Bennelongia Environmental Consultants

Lots 802 and 803 Erindale Road, Hamersley: SRE Invertebrate Assessment

Prepared for:

Strategen-JBS&G

February 2023

Final Report

Short-Range Endemics I Subterranean Fauna

Waterbirds I Wetlands

Lots 802 and 803 Erindale Road, Hamersley: SRE Invertebrate Assessment

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EXECUTIVE SUMMARY

Rezoning of the Local Planning Scheme is proposed at Lot 802 Erindale Road, Hamersley, Perth, in an area currently occupied by remnant *Banksia* and *Eucalyptus* woodland of the Swan Coastal Plain. The proposed development envelope on Lot 802 covers approximately 13.55 ha adjacent remnant bushland to the east throughout Lot 803, as well as to the southwest bordering Erindale Road and Reid Highway.

The Environmental Protection Authority (EPA) has identified terrestrial fauna, including short-range endemic (SRE) invertebrates, as a Preliminary Key Environmental Factor for the Project. SRE invertebrate species are defined as having an overall range of less than 10,000 km^2. 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 typically focuses on a selection of ground-dwelling invertebrate groups that contain a high proportion of range-restricted species (SRE Groups). The desktop review and field survey aimed to assess the potential ecological and conservation values of SRE invertebrate fauna at the Project.

The desktop assessment identified that a substantial number of species (136) from SRE Groups occur within the vicinity of the Project. This included 88 species of spider (modern and trapdoor), two species of harvestmen, six species of pseudoscorpion, three species of scorpion, 14 species of isopod, three species of centipede, 14 species of millipede and six species of land snail. Of these, two species were *Confirmed SREs,* 132 species were considered *Likely Potential* SREs (with varying levels of data deficiency), and nine species were considered *Unlikely Potential* SREs. There were also records of eight listed threatened or priority invertebrates in the search area.

A field survey undertaken in September 2022 collected 622 individuals from at least 25 species within the following SRE Groups: two species of scorpion, two species of pseudoscorpion, three species of spider, one species of harvestmen, four species of isopods, five species of centipede, four species of land snail and four species of millipede. When survey results were reviewed using available information regarding habitat specialisation, biology and ecology of the species or their close relatives, nine species were identified as W*idespread* (not SREs), four species were considered *Unlikely Potential* SREs, one species was considered a *Likely Potential* SRE and a further seven were assigned to the *Likely Potential* SRE category because they were data deficient. One *Confirmed* SRE was collected.

The *Confirmed* SRE, *Idiosoma sigillatum,* is a Priority 3 listed terrestrial invertebrate and is the predominant idiopid trapdoor spider on the Swan Coastal Plain. *I. sigillatum* is restricted to the Swan Coastal Plain and historically this species was widespread through the Greater Perth region. However, due to urban development, populations in this area have significantly declined. During the survey two individuals were collected from within and outside of the development envelope and it is anticipated that the Project is unlikely to have a significant impact on *I. sigillatum* populations.

Nineteen of the 25 species collected during field survey were found within the development envelope. Eight of these are widespread species, seven may have restricted ranges but were also collected outside the development envelope and the remaining four species are known only from within the proposed development envelope. The four species are:

- Opilionid: *Megalopsalis* sp. (Site 04 via trapping);
- Isopod: *Styloniscus* `BIS496` (Site 01 in *Eucalyptus* litter);
- Millipede: *Antichiropus* `DPI078` (Site 04 via trapping); and
- Millipede: Iulomorphidae sp. (Site 02 under a log).

The key threats from the proposed developments to species known only from the development envelope are habitat removal or degradation, either by part clearing (reducing habitat connectivity) or complete clearing of bush. The invertebrate fauna habitat within in the development envelope is

widespread throughout the greater survey area and the collection of many species both within and outside of the development envelope indicates good habitat connectivity. It is probable that the four currently restricted species have local occurrence outside the development envelope of the Project.

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1. INTRODUCTION

Rezoning of the Local Planning Scheme is proposed at Lot 802 Erindale Road, Hamersley, Perth (the Project, Figure 1). The area is currently occupied by remnant *Banksia* and *Eucalyptus* woodlands of the Swan Coastal Plain. The proposed development envelope on Lot 802 covers approximately 13.55 ha and includes a conservation area of 1.052 ha that will not be developed. Adjacent to Lot 802, remnant bushland also occurs to the east throughout Lot 803, as well as to the southwest bordering Erindale Road and Reid Highway (Figure 1).

The Environmental Protection Authority (EPA) has identified terrestrial fauna, including short-range endemic (SRE) invertebrates, as a *Preliminary Key Environmental Factor* for the Project. As such, Bennelongia Environmental Consultants were engaged to conduct a desktop assessment and field survey to assess the conservation values of SRE invertebrate fauna at the Project.

The specific aims of this assessment were to:

1. Review available information to assess the prospectivity of habitats within and in the vicinity of the Project for SRE fauna.
2. Compile and evaluate records of species belonging to SRE Groups in the vicinity of the Project (including listed species and communities).
3. Compile, evaluate, and assess the significance of potential SRE species collected during the field survey.
4. Consider the key threats associated with proposed development to determine the significance of any potential impacts to SRE species and/or other conservation significant invertebrates.

2. SRE FRAMEWORK

SRE species are defined as having overall ranges 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. Guidelines for the consideration and assessment of SRE invertebrates in Western Australia are provided in *Environmental Factor Guideline: terrestrial fauna* (EPA 2020) and *Technical Guidance: sampling of short range endemic invertebrate fauna* (EPA 2016). Assessment typically focuses on several taxonomic groups (SRE Groups) that are known to contain at least some, but more commonly moderate to high proportions of SRE species. The groups include land snails (Gastropoda); millipedes (Diplopoda); centipedes (Chilopoda); pseudoscorpions (Pseudoscorpiones); scorpions (Scorpiones); spiders [Araneae, mainly Mygalomorphae (trapdoor spiders)]; slaters (Isopoda); and harvestmen (Opiliones). Some other groups, such as velvet worms (Onychophora) and earthworms (Oligochaeta), are SRE Groups but are restricted to mesic landscapes.

Groups containing species that are mostly widespread due to high vagility, ecological plasticity or xeric adaptation, may also contain species with restricted ranges (e.g., Framenau *et al.* 2008; Rix *et al.* 2015) but these species are not included in SRE assessments. More importantly from the viewpoint of SRE surveys, many species belonging to SRE Groups are in fact widespread. Determining whether a species belonging to an SRE Group really has a significantly restricted range (<10,000 km^2) is often difficult. However, in many cases the distribution of an SRE Group species corresponds tightly with the extent of its preferred or obligate habitat(s), and ranges can be estimated from habitat extent. In other cases, species ranges reflect life history or behaviour, rather than historical biogeography, and species may be SREs through occupying only part of a widespread habitat (Harvey 2002; Harvey *et al.* 2011; Rix *et al.* 2015).

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Legend

- Development envelope
- Survey area

Figure 1. Location of the Project

The following classification, slightly modified from that used by the Western Australian Museum (WAM), was followed to determine whether a species is an SRE:

1. **Confirmed SREs** have a known distribution range < 10,000 km^2. The taxonomy is well known, and the group well represented in collections and/or via comprehensive sampling.
2. **Potential SREs** belong to a group with gaps in our knowledge, either because the group is not well represented in collections, taxonomic knowledge is incomplete, or the distribution is poorly understood due to insufficient sampling. Potential SREs can be divided into two groups.
    a. *Likely Potential*: current known distribution is out of date and requires further research, but habitat specificity and biology of the species suggests it is likely to have a restricted range.
        i. *Data Deficient* – this subcategory originally reflected taxonomic uncertainty but is now used to reflect uncertainty more generally, including when the species is represented by a single record and life history inferences are unclear.
    b. *Unlikely Potential*: current known distribution is out of date or vey incomplete and requires further research, but the species shows multiple habitat preferences, including non-prospective habitats, and biology of the species suggests it is unlikely to have a restricted range.
3. **Widespread (not SRE)** species have a known distribution range >10,000 km^2. The taxonomy is well known, and the group well represented in collections via comprehensive sampling. Large linear ranges may be used to infer range is >10,000 km^2.

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, and the distribution patterns of phylogenetically related surrogate species (ideally members of the same genus).

Even restricted species may have distributions that mostly lie outside a project area, so identifying SRE or potential SRE species is only the first part of a filtering process used to determine whether species may be threatened by a proposed development. The actual level of threat to an SRE species depends on its distribution relative to the development footprint, rather than SRE status alone. This distribution in relation to the area of disturbance can usually be inferred with at least moderate reliability, based on extent of the species' preferred habitat outside the area of disturbance, as well as within it.

3. LOCAL ENVIRONMENT

3.1. Regional Setting: Swan Coastal Plain

The Perth metropolitan area is located within the Swan Coastal Plain, encompassing low-lying areas from Cape Naturaliste to Jurien Bay, bordered to the west by the Indian Ocean and to the east by the Darling Escarpment. The surface geology of the sub-region primarily consists of a parallel series of Quaternary sand dunes, along with areas of alluvial, colluvial and lacustrine deposits (Appendix 1). The bordering Darling Escarpment is an uplifted section of the (Archean) Yilgarn Craton which primarily consists of granite terrains (Myers and Watkins 1985). The climate of the Swan Coastal Plain is Mediterranean, with cool, wet winters and warm, dry summers. The plain is part of a broader, ancient landscape in southwestern Australia that is isolated by bordering oceans and arid areas, and has remained unglaciated for hundreds of millions of years (Hopper and Gioia 2004). As a result of the long period of isolation, weathering and climatic stability, the region is characterised by high levels of diversity and endemism in both its flora and fauna; indeed, the Southwest Australian Floristic Region is recognised as a listed global biodiversity hotspot because of its biological richness and the high level of threat (Hopper and Gioia 2004). The Swan Coastal Plain itself is characterised by primarily eucalypt and *Banksia* woodlands, with some open forests occurring particularly south of Bunbury; while the northern area of the subregion consists of sandy heathlands and shrublands (Rix *et al.* 2015).

3.2. SRE Invertebrates of the Swan Coastal Plain

Despite its proximity and familiarity to most residents of Western Australia, the fauna of the Swan Coastal Plain has traditionally received less attention than other sub-regions of southwestern Australia (Rix *et al.* 2010). It has often been assumed that complex topologies such as the Darling Scarp will be more conducive to short-range endemic species than flat landscapes such as the Swan Coastal Plain, due to the occurrence of granite outcrops, sheltered gullies and other refugial habitats. However, there is a growing recognition that there can be considerable fine-scale differentiation of both microhabitats (for example, litter and substrate variation) and faunal assemblages on the Swan Coastal Plain, resulting in many endemic and range-restricted species (Rix *et al.* 2015; Rix *et al.* 2010). Several species of spider are restricted to leaf litter habitats on Quindalup dune systems (Rix 2006; Rix *et al.* 2010), while the millipede genus *Antichiropus,* one of the most diverse invertebrate genera in Western Australia (Framenau *et al.* 2008), contains one described species and likely several undescribed species that are endemic to bushland of the Swan Coastal Plain (Car *et al.* 2013). Bushland remnants in the Perth metropolitan region are considered important residual habitats for invertebrates; with larger remnants tending to host more diverse invertebrate communities (Harvey *et al.* 1997).

Extensive fragmentation of original habitats associated with the Perth metropolitan area has placed further pressure on the persistence of specialist and low-dispersing invertebrate species. For example, Rix *et al.* (2017a) found that the trapdoor spider *Idiosoma sigillatum* had declined across much of its former range and was now restricted to remnant reserves and woodland in and around the Perth metropolitan area, resulting it in meeting the criteria for 'vulnerable' assessment on the IUCN Red List. There are also several species of invertebrates on the Swan Coastal Plain from groups typically considered non-SRE that have been formally listed as threated, such as native bees and moths (Pille Arnold *et al.* 2019; Williams 2009).

3.3. Habitat Types

The vegetation of the survey area is broadly composed of remnant *Banksia* and *Eucalyptus* woodland. Specific vegetation mapping at Lots 802 and 803 was undertaken by Strategen-JBS&G (2020), which resulted in the identification of seven vegetation units, along with cleared land and parkland (Table 1; Figure 2). Lot 802, where the Project development is planned to occur, is dominated by low to mid *Banksia* (*B. attenuata* and *B. menziesii*) woodland over diverse shrubs and heath, with *Xanthorrhoea priessi* particularly prevalent in the understorey (Figure 2; Table 1). The vegetation of the survey area is in good to very good condition (Figure 3).

Several of the habitat types at the project have the potential to harbour SRE species. *Banksia*-eucalypt woodlands are generally considered to have moderate suitability for SRE fauna (Invertebrate Solutions 2019) and can contain microhabitats that might harbour SRE Groups, including bark, leaf litter beds, soil humus and large debris. Such microhabitats in Swan Coastal Plain bushland remnants have allowed the persistence of many relictual species such as ground-dwelling spiders within both Mygalomorphae and Araneomorphae (Jocqué 1995; Main 2012; Rix 2009). More specifically, *Banksia* woodland is recognised as both a highly diverse and highly threatened ecosystem, having declined from its original extent on the Swan Coastal Plain by approximately 50-60% (Pille Arnold *et al.* 2019; Threatened Species Scientific Committee 2016). Several threatened, priority and range-restricted invertebrates are known to be associated with *Banksia* woodlands, such as the graceful sun moth (*Synemon gratiosa;* (listed as P4 under BCA 2016, with a range of approximately 5000 km^2; i.e. is a confirmed SRE) and millipedes in the genus *Antichiropus* (Threatened Species Scientific Committee 2016).

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Figure 2. **Vegetation units in the project area, as per the vegetation mapping of Strategen-JBS&G (2020). Vegetation codes are described in Table 1.**

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Figure 3. **Vegetation condition in the project area, as per the vegetation mapping of Strategen-JBS&G (2020).**

Table 1: Vegetation units at Lots 802 and 803 identified by Strategen-JBS&G (2020).

Vegetation type	Description
BaDdSc	*Banksia attenuata* and *B. menziesii* isolated low to mid woodland over *Xanthorrhoea preissii*, *Hakea prostrata, Hibbertia hypericoides, Daviesia divaricata* subsp. *divaricata* and *Grevillea vestita* subsp. *vestita* open mid heathland over *Thysanotus dichotomus*, *Scaevola canescens, and Ptilotus polystachyus* herbland.
BaXpHh	*Banksia attenuata* and *B. menziesii* low woodland with some areas of *Eucalyptus marginata* mid open woodland over *Xanthorrhoea preissii*, with scattered *Macrozamia riedlei, Hakea prostrata* and *Jacksonia furcellata* tall sparse to open shrubland over *Hibbertia hypericoides*, *Petrophile macrostachya, Daviesia nudiflora* var. *nudiflora* heathland.
BpTrJs	*Banksia prionotes* low woodland over *Templetonia retusa* sparse mid shrubland over *Jacksonia sericea, Daviesia nudiflora* subsp. *nudiflora* and *Avena barbata* mixed open heathland/ tussock grassland.
BpXpAn	Woodland of *Banksia prionotes* over open shrubland of *Xanthorrhoea preissii*, *Grevillea vestita* and *Stirlingia latifolia* over open herbland of *Alexgeorgea nitens, Mesomelaena pseudostygia* and *Corynotheca micrantha* with occasional *Eucalyptus marginata* and *Banksia menziesii*.
GvCm	Open shrubland of *Grevillea vestita* with occasional *Macrozamia riedlei* and *Xanthorrhoea preissii* over closed herbland of *Corynotheca micrantha, Ehrharta calycina* and *Pelargonium capitatum*.
EmBmXp	Open woodland of *Eucalyptus marginata, Banksia menziesii* and *Banksia attenuata* over open shrubland of *Xanthorrhoea preissii, Calytrix fraseri* and *Gastrolobium capitatum* over open herbland of *Patersonia occidentalis, Tetraria octandra* and *Desmocladus flexuosus*.
EcJfBm	Closed grassland of *Ehrharta calycina* with emergent *Jacksonia furcellata* and *Banksia menziesii*.

4. DESKTOP ASSESSMENT

The prevalence of SRE Groups in the wider vicinity of the Project is described in a desktop assessment by Bennelongia (2021). This desktop report collated all previous records of terrestrial invertebrate species from Bennelongia and Western Australian Museum (WAM) databases, along with published taxonomic literature, from a search area that extended 50km north and south of the Project, bordered on the east by the Darling Scarp and on the west by the Indian Ocean (decimal degrees search area, top left: -31.4°S:115.5°E, bottom right -32.3°S:116.3°E). The Darling Scarp was excluded from the search area, as it is topographically and geologically distinct from the Swan Coastal Plain, and likely to contain many habitats and species that are not representative of the latter.

The desktop determined that the survey area, including the site of planned rezoning at Lot 802, features several habitat types that could be suitable for SRE species. The vegetation is broadly composed of a *Banksia* and *Eucalyptus* woodland; similar woodland remnants in southwestern Australia are known to contain a range of microhabitats that harbour range-restricted invertebrates, including bark, leaf litter beds, soil humus and large debris. Further, *Banksia* woodlands (which particularly dominate Lot 802) typically support rich invertebrate communities on the Swan Coastal Plain, and their former extent has been considerably fragmented. Several range-restricted invertebrates are associated with banksia woodlands of the Swan Coastal Plain, such as SRE millipedes of the genus *Antichiropus*. The vegetation at the Project also includes some plant species endemic to the region, which may be associated with host-specific invertebrates (e.g., *Macrozamia riedlei*).

Within the search area 136 species from the following SRE Groups were identified: spiders (51 species of modern spiders, 37 species of trapdoor spiders), harvestmen (two species), pseudoscorpions (six

species), scorpions (three species), slaters (14 species), centipedes (three species), millipedes (14 species) and land snails (six species) (See Appendix 2 for full species list).

Of these 136 species, two species were considered *Confirmed* SREs; the anapid spiders *Raveniella arenacea* and *R. subcirrata* both of which are endemic to the Swan Coastal Plain (Rix *et al.* 2010). Of the species assigned as *Potential* SREs, 132 were considered *Likely Potential* SREs (39 species were treated as 'likely' as a precautionary measure due to lack of data) and 9 were considered *Unlikely Potential* SREs. Eight listed invertebrate species occur within the search area.

The desktop assessment reinforced that a diverse community of potentially restricted species occurs on the Swan Coastal Plain around the Project, many of which have the potential to occur within the habitat of the Project.

4.1. Listed Communities and Species

Species in Western Australia that are rare, vulnerable to extinction of need special protection or management may be listed as 'Threatened' species under the *Biodiversity Conservation Act 2016* (BC Act) to receive protection. Species for which there is possible threat that is mostly not well documented may be listed informally as 'Priority' species by the Department of Biodiversity, Conservation and Attractions (DBCA)to receive protection. Species may also be listed as Threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1996* (EPBC Act).

Similarly ecological communities comprising a naturally occurring biological assemblage in a particular habitat type may be listed as Threatened Ecological Communities (TECs) under the BC and EPBC Acts or as Priority Ecological Communities (PECs) by DBCA.

The desktop search identified eight listed invertebrate species within the 50 km search area (Table 2; Appendix 3): three Threatened bees (*Leioproctus douglasiellus*, *Neopasiphae simplicior*, *Hesperocolletes douglasi*); two Priority mygalomorph spiders; one Priority midge; and two Priority bee. Several of these species have been found in bushland remnants in Perth that resemble the Project habitat.

Table 2: Listed Threatened and Priority terrestrial invertebrates in the 50 km search area.

Higher Classification	Lowest Identification	BCA (2016) Status	EPBC (1999) Status	Presence of habitat in Project area	Likelihood of occurrence in Project area
Arthropoda					
Arachnida					
Araneae					
Mygalomorphae					
Idiopidae	*Euoplos inornatus*	P3		Yes	Moderate
	Idiosoma sigillatum	P3		Yes	High
Hexapoda					
Entognatha					
Diptera					
Ceratopogonidae	*Austroconops mcmillani*	P2		Yes	Low
Insecta					
Hymenoptera					
Colletidae	*Hesperocolletes douglasi*	CR		Yes	Low-Moderate
	Hylaeus globuliferus	P3		Yes	Moderate
	Leioproctus contrarius	P3		Yes	Moderate
	Leioproctus douglasiellus	EN	CR	Yes	Moderate
	Neopasiphae simplicior	EN	CR	Yes	Low

Euoplos inornantus

The spider *Euoplus inornatus* occurs mostly on the western Darling Scarp, where it appears to prefer riparian habitats in jarrah forest (Rix *et al.* 2017b). However, there are two outlying populations in Perth that have been identified as *E. inornatus* based on morphological characters. The records in Perth occur some distance from the Project, in Kings Park and the Mount Henry Peninsula (Appendix 3; however, these populations are likely to be in *Banksia* woodland habitats similar to those in the Project area (Threatened Species Scientific Committee 2016).

Idiosoma sigillatum

The spider *Idiosoma sigillatum* is the most recorded of the listed species within the 50 km search area (Appendix 3). This species builds its burrows in leaf litter on sandy soils; it has become locally extinct across much of its former range, but populations still occur in some bushland fragments in Perth (Rix *et al.* 2017a; Rix *et al.* 2017b). This species has also been recorded in habitat fragments in the close vicinity of the Project (Appendix 3).

Austroconops mcmillani

The biting midge *Austroconops mcmillani* is one of only two extant species in a relictual Cretaceous genus (Borkent and Craig 2004). Recorded populations in the Perth area are some distance from the Project, with the nearest records being in Yanchep National Park north of Perth (Appendix 3). This species is considered likely to occur in *Banksia* woodland of the Swan Coastal Plain by the Threatened Species Scientific Committee (2016). However, this species is dependent on aquatic habitats for its larval stages and is therefore unlikely to occur within the Project area where there are no surface water features.

Hesperocolletes douglasi

Douglas' broad-headed bee, *H. douglasi*, was until recently known only from Rottnest Island. However, Pille Arnold *et al.* (2019) found a second specimen from remnant *Banksia* woodland of the northern Perth area (Appendix 3). It is currently unclear whether it occurs in other *Banksia* woodland fragments in the metropolitan area.

Hylaeus globuliferus

The Priority 3 bee *Hylaeus globuliferus* occurs throughout southwestern Australia, with the records in the 50 km search area occurring in bushland remnants of northern Perth (Appendix 3). This species appears to be a Proteaceae specialist (Houston 2018), relying on plants such as the *Banksia* species that occur in the Project area.

Leioproctus contrarius

The short-tongued bee *Leioproctus contrarius* is known only from the SCP, where it is a likely inhabitant of *Banksia* woodland fragment (Threatened Species Scientific Committee 2016). Records have typically been associated with host plants of the family Goodeniaceae, and it may be a specialist of *Leshcenaultia* flowers (Houston 2018). Species of *Leshcenaultia* were not recorded in the vegetation survey of the Project area, however other members of the family Goodeniaceae were, such as *Scaevola canescens*.

Leioproctus douglasiellus

Similar to its congener, *Leioproctus contratius*, the threatened bee *L. douglasiellus* has only been recorded from the Swan Coastal Plain and is a likely inhabitant of *Banksia* woodlands (Threatened Species Scientific Committee 2016). It has also been recorded on host plants within Goodeniaceae (DSEWPC 2013), although it is currently unclear whether it is a specialist of particular species/genera.

Neopasiphae simplicior

The threatened bee *Neopasiphae simplicior* is known only from a single location at Forrestdale Lake (DEWHA 2008). The Threatened Species Scientific Committee (2016) considers it a likely inhabitant of *Banksia* woodland communities on the SCP; however, the only known location of this species is not in the vicinity of the Project.

5. FIELD SURVEY

A field survey targeting invertebrates belonging to SRE Groups was carried out in the Project area (Lot 802 and 803) from 12 to 18 September 2022. The aim of the survey was to collect species from recognised SRE Groups from representative habitat types within the Project area. A total of 10 sites were sampled using a range of active search methods varying at each site according to habitat, knowledge of the biology of certain taxa, and visual observations of burrows or other tell-tale signs of target species. The distribution of sampling sites is shown in Figure 4, site details and photos are presented in Appendix 4.

5.1. Sampling techniques

As no single method is effective at capturing all types of target species, two team members spent at least one hour at each site utilising a variety of methods including dry pit trapping, active searching and leaf litter sampling as per EPA (2016).

Hand foraging consisted of actively searching for taxa belonging to SRE Groups in their preferred habitats making basic assumptions about the target species' (or Group's) biology. Hand foraging techniques included:

- Log flipping and raking: turning over and breaking apart logs and dead wood in search of isopods, myriapods, and pseudoscorpions. Raking also helps to uncover camouflaged mygalomorph spider burrows or to uncover buried land snails that may aestivate below the surface.
- Rock flipping: turning over rocks and other debris in search of harvestmen, centipedes, and isopods. Rocks were returned to their natural position when possible.
- Leaf litter sieving: sieving leaf litter to target litter- and soil-dwelling species. Leaf litter sieving also uncovers small-bodied SRE species (such as pseudoscorpions, millipedes, and land snails).
- Leaf blowing: hand-held leaf blowers were used to remove leaf litter and reveal mygalomorph spider burrows covered by litter or otherwise difficult to identify unaided. If found, burrows were examined; burrows likely to house a mygalomorph spider were then excavated.
  Bark peeling and tree digging: removing pieces of bark from trees with smooth and exfoliating bark for inspection, and removing dirt from the bases of trees to search for SRE taxa. These techniques were only applied at sites containing trees (i.e. not only shrubs or spinifex).
- Night searching: with the aid of ultraviolet torches, selected sites were visited at night in search of scorpions, which fluoresce under ultraviolet light and are thereby easily detected.

Two leaf litter samples per site were collected and transported in cloth bags to the laboratory and placed on Tullgren funnels to collect litter-dwelling invertebrates.

Dry trapping was also employed to collect wandering SREs that may have evaded hand foraging techniques. Three dry pitfall traps were installed at each site with 4 x 1 m drift fences. These were checked daily, with any vertebrate bycatch recorded and released. Each trap consisted of a 500-ml polycarbonate tube with a 70-mm aperture buried within 1 cm of the aperture. A 150 x 150-mm sheet of mesh (25 x 25-mm holes) was placed over the top of the tube to prevent vertebrates from entering while allowing SRE species, which tend to be small, to enter. A 30-cm lid on brackets was installed above each trap to provide shelter and to prevent the traps from filling with rain or other debris.

5.2. Laboratory techniques

Specimens collected in the field through hand forage techniques were placed in 100% ethanol and transported to the Bennelongia laboratory for sorting and identification. All samples were processed in the Bennelongia laboratory. Personnel involved in laboratory sorting of samples and species identifications include Jane McRae, Kevin Sagastume, Melanie Fulcher, Melita Pennifold, Ella Carstens and Adam Barnard. The desktop review was completed by Rowan Lymbery with the addition of survey results by Monique Moroney.

DNA sequencing was attempted on 10 specimens from the study area to provide or confirm species identifications. 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 30 µL to 80 µL depending on the quantity of material. Primer combinations used for PCR amplifications were LCO1490:HCO2198 and C1J1718:HC02198 for the MT-CO1 gene, and 16SAR-L:16BR-H for the 16S 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 (Appendix 5).

5.3. Personnel

Staff involved and their contributions are listed in Table 3.

Table 3. Staff involved in SRE assessment.

Personnel	Contribution
Huon Clark B.Sc. (Hons) Ph.D.	Field survey
Vitor Marques B.Sc. Dip. Lab.Tech	Field survey; GIS
Ella Carstens B.Sc.	Field survey; preliminary sample sorting
Adam Barnard B.Sc. (Hons)	Preliminary sample sorting
Jane McRae 30yrs industry experience, 15 publications, leading WA invertebrate taxonomist	Morphological identification
Kevin Sagastume B.Sc. MSc.	Morphological identification
Melanie Fulcher B.Sc. (Hons)	Morphological identification; genetic analysis
Melita Pennifold B.Sc. (Hons)	Morphological identification
Heather McLetchie B.Sc. (Hons)	Genetic analysis
Rowan Lymbery B.Sc. (Hons) PhD.	Desktop review; GIS
Monique Moroney B.Sc. (Hons)	Survey reporting; GIS; genetic analysis

6. SURVEY RESULTS

The survey resulted in the collection of 622 individuals from at least 25 species with the following groups represented: two species of scorpion, two species of pseudoscorpion, three species of spider, one species of harvestmen, four species of isopods, five species of centipede, four species of land snail and four species of millipede (Table 4; Figure 4).

Five records were identified to higher order only, due to either poor specimen condition, incorrect sex (female) or life stage (juveniles) for morphological species identification. Overall, approximately half the species collected during the survey are known to be widespread or unlikely to have restricted ranges (13 species). Ten species were considered to be *Potential* SREs (or *Likely Potential* SRE:DD). There was one *Confirmed* SRE species.

Bennelongia Environmental Consultants

GCS GDA 1994
Author: MMoroney
Date: 14/11/2022

Legend

Development envelope
Survey area

SRE Group
Centipede
Harvestmen
Isopod
Land Snail
Millipede
Mygalomorph
Pseudoscorpion
Scorpion

Figure 4. SRE groups collected during the survey

6.1. Species Accounts

Additional information pertaining to distributions and SRE status of species collected, within each SRE Group, is discussed below.

Gastropod (land snails)

During the survey four species of land snail were collected from the families Bothriembryontidae, Helicidae and Hygromidae. The *Bothriembryon* species, *Bothriembryon* cf. *kendricki* is likely the (widespread) *B. kendricki* with the uncertain identification being the result of specimen condition (i.e., shell only/shell weathering). It is unlikely these records represent a restricted species. The remaining three species are *Widespread* (Table 4). It is unlikely the proposed developments will affect land snails.

Scorpions

Two species of scorpion were collected during the survey, *Cercophonius sulcatus* and *Lychas* `*multipunctatus* group` (Table 4; Figure 4). The buthid scorpion *Lychas* `*multipunctatus* group` consists of a group of morphologically distinct, but undescribed, species that are widely distributed in north-western Western Australia. Specimens from this group have been collected widely throughout the Pilbara, Kimberly and Goldfields and the species within it are probably widespread (Bennelongia 2022; Harewood 2015). *Lychas* `*multipunctatus* group` was not documented in the desktop assessment, however, during the survey two individuals were collected from site 4 (Table 3; Figure 4).

Collected in leaf litter, sequencing of the juvenile Bothriuridae scorpion revealed a genetic match (at 7.7% 16S rRNA divergence) to the described species, *Cercophonius sulcatus*; which is *Widespread* throughout south-west Western Australia (Appendix 5) (Acosta 1990; ALA 2022).

Pseudoscorpions

Two species of pseudoscorpion of the families Chthoniidae and Olpiidae, were collected from the survey (Table 4; Figure 4). Terrestrial pseudoscorpions species are generally considered to have widespread distributions and it has been suggested that few species are SREs (Harvey 2002), although, some species have narrow ranges and are restricted to specialist habitats such as granite outcrops (Harvey 2010, 2012).

Beierolpium 8/4 `BPS456` is currently only known from the survey area but species of this genus are mostly widespread (Harvey and Leng 2008). *Beierolpium* 8/4 `BPS456` is an *Unlikely Potential* SRE and was collected outside of the Project development envelope (Table 3; Figure 4).

Similarly, the second species of pseudoscorpion, *Austrochthonius* `BPS455`, is currently only known from this survey. The Australian fauna of this genus consists of both terrestrial and subterranean species, with very few currently described species. Terrestrial *Austrochthonius* species can be quite common in leaf litter and soil (Harvey and Mould 2006). *Austrochthonius* `BPS455` is a *Likely Potential* SRE due to a deficiency of data. Both species of pseudoscorpion are unlikely to be affected by the proposed developments.

Mygalomorph (trapdoor) spiders

The survey collected three species of mygalomorph spider. This comprised one species each of Anamidae (open-holed trapdoor spiders), Barychelidae (brush-footed trapdoor spiders) and Idiopidae (armoured trapdoor spiders) (Table 4; Figure 4). Species of these families are typically confined to sandy or loose soil types because they lack a rastellum for digging in more compact soils, and are therefore likely to face particularly strong habitat restrictions (Main *et al.* 2000).

The species of brush-footed trapdoor spider, *Synothele michaelseni* is known from south-west Western Australia and is distributed throughout the Darling Ranges and the Swan Coastal Plain (Raven 1994). This is an *Unlikely Potential* SRE collected outside of the development envelope.

Idiosoma sigillatum is a Priority 3 species and was collected both within and outside of the development envelope (Site 01 and Site 07) (Table 4; Figure 4). *I. sigillatum* is the predominant idiopid trapdoor spider on the Swan Coastal Plain and is considered to have a relatively widespread, albeit bioregion and substrate specific, distribution (Rix *et al.* 2018). Historically this species was widespread in the Greater Perth area, however, due to urban development, populations have significantly declined. Consequently, this species is now largely restricted to remnant woodland habitats (Kings Park, Shenton Park, Bold Park etc.). *I. sigillatum* has a known distribution of around 7,100 km^2, with actual area of occupancy estimated at < 3,000 km^2 within that range (Rix *et al.* 2018). *I. sigillatum* is a *Confirmed* SRE although, due to its occurrence outside of the development envelope, it is unlikely to be affected by the proposed developments.

Three females of the genus *Aname* (Anamidae) were collected at Site 07 and sequencing was undertaken to identify them at species level (Table 4; Figure 4). Genetic analysis revealed that the specimens represent a new species, named *Aname* `BMYG200`, which is at least 8.9% divergent in the 16S rRNA gene to its closest relative, *Aname* `MYG030` (GenBank accession number MW518390) (Appendix 5). This level of divergence in this barcoding gene is more consistent with interspecific, rather than intraspecific divergence. This species is considered *Likely potential* SRE due to a deficiency of data however, as it was collected outside of the development envelope, the risk from the proposed developments is considered low

Opiliones (harvestmen)
One species of Opilionid was collected during the survey, *Megalopsalis* sp. This juvenile specimen was collected at Site 04 from a dry trap and was unable to be identified further (keys require mature males). The desktop assessment also identified an undescribed species of the same genus in the search area. Species of harvestmen may represent likely SREs due to their limited dispersal capability and specialised microhabitat requirements (Framenau *et al.* 2008), the genus *Megalopsalis* contains both restricted and non-restricted species (Taylor 2011; Taylor 2013). *Megalopsalis* sp. is considered a *Likely Potential* SRE due to a deficiency of data and has the potential to be impacted by the proposed developments of the Project (Table 4; Figure 4).

Isopods
Australian isopoda contains a largely undescribed and diverse group of terrestrial epigean crustaceans that, due to poor dispersal capabilities and specific habitat preferences, are often SREs (Judd 2004; Judd and Horwitz 2003; Judd and Tati 2011). Four species of Isopods from the families Armadillidae (Pseudodiploexochus `BIS495`), Philosciidae (*Laevophiloscia* `BIS493` and Philosciidae `BIS492`) and Styloniscidae (*Styloniscus* `BIS496`) were collected during the survey (Table 4; Figure 4). All species are undescribed and are morphologically distinct from morphospecies outlined within Judd (2004). The four species are currently only known from the Project area and are considered *Likely Potential* SREs: DD. Notably, however, their distributions within the Project area differ with three species collected as singletons (*Styloniscus* `BIS496`, Philosciidae `BIS492`, Pseudodiploexochus `BIS495` from sites 01, 07 and 09, respectively). In contrast, *Laevophiloscia* `BIS493` was collected across multiple sites in the survey area (Table 4; Figure 4).

Styloniscus `BIS496 is known only from Site 01 within the area of proposed development (Figure 4). The other species were collected outside the development envelope.

Centipedes (Chilopoda)
Five species of centipede of the orders Scolopendrida, Geophilida and Lithobiomorpha were identified from the survey (Table 4; Figure 4).

The geophillid, *Sepedonophilus* `BGE065` was collected both within and outside of the development envelope and is currently only known from this survey. The known Australian fauna of this group and the proportion of SRE species is poorly defined (EPA 2016) and *S.* `BGE065` is considered a *Potential* SRE

due to a deficiency of data. Lithobiomorpha sp. was not identified further as centipedes of this order are usually not considered SREs (Harvey 2000).

Three species of scolopendrid centipede were collected during the survey, of which two are *Widespread* throughout Australia, *Cormocephalus aurantiipes* and *Scolopendra morsitans*. The identification of specimens of *C. aurantiipes* was confirmed via DNA analysis, genetically matching *C. aurantiipes* (at only 0.4% Mt-COI divergence; GenBank accession number MK867509) (Appendix 5).

The third species, also of the genus *Cormocephalus,* is currently only known from this survey area and represents a new species, *Cormocephalus* `BSCOL096`. Confirmed via genetic analysis, *C.* `BSCOL096` is at least 17.2% divergent in the Mt-COI gene to its closest relative (GenBank accession number MK273223) (Appendix 5). Most species within the genus *Cormocephalus* are widespread (Koch 1983) and *C.* `BSCOL096` is considered an *Unlikely Potential* SRE collected within and outside of the development envelope of the Project.

Millipedes (Diplopoda)

Four species of millipede were collected from the survey area, including the introduced Portuguese millipede, *Ommatoiulus moreleti,* which is found throughout the southern regions of Australia (ALA 2022). Two species of polydesmid millipedes of the genus *Antichiropus* were also collected (Table 3; Figure 4).

Antichiropus `DPI078` is currently only known from the development envelope and is believed to represent a new morphospecies. Sequencing was attempted on this specimen but failed. This diverse genus has been extensively studied and many of the species within this genus are considered confirmed SREs (Car and Harvey 2014; Car *et al.* 2019; Car *et al.* 2013). *A.*`DPI078` is therefore a *Potential* SRE currently only known from the development envelope.

The second species of *Antichiropus* was sequenced and confirmed as *Antichiropus whistleri* (100% match GenBank accession number JN637365) (Appendix 5). *A. whistleri* was collected throughout the survey area and is *Widespread* (although restricted to the Swan Coastal Plain) (Car *et al.* 2013). It is unlikely to be affected by proposed developments.

The species Iulomorphidae sp. was collected at Site 02 during hand foraging (Table 4; Figure 4). Due to the specimen being female, it could not be identified further (keys require mature males) (Edward and Harvey 2010). The desktop assessment identified two species from the family Iulomorphidae (*Dinocambala ingens* and *Podykipus collinus*), both of which are restricted to the Perth area. The species collected is unlikely to be conspecific with *D. ingens* as it is restricted to the Darling Scarp (Edward and Harvey 2010; Framenau *et al.* 2008). Currently there are no publicly available sequences of *P. collinus* on GenBank and so it is not possible to confirm whether Iulomorphidae sp. is *P. collinus*. Iulomorphidae sp. is considered a *Likely Potential* SRE due to a deficiency of data.

Table 4. Species from SRE Groups collected during field survey

N.B. Records marked with an asterisk indicate higher order identifications likely conspecific with other listed species (not viewed as unique species), those coloured orange indicate sites within the proposed development envelope.

Higher Classification	Lowest Identification	Site 01	Site 02	Site 03	Site 04	Site 05	Site 06	Site 07	Site 08	Site 09	Site 10	Comments
Mollusca												
Gastropoda												
Bothriembryontidae	*Bothriembryon bulla*			1	2							Widespread
	Bothriembryon cf. *kendricki*			1						1		Uncertain taxonomy, although likely conspecific with described (widespread) species. It is unlikely these records represent a restricted species.
Helicidae	*Theba pisana*			94	5							Widespread
Hygromiidae	*Prietocella barbara*				2							Widespread
Arthropoda												
Chelicerata												
Arachnida												
Scorpiones												
Bothriuridae	*Cercophonius sulcatus*		1									Widespread
Buthidae	*Lychas `multipunctatus* group`				2							Manuscript name (not formally described but morphologically recognised). Likely represent a species complex in need of revisions. Unlikely Potential SRE.
Pseudoscorpiones												
Chthoniidae	*Austrochthonius* `BPS455`	4					3					Known only from this survey, current linear range of approximately 385 m. Likely Potential SRE: DD
Olpiidae	*Beierolpium* 8/4 `BPS456`							2				Currently only known from this survey. Unlikely Potential SRE
Araneae												

Higher Classification	Lowest Identification	Site 01	Site 02	Site 03	Site 04	Site 05	Site 06	Site 07	Site 08	Site 09	Site 10	Comments
Anamidae	*Aname* `BMYG200`							3				Currently only known from the survey area. New species confirmed via genetic analysis. Likely Potential SRE: DD
Barychelidae	*Synothele michaelseni*						1	1				Distributed throughout SW WA (Raven 1994). Unlikely Potential SRE
Idiopidae	*Idiosoma sigillatum*	1						1				P3 listed invertebrate and Confirmed SRE (Rix *et al.* 2018).
Opiliones												
Neopilionidae	*Megalopsalis* sp.				1							Higher order identification due to specimen juvenility. Likely Potential SRE: DD
Crustacea												
Malacostraca												
Isopoda												
Armadillidae	*Pseudodiploexochus* `BIS495`									1		Singleton currently only known from survey area, Likely Potential SRE: DD
Philosciidae	*Laevophiloscia* `BIS493`			1	11						3	Currently only known from survey area, current linear range of approximately 635 m. Likely Potential SRE: DD
	Philosciidae `BIS492`							1				Singleton currently only known from survey area, Likely Potential SRE: DD
Styloniscidae	*Styloniscus* `BIS496`	1										Singleton currently only known from the development envelope, Likely Potential SRE: DD
Myriapoda												
Chilopoda												
Geophilida												
Chilenophilidae	*Sepedonophilus* `BGE065`				1	4	1			5		Currently only known from survey area, Likely Potential SRE: DD
Lithobiomorpha	Lithobiomorpha sp.	1		6		4		2	1	1		Generally, members of this genus are not considered SREs (Harvey 2000).
Scolopendrida												
Scolopendridae	*Cormocephalus* `BSCOL096`	2	1					1				Currently only known from this survey. Unlikely Potential SRE

Higher Classification	Lowest Identification	Site 01	Site 02	Site 03	Site 04	Site 05	Site 06	Site 07	Site 08	Site 09	Site 10	Comments
	Cormocephalus aurantiipes		1					3	1		1	Widespread
	**Cormocephalus* sp.									1		Higher order identification, likely conspecific with an above species.
	Scolopendra laeta									1		Widespread
Diplopoda												
Julida												
Julidae	*Ommatoiulus moreleti*	46	39	27	49	67	32	28	14	96	33	Introduced Portuguese millipede, Widespread
Polydesmida												
Paradoxosomatidae	*Antichiropus* `DPI078`				1							New morphospecies, currently only known from the development envelope. Potential SRE
	Antichiropus whistleri		1			1		1	1			Widespread species (Car *et al.* 2013)
Spirostreptida												
Iulomorphidae	Iulomorphidae sp.		3									Higher order identification due to specimen sex. Likely Potential SRE: DD

7. DISCUSSION

The desktop review and field survey aimed to assess the potential ecological and conservation values of SRE invertebrate fauna with regards to the proposed development of Lot 802 (the Project).

Prospective habitats for SRE Groups occur at the Project, with vegetation primarily consisting of *Banksia* and *Eucalyptus* woodlands over diverse shrubs and heath known to contain a range of microhabitats that harbour range-restricted invertebrates. Furthermore, the remnant woodland at the Project is considerably fragmented as a result of urban development.

The desktop assessment identified that a substantial number of species (136) from SRE Groups occur within the vicinity of the Project. This included 88 species of spider (modern and trapdoor), two species of harvestmen, six species of pseudoscorpion, three species of scorpion, 14 species of isopod, three species of centipede, 14 species of millipede, and six species of land snail. Of these, two species were *Confirmed SREs,* 124 species were considered *Likely Potential* SREs (with varying levels of data deficiency), 9 species were considered *Unlikely Potential* SREs, and one was a *Widespread* species. Additionally, eight listed threatened or priority invertebrates occur within the search area.

The field survey, undertaken in September 2022, collected 622 individuals belonging to at least 25 species within the following groups: two species of scorpion, two species of pseudoscorpion, three species of spider, one species of harvestmen, four species of isopods, five species of centipede, four species of land snail and four species of millipede.

Based on available information regarding habitat specialisation, biology and ecology of the species or their close relatives, nine species were identified as W*idespread* (not SREs), four species were considered *Unlikely Potential* SREs, eight species were considered *Likely Potential* SREs (with seven of these *Likely Potential*: DD and one *Likely Potential* SRE). One *Confirmed* SRE was collected during the survey.

The *Confirmed* SRE, *Idiosoma sigillatum,* is a Priority 3 species and is the predominant idiopid trapdoor spider on the Swan Coastal Plain. Restricted to the Swan Coastal Plain *I. sigillatum* was historically widespread in the Greater Perth area. However, as a result of urban development, its populations have significantly declined. Two individuals of *I. sigillatum* were collected (one in and one outside the development envelope) and the Project is unlikely to have a significant impact on *I. sigillatum* populations. The distribution of this species is shown in Appendix 3.

During the survey, 18 other species were collected in the Project area, with seven of these being widespread species and seven local species that were also collected outside the Project. The remaining four species are known only from within the proposed development envelope. They are:

- Opilionid: *Megalopsalis* sp. (Site 04 via trapping);
- Isopod: *Styloniscus* `BIS496` (Site 01 in *Eucalyptus* litter);
- Millipede: *Antichiropus* `DPI078` (Site 04 via trapping); and
- Millipede: Iulomorphidae sp. (Site 02 under a log)

The key threats from the proposed developments to species known only from development envelope is the potential for habitat removal or degradation, either by part clearing (reducing habitat connectivity) or complete clearing of bush. The invertebrate fauna habitat within in the development envelope is widespread throughout the greater survey area and the collection of many species both within and outside of the development envelope indicates good habitat connectivity. It is probable that the four currently restricted species have local occurrence outside the development envelope of the Project.

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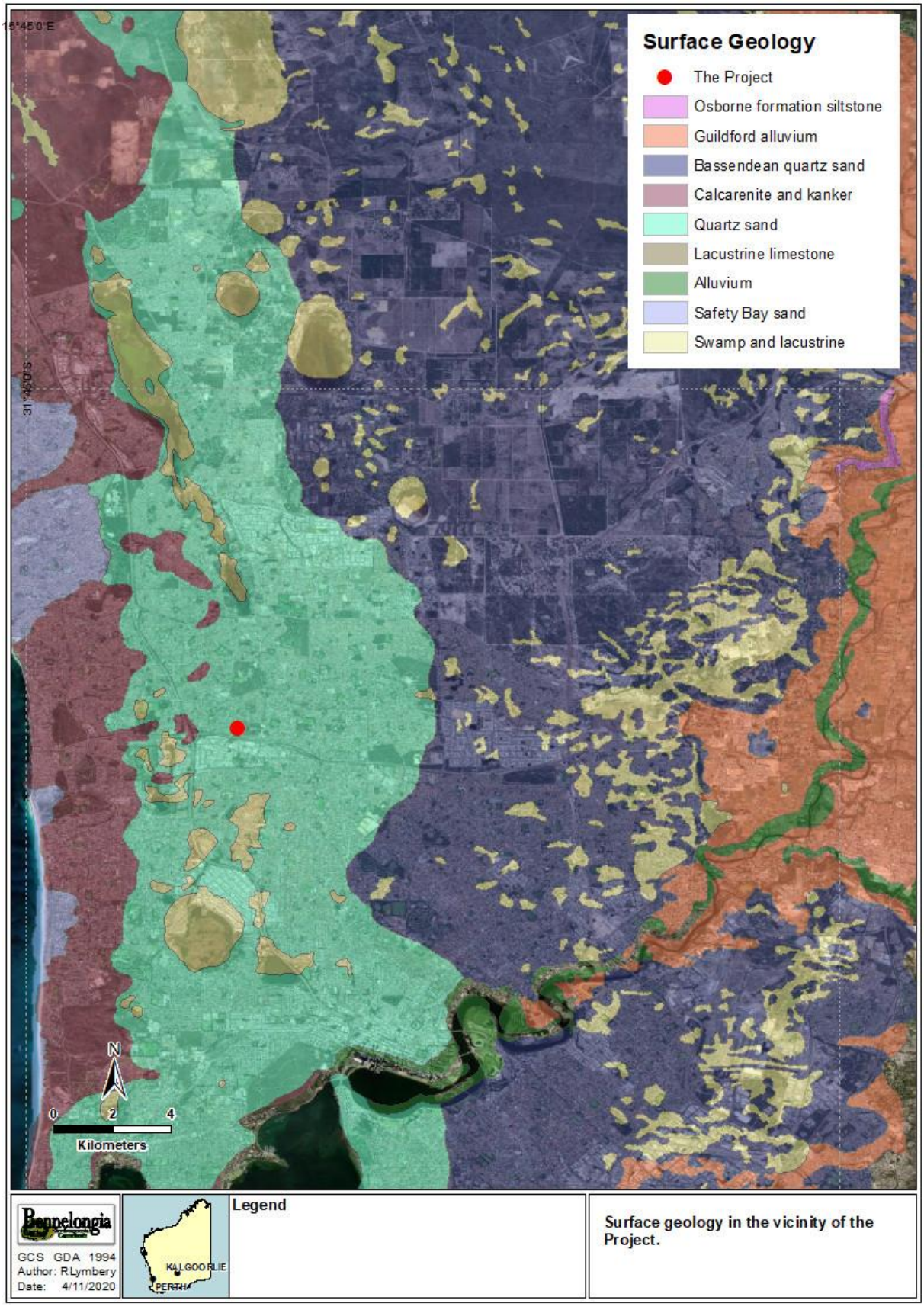
9. APPENDICES

Appendix 1. Surface geology in the vicinity of the project



Appendix 2. Species from SRE Groups in the Search Area

*Species marked with an asterisk under the SRE category column were data deficient and assigned as *likely potential SREs* by default.

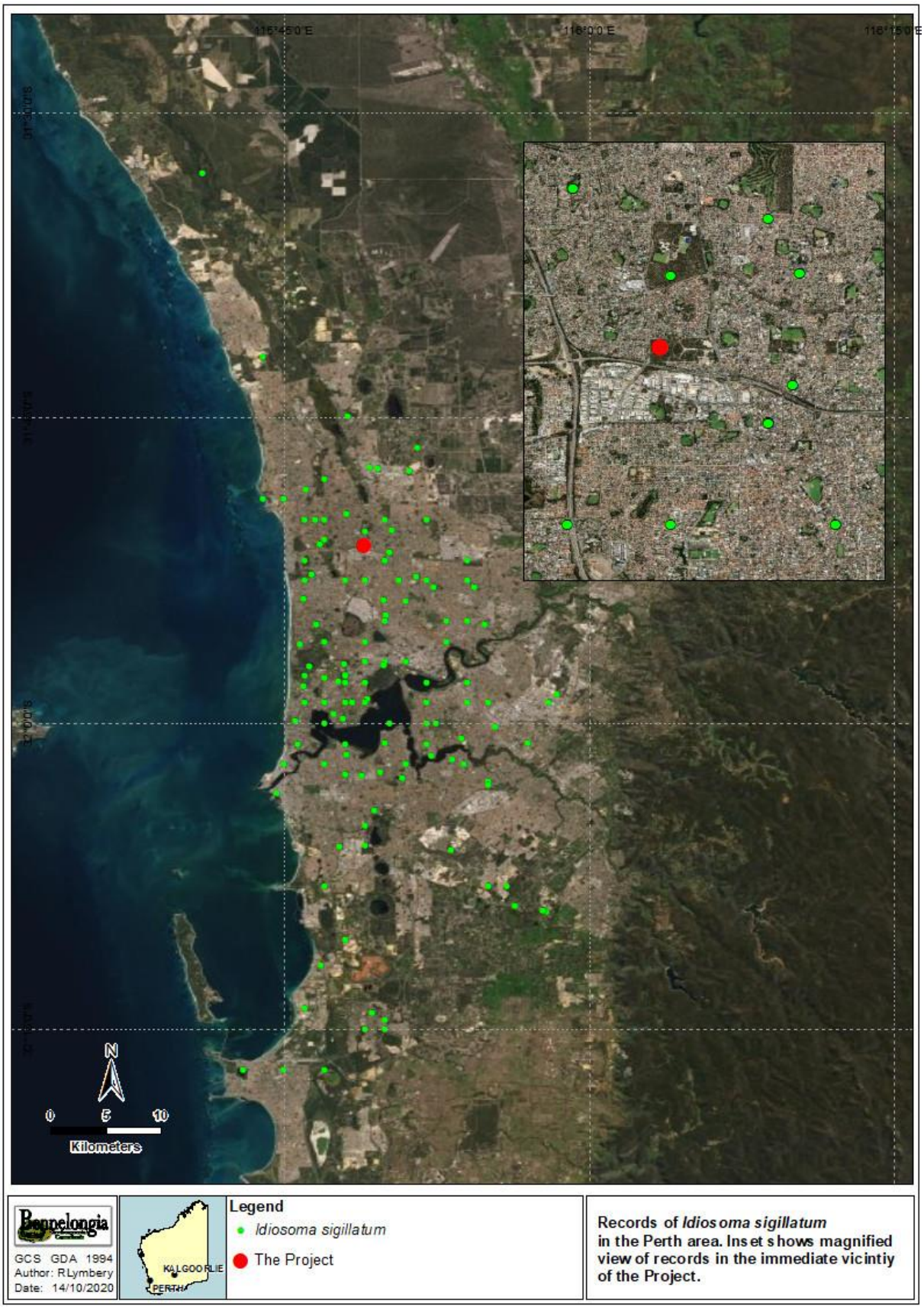
Higher Classification	Lowest Identification	SRE category
Arthropoda		
Chelicerata		
Arachnida		
Araneae		
Araneomorphae		
Anapidae	*Micropholcomma `sp.`*	Likely potential SRE
	Raveniella arenacea	Confirmed SRE
	Raveniella subcirrata	Confirmed SRE
Araneidae	*Paralarinia `sp.`*	Likely potential SRE*
Hersiliidae	*Tamopsis darlingtoniana*	Likely potential SRE*
Lamponidae	*Pseudolampona woodman*	Likely potential SRE
Lycosidae	*Artoria `sp.`*	Unlikely potential SRE
Malkaridae	*Westrarchaea sinuosa*	Likely potential SRE
Miturgidae	*`Miturgopelma` `echidna`*	Unlikely potential SRE
Oonopidae	*Opopaea framenaui*	Likely potential SRE*
	Opopaea gracillima	Likely potential SRE*
	Opopaea marangaroo	Likely potential SRE*
	Opopaea rixi	Likely potential SRE*
	Orchestina `aeroporta`	Likely potential SRE*
	Xestaspis `UBS Cat sp. 128`	Likely potential SRE*
	Xestaspis `UBS Cat sp. 19`	Likely potential SRE*
Orsolobidae	*Tasmanoonops `forsteri`*	Likely potential SRE
	Tasmanoonops `tuberosus`	Likely potential SRE
Salticidae	*Holoplatys dejongi*	Likely potential SRE*
	`Lycidas` `big embolis`	Likely potential SRE
	Lycidas `Brookdale sp. 1`	Likely potential SRE
	Lycidas `gyngyn`	Likely potential SRE
	Maratus clupeatus	Likely potential SRE
	Maratus mungaich	Likely potential SRE
	Maratus `roo`	Likely potential SRE*
	Maratus `sp. O`	Likely potential SRE*
	Maratus speciosus	Likely potential SRE
	Maratus speculifer	Likely potential SRE
	Maratus spicatus	Likely potential SRE
	Proszynellus nasalis	Likely potential SRE*
Theridiidae	*`Ctenopalpus` `thaleri`*	Likely potential SRE*
	`Diagmogala` `molliventer`	Likely potential SRE*
	`Tremaulus` `grayi`	Likely potential SRE*
	Billima attrita	Likely potential SRE*
	Enoplognatha `UBS Cat sp. 103`	Unlikely potential SRE
	Enoplognatha bidens	Unlikely potential SRE
	Phycosoma `L1-complex`	Unlikely potential SRE

Higher Classification	Lowest Identification	SRE category
Thomisidae	*Xysticus periscelis*	Likely potential SRE*
Trochanteriidae	*Tinytrema yarra*	Likely potential SRE
Zodariidae	*`Asteron grp` `sp. 1 (942)`*	Likely potential SRE*
	`Australutica? Cat Gen.1` `UBS Cat sp. 2`	Likely potential SRE
	Asteron `species group`	Likely potential SRE*
	Australutica `Brookdale sp. 1`	Likely potential SRE*
	Australutica `UBS Cat sp. 119`	Likely potential SRE*
	Chilumena `sp. nov.`	Likely potential SRE*
	Holasteron wamuseum	Likely potential SRE
	Masasteron tuart	Likely potential SRE
	Neostorena `Brookdale sp. 1`	Likely potential SRE*
	Neostorena `sp. 2`	Likely potential SRE*
	Neostorena `UBS sp. 2`	Likely potential SRE*
	Pentasteron `sp. nov. 3`	Likely potential SRE*
Mygalomorphae		
Actinopodidae	*Missulena `black chelicerae`*	Likely potential SRE
	Missulena `hoggi spp. group`	Likely potential SRE
	Missulena hoggi	Likely potential SRE
Anamidae	*`Chenistonia` `tepperi`*	Likely potential SRE
	Aname `coastal plain`	Likely potential SRE
	Aname `false black wish-bone`	Likely potential SRE
	Aname `kwonkan spp. group.`	Likely potential SRE
	Aname `metropolitan`	Likely potential SRE
	Aname `MYG405`	Likely potential SRE
	Aname `MYG496`	Likely potential SRE
	Aname `MYG633`	Likely potential SRE
	Aname `sp. nov.`	Likely potential SRE
	Aname `UBS Cat sp. 126`	Likely potential SRE
	Aname `UBS sp. 2`	Likely potential SRE
	Chenistonia `maculata?`	Likely potential SRE
	Kwonkan `Cat sp. 126`	Likely potential SRE
	Kwonkan `MYG060`	Likely potential SRE
	Kwonkan `UBS Cat sp. 124`	Likely potential SRE
	Kwonkan `UBS Cat sp. 126`	Likely potential SRE
	Proshermacha `MYG449`	Likely potential SRE
	Proshermacha `MYG490`	Likely potential SRE
	Proshermacha `sp.`	Likely potential SRE
	Teyl `MYG249`	Likely potential SRE
	Teyl `UBS Cat sp. 149`	Likely potential SRE
	Teyl `waldockae`	Likely potential SRE
Barychelidae	*Idiommata `cf. blackwalli`*	Likely potential SRE
	Idiommata `UBS Cat sp. 123`	Likely potential SRE
	Synothele michaelseni	Likely potential SRE
	Synothele mullaloo	Likely potential SRE
	Synothele rastelloides	Unlikely potential SRE
Euagridae	*Cethegus `sp.`*	Likely potential SRE

Higher Classification	Lowest Identification	SRE category
Idiopidae	*Gaius `villosus?`*	Likely potential SRE
	Idiosoma `coastal plain sp.`	Likely potential SRE
	Idiosoma `MYG188`	Likely potential SRE
	Idiosoma `MYG189`	Likely potential SRE
	Idiosoma `rhaphiduca sp. group`	Likely potential SRE
	Idiosoma `sp. nov. nec (cf. rhaphiduca)`	Likely potential SRE
Opiliones		
Neopilionidae	*Megalopsalis `sp.`*	Likely potential SRE*
Triaenonychidae	*Nunciella `sp. nov.`*	Likely potential SRE*
Pseudoscorpiones		
Chernetidae	*`Genus indet.` `tarsus IV without tactile seta`*	Likely potential SRE
	`PSEAAF` `PSE130`	Likely potential SRE
Chthoniidae	*Austrochthonius `similis`*	Likely potential SRE*
	Austrochthonius `sp. nov. 4`	Likely potential SRE*
Garypidae	*Synsphyronus `sp.`*	Likely potential SRE
Olpiidae	*Beierolpium `sp.`*	Likely potential SRE
Scorpiones		
Buthidae	*Lychas `majeri`*	Likely potential SRE*
	Lychas `majerorum`	Likely potential SRE*
Urodacidae	*Urodacus planimanus*	Likely potential SRE
Crustacea		
Malacostraca		
Eumalacostrata		
Isopoda		
Ligiamorpha	*Ligiamorpha `sp.`*	Likely potential SRE
Armadillidae	*Armadillidae indet*	Likely potential SRE*
	Buddelundia `sp. 3 (Judd 2002)`	Likely potential SRE
	Buddelundia `sp. 4 (Judd 2002)`	Likely potential SRE
	Buddelundia `sp. 7 (Judd 2002)`	Likely potential SRE
	Buddelundia cinerascens	Likely potential SRE
	Buddelundia inaequalis	Likely potential SRE
	Buddelundia indet.	Likely potential SRE
	Buddelundia nigripes	Unlikely potential SRE
	Cubaris `sp. 2 (Judd 2002)`	Likely potential SRE
	Spherillo `sp. 2 (Judd 2002)`	Unlikely potential SRE
Philosciidae	*Philosciidae `sp. 1 (Judd 2002)`*	Likely potential SRE
	Philosciidae `sp.`	Likely potential SRE
Styloniscidae	*Styloniscidae `sp.`*	Likely potential SRE*
Myriapoda		
Chilopoda		
Geophilida	*Eurytion incisunguis*	Likely potential SRE
Chilenophilidae		
Scolopendrida		
Cryptopidae	*Cryptops `cf. australis`*	Unlikely potential SRE
Scolopendridae	*Notiasemus glauerti*	Likely potential SRE

Higher Classification	Lowest Identification	SRE category
Diplopoda		
Polydesmida		
Paradoxosomatidae	*Antichiropus `GI/UBS1, DIP082/DIP172`*	Likely potential SRE
	Antichiropus `janine, DIP022`	Likely potential SRE
	Antichiropus `rottnest, DIP172`	Likely potential SRE
	Antichiropus `sp.`	Likely potential SRE
	Antichiropus `UBS1/GI, DIP141`	Likely potential SRE
	Antichiropus `UBS2, disgregus, DIP126`	Likely potential SRE
	Antichiropus `UBS2`UBS2, disgregus, DIP126`	Likely potential SRE
	Antichiropus `UBS3, DIP127`	Likely potential SRE
	Antichiropus `woodvale, DIP167`	Likely potential SRE
	Antichiropus accinctus DIP126`	Likely potential SRE
	Antichiropus whistleri	Widespread
Polyzoniida		
Siphonotidae	*`Genus indet.` `sp.`*	Likely potential SRE
Spirostreptida		
Iulomorphidae	*Dinocambala ingens*	Likely potential SRE
	Podykipus collinus	Likely potential SRE
Mollusca		
Gastropoda		
Stylommatophora		
Bothriembryontidae	*Bothriembryon cf. bulla*	Likely potential SRE
	Bothriembryon kendricki	Likely potential SRE
Charopidae	*Epinicium restifer*	Likely potential SRE
	Luinodiscus sublesta	Likely potential SRE
Hygromidae	*Hygromidae sp.*	Likely potential SRE*
Punctidae	*Westralaoma sp.*	Likely potential SRE*
Succineidae	*Succinea contenta*	Likely potential SRE

Appendix 3. Distribution of listed invertebrate species within the search area




Austroconops mcmillani
Hesperocolletes douglasi
Hylaeus globuliferus
Leioproctus contrarius
Hylaeus globuliferus
Hylaeus globuliferus
Europlos inornatus
Neopasiphae simplicior
Leioproctus contrarius
Neopasiphae simplicior
Leioproctus dougasiellus
N
0
42.5
85
Kilometers
GCS GDA 1994
Author: RLymbery
Date: 14/10/2020
KALGOORLIE
PERTH
Legend
The Project
Records of other Threatened and Priority invertebrate species in the Perth area.

Appendix 4. Photographs of sites sampled

Site 01

Site 01

Site 02

Site 02

Site 03

Site 03

Site 04

Site 04

Site 05

Site 05

Site 06

Site 06

Site 07

Site 07

Site 08

Site 08

Site 09

Site 09

Site 10

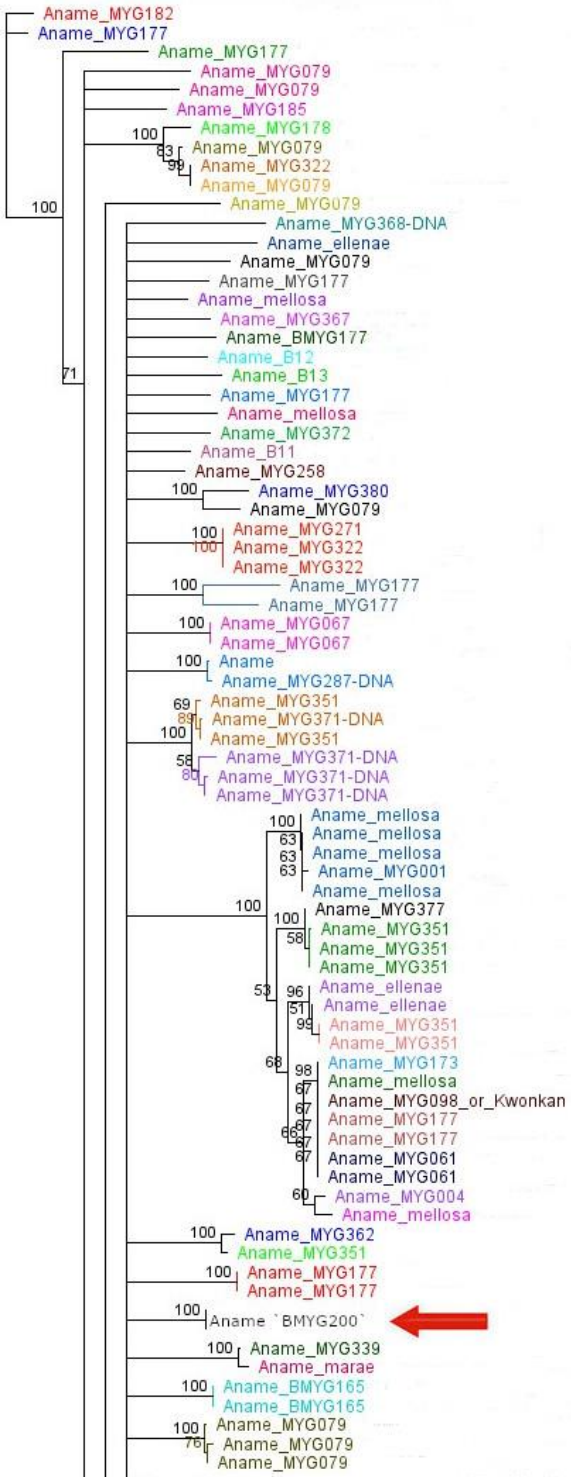
Site 10

Appendix 5. Molecular Analysis

DNA sequencing was attempted on ten specimens from the study area.

***Aname* sp.**

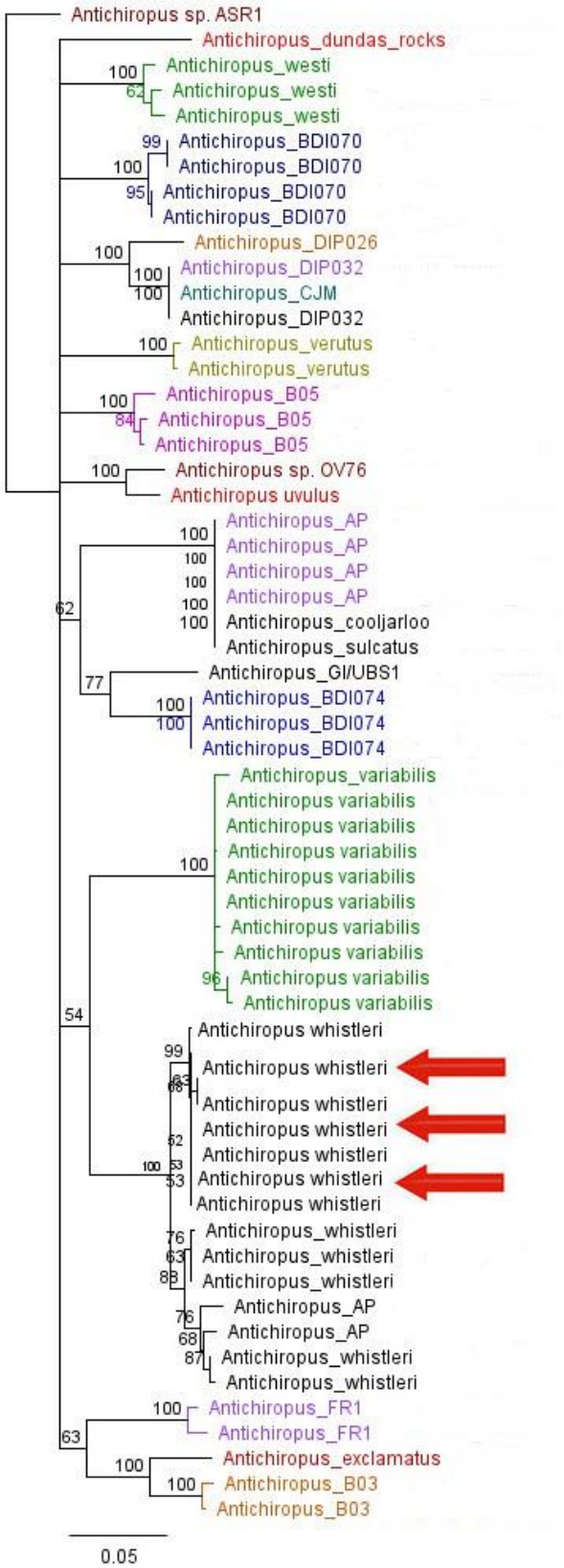
Aname sp. was sequenced for molecular analysis and compared with other sequences from the same genus in the Bennelongia database and on Genbank. Genetic analysis revealed no close matches, with the closet relative (at 8.9% 16S rRNA divergence) being *Aname* `MYG030` (GenBank accession number MW518390). The specimens likely represent a new species and were assigned the new morphospecies code *Aname* `BMYG200`.



Maximum likelihood phylogenetic tree from the genus *Aname*. The species sequenced from the current survey are highlighted with a red arrow.

***Antichiropus* sp.**

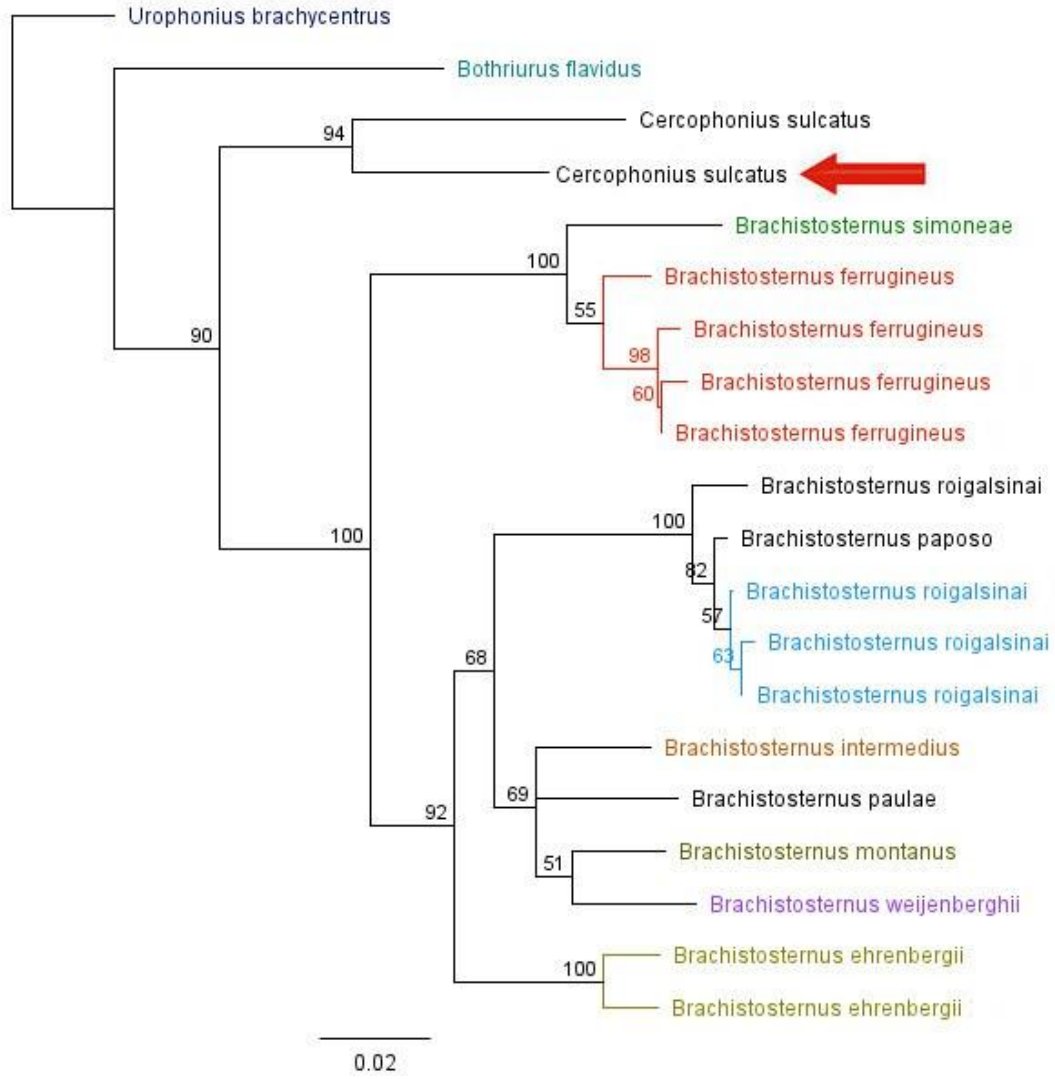
Three *Antichiropus* specimens were sequenced for molecular analysis and compared with other sequences from the same genus in the Bennelongia database and on Genbank. All three specimens matched genetically with *Antichiropus whistleri* (100% match GenBank accession number JN637365).



Maximum likelihood phylogenetic tree from the genus *Antichiropus*. The species sequenced from the current survey are highlighted with a red arrow.

***Cercophonius* sp.**

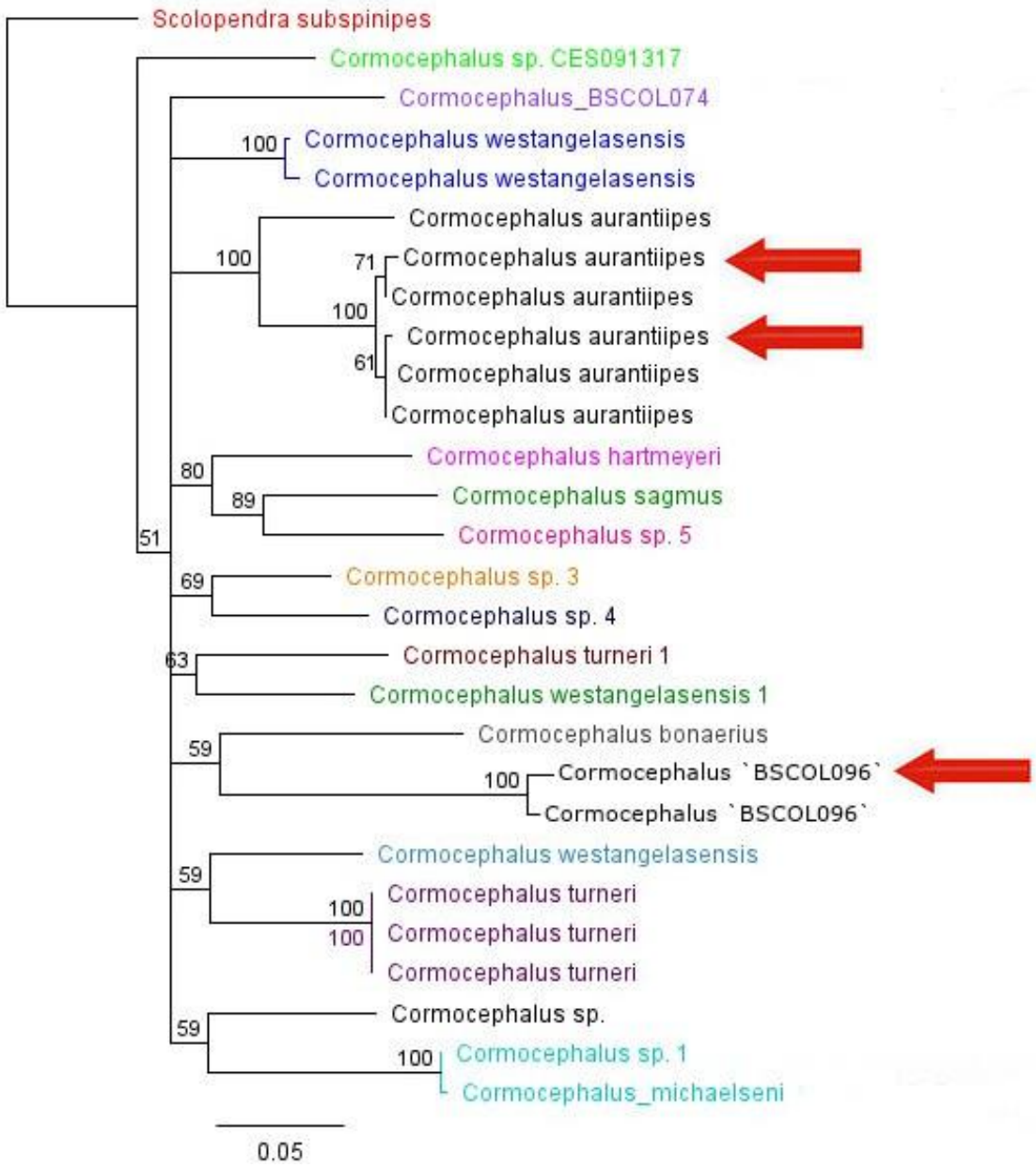
One juvenile *Cercophonius* sp. was sequenced for molecular analysis and compared with other sequences from the same family in the Bennelongia database and on Genbank. The specimen matched closely with *Cercophonius sulcatus* (at 7.7% 16S rRNA divergence).



Maximum likelihood phylogenetic tree from the family Bothriuridae. The species sequenced from the current survey are highlighted with a red arrow.

***Cormocephalus* sp.**

Three specimens of *Cercophonius* sp. were sequenced for molecular analysis and compared with other sequences from the same genus in the Bennelongia database and on Genbank. Two specimens matched closely with *Cormocephalus aurantiipes* (at 0.4% Mt-COI divergence; GenBank accession number MK867509). No close matches were found for the third specimen, at 17.2% divergent in the Mt-COI gene to its closest relative (GenBank accession number MK273223) and was assigned the new morphospecies code *Cormocephalus* `BSCOL096`.



Maximum likelihood phylogenetic tree from the genus *Cormocephalus*. The species sequenced from the current survey are highlighted with a red arrow.

Antichiropus* `DPI078` and *Antichiropus whistleri

The isopods *Antichiropus* `DPI078` and *Antichiropus whistleri* were also sequenced and unfortunately, the sequences returned were of poor quality and could not be used in an informative analysis.