Biota Environmental Sciences

A Short Range Endemic Invertebrate Fauna Survey of the Southern Koolyanobbing Range

Prepared for Cliffs Asia Pacific Iron Ore Pty Ltd

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Southern Koolyanobbing Range SRE Fauna Survey

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1.1 Introduction

Cliffs Asia Pacific Iron Ore Pty Ltd (Cliffs) operates three iron ore mines at Koolyanobbing Range, Mt Jackson Range and the Windarling Range, with an ore processing facility at the Koolyanobbing Range mine. Together, these three operations form the Yilgarn Operations.

Biota Environmental Sciences (Biota) was commissioned by Cliffs to conduct a short range endemic (SRE) invertebrate fauna survey in an area of identified mineral prospectivity (herein referred to as the Investigation Area) located at the southern Koolyanobbing Range (herein referred to as the Study Area).

1.2 Methods

SRE searches were conducted at 33 locations across the Study Area, both within and outside of the Investigation Area, using non-systematic sampling techniques. The following invertebrate groups were targeted:

- Mygalomorphae (trapdoor spiders);
- Pseudoscorpionida (pseudoscorpions);
- Scorpionida (scorpions);
- Diplopoda (millipedes); and
- Pulmonata (land snails).

1.3 Results

The SRE fauna survey recorded 21 taxa / morphotypes comprising one land snail taxon, five millipede taxa and fifteen mygalomorph morphotypes. The majority of taxa /morphotypes were found to occur across the Study Area, both within and outside of the Investigation Area, and have also been recorded from surveys conducted previously in the region. Of those that have not been collected previously, none were restricted to inside the Investigation Area; all were collected across the broader Study Area of the southern Koolyanobbing Range.

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2.0 Introduction

2.1 Survey Background

Cliffs Asia Pacific Iron Ore Pty Ltd (Cliffs) operates three iron ore mines at Koolyanobbing Range, Mt Jackson Range and the Windarling Range, with an ore processing facility at the Koolyanobbing Range mine. Together, these three operations form the Yilgarn Operations.

Biota Environmental Sciences (Biota) was commissioned by Cliffs to conduct a short range endemic (SRE) invertebrate fauna survey in an area of identified mineral prospectivity (herein referred to as the Investigation Area) located at the southern Koolyanobbing Range (herein referred to as the Study Area) (Figure 2.1).

2.2 Terminology

2.2.1 Study Area

The Study Area is defined in this report as the area of the southern Koolyanobbing Range encompassing all the survey sites, both within and outside the Investigation Area.

2.2.2 Investigation Area

The Investigation Area is defined in this report as the area of identified mineral prospectivity in which terrestrial disturbance could potentially occur from a mine development.

2.3 Study Objectives and Scope

2.3.1 Scope

This report documents the methods, results and key findings of the terrestrial SRE invertebrate fauna survey within the Study Area. It provides an assessment of the potential SRE species recorded.

The scope of the study was to:

- determine the potential of SRE fauna existing in the Study Area using a desktop assessment;
- undertake a targeted terrestrial SRE fauna survey of the Study Area, with a specific focus on the Investigation Area, consistent with relevant EPA Guidance Statements;
- document the potential SRE fauna assemblage within the Study Area and Investigation Area using established sampling techniques; and
- identify any potential SRE fauna that may be of conservation significance.

The survey was planned and conducted in accordance with EPA Guidance Statement 20, "Sampling Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia" (EPA 2009).

2.3.2 Purpose of the Report

This document reports on the desktop assessment and SRE fauna survey conducted in the Study Area and examines potential conservation issues. Its intended use is as a supporting document for environmental impact assessment. Both the survey and report are subject to specific limitations that are discussed in more detail in Section 4.4.

2.4 Short Range Endemic Invertebrate Fauna

Certain invertebrate groups display naturally small distributions (less than 10,000 km^2) and are referred to as short-range endemic invertebrates (general reference: Harvey 2002; freshwater snails: Ponder and Colgan 2002; land snails: Johnson et al. 2004; mygalomorph spiders: York Main et al. 2000). These invertebrates often possess similar ecological and life-history characteristics and are in part characterised by low fecundity, slow growth, poor dispersal capabilities (Harvey 2002).

Short-Range Endemic invertebrates are often confined to disjunct 'refugial' habitats, having persisted from a time when moist conditions were more evenly distributed throughout the Australian landscape (Harvey 2002).

Given the importance of short-range endemism to biodiversity conservation, the assessment of such taxa is an important component of impact assessment. For the purposes of this report, the potential SRE invertebrate groups that are most likely to occur within the Study Area include land snails, mygalomorph spiders, millipedes, scorpions and pseudoscorpions.

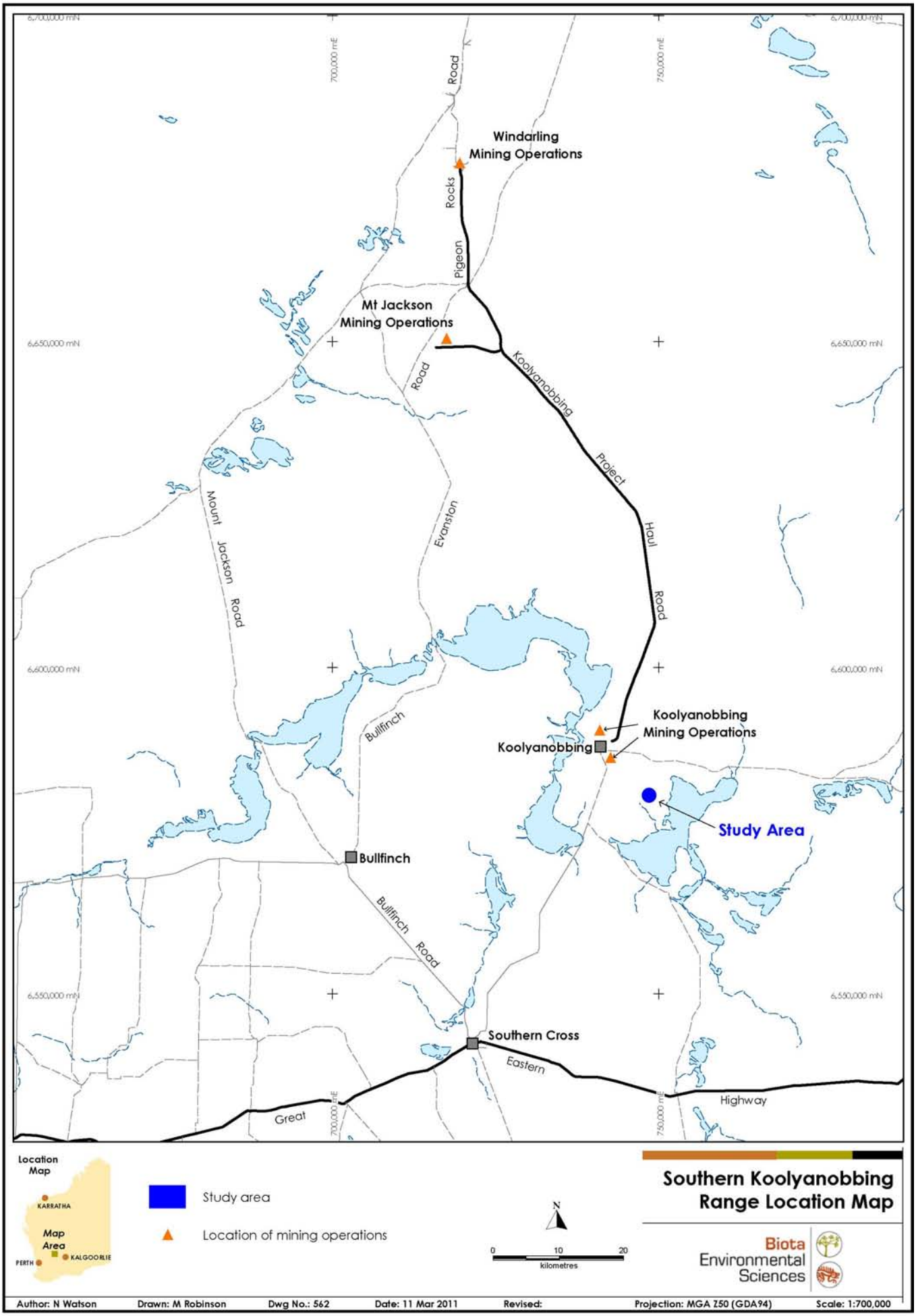

Figure 2.1: Location of the Yilgarn Operations and the Southern Koolyanobbing Range Study Area

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3.0 Desktop Assessment

The preliminary assessment of existing information included a desktop review of previous surveys and land systems in the locality of the study area.

3.1 Previous Surveys

Several fauna surveys have been carried out in the Midwest and Goldfields region surrounding the Koolyanobbing Range, as well as for the operations managed by Cliffs at the Windarling Range, Mt Jackson Range and the Koolyanobbing Range. These surveys include but would not be limited to:

- Windarling/Mt Jackson Project: Fauna Studies (Bamford and Metcalf 2005).
- Fauna Assessment of the J1 Mining Area (Bamford 2006).
- Windarling/Mt Jackson Project - Report on the 2004/2005 Fauna Surveys (Bamford and Bancroft 2006).
- Windarling/Mt Jackson Project: Fauna Monitoring 2004 – 2006 (Bamford and Metcalf 2007).
- Fauna assessment of the Koolyanobbing area (Bamford and Turpin 2007).
- Fauna Survey of the Carina Prospect (Ninox Wildlife Consulting 2009).
- Koolyanobbing Expansion Project - Fauna Assessment Survey (Ecologia Environmental Consultants (Ecologia 2001).
- Mt Jackson Short Range Endemic Survey (Biota Environmental Sciences 2009).
- Deception Deposit Short Range Endemic Survey (Biota Environmental Sciences 2011a).
- Windarling W4 East Short Range Endemic Survey (Biota Environmental Sciences 2011b).
- Short Range Endemic Invertebrate Fauna Survey Windarling Range (Biota Environmental Sciences 2012).

Table 3.1: Summary of potential SRE taxa recognised from surveys in the region

Taxa	Distribution	Survey
Antichiropus sp. nov. 'Mt Jackson'	Mt Jackson, Windarling, Deception	Bamford 2006; Biota 2011a, 2012
Atelomastix bamfordi	Mt Jackson, Windarling, Deception	Bamford 2006; Biota 2011a, 2011b
Atelomastix sp. nov. 'Yendilberin'	Yendilberin Hills	Ninox 2009; Framenau and Harvey 2008
Antichiropus sp. nov. `Mt Gibson 1`	Yendilberin Hills (Previously also recorded at Mt Gibson)	Ninox 2009; Framenau and Harvey 2008
Antichiropus 'Mt Jackson sp.2'	Mt Jackson, Windarling, Deception	Biota 2011a, 2011b, 2012
affin. *Galeosoma*	Windarling, Deception	Biota 2011a, 2012
Teyl `MYG021`	Yendilberin Hills	Ninox 2009; Framenau and Harvey 2009
Yilgarnia `MYG197`	Deception	Biota 2011a
Aname sp. `male indet`	Deception	Biota 2011a
Teyl `MYG217`	Deception	Biota 2011a

3.2 Biological Context of the Study Area

3.2.1 Land Systems

Land systems have not previously been mapped for the Study Area.

3.2.2 Vegetation Mapping

Beard (1975) mapped the vegetation of the South-west of WA at a scale of 1: 1,000,000. The Study Area intersects 3 of Beard's vegetation units, shown in Figure 3.1.

3.2.3 IBRA Bioregions

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions and 403 subregions within Australia (Environment Australia 2000). The Study Area lies in the north of the Southern Cross subregion of the Coolgardie bioregion, which is described by Environment Australia (2000) as:

> "*Mallees and scrubs on sandplains associated with lateritised uplands, playas and granite outcrops. Diverse woodlands rich in endemic eucalypts, on low greenstone hills, valley alluvials and broad plains of calcareous earths. In the west, the scrubs are rich in endemic Proteaceae, in the east they are rich in endemic acacias*."

The region is considered to support centres of endemism based around the ironstone formation ranges.

3.2.4 Ironstone Ranges of the Yilgarn Region

The iron formation ranges of the Yilgarn Craton make up a small proportion of the land in the region, which is predominantly flat. They are ancient, isolated features which have different geology, soils and biological aspects to the surrounding land, and are seen to represent a unique habitat for endemic flora and flora in the region (DEC 2007). The extent of local endemism to particular ironstone ranges is difficult to establish for the majority of species due to the limited data gathered to date. Nevertheless, the disjunct nature of the ironstone ranges means they are likely candidates to support species with isolated, small distributions.

The desktop assessment suggests a high probability for the presence of potential SRE fauna within the Study Area. Several putative SRE taxa have been highlighted by the WA Museum from various studies in the region and the iron formation ranges are considered to represent areas with significant potential to support SRE fauna.

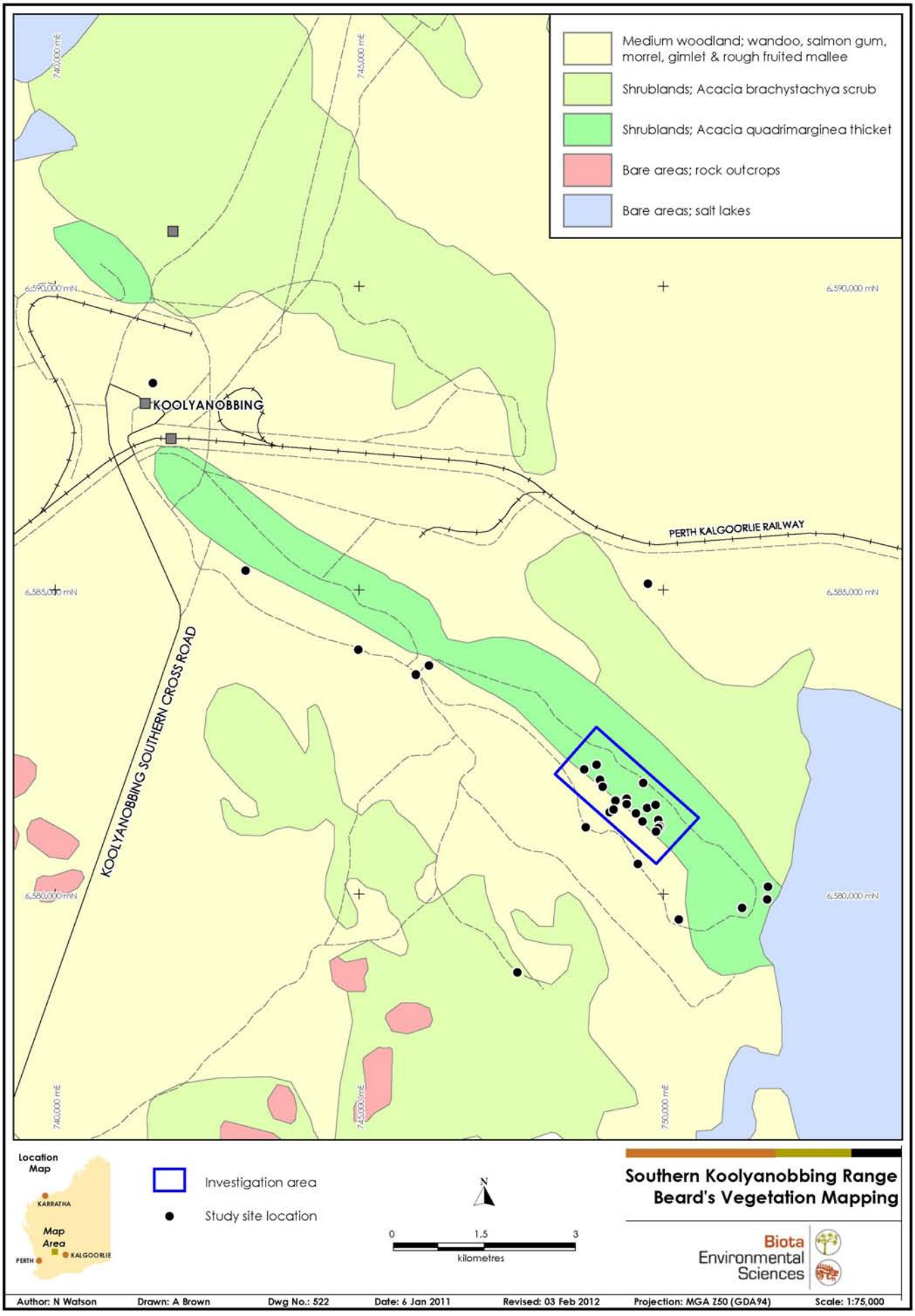

Figure 3.1: Beard's vegetation mapping units in the locality of the Study Area and the Investigation Area

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4.0 Survey Methodology

4.1 Survey Team and Timing

The 8-day survey was undertaken between 18/08//2009 and 25/08/2009 by R. Teale and Z. Hamilton (both of Biota). The survey methodology and target species were discussed broadly with Dr. Mark Harvey (WA Museum) prior to the survey.

4.2 Climate and Weather

The average temperatures at Southern Cross range from a monthly maximum of 35 °C to a minimum of 5°C. The average annual rainfall is 294 mm and can vary between 200 and 340 mm. While rainfall can occur during all months (average 24.5 mm), most rainfall is received during winter (May – August). However, significant rainfall can also occur in summer, when northwest cyclonic events penetrate inland. Long-term climate averages from Southern Cross are shown in Figure 4.1.

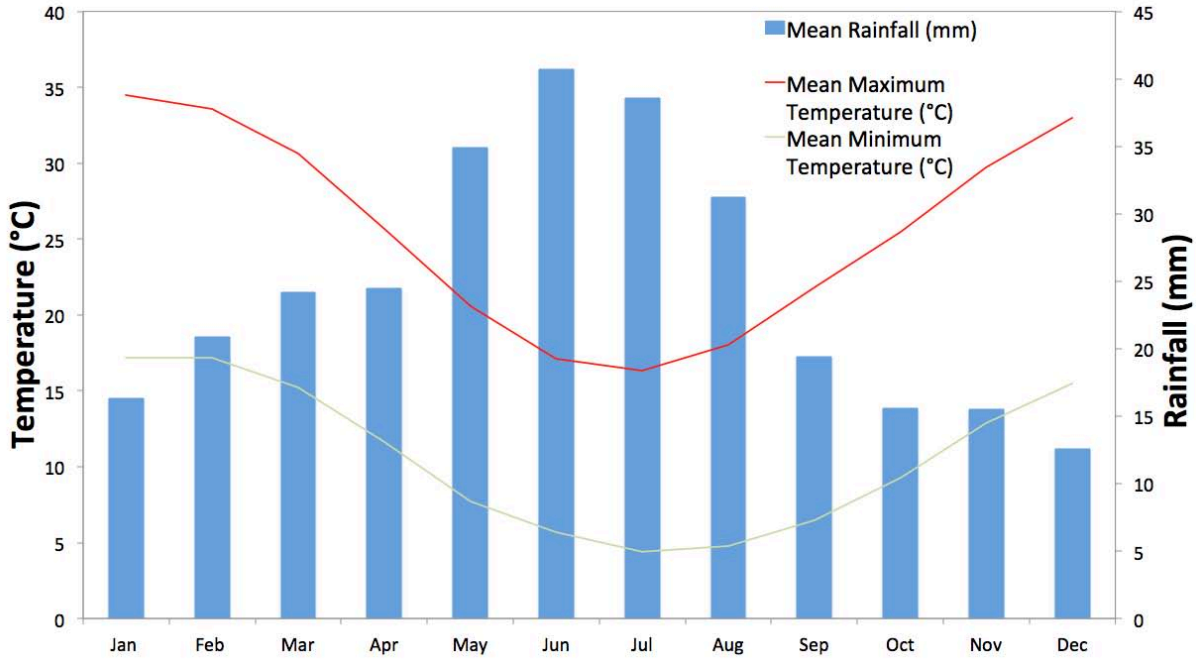

Figure 4.1: **Long-term climatological summary for Southern Cross using data from 1895 to 2007** (data provided by the Bureau of Meteorology).

The annual rainfall during the year of survey (2009) was 238.4 mm. August recorded a significant amount of rainfall with more received in the week preceding the survey (32.6 mm) than the long-term average for the entire month (31.2 mm; averaged across 1895-2007). Temperatures during the survey month averaged 18.6°C, similar to the monthly average of 18.3°C. Many SRE invertebrate fauna groups become more mobile after rainfall events, so the survey weather conditions were considered conducive to SRE invertebrate fauna sampling.

Table 4.1: Daily weather observations during survey period
(data provided by the Bureau of Meteorology for Southern Cross weather station).

Survey date	18/08/09	19/08/09	20/08/09	21/08/09	22/08/09	23/08/09	24/08/09	25/08/09
Max temp (°C)	19.4	18	16.5	14.2	16.1	15.2	13.8	16.7
Rainfall (mm)	0.2	3.8	2.4	5.6	0.4	4.6	0.6	0

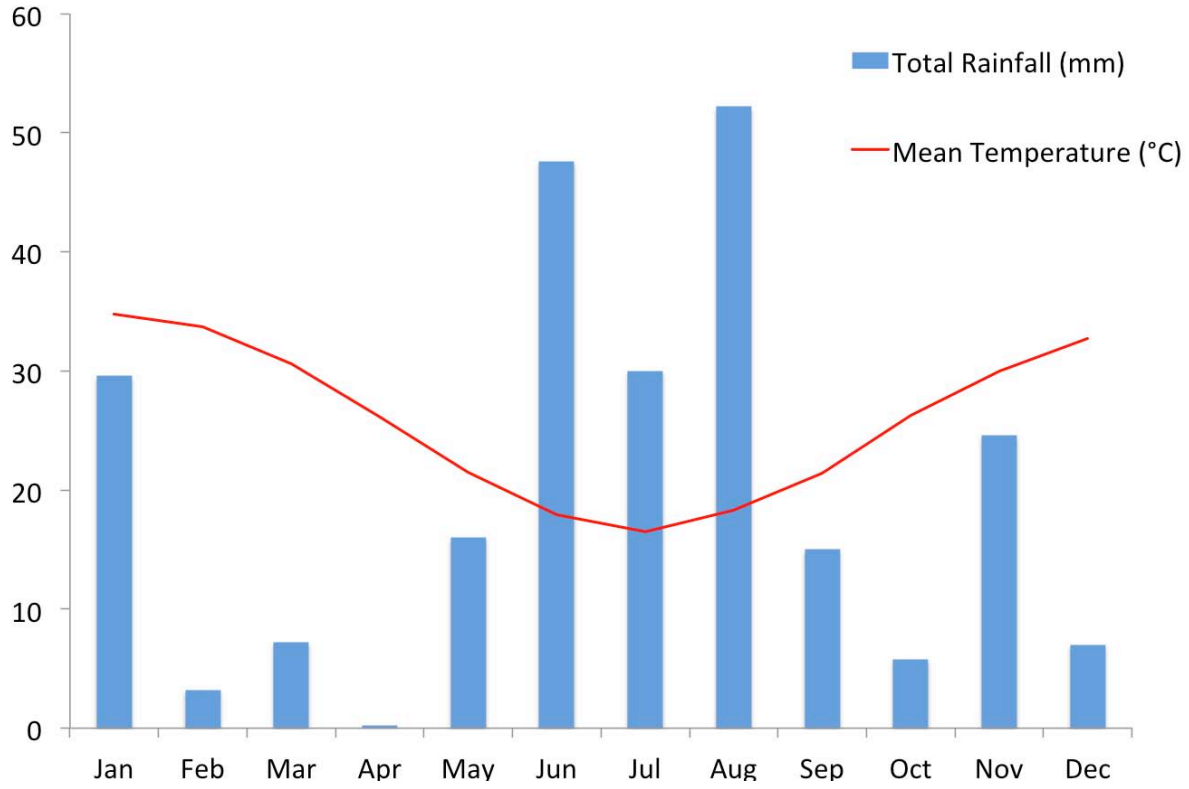

Figure 4.2: Monthly rainfall and average temperatures for survey year (2009) at Southern Cross
(data provided by the Bureau of Meteorology).

4.3 Field Sampling Methodology and Survey Effort

Consistent with the Guidance Statement 20 (EPA 2009) a phased approach was conducted, comprising:

- an initial desktop assessment of the likelihood of SREs based on available information, including previous sampling, broad habitat types and the likelihood of those habitats to support potential SRE taxa (see Section 3.0 above);
- consultation with relevant authorities and/or Decision Making Authorities (DMAs);
- stratified sampling across habitats within the Study Area, including both within and outside of the Investigation Area; and
- risk-based interpretation of data.

4.3.1 Sampling Techniques

Representative habitat types and associated vegetation units were identified in the Study Area (Plates 4.1-4.5). SRE searches were conducted at 33 locations inside and outside the Investigation Area (Table 4.2, Figure 4.3). Sites were selected to provide representative sampling across the range of habitats present. Additionally, sites were selected at locations where potential SRE species were predicted more likely to occur.

Plate 4.1: Rocky ridges

Plate 4.2: Rocky slopes with mixed shrubland

Plate 4.3: Footslopes with scattered Mulga

Plate 4.4: Melaleuca and Acacia Woodland

Plate 4.5: Microhabitat at base of Eucalypt

Table 4.2: Targeted SRE search site descriptions and locations

Site	Habitat Description	Latitude	Longitude
KL01	*Eucalyptus* grove in slight valley.	30°52`13.40"E	119°36`41.04"S
KL02	*Eucalyptus* woodland, stony sandy loam.	30°51`18.32"E	119°34`18.80"S
KL03	On top of range, shallow northern aspect. *Hakea* litter bed, rocky substrate with stony loam.	30°52`13.22"E	119°36`14.07"S
KL04	Rocky slope on north side of range with SW aspect. Hakea litter bed on exposed rocky slope with skeletal soil.	30°52`12.25"E	119°36`14.29"S
KL05	Lower slope/slight valley Eucalypt woodland with stony loam soil. Deep leaf litter beds under Eucalypts.	30°52`04.33"E	119°36`11.84"S

Site	Habitat Description	Latitude	Longitude
KL06	Steep rocky slope near top of range, north facing aspect.	30°52`22.94"S	119°36`31.25"E
KL07	Steep rocky slope near top of range, north facing aspect.	30°52`25.10"S	119°36`31.25"E
KL08	Steep rocky slope near top of range, north facing aspect.	30°52`26.76"S	119°36`43.84"E
KL09	South facing rocky hill slope, stony/rocky loam.	30°52`25.28"S	119°36`49.14"E
KL10	Near top of range, slight northern aspect. Low shrubs (2-3m) including *Allocasuarina Acacia.*	30°52`33.92"S	119°36`51.26"E
KL11	Near top of range, slight northern aspect. Low shrubs (2-3m) including *Allocasuarina Acacia.*	30°52`36.15"S	119°36`51.94"E
KL12	Near top of range, slight northern aspect.	30°52`37.23"S	119°36`50.94"E
KL13	Top of range, slight northern aspect.	30°52`39.18"S	119°36`49.64"E
KL14	Top of range, slight northern aspect. *Allocasuarina acacia, Hakea* on stony shallow loam.	30°52`34.43"S	119°36`41.26"E
KL15	Flats at salt lake margin vegetated with open *Acacia* woodland.	30°53`13.88"S	119°37`59.37"E
KL16	Rocky outcrop with tall shrubs and scattered Eucalypts. Skeletal soil over rocks and stony loam.	30°53`6.97"S	119°37`59.66"E
KL17	Laterite ridge with sparse *Callitris* and *Acacia,* scattered Eucalypts. Little leaf litter.	30° 52` 37.70"S	119° 36`06.01"E
KL18	Shallow incised drainage through Eucalypt woodland. Deep leaf litter at base of Eucalypts. Litter and debris along drainage.	30°52`56.60"S	119°36`38.88"E
KL19	Rocky hill at Eastern end of Koolyanobbing range. Slight south east aspect. Mid-height shrubs including *Hakea*, also scattered Eucalypts.	30°53`26.7"S	119°37`05.2"E
KL20	Eastern end of Koolyanobbing range. Rocky with skeletal soil. Eastern aspect. Tall shrubs/trees, *Acacia* and *Hakea*.	30°53`19.39"S	119°37`44.72"E
KL21	Near top of range on north facing slope. Rocky loam with exposed rock. Tall shrubs including *Hakea*.	30°52`16.68"S	119°36`16.70"E
KL22	Top of hill with slight north west aspect. Tall shrubs including *Allocasuarina, Acacia, Hakea*. Soil loam with small rocks.	30°52`6.92"S	119°36`04.21"E
KL23	Top of range, slight northern aspect. Tall shrubs including *Allocasuarina, Acacia, Hakea.*	30°52`16.68"S	119°36`16.70"E
KL24	Top of range, slight northern aspect. Tall shrubs including *Allocasuarina, Acacia, Hakea.*	30°52`23.63"S	119°36`24.44"E
KL25	Mid slope with southern aspect. Tall shrubs including *Allocasuarina, Acacia, Hakea.*	30°52`29.53"S	119°36`20.59"E
KL26	Base of deep gully with southern aspect. Eucalypts at base of gully, not much scree.	30°52`28.75"S	119°36`23.99"E
KL27	Near top of ridge with northern aspect.	30°52`29.67"S	119°36`37.01"S
KL28	Top of adjacent ridge.	30°53`56.63"S	119°35`26.56"E
KL29	Valley between adjacent peaks of the range.	30°51`13.50"S	119°34`26.79"E

Site	Habitat Description	Latitude	Longitude
KL30	Gentle stony slope at base of range, stony loam.	30°51`06.50"S	119°33`43.10"E
KL31	Stony midslope, rocks. Vegetated with *Acacia* (3m height). Shallow litter bed.	30°50`27.49"S	119°36`41.04"E
KL32	Site description not recorded.	30°50`25.4"S	119°32`32.8"E
KL33	Site description not recorded.	30°48`46.37"S	119°31`32.20"E

Specific invertebrate groups were targeted using non-systematic collection techniques. Groups targeted during the survey were those considered most likely to potentially support SRE taxa (EPA 2009), including:

- Mygalomorphae (trapdoor spiders);
- Pseudoscorpionida (pseudoscorpions);
- Scorpionida (scorpions);
- Diplopoda (millipedes); and
- Pulmonata (land snails).

4.3.1.1 Mygalomorph spiders

Mygalomorph spider burrows were located visually and were photographed prior to excavation. Holes were dug adjacent to each burrow thereby allowing the burrow to be followed down with forceps until the spider was located. Collected spiders were preserved in 70% ethanol, with one leg removed and placed in 100% ethanol for future molecular studies, if required.

4.3.1.2 Pseudoscorpions

Searches for pseudoscorpions were conducted by:

- searching on trees and beneath bark;
- searching under rocks;
- raking soil and leaf litter; and
- sieving soil and leaf litter.

Specimens were preserved in 70% ethanol.

4.3.1.3 Scorpions

Visual searches for scorpion burrows were conducted. Although no burrows were located during the survey, a few scorpions were collected opportunistically while raking soil and leaf litter and searching under rocks. Specimens were preserved in 70% ethanol.

4.3.1.4 Millipedes

Millipedes were located by raking through leaf litter and debris. All specimens collected were preserved in 70% ethanol.

4.3.1.5 Land Snails

Searches for land snails were conducted by:

- excavating the soil and leaf litter around the base of hummocks;
- searching under rocks and in rock crevices; and
- sieving soil and leaf litter.

Live specimens are kept and sent to the Western Australian Museum for identification.

4.3.2 Specimen Lodgement

All specimens were lodged with the Western Australian Museum in accordance with the preferred lodgement methods and procedures as outlined in EPA Guidance Statement 20 (EPA 2009). Specimen identification was undertaken by Dr Volker Framenau, Dr Mark Harvey, Ms Karen Edward (mygalomorph spiders, millipedes, all of the Western Australian Museum), Dr Barbara York Main (mygalomorph spiders, University of Western Australia) and Mr Roy Teale (land snails, Biota).

4.4 Limitations

There are several key limitations discussed by Guidance Statement 20 in respect of assessing SREs for the purpose of EIA. Broadly these include:

- lack of a taxonomic framework (e.g. many groups do not have a complete taxonomic framework);
- insufficient taxonomic expertise to complete all identifications for many groups (e.g. for many land snails, there is insufficient expertise to undertake the necessary dissection to resolve species level taxonomy);
- sampling difficulties for many taxa, particularly mygalomorph spiders (female and juvenile specimens are often impossible to assign to species level using taxonomy alone); and
- incomplete knowledge of the ecology of many taxa.

In addition:

- not all sections of the Study Area were equally ground-truthed or sampled for SREs fauna due to access limitations (lack of tracks and inaccessible elevated topographies); and
- habitat units considered representative of the units present within the Study Area were sampled, however not all microhabitats were sampled during the survey.

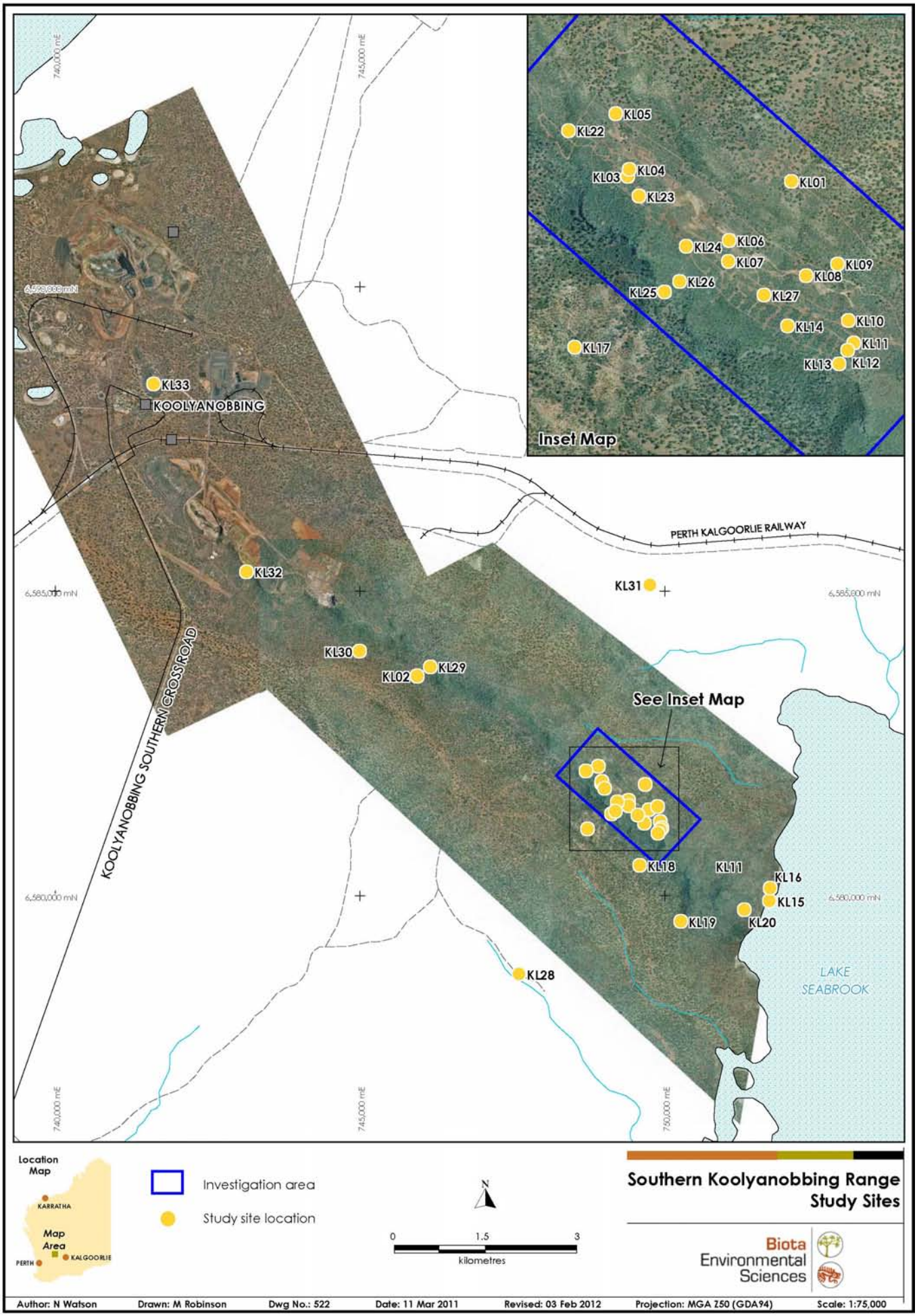

Figure 4.3: SRE search sites within the Study Area and the Investigation Area

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5.0 Results and Discussion

SRE fauna are clearly defined by Harvey (2002) as invertebrate fauna having distributions of less than 10,000km^2. In reality we do not have sufficient information on the entire range of these taxa to confidently identify them as SRE fauna hence they are discussed here as *potential* SRE fauna.

5.1 Land Snails

This survey recorded several taxa of land snails including an undescribed *Bothriembryon* and several microsnails. Microsnails are considered to have broad distributions (Solem 1997) and are therefore unlikely to represent SRE taxa, and so are not discussed further in this report.

5.1.1 Bulimulidae

5.1.1.1 *Bothriembryon* sp.

Specimens of this undescribed species were recorded from nine sites both within and outside of the Investigation Area. Live specimens were readily raked from debris at the base of large Eucalypts and from beneath large rocks in sheltered environments. Like other *Bothriembryon*, these specimens were all free-sealers in loose soil. Similar shells to those collected at the Mt Jackson Range (Biota 2009) and the Windarling Range (Biota 2011b) were evident in many locations. Specimens were collected from woodland environments surrounding the Koolyanobbing Range, as well as on the Koolyanobbing Range, and the former appeared to be the preferred habitat (based on shell density). Given this, it is considered unlikely that a mine development within the Investigation Area will significantly alter the abundance, distribution and conservation status of this taxon.

5.2 Millipedes

5.2.1 Iulomorphidae

5.2.1.1 *Atelomastix bamfordi*

Atelomastix bamfordi was found to be abundant in the Study Area, both inside and outside of the Investigation Area (Table 5.2). This taxon has been recorded from the Windarling Range (Biota 2011b), Mt Jackson Range (Biota 2009), the Die Hardy Range (Biota 2011a) and the Helena and Aurora Ranges (H. Nistelberger, pers. comm. 2012). The species is also known to occur 70 km to the south of the Koolyanobbing Range at Marvel Loch (WA Museum database). *Atelomastix bamfordi* has now been recorded from sites that are separated by a total linear distance of over 180 km. However, across much of this distributional extent (i.e. northwards from the Koolyanobbing Range) has only been found on the ironstone ranges but not on the intervening flats. Within the Study Area, this taxon was found in an array of microhabitats (with suitable accumulations of leaf litter) from North, South, East and West facing aspects, whereas, on Windarling Range it was found only in deep leaf litter on south facing slopes. This difference in occupied microhabitat and the decrease in relative abundance may reflect the lower average annual rainfall of the Windarling Range.

5.2.1.2 *Atelomastix* sp.

A number of individuals belonging to the genus *Atelomastix* were collected that could not be assigned to species since they were juveniles, however it is thought that they most likely represent *Atelomastix bamfordi*. These specimens were collected from inside and outside of the Investigation Area.

5.2.2 Paradoxosomatidae

5.2.2.1 *Antichiropus* sp. `Mt Jackson 1`

The survey current survey at Koolyanobbing recorded specimens belonging to *Antichiropus* 'Mt Jackson 1' inside and outside of the Investigation Area. This taxon has previously been recorded from a variety of locations on the Mt Jackson Range and the Windarling Range, as well as from the area of Deception Deposit located approximately 20km north of the Windarling Range (Biota 2009, Biota 2011a, Biota 2011b). Specimens have been collected from the rocky uplands of the various ranges, as well as from the adjoining Eucalypt dominated flats. Given the recorded distribution of this taxon, it is considered unlikely that a mine development within the Investigation Area will significantly alter the abundance, distribution and conservation status of this taxon.

5.2.2.2 *Antichiropus* sp. `Koolyanobbing`

A novel taxon, *Antichiropus* sp. 'Koolyanobbing', was collected from inside and outside of the Investigation Area. This taxon is distinct from previously collected *Antichiropus* and was not previously collected at either the Windarling Range (Biota 2011b) or Mt Jackson Range (Biota 2009). The novel taxon was collected from along the surveyed length of the Koolyanobbing Range, i.e. from Site KL33 in the North and West of the study area to KL20 in the far South and East of the study area (a linear distance of 13 km). Site KL33 is located on a small isolated hill of the Koolyanobbing Range suggesting that populations are either relictual on the uplands of the Koolyanobbing Range (and its various discreet ridges and hills) or that a single contiguous population also occupies the intervening flat woodlands. Further survey effort could focus off the main part of the Koolyanobbing Range with the view to establish whether the distribution of this taxon extends beyond the Koolyanobbing Range to the adjacent flat woodland area.

5.2.2.3 *Antichiropus* sp.

Ten juvenile and two adult female specimens of *Antichiropus* were also collected from inside and outside of the Investigation Area that could not be identified to species level (see Table 5.6) (noting taxonomic identification of millipede taxa is only possible with adult males). It is possible that they belong to either *Antichiropus* 'Mt Jackson 1' and/or *Antichiropus* 'Mt Jackson 2', however it is likely that only genetic studies on the preserved specimens will be able to confirm the identity of these specimens.

5.3 Mygalomorph Spiders

Fifteen mygalomorph morphotypes from four families were recorded within the Study Area. Many of the specimens collected were juveniles and therefore could not be accurately assigned to known taxa using morphological characters. The adults were mostly females and in many instances could therefore also not be assigned to known taxa using morphological characters alone (male genitalia are required for species identification). Burrow types for some taxa are shown in Plates 5.1 to Plate 5.9.

5.3.1 Idiopidae

5.3.1.1 *Aganippe castellum* "Tree-stem *Aganippe*"

A burrow of this taxon was noted during the survey outside of the Investigation Area but was not excavated. This taxon has been recorded more widely in the region, including from the Mt Jackson Range (Biota 2009) Windarling Range (Biota 2010b) and the Deception Deposit (Biota 2011a). It is not considered to represent a SRE species.

Plate 5.1: ***Aganippe castellum* burrow lid**

5.3.1.2 *Aganippe* 'sp.2'

Six specimens of *Aganippe* 'sp.2' were collected from sites inside and outside of the Investigation Area. This species has a 'twig-lined' burrow entrance with a conspicuous clay-door (see Plate 5.2; Plate 5.3). Five of the specimens collected during the survey were juveniles. As juveniles of this species show many similarities to juvenile *Gaius*, identification of these five specimens on morphology alone is tentative. This species has not previously been recorded during other surveys in the region.

Plate 5.2: ***Aganippe* `sp.2` burrow lid (specimen M20090820.KL15-6)**

Plate 5.3: ***Aganippe* `sp.2` burrow lid (specimen M20090820.KL15-9)**

5.3.1.3 Idiopidae 'sp.'

Two juvenile specimens of *Idiopidae* 'sp.' were recorded from within the Investigation Area, with no recordings within the broader Study Area. Both specimens had 'twig-lined' burrows and were found amongst a cluster of burrows (see Plate 5.4). These individuals could not be taxonomically assigned and may well be juveniles of *Gaius* or *Aganippe*.

Plate 5.4: Cluster of *Idiopidae* 'sp. juv' burrows

5.3.1.4 *Eucyrtops* 'sp.1'

One individual specimen of *Eucyrtops* 'sp.1' was collected from inside the Investigation Area. A single juvenile specimen of this species has also previously been collected from the Windarling Range (Biota 2010b).

5.3.1.5 *Eucyrtops* 'sp.2'

One individual specimen of *Eucyrtops* 'sp.2' was collected from within the Investigation Area, with no recordings within the broader Study Area.

5.3.1.6 *Eucyrtops* sp.

A single female *Eucyrtops* sp. specimen was collected from a site within the Investigation Area, with no recordings within the broader Study Area.

5.3.1.7 *Gaius* 'sp. '

Two adult female specimens of *Gaius* sp. were collected from sites inside and outside of the Investigation Area. This species constructs 'leaf-lined' or 'twig-lined' burrows (see Plate 5.5).

Plate 5.5: Typical 'leaf-lined' *Gaius* burrow (specimen M20090819.KL05-3)

5.3.1.8 *Idiosoma* sp.

A single adult female of *Idiosoma* sp. was collected from a site outside of the Investigation Area. This collection is noteworthy as it is considered outside the typical *Idiosoma* distribution (V. Framenau, WA Museum, pers. comm. 2010).

Plate 5.6: ***Idiosoma* burrow lid closed (specimen M20090823.KL30-7)**

Plate 5.7: ***Idiosoma* burrow lid open (specimen M20090823.KL30-7)**

5.3.2 Nemesiidae

5.3.2.1 Hooded *Aname* 'sp. 1'

Six juveniles and one adult female specimen of *Aname* 'sp.1' were recorded from sites both inside and outside of the Investigation Area. This species has an open burrow entrance (no door) and constructs a 'hood' over the entrance using a combination of web and soil (see Plate 5.8). Morphological appraisals suggest that this *Aname* species has also been collected at the Windarling Range (Biota 2011b), and an *Aname* with the same burrow entrance type has also been collected at the Mt Jackson Range (Biota 2009).

Plate 5.8: **"Hooded" Burrow entrance of *Aname* 'sp.1' collected from Windarling**

5.3.2.2 *Aname* 'sp.'

One juvenile specimen was collected from outside of the Investigation Area that has a morphotype that does not match any of the other collected *Aname* species from the study area (Volker Framenau, WA Museum, pers. comm. Jan 2010).

5.3.2.3 *Aname* 'sp. 2' "Y –shaped Burrow"

One adult female and eight juvenile specimens of *Aname* 'sp.2' were recorded from sites inside and outside of the Investigation Area. This species, like many of the *Aname* species, does not construct a 'door' to the burrow entrance, instead this species has two open unconcealed entrances that join up to a singular burrow, just below the soil surface, hence why it is sometime referred to as a "Y-shaped" burrow entrance. This species was also previously recorded from the Windarling Range (Biota 2010b). *Aname* species with a similar burrow type were also previously collected in the vicinity of the Mt Jackson Range (Biota 2009).

5.3.2.4 *Aname* 'sp.3' (previously referred to also as "*Aname* Y-shaped")

One female and two juvenile specimens of *Aname* 'sp.3' were collected from sites within and outside of the Investigation Area. This species, like *Aname* 'sp.2', constructs a "Y-shaped" burrow and has open, unconcealed burrow entrances.

5.3.2.5 *Aname tepperi*

A single male individual specimen of *Aname tepperi* was collected from the Study Area, outside of the Investigation Area. This species has also previously been collected at the Windarling Range (Biota 2010b) and the Mt Jackson Range (Biota 2009). This was the only species for which males were collected, providing assurance in identification. This species is not regarded to be an SRE.

5.3.3 Dipluridae

5.3.3.1 *Cethegus* 'sp.'

A single juvenile specimen of *Cethegus* was collected from outside of the Investigation Area. *Cethegus* specimens were also previously collected from Deception Deposit (Biota 2011a), Windarling Range (Biota 2011b) and the Mt Jackson (Biota 2009) however as adult males weren't collected from both the Windarling Range and the current Study Area, these specimens were unable to be assigned to species. The burrow type for this species/genus is distinct from other mygalomorph spiders in the vicinity and has a 'messy' webbed double entrance (Plate 5.9).

Plate 5.9: *Cethegus* sp. burrow type - photo from Mt Jackson (Biota 2009)

5.3.4 Barychelidae

5.3.4.1 *Synothele* sp.2

Three specimens assigned to the species *Synothele* 'sp. 2' were collected from outside of the Investigation Area. This species was not previously recorded from either the Windarling Range (Biota 2011b) or the Mt Jackson Range (Biota 2009).

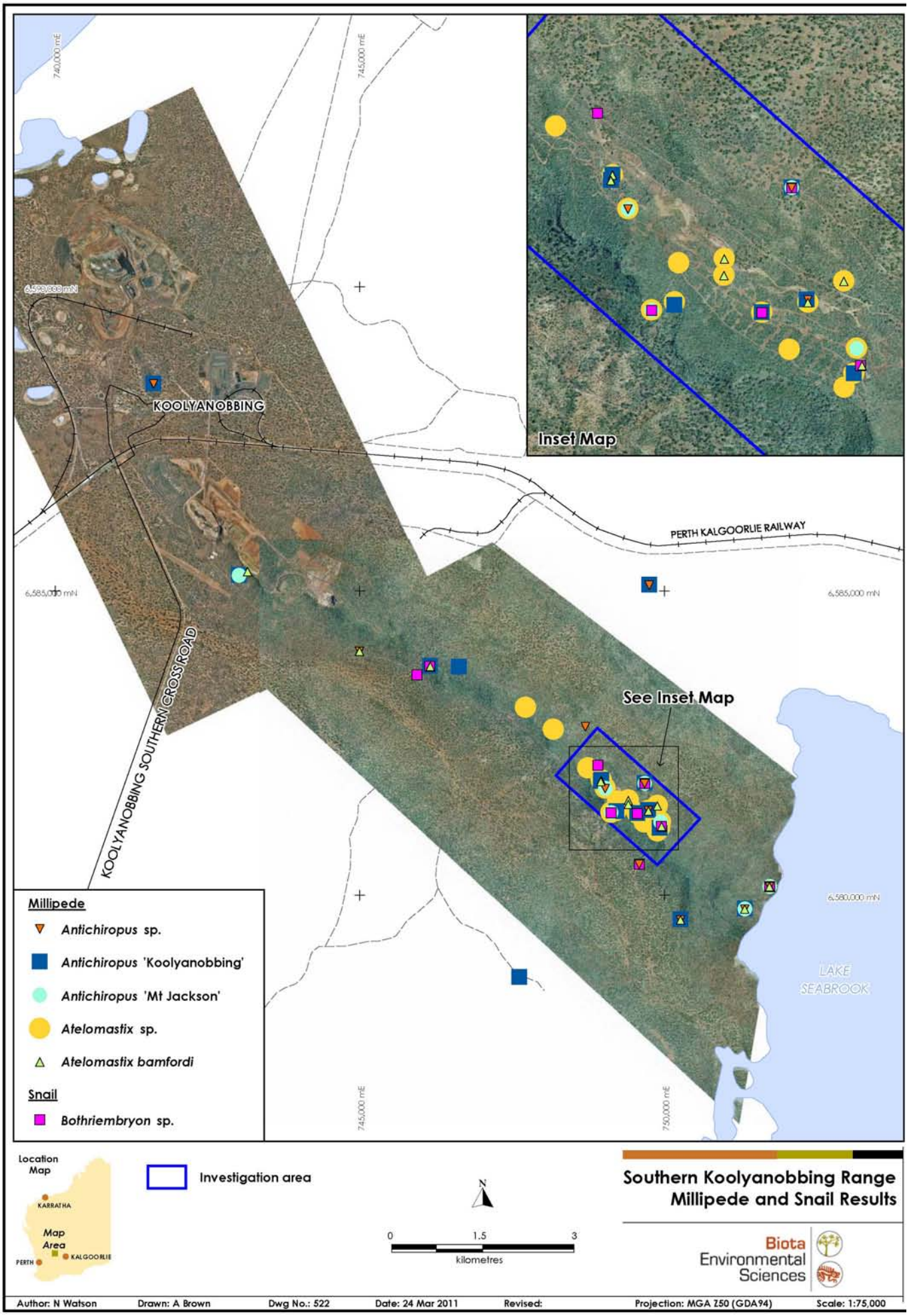

Figure 5.1: Invertebrates collected from the Study Area and Investigation Area

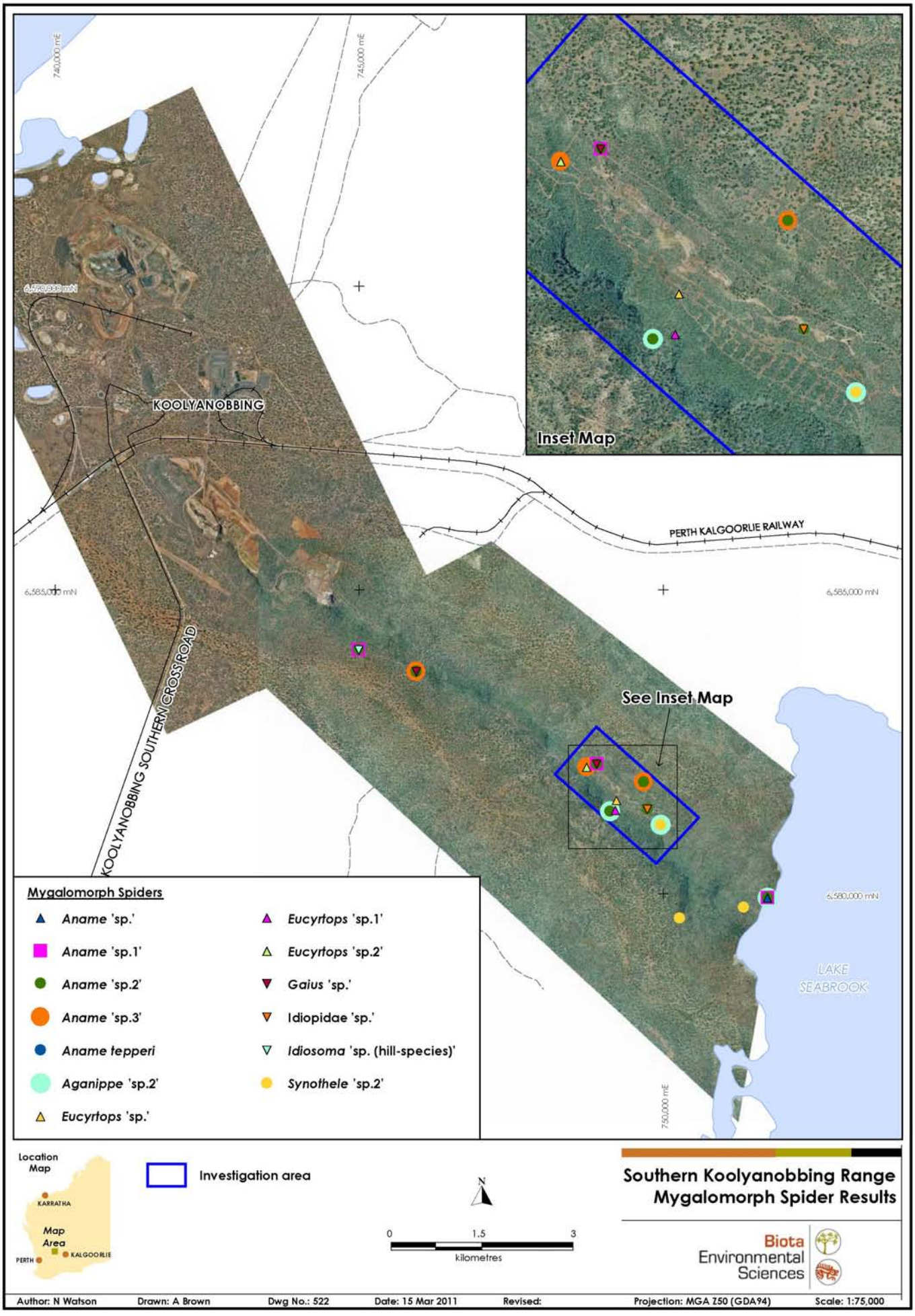

Figure 5.2: Invertebrates collected from the Study Area and Investigation Area

6.0 Conservation Significance

6.1 Threatened Fauna

None of the taxa recorded during the survey are formally listed under the Western Australian Wildlife Conservation (Specially Protected Fauna) Notice 2010 (Minister for Environment; Youth 2010), nor are any offered additional protection under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

6.2 Risk Assessment for Potential SREs

The majority of taxa recorded by the current survey are either undescribed or tentatively identified and all are poorly known, hence establishing the broader distribution and likely SRE status of any taxon is very difficult.

The EPA expects that the following objectives will be met as far as is practicable:

- ensure the protection of key habitats for SRE species;
- maintain the distribution, abundance and productivity of populations of SRE taxa; and
- ensure that the conservation status of SRE taxa is not changed as a result of development proposals. (The "change in conservation status" refers to a change in a taxon's status under the International Union for the Conservation of Nature (IUCN) criteria. In reality this is difficult to establish for many SRE taxa, as they would mostly be categorised as data deficient.)

For poorly known species such as most SREs, meeting these objectives can be difficult to clearly demonstrate primarily due to the absence of contextual information on broader distributions. The EPA has recognised this key limitation and has recommended that an assessment can proceed on the basis of a risk assessment in which the following criteria are considered:

- the relationship between habitat and taxon distribution;
- local distribution of that habit based on available thematic layers; e.g. geology, soils, vegetation, drainage (vegetation units may be preferable, as these are often mapped at the finest scale); and
- proportion of suitable habitat that may be disturbed by a project.

However, the risk assessment can only proceed once reasonable effort has been expended in assessing the likelihood of the occurrence of SREs and appropriate survey effort and/or database searches have been made. In this particular case, assessment of the Study Area has determined that it supports potential SRE taxa. Specimens have been lodged with the WA Museum and experts and the literature consulted about the potential broader distribution of all potential SRE taxa.

A risk assessment for the three groups of invertebrates from which potential SRE taxa were recorded (i.e. land snails (Section 5.1), millipedes (Section 5.2) and mygalomorph spiders (Section 5.3) is provided below and summarised in Table 6.1.

6.2.1 Land Snails

The undescribed *Bothriembryon* sp. land snail was commonly recorded from the base of large eucalypts on the lower lying areas, as well as from under rocks and debris along the range. Shells similar to those recorded in the Study Area have previously been collected from the Mt Jackson Range (Biota 2009) and the Windarling Range (Biota 2012). It would appear that this taxon is widely distributed in the region between the Koolyanobbing Range and the Mt Jackson Range and whilst this taxon may still qualify as an SRE, it is considered that a mine development within the Investigation Area will not significantly impact this species, and therefore the key EPA objectives in respect this taxon can be met.

6.2.2 Millipedes

The survey recorded three species of millipede: *Atelomastix bamfordi*, *Antichiropus* 'Mt Jackson 1', and *Antichiropus* 'Koolyanobbing', plus numerous juvenile specimens that were unable to be assigned to species level within the *Antichiropus* and *Atelomastix* genera. With the exception of the new taxon, *Antichiropus* 'Koolyanobbing', the other two recognised taxa have previously been recorded from ironstone ranges and more generally from a variety of locations on the Koolyanobbing Range, Mt Jackson Range and the Windarling Range.

The new taxon *Antichiropus* 'Koolyanobbing', while not seen before, was collected from along the surveyed length of the Koolyanobbing Range i.e. from Site KL33 in the North and West of the study area to KL20 in the far South and East of the Study Area (a linear distance of 13 km). Site KL33 is located on a small isolated hill of the Koolyanobbing Range suggesting that populations are either relictual on the uplands of the range (and its various discreet ridges and hills) or that a single contiguous population also occupies the intervening low lying woodlands. Further survey effort should focus away from the main part of the Koolyanobbing Range, with the view to establishing whether the species occupies the woodlands and is therefore likely to have a distribution extending beyond the Range. Preliminary findings from an ongoing study indicate that *Antichiropus* does not appear to be restricted to the ironstone ranges (H. Nistelberger, pers. comm. 2012). *Atelomastix* specimens have not yet been recorded on the flat terrain between ranges, suggesting that the populations (whilst belonging to the same species) may be isolated.

Definitive statements about the likely impacts arising from mine development within the Investigation Area on any of the millipede species are difficult to make given the paucity of data, however based on the habitats from which they have been collected, it is considered likely that all three millipede taxa recorded during the survey would likely occur elsewhere across the broader southern Koolyanobbing Range Study Area where these habitats also occur.

6.2.3 Mygalomorph Spiders

Many of the specimens collected were juveniles or adult females and these cannot always be accurately assigned to known taxa using morphological characters alone. Of those that were assigned to known species, two do not qualify as SRE taxa (*Aganippe castellum* and *Aname tepperi*).

Of the remainder, five morphotypes have been recorded from previous surveys in the surrounding region, and whilst potentially representing SREs on the basis of distributional extent (i.e. occupying an area <10,000km^2) the habitats from which they were recorded extend beyond the scale of the Investigation Area:

- *Aname* sp. 2, recorded at Windarling Range and Mt Jackson Range
- Hooded *Aname,* recorded at Deception Deposit and Windarling Range
- *Gaius*, recorded at Windarling Range and Deception Deposit
- *Eucyrtops* sp.1, also collected from Windarling Range
- *Idiosoma*
- *Cethegus* sp., juveniles recorded from Windarling Range and Mt Jackson Range, it is unknown whether they are the same species as the male collected from the Study Area.

Four morphotypes were collected that have not been recorded within the area previously (*Aname* sp. 3, *Synothele* sp.2, *Aganippe* sp.2, *Eucyrtops* sp. 2), however all of these were collected from outside of the Investigation Area. It is therefore considered unlikely that mine development within the Investigation Area will significantly alter the abundance, distribution and conservation status of these taxa.

Individuals belonging to three morphotypes (*Aname* sp., *Eucyrtops* sp. and Idiopidae sp.) were unable to be taxonomically assigned further since only juvenile or female specimens were collected, making comments on their distribution impossible.

Table 6.1: Summary of potential SRE taxa recorded from Study Area and Investigation Area

TAXA **Family**	**Genus**	**Species**	**Inside Investigation Area**	**Outside Investigation Area**	**Recorded from other studies**
PULMONATE SNAILS Orthalicidae	*Bothriembryon*	sp.	Yes	Yes	Yes
MILLIPEDES Iulomorphidae	*Atelomastix*	*bamfordi*	Yes	Yes	Yes
		sp.	Yes	Yes	Yes
Paradoxosomatidae	*Antichiropus*	'Mt Jackson sp.1'	Yes	Yes	Yes
		'Koolyanobbing'	Yes	Yes	No
		sp.	Yes	Yes	Yes
MYGALOMORPH SPIDERS Idiopidae	*Aganippe*	*castellum*	No	Yes	Yes
		sp.2	Yes	Yes	No
	Eucyrtops	sp.1	Yes	No	Yes
		sp.2	Yes	No	No
		sp.	Yes	No	Not taxonomically assigned
	Gaius	sp.	Yes	Yes	Yes
	Idiosoma	sp.	No	Yes	Yes
	Idiopidae	sp.	Yes	No	Not taxonomically assigned
Nemesiidae	*Aname*	*tepperi*	No	Yes	Yes
		sp. 1 'Hooded'	Yes	Yes	Yes
		sp. 2 'Y-shaped'	Yes	Yes	Yes
		sp. 3	No	Yes	No
		sp.	No	Yes	Not taxonomically assigned
Dipluridae	*Cethegus*	sp.	No	Yes	Yes
Barychelidae	*Synothele*	sp. 2	No	Yes	No

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7.0 Conclusions

7.1 Southern Koolyanobbing Range SRE Survey

In total, the Study Area at the southern Koolyanobbing Range recorded approximately 21 putative taxa from groups known to support SREs, including one land snail, five millipede taxa and approximately 15 mygalomorph taxa. Of the 21 taxa, three were not considered to represent SREs, including the mygalomorph spiders *Aganippe castellum*, *Gaius* sp. and *Aname* sp. '*tepperi* gp'.

The SRE status of many of the taxa cannot be confidently established due to insufficient contextual information. For the purpose of this assessment, a conservative approach has been taken in treating them as potential SREs. These taxa fall into three broad groups:

- Group 1 - morphotypes for which there is local context;

  Included in this category are those taxa that have been recorded from other study areas in the region of Cliffs' operations (e.g. contextual sites on the Koolyanobbing Range, Mt Jackson Range, Die Hardy Range and Windarling Range), and which are known to extend over a linear distance of up to 100 km. Included in this group are six mygalomorph morphotypes (*Aname* sp. 2, Hooded *Aname, Gaius*, *Eucyrtops* sp.1, *Idiosoma, Cethegus* sp.), one land snail taxon (*Bothriembryon* sp.) and two millipede taxa (*Atelomastix bamfordi,* and *Antichiropus* 'Mt. Jackson 1').

  The working definition of an SRE is a species with a range of less than 10,000 km^2. Whilst these taxa may qualify as SREs based on range size, some will have ranges that extend well beyond the Study Area, hence the EPA (2009) objectives in respect of SREs can probably be met for mine development within the Investigation Area.

- Group 2 - specimens that could not be assigned beyond the level of genus, and where that genus has not previously been recorded by local studies; also those burrow morphologies for which there is similarly no local context. These specimens may belong to widespread taxa but until they can be assigned at species level, they should be treated as potential SREs.

  This group included three mygalomorph morphotypes (*Aname* sp., *Eucyrtops* sp. and Idiopidae sp.) and one millipede taxon (*Antichiropus* 'Koolyanobbing').

  All have been recorded from sites outside of the Investigation Area and all taxa have been recorded from habitats that occur more broadly at least locally.

- Group 3 - specimens assigned to species level that were previously unknown to the WA Museum. This group included four taxa, all mygalomorph spiders including *Aname* sp. 3, *Synothele* sp.2, *Aganippe* sp.2, *Eucyrtops* sp. 2.

  All of these taxa, except have been recorded from outside of the Study Area and from habitat types that extend more broadly, at least locally.

In summary the majority of taxa were found to occur both within and outside of the Investigation Area (Table 6.1) and have been recorded from surveys conducted previously in the region (Biota 2009, 2011a, 2011b, 2012). Of those that have not been collected previously, none were restricted to the Investigation Area (Table 6.1).

If Cliffs is to continue further operations in the region, it would be beneficial to further test the assumption that species distributions occur across the extent of the Koolyanobbing Range using molecular studies. This is especially relevant when recorded SRE fauna specimens are either females or juveniles (i.e. they lack morphological features typically used for taxonomic assignment to species level). Molecular studies could also be extended to include specimens from adjacent ranges (such as the Windarling Range and Mt Jackson Range where Cliffs currently has mine operations) to establish whether the ranges are sufficiently isolated to support

distinct though similar taxa, and thereby also shed light on phylogeographic patterns and enable better predictions about the likely distribution of taxa.

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