.

Muchmore, W.B. (1972) A phoretic Metatemnus (Pseudoscorpionida, Atemnidae) from Malaysia. *Entomol. News* **83**: 11-14.

Pillans, B. (2007) Pre-Quaternary landscape inheritance in Australia. *Journal of Quaternary Science* **22**(5): 439-447.

Pinder, A.M., Halse, S.A., Shiel, R.J., and McRae, J.M. (2010) An arid zone awash with diversity: patterns in the distribution of aquatic invertebrates in the Pilbara region of Western Australia. A Biodiversity Survey of the Pilbara Region of Western Australia, 2002 – 2007. Records of the Western Australian Museum, Perth, WA, 205-246 pp. pp.

Qiagen (2006) 'DNeasy blood & tissue handbook.' In (Qiagen) Available at https://www.qiagen.com/au/resources/resourcedetail?id=6b09dfb8-6319-464d-996c-79e8c7045a50&lang=en

Raven, R.J. (1994) Mygalomorph spiders of the Barychelidae in Australia and the Western Pacific. *Memoirs of the Queensland Museum* **35**(2): 291-706.

Reid, A. (2002) Western Australian Onychophora (Peripatopsidae): a new genus, Kumbadjena, for a southern species-complex. *Records of the Western Australian Museum* **21**: 129-155.

Rix, M.G., Cooper, S.J.B., Meusemann, K., Klopfstein, S., Harrison, S.E., Harvey, M.S., and Austin, A.D. (2017a) Post-Eocene climate change across continental Australia and the diversification of Australasian spiny trapdoor spiders (Idiopidae: Arbanitinae). *Molecular Phylogenetics and Evolution* **109**: 302-320.

Rix, M.G., Edwards, D.L., Byrne, M., Harvey, M.S., Joseph, L., and Roberts, J.D. (2015) Biogeogaphy and speciation of terrestrial fauna in the south-western Australian biodiversity hotspot. *Biological Reviews* **90**: 762-793.

Rix, M.G., Raven, R.J., Main, B.Y., Harrison, S.E., Austin, A.D., Cooper, S.J.B., and Harvey, M.S. (2017b) The Australasian spiny trapdoor spiders of the family Idiopidae (Mygalomorphae : Arbanitinae): a relimitation and revision at the generic level. *Invertebrate Systematics* **31**(5): 566-634.

Simon, C., Frati, F., Beckenbach, A., Crespi, B., Liu, H., and Flook, P. (1994) Evolution, Weighting, and Phylogenetic Utility of Mitochondrial Gene Sequences and a Compilation of Conserved Polymerase Chain Reaction Primers. *Annals of the Entomological Society of America* **87**(6): 651-701.

Solem, A. (1984) Small land snails from Northern Australia, III: Species of Helicodiscidae and Charopidae. *Journal of the Malacological Society of Australia* **6**(3-4): 155-179.

Solem, A. (1997) Camaenid Land Snails from Western and Central Australia (Mollusca: Pulmonata: Camaenidae). VII, Taxa from Dampierland through the Nullarbor. *Records of the Western Australian Museum* **Supplement No 50**: 1461-1906.

Stankowski, S., and Johnson, M.S. (2014) Biogeographic discordance of molecular phylogenetic and phenotypic variation in a continental archipelago radiation of land snails. *BMC Evolutionary Biology* **14**: 2.

Umwelt-Australia (2021) Woodie Woodie Flora and Vegetation Report

Western Wildlife (2021) Woodie Woodie Project: Detailed Vertebrate Fauna Survey 2020-2021. Western Wildlife, Mahogany Creek, WA, 63 pp.

Whisson, C., and Kirkendale, L. (2014a) Field Guide to the terrestrial and freshwater molluscs of the North West, version 1.0. Western Australian Museum, Perth, WA. http://museum.wa.gov.au/catalogues-beta/wam-fieldguides/pilbara-snails, (retrieved

Whisson, C., and Kirkendale, L. (2014b) Field Guide to the terrestrial and freshwater molluscs of the North West, version 1.0. In '.' (Western Australian Museum, Perth)

Whisson, C., and Köhler, F. (2013) Gastrocopta (Mollusca, Gastropoda, Pupillidae) in the Pilbara region of Western Australia. *ZooKeys* **261**(0): 15-39.

White, P.S., Morran, L., and de Roode, J., 2017. Phoresy.

9. APPENDICES

9.1. Higher order taxa of SRE groups in the desktop search area

Higher Classification	Lowest Identification	No. of Records	Status
Arthropoda			
Arachnida			
Araneae			
Nemesiidae	Anaminae sp.	1	Likely represented by *Aname* `MYG001 group` in the search area
Scorpiones			
Buthidae	Buthidae sp.	2	Likely represented by one of the *Lychas* species in the search area
	Lychas sp.	4	
Urodacidae	*Urodacus* sp.	1	Likely represented by one of the *Urodacus* species in the search area
Diplopoda			
Polydesmida			
Paradoxosomatidae	*Antichiropus* sp.	1	Likely represented by one of the species from this genus in the search area
Mollusca			
Gastropoda			
Camaenidae	*Rhagada* nr *richardsonii*	9	These records are likely to be shells and cannot be identified to species without live material. However, they are very likely to be the same as one of the two species from the search area
	Rhagada cf. *radleyi*	5	
	Rhagada sp.		

9.2. Survey methodology

Site				Sample	Rock	Burrow	Litter	Bark	Log	Tree	Leaf	Light & UV	No. of	No. of	No. of	Sampling Dates	
Number	Latitude	Longitude	Type	Methods	Turn	Digging	Sieve	Peeling	Turning	Dig	Blow	Spotlight	Wet Traps	Cup Traps	Litter Bags	Active search	Trapping Dates
1	-21.62676436	121.2015228	Reference	TFL	Y		Y	Y					3	0	2	20/08/2019	20/08 – 7/10/2019
2	-21.58594103	121.2165762	Reference	FL	Y		Y					Y	0	0	2	21/08, 6/10/2019	
3	-21.5854686	121.2152832	Reference	TFL	Y		Y			Y		Y	3	0	2	21/08/2019	21/08 – 6/10/2019
4	-21.58257446	121.2132863	Reference	FL	Y		Y	Y		Y		Y	0	0	2	21/08/2019	
5	-21.59647116	121.2439675	Impact	TFL	Y	Y							3	0	2	21/08/2019	21/08 – 3/10/2019
6	-21.59647698	121.2416366	Impact	TFL			Y						3	0	2	21/08/2019	21/08 – 3/10/2019
7	-21.69804017	121.2295876	Reference	FL	Y		Y						0	0	2	22/08/2019	
8	-21.69749679	121.2289133	Reference	TFL			Y	Y					3	0	2	22/08/2019	22/08 – 3/10/2019
9	-21.69111083	121.2169198	Reference	TFL			Y						3	0	2	22/08/2019	22/08 – 3/10/2019
10	-21.69073086	121.218085	Reference	TFL			Y	Y					3	0	2	22/08/2019	22/08 – 3/10/2019
11	-21.7098747	121.2232659	Reference	FL	Y		Y						0	0	2	22/08/2019	
12	-21.705848	121.2251228	Reference	TFL		Y	Y						3	0	2	22/08/2019	22/08 – 3/10/2019
13	-21.61644184	121.1738615	Reference	TFL			Y	Y	Y				3	0	2	23/08/2019	23/08 – 4/10/2019
14	-21.60135193	121.1707917	Reference	TFL			Y						3	0	2	23/08/2019	23/08 – 4/10/2019
15	-21.60195318	121.175174	Reference	TFL			Y				Y		3	0	2	23/08/2019	23/08 – 4/10/2019
16	-21.65608007	121.1501907	Reference	TFL			Y	Y					3	0	2	23/08/2019	23/08 – 4/10/2019
17	-21.65788875	121.146966	Reference	TFL	Y		Y						1	0	2	23/08/2019	23/08 – 4/10/2019
18	-21.63239421	121.1508113	Reference	TFL			Y						3	0	2	23/08/2019	23/08 – 4/10/2019
19	-21.69132611	121.1545734	Reference	TFL		Y	Y						2	0	2	23/08, 4/10/2019	23/08 – 4/10/2019
20	-21.69137035	121.1533624	Reference	FL	Y								0	0	2	23/08/2019	
21	-21.70952532	121.1929231	Reference	TFL			Y	Y			Y	Y	6	0	2	24/08/2019	24/08 – 5/10/2019
22	-21.72221338	121.1993249	Reference	TFL			Y	Y				Y	6	0	2	24/08/2019	24/08 – 5/10/2019
23	-21.70475161	121.1904891	Reference	TFL		Y	Y					Y	6	6	2	24/08/2019	24/08 – 4/10/2019
24	-21.73470599	121.2300185	Impact	TFL	Y		Y	Y					3	0	2	24/08/2019	24/08 – 4/10/2019
25	-21.73640666	121.2328951	Impact	TFL			Y	Y					6	0	2	24/08, 4/10/2019	24/08 – 5/10/2019
26	-21.73587803	121.2333576	Impact	FL	Y		Y						0	0	2	24/08/2019	
27	-21.71456349	121.2340932	Reference	TFL		Y	Y						3	1	2	24/08/2019	24/08 – 4/10/2019
28	-21.71418011	121.2294519	Reference	FL	Y		Y						0	0	2	25/08/2019	
29	-21.71233782	121.2285048	Reference	F	Y								0	0	0	25/08/2019	
30	-21.71187616	121.2287279	Reference	FL	Y		Y						0	0	2	25/08/2019	
31	-21.71292249	121.2294485	Reference	FL	Y		Y						0	0	2	25/08/2019	
32	-21.76274939	121.2445292	Reference	FL			Y						0	0	2	25/08/2019	
33	-21.75708081	121.2227464	Reference	FL	Y		Y						0	0	2	25/08/2019	
34	-21.76237312	121.2362683	Reference	TFL			Y		Y				6	0	2	25/08/2019	25/08 – 5/10/2019
35	-21.68652685	121.2536972	Impact	TFL	Y		Y						3	0	2	25/08/2019	25/08 – 6/10/2019
36	-21.68577338	121.2522098	Impact	TFL		Y	Y						3	0	2	25/08/2019	25/08 – 6/10/2019
37	-21.68283521	121.2513174	Reference	TFL			Y						3	0	2	25/08/2019	25/08 – 6/10/2019
38	-21.61646833	121.2510955	Impact	TFL		Y	Y						6	0	2	26/08/2019	26/08 – 7/10/2019
39	-21.5687069	121.2378208	Reference	FL	Y		Y						0	0	2	26/08/2019	
40	-21.57028949	121.2360177	Reference	TFL	Y								6	0	0	26/08/2019	26/08 – 4/10/2019
41	-21.56705815	121.2374742	Reference	F	Y								0	0	0	26/08/2019	
42	-21.55700228	121.2352946	Reference	TFL	Y		Y						4	0	2	26/08/2019	26/08 – 4/10/2019
43	-21.56217085	121.2303348	Reference	F	Y							Y	0	0	0	26/08, 7/10/2019	

Site				Sample	Rock	Burrow	Litter	Bark	Log	Tree	Leaf	Light & UV	No. of	No. of	No. of	Sampling Dates	
Number	Latitude	Longitude	Type	Methods	Turn	Digging	Sieve	Peeling	Turning	Dig	Blow	Spotlight	Wet Traps	Cup Traps	Litter Bags	Active search	Trapping Dates
44	-21.57584546	121.2290878	Reference	F	Y								0	0	0	26/08/2019	
45	-21.55772273	121.1950357	Reference	F	Y		Y	Y	Y	Y			0	0	0	27/08/2019	
46	-21.55673153	121.1896743	Reference	F	Y		Y	Y	Y	Y			0	0	0	27/08/2019	
47	-21.57281435	121.2147229	Reference	F	Y		Y						0	0	0	27/08/2019	
48	-21.68889672	121.1611081	Reference	F	Y	Y	Y	Y	Y		Y	Y	0	2	0	4/10/2019	
49	-21.67576742	121.1538508	Reference	F	Y								0	0	0	4/10/2019	
50	-21.68848335	121.150819	Reference	F	Y	Y	Y	Y	Y	Y	Y		0	0	0	5/10/2019	
51	-21.64921108	121.2380367	Impact	FL		Y	Y	Y	Y	Y	Y	Y	0	2	2	6/10/2019	
52	-21.65492258	121.2348054	Impact	FL			Y		Y		Y	Y	0	0	2	6/10/2019	
53	-21.65136552	121.2347901	Impact	FL			Y	Y				Y	0	0	2	6/10/2019	
54	-21.70104793	121.2343607	Reference	F	Y							Y	0	0	0	5/10/2019	
55	-21.72436389	121.2219306	Impact	F	Y								0	0	0	6/10/2019	
56	-21.72357111	121.2204564	Reference	FL	Y		Y						0	0	2	6/10/2019	
57	-21.72341111	121.2209889	Impact	F	Y		Y						0	0	0	6/10/2019	
58	-21.72418611	121.2203361	Impact	FL			Y	Y		Y			0	0	2	6/10/2019	
59	-21.72441667	121.2209389	Impact	F	Y								0	0	0	6/10/2019	
60	-21.72706918	121.2216816	Impact	FL	Y		Y	Y	Y	Y			0	0	2	6/10/2019	
61	-21.56339934	121.2321119	Reference	F	Y							Y	0	0	0	6/10/2019	
62	-21.56213222	121.231308	Reference	F		Y	Y					Y	0	3	0	6/10/2019	
63	-21.59243833	121.2334747	Impact	FL	Y		Y						0	0	2	7/10/2019	
64	-21.59302361	121.2336425	Impact	F			Y						0	0	0	7/10/2019	
65	-21.57206989	121.1985905	Reference	FL	Y		Y				Y		0	0	2	7/10/2019	
66	-21.57213471	121.199526	Impact	F							Y		0	0	0	6/10/2019	
67	-21.5766709	121.1990018	Reference	FL	Y		Y	Y	Y				0	0	2	7/10/2019	
68	-21.62071113	121.2286643	Impact	FL			Y	Y					0	0	2	7/10/2019	
69	-21.65211191	121.2226601	Reference	FL	Y		Y	Y	Y	Y	Y		0	0	2	7/10/2019	
70	-21.65624922	121.2257715	Reference	FL			Y	Y	Y	Y			0	0	2	7/10/2019	
71	-21.72268917	121.2212014	Reference	F	Y								0	0	0	6/10/2019	
72	-21.72422194	121.2232903	Reference	F	Y								0	0	0	6/10/2019	
73	-21.56158806	121.2317228	Reference	F	Y								0	0	0	6/10/2019	
74	-21.80310947	121.1978431	Reference	TFL	Y	Y		Y		Y		Y	3	0	2	26/03/2021	26/03 - 15/05/2021
75	-21.80117611	121.2223981	Reference	TFL	Y	Y		Y	Y	Y			3	0	2	27/03/2021	27/03 - 14/05/2021
76	-21.80988611	121.228425	Reference	TFL	Y			Y	Y	Y			3	0	2	27/03/2021	27/03 - 14/05/2021
77	-21.80254194	121.239435	Reference	TFL	Y	Y		Y		Y		Y	3	0	2	27/03/2021	27/03 - 16/05/2021
78	-21.79469611	121.2191169	Reference	TFL	Y	Y				Y	Y		3	0	2	27/03/2021	27/03 - 14/05/2021
79	-21.77983806	121.2212961	Reference	TFL		Y		Y		Y	Y		3	0	2	27/03/2021	27/03 - 14/05/2021
80	-21.53721306	121.2307561	Reference	TFL	Y			Y	Y	Y			3	0	2	28/03/2021	28/03 - 14/05/2021
81	-21.53848389	121.2350211	Reference	TFL	Y	Y		Y	Y	Y			3	0	2	28/03/2021	28/03 - 14/05/2021
82	-21.54111611	121.23043	Reference	TFL	Y			Y		Y			3	0	2	28/03/2021	28/03 - 14/05/2021
83	-21.54603806	121.234045	Reference	TFL	Y			Y	Y	Y			3	0	2	28/03/2021	28/03 - 14/05/2021
84	-21.56302389	121.2373219	Reference	TFL	Y			Y	Y	Y	Y		3	0	2	28/03/2021	28/03 - 14/05/2021
85	-21.77037	121.2161261	Reference	TFL	Y			Y	Y	Y	Y		3	0	2	29/03/2021	29/03 - 14/05/2021
86	-21.768725	121.2115561	Reference	TFL	Y			Y	Y	Y	Y		3	6	2	29/03/2021	29/03 - 14/05/2021
87	-21.76748306	121.2223219	Reference	TFL	Y			Y	Y	Y			3	0	2	29/03/2021	29/03 - 14/05/2021
88	-21.66644806	121.2581661	Reference	TFL	Y			Y	Y	Y	Y	Y	3	4	2	29/03/2021	29/03 - 14/05/2021

Site				Sample	Rock	Burrow	Litter	Bark	Log	Tree	Leaf	Light & UV	No. of	No. of	No. of	Sampling Dates	
Number	**Latitude**	**Longitude**	**Type**	**Methods**	**Turn**	**Digging**	**Sieve**	**Peeling**	**Turning**	**Dig**	**Blow**	**Spotlight**	**Wet Traps**	**Cup Traps**	**Litter Bags**	**Active search**	**Trapping Dates**
89	-21.77743611	121.2471731	Reference	TFL	Y			Y	Y	Y			3	0	2	30/03/2021	30/03 - 14/05/2021
90	-21.62323111	121.2567239	Reference	TFL	Y			Y		Y	Y	Y	3	3	2	30/03/2021	30/03 - 14/05/2021
91	-21.530715	121.1988039	Reference	TFL	Y			Y	Y	Y		Y	3	0	2	31/03/2021	31/03 - 15/05/2021
92	-21.53625889	121.194975	Reference	TFL	Y	Y		Y	Y	Y	Y	Y	3	0	2	31/03/2021	31/03 - 15/05/2021
93	-21.53963111	121.201445	Reference	TFL	Y			Y	Y	Y			3	0	2	31/03/2021	31/03 - 14/05/2021
94	-21.747996	121.230000	Reference	F				Y					0	0	0	13/10/2021	
95	-21.747376	121.230120	Reference	F				Y					0	0	0	13/10/2021	
96	-21.744096	121.225232	Reference	F				Y					0	0	0	13/10/2021	
97	-21.750621	121.237359	Reference	F				Y					0	0	0	13/10/2021	
98	-21.698591	121.211168	Reference	F				Y					0	0	0	13/10/2021	
Total					**62**	**18**	**57**	**46**	**26**	**30**	**17**	**20**	**163**	**27**	**142**	**102**	**48**

9.3. Site Characteristics

Site	Soil		Landform		Slope		Shade	Condition		% Cover of Litter Depths			Vegetation		
	Group	Density	Primary	Secondary	Angle	Aspect	Cover	Fire	Stock	<1cm	1-5 cm	>5cm	Dominant	Secondary	Present
1	Fine	Clay	Major Creekline	Overhanging Rock	Gentle	E/W	20%	0	3	94.9	5	0.1	Eucalyptus Woodland	Spinifex	
2	Coarse Fine	Clay	Gorge	Major Creekline	Steep	S	10%	0	2	83	15	2	Eucalyptus, Ficus, Whitewoods		
3	Coarse Fine	Sand and Clay	Gorge	Major Creekline	Steep	S	10%	0	3	94.9	5	0.1	Eucalyptus, Ficus, Whitewoods		
4	Coarse Fine	Sand and Clay	Gorge	Major Creekline	Steep	SW	10%	0	2	94.9	5	0.1	Eucalyptus Woodland		
5	Coarse Fine	Sand and Clay	Minor Creekline		Flat	E/W	10%	0	2	98	2	0	Acacia Shrubland	Spinifex	
6	Coarse Fine	Sand and Clay	Plain		Flat	-	2%	0	0	98	2	0	Grassland	Spinifex	
7	Coarse Fine	Sand and Rock	Rocky Outcrop	Gully	Steep	SW	2%	0	1	99.9	0.1	0	Whitewood	Spinifex	
8	Coarse Fine	Sand	Minor Creekline		Gentle	N/S	7%	0	2	99.9	0.1	0	Whitewood	Spinifex	
9	Coarse Fine	Rock and Clay	Plain		Flat	-	2%	0	2	99	1	0	Grassland	Spinifex	
10	Coarse Fine	Rock and Clay	Major Creekline		Gentle	E/W	20%	0	2	94.9	5	0.1	Eucalyptus Woodland		
11	Coarse Fine	Sand and Rock	Gorge		Steep	N/S	25%	0	0	99	1	0	Eucalyptus Woodland		
12	Coarse Fine	Sand and Clay	Plain		Gentle	-	2%	0	2	99.9	0.1	0	Acacia Shrubland	Grassland	
13	Coarse Fine Organic	Clay Rock Sand River Bed	Major Creekline		Gentle	E/W	40%	0	2	93	5	2	Eucalyptus Woodland		
14	Fine	Sand and Rock	Plain		Flat	-	2%	0	1	99.9	0.1	0	Grassland	Hummock	
15	Coarse Fine	Sand and Rock	Minor Creekline	Plain	Gentle	N/S	2%	0	3	98	2	0	Acacia Shrubland		
16	Coarse Fine	Clay Rock Sand	Major Creekline		Moderate	N/S	10%	3	2	93	5	2	Eucalyptus Woodland	Melaleuca	
17	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	E	15%	1	0	95	5	0	Ficus		
18	Coarse Fine	Sand and Rock	Major Creekline		Gentle	N/S	15%	0	3	97.9	2	0.1	Eucalyptus Woodland		
19	Coarse Fine	Sand and Rock	Minor Creekline	Plain	Gentle	E/W	2%	3	2	99.9	0.1	0	Grassland	Eucalyptus	
20	Coarse Fine	Rock	Rocky Outcrop		Steep	SW	5%	0	1	99.9	0.1	0	Eucalyptus		
21	Coarse Fine	Sand and Rock	Minor Creekline		Gentle	E/W	4%	0	1	95	5	0	Eucalyptus Woodland	Acacia Shrubland	Grassland
22	Coarse Fine	Sand	Minor Creekline	Plain	Gentle	NE/SW	2%	0	1	97	3	0	Eucalyptus Woodland	Acacia	
23	Coarse Fine	Sand and Rock	Plain		Gentle	-	1%	0	1	99.9	0.1	0	Acacia Shrubland		
24	Coarse Fine	Sand and Rock	Minor Creekline		Gentle	E/W	3%	0	2	98	2	0	Eucalyptus Woodland	Acacia Shrubland	Grassland
25	Coarse Fine	Sand and Rock	Minor Creekline		Gentle	E/W	2%	0	3	97.9	2	0.1	Eucalyptus Woodland	Acacia Shrubland	Grassland
26	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	E/W	5%	0	0	97.5	2	0.5	Grassland	Ficus	
27	Fine	Clay and Rock	Plain		Flat	-	1%	2	1	99.9	0.1	0	Grassland	Acacia Shrubland	
28	Coarse Fine	Clay and Rock	Rocky Outcrop		Steep	E	15%	0	0	99.9	0.1	0	Grassland	Eucalyptus	
29	Coarse Fine	Clay and Rock	Stony hill	Rocky Outcrop	Gentle	-	0%	0	0	100	0	0	Grassland	Spinifex	
30	Coarse Organic	Ficus debris, Rock and Clay	Gorge		Steep	S	5%	0	0	94.9	5	0.1	Ficus	Acacia Shrubland	Spinifex
31	Coarse Fine Organic	Clay, Rock and Ficus debris	Rocky Outcrop		Steep	W	5%	0	0	89	10	1	Ficus	Spinifex	
32	Coarse	Gravel	Minor Creekline	Rocky Outcrop	Steep	E/W	5%	0	1	99.9	0.1	0	Eucalyptus Woodland	Buffel	Tussock
33	Coarse Fine	Clay and Rock	Rocky Outcrop		Moderate	S	1%	1	0	99.9	0.1	0	Grassland		
34	Fine	Clay	Major Creekline		Moderate	N/S	5%	0	2	96	3	1	Eucalyptus Woodland	Acacia Shrubland	Grassland
35	Coarse Fine	Sand and Rock	Rocky Outcrop		Gentle	NE	1%	0	0	99.9	0.1	0	Grassland		
36	Coarse Fine	Clay and Rock	Plain		Gentle	E	1%	0	0	99.9	0.1	0	Grassland	Acacia Shrubland	
37	Coarse Fine	Clay and Rock	Plain		Gentle	NE	5%	0	3	99.9	0.1	0	Grassland	Acacia Shrubland	
38	Coarse Fine	Clay and Rock	Plain		Gentle	S	0%	0	2	99.9	0.1	0	Grassland		
39	Coarse Fine	Sand and Rock	Gorge		Steep	E/W	2%	2	0	98	2	0	Eucalyptus Woodland		
40	Coarse Fine	Sand and Rock	Minor Creekline		Gentle	E/W	1%	2	0	99.9	0.1	0	Eucalyptus Woodland	Acacia Shrubland	Grassland
41	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	E/W	1%	2	0	99.9	0.1	0	Eucalyptus Woodland		
42	Coarse Fine	Clay and Rock	Minor Creekline		Gentle	E/W	5%	1	1	99	1	0	Eucalyptus Woodland	Acacia Shrubland	Grassland
43	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	S	2%	0	0	99.9	0.1	0	Grassland		
44	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	S	1%	1	0	99.9	0.1	0	Grassland	Eucalyptus	

Site	Soil		Landform		Slope		Shade	Condition		% Cover of Litter Depths			Vegetation		
	Group	Density	Primary	Secondary	Angle	Aspect	Cover	Fire	Stock	<1cm	1-5 cm	>5cm	Dominant	Secondary	Present
45	Coarse	Rock	Gorge	Major Creekline	Steep	E/W	2%	2	0	97.9	2	0.1	Ficus		
46	Coarse Fine	Sand and Rock	Gorge	Major Creekline	Steep	E/W	2%	2	0	94.9	5	0.1	Grassland		
47	Coarse Fine	Sand and Rock	Gorge	Major Creekline	Steep	E/W	2%	2	0	97.9	2	0.1	Grassland	Eucalyptus	
48	Coarse Fine	Sand	Plain	Minor Creekline	Flat	-	2%	3	2	99.9	0.1	0	Grassland	Eucalyptus	
49	Coarse Fine	Sand and Rock	Rocky Outcrop		Moderate	-	0%	3	0	99.9	0.1	0		Acacia Shrubland	
50	Coarse Fine	Sand and Rock	Rocky Outcrop	Major Creekline	Steep	W	5%	3	2	97.9	2	0.1	Whitewood	Shrubland	
51	Coarse Fine	Sand and Rock	Minor Creekline	Plain	Gentle	-	6%	0	3	96	3	1	Eucalyptus Woodland	Grassland	
52	Coarse Fine	Sand and Rock	Plain		Flat	-	2%	0	3	97.9	2	0.1	Grassland	Shrubland	
53	Coarse Fine	Clay and Rock	Plain		Gentle	-	2%	0	2	97.9	2	0.1	Acacia Shrubland	Grassland	
54	Coarse Fine	Clay and Rock	Rocky Outcrop (Artificial)		Steep	S	4%	0	0	99	1	0			
55	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	S	3%	0	0	99	1	0	Grassland	Shrubland	
56	Coarse Fine	Sand and Rock	Rocky Outcrop		Moderate	S/W	3%	0	0	98	2	0	Grassland	Shrubland	
57	Coarse Fine	Sand and Rock	Rocky Outcrop		Moderate	S/W	4%	0	0	99.9	0.1	0	Grassland	Shrubland	
58	Coarse Fine	Sand and Rock	Minor Creekline		Gentle	N/S	6%	0	1	98	2	0	Grassland	Shrubland	
59	Coarse Fine	Sand and Rock	Rocky Outcrop		Moderate	N	2%	0	0	99	1	0	Grassland	Shrubland	
60	Coarse Fine	Sand and Rock	Minor Creekline		Flat	-	8%	0	3	97.9	2	0.1	Eucalyptus Woodland	Shrubland	
61	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	S/W	10%	0	0	99	1	0	Grassland	Shrubland	
62	Coarse Fine	Sand and Rock	Plain		Flat	-	5%	0	2	99	1	0	Grassland	Shrubland	
63	Coarse Fine	Sand and Rock	Rocky Outcrop		Gentle	S/W	4%	0	2	99	1	0	Grassland	Shrubland	
64	Coarse Fine	Sand and Rock	Plain		Flat	-	3%	0	2	99	1	0	Grassland	Acacia Shrubland	
65	Coarse Fine	Sand and Rock	Rocky Outcrop		Gentle	S/W	1%	3	0	99.9	0.1	0	Grassland		
66	Coarse	Rock	Stony hill		Flat	-	1%	1	0	99.9	0.1	0	Grassland		
67	Coarse Fine	Sand and Rock	Gorge	Rocky Outcrop	Steep	S	4%	1	1	99	1	0	Grassland	Shrubland	
68	Coarse Fine	Sand and Rock	Plain		Gentle	S	6%	1	1	99	1	0	Eucalyptus Woodland	Grassland	
69	Coarse Fine	Sand and Rock	Minor Creekline		Gentle	-	7%	0	3	97.9	2	0.1	Eucalyptus Woodland	Grassland	
70	Coarse Fine	Sand and Rock	Floodplain		Flat	-	6%	0	3	98	2	0	Eucalyptus Woodland	Grassland	
71	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	S	1%	0	1	97.9	2	0.1	Shrubland	Grassland	
72	Coarse Fine	Sand and Rock	Rocky Outcrop		Gentle	S/W	2%	0	0	99.9	0.1	0	Shrubland	Grassland	
73	Coarse Fine	Sand and Rock	Rocky Outcrop		Steep	S/W	1%	0	0	99.9	0.1	0	Grassland		
74	Coarse Fine	Medium Clay	Major Creekline		Flat	-	45%	1	1	90	10	0	Grassland	Spinifex	Eucalyptus
75	Coarse Fine	Medium Clay and Rock	Rocky Outcrop		Steep	South	25%	0	0	94	6	0	Grassland	Spinifex	Whitewood
76	Coarse Fine	Medium Clay and Rock	Rocky Outcrop		Steep	S/W	50%	0	0	88	12	0	Grassland	Spinifex	Whitewood
77	Coarse Fine	Medium Clay and Rock	Minor Creekline	Rocky Outcrop	Steep	S/W	35%	0	0	88	12	0	Whitewood on creekline	Shrubland	
78	Coarse Fine	Sandy Clay Loam	Minor Creekline		Low	N/W	50%	0	0	94	6	0	Shrubland	Spinifex	Whitewood
79	Coarse Fine	Clayey Sand	Minor Creekline		Flat	-	35%	1	2	85	15	0	Shrubland	Spinifex	Ficus
80	Coarse Fine	Medium Clay	Minor Creekline		Moderate	West	50%	0	0	75	25	0	Shrubland	Spinifex	
81	Coarse Fine	Medium Clay	Minor Creekline		Moderate	North	15%	1	0	92	8	0	Spinifex	Whitewood	
82	Coarse Fine	Light Clay	Minor Creekline		Flat	-	50%	0	0	75	25	0	Shrubland	Whitewood	
83	Coarse Fine	Loam and Rock	Rocky Outcrop		Steep	East	60%	1	0	75	25	0	Shrubland	Spinifex	Whitewood
84	Coarse Fine	Medium Clay and Rock	Rocky Outcrop	Large cave	Very Steep	South	70%	1	0	63	35	2	Spinifex	Whitewood	
85	Coarse Fine	Clayey Sand	Minor Creekline		Flat	-	25%	0	0	88	12	0	Spinifex	Shrubland	
86	Coarse Fine	Medium Clay	Plain		Flat	-	35%	1	0	63	35	2	Spinifex	Whitewood	Shrubland
87	Coarse Fine	Medium Clay	Minor Creekline		Steep	West	25%	0	0	55	40	5	Spinifex	Shrubland	Whitewood
88	Coarse Fine	Clayey Sand	Minor Creekline	Rocky outcrop	Moderate	South	45%	0	2	78	20	2	Grassland	Spinifex	Whitewood
89	Coarse Fine	Medium Clay	Major Creekline		Steep	South	65%	0	2	94	6	0	Grassland	Whitewood	

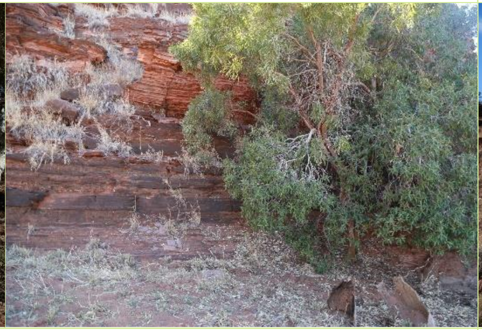
Site	Soil		Landform		Slope		Shade	Condition		% Cover of Litter Depths			Vegetation		
	Group	Density	Primary	Secondary	Angle	Aspect	Cover	Fire	Stock	<1cm	1-5 cm	>5cm	Dominant	Secondary	Present
90	Coarse Fine	Clayey Sand	Major Creekline		Flat	-	35%	0	3	82	18	0	Grassland	Whitewood	
91	Coarse Fine	Medium Clay	Minor Creekline		Moderate	South	30%	1	0	92.5	7	0.5	Spinifex	Shrubland	
92	Coarse Fine	Medium Heavy Clay	Minor Creekline		Low	N/E	45%	0	2	79	20	1	Grassland	Ficus	Spinifex
93	Coarse Fine	Medium Clay	Rocky outcrop/Gorge	Stony hill	Steep	South	15%	0	0	92.5	7	0.5	Spinifex	Ficus	
94	Coarse Fine	Medium Clay and Rock	Minor Creekline		Flat	-	5%	0	0	80	19.9	0.1	Spinifex	Grassland	Eucalyptus
95	Coarse Fine	Sand and Rock	Minor Creekline		Low	East	5%	0	0	90	10	0	Spinifex	Grassland	Eucalyptus
96	Coarse Fine	Medium Clay	Minor Creekline		Flat	-	15%	0	1	75	24.9	0.1	Spinifex	Acacia Shrubland	Eucalyptus
97	Coarse Fine	Medium Clay	Major Creekline		Flat	-	25%	0	2	65	34.5	0.5	Grassland	Eucalyptus	
98	Coarse Fine	Clayey Sand	Minor Creekline		Flat	-	25%	0	2	90	10	0	Grassland	Eucalyptus	

9.4. Photos of SRE Sites

Site 01


Site 02


Site 03

Site 04


Site 05


Site 06


Site 07

Site 08

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Site 20


Site 21


Site 22


Site 23


Site 24


Site 25


Site 26


Site 27


Site 28


Site 29

Only one photo available.

Site 30


Site 31

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Site 55


Site 56


Site 57

Only one photo available.

Site 58


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Site 61


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Only one photo available.

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Site 89


Site 90


Site 91	Site 92
 	 
Site 93	**Site 94**
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Site 95	**Site 96**
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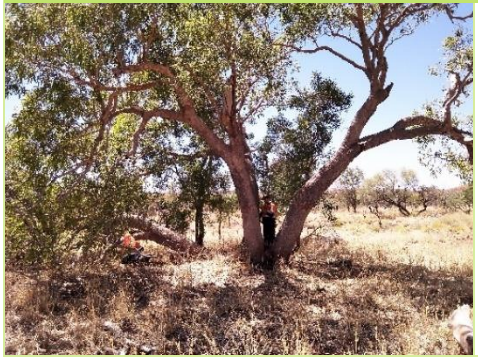
Site 97		Site 98	
	Only one photo available.		Only one photo available.