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RAIL OPERATIONS

RGP5 RAIL DUPLICATION PROJECT:

CHICHESTER DEVIATION SHORT RANGE ENDEMIC INVERTEBRATE SURVEY & A TARGETED SURVEY FOR THE TRAPDOOR SPIDER, *AURECOCRYPTA* SP.

IRON ORE

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Table of Contents

Tables

Figures

Executive Summary

BHP Billiton Iron Ore Pty Ltd commission Calibre Engenium to design the RGP5 Rail Duplication Project and ecologia Environment was subsequently commissioned to undertake a survey of the short range endemic (SRE) invertebrate fauna associated with the Chichester Deviation section of the project (hereafter referred to as 'the project'). Ecologia is providing the required experience and expertise to undertake an investigation of the potential environmental impacts to SRE species associated with the project.

The main disturbance caused by the proposed Chichester Deviation is the removal of potential SRE habitat within the linear project footprint area, which will provide passage through and between the hills of the Chichester Range. Construction of access tracks to and from site and vibrations from the operational rail system are also potential impacts.

The Chichester landscape consists of many gradual sloping hills in a matrix of low lying plains. The new rail construction is to remain fairly level during its course and low-lying areas will require building up with rocky strata to elevate the rail (i.e. reduce risk of flooding) while 'cuts' will be made at the base of hills to reduce rail incline. For the most part, it is believed that these cuts will involve 'shaving off' small areas at the foot of the slopes, however, larger cuts were identified which will potentially involve greater disturbance. Studies show that sheltered areas such as south facing slopes and densely vegetated areas are more likely to contain SRE species than more exposed areas. These 'cuts' along with several smaller 'cuts' were targeted for sampling during phase 1 of the SRE survey.

During the first phase of sampling within the impact area, ten pitfall traps were placed at nine individual sites along the length of the Chichester Deviation where hillside cuts were proposed. These were opened for a six week trapping period (17/9/07-29/10/07). A large number of invertebrate specimens were collected during the survey and most of these belonged to insect groups that were unlikely to be short range endemic species (SREs). Three potential SRE groups were identified including centipedes, pseudoscorpions and mygalomorph spiders. Species within these groups were sent to experts who provided information on the conservation significance of each species.

One species of trapdoor spider, *Aurecocrypta* sp., was collected at two sites within the impact area which was identified as being of high conservation value due to the likelihood that it represented an SRE species (potentially restricted to the Chichester Range). Only four male specimens of the species were found at the two sites, which occurred on slopes at the northern end of the proposed rail deviation.

Due to concerns that the Chichester Deviation could impact a potentially localised population of *Aurecocrypta* sp., a targeted survey was instigated to identify the distribution of the species within the Chichester Range. The sampling effort included five rounds of sampling (7/4/08-5/5/08, 5/5/08-9/6/08, 9/6/08-7/7/08, 7/7/08-18/8/08 and 12/9/08-17/9/08), in which pitfall trap sites were placed in numerous habitats throughout the Chichester Range. Sampling eventually uncovered two new specimens, one of which occurred near the original collection locality and the second occurred outside the impact area on the western side of the deviation. The taxonomic expert of *Aurecocrypta*, Dr Robert Raven, was

employed to examine the specimens and their habitat within the Chichester Range. Dr Raven also examined specimens at the WA museum and was able to determine that the species from the Chichester Range was a new undescribed species. The numerous museum records of the species also illustrated that the species is widespread in northern Western Australia and is not a Short Range Endemic species. It is therefore proposed that the *Aurecocrypta* species which was found within the Chichester Deviation is secure and unlikely to be significantly impacted upon by the project.

Table S1 Summary of total survey effort

Sampling	Number of Sites	Number of Traps	Number of Trap Nights	Foraging Time (hours)
Round 1 17/9/07-29/10/07	9	90	44	18
Round 2 7/4/08-5/5/08	15	150	28	30
Round 3 5/5/08-9/6/08	15	150	31	40
Round 4 9/6/08-7/7/08	15	150	28	40
Round 5 7/7/08-18/8/08	30	300	42	80
Round 6 12/9/08-17/9/08	30	300	44	80
Total	**114**	**1140**	**217**	**288**

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

BHP Billiton Iron Ore Pty Ltd is one of the world's leading producers of iron ore with seven mining operations in the Pilbara region of north-western Australia producing over 100 million tonnes of iron ore per annum. A heavy haulage railway is used to carry iron ore from the inland mining operations to Port Hedland for shipping overseas. BHPBIO owns two separate rail lines; one running from Newman to Port Hedland and another running between Port Hedland and Yarrie. The 426 kilometre railway line from Newman to Port Hedland, known as the Newman Mainline, is one of Australia's longest privately owned railways and services mines at Mt Whaleback and Ore bodies 23, 25 and 29, with extensions to the Ore body 18, Jimblebar, Yandi and Area C mining operations.

The current mainline consists of a single track with passing sidings spaced at approximately 15-20 kilometre intervals. Recent growth in the world iron ore market has created an opportunity for BHPBIO to bring on additional capacity from its Pilbara operations involving a series of expansion proposals associated with port, rail and mine.

Additional rail capacity is an essential element in the proposed expansion program and involves duplicating approximately 325 km of the existing rail network. The proposed expansion includes additional track infrastructure, a new signalling system, a communication fibre optic backbone and associated access roads. Rail expansion is proposed for implementation in a phased approach. The Project location is shown in Figure 1.1.

One portion of the proposed rail upgrade involves construction of a new rail through the Chichester Range (the Chichester Deviation). The Project involves construction of 23 km of dual track railway and associated rail infrastructure up to 6 km west of the existing Port Hedland to Newman railway (Mainline).

The Chichester landscape consists of many gradual sloping hills in a matrix of low lying plains and creek beds. Most of this area is vegetated with arid adapted plant communities which are dominated by *Acacia, Eucalyptus* and *Triodia* species.

The main disturbance caused by the proposed Chichester Deviation is the removal of potential SRE habitat within the linear project footprint area, which will provide passage through and between the hills of the Chichester Range. Construction of access tracks to and from site and vibrations from the operational rail system are also potential impacts.

The proposed railway is to remain consistently level during its course. Therefore, the low-lying areas will require building up with rocky strata to elevate the rail above the plain (i.e. reduce risk of flooding) and 'cuts' will be made at the base of hills and through ridges to reduce the rails incline. For the most part, it is believed that these cuts will involve 'shaving off' small areas at the feet of ridges; however, larger cuts will potentially involve greater geological disturbance. Sheltered areas such as south facing slopes have a greater capacity to retain water and these habitats are more likely to contain short range endemic species than flatter exposed areas (Main 1999; Harvey 2002). The major 'cuts' affecting south facing slopes were targeted for sampling during phase 1 of the survey.

Phase 1 sampling revealed that a large number of invertebrate species occurred within the proposed impact area of the Chichester Deviation. Most of the invertebrate species were insects, which generally have strong powers of dispersal and are unlikely to be short range endemic species. Three potential SRE groups were identified: centipedes, pseudoscorpions and mygalomorph spiders. Species within these groups were sent to experts who provided information on the identity and conservation value of the species. An undescribed species of trapdoor spider from the genus *Aurecocrypta* (Raven), was identified as being of high conservation value owing to its likelihood of being a short range endemic species; potentially restricted to the Chichester Range. Only four male specimens of the species were found at two sites at the northern end of the impact area.

Owing to concerns that the proposed Chichester Deviation could impact on this potentially localised population of *Aurecocrypta* a targeted survey was instigated to identify the extent of the distribution of the species within the Chichester Range. Sampling efforts included five rounds of sampling in which wet pitfall trap sites were placed in numerous habitats on the eastern and western sides of the Chichester Deviation:

1) 7/4/08-5/5/08

2) 5/5/08-9/6/08

3) 9/6/08-7/7/08

4) 7/7/08-18/8/08

5) 12/9/08-17/9/08

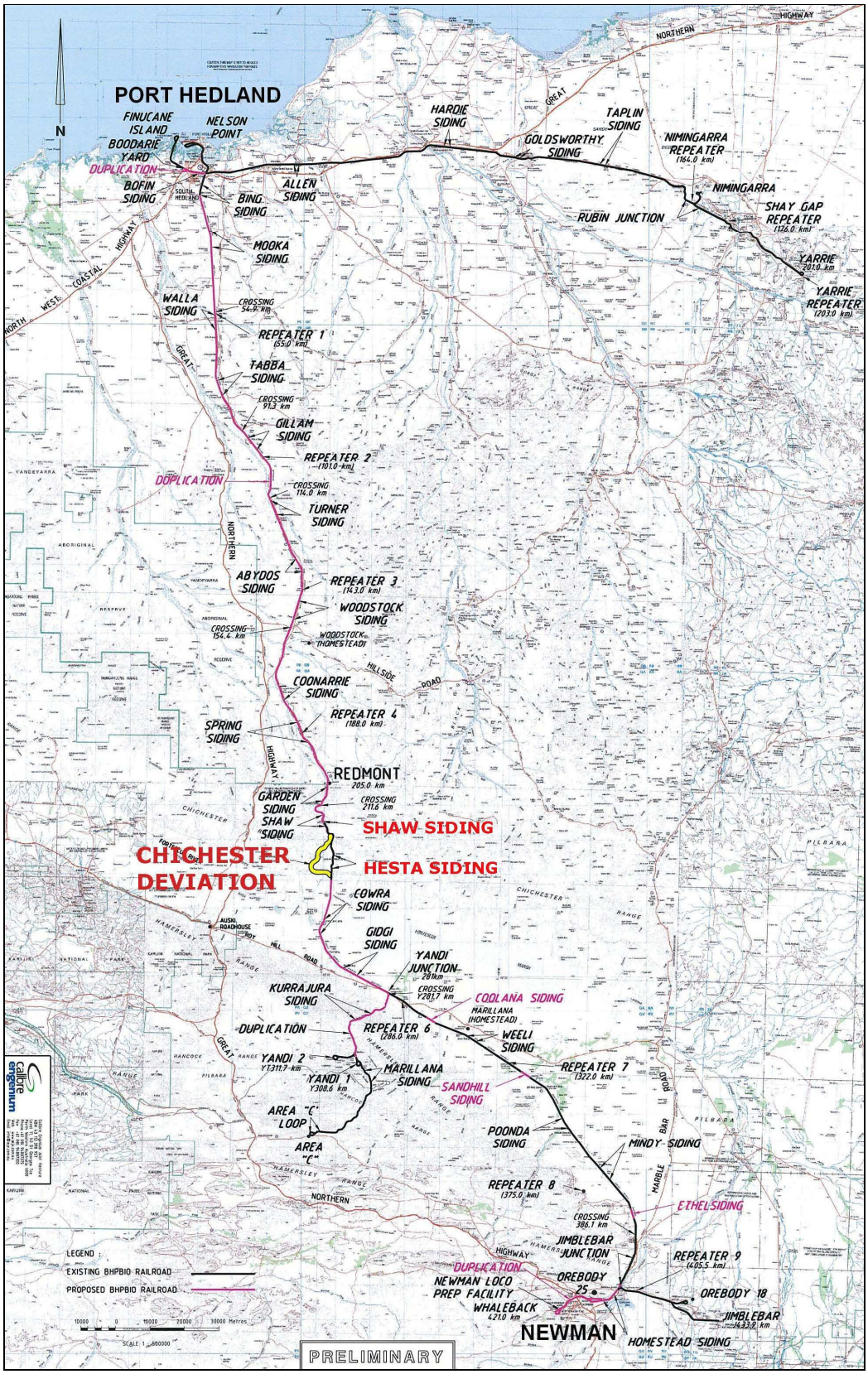


Figure 1-1 Overview Map. The Newman to Port Hedland Rail

1.2 LEGISLATIVE FRAMEWORK

The *Environmental Protection Act 1986* is "an Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing." Section 4a of this Act outlines five principles that are required to be addressed to ensure that the objectives of the Act are addressed. Three of these principles are relevant to native fauna and flora:

- *The Precautionary Principle*

  Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- *The Principles of Intergenerational Equity*

  The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

- *The Principle of the Conservation of Biological Diversity and Ecological Integrity*

  Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines produced by the EPA, in this case Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact in Western Australia (EPA 2004), and principles outlined in the EPA's Position Statement No. 3 Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA 2002).

Native fauna in Western Australia are protected at a Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and at a State level under the *Wildlife Conservation Act 1950* (WC Act).

The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and to promote the conservation of biodiversity. The EPBC Act includes provisions to protect native species (and in particular prevent the extinction, and promote the recovery, of threatened species) and ensure the conservation of migratory species. In addition to the principles outlined in Section 4a of the EP Act, Section 3a of the EPBC Act includes a principle of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

The WC Act was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all fauna and flora within Western Australia is protected; however, the Minister may, via a notice published in the *Government Gazette*, declare a list of fauna taxa identified as likely to become extinct, or is rare, or otherwise in need of special protection.

1.3 SURVEY OBJECTIVES

BHPIO-ADP commissioned ecologia Environment to undertake a baseline biological survey of the invertebrate fauna of the Chichester Deviation as part of the environmental impact assessment for the project.

The EPA's objectives with regards to fauna management are to:

- maintain the abundance, species diversity and geographical distribution of Short Range Endemic terrestrial invertebrate fauna; and
- protect Specially Protected (Threatened) fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.*

Hence, the primary objective of this study was to provide sufficient information to the EPA to assess the impact of the project on the invertebrate fauna of the area, thereby ensuring that these objectives will be upheld.

Specifically, the objectives of this survey were to undertake a survey that satisfies the requirements documented in EPA's Guidance Statement 56 and Position Statement No. 3, thus providing:

- A review of background information (including literature and database searches);
- An inventory of Short Range Endemic (SRE) fauna species occurring in the study area, incorporating recent published and unpublished records;
- An inventory of species of biological and conservation significance recorded or likely to occur within the project area and surrounds;
- A review of regional and biogeographical significance, including the conservation status of species recorded in the project area; and
- A risk assessment to determine likely impacts of threatening processes on SRE fauna within the study area.

1.4 OVERVIEW OF SHORT RANGE ENDEMISM IN THE RGP5 PROJECT AREA

Endemism refers to the restriction of species to a particular area, whether it be at the continental, national or local level (Allen *et al.* 2002). Short range endemism refers to endemic species with restricted ranges, which in Western Australian is currently defined as less than 10,000 km^2 (100 km x 100 km) (Harvey 2002). Such taxa are usually invertebrates, which often display poor dispersal ability or have a defined or restrictive biology that promotes their isolation and eventual speciation. It is important to note that the potential SRE groups listed in this review are not exhaustive, and that invertebrates are historically understudied and in many cases lack formal descriptions. Reliable taxonomic evaluation of many species has begun relatively recently and thus the availability of literature relevant to SREs is still scarce. It must also be stressed that the precautionary principle, as adopted by the EPA / DoE under Section 4a of the Environmental Protection Act 1986, is currently a guiding principle of this study.

1.4.1 Processes promoting short range endemism

Short-range endemism is influenced by numerous processes which generally contribute to the isolation of species. A number of factors, including the ability and opportunity to disperse, life history, physiology, habitat requirements, habitat availability, biotic and abiotic interactions, and historical conditions, influence not only the distribution of a species, but also the mechanisms of differentiation and speciation (Ponder and Colgan 2002).

Isolated populations of both plants and animals tend to differentiate both morphologically and genetically as they are influenced by different selective pressures over time. A combination of novel mutations and genetic drift promote the accumulation of genetic differences between isolated populations. Conversely, the maintenance of genetic similarity is promoted by a lack of isolation through migration between the populations, repeated mutation and balancing selection (Wright 1943). The magnitude of differentiation and speciation between populations will be determined by the relative magnitude of these factors, with the amount of migration generally being the strongest determinant. Migration is governed by the vagility of the taxon as well as geographical barriers to dispersal. Taxa that exhibit short-range endemism are generally characterised by poor dispersal, low growth rates, low fecundity and reliance on habitat types that are discontinuous (Harvey 2002).

A number of habitats in Australia contain short-range endemic species because they are isolated by geographic barriers. Islands are a classic example, where terrestrial fauna are surrounded by a marine environment which may impede migration and thus gene flow. Habitats such as mountain tops, aquifers, lakes and caves are essentially islands exhibiting unique environmental conditions in comparison to the surrounding landscape. At first glance, the Chichester Range appears to be relatively homogenous; however, closer inspection reveals a mosaic of habitats such as small pockets of *Acacia* thickets surrounded by bare rocky ground or Spinifex.

Harvey (2002) states that “freshwater habitats in Australia have a high proportion of short-range endemic species and many are restricted to individual river systems or drainage basins. Permanent freshwater ecosystems provide stable environments for a wide variety of taxa including many relictual lineages from Gondwanan periods.” No permanent water

bodies are known to occur within the Project area and therefore taxa such as isopods from the family Phreatoicidae, which are typically short range endemics, are unlikely to occur.

Historical connections of habitats are also important in determining current species distributions and often explain patterns that are otherwise inexplicable under present conditions. Relictual short range endemics are taxa which occur in population/s which represent remnants of a formerly widespread species. These species are typically confined to specific habitats, and in some cases, single geographic areas (Main 1996). Relictual short-range endemics include species from Gondwanan periods (180-65 million years ago) and tend to have a very restrictive biology (Main 1996).

In Western Australia, relictual taxa generally occur in fragmented populations, from lineages reaching back to historically wetter periods (Main 1996). During the Miocene period (from 25 million to 13 million years ago), Australia underwent significant aridification, resulting in the contraction of many areas of moist habitat and the fragmentation of populations of fauna occurring in these areas (Hill 1994). This onset of progressively dryer and more seasonal climatic conditions resulted in moist habitats becoming increasingly fragmented. Relictual species now generally persist in habitats characterised by permanent moisture and shade, maintained by high rainfall and/or prevalence of fog, whether induced by topography or coastal proximity, or areas associated with freshwater courses (e.g. swamps or swampy headwater of river systems), caves, or microhabitats associated with southern slopes of hills and ranges, rocky outcrops, deep litter beds, or various combinations of these features (Main 1996, 1999). These habitats support only small and spatially isolated populations, which are further restricted by their low dispersal powers.

1.4.2 Current knowledge of the Short Range Endemic species in the Pilbara of Western Australia with emphasis on the study area

Groups or organisms which display short range endemism include (but are not limited to) molluscs (e.g. camaenid and orthalicid land snails), onychophorans (velvet worms), millipedes, many arachnids (scorpions, pseudoscorpions, schizomids, mygalomorph spiders) and crustaceans (isopods) (Harvey 2002). The current state of knowledge on short range endemism of particular species in Australia, including the Pilbara is relatively poor. The paucity of targeted collections makes assessing the likely occurrence and the distribution of SRE fauna very difficult.

Studies show that the Pilbara contains a large number of arid adapted invertebrate species such as Scorpions, Pseudoscorpions and Centipedes. Other SRE groups that are likely to be collected in the study site in lesser numbers include Isopods, Mygalomorph spiders and snails.

2.0 REGIONAL SETTING

2.1 LOCATION

The Chichester Deviation project area is located approximately 20km south of Redmont Camp (150 km north-west of Newman). The entire rail will extend approximately 300 km north-north west to Port Hedland, parallel to the existing BHP Billiton Iron Ore Pty Ltd (BHPB) Newman to Port Hedland Railway (Figure 1.1).

2.2 CLIMATE

Climate data for the project is based on records from Wittenoom which occurs south east of the Chichester Range. The Pilbara region of Western Australia experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September (Figure 2.1). Annual evaporation exceeds rainfall by as much as 500 mm per year (Figure 2.2). Seasonally low but unreliable rainfall, together with high temperatures and high diurnal temperature variations are also characteristic climatic features of the region.

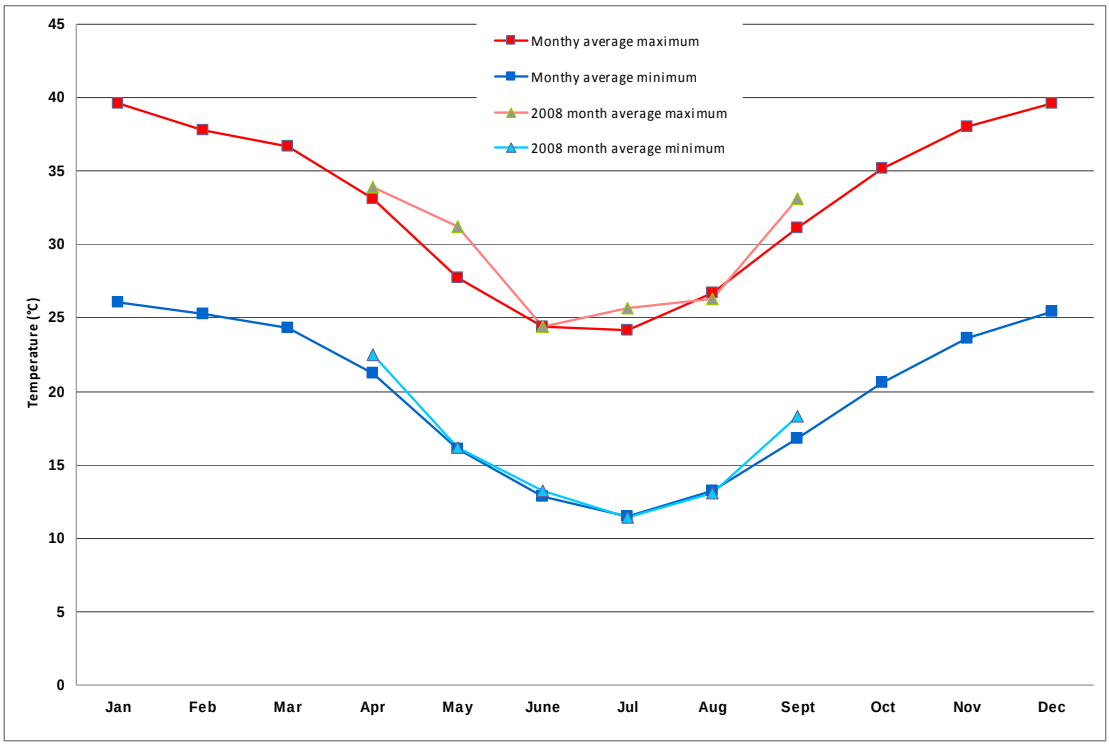


Figure 2-1 Wittenoom Weather Station Data. Summary of Maximum and Minimum monthly temperature. (Average 1951-2008 & 2008)

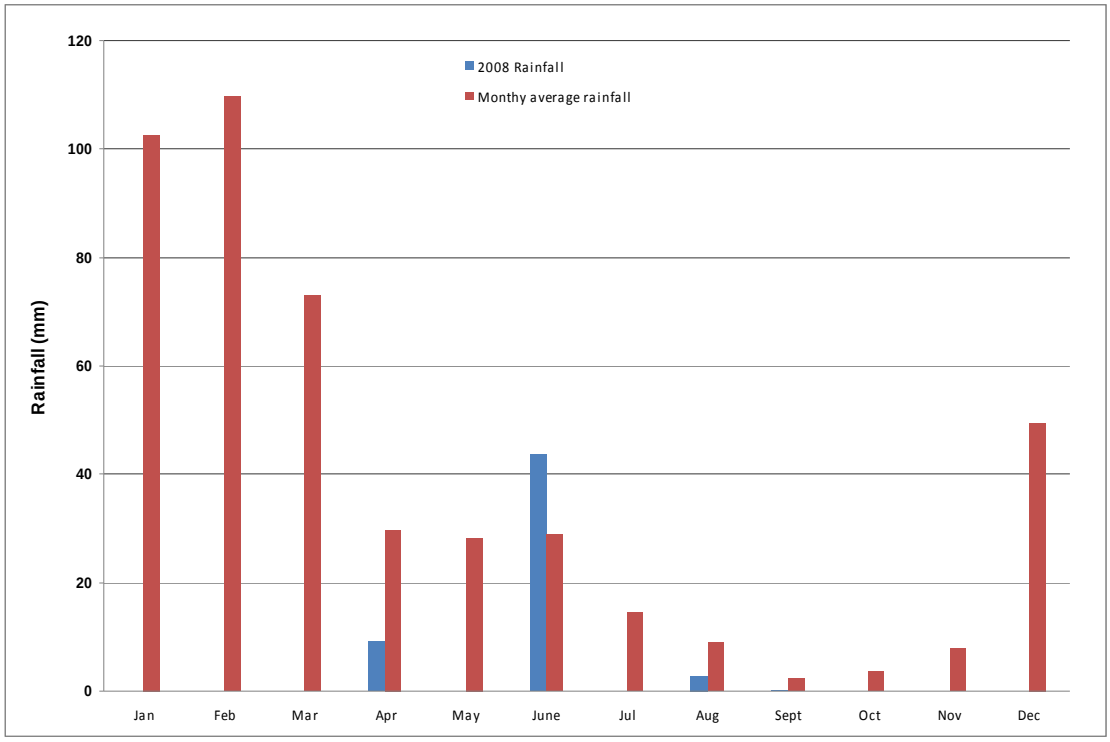


Figure 2-2 Wittenoom Weather Station Data. Summary monthly mean monthly rainfall (1951-2008 & 2008).

2.3 BIOREGIONS

The Chichester Deviation is within the PIL1 Chichester subregion and the PIL2 Fortescue Plains subregion. The Chichester subregion comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is Semi-desert-tropical and receives 300mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock). The subregional area is 9,044,560ha.

The Fortescue Plains subregion comprises alluvial plains and river frontage dominate the Fortescue Plains subregion. Extensive salt marsh, mulga-bunch grass and short grass communities occur on alluvial plains in the east. Deeply incised gorge systems occur in the lower west. River gum woodlands fringe the drainage lines. The region is also the northern limit of Mulga (*Acacia aneura*). An extensive calcrete aquifer (originating within a palaeo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of river gum and cadjeput Melaleuca woodlands. Climatic conditions are semi desert tropical, with an average rainfall of 300

mm, falling mainly in summer cyclonic events. Drainage occurs to the north-west. The Subregional area is 2,041,914ha.

3.0 SURVEY METHODS

The survey methods adopted by *ecologia* have been developed in consultation with senior Western Australian Museum (WAM) staff and other local experts. Currently, the Environmental Protection Authority's Guidance Statement No. 56 (EPA 2004) and Position Statement 3 (EPA 2002), provide no specific instructions on the expected design of SRE surveys. Thus the temporal and spatial replication attained with the systematic pitfall trap approach and the effort attained with foraging activities, is at the discretion of the environmental consultant conducting the SRE survey.

3.1 SURVEY TIMING

This first phase of the survey was instigated from 7/4/08-5/5/08. Based on the findings of this survey which were processed during April 2008 an additional five rounds of sampling were conducted as part of a targeted survey for the species *Aurecocrypta* sp. sampling occurred on the following dates

1) 7/4/08-5/5/08

2) 5/5/08-9/6/08

3) 9/6/08-7/7/08

4) 7/7/08-18/8/08

5) 12/9/08-17/9/08

3.2 SITE SELECTION

As discussed in the literature review (Section 1.4) short range endemic invertebrate taxa are generally found in refugia and microhabitats and thus such habitats were the focus of the survey effort in phase 1.

Habitats which were found to contain potential short range endemic species while foraging or from the phase 1 pitfall trapping effort, were targeted during all other phases of the survey. These habitats included shaded areas such as gullies which were densely vegetated with *Acacia* species and areas with a deep soil or leaf litter layer.

In order to narrow the focus of the sampling, aerial photographs were inspected for vegetated southern facing slopes and gullies, which were also targeted for sampling.

On 20/6/08 an aerial survey (by helicopter) of the Chichester range was conducted to identify potential habitats of *Aurecocrypta* sp. in areas inaccessible by road. This survey identified 30 potential sites which were later verified on the ground during site selection (7/7/08-18/8/08).

3.3 DETERMINATION OF SURVEY SAMPLING DESIGN AND INTENSITY

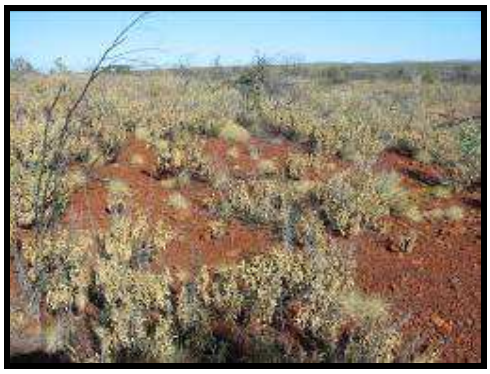
Prior to the development of survey methods, a review of factors likely to influence survey design was undertaken.

A combination of pit fall trapping and hand foraging was selected as the most suitable sampling method because all SRE invertebrates likely to be present in the region are ground dwelling species hand foraging was employed to collect the more cryptic species that are

less likely to be collected by pitfall traps. For example, female Mygalomorph spiders are uncommonly collected in pitfall traps because they rarely leave their burrows unless disturbed.

Topographical maps were consulted to identify putatively sensitive areas that were likely to be disturbed by the proposed development. Further refinements to the sampling sites were made in the field and other areas in the impact site were also examined to identify inconspicuous short range endemic habitats. The number of sites in phase 1 was determined by the size of the impact area and the number of potential SRE habitats within it. Ten pitfall traps were selectively placed within each site with the aim of sampling as many microhabitats as possible within each.

Figure 3-1 Habitat characteristics of survey sites (Phases 1 and 2)

PHASE 1 SURVEY SITES AND HABITAT CHARACTERSITICS	SITE PICTURE
Site 1A A gradually inclining south facing slope vegetated with *Triodia* (spinifex) hummocks and small shrubs. The site also contained dense clumps of dead vegetation and a 3m wide by 10 m long drainage line.	
Site 1B Crest of a gradual south facing slope with a pebbly surface sparsely vegetated with small shrubs including *Triodia* (spinifex) and mulla mulla.	

Site 2A The base of a gradual south facing slope with a pebbly surface sparsely vegetated with small shrubs and dense aggregating *Triodia* (spinifex) hummocks.	
Site 2B Crest of a gradual south facing slope with a pebbly surface scattered with few small shrubs. Lots of bare ground with loose pebbles.	
Site 3A Base of a steep south facing slope with a rocky surface, shaded by large *Acacia aneura* shrubs.	

Site 3B Crest of a steep south facing slope, shaded by large boulders and large *Acacia aneura* shrubs.	
Site 4A and 4B A gradual south facing slope densely vegetated by *Triodia* (spinifex) hummocks and small acacias and eucalypts. Traps in Site A occurred at the base of the slope while those in Site B occurred beneath the ridge.	
Site 5A Base of a gradual south facing slope densely vegetated with *Triodia* (spinifex) hummocks and several large eucalypts. A deep sandy drainage line also ran along the base of the slope (perpendicular to the rising slope).	
Site 5B Crest of a gradual south facing slope densely vegetated with *Triodia* (spinifex) hummocks and several large eucalypts.	

Site 6A A gradual east facing slope, sparsely vegetated with *Triodia* (spinifex) hummocks and shaded by dense *Acacia aneura* shrubs.	
Site 6B Crest of a gradual south-east facing slope, sparsely vegetated with *Triodia* (spinifex) hummocks and shaded by dense *Acacia aneura* shrubs. Strong shade on the ground also occurred due to the presence of large boulders.	
Site 7A A vegetated area at the base of a gradual east facing slope, sparsely vegetated with *Triodia* (spinifex) hummocks and shaded by dense *Acacia aneura* shrubs.	

Site 7B Crest of a gradual east facing rocky slope, sparsely vegetated with *Triodia* (spinifex) hummocks and shaded by dense *Acacia aneura* shrubs. Erosion of the rock suggested that this area was also a drainage line.	
Site 8A Base of a steep south facing slope densely vegetated with *Triodia* (spinifex) hummocks and large Acacia anuera. Large boulders also provided shade close to the ground.	
Site 8B Crest of a steep south facing slope, shaded by large mesa type rocks and large *Acacia aneura* shrubs.	

Site 9A & B Traps were placed at two sites on a steep east facing slope densely vegetated with *Triodia* (spinifex) hummocks and a few large *Acacia aneura* shrubs. The crest was capped by an outcrop of large boulders. Traps in Site A occurred at the base of the slope while those in Site B occurred within the shade of the mesa rocks.	

PHASE 2 SURVEY SITES AND HABITAT CHARACTERSITICS	SITE PICTURE
Site 10 Alluvial flat at the base of a south facing slope with little vegetation, mostly *Triodia* (spinifex) and small shrubs.	
Site 11 Rocky south facing slope dominated by low lying *Triodia* (spinifex) and few grasses. Shaded near crest by large boulders.	
Site 12 Rocky south facing slope dominated by low lying *Triodia* (spinifex) and few grasses. Shaded near crest by large boulders.	

Site 13 South facing slope with few large shady *Acacia* shrubs. Understorey dominated by low *Triodia* (spinifex).	
Site 14 South facing slope with few large shady *Acacia* shrubs. Understorey dominated by low *Triodia* (spinifex).	
Site 15 South facing slope with few large shady *Acacia* shrubs. Understorey dominated by low *Triodia* (spinifex).	

Site 16 Steep rocky south facing slope within a shaded gorge. Shaded by a few *Acacia* shrubs. Ground cover consisting of numerous annual herbs and grasses.	
Site 17 Steep rocky south facing slope within a shaded gorge. Shaded by a few *Acacia* shrubs. Ground cover consisting of numerous annual herbs and grasses.	
Site 18 Dense patch of shaded *Acacia* shrubs near crest of a rocky south facing slope. Understorey consisting of low *Triodia* (spinifex).	

Site 19 Steep rocky south facing slope within a shaded gorge. Shaded by a few *Acacia* shrubs. Ground cover consisting of numerous annual herbs and grasses.	
Site 20 Steep rocky south facing slope within a shaded gorge. Shaded by a few *Acacia* shrubs. Ground cover consisting of numerous annual herbs and grasses.	
Site 21 Patch of shaded acacias on an alluvial flat. Rocky surface with numerous pebbles and sparsely vegetated with grasses and herbs.	

Site 22 Steep rocky south facing slope shaded by few large acacias and sparse ground cover consisting of several species of small herbs and grasses.	
Site 23 South facing rocky slope densly vegetated in low *Triodia* (spinifex) and tall grasses.	
Site 24 Steep south facing slope above creekline. Shaded by large *Acacia* shrubs. Ground cover consisting mostly of grasses and herbs groing between large boulders.	

Site 25 A south facing slope densely vegetated with *Acacia* shrubs. Substrate consisting mostly of loose rock and firm clay/sand between large boulders	
Site 26 A deep gorge densely vegetated with *Acacia* shrubs (shaded). Substrate consisting mostly of loose rock and firm clay/sand between large boulders	
Site 27 An island of *Acacia* shrubs on a flat plane surrounded by *Triodia* (spinifex). Substrate consisting of deep clay/sand with loose white quartz on the surface.	
Site 28 An island of acacias on a flat plane surrounded by *Triodia* (spinifex). Substrate consisting of deep clay/sand with loose white quartz and pebbles on the surface.	

Site 29 A deep gorge densely vegetated with *Acacia* shrubs. (very shaded). Substrate consisting mostly of loose rock and firm clay/sand between large boulders	
Site 30 A deep gorge densely vegetated with *Acacia* shrubs. *Triodia* (spinifex) under storey. Alluvium collected within creekline. Substrate consisting mostly of loose rock and firm clay/sand between large boulders. Bare patches of clay/sand occurring above the creekline.	
Site 31 A deep gorge densely vegetated with *Acacia* shrubs (shaded). Substrate consisting mostly of loose rock and firm clay/sand.	
Site 32 A deep gorge densely vegetated with shading *Acacia* shrubs. Substrate consisting mostly of loose rock and firm clay/sand.	

Site 33 Flat *Acacia* habitat above deep gorge habitat. Substrate consisting of deep clay/sand and small pebbles on the surface.	
Site 34 Flat *Acacia* habitat, appeared prone to flooding. Substrate consisting of cracking clay/sand and smooth round boulders.	
Site 35 A deep gorge densely vegetated with *Acacia* shrubs (shaded). Understorey with tall grass species. Substrate consisting mostly of loose rock and firm clay/sand.	
Site 36 Flat acacia habitat with a *Triodia* (spinifex) understorey. Deep clay/sand layer with lots of bare open ground between *Triodia* (spinifex).	

Site 37 Flat open area with tall *Acacia* shrubs above sparse *Triodia* (spinifex). Substrate was a deep clay/sand layer. Appeared prone to flooding in areas.	
Site 38 Deep gorge with dense *Acacia* shrubs (shaded). Substrate consisting mostly of loose rock and firm clay/sand between large boulders. Very little bare ground.	
Site 39 Northern edge of extensive *Acacia* plain at the southern end of the deviation below the Chichester Range. Tall acacias over *Triodia* (spinifex) patches. Lots of open ground with deep clay/sand layer.	
Site 40 Flat open area with tall *Acacia* shrubs above sparse *Triodia* (spinifex). Substrate was a deep clay/sand layer. Appeared prone to flooding in areas.	

Site 41 Flat open area with tall *Acacia* shrubs above sparse *Triodia* (spinifex). Substrate was a deep clay/sand layer. Appeared prone to flooding in areas. Also appeared disturbed by cattle.	
Site 42 Flat open area with tall *Acacia* shrubs above sparse *Triodia* (spinifex). Substrate was a deep clay/sand layer.	
Site 43 Flat open area with tall *Acacia* shrubs above sparse *Triodia* (spinifex). Substrate was a deep clay/sand layer.	
Site 44 South facing slope very similar habitat to where original spiders were found during phase 1 (Site 6A). Pocket of *Acacia* shrubs. Unburned. Substrate consisted of shallow sand/clay layer and loose rock and boulders.	

Site 45 Gradual slope with tall *Acacia* shrubs (shaded). Substrate consisted of a deep clay/sand layer with small pebbles and rock on the surface.	
Site 46 Flat open area with tall *Acacia* shrubs above sparse *Triodia* (spinifex). Substrate was a deep clay/sand layer.	

Table 3-1 GPS coordinates of pitfall trap sites within the Chichester Range

Datum Site	WGS-84 Easting	UTM- 50K Northing	Datum Site	WGS-84 Easting	UTM- 50K Northing
1	703835.0	7540726.9	**24**	705715.0	7560254.0
2	703227.5	7543120.8	**25**	708713.0	7562664.0
3	705372.8	7546486.8	**26**	708881.0	7563556.0
4	707371.3	7548494.3	**27**	696353.0	7554066.0
5	707820.4	7549063.7	**28**	690341.0	7547974.0
6	708210.5	7549428.6	**29**	690887.0	7546706.0
7	708339.9	7549410.0	**30**	700928.0	7546052.0
8	708376.4	7549542.4	**31**	700409.0	7545806.0
9	708207.6	7551288.1	**32**	701421.0	7546505.0
10	707995.0	7549155.0	**33**	701652.0	7546603.0
11	708872.0	7549415.0	**34**	709158.0	7554887.0
12	708894.0	7549431.0	**35**	709405.0	7551309.0
13	708097.0	7549206.0	**36**	709500.0	7546188.0
14	708103.0	7549098.0	**37**	694928.0	7547290.0
15	708098.0	7549167.0	**38**	696913.0	7544342.0
16	708219.0	7549571.0	**39**	698776.0	7541174.0
17	708157.0	7549572.0	**40**	709106.0	7545822.0
18	708001.0	7549850.0	**41**	708859.0	7545040.0
19	707681.0	7550442.0	**42**	705999.0	7540570.0
20	707864.0	7550309.0	**43**	702169.0	7541058.0
21	707937.0	7549013.0	**44**	707975.0	7549489.0
22	705205.0	7560117.0	**45**	709259.0	7544493.0
23	704937.0	7559582.0	**46**	708330.0	7534261.0

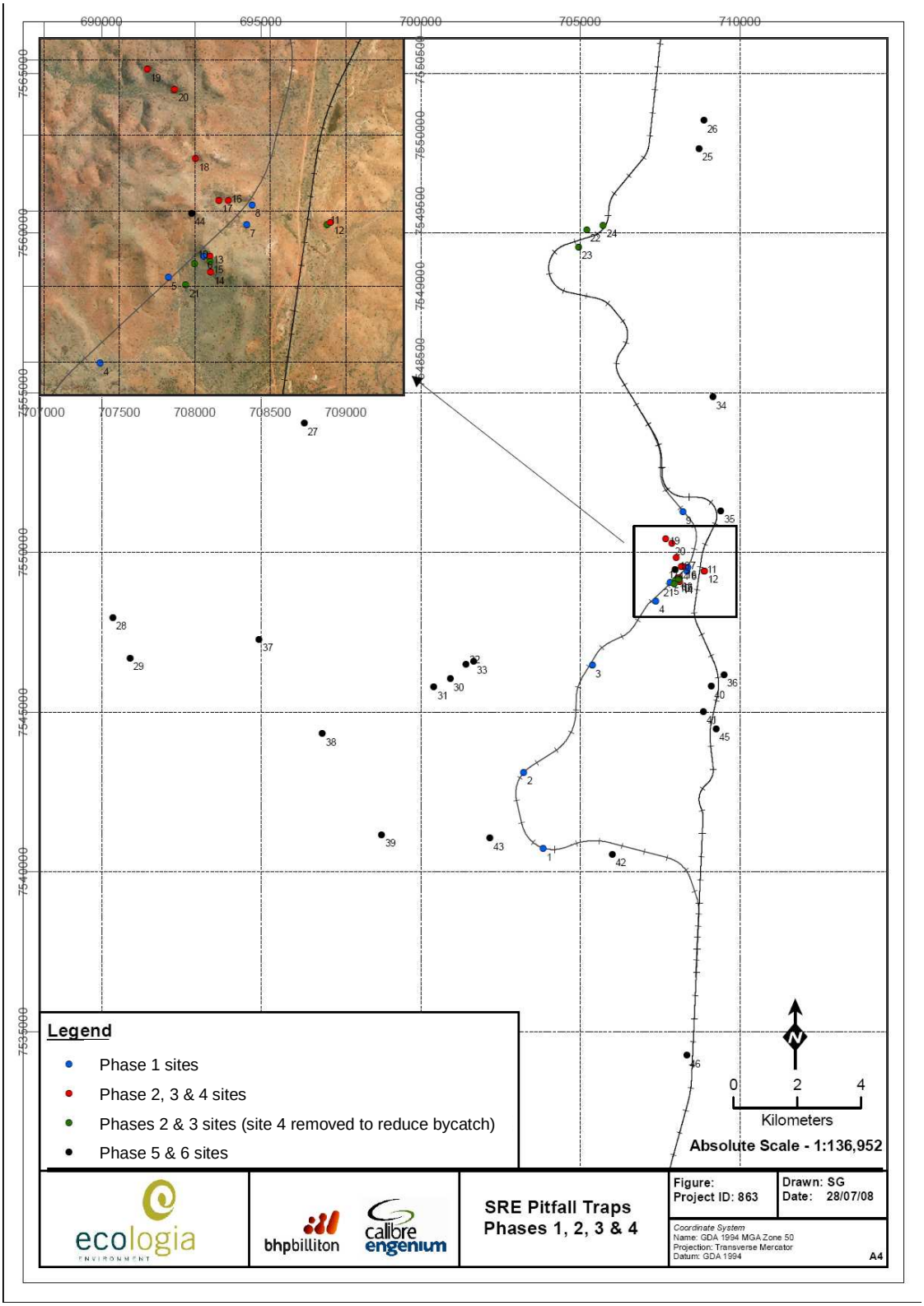


Figure 3-3 Pitfall trapping sites in the Chichester Range in relation to the RGP5 Rail

3.4 SAMPLING METHODS

The survey was undertaken using a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling refers to data methodically collected over a fixed time period within a discrete habitat type, using an equal or standardised sampling effort (pitfall trapping). The resulting information can be analysed statistically, facilitating comparisons between habitats and seasons. Opportunistic sampling includes data collected non-systematically from within fixed sampling sites.

3.4.1 Systematic Sampling: Pitfall Trapping

A total of 18 pitfall trap sites were established. Each site comprised 5 invertebrate pitfall traps. Each trap was placed in suitable microhabitats in each habitat under investigation. Such microhabitats might include areas under shade-bearing shrubs, up against shady side of larger rocks and boulders, on river banks and southern hill slopes.

Each trap consisted of two litre containers containing ca one litre trapping solution (Ethylene Glycol (ca 30%) and Formaldehyde (ca 4-5 %). This solution euthanizes collected animals and fixes tissues. To minimise the chance of vertebrate by-catch, each trap was roofed with a plastic bucket lid positioned 3 cm above the soil surface and weighed down with rocks and/or branches.

3.4.2 Opportunistic Sampling: Hand foraging

Hand foraging was conducted at all 18 sites, representing 18 vegetation associations. These sites encompassed both the minor and major vegetation associations. A site was considered completed after 30 minutes of foraging with two people (1 person–hour). Thus a total of 18 person hours was spent foraging in the project area.

Specifically, foraging included lifting of rocks (pseudoscorpions and snails), raking leaf litter (millipedes, centipedes) at the base of large shade bearing trees and old decaying logs and cracking open portions larger logs and debris (pseudoscorpions, centipedes, millipedes and isopods). Scanning the ground for trapdoor spider burrows.

3.5 TAXONOMY AND NOMENCLATURE

Each specimen was identified to the lowest possible taxonomic unit by *ecologia* scientists. For most species this was ordinal level. All of the centipedes were identified to species level using the online key 'Centipedes of Australia (http://www.ento.csiro.au/biology/centipedes/centipedeKey.html). The scorpions and pseudoscorpions were identified to species level by Dr Erich Volschenk and Dr Mark Harvey respectively (Western Australian Museum). The mygalomorph spiders were identified to genus level by ecologia scientists and were subsequently sent to Dr Robert Raven of the Queensland Museum for species level determination.

3.6 SURVEY LIMITATIONS

Limitations of the current survey are summarised (Table 3-2).

Table 3-2 Summary of survey limitations

CONSTRAINT	RELEVANT (yes/no)	COMMENT
Competency/ experience of the consultant carrying out the survey.	No	All team members have sufficient academic qualifications and experience with Short Range Endemic survey techniques to conduct this survey.
Scope (which faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	All groups known to include SRE taxa were targeted using both pitfall trapping and foraging techniques. SRE habitats were targeted during sites selection.
Proportion of fauna identified, recorded and/ or collected.	No	SRE taxa are poorly known in WA and many parts of the Pilbara have only recently been sampled. It is therefore difficult to determine if the taxa collected during this survey are highly representative of actual invertebrate assemblages occurring within the Chichester Range; however, given that sampling was intensive and widespread, it is highly likely that a large proportion of these assemblages has now been examined.
Sources of information (previously available information as distinct from new data).	No	All literature related to the invertebrate survey was examined and all expertise relevant to individual SRE groups was employed.
The proportion of the task achieved and further work which might be needed.	No	A comprehensive SRE survey of Invertebrate fauna was conducted and a targeted survey was then conducted for a potential SRE species.
Timing/ weather/ season/ cycle.	No	Sampling occurred in all seasons during a 12 month period.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	Although a widespread fire occurred throughout the Chichester Range, which may have affected the phase 1 survey, new sample sites were established in many habitats in unburnt areas during sampling phases 2, 3, 4, 5 and 6.
Intensity (in retrospect was the intensity adequate?).	No	The intensity was definitely adequate. All major cuts to the landscape required by the proposal were sampled both systematically and opportunistically.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	Dr Robert Raven, who is an internationally recognised authority on Trap-door spider taxonomy and author of the genus *Aurecocrypta*, was employed for his taxonomic and field collecting expertise.
Remoteness and/ or access problems.	No	Access to all areas of the Chichester Range was made possible through use of both 4WD vehicles and a helicopter.
Efficacy of sampling methods (i.e. any groups not sampled by survey methods).	No	All ground dwelling species were sampled using pitfall traps while oppurtunistic hand foraging was conducted to collect more cryptic species.

3.7 SURVEY TEAM AND INDIVIDUAL SURVEY EFFORTS

Person	Title	Survey Effort
Gilbert Whyte	Level 2 Invertebrate Biologist	All phases of fieldwork/logistics, specimen sorting, species identification (general) and production of the report (predominant project manager)
Jarrad Clark	Senior Invertebrate Biologist	2 phases of fieldwork/logistics (initial project manager)
Laura Quinn	Level 1 Invertebrate Biologist	4 phases of fieldwork/logistics and specimen sorting
Nicolas Dight	Level 1 Invertebrate Biologist	1 phase of fieldwork/logistics and specimen sorting
Dr Vickie Cartledge	Level 1 Zoologist (Invertebrate casual)	1 phase of fieldwork
Dr Erich Volschenk	Senior Invertebrate Biologist	1 phase of fieldwork and species identification (Scorpiones)
Dr Robert Raven	Contracted Invertebrate Expert	1 phase of fieldwork and species identification (Mygalomorphae)

4.0 RESULTS: INVEREBRATE TAXA WITHIN THE PROJECT AREA

4.1 ARACHNIDS (PHYLUM: ARTHROPODA, SUB CLASS: ARACHNIDA)

4.1.1 Trap-Door Spiders (Mygalomorphae)

Four individuals of a mygalomorph spider species in the family, Barychelidae, were collected (Table 4.1). These were identified by Dr Robert Raven as belonging to the genus *Aurecocrypta*. All four specimens were males.

Within *Aurecocrypta*, there are only two formally described species; *Aurecocrypta lugubris* (Raven) and *Aurecocrypta katersi* (Raven). At the beginning of the survey *A. lugubris* was known only from its type locality at Pearce ~65km north east of Perth (about 31°30'S, 116°00'E). *Aurecocrypta katersi* is known only from Katers Island in the Kimberley. Both species are currently believed to be SRE species, though this may or may be a function of a lack of sampling within their respective regions. Both species are also respectively known from single female specimens.

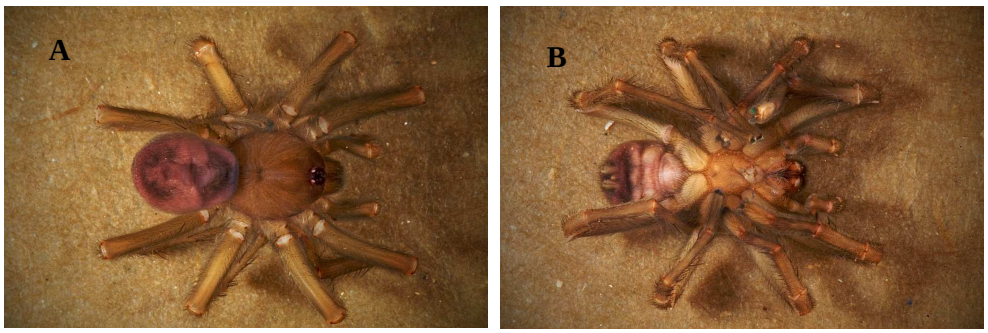


Figure 4-1 An adult male specimen of the Barychelid spider; *Aurecocrypta* sp. "Chichester". A, dorsal; B, ventral.

Table 4-1 Mygalomorph spiders collected during the phase 1 survey effort

Site	Class	Infraorder	Family	Genus	Species	No specimens
Site 6A	Arachnida	Mygalomorphae	Barychelidae	*Aurecocrypta*	"Chichester"	3
Site 7A	Arachnida	Mygalomorphae	Barychelidae	*Aurecocrypta*	"Chichester"	1

4.1.2 Aranaeomorph Spiders (Aranaeomorphae)

A large number of aranaeomorph species were collected during the survey (Table 4.2). The most common species belonged to the Lycosidae and Miturgidae. These spiders are fast moving, active ground hunters which are therefore easily collected in pitfall traps. Other aranaeomorphs collected in lower numbers included representitives of the families Lamponidae, Gnaphosidae and Clubionidae.

All of the species collected appeared to be generalist predators with strong powers of dispersal (i.e. Ballooning), it is unlikely that any are short range endemic species (Harvey

2002). No specialist taxa such as those which are restricted to specific habitats such as rocky outcrops (Selenopidae, Trochanteridae), were collected from within the impact area.

Table 4-2 Aranaeomorph spiders collected during the phase 1 survey effort

Site	Class	Infraorder	No morpho species
Site 1B	Arachnida	Aranaeomorpha	1
Site 3A	Arachnida	Aranaeomorpha	6
Site 4A	Arachnida	Aranaeomorpha	12
Site 4B	Arachnida	Aranaeomorpha	7
Site 5A	Arachnida	Aranaeomorpha	6
Site 5A	Arachnida	Aranaeomorpha	4
Site 5B	Arachnida	Aranaeomorpha	6
Site 6A	Arachnida	Aranaeomorpha	9
Site 7A	Arachnida	Aranaeomorpha	10
Site 7B	Arachnida	Aranaeomorpha	5
Site 8A	Arachnida	Aranaeomorpha	7
Site 9A	Arachnida	Aranaeomorpha	3

4.1.3 Pseudoscorpions

At least three species of pseudoscorpion, belonging to the family Olpiidae, were collected from a number of sites. Very little is known about the biology and taxonomy of these pseudoscorpions and their status as short-range endemics is presently undetermined (Table 4.3).

Table 4-3 Pseudoscorpions collected during the phase 1 survey effort

Site	Class	Order	Family	Genus
Site7B	Arachnida	Psudoscorpionida	Olpiidae	*Beierolpium*
Site 5B	Arachnida	Psudoscorpionida	Olpiidae	*Beierolpium*
Site 7B	Arachnida	Psudoscorpionida	Olpiidae	*Beierolpium*
Site 5B	Arachnida	Psudoscorpionida	Olpiidae	*Beierolpium*
Site 7B	Arachnida	Psudoscorpionida	Olpiidae	*Beierolpium*
Site 8B	Arachnida	Psudoscorpionida	Olpiidae	*Eurolpium*
Site 9B	Arachnida	Psudoscorpionida	Olpiidae	*Indolpium*
Site 4A	Arachnida	Psudoscorpionida	Opliidae	*Indolpium*
Site 5B	Arachnida	Psudoscorpionida	Olpiidae	*Indolpium*
Site 9A	Arachnida	Psudoscorpionida	Olpiidae	*Indolpium*
Site 7B	Arachnida	Psudoscorpionida	Opliidae	*Indolpium*
Site 5B	Arachnida	Psudoscorpionida	Opliidae	*Indolpium*

4.1.4 Mites and Ticks

Two mite (Acari) specimens belonging to the same species, and 1 tick (Acarina) species were collected during the survey. Morphological features of these specimens did not indicate any degree of specialisation and they are therefore likely to be ubiquitous species rather than SREs (Table 4.4).

Table 4-4 Mites and ticks collected during the phase 1 survey effort

Site	Class	Order	species	No individuals
Site 4B	Arachnida	Acari	unknown	1
Site 5B	Arachnida	Acari	unknown	1

Site 3A	Arachnida	Acarina	unknown	1

4.1.5 Scorpions

All of the scorpion specimens collected from the pitfall trapping effort belonged to the family Buthidae (Table 4.5). Two underscribed species were collected ('hairy tail' and 'spiney hairy tail') and a third species; *Lychas* 'bituberculatus'. The systematics of *Lychas* is presently under revision and the species identified here appears to be widespread throughout the Pilbara region (ES Volschenk pers. com.)

Species within the genus *Urodacus* genus were later collected during foraging.

Table 4-5 Scorpions collected during the Phase 1 survey effort

Site	Class	Order	Family	Genus	Species
Site9B	Arachnida	Scorpiones	Buthidae	*Lychas*	'hairy tail'
Site 6A	Arachnida	Scorpiones	Buthidae	*Lychas*	*'hairy tail'*
Site 7A	Arachnida	Scorpiones	Buthidae	*Lychas*	*'spiney hairy tail'*
Site 1B	Arachnida	Scorpiones	Buthidae	*Lychas*	*'spiney hairy tail'*
Site 4B	Arachnida	Scorpiones	Buthidae	*Lychas*	*bituberculatus*
Site 9A	Arachnida	Scorpiones	Buthidae	*Lychas*	*bituberculatus*
Site 6B	Arachnida	Scorpiones	Buthidae	*Lychas*	*bituberculatus*
Site 6A	Arachnida	Scorpiones	Buthidae	*Lychas*	*bituberculatus*

4.1.6 Harvestmen (Opiliones)

Two individuals of an unidentified harvestmen species were collected. Due to a lack of information regarding the biology of the species collected, it could not be determined whether these represented SRE species.

4.2 CRUSTACEANS (PHYLUM ATHROPODA, SUBCLASS CRUSTACEA)

4.2.1 Isopods

Isopods were collected from all sites during the survey. All of these specimens were identified as common species (Armadillidae) and were unlikely to represent SRE taxa.

4.3 MILLIPEDES AND CENTIPEDES (PHYLUM ARTHROPODA, SUBCLASS MYRIAPODA)

4.3.1 Centipedes

Four species of centipede were collected during the survey. These were three species of scolopendramorph; *Cormocephalus* sp. *Scolopendra morsitans* and *Scolopendra* sp. Owing to a lack of information regarding the biology of the species collected, the short-range endemic status of *Cormocephalus* sp. and *Scolopendra* sp. could not be determined. *Scolopendra morsitans* has a very wide distribution and is not a short-range endemic.

4.3.2 Millipedes

No millipedes were collected during phase 1 of the survey. This may have been due to a lack of leaf litter in most habitats within the Chichester Range where sampling occured.

4.4 INSECTS (PHYLUM: ATHROPODA, CLASS: INSECTA)

As expected, a large number of insect species were collected during the survey. Most insects have relatively good powers of dispersal by flight and very few species are currently known to have high endemicity (i.e. mostly troglobitic species). No species were identified as being likely to be SREs (Table 4.6).

Table 4-6 Insect species collected during the phase 1 survey effort

Site	Order	Family	No Morpho Species
Site 1B	Blattodea	Blattidae	1
	Coleoptera	Curculionidae	1
	Collembola	Unknown	2
	Hymenoptera	Formacidae	4
		Sphecidae	1
	Lepidoptera	Unknown	2
	Orthoptera	Gryllidae	1
	Thysanura	Unknown	1
Site 2B	Blattodea	Blattidae	1
	Coleoptera	Curculionidae	2
		Scarabaeidae	1
	Hymenoptera	Formacidae	5
		Sphecidae	1
	Lepidoptera	Anthelidae	1
	Orthoptera	Gryllidae	1
	Thysanura	Unknown	1
Site 3A	Blattodea	Blattellidae	1
		Blattidae	4
	Coleoptera	Brentidae	1
		Curculionidae	2
		Scarabaeidae	1
		Tenebrionidae	2
	Collembola	Unknown	2
	Hemiptera	Pentatomidae	2
		Reduviidae	1
	Hymenoptera	Formacidae	5
		Sphecidae	1
	Orthoptera	Acrididae	4
		Gryllidae	2
	Thysanura	Unknown	1
Site 4A	Blattodea	Blaberidae	1
		Blattelidae	1
	Coleoptera	Brenthidae	1
		Bruchidae	1
		Curculionidae	4
		Elateridae	2
		Scarabaeidae	1
		Tenebrionidae	2
	Diptera	Muscidae	1
		Stratiomyidae	1

Site	Order	Family	No Morpho Species
	Hemiptera	Cicadellidae	1
		Coreidae	1
		Eurybrachidae	1
		Reduviidae	1
		Tessaratomidae	1
	Hymenoptera	Formacidae	1
		Mutalidae	2
		Pompillidae	1
		Unknown	1
	Lepidoptera	Oecophoridae	1
		Tortricidae	1
	Mantodea	Amorphoschelidae	1
		Mantidae	1
	Neuroptera	Myrmeliontidae	1
	Orthoptera	Acrididae	1
		Gryacrididae	2
	Thysanura	Unknown	1
Site 4B	Coleoptera	Carabidae	1
		Curculionidae	1
		Tenebrionidae	1
		Unknown	1
	Diptera	Muscidae	1
	Hemiptera	Cercopidae	1
		Pentatomidae	1
	Hymenoptera	Formacidae	6
		Mutillidae	1
		Mutillidae	1
		Sphecidae	1
	Mantodea	Mantidae	1
	Orthoptera	Gryllidae	3
Site 5A	Blattodea	Blattellidae	1
	Coleoptera	Carabidae	1
		Carabidae	1
		Curculionidae	2
		Elateridae	1
		Tenebrionidae	2
		Tenebrionidae	1
	Diptera	Muscidae	1
	Hemiptera	Cicadellidae	1
		Pentatomidae	1
		Reduviidae	1
	Hymenoptera	Formacidae	3
		Formacidae	5
		Mutillidae	1
		Sphecidae	1
	Orthoptera	Acrididae	1
		Gryllidae	1
		Gryllidae	1

Site	Order	Family	No Morpho Species
	Thysanura	Unknown	1
Site 5B	Blattodea	Blaberidae	1
	Coleoptera	Carabidae	2
		Curculionidae	2
		Dermestidae	1
		Elateridae	1
		Tenebrionidae	2
	Collembola	unknown	1
	Diptera	Asilidae	1
	Hemiptera	Cercopidae	1
		Eurybrachidae	1
		Pentatomidae	1
		Reduviidae	1
	Hymnenoptera	Apidae	1
		Chalcidoidea	2
		Formacidae	1
	Mantodea	Mantidae	1
	Orthoptera	Gryllidae	1
	Thysanura	unknown	2
Site 6A	Blattodea	Blattidae	2
	Hemiptera	Aleydidae	1
		Pentatomidae	1
	Hymenoptera	Formacidae	1
		Sphecidae	1
	Mantodea	Mantidae	1
	Orthoptera	Acrididae	1
	Orthoptera	Gryllidae	5
	Thysanura	Unknown	1
Site 6B	Blattodea	Blattidae	1
	Coleoptera	Curculionidae	2
	Collembola	Unknown	1
	Hemiptera	Lygaeidae	1
	Hymenoptera	Evanidae	1
		Formacidae	3
		Mutillidae	1
		Sphecidae	1
	Mantodea	Mantidae	1
	Orthoptera	Gryllidae	2
Site 7A	Coleoptera	Tenebrionidae	1
	Collembola	Unknown	1
	Hemiptera	Pentatomidae	2
	Hymenoptera	Formacidae	5
		Vespidae	1
	Lepidoptera	Anthelidae	1
	Mantodea	Amorphoschelidae	1
		Mantidae	1
	Neuroptera	Myrmeliontidae	1
Site 7B	Blattodea	Blattidae	1
	Coleoptera	Curculionidae	1
		Elateridae	1

Site	Order	Family	No Morpho Species
	Collembola	Unknown	1
	Hemiptera	Lygaeidae	1
		Reduviidae	1
	Hymenoptera	Formacidae	2
		Sphecidae	1
	Mantodea	Mantidae	1
	Orthoptera	Gryllacrididae	1
		Gryllidae	2
	Thysanura	Unknown	1
Site 8A	Blattodea	Blattellidae	1
		Blattidae	1
	Hemiptera	Cicadellidae	1
	Hymenoptera	Sphecidae	1
	Lepidoptera	Noctuidae	1
		Oecophoridae	1
	Mantodea	Mantidae	1
	Neuroptera	Mantispidae	1
	Thysanura	Unknown	1
Site 9A	Blattodea	Blaberidae	1
		Blattellidae	12
	Coleoptera	Curculionidae	1
		Elateridae	1
		Enterophagidae?	1
		Tenebrionidae	2
	Collembola	unknown	1
	Diptera	Tabanidae	1
	Hemiptera	Pentatomidae	1
		Reduviidae	1
	Hymenoptera	Brachonidae	1
		Chrysipidae	1
		Formacidae	1
		Mutillidae	1
	Neuroptera	Myrmeliontidae	1
	Orthoptera	Acrididae	1
		Gryllidae	1
		Tettigoniidae	1
	Pscoptera	unknown	1
	Thysanura	unknown	1
Site 9B	Blattodea	Blattidae	2
	Hemiptera	Pentatomidae	1
		Reduviidae	1
	Hymenoptera	Formacidae	5
		Pompillidae	1
	Orthoptera	Gryllidae	3
	Thysanura	Unknown	1

5.0 SUMMARY OF FINDINGS WITHIN THE IMPACT AREA

A large number of invertebrate taxa were collected during the phase 1 survey of the RGP5 impact area; however, the majority of these species belonged to groups which were unlikely to be SREs (i.e. Non-SREs: mostly flying insects and ballooning spider species).

Species which were identified as having greater potential to be SREs (as indicated by the literature) were sent to taxonomic specialists who then provided information regarding the likelihood of endemicity for individual species. These species included Scorpions (Scorpiones), Harvestmen (Opiliones), Pseudoscorpions (Pseudoscorpionida), Trap-door spiders (Mygalomorphae) and Centipedes (Chilopoda).

The only species collected during the survey that had a strong likelihood of being an short range endemic species was the mygalomorph spider *Aurecocrypta* "Chichester" sp. Very little was known about the ecology of this *Aurecocrypta* species and its taxonomic relatedness to *A. lugubris* or *A. katersi*. A targeted follow up survey for the species was instigated on the recommendation of Dr R. Raven to collect more specimens. This survey was intended to collect female specimens to allow direct comparison with the type specimens of *A. lugubris* and *A. katersi*. As well as elucidating the identity of the species, the collection of more specimens from other habitats outside the project area would also determine if the species was restricted to the project area, and allow an assessment of potential species impacts.

6.0 *AURECOCRYPTA* SP. TARGETED SURVEY

6.1 TARGETED SURVEY DESIGN

The original male specimens of *Aurecocrypta* "Chichester" sp. were collected from pitfall traps which were placed within two sites (Phase 1: three specimens from site 6A and one specimen from site 7A, Figure 3.1). These sites occurred within 300m of each other and both had similar habitat characteristics: South facing slopes with a moderately dense *Acacia* sp. overstorey, a *Triodia* sp. (spinfex) understorey and a rocky substrate with very shallow soil.

The habitat in which *Aurecocrypta* "Chichester" was originally found was targeted for the collection of new specimens both within and outside the project area within the Chichester Range.

On the 7/4/08, 15 new pitfall trap sites (eight near the proposed rail deviation corridor and seven outside the corridor) were established to collect male specimens. Extensive foraging was also conducted to locate female specimens within these sites and other areas of the Chichester Range. This survey was unsuccessful and the majority of these sites were removed by mid 2008. It is thought that the impacts of a widespread bush fire in the region may have impacted on spider populations in these areas (R. Raven. pers com.). Also, low rainfall occurred during the sampling period which may have created adverse conditions for foraging males (Figure 2.2).

On the 7/7/08, 22 new sites were established. These sites were selected in more remote areas of the Chichester Range by helicopter. Unburnt habitats which appeared suitable or contained evidence of mygalomorph (trapdoor) spiders were targeted (Table 6.1).

6.2 RESULTS OF THE TARGETED SURVEY

Despite the intensive survey effort, only two new specimens of the *Aurecocrypta*"Chichester" species were collected.

One of these specimens was collected by R. Raven (8/08) within 200m of site 6A within the proposed rail corridor where some of the original males of the species were collected (-22.152342N 119.006825E) (Figure 6.1). This specimen was a female and was excavated from its burrow which had a cryptic trapdoor with no twig lining. The habitat was similar to site 6A and was an east facing slope which was unburned and densely vegetated with both *Acacia* sp. and *Triodia* sp., with rocky substrate and shallow soil. The female specimen has been examined and it is believed to be a female representative of the *A."Chichester"* species. After comparing this specimen with the type specimens of *A. lugubris* and *A. katersi*, it has now been determined by R. Raven that the Chichester species is taxonomically different from *A. lugubris* and *A. katersi* and is therefore a new undescribed species.

The second specimen was collected by G. Whyte (6/08) and was also a female spider which was excavated from its burrow, which occurred very close to Site 38 (-22.177941N 118.938345E) (Figure 6.1). The burrow of this specimen occurred in a deep gorge densely vegetated with numerous shrubs (tentatively identified as *Allocasuarina* sp.). This specimen occurred several km to the western side of the proposed rail corridor, indicating that this species occurs outside the impact area of the proposed rail deviation.

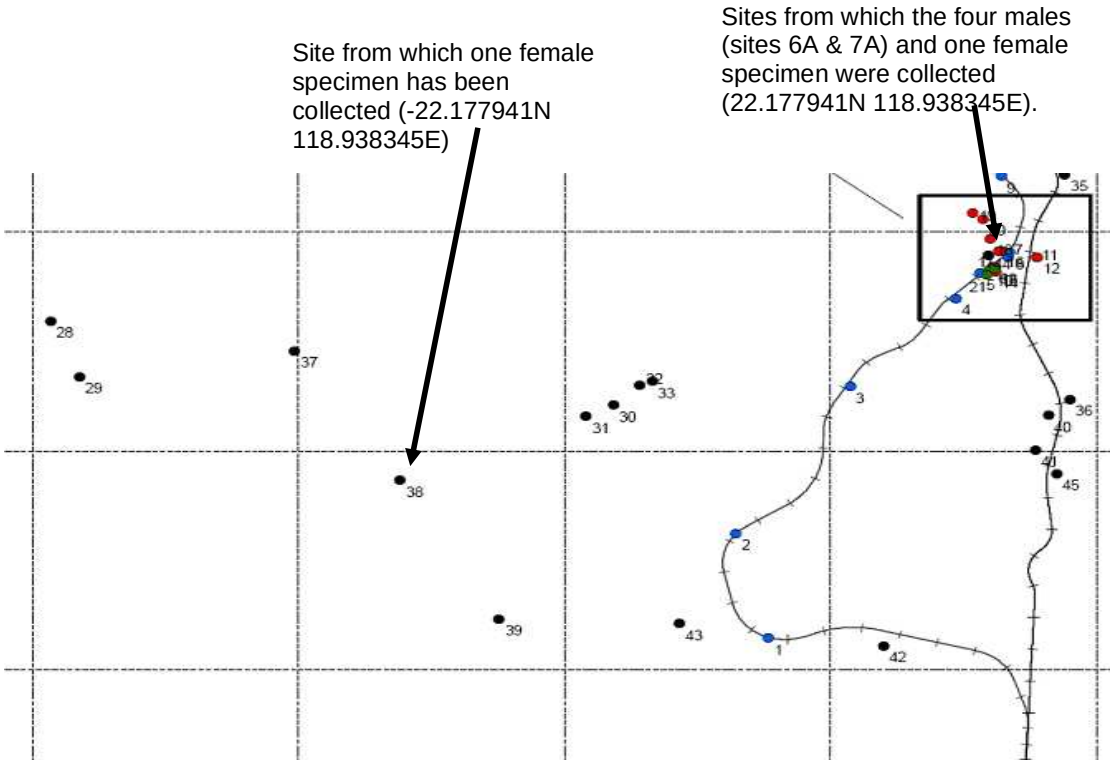


Figure 6-1 Pitfall trap sites within the Chichester and the locations of *Aurecocrypta* specimens found in relation to the RGP5 project area

During the foraging effort for *Aurecocrypta* specimens, five other species of mygalomorph spiders were collected and identified. These included, *Synothele* sp. (Barychelidae), *Aganippe* sp. (Idiopidae), *Conothele* sp. (Ctenizidae), *Aname* sp. (Nemesiidae) and *Missulena* sp. (Actinopodidae) (Table 6.1 & Figures 6.2 & 6.3). These species were abundant in many habitats and although some populations did occur within the impact area of the Chichester deviation, all species were also found occurring in viable populations occurring outside the impact area. None of these species are likely to be short range endemics and they are therefore unlikely to be impacted upon by the proposed RGP5 rail duplication project.

Figure 6-2 Mygalomorph species and aranaeomorph species collected at various localities within the Chichester Range.

Table 6-1 Coordinates of other mygalomorph species found within the Chichester Range

		UTM Zone 50	
Species	**map no**	**Easting**	**Northing**
Conothele sp.	1	708713.0	7562664.0
Conothele sp.	2	709158.0	7554887.0
Conothele sp.	3	706954.7	7548943.7
Conothele sp.	4	705756.0	7521548.0
Agannipe sp.	5	696353.0	7554066.0
Agannipe sp.	6	701652.0	7546603.0
Agannipe sp.	7	702169.0	7541058.0
Agannipe sp.	8	707937.0	7549013.0
Missulena sp.	9	709500.0	7546188.0
Missulena sp.	10	705999.0	7540570.0
Missulena sp.	11	709259.0	7544493.0
Missulena sp.	12	702169.0	7541058.0
Missulena sp.	13	708103.0	7549098.0
Synothele sp.	14	698776.0	7541174.0
Synothele sp.	15	708859.0	7545040.0
Synothele sp.	16	706789.5	7511802.1
Synothele sp.	17	696913.0	7544342.0
Aname sp.	18	708219.0	7549571.0
Aname sp.	19	707995.0	7549155.0
Aname sp.	20	708103.0	7549098.0
Aname sp.	21	708098.0	7549167.0
Aname sp.	22	704937.0	7559582.0
Aname sp.	23	708894.0	7549431.0
Aname sp.	24	707371.3	7548494.3

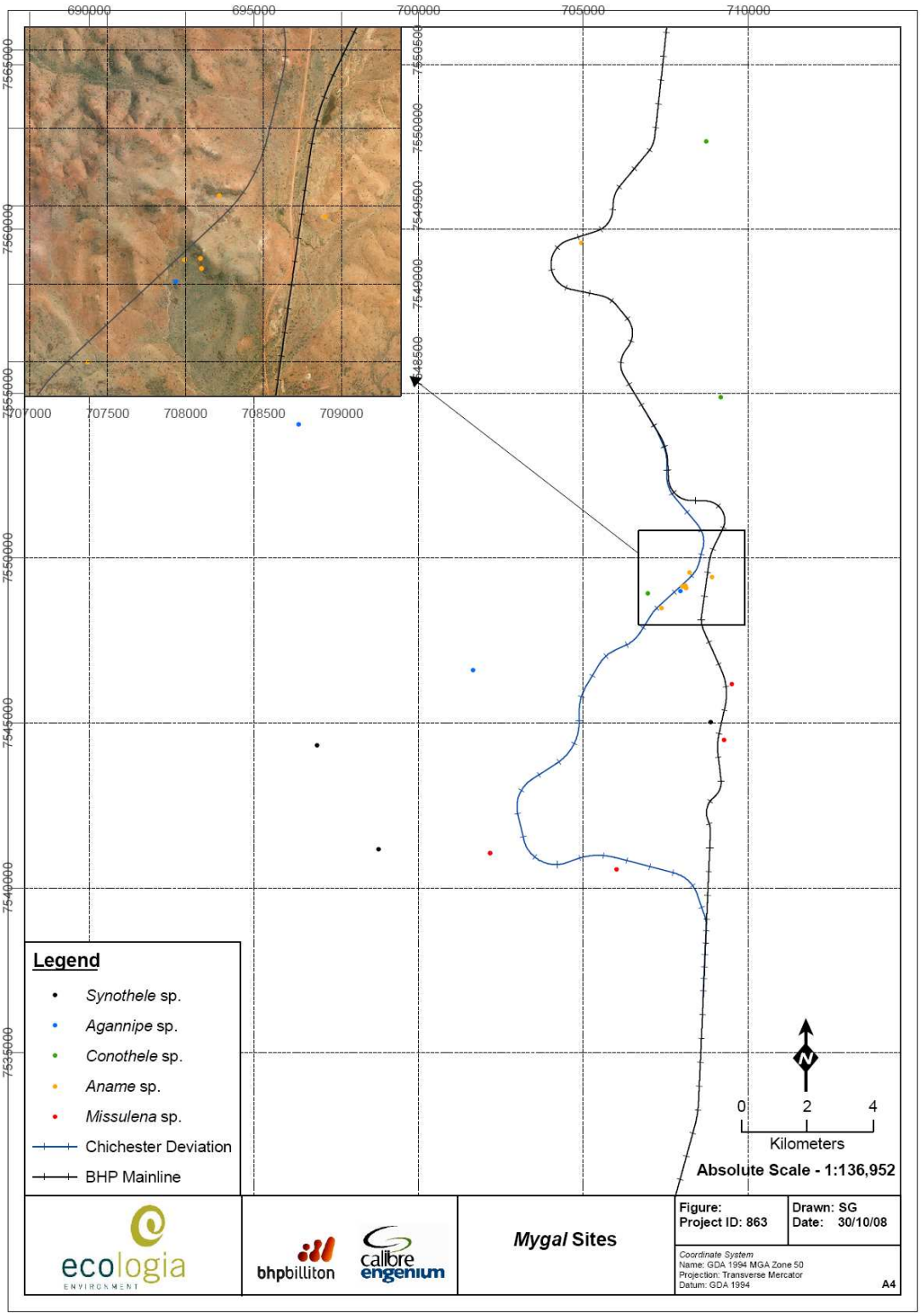


Figure 6-3 The locations of Mygalomorph species found within the Chichester Range in relation to the RGP5 project area

An examination of *Aurecocrypta* specimens at both the WA Museum and ecologia by Dr Robert Raven has subsequently revealed that *Aurecocrypta* 'Chichester' is actually a widespread species in the Pilbara and throughout northern Western Australia (Table 6.3 & Figure 6.4).

Table 6-2 *Aurecocrypta* 'Chichester' specimens found both within and outside the Chichester

Specimen Details			GPS Data		
Sp no	Locality	Details	zone	longitude	latitude
1	Chichester Range	3 males collected by ecologia pitfall trapping in Sep 2007	50	708210.5	7549428.6
2	Chichester Range	1 male collected by ecologia pitfall trapping in Sep 2007	50	708339.9	7549410.0
3	Chichester Range	1 female collected by ecologia foraging in Jun 2008	50	661846.3	7554495.5
4	Chichester Range	1 female collected by R.Raven foraging in Aug 2008	50	707434.4	7548959.9
5	Robinson Range	1 male collected by ecologia pitfall trapping in Apr 08	50	261638.3	7394826.8
6	Jack Hills	1 male collected by ecologia pitfall trapping in July 08	50	523379.3	7117451.2
7	Weld Range	1 male collected by ecologia pitfall trapping in Aug 08	50	579575.6	7029279.2
8	Weld Range	1 male collected by ecologia pitfall trapping in Aug 08	50	562535.5	7019602.2
9	Hammersley Ranges	Collector Unknown, WAM Record	50	699231.7	7464475.8
10	22.1km west Pannawonica	Collector Unknown, WAM Record	50	408739.7	7600764.1
11	West Turner Syncline	Collector Unknown, WAM Record	50	549975.2	7486840.1
12	Sulphur Springs	Collector Unknown, WAM Record	50	728663.8	7658004.0
13	Sulphur Springs	Collector Unknown, WAM Record	50	731762.0	7660791.2
14	Sulphur Springs	Collector Unknown, WAM Record	50	731762.0	7660791.2
15	Sulphur Springs	Collector Unknown, WAM Record	50	729585.5	7662021.5
16	Sulphur Springs	Collector Unknown, WAM Record	50	728663.8	7658004.0
17	Sulphur Springs	Collector Unknown, WAM Record	50	728663.8	7658004.0
18	waramboo 50.5k W of Panna	Collector Unknown, WAM Record	50	379462.6	7603615.1
19	Barlee Ra Nat Reserve	Collector Unknown, WAM Record	50	371672.6	7444859.6
20	Tanami, 89k W of Tanami Dc	Collector Unknown, WAM Record	50	485345.1	7800746.6
21	Mesa J, 16.6km SW Pannaw	Collector Unknown, WAM Record	50	420126.4	7593599.2
22	Waramboo, 52.1 k W of Pani	Collector Unknown, WAM Record	50	377850.4	7603941.2

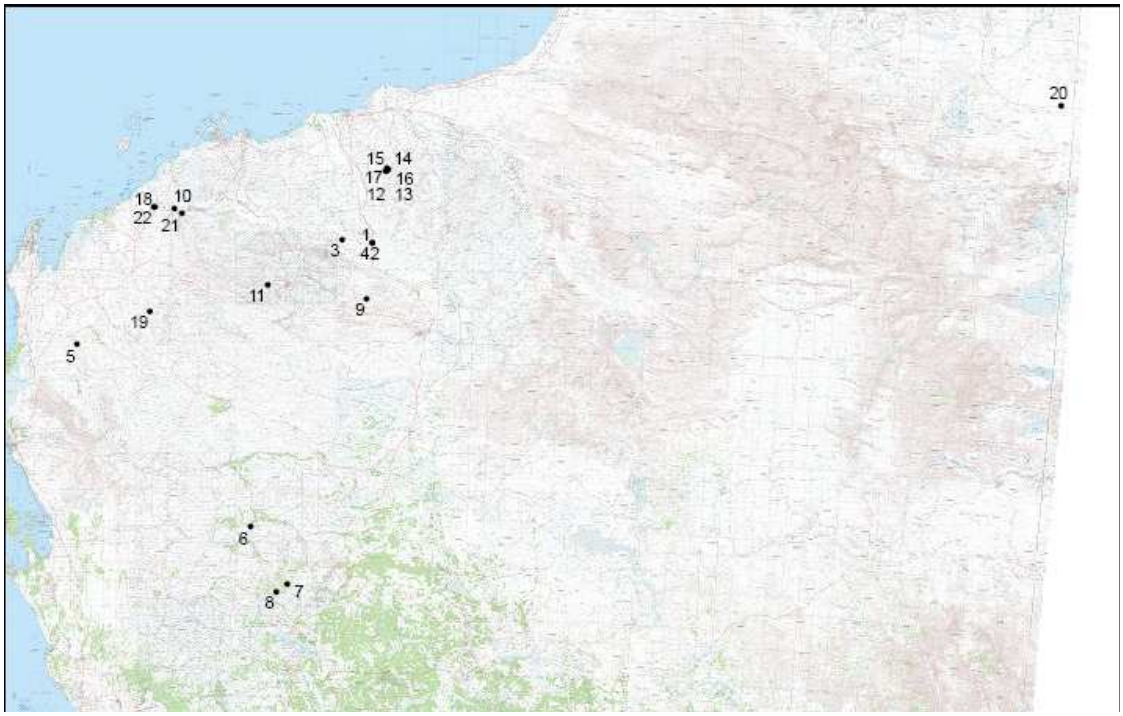


Figure 6-4 Aurecocrypta specimens found both within and outside the Chichester

6.3 THE STATUS OF AURECOCRYPTA "CHICHESTER" SP. NOV

Extensive foraging has now been conducted throughout the Chichester Range and numerous invertebrate species including other mygalomorph species have been found in numerous habitats (Figure 6.3).

Due to the widspread distribution pattern of *Aurecocrypta* 'Chichester', as indicated by species records, it has now been determined that the species is not a short range endemic species (Distribution > 10 000 km²) (Raven 2008). Examination of the Chichester Range study area indicate that the populations of *Aurecocrypta* occuring there are not highly localised. It is therefore unlikely that the Chichester Deviation will have a significant impact on the species; *Aurecocrypta* 'Chichester' within the Chichester Range.

6.4 POTENTIAL IMPACTS TO SHORT RANGE ENDEMIC INVERTEBRATES

Although no SREs were identified during the project survey, implementation of the Project could result in impacts to SREs, if present, due to disturbance to potential SRE habitat from vegetation clearing, dust and fire. Management Recommendations to minimise these impacts are included below.

MANAGEMENT RECOMMENDATIONS

1. Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field.
2. Areas that are likely to contain potential SRE species such as drainage lines, south facing slopes and other densely vegetated areas with high moisture retention should not be cleared of vegetation if possible.
3. Cleared areas should be rehabilitated as soon as practical.
4. Culverts should be placed in near proximity to where *Aurecocrypta* specimens were collected to facilitate dispersal of wandering male spiders between either side of the proposed rail.
5. Dust suppression measures should be implemented, including management of road speed on unsealed roads.
6. A fire prevention strategy should be implemented.
7. All vehicles should be fitted with fire extinguishers & all personnel trained in their use.

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