

Minjar Gold Project Fauna Assessment



Examining a spider burrow with milliscope. Photo: M.Bamford.

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Executive summary

As part of Environmental Impact Assessment for the development of the Minjar Gold Project, Bamford Consulting Ecologists (BCE) was commissioned to conduct a Level 1 fauna assessment (desktop review and site inspection) and additional targeted searches for conservation significant species within a number of proposed exploration, mining and infrastructure areas. A Level 1 fauna assessment and site inspection was undertaken at 28 sites between 28th September and 3rd October 2013 (ES Table 1). The initial site investigations were used to gather data on fauna assemblages, vegetation/substrate associations and habitat. Information was then used to prioritise areas for further targeted sampling. Thirteen sites were selected for more detailed investigations (including Malleefowl searches and quadrat sampling for the Shield-backed Trapdoor Spider) and surveyed between 19th and 23rd October 2013 (ES Table 1). BCE has conducted numerous fauna surveys in the area dating back to 2004, however the proposed areas have not been previously surveyed or assessed for conservation significant fauna.

BCE uses an impact assessment process with the following components:

- The identification of **fauna values**:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Species of conservation significance;
 - Recognition of vegetation/substrate associations that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
 - Patterns of biodiversity across the landscape; and
 - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - Degradation of habitat due to weed invasion leading to population decline;
 - Ongoing mortality from operations;
 - Species interactions including feral and overabundant native species;
 - Hydrological change;
 - Altered fire regimes; and
 - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts.

Key **fauna values** are provided for all sites and include the following.

Fauna assemblage and conservation significant species

The desktop study identified 252 vertebrate fauna species as potentially occurring in the project areas. This comprised eight frogs, 66 reptiles, 146 birds and 27 native and five introduced mammals. Note that this assemblage is derived from species databases and includes species that may occur occasionally on the sites, but for which the sites are not important (such as birds that rarely fly overhead). The assemblage includes at least 31 species of conservation significance (including one

invertebrate species). Sixty two vertebrate fauna species were recorded during the September and October field investigations including: 12 reptiles, 44 birds and four native and two introduced mammals. The number of fauna species recorded is low as the focus of the investigation was to primarily target conservation significant species. No trapping was conducted during the two survey periods. Seven conservation significant fauna species were recorded, the Western Spiny-tailed Skink, Malleefowl, White-browed Babbler, Crested Bellbird, Redthroat, Woolley's Pseudantechinus and Shield-backed Trapdoor Spider. No evidence of the Gilled Slender Blue-tongue was recorded during the surveys and there were few sightings of Major Mitchell's Cockatoo, although potentially suitable habitat for several conservation significant species was identified in the project areas (ES Table 1). A trapdoor spider similar to the Priority 4 Tree-stem Trapdoor Spider *Aganippe castellum* was recorded at some of the sites in the Mt Mulgine area. This is potentially an undescribed and short range endemic species.

ES Table 1. Summary of conservation significant species recorded at each project area, (Yes) indicates habitat potentially suitable while Yes indicates species recorded.

Survey Area (Size - ha)	Malleefowl (Evidence)	Shield-backed Trapdoor Spider	Spider burrow density (burrows/ha)	Western Spiny- tailed Skink	Gilled Slender Blue-tongue
October 2013*					
Monte Christo (14ha)	Yes (1 very old inactive mound)	Yes	883	No	(Yes)
Gnow's Nest (33ha)	Yes (1 old inactive mound)	Yes	375	No	(Yes)
Allegro (24ha)	Yes (3 old inactive mounds)	Yes	100	No	(Yes)
Goblin (57ha)	(Yes)	Yes	230	No	(Yes)
Tickford and Haul Road (33ha)	Yes (3 old inactive mounds)	Yes	236	No	(Yes)
South Windinne and Haul Road (55ha)	Yes (3 old inactive mounds)	Yes	146	No	(Yes)
South Island (28ha)	Yes (1 very old inactive mound)	Yes	380	No	No
Goatsville (42ha)	(Yes)	(Yes)	No	No	(Yes)
New Target 2 (also NT20) (46ha)	Yes (1 old inactive mound)	No	No	(Yes)	(Yes)
New Target 13 (also NT6) (49ha)	(Yes)	No	No	(Yes)	(Yes)

Survey Area (Size - ha)	Malleefowl (Evidence)	Shield-backed Trapdoor Spider	Spider burrow density (burrows/ha)	Western Spiny- tailed Skink	Gilled Slender Blue-tongue
Allentown (59ha)	(Yes)	Yes	450	(Yes)	No
New Target 5 (38ha)	Yes (2 old inactive mounds)	Yes	140	No	No
Wolf (73ha)	Yes (5 old inactive mounds)	Yes	110	No	No
September 2013					
Paradise City (68ha)	(Yes)	(Yes)	NA	(Yes)	(Yes)
New Target 15 (45ha)	(Yes)	Yes	NA	(Yes)	No
New Target 15 Haul Road (14ha)	Yes (2 old inactive mounds)	No	0?	Yes (2 active and 2 inactive colonies)	No
Haul road from Goatsville to Allantown (9ha)	(Yes)	(Yes)	NA	(Yes)	(Yes)
Haul road from New Target 13 to Target 2 (6ha)	(Yes)	(Yes)	NA	No	No
Haul Road from New Target 5 to Wolf (8ha)	(Yes)	No	NA	No	No
Bugeye North (116ha)	(Yes)	Yes	NA	(Yes)	No
Sprite (79ha)	Yes (Feather)	No	0?	No	No
New Target 26 (25ha)	(Yes)	No	0?	(Yes)	No
Fairey Well (27ha)	(Yes)	Yes	NA	(Yes)	No
Sunbeam (88ha)	Yes	Yes	NA	(Yes)	No
Keranne (54ha)	No	No	0?	(Yes)	No
New Target 25 (75ha)	(Yes)	Yes	NA	(Yes)	No
Spacely (29ha)	(Yes)	Yes	NA	No	No
Beryl West (183ha)	No	Yes	NA	(Yes)	No

*Survey areas listed in October 2013 were also assessed during site investigations in September 2013.

0? Under spider burrow density Indicates no spiders found but absence cannot be assumed due to some possibly suitable habitat

Vegetation and substrate associations

Three main VSA types were recorded in the project areas and include:

1. Hills, consisting of rocky ironstone banded ridges supporting mixed shrubland on shallow rocky-loam soils;
2. Foothills and slopes (lower to upper), supporting acacia shrubland (occasionally dense and tall) on gravelly-loam soils and;
3. Plains with very little relief, supporting acacia shrubland at variable densities and/or well-developed eucalypt woodlands on loam soils.

The rocky hills and associated slope VSAs are regionally restricted and are likely to become more significant for biodiversity conservation, as the number of developments affecting this VSA type increases. It is therefore recommended that prior to obtaining approvals to develop the Minjar Gold Project, further work be undertaken to quantify the regional extent of this VSA type and the likely impacts to this VSA due to this and other projects.

Patterns of biodiversity

Biodiversity is likely to be spread across the VSAs and the landscape, however areas of particular significance include the:

- Rocky ridges for the Gilled Slender Blue-tongue and potential SRE invertebrates;
- Foothills and lower to upper slopes with acacia shrubland over gravelly-loam soils are key habitat for Malleefowl and the Shield-backed Trapdoor Spider; and
- Eucalypt woodlands are likely to be important for hollow-dependent species, including the Major Mitchell's Cockatoo and Western Spiny-tailed Skink.

Ecological Processes

Impacts on conservation significant fauna species are expected to be mostly negligible to minor, due to the relatively small footprint of most of the project areas which are located within mostly widespread habitats with the exception of the rocky ridges. Project areas of greatest concern are Goblin (potential for several CS species), Monte Christo, Allentown and Gnow's Nest (high spider burrow densities) and New Target 15 Haul Road (active Western Spiny-tailed Skink colonies). A large Banded Ironstone Formation (BIF) ridge is situated in the Goblin project area and is likely to support populations of significant and potentially restricted fauna. The cumulative impacts of this and other developments upon conservation significant species also need to be considered. The main processes affecting the fauna assemblage include: loss, fragmentation and degradation of habitat, ongoing mortality, species interactions, hydrological changes, altered fire regimes and disturbance.

Recommendations relate to impacts and include:

- Determine the regional extent the Hills, consisting of rocky ironstone banded ridges supporting mixed shrubland on shallow rocky-loam soils VSA and the proportion of this VSA potentially affected by this project;
- Minimise vegetation clearing;
- Clearly delineate areas to be cleared;

- Maximise the use of existing tracks and degraded areas;
- Progressively rehabilitate areas as soon as practical;
- Avoid disturbance to rocky ridges and slope VSAs (where practical);
- Avoid disturbance to large, mature, hollow-bearing trees and Malleefowl mounds;
- Re-align the proposed New Target 15 Haul Road to avoid two active Western Spiny-tailed Skink colonies;
- Develop, implement and monitor a weed management and hygiene plan, which maintains vehicle hygiene in uncontaminated areas;
- Restrict vehicle access;
- Enforce minimum speed limits;
- Erect signage in areas of high wildlife activity (e.g. Malleefowl);
- Educate mine personnel with respect to fauna through the induction process;
- Record and report all fauna incidents to the Minjar Gold environment department;
- Discourage the presence of feral species, particularly the feral Goat, Cat and Fox, by the use of appropriate waste management procedures and removing artificial water sources;
- Develop and implement a feral species management plan in consultation with surrounding land holders and the Department of Parks and Wildlife;
- Minimise changes to existing hydrological flow patterns; and
- Develop a fire management plan in consultation with DPaW (which includes regard for the ecological role of fire).

It should be noted that at the time of writing no exploration, mine or infrastructure plans were available. Therefore, impacts upon fauna may need to be revised in the future, subject to a final project plan.

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1 Introduction

1.1 Overview

As part of Environmental Impact Assessment for the development of the Minjar Gold Project, Bamford Consulting Ecologists (BCE) was commissioned to conduct a Level 1 fauna assessment (desktop review and site inspection) and additional targeted surveys for conservation significant species within a number of proposed exploration, mining and infrastructure areas. A Level 1 fauna assessment is required to identify the fauna values of a site so that impacts upon these from any proposed development can be assessed and minimised where possible. It should be noted that at the time of writing no exploration, mine or infrastructure plans were available, only a basic search area.

1.2 General approach to fauna impact assessment

The purpose of impact assessment is to provide government agencies with the information they need to decide upon the significance of impacts of a proposed development. BCE uses an impact assessment process with the following components:

- The identification of **fauna values**:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Species of conservation significance;
 - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
 - Patterns of biodiversity across the landscape;
 - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - Degradation of habitat due to weed invasion leading to population decline;
 - Ongoing mortality from operations;
 - Species interactions including feral and overabundant native species;
 - Hydrological change;
 - Altered fire regimes; and
 - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts.

Descriptions and background information on these values and processes can be found in Appendices 1 to 4. Based on this impact assessment process, the objectives of investigations are to: identify fauna values; review impacting processes with respect to these values and the proposed development; and provide recommendations to mitigate these impacts.

1.3 Project description

The Minjar Gold Project is located approximately 360 kilometres (km) north northeast of Perth, 230km east of Geraldton and 70km southeast of Yalgoo. The entire project tenements cover an area of approximately 1,400km² and traverse a north to south alignment over the Yalgoo-Singleton Greenstone Belt. Minjar Gold is currently exploring new areas to expand their operations and has identified 28 sites covering an area of 1377 hectares (ha). The project areas range from Monte Christo in the north to Beryl West and Wolf in the south, a distance of approximately 80km (Figure 1).

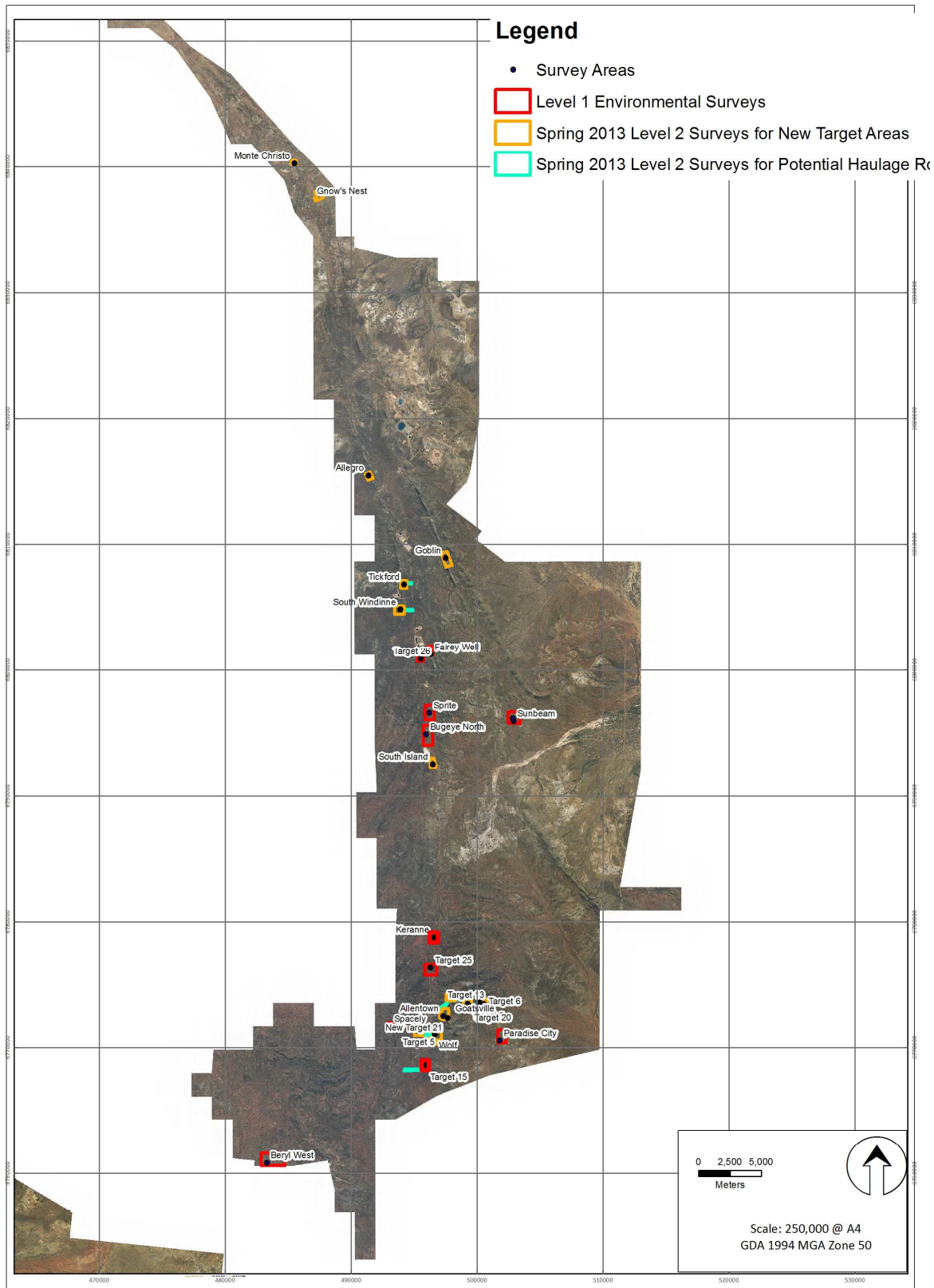


Figure 1. Location of proposed project areas.

2 Background

2.1 Regional description

The 28 project areas are situated within the interface between the arid Eremaean Botanical Province and the milder South West Botanical Province, in the Yalgoo Bioregion of the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (Figure 2, Environment Australia, 2000; McKenzie et al., 2003). The general features of the Yalgoo bioregion region are summarised by McKenzie et al., (2003), which is characterised by *Calitris-E. salubris*, mulga, and bowgada open woodlands and scrubs on earth to sandy-earth plains in the western Yilgarn Craton and the southern Carnarvon Basin. The latter has a basement of Phanerozoic sediments and is rich in ephemerals. The climate is Mediterranean, semi-arid to arid and warm. The dominant land use in the region is grazing, with smaller areas of conservation estate, unoccupied Crown land/Crown reserves and mining.



Figure 2. IBRA Subregions in Western Australia.

Note the project areas lies in the Yal (Yalgoo) IBRA subregion

Special values in the region include the Tallering Peak ironstone and Jaspilite Range (unique landform and vegetation complexes), banded ironstone in the Mt Gibson Ranges (containing a significant number of endangered flora), Warradagga Rock (a granite outcrop with endangered flora and invertebrates in ephemeral ponds) and the Mt Singleton Ranges (where there is a number of endangered flora with some unusual vegetation associations). Vertebrate fauna species of conservation significance recorded from the region include:

- Spiny-tailed Skink (*Egernia stokesii badia*);
- Gilled Slender Blue-tongue (*Cyclodomorphus branchialis*);
- South-West Carpet Python (*Morelia spilota imbricata*);
- Slender-billed Thornbill (*Acanthiza iredalei iredalei*);
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*);
- Peregrine Falcon (*Falco peregrinus*);
- Malleefowl (*Leipoa ocellata*); and
- Major Mitchell's Cockatoo (*Cacatua leadbeateri mollis*).

A further four conservation significant invertebrate species are expected to occur in the region, and include the Shield-backed Trapdoor Spider (*Idiosoma nigrum*), a Scorpion (*Urodacus* Mt Gairdner), the millipede (*Antichiropus* sp. nov. 'PM1') and the millipede (*Antichiropus* sp. nov. 'Karara'), the latter known only from specimens collected by BCE during investigations carried out for Karara Mining Limited (KML).

The survey areas generally consist of a combination of the following main landform and habitat features:

- Hills, consisting of banded ironstone ridges, supporting a shrubland and low woodland of acacia and allocasuarina growing in generally shallow rocky-loam soils;
- Foothills and slopes of gravelly-loam soils, supporting a tall and occasionally dense acacia shrubland. Some eucalypts also present; and
- Plains of red loam soils with very little relief, supporting Narrow-leaf mulga at variable densities and generally with little understorey. *Callitris* is present in some areas of sandy-loam soils. Emergent eucalypts are a significant component of this landform and vegetation type in some areas, generally close to the foothills and in low-lying areas where water may concentrate.

3 Methods

3.1 Overview

The methods used in these investigations are based upon the general approach to fauna investigations for impact assessment as outlined in Section 1.2 and with reference to Appendices 1 to 4. Thus, the impact assessment process involves the identification of fauna values, review of impacting processes and preparation of mitigation recommendations.

In addition, the approach to fauna impact assessment was carried out with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (EPA 2002; EPA 2004). The EPA proposes two levels of investigation that differ in the approach to field investigations, Level 1 being a review of data and a site reconnaissance to place data into the perspective of the site, and Level 2 being a literature review and intensive field investigations (e.g. trapping and other intensive sampling). The level of assessment recommended by the EPA is determined by the size and location of the proposed disturbance, the sensitivity of the surrounding environment in which the disturbance is planned, and the availability of pre-existing data. Due to the small size of the project areas (ranging from 6 to 183ha), a Level 1 Fauna Survey with additional targeted sampling for significant species was recommended. The project areas lie within a region already extensively surveyed by BCE, including Level 1 and Level 2 surveys and those targeting conservation significant species, therefore surveys were used to focus primarily on conservation significant species and their habitats.

The following approach and methods is divided into three groupings that relate to the stages and the objectives of impact assessment:

- Desktop assessment. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach.
- Field investigations. The purpose of the field investigations is to gather information on this assemblage: confirm the presence of as many species as possible (with an emphasis on species of conservation significance), place the list generated by the desktop review into the context of the environment of the project area, collect information on the distribution and abundance of this assemblage, and develop an understanding of the project area's ecological processes that maintain the fauna. Note that field investigations cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible in the EIA process. For example, in an intensive trapping study, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford (2010) has found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling.

- Impact assessment. Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

3.2 Desktop assessment

3.2.1 Sources of information

Information on the fauna assemblage of the project area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Department of Parks and Wildlife (DPaW) Naturemap (incorporating the Western Australian Museum's FaunaBase and the DPaW Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler *et al.* (2000);
- Reptiles: Storr *et al.* (1983); Storr *et al.* (1990); Storr *et al.* (1999); Storr *et al.* (2002) and Wilson & Swan (2008);
- Birds: Blakers *et al.* (1984); Johnstone and Storr (1998, 2004) and Barrett *et al.* (2003); and
- Mammals: Menkhorst & Knight (2001); Strahan (2004); Churchill (2008); and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
NatureMap (DPaW 2013)	Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA.	28 51 05S, 116 56 06E, plus 40km buffer
BirdLife Australia Atlas Database	Records of bird observations in Australia, 1998-2013.	Species list for the 1 degree grid cell containing 28.79913, 116.95082,
EPBC Protected Matters	Records on matters of national environmental significance protected under the EPBC Act.	28 51 05S, 116 56 06E, plus 10km buffer

3.2.2 Previous fauna surveys

BCE has completed a number of field investigations and studies in the Minjar and Karara region since 2004. Information from the BCE database as well as relevant reports has been compiled to produce this document. Reports used include the following:

- Bamford, M. (2003). Fauna Assessment for the Highland Chief Area. Unpubl, report by Bamford Consulting Ecologists for Gindalbie Metals.

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3.2.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) *Checklist of the Vertebrates of Western Australia 2008*. The authorities used for each vertebrate group were: amphibians (Doughty and Maryan, 2010a), reptiles (Doughty and Maryan, 2010b), birds (Christidis and Boles, 2008), and mammals (How *et al.*, 2009). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in Appendix 5.

3.2.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it was highly unlikely that these species would be present. Some are also known to be regionally extinct. In general, however, species returned by the desktop review process are considered to be potentially present in the survey area whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This is because fauna are highly mobile, often seasonal and frequently cryptic. This is particularly important for conservation significant species that are often rare and hard to find.

Interpretation of species lists generated through the desktop review included assigning an expected status within the survey area to species of conservation significance. This is particularly important for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive. The status categories used are:

- Resident: species with a population permanently present in the survey area;
- Regular migrant or visitor: species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;
- Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;

- Vagrant: species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and
- Locally extinct: species that has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

3.3 Field survey

3.3.1 Overview

A Level 1 Fauna Assessment and site inspection was undertaken at 28 sites between 28th September and 3rd October 2013 (Total area: 1377ha). The initial investigations were used to gather data on fauna assemblages, vegetation/substrate associations and habitat of the survey areas. Information was then used to prioritise areas for further targeted sampling. Thirteen sites (551ha) were selected for more detailed investigations and assessed between 19th and 23rd October 2013. Sites were selected if suitable habitat and/or conservation significant fauna were recorded. A summary of the project areas surveyed is provided in Table 2.

Table 2. Summary of the project areas surveyed in September and October 2013

Survey Area	Size (ha)	Proposed Use	September 2013 Survey	October 2013 Survey
Paradise City	68	Exploration	X	
New Target 15	45	Mining	X	
New Target 15 Haul Road	14	Haul Rd	X	
Haul road from Goatsville to Allantown	9	Haul Rd	X	
Haul road from New Target 13 to Target 2	6	Haul Rd	X	
Haul Road from New Target 5 to Wolf	8	Haul Rd	X	
Bugeye North	116	Exploration	X	
Sprite	79	Exploration	X	
New Target 26 (also Valencia)	25	Exploration	X	
Fairey Well	27	Exploration	X	
Sunbeam	88	Exploration	X	
Keranne	54	Mining	X	
New Target 25	75	Mining	X	
Spacely	29	Mining	X	
Beryl West	183	Exploration	X	
Monte Christo	14	Mining	X	X
Gnow's Nest	33	Mining	X	X
Allegro	24	Mining	X	X
Goblin	57	Mining	X	X
Tickford and Tickford Haul Road	33	Mining, Haul Road	X	X
South Windinne and South Windinne Haul Road	55	Mining, Haul Road	X	X
South Island	28	Mining	X	X
Goatsville	42	Mining	X	X
New Target 2 (also NT20)	46	Mining	X	X
New Target 13 (also NT6)	49	Mining	X	X
Allentown	59	Mining	X	X

Survey Area	Size (ha)	Proposed Use	September 2013 Survey	October 2013 Survey
New Target 5	38	Mining	X	X
Wolf	73	Mining	X	X
Total area	1377			

The field surveys included several components:

- Targeted searching for conservation significant fauna such as Malleefowl, Western Spiny-tailed Skink and Gilled Slender Blue-tongue;
- Transect and quadrat surveys to determine absence, presence and burrow density of the Shield-backed Trapdoor Spider;
- Opportunistic fauna observations; and
- Habitat assessment.

3.3.2 Personnel

The first reconnaissance field survey was conducted by Dr Michael Bamford (B.Sc. Hons. Ph.D.), Peter Smith (Dip. Ag.), Sarah Smith (B.Sc.) and Tim Gamblin (B.Sc. Cert Env. Man.). The second field survey was undertaken by Dr Michael Bamford, Gill Basnett (B.Sc. M.Sc.), Tim Gamblin and Cameron Everard (B.Sc. M.Sc.). This fauna assessment document was prepared by Cameron Everard and Dr Michael Bamford.

3.3.3 Vegetation and substrate associations

Vegetation and Substrate Associations (VSAs) were assessed for all project sites during the desktop review and during the field investigations. Within the project sites, each distinct VSA type was visited to develop an understanding of major fauna habitat types and to assess the likely presence of conservation significant species.

3.3.4 Targeted searching for conservation significant species

Several of the conservation significant species recorded during the desktop assessment, and previous surveys in the region, can be found by searching for evidence of their activities (e.g. scats, tracks, diggings, burrows) or listening for their call. Searching for evidence of significant fauna was consequently undertaken by walking through habitat considered suitable for such species, and by targeted searches for the Spiny-tailed Skink within old logs, within rock piles for the Gilled Slender Blue-tongue and mounds and for tracks and feathers of Malleefowl. Priority bird species such as Major Mitchell's Cockatoo were searched for by opportunistic observation and by checking hollows in eucalypt trees. Sightings or observations of Priority bird species and other conservation significant fauna were conducted at all times. Observations and searching for millipedes were conducted but conditions were unseasonably dry, resulting in low levels of millipede activity.

Shield-backed Trapdoor Spider

The Shield-backed Trapdoor Spider can readily be found opportunistically if searching is carried out in their preferred environment. The survey requirements for the proposed project areas were to determine the species' absence/presence and general distribution at a local scale. Surveys to determine the general distribution and density of the Shield-backed Trapdoor Spider were based on 2 x 50m quadrats spaced at 100m intervals along the transect line. The number of transects and quadrats conducted at each project site were determined by the presence and extent of suitable habitat. As indicated in Table 3, one hundred and four quadrats were established over 13 different project sites during the October 2013 surveys (total area of quadrats – 10,400m²), locations provided in Appendix 6. Each quadrat was searched intensively by four people by laying out a 50m tape measure and searching 1m either side of this so that all spider burrows could be found. Densities were calculated based upon the area of quadrats and the number of spiders in the quadrats. The survey methodology was originally developed by BCE for Karara Mining, and has been reviewed and approved by a DPaW biostatistics specialist (M. Williams pers comm, 2013).

For each burrow found, the distance along the midline of the quadrat from the origin and the internal (lumen) diameter of the burrow was recorded. A millscope was used to confirm the species of spider present in the majority of burrows; this proved to be especially important at Goatsville, New Target 13 and New Target 2, as other species of trapdoor spider (e.g. *Aganippe sp.* and *Anidiops sp.*) are present and have burrow architecture very similar to that of the Shield-backed Trapdoor Spider.

Table 3. Summary of Shield-backed Trapdoor Spider searches October 2013.

Site	Number of quadrats (2m x 50m)			Search area (m ²)
	Transect 1	Transect 2	Transect 3	
Monte Christo	4	2	NA	600
Gnow's Nest	5	3	NA	800
Allegro	5	5	NA	1000
Goblin	5	5	NA	1000
Tickford and Tickford Haul Road	7	4	NA	1100
South Windinne and South Windinne	5	5	5	1500
South Island	5	NA	NA	500
Goatsville	4	NA	NA	400
New Target 2 (also NT20)	5	NA	NA	500
New Target 13 (also NT6)	5	NA	NA	500
Allentown	5	5	NA	1000
New Target 5	5	NA	NA	500
Wolf	4	3	3	1000
Total	64	32	8	10,400

Malleefowl

While personnel walked along and between the 2 x 50m spider quadrats, they also searched for Malleefowl evidence (mounds, tracks, feathers and diggings); such evidence was also searched for opportunistically at all other times. Information collected on each mound included height, width, crater depth (if present), activity, building materials, vegetation, landscape placement and location (GPS coordinates are given in Appendix 7). Four personnel visited all project areas except for Kerrane and Beryl West, visited by two people.

The survey intensity at 13 targeted sites was as follows.

Western Spiny-tailed Skink

York Gum woodland, especially large eucalypts and logs considered suitable habitat, was identified and searched for evidence (latrine scats) of the Western Spiny-tailed Skink. Western Spiny-tailed Skink evidence was described and locations recorded.

3.3.5 *Opportunistic observations*

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while travelling through the site, as well as collection of potential short range endemic species.

3.4 Survey limitations

The EPA Guidance Statement 56 (EPA, 2004) outlines a number of limitations that may arise during surveying. These survey limitations are addressed in Table 4.

Table 4. Survey limitations as outlined by EPA (2004).

EPA Limitation	Limitation Exists	BCE Comment
Level of survey.	No	Level 1 and targeted survey (desktop study and two field surveys). Survey intensity was deemed adequate due to the level of survey and the number of fauna surveys previously conducted in the region by BCE.
Competency/experience of the consultant(s) carrying out the survey.	No	The authors have had extensive experience in conducting desktop reviews, site inspections and targeted surveys for significant species.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	No	As a level 1 survey, the scope was not to comprehensively sample fauna; the inspection was adequate to define fauna habitats and there was abundant desktop data on the fauna assemblage in the region. Targeted searching for Malleefowl, Shield-backed Trapdoor Spider and Western Spiny-tailed Skink was conducted across the survey areas. No constraints limited the survey.
Proportion of fauna identified, recorded and/or collected.	No	All fauna observed was identified. Two <i>Aganippe</i> specimens collected for DNA analysis.

Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	No	Sources include previous fauna survey reports from the area and databases (BA, DPaW, WAM and EPBC)
The proportion of the task achieved and further work which might be needed.	Partial	Site reconnaissance and targeted field surveys were completed. Due to survey findings further work may be needed to monitor mining impacts on significant fauna and habitats.
Timing/weather/season/cycle.	No	Site reconnaissance and targeted field surveys conducted during September and October 2013. However, it is the nature of arid and semi-arid environments that some species are nomadic or episodic. Conditions were mild with no rainfall recorded.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No	No disturbances affected the surveys.
Intensity. (In retrospect, was the intensity adequate?)	No	Survey intensity adequate to record conservation significant fauna and habitats.
Completeness (e.g. was relevant area fully surveyed).	No	Survey intensity was moderate, but supported by previous intensive studies in nearby and similar habitats. Desktop study covered survey area and adjacent habitats. All survey areas were visited and assessed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	All species identified to taxon level.
Remoteness and/or access problems.	No	No access problems.
Availability of contextual (e.g. biogeographic) information on the region.	No	Extensive regional information was available and was consulted (e.g. databases).

3.5 Presentation of results for impact assessment

While some impacts are unavoidable during a development, of concern are long-term, deleterious impacts upon biodiversity. This is reflected in documents such as the Significant Impact Guidelines provided by the Commonwealth Department of Environment (DoE) (Appendix 4). Significant impacts may occur if:

- There is direct impact upon a VSA and the VSA is rare, a large proportion of the VSA is affected and the VSA supports conservation significant fauna;
- There is direct impact upon conservation significant fauna; and
- Ecological processes are altered and this affects large numbers of species or large proportions of populations, including conservation significant species.

The impact assessment process therefore involves reviewing the fauna values identified through the desktop assessment and field investigations with respect to the project and impacting processes. The severity of impacts on the fauna assemblage and conservation significant fauna can then be quantified on the basis of predicted population change. The presentation of this assessment follows the general approach to impact assessment as given in Section 1.2, but modified to suit the characteristics of the sites. Key components to the general approach to impact assessment are addressed as follows:

Fauna values

This section presents the results of the desktop and field investigations in terms of key fauna values (described in detail in Appendix 1):

- Assemblage characteristics (uniqueness, completeness and richness) - based upon desktop assessment and information from the site inspection;
- Species of conservation significance – based upon desktop assessment and site inspection;
- Recognition of ecotypes or vegetation/substrate associations (VSAs) - based upon desktop assessment and site inspection;
- Patterns of biodiversity across the landscape - based upon desktop assessment and site inspection; and
- Ecological processes upon which the fauna depend - based upon desktop assessment and site inspection.

Impact assessment

This section reviews impacting processes (as described in detail in Appendix 2) with respect to the proposed project activities and examines the potential effect of these impacts upon biodiversity. It expands upon Section 1.3 and discusses the contribution of project disturbances to impacting processes, and the consequences of this with respect to biodiversity. A major component of impact assessment is consideration of threats to species of conservation significance as these are a major and sensitive element of biodiversity. Therefore, the impact assessment includes the following:

- Review of impacting processes; will the proposal result in:
 - Habitat loss leading to population decline, especially for significant species;

- Habitat loss leading to population fragmentation, especially for significant species;
 - Weed invasion that leads to habitat degradation;
 - Ongoing mortality;
 - Species interactions that adversely affect native fauna, particularly significant species;
 - Hydrological change;
 - Altered fire regimes; and
 - Disturbance (dust, light, noise).
- Summary of impacts upon significant species, and other fauna values.

The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

3.5.1 *Criteria for impact assessment*

Impact assessment criteria are based on the severity of impacts on the fauna assemblage and conservation significant fauna, and were quantified on the basis of predicted population change (Table 5). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

Table 5. Assessment criteria of impacts upon fauna.

Impact category	Observed impact
Negligible	Effectively no population decline; at most few individuals impacted and any decline in population size within the normal range of annual variability.
Minor	Short-term population decline (recovery after end of project) within project area, no change in viability of conservation status of population. Where environment permanently altered, no change in viability or conservation status of population.
Moderate	Permanent population decline, change in viability or conservation status of population considered unlikely.
Major	Permanent population decline resulting in change in viability or conservation status of population.
Critical	Taxon extinction.

4 Results

4.1 Vertebrate fauna

4.1.1 Overview of fauna assemblage

The desktop study identified 252 vertebrate fauna species as potentially occurring in the project areas (Table 6 and Appendix 5): eight frogs, 66 reptiles, 146 birds and 27 native and five introduced mammals. Note that this assemblage comes from databases and includes species that may occur occasionally on the site, but for which it is not important (such as birds that rarely fly overhead). The assemblage includes at least 31 species of conservation significance (including one invertebrate species).

Sixty two vertebrate fauna species were recorded during the September and October field investigations (Table 6 and Appendix 5) including: 12 reptiles, 44 birds and four native and two introduced mammals. Note that number of fauna species recorded is low as the focus of the investigation was to primarily target conservation significant species.

Table 6. Composition of vertebrate fauna assemblage expected to occur and recorded within the project areas.

Taxon	Number of species expected	Number of species recorded	Significant fauna expected (recorded)		
			CS1	CS2	CS3
Frogs	8	-	0	0	0
Reptiles	66	12	3 (1)	0	2
Birds	146	44	5 (2)	7 (2)	10 (1)
Native Mammals	27	4	0	0	3 (1)
Introduced Mammals	5	2	-	-	-
Total	252	62	8 (3)	7 (2)	15 (2)

This vertebrate assemblage is typical of the southern Murchison with a strong representation of generally widespread arid zone species, but also species more typical of the Wheatbelt. Conservation significant species are discussed further in Section 4.2. Previous studies by BCE in the region have identified the following key features of the fauna assemblage in the project areas:

- **Uniqueness:** The assemblage on most ridges in the area has a species composition that reflects the geology and geography of the region. The ironstone ridges and dense midslope habitats of the ridge appear to have a high diversity and abundance of species restricted to this habitat. This applies to the Goblin project area where rocky ridges are present. Although similar faunal assemblages may be present on surrounding ironstone hills, cumulative impacts of adjacent mining operations on Karara, Terapod and Blue Hills are likely to make remaining ridges in the area important habitat refuges in the future.

- **Completeness:** The assemblage almost entirely lacks a major component, medium sized (“critical weight range”) mammals. These have declined across much of southern Australia due to factors such as predation by feral species (particularly the Red Fox) and altered fire regimes (Burbidge and McKenzie, 1989). Despite this, the assemblage is otherwise substantially complete because the survey areas lie within largely undisturbed environments.
- **Richness:** The assemblage can be described as only moderately rich in a regional sense. This is partly because of the loss of some mammal species. Rocky ridges are more developed with a high variety of environmental niches compared with surrounding areas.

In terms of fauna value, the most important features of the assemblage is that it contains elements that have and are likely to continue to decline or disappear from the adjacent ironstone ridges as mining operations continue in the region (e.g. Karara, Terapod, Blue Hills and other proposed areas). The rocky hills and associated slope VSAs are of particular relevance to the fauna assemblage as this VSA is regionally restricted and is likely to become more significant for biodiversity conservation, as the number of developments affecting this VSA type increases. It is therefore recommended that prior to obtaining approvals to develop the Minjar Gold Project, further work be undertaken to quantify the regional extent of this VSA type to and the likely impacts to this VSA due to this and other projects.

4.2 Conservation significant species

Details on species of conservation significance returned from the database searches and those that are likely to occur in the survey areas are presented in Table 7. This list includes five reptile, 22 bird, three mammal species and five invertebrate species. One of the invertebrate species was recorded only during the current surveys. Note that species extinct in the region and that may have been present historically on the basis of broad patterns of distribution have not been included.

Table 7. Conservation status of significant fauna species expected to occur in the project areas.

Common Name	Scientific Name	Conservation Status			Recorded in the project areas or local area
		CS1	CS2	CS3	
REPTILES					
Southwest Carpet Python	<i>Morelia spilota imbricata</i>	S4			Yalgoo
Western Spiny-tailed Skink	<i>Egernia stokesii badia</i>	En			Recorded
Gilled Slender Blue-tongue	<i>Cyclodomorphus branchialis</i>	S1			Karara, Mungada
Reticulated Velvet Gecko	<i>Oedura reticulata</i>			RL	Karara
Mulga Dragon	<i>Caimanops amphiboluroides</i>			RL	Mungada
BIRDS					
Fork-tailed Swift	<i>Apus pacificus</i>	Mig, S3			Morawa
Malleefowl	<i>Leipoa ocellata</i>	V, S1			Recorded
Peregrine Falcon	<i>Falco peregrinus</i>	S4		BIF	Mungada, Minjar*
Rainbow Bee-eater	<i>Merops ornatus</i>	Mig, S3			Recorded
Slender-billed Thornbill	<i>Acanthiza iredalei</i>	V			Mt Magnet
Major Mitchell's Cockatoo	<i>Cacatua leadbeateri</i>		S4		Karara
White-browed Babbler (wheatbelt form)	<i>Pomatostomus superciliosus</i>		P4		Recorded
Australian Bustard	<i>Ardeotis australis</i>		P4		Mongers Lake
Bush Stone-curlew	<i>Burhinus grallarius</i>		P4		Badja, Mulloo Hill
Crested Bellbird	<i>Oreoica gutturalis</i>		P4		Recorded
Rufous Fieldwren (western wheatbelt)	<i>Calamanthus campestris montanellus</i>		P4		Mongers Lake
Grey Falcon	<i>Falco hypoleucos</i>		P4		None
Square-tailed Kite	<i>Lophoictinia isura</i>			LC	Mungada
Regent Parrot	<i>Polytelis anthopeplus anthopeplus</i>			LC	Karara
Scarlet-chested Parrot	<i>Neophema splendida</i>			LC	None
Redthroat	<i>Sericornis brunneus</i>			LC	Recorded
Southern Scrub-robin	<i>Drymodes brunneopygi</i>				Mongers Lake
Western Yellow Robin	<i>Eopsaltria griseogularis rosinae</i>			LC	Karara
Rufous Tree-creeper	<i>Climacteris rufa</i>			RL	Karara
Golden Whistler	<i>Pachycephala pectoralis</i>			RL	Karara

Common Name	Scientific Name	Conservation Status			Recorded in the project areas or local area
		CS1	CS2	CS3	
Gilbert's Whistler	<i>Pachycephala gilberti</i>			DW	Mungada
Grey Honeyeater	<i>Conopophila whitei</i>			RL	Mongers Lake
MAMMALS					
Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>			BIF	Recorded
Kultarr	<i>Antechinomys laniger</i>			RL	Badja
Common Brushtail Possum	<i>Trichosurus vulpecula vulpecula</i>			RL	Lochada
INVERTEBRATES					
Shield-backed Trapdoor Spider	<i>Idiosoma nigrum</i>	V, S1			Recorded
"Mt Mulgine Trapdoor Spider"	<i>Aganippe aff castellum</i>			?SRE	Recorded
Millipede	<i>Antichiropus sp. nov. 'PM1'</i>			SRE	
Millipede	<i>Antichiropus sp. nov. 'Karara'</i>			SRE	Karara
Scorpion	<i>Urodacus 'Mt Gairdner'</i>			SRE	

See Appendix 1 for descriptions of conservation significance levels.

EPBC Act listed species: V = Vulnerable, En = Endangered, Cr = Critically Endangered, Mig = Migratory.

WC Act listed species: S1 = Schedule 1, S3 = Schedule 3, S4 = Schedule 4, DPaW Priority Species: P1 = Priority 1, P2 = Priority 2, P3 = Priority 3, P4 = Priority 4, P5 = Priority 5.

BIF = species dependant on Banded Ironstone Formation ridges, LC = species listed as threatened (least concern) by Garnett *et al.*, (2010), DW = declining woodland species, RL = species at limit of their range.

*Recorded by APM (2012)

Records of significant species in the general region have been well documented from previous BCE surveys (Section 3.2.2). Nine conservation significant fauna species were recorded during the surveys: the Western Spiny-tailed Skink, Malleefowl, Major Mitchell's Cockatoo, White-browed Babbler, Crested Bellbird, Redthroat, Woolley's Pseudantechinus, Shield-backed Trapdoor Spider and the "Mt Mulgine Trapdoor Spider". The latter is a species that appears similar to the Priority 4 (therefore CS2) Tree-stem Trapdoor Spider *Aganippe castellum*, and was identified as such from specimens collected by BCE around sites at Mt Mulgine by Phoenix Environmental (2013), but it is probably an undescribed species that may be an SRE. This species is further discussed in Section 4.17.2 Within the current Minjar study, this spider was found only at sites in the Mt Mulgine area, and usually occurred instead of the Shield-backed Trapdoor Spider. No evidence of the Gilled Slender Blue-tongue was recorded in any of the areas during the surveys (Appendix 5), but suitable habitat for this species was identified in some of the project areas.

Conservation significant species are quite habitat specific and depend on different VSA types. For example, Malleefowl and the Shield-backed Trapdoor Spider are usually recorded on the slopes of ironstone hills and dense vegetation with gravelly loam soils, and are not found in the heavy clay soils of the surrounding eucalypt plains. In contrast, the Western Spiny-tailed Skink and Major Mitchell's Cockatoo are generally found on flat eucalypt plains with heavy clay to loam soils and large trees. The only records of the Gilled Slender Blue-tongue are from Karara and Mungada on

rocky ridges. Additional background information such as status, habitat preference and distribution of the five conservation significant species found with project sites is provided in Appendix 9.

A stand-alone assessment for each of the 13 targeted project areas surveyed in October 2013 (Table 2) is provided in Sections 4.3 to 4.15.

1. Monte Christo (Section 4.3);
2. Gnow's Nest (Section 4.4);
3. Allegro (Section 4.5);
4. Goblin (Section 4.6);
5. Tickford and Tickford Haul Road* (Section 4.7);
6. South Windinne and South Windinne Haul Road* (Section 4.8);
7. South Island (Section 4.9);
8. Goatsville (Section 4.10);
9. New Target 2 (Section 4.11);
10. New Target 13 (Section 4.12);
11. Allentown (Section 4.13);
12. New Target 5 (Section 4.14); and
13. Wolf (Section 4.15).

*Note: Tickford and South Windinne haul roads have included with the main survey areas.

VSA's were assessed during the field investigations as they provide useful information in which to understand the major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area. The assessment of each site includes a description of the area, results from the targeted surveys and discussion of VSA's and significant fauna. Results from the initial site investigations conducted in September 2013 are summarised in Section 4.16 (Table 21).

Impacts and management recommendations that apply to all 28 sites are discussed in Sections 5 and 6 respectively. It should be stressed that at the time of writing no project description was available and therefore the assessment of impacts on conservation significant fauna can only be discussed in general terms. Note that impacts upon fauna may need to be revised in the future subject to a final project plan, particularly in relation to effects on the rocky hills and associated slope VSA and related fauna assemblage.

4.3 Monte Christo

4.3.1 Site description

The Monte Christo project area is located in the northern extent of the Minjar tenements, approximately 3km north east of Gnow's Nest (Figure 1). The projects area is small (14ha) and consists of small rocky hills and low flat valleys (Figure 3). Distinctive features for the site include a small quartz ridge situated in the centre of the project area and a small BIF ridge (approximately 80m x 20m) located in the north east corner.

Two main VSAs were identified:

- 1) Open medium acacia shrubland and low shrubs (*Eremophila* sp) over gravel, cobble, rock and quartz, with red loam on lower slopes of a low hill (Plate 1); and
- 2) Open low mixed shrubs on cobble and rock outcrops on top of a small BIF ridge (Plate 2).

Vegetation densities varied across the site from sparse along the western boundary and increasing through to the east of the project area (Figure 3).



Plate 1. Open medium acacia shrubland and low shrubs over gravel, cobble, rock and quartz with red loam on lower slopes.



Plate 2. Open low mixed shrubs on cobble and rock outcrops on top of a small BIF ridge.

4.3.2 Fauna assemblage

Eighteen vertebrate fauna species were opportunistically recorded during the transect searches including two reptile, 12 bird and four mammal species (Appendix 5). Varanid and echidna diggings were recorded throughout the site and two introduced mammal species were present, the rabbit and goat. Note that total number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 8 and presented in Figure 3. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 8. Conservation significant species at Monte Christo.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (1 very old inactive mound)	Potential visitor	Vegetation too sparse, except in small valley areas
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes - 6 quadrats, 53 burrows (Density: 883 burrows/ha); opportunistic survey 17 burrows ; lumen diameter 5- 18 mm.	Resident	Mostly recorded on the eastern side of the site
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	No suitable habitat
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists in small BIF ridge
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Unlikely	No suitable habitat
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

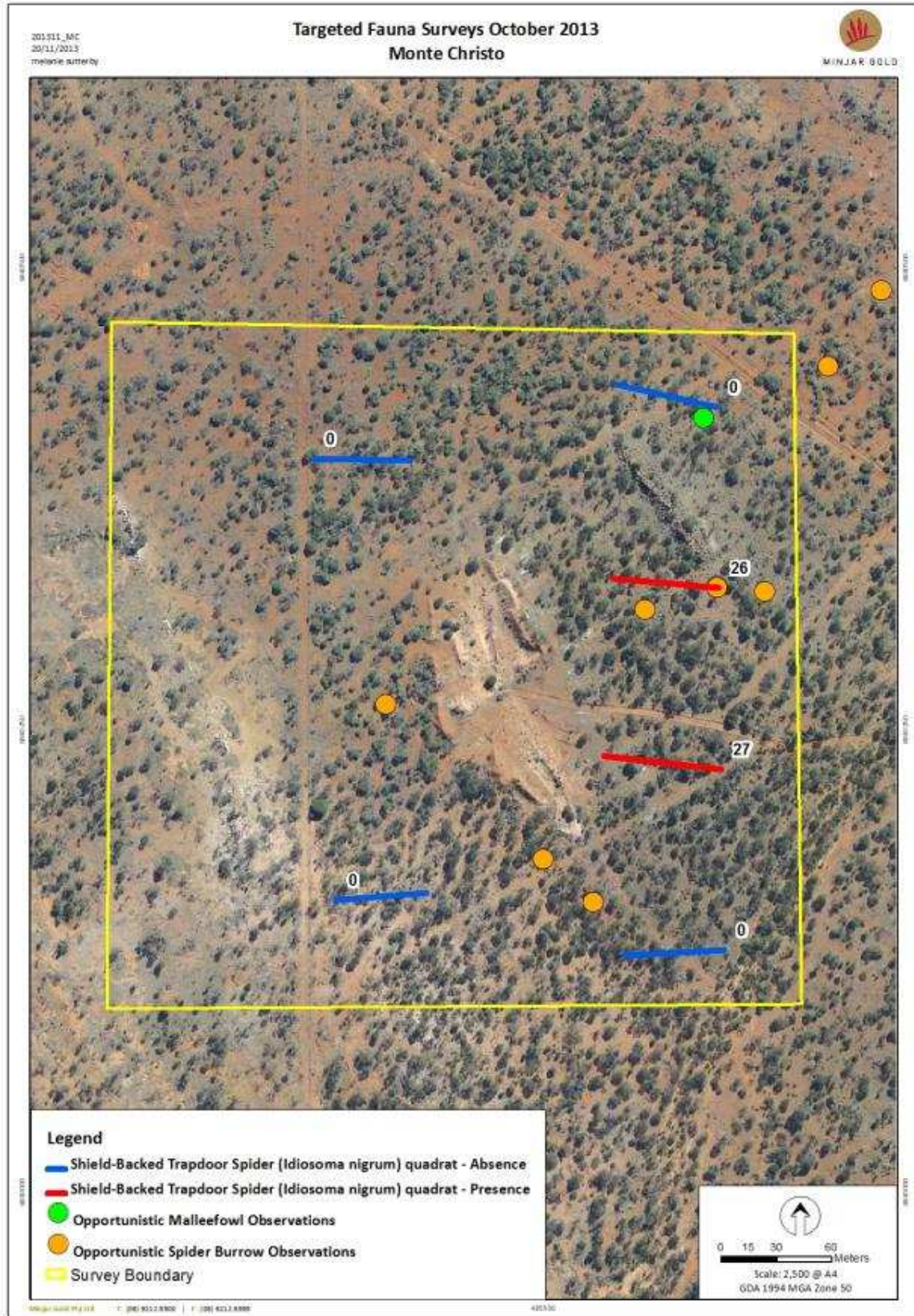


Figure 3. Location of spider quadrats and conservation significant species recorded at Monte Christo.

4.3.3 Discussion

VSA's and conservation significant species

The Monte Christo project area consists of open acacia shrubland over gravel and rock with red loam on lower slopes. The VSA type is regionally widespread and well-represented outside the survey area in the greater Minjar and Karara region. Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider and Malleefowl (both recorded during the survey), although only a small area of Malleefowl habitat occurs within the survey area. The Monte Christo project area recorded the highest spider burrow density of all the sites (883 burrows/ha), with the majority of spiders located along the eastern boundary of the site, where denser acacia shrubland and leaf litter occurs.

No suitable habitat (e.g. Eucalypt woodland) is present for the Western Spiny-tailed Skink or Major Mitchell's Cockatoo and therefore these species are unlikely to occur. The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists on the small BIF ridge located in the north east corner of the site. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.4 Gnow's Nest

4.4.1 Site description

The Gnow's Nest project area is located in the northern extent of the Minjar tenements, approximately 3km south east of Monte Cristo (Figure 1). The project area consists of undulating low hills comprising quartz, BIF and conglomerate with shallow valleys and covers an area of 33ha (Figure 4). An ephemeral drainage line traverses the southern boundary of the project area. The site is extensively degraded due to historical mining activities and goats.

Two main VSAs were identified:

- 3) Open medium acacia shrubland and mulga over low myrtaceous shrubs on gravel, cobble and rock with loam on lower slopes of a low hill (Plate 3); and
- 4) Open low to medium acacia shrubland on gravel, cobble and rock with loam at the top of a low hill (Plate 4).

Vegetation densities varied across the site from dense acacia shrublands in the valleys located along the eastern boundary to open shrubland with rock, cobble and little understorey in the western and central parts of the project area.



Plate 3. Open medium acacia shrubland and mulga over low myrtaceous shrubs on gravel, cobble and rock with loam on lower slopes.



Plate 4. Open low to medium acacia shrubland on gravel, cobble and rock with loam at the top of a low hill.

4.4.2 Fauna assemblage

Fourteen vertebrate fauna species were opportunistically recorded during the transect searches including three reptile, eight bird and three mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 9 and presented in Figure 4. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 9. Conservation significant species at Gnow's Nest.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (1 old inactive mound)	Potential visitor	Suitable habitat exists in dense valley areas
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes - 8 quadrats, 30 burrows (Density: 375 burrows/ha); opportunistic survey 4 burrows; lumen diameter 5-19 mm.	Resident	Spiders present in both VSA types (lower slopes and hills)
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	No suitable habitat
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists in rocky areas
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Unlikely	No suitable habitat
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

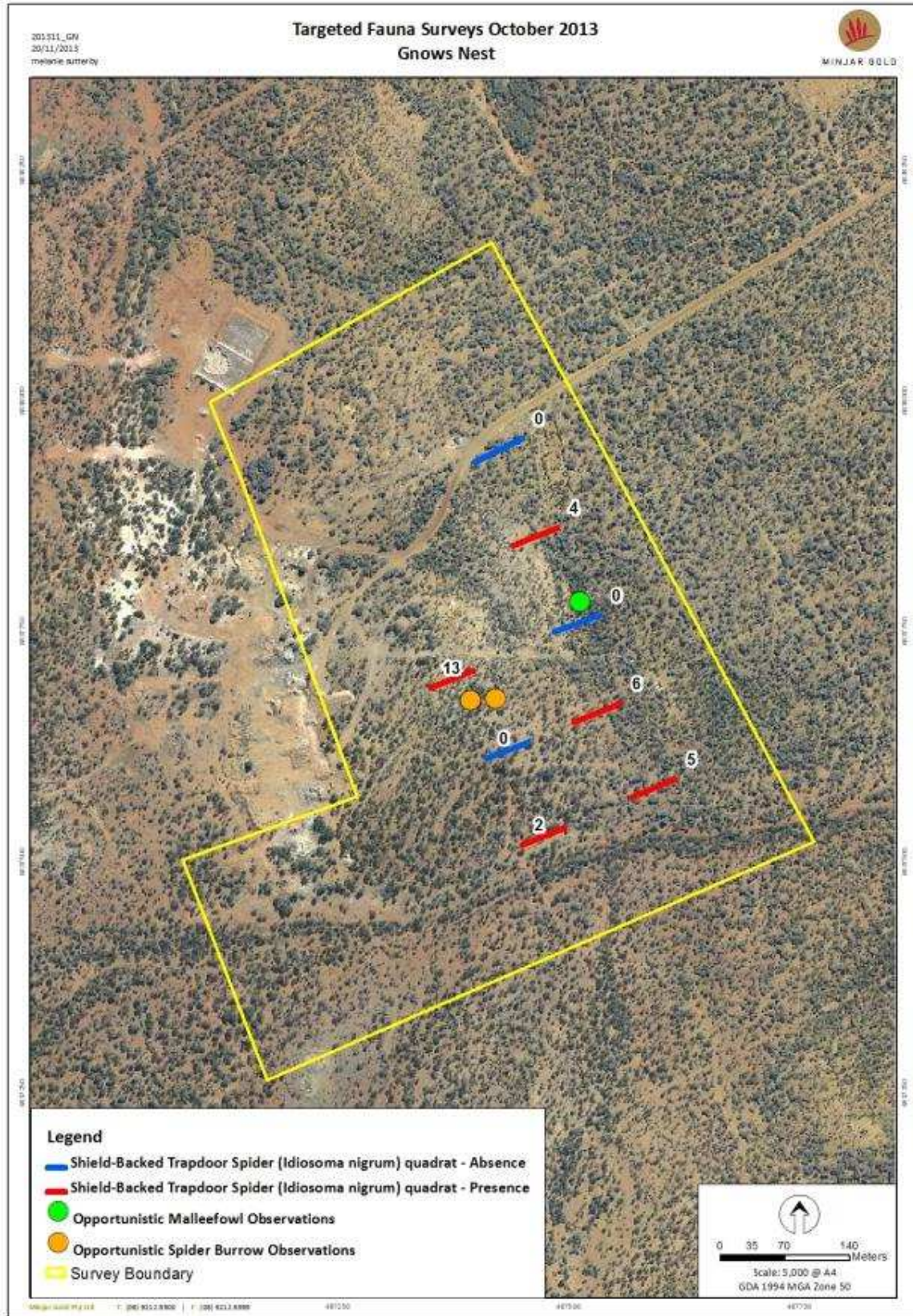


Figure 4. Location of spider quadrats and conservation significant species recorded at Gnow's Nest.

4.4.3 Discussion

VSAs and conservation significant species

The Gnow's Nest project area consists of open acacia shrubland over gravel and rock with loam on lower slopes and low hills. The VSA type is regionally widespread and well-represented outside the project area in the greater Minjar and Karara region. Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider and Malleefowl (both recorded during the survey). Spider burrows were recorded in each VSA type (Figure 4), including areas of dense vegetation and open rocky areas with sparse vegetation. No suitable habitat (e.g. Eucalypt woodland) is present for the Western Spiny-tailed Skink or Major Mitchell's Cockatoo and therefore these species are unlikely to occur. The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists on the rocky substrate located in the centre of the site. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.5 Allegro

4.5.1 Site description

The Allegro project area is located in the central extent of the Minjar tenements approximately 22km south east of Gnow's Nest and 3km north west of the Minjar Camp (Figure 1). The project area is small (24ha) and consists of mixed acacia shrubland surrounding a small low BIF ridge (approximately 200m x 100m) (Figure 5).

Three main VSAs were identified:

1. Open medium acacia shrubland and mulga over gravel loam on lower slopes to flats (Plate 5);
2. Open medium acacia shrubland and mulga over rock, cobble and gravel loam on mid slopes (Plate 6); and
3. Open medium acacia shrubland and mulga over rock outcrops, cobble and gravel loam on upper slopes of a low BIF ridge (Plate 7).



Plate 5. Open medium acacia shrubland and mulga over gravel loam on lower slopes to flats.



Plate 6. Open medium acacia shrubland and mulga over rock, cobble and gravel loam on mid slopes.



Plate 7. Open medium acacia shrubland and mulga over rock outcrops, cobble and gravel loam on upper slopes

4.5.2 *Fauna assemblage*

Fifteen vertebrate fauna species were opportunistically recorded during the transect searches including one reptile, ten bird and four mammal species (Appendix 5). Varanid and echidna diggings were recorded throughout the site and two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 10 and presented in Figure 5. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 10. Conservation significant species at Allegro.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (3 old inactive mounds)	Potential visitor	Suitable habitat present, especially dense acacia shrubland near BIF ridge
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes – 10 quadrats, 10 burrows (Density: 100 burrows/ha); opportunistic survey 8 burrows; lumen diameter 4-19 mm.	Resident	Present, but in low densities
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	No suitable habitat
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists in small BIF ridge
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Unlikely	No suitable habitat
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

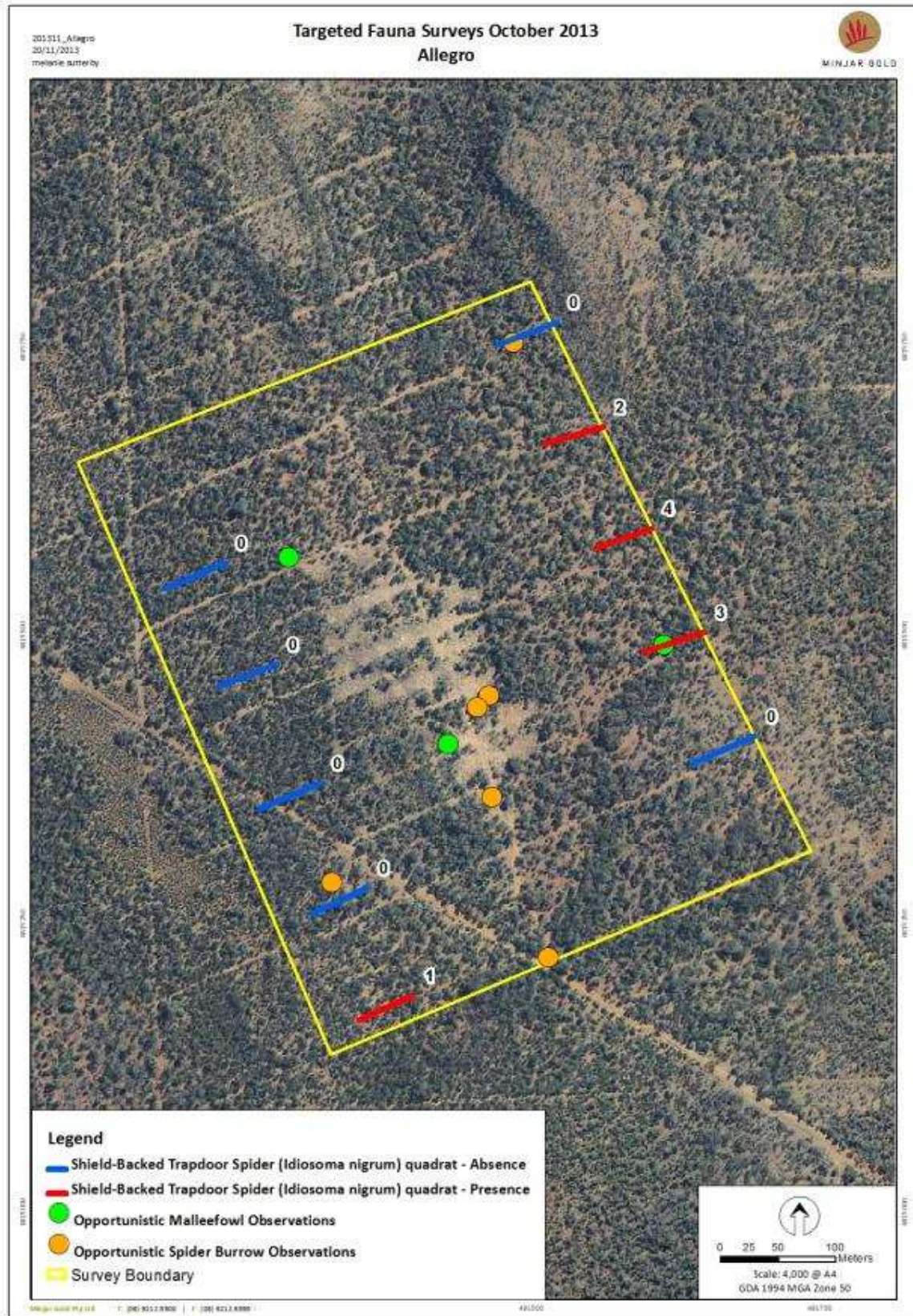


Figure 5. Location of spider quadrats and conservation significant species recorded at Allegro.

4.5.3 Discussion

VSAs and conservation significant species

The Allegro project area consists of open acacia shrubland with dense vegetation and gravel loam occurring on the lower slopes and rock outcropping on the upper slopes of the low hill. These VSA types are regionally widespread and well-represented outside the survey area in the greater Minjar and Karara region.

Conservation significant fauna associated with these VSA types include the Shield-backed Trapdoor Spider and Malleefowl (both recorded during the survey), although only a small area of habitat is available for the latter on the surrounding lower slopes. Spiders were recorded in low densities on the gravelly lower slopes where denser vegetation and leaf litter occurs. No suitable habitat (e.g. Eucalypt woodland) is present for the Western Spiny-tailed Skink or Major Mitchell's Cockatoo and therefore these species are unlikely to occur. The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists within the BIF ridge located in the centre of the site. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.6 Goblin

4.6.1 Site description

The Goblin project area is located in the central extent of the Minjar tenements, approximately 4km north east of Tickford (Figure 1). A prominent BIF ridge traverses the entire project area from north to south and covers an area of 57ha (Figure 6). The exposed rock ridge supports a low acacia shrubland of varying densities where soil is available. Steep upper slopes are characterised by loose scree, cobble and rocks with vegetation becoming denser down slope and increasing with loam and sand at the foothills.

Two main VSAs were identified:

1. Open to dense medium acacia shrubland with low myrtaceous shrubs over gravelly loam and cobble on lower slopes of a BIF ridge (Plate 8); and
2. Open low to medium mixed acacia shrubland with scattered low myrtaceous shrubs over boulders, rocks, and cobble on mid to upper slopes of a BIF ridge (Plate 9).



Plate 8. Open to dense medium acacia shrubland with low myrtaceous shrubs over gravelly loam and cobble on lower slopes of a BIF ridge.



Plate 9. Open low to medium mixed acacia shrubland with scattered low myrtaceous shrubs over boulders, rocks, and cobble on mid to upper slopes of a BIF ridge.

4.6.2 Fauna assemblage

Fourteen vertebrate fauna species were opportunistically recorded during the transect searches including three reptile, seven bird and four mammal species (Appendix 5). Varanid and echidna diggings were recorded throughout the site and two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 11 and presented in Figure 6. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 11. Conservation significant species at Goblin.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	No	Potential visitor to lower slopes	Project area dominated by BIF ridge except surrounding shrublands
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes – 10 quadrats, 23 burrows (Density:230 burrows/ha); opportunistic survey 10 burrows; lumen diameter 4-19 mm.	Resident	Recorded on the lower to mid slopes of the ridge
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	No suitable habitat
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists on BIF ridge
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Unlikely	No suitable habitat
Woolley's Pseudantechinus (<i>Pseudantechinus woolleyae</i>)	(CS3)	Crevice on BIF ridges	Karara, Mungada, Shine*	Yes	Resident	Scats recorded on the eastern mid slopes of the BIF ridge
SRE invertebrates (<i>Antichiropus spp.</i>)		Ironstone ridges and slopes	Karara, Mungada	No	Potential resident	Possible habitat exists on BIF ridge

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

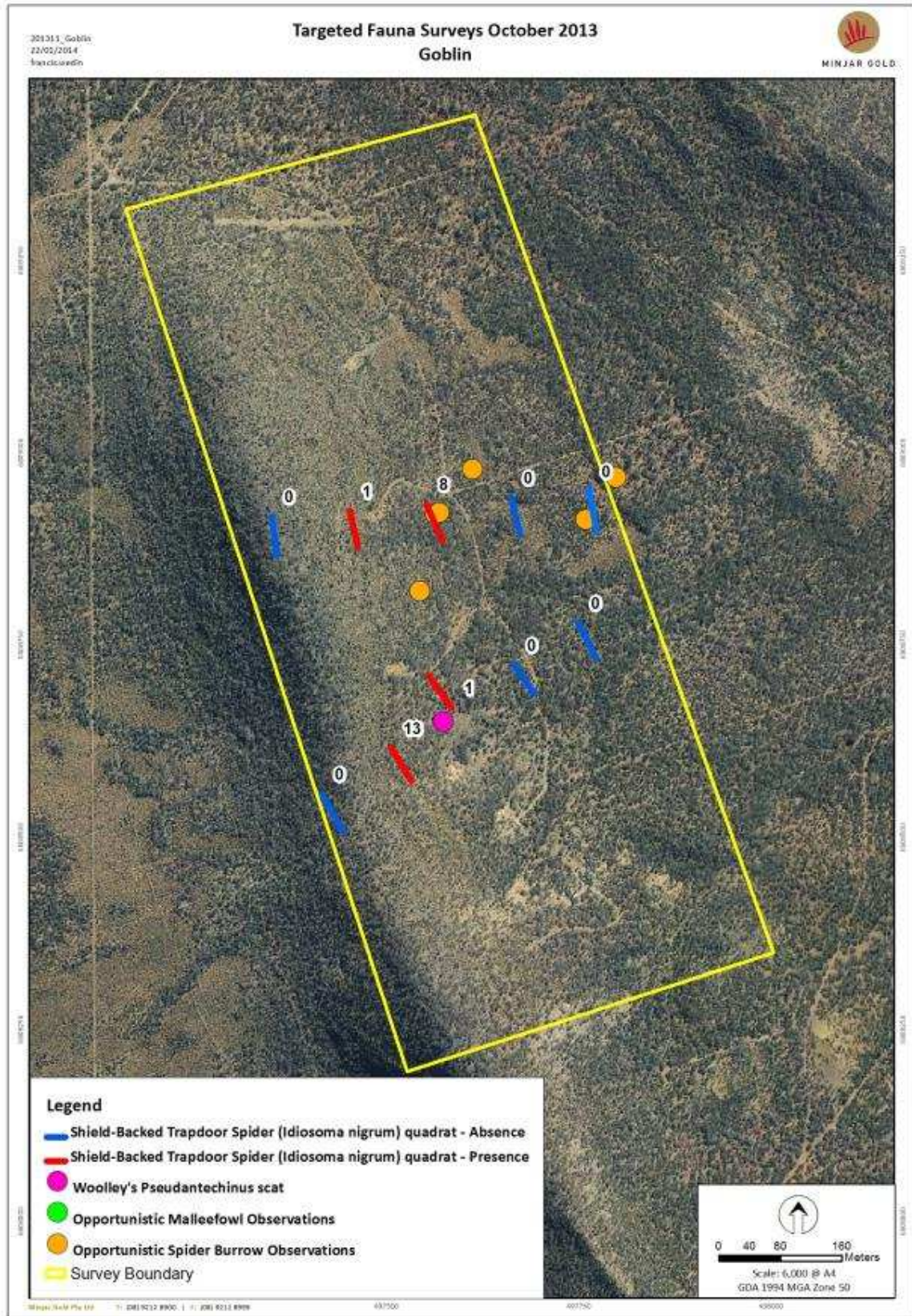


Figure 6. Location of spider quadrats and conservation significant species recorded at Goblin.

4.6.3 Discussion

VSAs and conservation significant species

The Goblin project area consists of a prominent BIF ridge surrounded with acacia shrubland at different densities and strata. Whilst acacia shrublands on lower slopes are regionally widespread and well-represented outside the project area in the greater Minjar and Karara region, large BIF ridges are less common and regionally restricted. Furthermore, many BIF ridges in the region are earmarked for mining development and are likely to increase in importance in terms of biodiversity conservation. As a result, the Goblin project area is of higher importance compared to other sites.

Conservation significant fauna associated with the lower slopes include the Shield-backed Trapdoor Spider (recorded during the survey) and potentially Malleefowl, although only a small area of habitat is available for the latter. Spiders were recorded along the eastern side of the BIF ridge, where denser vegetation, leaf litter and suitable substrate occurs. No spider burrows were recorded on the upper slopes or top of the BIF ridge. No suitable habitat (e.g. Eucalypt woodland) is present for the Western Spiny-tailed Skink or Major Mitchell's Cockatoo and therefore these species are unlikely to occur.

The Gilled Slender Blue-tongue was not recorded although suitable habitat for this species exists on the BIF ridge. This species has been recorded by BCE on the Karara and Mungada ridges. Other records (two further specimens, M. Bamford unpub. data) are all from rocky habitat, suggesting that the species may be restricted to such environments. Wilson and Swan (2008), however, suggest that it occurs on heavy red soils. The Gilled Slender Blue-tongue has a restricted distribution which may be disjunct due to the pattern of habitat availability. The Woolley's Pseudantechinus was confirmed (through a number of scats) in the rock crevices on the eastern side of the BIF ridge and may be restricted to the BIF ridge. This species has also been recorded on BIF ridges at Karara, Mungada and Shine. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.7 Tickford and Tickford Haul Road

4.7.1 Site description

The Tickford project area (including the main lease area and haul road) is located in the central extent of the Minjar tenements, approximately 3km south west of Goblin and 2km north of South Windinne (Figure 1). The projects area is 33ha and consists of a low BIF hill (aligned north to south) with a short haul road (approximately 400m long). The proposed haul road passes through tall acacia shrubland in a westerly direction towards the lease area, with soils ranging from gravelly loam on the flats increasing with cobble and rock at height (Figure 7).

Two main VSAs were identified:

1. Open tall acacia shrubland (*Acacia grasbyi*) with low myrtaceous shrubs over gravel loam on flats to lower slopes (Plate 10); and
2. Open low to medium acacia shrubland over gravelly loam, cobble and areas of exposed rock on mid to upper slopes (Plate 11).



Plate 10. Open tall acacia shrubland with low myrtaceous shrubs over gravel loam on flats to lower slopes.



Plate 11. Open low to medium acacia shrubland over gravelly loam, cobble and areas of exposed rock on mid to upper slopes.

4.7.2 Fauna assemblage

Ten vertebrate fauna species were opportunistically recorded during the transect searches including one reptile, five bird and four mammal species (Appendix 5). Varanid and echidna diggings were recorded throughout the site and two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 12 and presented in Figure 7. Information on Malleefowl is provided in Appendix 7. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 12. Conservation significant species at Tickford.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (3 old inactive mounds and track); mounds were aged from moderately old (5-20 years) to very old (100+ years)	Visitor	Possible habitat exists
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes – 11 quadrats, 26 burrows (Density: 236 burrows/ha); opportunistic survey 31 burrows; lumen diameter 5- 20 mm.	Resident	Recorded on the lower slopes of a rocky hill; no spider burrow were recorded on the haul road.
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	No suitable habitat
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists on low rocky hill
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Unlikely	No suitable habitat
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Potential resident	Possible habitat exists on low rocky hill

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

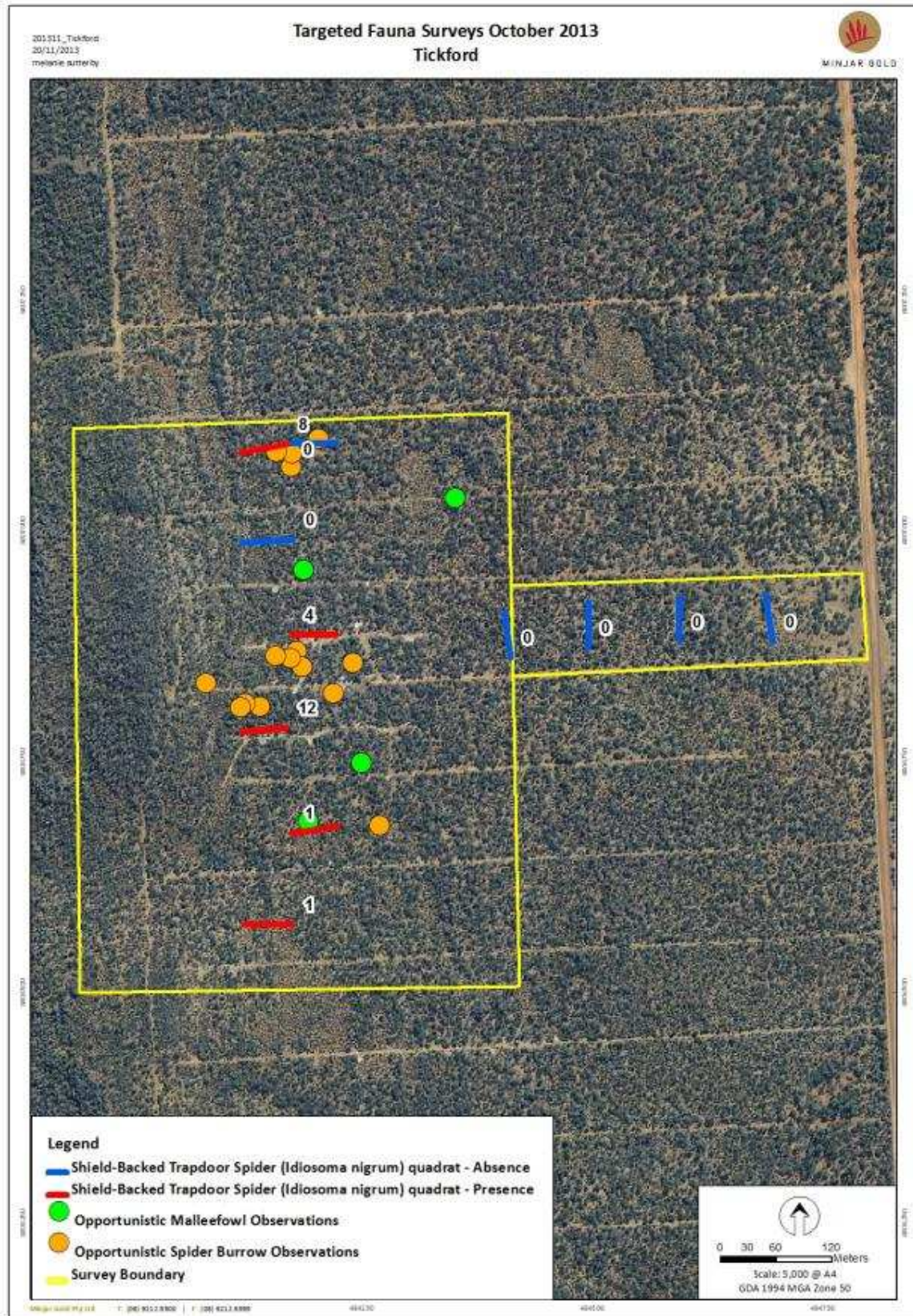


Figure 7. Location of spider quadrats and conservation significant species recorded at Tickford.

4.7.3 Discussion

VSA's and conservation significant species

The Tickford project area consists of tall open acacia shrubland over gravelly loam on flats and low to medium acacia shrubland with increasing rock on mid to upper slopes of a low hill. Both VSA types are regionally widespread and well-represented outside the project area in the greater Minjar and Karara region. Conservation significant fauna associated with these VSA types include the Shield-backed Trapdoor Spider and Malleefowl (both recorded during the survey). Spiders were recorded along the ridge of the low BIF hill in dense vegetation and gravelly loam soils. Burrow densities at Tickford (230 burrows/ha) were similar to those recorded at Shine (270 burrows/ha), located approximately 1km north (Bamford, 2012). Vegetation densities across the site are suitable for Malleefowl, however soils are likely to be too clayey in the eastern part of the haul road. A single Malleefowl track was recorded indicating that this species does move through the project area. Although no active Malleefowl mounds were recorded, an active mound was recorded at Shine, located approximately 1.5km north of the Tickford project area (Bamford, 2012), with home ranges extending up to 4.6 km² (Marchant and Higgins, 1993).

No suitable habitat (e.g. Eucalypt woodland) is present for the Western Spiny-tailed Skink or Major Mitchell's Cockatoo and therefore these species are unlikely to occur. Scats from the Western Spiny-tailed Skink have been recorded in eucalypt woodland approximately 0.5km west of the project area (Bamford, 2012). The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists on the low BIF hill. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.8 South Windinne and South Windinne Haul Road

4.8.1 Site description

The South Windinne project area (including the main lease area and haul road) is located in the central extent of the Minjar tenements, approximately 2km south of Tickford (Figure 1).

The projects area consists of a low rocky ridge (aligned north to south) and a short haul road (approximately 800m long). The proposed haul road passes through medium acacia shrubland in a westerly direction towards the lease area, with soils ranging from gravelly loam on the flats increasing with cobble and exposed rock at the ridge (Figure 8).

Two main VSAs were identified:

1. Open medium acacia shrubland with low mixed myrtaceous shrubs over gravel and loam on lower slopes (Plate 12); and
2. Open medium acacia shrubland with low mixed myrtaceous shrubs over rock, cobble and gravel loam on mid to upper slopes (Plate 13).



Plate 12. Open medium acacia shrubland with low mixed myrtaceous shrubs over gravel and loam on lower slopes.



Plate 13. Open medium acacia shrubland with low mixed myrtaceous shrubs over rock, cobble and gravel loam on mid to upper slopes.

4.8.2 Fauna assemblage

Thirteen vertebrate fauna species were opportunistically recorded during the transect searches including one reptile, eight bird and four mammal species (Appendix 5). Varanid and echidna diggings were recorded throughout the site and two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 13 and presented in Figure 8. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 13. Conservation significant species at South Windinne.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (3 old inactive mounds)	Likely visitor	Possible habitat exists
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes 15 quadrats, 22 burrows (Density: 146 burrows/ha); opportunistic survey 22 burrows; lumen diameter 5-20 mm.	Resident	Recorded on the lower slopes of a rocky hill
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	No suitable habitat
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists on BIF ridge
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Unlikely	No suitable habitat
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Potential resident	Possible habitat exists on BIF ridge

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

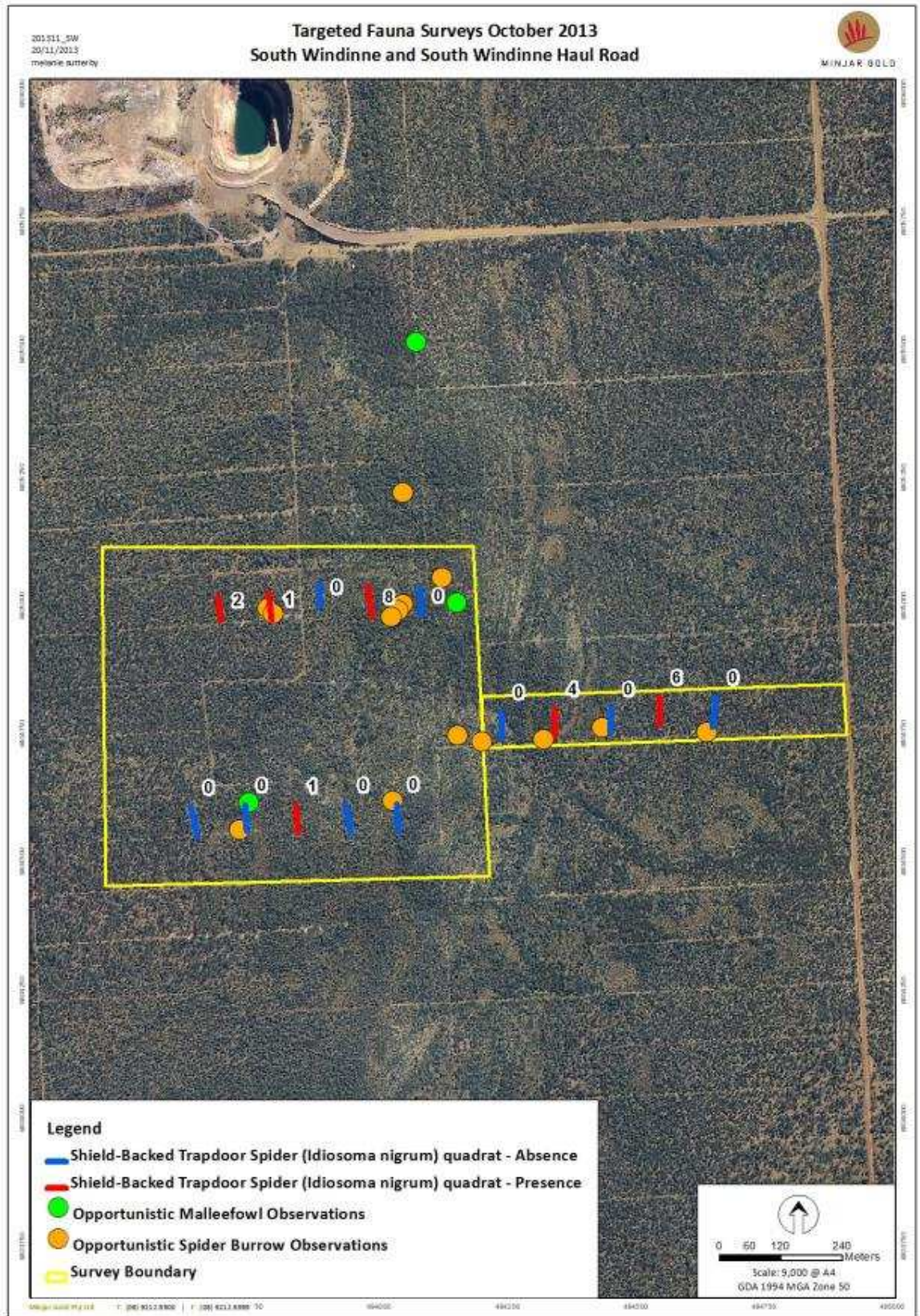


Figure 8. Location of spider quadrats and conservation significant species recorded at South Windinne.

4.8.3 Discussion

VSA types and conservation significant species

The South Windinne project area consists of open medium acacia shrubland over gravelly loam on flats and medium acacia shrubland with increasing rock on mid to upper slopes of a low ridge. Both VSA types are regionally widespread and well-represented outside the project area in the greater Minjar and Karara region.

Conservation significant fauna associated with these VSA types include the Shield-backed Trapdoor Spider and Malleefowl (both recorded during the survey). Spiders were recorded along the ridge in dense vegetation and gravelly loam soils. Burrow densities at South Windinne (146 burrows/ha) were lower than other sites such as Tickford and Shine, which recorded 230 and 270 burrows/ha respectively (Bamford, 2012). Vegetation densities across the site are suitable for Malleefowl, although no active mounds were recorded. No suitable habitat (e.g. Eucalypt woodland) is present for the Western Spiny-tailed Skink or Major Mitchell's Cockatoo and therefore these species are unlikely to occur. The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists on the low BIF ridge. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.9 South Island

4.9.1 Site description

The South Island project area is located in the central extent of the Minjar tenements, approximately 12km south of South Windinne (Figure 1). The project area is small (28ha) and consists of a small greenstone hill with open acacia shrubland and patches of eucalypt woodland in the north east and south west of the site (Figure 9). Vegetation across the site has been extensively degraded by goats.

Two main VSAs were identified:

1. Open medium acacia shrubland on gravel, cobble and rock with loam on lower slopes of a low hill (Plate 14); and
2. Open eucalypt woodland over medium acacia shrubland on gravel, cobble and loam on flats (Plate 15).



Plate 14. Open medium acacia shrubland on gravel, cobble and rock with loam on lower slopes of a low hill.



Plate 15. Open eucalypt woodland over medium acacia shrubland on gravel, cobble and loam on flats.

4.9.2 Fauna assemblage

Fourteen vertebrate fauna species were opportunistically recorded during the transect searches including 11 bird and three mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 14 and presented in Figure 9. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 14. Conservation significant species at South Island.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (1 very old inactive mound)	Potential visitor	Suitable habitat exists, although vegetation heavily grazed
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes – 5 quadrats, 19 burrows (Density: 380 burrows/ha); opportunistic survey 15 burrows; lumen diameter 4-18 mm.	Resident	Recorded on the slopes of a low hill
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	Some eucalypt woodland present but heavily degraded by goats
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Unlikely	Lack of suitable habitat
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Potential visitor	Lack of large eucalypt trees and hollows
SRE invertebrates (<i>Antichiropus spp.</i>)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).



Figure 9. Location of spider quadrats and conservation significant species recorded at South Island.

4.9.3 Discussion

VSA and conservation significant species

The South Island project area consists of open acacia shrubland over gravelly loam on low hills with patches of eucalypt woodland. Both VSA types are regionally widespread and well-represented outside the project area in the greater Minjar and Karara region.

Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider (recorded during the survey) and potentially Malleefowl. Spider burrows were recorded throughout the project area on the slopes of the low hill (Figure 9). An old inactive Malleefowl mound was recorded at the site and soils are suitable for mound construction, however vegetation is generally too open due to overgrazing from goats and therefore may be unsuitable for Malleefowl. Two old inactive Malleefowl mounds were also recorded around the northwest boundary of the project area by APM (2012). Some eucalypt woodland habitat is present for the Western Spiny-tailed Skink and Major Mitchell's Cockatoo, but lacks both understorey vegetation and large hollows for these species and therefore these species are unlikely to occur. The Gilled Slender Blue-tongue was not recorded during the survey and is unlikely to occur due to the lack of suitable habitat in the project area.

Overgrazing by goats has led to some habitat degradation in the eucalypt woodland and is likely to increase with further development in the area unless managed. Goats are attracted to the area by a permanent water source (an old historical mine pit) located to the north west of the site. Overgrazing depletes vegetation that may be a food source or habitat for other species such as the Western Spiny-tailed Skink or Malleefowl. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.10 Goatsville

4.10.1 Site description

The Goatsville project area is located in the southern extent of the Minjar tenements, approximately 20km south of South Island and 1km north of Allentown (Figure 1). The project area consists of a complex landscape of hills and valleys above a surrounding plain and covers an area of 42ha (Figure 10).

Three main VSAs were identified:

1. Open tall acacia shrubland and mixed low shrubs (*Eremophila* sp) over gravel loam on lower slopes of a low hill (Plate 16).
2. Open tall acacia shrubland and mixed low shrubs (*Eremophila* sp) over rock outcrops (greenstone and quartz), cobble and loam on lower slopes of a low hill (Plate 17); and
3. Open eucalypt woodland with sparse understorey over red loam (no plate available).



Plate 16. Open tall acacia shrubland and mixed low shrubs (*Eremophila* sp) over gravel loam on lower slopes of a low hill.



Plate 17. Open tall acacia shrubland and mixed low shrubs (*Eremophila* sp) over rock outcrops (greenstone and quartz), cobble and loam on lower slopes of a low hill.

4.10.2 Fauna assemblage

Seventeen vertebrate fauna species were opportunistically recorded during the transect searches including 14 bird and three mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 15 and presented in Figure 10. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 15. Conservation significant species at Goatsville.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	No	Potential visitor	Potential habitat exists
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	No.	Potential resident	Potential habitat exists
“Mt Mulgine Trapdoor Spider” (<i>Aganippe aff castellum</i>)	?CS3	Lower slopes	NA	Two burrows recorded at one location during opportunistic searches	Resident	
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Potential resident	Possible habitat exists in eucalypt woodland but lacks understorey
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists on rock outcrops
Major Mitchell’s Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Potential visitor	Possible habitat exists in eucalypt woodland, no hollows recorded
SRE invertebrates (<i>Antichiropus spp.</i>)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).



Figure 10. Location of spider quadrats and conservation significant species recorded at Goatsville.

4.10.3 Discussion

VSA and conservation significant species

The Goatsville project area consists of open tall acacia shrubland over gravel loam and rock on lower slopes of a low hill surrounded by red loam plains and isolated patches of eucalypt woodland. These VSA types are regionally widespread and well-represented outside the survey area in the greater Minjar and Karara region. Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider and Malleefowl, although only a small area of suitable habitat is available for the latter within the project area. No evidence of Malleefowl activity was recorded in the Goatsville project area, however the species may visit the area. In 2012, an active Malleefowl mound was recorded in the Blackdog tenement approximately 1.5km west of Goatsville (APM, 2012). The Shield-backed Trapdoor Spider was not recorded in the quadrats or project area, however two burrows of the "Mt Mulgine Spider" *Aganippe aff castellum* were found during opportunistic searches. This is an apparently undescribed species (see Section 4.17.2 for a brief discussion on this species).

Some eucalypt woodland habitat is present for the Western Spiny-tailed Skink and Major Mitchell's Cockatoo, but lacks both understorey vegetation and large hollows for these species and therefore are unlikely to occur. The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists on the greenstone and quartz rock outcrops. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.11 New Target 2

4.11.1 Site description

The New Target 2 project area (also referred to as New Target 20) is located in the southern extent of the Minjar tenements and covers an area of 46ha. The site is located approximately 0.7km east of Goatsville and 0.6km west of New Target 13 (Figure 1).

Three main VSAs were identified:

1. Open tall allocasurina and acacia shrubland over gravel and cobble on flat red loam (Plate 18);
2. Open tall melaleuca and low to medium acacia shrubland over rock, cobble and gravel loam on lower slopes (Plate 19); and
3. Open eucalypt woodland and medium acacia shrubland over gravel loam on lower slopes (no plate available).



Plate 18. Open tall allocasurina and acacia shrubland over gravel and cobble on flat red loam.



Plate 19. Open tall melaleuca and low to medium acacia shrubland over rock, cobble and gravel loam on lower slopes.

4.11.2 Fauna assemblage

Eight vertebrate fauna species were opportunistically recorded during the transect searches including one reptile, four bird and three mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 16 and presented in Figure 11. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 16. Conservation significant species at New Target 2.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (1 old inactive mound)	Potential visitor	Potential habitat exists in dense acacia shrubland
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	No	Potential resident	Potential habitat exists on lower slopes but species may be replaced in this area by the "Mt Mulgine Trapdoor Spider"
"Mt Mulgine Trapdoor Spider" (<i>Aganippe aff castellum</i>)	?CS3	Lower slopes	NA	Several burrows found	Resident	Appeared to be the common trapdoor spider in this area
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Potential resident	Potential habitat exists in eucalypt woodland but lacks understorey
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Potential habitat exists on rock outcrops
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Potential visitor	Potential habitat exists in eucalypt woodland, no hollows recorded
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

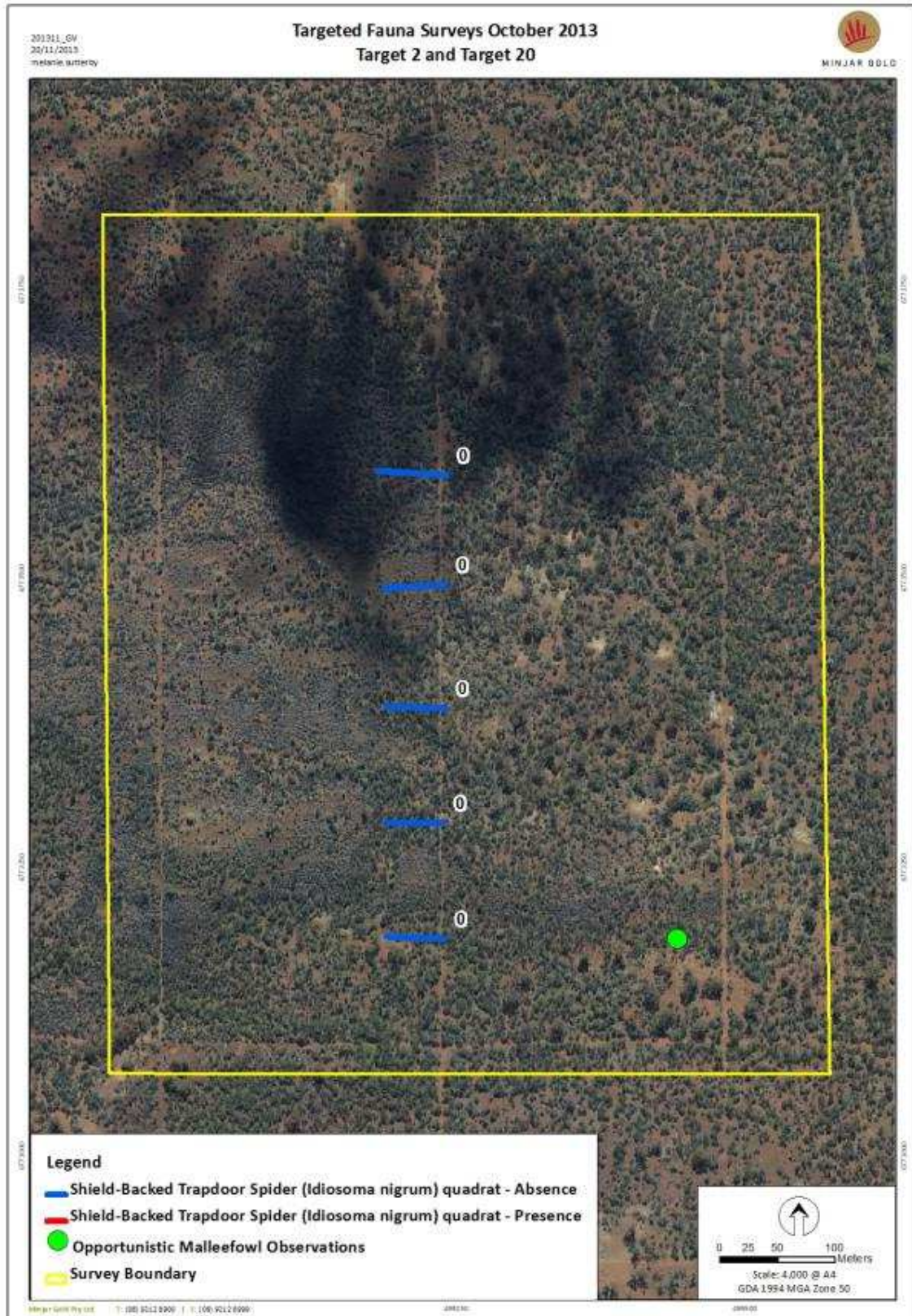


Figure 11. Location of spider quadrats and conservation significant species recorded at New Target 2.

4.11.3 Discussion

VSA and conservation significant species

The project area consists of open tall shrubland of allocasurina, acacia and melaleuca over gravel loam, cobble and rock on lower slopes and isolated patches of eucalypt woodland. These VSA types are regionally widespread and well-represented outside the survey area in the greater Minjar and Karara region.

Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider and potentially Malleefowl. An old inactive Malleefowl mound was recorded in the project area and suitable habitat (dense acacia shrubland) is present at the site. An active Malleefowl mound was recorded in 2012 at the Blackdog tenement approximately 3km west of the project area (APM, 2012). The Shield-backed Trapdoor Spider was not recorded in the project area, although suitable habitat is present. However, the "Mt Mulgine Trapdoor Spider" and another species of Trapdoor Spider, *Anidiops villosus*, were common. The latter is not of conservation significance, but the "Mt Mulgine Trapdoor Spider" may be undescribed and an SRE. Further discussion on this species is provided in Section 4.17.

Some eucalypt woodland habitat is present for the Western Spiny-tailed Skink and Major Mitchell's Cockatoo, but lacks both understorey vegetation and large hollows for these species and therefore are unlikely to occur. The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists in rocky areas. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.12 New Target 13

4.12.1 Site description

The New Target 13 project area (also referred to as New Target 6) is located in the southern extent of the Minjar tenements and covers an area of 49ha. The site is approximately 0.6km east of New Target 2 (Figure 1).

Three main VSAs were identified:

1. Open sparse allocasurina and medium to low acacia shrubland over cobble and gravel red loam flats on lower slopes (Plate 20);
2. Open allocasurina and medium acacia shrubland over rock, cobble and gravel with red loam on mid slopes (Plate 21); and
3. Open sparse allocasurina and low acacia shrubland over gravel, outcrop rock and boulders with red loam on upper and top of slope (Plate 22).

Scattered low eucalypts and exposed greenstone rock outcrops are also present throughout the project area.



Plate 20. Open sparse allocasurina and medium to low acacia shrubland over cobble and gravel red loam flats on lower slopes.



Plate 21. Open allocasurina and medium acacia shrubland over rock, cobble and gravel with red loam on mid slopes



Plate 22. Open sparse allocasurina and low acacia shrubland over gravel, outcrop rock and boulders with red loam on upper and top of slope

4.12.2 Fauna assemblage

Twenty vertebrate fauna species were opportunistically recorded during the transect searches including two reptile, 15 bird and three mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 17 and presented in Figure 12. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 17. Conservation significant species at New Target 13.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	No	Potential visitor	Potential habitat exists in acacia shrubland
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	No	Potential resident	Potential habitat exists on lower slopes
“Mt Mulgine Trapdoor Spider” (<i>Aganippe aff castellum</i>)	?CS3	Lower slopes	NA	Several burrows found	Resident	Appeared to be the common trapdoor spider in this area
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Potential resident	Possible habitat exists
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Potential resident	Possible habitat exists on rock outcrops
Major Mitchell’s Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Potential visitor	Possible habitat exists in eucalypt woodland, although no hollows recorded
SRE invertebrates (<i>Antichiropus spp.</i>)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).



Figure 12. Location of spider quadrats and conservation significant species recorded at New Target 13.

4.12.3 Discussion

The project area consists of open allocasuarina and acacia shrubland over gravel loam, and cobble on the flats and lower slopes, with increasing rock and low shrubland on the mid to upper slopes. These VSA types are regionally widespread and well-represented outside the survey area in the greater Minjar and Karara region. Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider and potentially Malleefowl. No Malleefowl mounds were recorded, although suitable habitat is present at the site. The Shield-backed Trapdoor Spider was not recorded in the project area, but could be present.

The Shield-backed Trapdoor Spider was not recorded in the project area, although suitable habitat is present. However, the "Mt Mulgine Trapdoor Spider" and another species of Trapdoor Spider, *Anidiops villosus*, were common. The latter is not of conservation significance, but the "Mt Mulgine Trapdoor Spider" may be undescribed and an SRE. Further discussion on this species is provided in Section 4.17.

Some eucalypt woodland habitat is present for the Western Spiny-tailed Skink and Major Mitchell's Cockatoo, but limited due to the lack of understorey and hollows. The Gilled Slender Blue-tongue was not recorded although some suitable habitat for this species exists in the rocky areas. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.13 Allentown

4.13.1 Site description

The Allentown project area is located in the southern extent of the Minjar tenements approximately 1km south of Goatsville and 1.5km south west of New Target 2 (Figure 1). The site has been previously disturbed by mining activities and covers an area of 59ha (Figure 13).

Three main VSAs were identified:

1. Open eucalypt woodland and medium acacia shrubland over gravel red loam (with occasional cobble and rock) on low to mid slopes (Plate 23);
2. Open tall acacia shrubland on rock, cobble and gravel red loam between low hill slopes (Plate 24); and
3. Open medium to low acacia shrubland over cobble, quartz and gravel red loam on low hill slopes (Plate 25).



Plate 23. Open eucalypt woodland and medium acacia shrubland over gravel red loam (with occasional cobble and rock) on low to mid slopes.



Plate 24. Open tall acacia shrubland on rock, cobble and gravel red loam between low hill slopes.



Plate 25. Open medium to low acacia shrubland over cobble, quartz and gravel red loam on low hill slopes.

4.13.2 Fauna assemblage

Twenty one vertebrate fauna species were opportunistically recorded during the transect searches including six reptile, 12 bird and three mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 18 and presented in Figure 13. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 18. Conservation significant species at Allentown.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	No	Potential visitor	Limited habitat available due to sparse vegetation
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes - 10 quadrats, 45 burrows (Density: 450 burrows/ha); opportunistic survey 5 burrows; lumen diameter 5-19 mm.	Resident	Recorded on gravelly lower slopes with dense vegetation. Spider burrows from the genera <i>Aganippe</i> sp. Were also recorded within the project area.
“Mt Mulgine Trapdoor Spider” (<i>Aganippe aff castellum</i>)	?CS3	Lower slopes	NA	Several burrows found	Resident	Appeared to occur slightly lower in the landscape and in heavier soil than the Shield- backed Trapdoor Spider
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Potential resident	Limited habitat available, few large eucalypts but sparse understorey
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Unlikely	Limited rocky habitat available
Major Mitchell’s Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Potential visitor	Possible habitat exists in eucalypt woodland, no hollows recorded
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

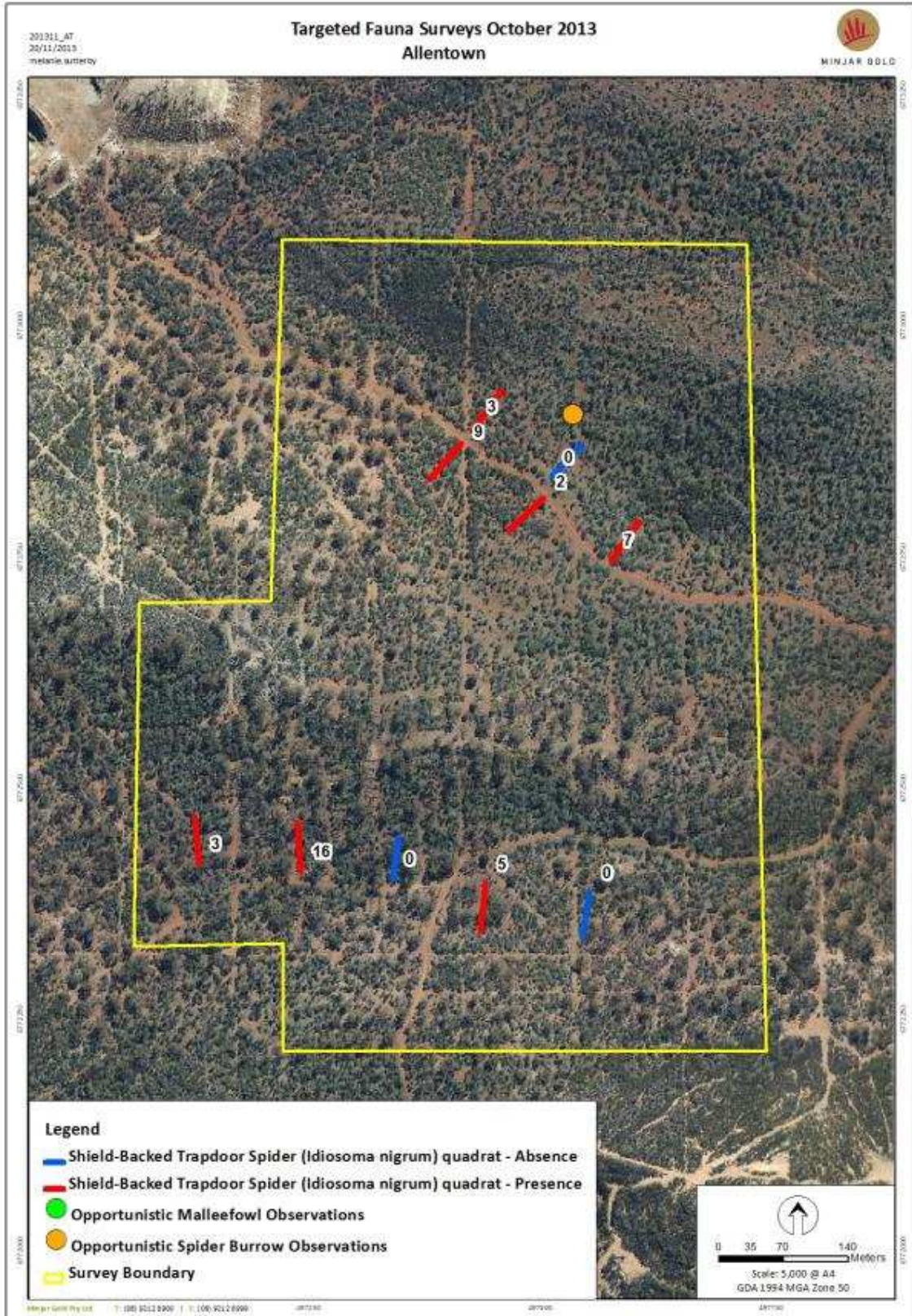


Figure 13. Location of spider quadrats and conservation significant species recorded at Allentown.

4.13.3 Discussion

VSA's and conservation significant species

The Allentown project area consists of patches of eucalypt woodland and open low to tall acacia shrubland with gravel loam and cobble on the lower slopes of low hills. These VSA types are regionally widespread and well-represented outside the survey area in the greater Minjar and Karara region.

Conservation significant fauna associated with these VSA types include the Shield-backed Trapdoor Spider (recorded during the survey) and potentially Malleefowl, although only a limited area of habitat is available for this species as the vegetation is mostly too sparse. An active mound was recorded in the Blackdog tenement in 2012 (50J 496318E, 6774108N), approximately 1.5km northwest of the Allentown project area (APM, 2012). Shield-backed Trapdoor Spider burrows were recorded in high densities on the gravelly lower slopes where denser vegetation and leaf litter occurs. The "Mt Mulgine Trapdoor Spider" was found on lower slopes and flats, notably near the Highland Chief mine. Some eucalypt woodland habitat is present for the Western Spiny-tailed Skink and Major Mitchell's Cockatoo, but limited due to the lack of understorey and hollows. The Gilled Slender Blue-tongue was not recorded and is unlikely to occur due to the lack of suitable habitat. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.14 New Target 5

4.14.1 Site description

The New Target 5 project area is located in the southern extent of the Minjar tenements, approximately 1km west of Wolf (Figure 1). The area consists of a several small low rocky hills supporting open acacia shrubland surrounded by patches of open eucalypt woodland on loam plains (Figure 14). The site is small (38ha) and the vegetation has been extensively grazed by goats.

Two main VSAs were identified:

1. Open medium acacia shrubland over rock, cobble and gravel loam on the slopes of a low hill (Plate 26); and
2. Open eucalypt woodland over sparse shrubland on gravel loam plains (no plate available).



Plate 26. Open medium acacia shrubland over rock, cobble and gravel loam on the slopes of a low hill.

4.14.2 Fauna assemblage

Fourteen vertebrate fauna species were opportunistically recorded during the transect searches including five bird and three mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 19 and presented in Figure 14. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 19. Conservation significant species at New Target 5.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (2 old inactive mounds)	Potential visitor	Suitable habitat exists, although vegetation heavily grazed
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes - 5 quadrats, 7 burrows (Density: 140 burrows/ha); opportunistic survey 14 burrows; lumen diameter 6-16 mm.	Resident	Recorded on the slopes of low rocky hills
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	Some eucalypt woodland present but heavily degraded by goats
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Unlikely	Small area of suitable rocky habitat
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Potential visitor	Some eucalypt woodland present, no hollows recorded
SRE invertebrates (<i>Antichiropus spp.</i>)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

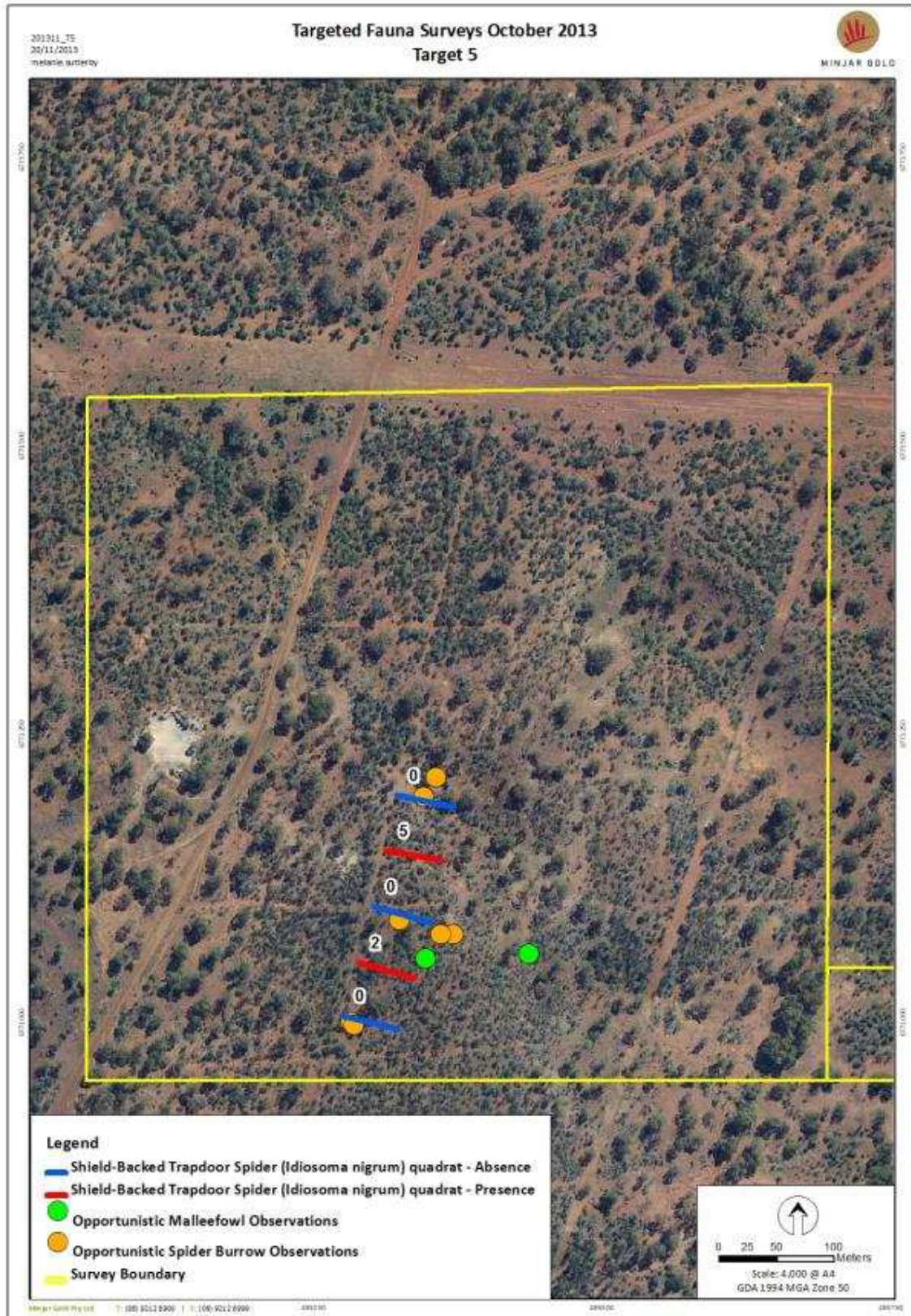


Figure 13. Location of spider quadrats and conservation significant species recorded at New Target 5.

4.14.3 Discussion

VSA's and conservation significant species

The New Target 5 project area consists of several small low rocky hills supporting open acacia shrubland surrounded by patches of open eucalypt woodland on loam plains. Both VSA types are regionally widespread and well-represented outside the project area in the greater Minjar and Karara region.

Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider (recorded during the survey) and potentially Malleefowl. Spider burrows were recorded on the slopes of the low rocky hill (Figure 14). Two old inactive Malleefowl mounds were recorded at the site and soils are suitable for mound construction, however the vegetation is generally too open and sparse, due to overgrazing from goats and therefore may be less suitable for Malleefowl.

Some eucalypt woodland habitat is present for the Western Spiny-tailed Skink and Major Mitchell's Cockatoo, but lacks both understorey vegetation and large hollows for these species and therefore are unlikely to occur. Several scats from the Western Spiny-tailed Skink was recorded in 2012 in the Camp prospect (50J 495673E, 6771946N), approximately 0.8km north of the project area, although further intensive trapping and motion sensitive cameras did not locate the skink (APM, 2012). The Gilled Slender Blue-tongue was not recorded during the survey and is unlikely to occur due to the small area of suitable rocky habitat in the project area.

Overgrazing by goats has led to some habitat degradation in the eucalypt woodland and is likely to increase with further development in the area unless managed. Goats are attracted to the area by a permanent water source (e.g. Highland Chief pit) located approximately 2.5km to the north east of the site. Overgrazing depletes vegetation that may be a food source or habitat for other species such as the Western Spiny-tailed Skink and Malleefowl. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.15 Wolf

4.15.1 Site description

The Wolf project area is located in the southern extent of the Minjar tenements, approximately 1km east of New Target 5 (Figure 1). The project area consists of various mixed tall shrublands over gravelly loam and rock substrates at various sizes and isolated patches of Eucalypt woodland on loam. The site covers an area of 73ha (Figure 15).

Four main VSAs were identified:

1. Open tall allocasuarina and medium acacia shrubland over rock, quartz and gravel loam on lower slopes (Plate 27);
2. Open tall acacia shrubland and sparse mixed shrubs over, cobble, quartz and rock with gravel loam on lower slopes (Plate 28);
3. Open medium melaleuca shrubland and low Myrtaceous shrubs over rock, quartz and gravel loam on lower slopes (no plate available); and
4. Open eucalypt woodland and acacia shrubland over gravel loam plains (no plate available).



Plate 27. Open tall allocasuarina and medium acacia shrubland over rock, quartz and gravel loam on lower slopes.



Plate 28. Open tall acacia shrubland and sparse mixed shrubs over, cobble, quartz and rock with gravel loam on lower slopes.

4.15.2 Fauna assemblage

Twenty six vertebrate fauna species were opportunistically recorded during the transect searches including three reptile, 18 bird and five mammal species (Appendix 5). Two introduced mammal species were present, the rabbit and goat. Note that number of fauna species recorded is low as the focus of the survey was to target conservation significant species. Species lists for all fauna recorded are presented in Appendix 5.

Targeted Fauna

Results of the field investigations are summarised in Table 20 and presented in Figure 15. A brief discussion on targeted conservation significant fauna species and VSAs is given below.

Table 20. Conservation significant species at Wolf.

Common name (Scientific name)	EPBC Act (WA Act)	Preferred habitat type	Recorded in the region	Recorded in the project area	Likely status in the project area	Comments
Malleefowl (<i>Leipoa ocellata</i>)	VU (S1)	Acacia shrublands	Karara, Mungada, Shine*	Yes (5 old inactive mounds and one recently used - within 5 years)	Potential visitor	Suitable shrubland habitat exists
Shield-backed Trapdoor Spider (<i>Idiosoma nigrum</i>)	(S1)	Ironstone ridges and slopes	Karara, Mungada, Shine*	Yes - 10 quadrats, 11 burrows (Density: 110 burrows/ha); opportunistic survey 4 burrows; lumen diameter 6-18 mm.	Resident	Recorded on the slopes of low hills
Western Spiny-tailed Skink (<i>Egernia stokesii badia</i>)	EN (EN)	Eucalypt woodland, with adjacent understorey	Karara, Mungada, Shine*	No	Unlikely	Some eucalypt woodland present but sparse understorey
Gilled Slender Blue-tongue (<i>Cyclodomorphus branchialis</i>)	(S1)	Acacia shrublands, BIF ridges	Karara, Mungada	No	Unlikely	Small area of suitable rocky habitat
Major Mitchell's Cockatoo (<i>Lophochroa leadbeateri</i>)	(S4)	Eucalypt woodland and drainage lines	Karara, Mungada	No	Potential visitor	Some eucalypt woodland present, no hollows recorded
Woolley's Pseudantechinus (<i>Pseudantechinus woolleyae</i>)	(CS3)	Crevice on BIF ridges	Karara, Mungada, Shine*	Yes	Resident	Scats recorded near the southern boundary of the project area
SRE invertebrates (<i>Antichiropus</i> spp.)		Ironstone ridges and slopes	Karara, Mungada	No	Probably not present	

*Note: Shine is a KML tenement located approximately 1km north of the Tickford project area (Figure 1).

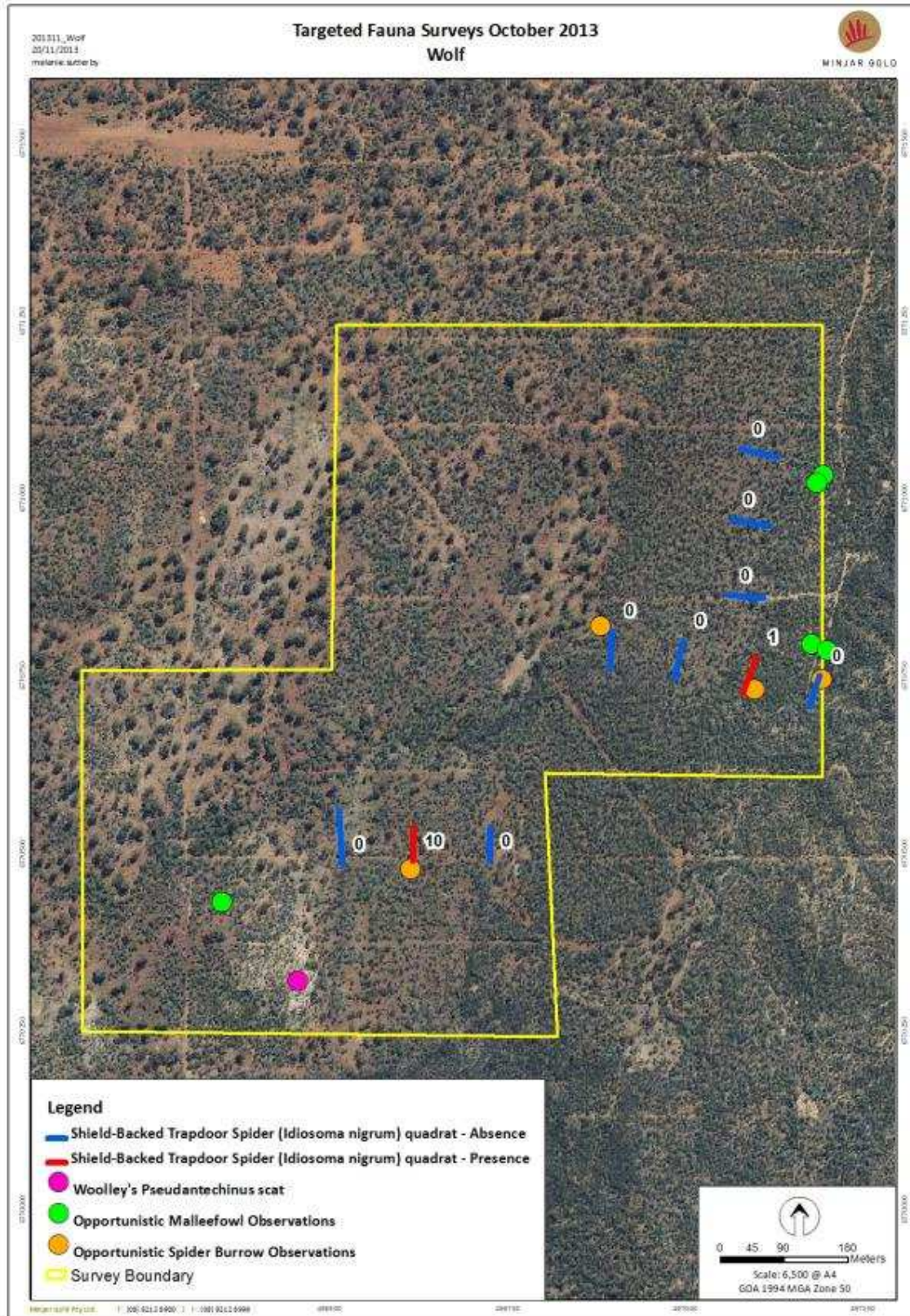


Figure 14. Location of spider quadrats and conservation significant species recorded at Wolf.

4.15.3 Discussion

VSA and conservation significant species

The Wolf project area consists of medium to tall open shrublands on gravelly loam to rocky lower slopes and open eucalypt woodland on loam plains. VSA types recorded from the survey are regionally widespread and well-represented outside the project area in the greater Minjar and Karara region.

Conservation significant fauna associated with this VSA type include the Shield-backed Trapdoor Spider (recorded during the survey) and potentially Malleefowl. Spider burrows were recorded in the shrubland on lower gravelly slopes (Figure 15). Five inactive Malleefowl mounds were recorded at the site, with vegetation and substrates highly suitable for mound construction. Some eucalypt woodland habitat is present for the Western Spiny-tailed Skink and Major Mitchell's Cockatoo, but lacks both understorey vegetation and large hollows for these species and therefore these species are unlikely to occur. The Gilled Slender Blue-tongue was not recorded during the survey and is unlikely to occur due to the small area of suitable rocky habitat in the project area. The Woolley's Pseudantechinus was confirmed (through a number of scats) in the rock crevices on the southern boundary and may be restricted to this area. This species was also recorded at the Goblin project area and other BIF ridges in the region such as Karara, Mungada and Shine. Further discussion of impacts and management recommendations are provided in Sections 5 and 6 respectively.

4.16 Fauna assessment of other survey sites

As discussed, a Level 1 Fauna Assessment and site inspection was conducted at 28 sites between 28th September and 3rd October 2013 (Table 2). These initial investigations were used to gather data on fauna assemblages, VSAs and habitat of the survey areas. Information was then used to prioritise areas for further targeted sampling. Of the 28 sites, 13 were selected for more detailed investigations in October 2013 and are discussed above in Sections 4.3 - 4.15. Results from the initial site investigations (other 15 sites) conducted in September 2013 and not re-surveyed in October 2013 are summarised in Table 21 below and include:

1. Paradise City;
2. New Target 15;
3. New Target 15 Haul Road;
4. Haul road from Goatsville to Allantown;
5. Haul road from New Target 13 to Target 2;
6. Haul Road from New Target 5 to Wolf;
7. Bugeye North;
8. Sprite;
9. New Target 26;
10. Fairey Well;
11. Sunbeam;
12. Keranne;
13. New Target 25;
14. Spacely; and
15. Beryl West.

Locations of these sites are provided in Figure 1 and Appendix 10. Species lists for all fauna recorded during these surveys are presented in Appendix 11.

Table 21. VSAs and conservation significant species for project areas surveyed in September 2013.

Survey Area (Size - ha)	VSA assessment	Conservation significant species			
		Malleefowl	Shield-backed Trapdoor Spider	Western Spiny-tailed Skink	Gilled Slender Blue- tongue
Paradise City (68ha)	Open medium to tall acacia shrubland (<i>Acacia aff quadrimarginea</i>) over rock, cobble and gravel loam on undulating low rocky hills and small drainage lines of loam soils.	Not recorded. Potential to occur, although vegetation very sparse.	Not recorded, but suitable soil and vegetation are present for this species.	Not recorded. Suitable habitat for this species is limited in the project area.	Not recorded. Species unlikely, although some small rocky areas are present in the project area.
New Target 15 (45ha)	Moderately dense medium to tall acacia shrubland with scattered eucalypts over gravel loam on low to upper slopes.	Not recorded. Suitable habitat (dense shrubland) is present in the project area.	Yes. 13 spider burrows in six locations (recorded in tall acacia shrubland with rock, cobble and gravel on upper slopes.	Not recorded. Suitable habitat for this species is limited in the project area.	Not recorded. Species unlikely, due to lack of suitable habitat.
New Target 15 Haul Road (14ha)	Open eucalypt woodland (<i>E.loxophleba</i>) with variable and patchy understorey over loam on flats, rising to closed medium to tall acacia shrubland over cobble and gravel loam on low hill to the east. Small drainage line present in the west.	Yes. Two inactive (old and very old) mounds recorded (Figure 16).	Not recorded. Suitable habitat for this species is limited in the project area.	Yes. Four colonies (two active and two inactive) recorded in fallen York Gum with shrubs around (Plate 29). Locations provided in Figure 16 and Appendix 8.	Not recorded. Species unlikely, although some small rocky areas are present in the project area.

Survey Area (Size - ha)	VSA assessment	Conservation significant species			
		Malleefowl	Shield-backed Trapdoor Spider	Western Spiny-tailed Skink	Gilled Slender Blue- tongue
Haul road from Goatsville to Allentown (9ha)	Haul road traverses a valley between two hills and across an undulating plain dissected by drainage lines. Tall acacia shrubland (<i>Acacia aff quadrimarginea</i>) and mixed low shrubs over gravel loam on hill slopes. On the plains, tall acacia shrubland with mostly medium density but occasionally forming thickets and areas of dense mixed shrubs on loam.	Not recorded. Suitable habitat (dense shrubland) is present in the project area.	Not recorded. Suitable habitat (dense shrubland) is present in the project area. The "Mt Mulgine Trapdoor Spider" was present at the southern end of the haul road and was also found in Goatsville.	Not recorded. Lack of suitable habitat for this species. Some eucalypts but surrounded by sparse understorey.	Not recorded. Species unlikely, although some small rocky areas are present in the project area.
Haul road from Target 13 to Target 2 (6ha)	Open tall acacia and melaleuca shrubland with scattered eucalypts over cobble and gravelly loam on flat to low slight rise, with some areas of exposed greenstone. Major drainage line passes through the haul road.	Not recorded. Suitable habitat (dense shrubland) is present in the project area.	Not recorded. Suitable habitat (dense shrubland) is present in the project area.	Not recorded. Lack of suitable habitat. Some eucalypts present but surrounded by sparse understorey.	Not recorded. Species unlikely, although some small rocky areas are present in the project area.
Haul Road from New Target 5 to Wolf (8ha)	Haul road passes through open eucalypt woodland (<i>E.salubris</i>) and mixed shrubs over loam plains with some bare areas and sparse understorey. Also traverses through medium-dense acacia shrubland over loam soil either side of a deeply incised drainage line. In the east the haul road rises onto a rocky ridge supporting mixed acacia shrubland.	Not recorded. Some suitable habitat in the project area.	Not recorded. Limited suitable habitat except on small rocky ridge.	Not recorded. Lack of suitable habitat. Some eucalypts present but surrounded by sparse understorey.	Not recorded. Species unlikely, although some small rocky areas are present in the project area.

Survey Area (Size - ha)	VSA assessment	Conservation significant species			
		Malleefowl	Shield-backed Trapdoor Spider	Western Spiny-tailed Skink	Gilled Slender Blue- tongue
Bugeye North (116ha)	Majority of the site consists of moderately dense tall acacia and casuarina shrubland (sometimes forming thickets), over gravelly red loam on low slopes. In the east, a low BIF ridge with low myrtaceous shrubs over shallow rocky loam. East of the ridge, low slopes support moderately-dense to closed, tall acacia shrubland on cobble and gravelly red loam, with isolated patches of open eucalypt woodland.	Not recorded. Suitable habitat (dense shrubland) is present in the project area.	Yes. Seven burrows recorded in three locations east of the BIF ridge.	Not recorded. Suitable habitat for this species is located in eucalypt woodland east of BIF ridge.	Not recorded. Species unlikely, although some small rocky areas are present in the project area (e.g. BIF ridge).
Sprite (79ha)	Medium dense acacia shrubland with scattered emergent, tall melaleuca on yellow-brown clayey-loam with scattered gravel and pisolite. In the north, soils are sandy with small, scattered Mallee over mixed low shrubland and slightly rising to the east.	Yes. Malleefowl feather. Suitable habitat (dense shrubland) is present in the project area.	Not recorded. Limited suitable habitat and unlikely to be present.	Not recorded. Limited suitable habitat and unlikely to be present.	Not recorded. Limited suitable habitat and unlikely to be present.
New Target 26 (also Valencia) (25ha)	Mid-dense to closed tall acacia shrubland on cobble and red loam plains. In the east, soils are sandier with sand pines and scattered large eucalypts.	Not recorded. Suitable habitat (dense shrubland) is present in the project area. Three old inactive Malleefowl Mounds were previously recorded outside the northern boundary (APM, 2012).	Not recorded. Most of the project area is unsuitable for this species. Burrows have been recorded just outside the northern boundary, where soils have more cobble and rock.	Not recorded. Some eucalypts present but surrounded by sparse and degraded understorey.	Not recorded. Limited suitable habitat and unlikely to be present.

Survey Area (Size - ha)	VSA assessment	Conservation significant species			
		Malleefowl	Shield-backed Trapdoor Spider	Western Spiny-tailed Skink	Gilled Slender Blue- tongue
Fairey Well (27ha)	Low to medium acacia shrubland (mostly medium density), with cobbles and loam on rocky slopes and exposed BIF on hill-tops. Two small, rocky hills with a drainage line between. Acacia thickets on loam in the drainage line.	Not recorded. Much of the site is too steep, although potential for mounds in dense shrubland. Two old inactive Malleefowl Mounds were previously recorded outside the south eastern boundary (APM, 2012).	Yes. Five burrows recorded in three locations on rocky slopes with acacia shrubland.	Not recorded. Some large eucalypts present but surrounded by sparse and degraded understorey.	Not recorded. Limited suitable habitat and unlikely to be present.
Sunbeam (88ha)	Broad, shallow valley with rock and quartz outcropping. Open tall acacia shrubland over cobble, gravel and loam. Some areas with “carpet” of small quartz rocks and scattered large eucalypts.	Yes. One very old inactive mound recorded. Vegetation is too sparse over site.	Yes. 10 burrows recorded in five locations in acacia shrubland. Burrows also recorded outside the project area.	Not recorded. Some large eucalypts present but surrounded by sparse and degraded understorey.	Not recorded. Suitable rocky habitat is present in the project area.
Keranne (54ha)	Open, scattered eucalypts and tall mixed acacia shrubland over loamy plains. The south west corner of the site comprises scattered eucalypts (<i>E. loxophleba</i>) with sparse low mixed shrubs on red-brown cracking clay.	Not recorded. Unlikely to be present due to lack of suitable habitat.	Not recorded. Unlikely to be present due to lack of suitable habitat.	Not recorded. Although suitable habitat for this species is located in the project area.	Not recorded. Unlikely to be present due to lack of suitable habitat.

Survey Area (Size - ha)	VSA assessment	Conservation significant species			
		Malleefowl	Shield-backed Trapdoor Spider	Western Spiny-tailed Skink	Gilled Slender Blue- tongue
New Target 25 (75ha)	Open medium low mixed shrubland on gravelly loam low rise. Closed eucalypt woodland with dense mixed shrubland on red-brown loam in drainage line. Open eucalypt woodland with low mixed shrubland on loamy plain.	Not recorded. Suitable habitat (dense shrubland) is present in the project area.	Yes. Four burrows recorded in one location.	Not recorded. Although suitable habitat for this species is located in the project area.	Not recorded. Unlikely to be present due to lack of suitable habitat.
Spacely (29ha)	Mostly tall, dense mixed acacia shrubland on gravelly loam with emergent eucalypts in drainage line and isolated throughout. Isolated pockets of low acacia and myrtaceous shrubland on loam. In the north, tall dense mixed melaleuca and acacia shrubland with scattered small eucalypts on a loam rise.	Not recorded. Suitable habitat (dense shrubland) is present in the project area.	Yes. One burrow recorded. Suitable habitat present.	Not recorded. Limited suitable habitat and unlikely to be present.	Not recorded. Unlikely to be present due to lack of suitable habitat.
Beryl West (183ha)	Sparse eucalypt woodland (<i>E. loxophleba</i>) with scattered mixed low shrubland on loamy plain. Open mixed shrubland on loam with cobbles and outcropping rock on low rise. Dense medium to tall eucalypt woodland (<i>E salubris</i>) on loam between two low ridges. Mixed shrubland with outcropping rock, cobble and loam on a low ridge.	Not recorded. Much of the vegetation over the project area is sparse and degraded.	Yes. Four burrows recorded in one location, although most of the project area is unsuitable for this species.	Not recorded. Some large eucalypts present but surrounded by sparse and degraded understorey.	Not recorded. Suitable rocky habitat is present in the project area.

In summary, key observations from the above assessment (Table 20) include:

- Evidence of Malleefowl recorded at New Target 15 Haul Road (two old inactive mounds), Sprite (feather) and Sunbeam (old inactive mound);
- Shield-backed Trapdoor Spider burrows recorded at New Target 15, Bugeye North, New Target 26 (Valencia), Fairey Well, Sunbeam, New Target 25, Spacely and Beryl West;
- The “Mt Mulgine Trapdoor Spider” found along the Goatsville to Allantown Haul Road.
- Evidence of the Western Spiny-tailed Skink recorded at New Target 15 Haul Road, including two active and two inactive colonies (Plates 29 and 30); and
- Woolley's Pseudantechinus (*Pseudantechinus woolleyae*) scats were recorded at Paradise and outside the northern boundary of the Sunbeam project area.



Plate 29. One of two active Western Spiny-tailed Skink (*Egernia stokesii*) colonies recorded at New Target 15 Haul Road (Two inactive colonies also recorded).



Plate 30. Western Spiny-tailed Skink scats recorded at New Target 15 Haul Road.



Plate 31. Western Spiny-tailed Skink. Latrine sites of this species were recorded at New Target 15 Haul Road.

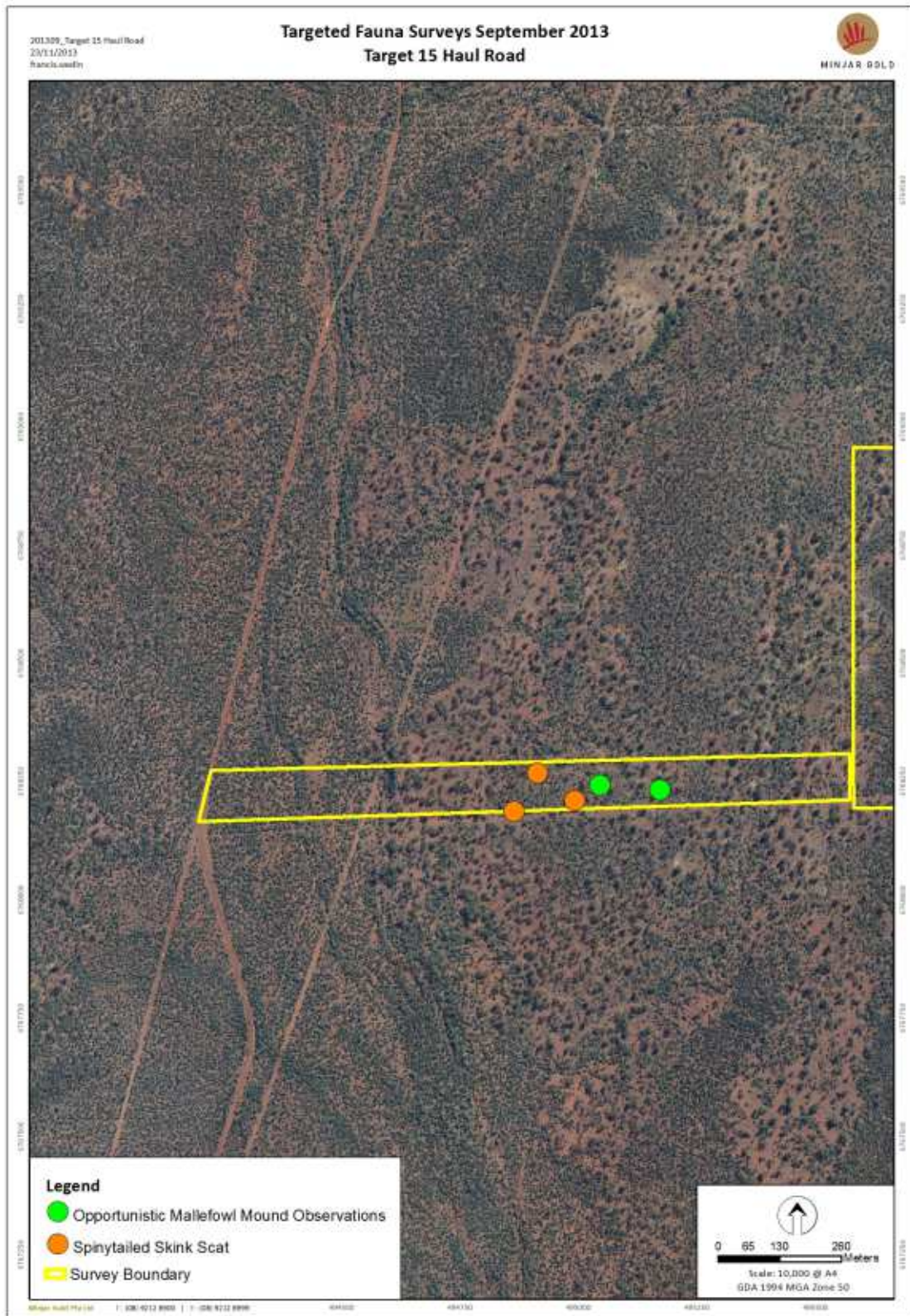


Figure 15. Locations of conservation significant fauna recorded at New Target 15 Haul Road.

4.17 Summary of conservation significant species

The following summarises observations regarding conservation significant fauna noted from the surveys (Table 22).

4.17.1 Malleefowl

Inactive Malleefowl mounds were located at 10 of the 28 sites, while suitable habitat for Malleefowl was recorded at 26 of the 28 sites (all except Keranne and Beryl West). A total of 22 old inactive mounds was recorded, with the highest number of mounds noted at Wolf (five old inactive mounds). The majority of mounds were located on slopes of mixed shrubland over gravelly loam soils. No active mounds were recorded during the surveys. The species has been recorded widely throughout Karara, Mungada and Shine area.

4.17.2 Shield-backed Trapdoor Spider and "Mt Mulgine Trapdoor Spider"

The Shield-backed Trapdoor Spider was recorded at 17 of the 28 sites surveyed (Table 22). Burrows were not found at New Target 2, 13, 26, Sprite, Keranne, Goatsville, Paradise City and haul roads: New Target 15, New Target 5 to Wolf, Goatsville to Allantown and New Target 13 to New Target 2. It was concluded that there was no suitable habitat for the species at New Target 2, 13, 26, Sprite and Keranne, and the haul roads New Target 15 and New Target 5 to Wolf.

One hundred and four separate quadrats were established over 13 different project sites, with a search area of 10,400m². A total of 247 Shield-backed Trapdoor Spider burrows was recorded during quadrat surveys, with an additional 180 recorded opportunistically. The maximum number of burrows found within a single quadrat (100m²) was 26 and 27, both with matriarchal clusters and both recorded at Monte Christo. The highest burrow densities were recorded at Monte Christo, Allentown and Gnow's Nest (886, 450 and 375 burrows/ha respectively). The lowest recorded densities were found at Allegro, Wolf and New Target 5 (100, 110 and 140 burrows/ha respectively). The Shield-backed Trapdoor Spider also occurs throughout Karara, Mungada and Shine at densities of 302, 296 and 270 burrows/ha respectively (Bamford, 2012). Thus, average spider densities at some of the project sites (e.g. Monte Christo, Allentown and Gnow's Nest) are noticeably high, although densities are not uniform across the preferred habitat type or project site. Overall, burrow densities at the Minjar sites were of a similar order of magnitude as found at KML sites. Quadrats with high numbers of burrows were often characterised by acacia shrubs with many burrows constructed from acacia phyllodes and sometimes allocasuarina and melaleuca leaves.

In studies undertaken around Karara for KML, the Shield-backed Trapdoor Spider has been identified by burrow architecture such as the decorations on the lid and the constriction of the burrow at a depth of a few centimetres, and also position in the landscape on hills and slopes in often rocky and/or gravelly loam. Where uncertainty existed, identification was confirmed by examining the spider with a milliscope inserted down the burrow. In the Minjar area, however, there appeared to be greater variation in burrow structure than around Karara, including having a tapered rather than constricted burrow, and with some animals living lower in the landscape than expected. This was also found further east in Ninghan Station, where studies undertaken for KML found confirmed Shield-backed Trapdoor Spiders with a tapering rather than constricted burrow

and living on loam flats. These observations suggest there may be genetic variation in the species from west to east.

While conducting surveys of the Shield-backed Trapdoor Spider in the Mt Mulgine area, burrows of two other trapdoor spiders were found. *Anidiops villosus* is a large, widespread species and the burrow architecture differs from that of Shield-backed Trapdoor Spider, but the second species had a burrow very similar in appearance to that of Shield-backed Trapdoor Spider. It was confirmed as a different species through examination via a milliscope (see cover photograph). Two specimens collected were identified as the Priority 4 (therefore CS2) Tree-stem Trapdoor Spider *Aganippe castellum* by Phoenix Environmental (2013), however, the burrow architecture was quite unlike that of the Tree-stem Trapdoor Spider (which has burrows that extend above ground level and attached to the stem of a shrub), so this is probably an undescribed species. In a genetic study of the Tree-stem Trapdoor Spider, Helix Molecular Solutions (2009) concluded that a single specimen from Yalardy Station (near Shark Bay) represents an undescribed species; the Mt Mulgine spiders may be allied to this Yalardy spider. The "Mt Mulgine Trapdoor Spider" may also have been found on Ninghan Station to the east of the Minjar area during studies undertaken for KML (BCE unpubl. records) but the identification was uncertain as only a juvenile was collected. Within the current Minjar study, this spider was found only at sites in the Mt Mulgine area, and usually occurred instead of the Shield-backed Trapdoor Spider. It tended to occur slightly lower in the landscape in heavier soils than the Shield-backed Trapdoor Spider, but at one location (Target 5) the two species were virtually living within metres of each other.

4.17.3 *Western Spiny-tailed Skink and Gilled Slender Blue-tongue*

The Western Spiny-tailed Skink was only recorded at the New Target 15 Haul Road, although suitable eucalypt woodland habitat exists for this species at several locations (Table 22). Four colonies (two active and two inactive) were recorded in fallen York Gum with surrounding shrubs. Scat sizes ranged from small to medium to very large with some very fresh, suggesting that animals are resident at two locations. The lack of observations in other areas is probably due to a large proportion of the York Gum (*Eucalyptus loxophleba*) woodlands surveyed being degraded and eroded from over grazing. 'Islands' of fallen logs, even with suitable hollows, are not suitable habitat for the skink when surrounded by degraded areas. The Western Spiny-tailed Skink has been recorded at Karara, Mungada and Shine. The Gilled Slender Blue-tongue was not recorded at any of the project areas, although may occur where rocky ridges are present (e.g. Goblin, Allegro and Monte Christo). This species has been recorded on rocky ridges at Karara and Mungada.

4.17.4 *Other conservation significant fauna*

- Woolley's Pseudantechinus. This species was recorded in rock crevices at Goblin, Wolf, Paradise and outside the northern boundary of the Sunbeam project area.
- Major Mitchell's Cockatoo. This species was not found during the surveys, but is regularly seen throughout the greater Karara region. Although suitable eucalypt woodland is present at some of the sites, no hollows were recorded.

- SRE invertebrates. Project areas with rocky mid to upper slopes have potential habitat for SRE invertebrates and include Goblin, Allegro and Monte Christo.
- No other conservation significant species (such as the South-west Carpet Python, Carnaby's Black-Cockatoo or Peregrine Falcon) were recorded during the surveys.

Based on the above, the most important project areas for conservation significant species are: Goblin (several species), Monte Christo, Allentown and Gnow's Nest (highest spider burrow densities) and New Target 15 Haul Road (presence of active Western Spiny-tailed Skink colonies).

Table 22. Summary of conservation significant species recorded at each project area.

(Yes) indicates habitat potentially suitable while Yes indicates species recorded.

Survey Area	Malleefowl (Evidence)	Shield-backed Trapdoor Spider	Spider burrow density (burrows/ha)	Western Spiny-tailed Skink	Gilled Slender Blue- tongue
October 2013*					
Monte Christo	Yes (1 very old inactive mound)	Yes	883	No	(Yes)
Gnow's Nest	Yes (1 old inactive mound)	Yes	375	No	(Yes)
Allegro	Yes (3 old inactive mounds)	Yes	100	No	(Yes)
Goblin	(Yes)	Yes	230	No	(Yes)
Tickford and Haul Road	Yes (3 old inactive mounds)	Yes	236	No	(Yes)
South Windinne and Haul Road	Yes (3 old inactive mounds)	Yes	146	No	(Yes)
South Island	Yes (1 very old inactive mound)	Yes	380	No	No
Goatsville	(Yes)	(Yes)	No	No	(Yes)
New Target 2 (also NT20)	Yes (1 old inactive mound)	No	No	(Yes)	(Yes)
New Target 13 (also NT6)	(Yes)	No	No	(Yes)	(Yes)
Allentown	(Yes)	Yes	450	(Yes)	No
New Target 5	Yes (2 old inactive mounds)	Yes	140	No	No
Wolf	Yes (5 old inactive mounds)	Yes	110	No	No
September 2013					
Paradise City	(Yes)	(Yes)	-	(Yes)	(Yes)
New Target 15	(Yes)	Yes	-	(Yes)	No
New Target 15 Haul Road	Yes (2 old inactive mounds)	No	-	Yes (2 active and 2 inactive colonies)	No
Haul road from Goatsville to Allantown	(Yes)	(Yes)	-	(Yes)	(Yes)

Survey Area	Malleefowl (Evidence)	Shield-backed Trapdoor Spider	Spider burrow density (burrows/ha)	Western Spiny-tailed Skink	Gilled Slender Blue-tongue
Haul road from New Target 13 to Target 2	(Yes)	(Yes)	-	No	No
Haul Road from New Target 5 to Wolf	(Yes)	No	-	No	No
Bugeye North	(Yes)	Yes	-	(Yes)	No
Sprite	Yes (Feather)	No	-	No	No
New Target 26	(Yes)	No	-	(Yes)	No
Fairey Well	(Yes)	Yes	-	(Yes)	No
Sunbeam	Yes	Yes	-	(Yes)	No
Keranne	No	No	-	(Yes)	No
New Target 25	(Yes)	Yes	-	(Yes)	No
Spacely	(Yes)	Yes	-	No	No
Beryl West	No	Yes	-	(Yes)	No

*Survey areas listed in October 2013 were also assessed during site investigations in September 2013.

4.18 Vegetation and substrate associations

Three main VSA types were recorded in the project areas (surveyed in October 2013). Their representation at each site and associated conservation significant fauna is discussed below.

1. **Hills** consisting of rocky banded ironstone ridges, supporting mixed shrublands on shallow rocky-loam soils.
 - a. Representation. Large ironstone ridge occurs at Goblin, with smaller ridges and hills at Goblin, Allegro, Monte Christo, South Windinne, Paradise City, Bugeye North and Fairey Well. This VSA type is widespread but small in extent in the region and many examples are targeted for mining development.
 - b. Conservation significant fauna. This VSA is likely to support a restricted fauna assemblage and habitat specialist species. Conservation significant species occurring within this habitat type include Malleefowl, Shield-backed Trapdoor Spider, Gilled Slender Blue-tongue and SRE invertebrates.
2. **Foothills and slopes** (lower to upper), supporting acacia shrubland (occasionally dense and tall) on gravelly-loam soils.
 - a. Representation. Located at Monte Christo, Gnow's Nest, Allegro, Goblin, Tickford, South Windinne, South Island, Goatsville, New Target 2, 5, 13, 15, 25 Allentown, Wolf, Bugeye North, Sprite, Fairey Well, Sunbeam, Spacely and Beryl West. Widespread throughout region but often small in extent, with many examples targeted for development.

- b. Conservation significant fauna. Dense vegetation or acacia thicket is usually present on the lower slopes of hills where water concentrates. Such areas are important for the Shield-backed Trapdoor Spider, Malleefowl, Gilled Slender Blue-tongue (in rocky areas) and SRE invertebrates. Dense vegetation in gullies often supports high densities of birds that have declined in the nearby Wheatbelt areas.
3. **Plains** with very little relief, supporting acacia shrubland at variable densities and/or well-developed eucalypt woodlands on loam soils.
 - a. Representation. Present at South Island, Goatsville, New Target 2, 5, 25, 26, Wolf, Keranne, Spacely and Beryl West. This VSA type is widespread and generally common in the region.
 - b. Conservation significant fauna. Supports a reduced number of conservation significant fauna, when compared to the surrounding ridges. However Malleefowl may “nest” in areas of dense vegetation on gravelly loam. The Western Spiny-tailed Skink and Major Mitchell’s Cockatoo are associated with areas of eucalypt woodland.

Habitats and VSAs of conservation significance tend to be those that are both rare across the landscape and that are important for significant species and/or for biodiversity. In particular, the rocky hills and associated slope VSAs are regionally restricted and are likely to become more significant for biodiversity conservation as the number of developments affecting this VSA type increases. It is therefore recommended that prior to obtaining approvals to develop the Minjar Gold Project, further work be undertaken to quantify the regional extent of this VSA type to and the likely impacts to this VSA due to this and other projects.

4.19 Patterns of biodiversity

Patterns of biodiversity can be interpreted from initial field observations and the characteristics of the VSAs described above, although intensive field investigations are required to provide detailed information.

Since 2004, BCE has conducted a number of investigations and assessments within the region (Section 3.2.2), which has resulted in a good understanding of the patterns of biodiversity across a heterogeneous landscape. Surveys conducted at the above project areas and at other sites, such as Karara, Mungada and Shine have found the following key patterns relevant to impact assessment:

- Rocky ridges support the Gilled Slender Blue-tongue and potential SRE invertebrates;
- Foothills and lower to upper slopes with acacia shrubland over gravelly loam soils are key habitat for Malleefowl and the Shield-backed Trapdoor Spider;
- Eucalypt woodlands are important for hollow-dependent species, including the Major Mitchells Cockatoo and Western Spiny-tailed Skink; and
- A suite of birds that has declined in the nearby Wheatbelt area is associated with dense thickets along gullies and lower slopes of ridges.

4.20 Ecological processes

The project areas are situated in several different VSA types and position in the landscape from flat loam plains to rocky ridges. The nature of the landscape and fauna assemblage indicates some of the ecological processes that may be important (Appendix 4). These include:

Local hydrology. Interruption of hydrological processes can have significant effects because they underpin primary production in ecosystems and there are specific, typically rare habitats that are hydrology-dependent. Drainage lines that radiate out from a ridge can be important for adjacent woodlands and dense acacia thickets that depend on runoff. Development of the large BIF ridge located at the Goblin project area may impact local hydrological flows and surrounding vegetation. Roads may alter both surface and sub-surface hydrology.

Fire. Fire is recognised as a factor in the dynamics of fauna populations in the south-west of Western Australia (Bamford and Roberts, 2003) and is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie, 1998). There are a number of areas with thick vegetation which would be particularly prone to fire, particularly in the mid to lower slope VSAs. In terms of conservation management, it is not fire per se but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity.

Feral predators and interactions with over-abundant native species. Feral predators are a major factor in the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1998), and there is growing evidence that over-abundant native species can adversely affect biodiversity (Harrington 2002). The increase in the abundance of Galahs and Corellas across the Wheatbelt may have contributed to declines of some other cockatoo species including Major Mitchells' Cockatoo (Saunders and Ingram, 1995). The fauna assemblage of the region has already been impacted by feral species (loss of a major component of the mammal fauna), and several feral species are present e.g. goats and rabbits (Appendix 5).

Feral Herbivores. Large populations of feral goats were recorded during the field surveys. Groups of up to 50 goats were regularly seen along the Minjar Haul Road south of the Minjar accommodation camp. Feral herbivores such as goats cause serious degradation to vegetation and soils in the area and can significantly impact fauna, such as the Western Spiny-tailed Skink which depends on low understorey shrubs next to old dead trees. The absence of this species from many of the project areas where Eucalypt woodland is present possibly results from habitat degradation due to grazing by sheep, goats and rabbits. The lack of recent Malleefowl breeding at all of the sites could similarly be due to grazing impacts from feral herbivores that compete with both adult and juvenile Malleefowl. Mining activity has the potential to alter the abundance of feral species and it was noted that feral goat numbers were particularly concentrated around artificial water sources at dams, bores and old mining pits. The control of goats should be an integral component and central to any fauna management in the area.

Habitat degradation due to weed invasion. The project areas currently have low levels of weed invasion. Exploration, construction and operation of these new areas, may increase the potential for weed invasion and lead to further habitat degradation, particularly with the movement of equipment and vehicles along roads. Project controls particularly hygiene measures should be implemented.

5 Impact assessment

5.1 Overview of Impacts

As outlined in section 1.3, Minjar Gold is investigating the development of new project areas located approximately 70km southeast of Yalgoo, Western Australia. A level 1 fauna assessment identified the fauna values of the area. The following sections examine possible impacts upon these fauna values based upon the impacting or threatening processes outlined in Appendix 2. Impacts are summarised in Tables 23 and 24. Impact criteria are outlined in Table 5. Recommendations relating to impacts are made in Section 6.

Note that the assessment of impacts has been combined for all project areas, as impacts on fauna are likely to be similar across the sites, depending on what VSA types are present at individual sites. Impacts on conservation significant fauna species are considered to be mostly negligible to minor, due to the relatively small footprint of most of the exploration areas and the presence of similar habitat elsewhere, with the exception of large rocky ridges such as those present at the Goblin site. The main processes affecting the fauna assemblage include: loss, fragmentation and degradation of habitat, ongoing mortality, species interactions, hydrological changes, altered fire regimes and disturbance (dust, light and noise).

5.1.1 *Loss of habitat leading to population decline*

The development of the proposed project areas would result in up to 1377ha of habitat loss. Areas such as South Island, Goatsville, New Target 2, 5, 25, 26, Wolf, Keranne, Spacely and Beryl West are of least concern due to the major VSA type (flat loam plains) being widespread in the region. These areas are also relatively small in size, ranging from 6 to 183 ha. Of more concern are areas such as Goblin, Allegro, Monte Christo, South Windinne, Paradise City, Bugeye North and Fairey Well due to the presence of rocky ridge habitat/VSA, and associated conservation significant fauna. Although some of these areas are small, they contain habitats which are usually restricted and targeted for mining development. These VSAs are expected to support a number of conservation significant species, species with restricted ranges, specialist species and potentially short-range endemic fauna. Some, such as invertebrates, may occur as more or less isolated populations on each hill and such isolated populations may be adversely affected if a substantial part of their available habitat is lost. The large BIF ridge located within the Goblin project area is of particular concern due to its size and potential to support conservation significant fauna.

It is therefore recommended that prior to obtaining approvals to develop the Minjar Gold Project, further work be undertaken to quantify the regional extent of the rocky ridge habitat VSA type, which includes BIF ridges, and to understand the likely impacts to this VSA.

To minimise loss of significant fauna species, impacts to the rocky ridges and slopes VSAs should be minimised where practical. Additionally, disturbances to breeding habitat of conservation significant species should be avoided. Numerous Malleefowl mounds have been located within the projects areas and efforts should be made to minimise disturbances to these, particularly those that are found to be recently active (within 5 years). In addition, eucalypt woodland is present in some of the project areas and may contain tree hollows and logs providing breeding habitat to the Major Mitchell's Cockatoo and Western Spiny-tailed Skink (recorded at New Target

15 Haul Road). Disturbances to tree hollows and large fallen logs should also be avoided (where practicable).

The project areas are situated in a highly heterogeneous landscape of rocky hills, gravelly slopes and flat loam plains, with fauna species expected to be much more widespread than the impact area. Overall impacts resulting from habitat loss are likely to be minor, even in the case of rocky ridge and slope VSAs, as considerable areas of this habitat type occur outside the proposed disturbance areas (e.g. Mungada).

5.1.2 Loss of habitat leading to population fragmentation

The project areas comprise a combination of habitats and movement of fauna almost certainly occurs within and across these different habitat types. Proposed lineal infrastructure such as haul roads are situated in VSAs that are regionally widespread e.g. eucalypt woodland or acacia shrubland and therefore are unlikely to significantly impact the movement of fauna. Two active colonies of the Western Spiny-tailed Skink and two old inactive Malleefowl mounds were recorded in the New Target 15 Haul Road. It is recommended that the proposed haul road route is realigned to avoid disturbance of these conservation significant species. Species dependent upon the rocky ridges and slopes VSAs already face barriers to movement as these VSAs are naturally localised, but it is not clear to what extent they rely on movement between habitat patches, or to what extent they might be affected by the loss of some of these habitat patches. Rocky hills could act as “stepping stones” for dispersal across the landscape, and thus the loss or alteration to these habitats is likely to contribute to a reduction in landscape permeability for these species. However it is difficult to predict the significance of this effect and the species are probably already adapted to fragmented landscapes. The cumulative reduction in size or loss of many of the rocky ridges in the region (from Wolf in the south to Monte Christo in the north) could lead to increased fragmentation of ridge-dependent fauna populations, and the impact could be Minor to Moderate. The impact is not considered greater than this because areas of similar habitat will be retained, development of some ridges will be incomplete and the species populations are already fragmented.

5.1.3 Degradation of habitat due to weed invasion

At the time of the surveys, the presence of weeds was very low, and therefore impacts from invasion are considered negligible. However, the clearing of vegetation and increase in traffic has the potential to introduce weed species which are not already present. The extent of this impact depends largely upon management and can be considered to be negligible or minor with adequate onsite environmental management procedures.

5.1.4 Ongoing mortality

Direct mortality of common species during clearing is unavoidable but can be minimised. In general, areas to be cleared are small within the context of the regional landscape so mortality during clearing is likely to represent only a small proportion of the regional population. The viability of species that occur at low population densities in areas adjacent to the survey area may be compromised by ongoing mortality. Cumulative impacts arising from ongoing mortality as a result of roadkill over the life of the project (including other companies operating in the area) may

have a significant impact on local Malleefowl populations. However, if managed properly, increased mortality will only occur for the life of the project, so can be considered temporary and therefore only a minor impact.

5.1.5 Species interactions

Feral species are a major concern in general but are a small component of the fauna of the survey area, although feral goats were recorded during the survey and occur throughout the region in large numbers.

Vegetation degradation by cattle, goats and rabbits is an increasing issue in the region and there is already some evidence of adverse impacts from over-grazing. Foxes and feral cats are likely to be attracted by current and future disturbance, possibly leading to increased local impacts on native fauna in disturbed areas. Inappropriate waste management may also attract foxes and feral cats, as well as native predators and scavengers, which may exacerbate localised impacts on other native fauna. Feral species can be managed through onsite management procedures and assuming such procedures are adopted, impacts are considered Minor.

5.1.6 Hydrological changes

Interruptions to hydrological processes can be a concern where disturbances are associated with drainage lines. Small drainage lines are present at Gnow's Nest, Paradise City, Fairy Well and the haul roads New Target 15, New Target 13 to New Target 2 and Goatsville to Allentown. It is unclear if there will be localised impacts from the development of these project areas, as no project description was available at the time of writing. However, given the small size of the project areas involved, impacts are likely to be minimal. Efforts must be made, where possible, to avoid changing the local hydrology of the area, however it is noted that the proportional impact of this development is likely to be negligible or minor as impacts can be managed.

5.1.7 Altered fire regimes

Development of the areas could affect fire regimes through increased human access, but as access is already available through much of the area, this risk is unlikely to be greatly increased. There may even be potential for the development to be used as an opportunity for improved fire management in the region. Impacts of altered fire regimes are therefore anticipated to be negligible.

5.1.8 Disturbance

There is likely to be some localised disturbance during the development of the project areas. Impacts of dust, light and noise upon fauna are difficult to predict, but experience from existing mines in the south-west (Worsley and Alcoa operations), and other operations in the Pilbara (BHP Billiton Nimingarra, Cattle Gorge, Sunrise Hill) suggests that fauna, including fauna of conservation significance, are very tolerant of these forms of disturbance, although they should be minimised where possible. An ongoing study on the impact of disturbance from mining upon the Shield-backed Trapdoor Spider (Bancroft and Bamford, 2012) has found no discernible effect. In general, impacts from disturbances are likely to be Negligible or Minor.

5.1.9 *Summary of impacts*

Impacts upon key fauna values (important VSAs and conservation significant fauna of interest) are summarised in Table 23. Impacts upon ecological processes are provided in Table 24. Only **negligible or minor** impacts to ecological processes are expected provided appropriate management strategies are enacted. Impacts upon fauna values are generally considered to be only **minor or minor to moderate**, even upon conservation significant species. This is due to the relatively small footprint of the project areas in the context of the greater region, which are generally located within widespread habitats. Individual project areas of greatest concern are Goblin (potential for several CS species), Monte Christo, Allentown and Gnow's Nest (high spider burrow densities) and New Target 15 Haul Road (active Western Spiny-tailed Skink colonies). A large BIF ridge is situated in the Goblin project area and is likely to support populations of conservation significant and potentially restricted fauna.

Table 23. Summary of potential impacts upon key fauna values, including conservation significant species that are expected to occur in the project areas.

Criteria for significance of impacts are outlined in Section 3.5.1.

Fauna value/species name	Nature and significance of likely impact		Action required
	Nature of impact	Significance	
Fauna assemblage	Loss of habitat (rocky ironstone ridges and slope VSAs).	Minor to Moderate.	Avoid disturbance to rocky ridges and slopes where possible.
VSAs	Restricted VSAs (rocky ridges) are targeted, combined with loss of adjacent ridges.	Minor to Moderate	Disturbances to rocky ridge and slope VSAs are to be minimised where practical.
Western Spiny-tailed Skink	Habitat loss, disturbances to breeding (removal of habitat trees and logs)	Minor. This species occurs in fragmented populations in the region and may occur in some project areas, however considerable habitat occurs outside the disturbance area.	Avoid impact in likely habitat (eucalypt woodland). Conduct surveys of areas with large eucalypts if such vegetation is in impact areas. Species can be found by presence of communal latrine. Translocation programs may be required if species is found to occur within disturbance area.
Gilled Slender Blue-tongue	Habitat loss, fragmentation and disturbance.	Minor to Moderate. This species appears to be restricted to the VSAs being targetted for mining, but suitable habitat will remain in the region.	Minimise loss of suitable habitat (rocky ridges).
Malleefowl	Loss of habitat, risk of increased mortality (roadkill) and predation. Loss of breeding sites (mounds).	Minor. Resident population of Malleefowl likely be impacted, however disturbance area is small and habitat is extensive in local area.	Design projects to minimise disturbance to species. Minimise habitat loss and avoid disturbance to Malleefowl mounds, in particular recently active mounds. Signage on roads near mounds to minimise roadkill. Conduct ongoing monitoring to determine impacts on local population.
Major Mitchell's Cockatoo	Loss of breeding habitat (tree hollows)	Negligible to Minor. Impacts to this species are likely to be minor as little eucalypt woodland is being impacted and it is widespread within the region.	Avoid disturbance to large, mature eucalypt trees. Minor loss of breeding habitat possible. Survey impact areas in suitable vegetation to locate nests and avoid nests where possible.
Shield-backed	Loss of habitat and	Minor to Moderate.	Design projects to minimise

Fauna value/species name	Nature and significance of likely impact		Action required
	Nature of impact	Significance	
Trapdoor Spider	disturbance	Resident populations of spiders likely be impacted, but spiders occur at high densities and thus large numbers will be retained on undeveloped hills and around the margins of impact sites.	disturbance to species and habitat. Avoid disturbance to rocky ironstone ridges and slopes, where practical. Minimise habitat loss.
SRE invertebrates	Loss of habitat and disturbance	Minor to Moderate. Resident populations likely be impacted, but populations will be retained on undeveloped hills and around the margins of impact sites.	Design projects to minimise habitat loss.

Table 24. Summary of potential impacts upon ecological processes.

Impacting process	Impact
Loss of habitat leading to population decline	Minor to Moderate. Some loss of restricted VSAs (e.g. ridges) can be expected, leading to localised population declines.
Loss of habitat leading to population fragmentation	Minor. Some fragmentation or disruption of movement is anticipated as the developments lie within both isolated and continuous habitats. Impacts not expected to be great as fauna probably already adapted to fragmented landscapes.
Degradation of habitat due to weed invasions	Negligible to Minor. Increased risk of weed invasion as there will be a higher degree of traffic in the area allowing a greater access of weeds into the area, but an impact that can be managed.
Ongoing mortality	Minor. An increase in traffic may result in more roadkill of significant species that occur in very low numbers in the area, particularly Malleefowl. Impacts can be managed with onsite procedures.
Species interactions (including feral or over-abundant native species)	Minor. Some potential for impact if populations of feral species increase, but this can be managed. Ironically, the impact of feral species upon the fauna assemblage has been considerable, with the result that further impacts are not likely to be of great significance. There is potential for feral fauna control as part of development to benefit native fauna.
Hydrological changes	Negligible to Minor. There may be some loss or alteration to vegetation and habitats as a result of hydrological changes; however impacts are likely to be localised and negligible if hydrological flows are managed.
Changes in fire regimes	Negligible. There should be little risk of a change in the fire regime, and there is the opportunity for improved fire management.
Disturbance (dust, light and noise)	Negligible. Some disturbance may result from the effects of dust, light and vibration, but are mostly unknown. Studies so far suggest fauna tolerant of these effects.

6 Recommendations

Fauna investigations conducted by BCE in the area since 2004 has shown habitats targeted for development support a diverse and rich fauna assemblage, including several conservation significant species. Surveys of in September and October 2013 recorded four conservation significant fauna species: the Malleefowl, Western Spiny-tailed Skink, Woolley's Pseudantechinus and Shield-backed Trapdoor Spider. Ironstone ridges and adjacent slopes were identified as especially important for conservation significant fauna. Fauna are likely to be impacted largely through loss of habitat, ongoing mortality from roadkill, species interactions and hydrological changes.

Section 5 (Impact Assessment) identified several potential adverse impacts that may occur from the development of the exploration areas. Management strategies are recommended below to reduce the potential impacts of the development on fauna species.

Loss of habitat

- Minimise vegetation clearing;
- Minimise the disturbance footprint;
- Maximise the use of existing tracks and degraded areas;
- Clearly delineate areas to be cleared;
- Progressively rehabilitate areas as soon as practical (e.g. exploration drill lines);
- Avoid disturbance to rocky ironstone ridge and slope VSAs where practical;
- Avoid disturbance to large, mature, hollow-bearing trees;
- Avoid disturbance to Malleefowl mounds; and
- Re-align the proposed New Target 15 Haul Road to avoid two active Western Spiny-tailed Skink colonies (Figure 16).

Habitat fragmentation

- Minimise large scale vegetation clearing;
- Consider road, bund and pipeline placement, which can affect fauna movement; and
- Retain areas of native vegetation that maintain linkages to adjacent vegetation.

Degradation of habitat due to weed invasions

- Develop, implement and monitor a weed management and hygiene plan, which maintains vehicle hygiene in uncontaminated areas.

Ongoing mortality

- Restrict vehicle access;
- Enforce minimum speed limits;
- Erect signage in areas of high wildlife activity (e.g. Malleefowl);
- Educate mine personnel with respect to fauna through the induction process;
- Record and report all fauna incidents to the KML environment department; and
- Develop and implement a fauna management plan.

Species interactions (including feral or over-abundant native species)

- Discourage the presence of feral species, particularly the feral Goat, Cat and Fox, by the use of appropriate waste management procedures and removing artificial water sources (where practical); and
- Develop and implement a feral species management plan in consultation with surrounding land holders and DPaW.

Hydrological changes

- Minimise changes to existing hydrological flow patterns;
- Develop an understanding of the surface and sub-surface drainage in order to identify the potential for hydrological changes; and
- Where practical, implement management actions if hydrological changes are likely to affect significant fauna habitats.

Changes in fire regimes

- Develop a fire management plan in consultation with DPaW (which includes regard for the ecological role of fire).

Disturbance (dust, light and noise)

- Minimise the production of dust, noise and light spill; and
- Implement dust suppression and traffic management strategies.

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8 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a

large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Western Australian Wildlife Conservation Act 1950* (Wildlife Conservation Act). In addition, the Western Australian Department of Parks and Wildlife (DPaW) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in [Appendix 3](#).

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The Wildlife Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) 2: Species listed as Priority by the DPaW but not listed under State or Commonwealth Acts.

In Western Australia, the DPaW has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Wildlife Conservation Act but for which the DPaW feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA, 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environment and Conservation, now DPaW, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidan crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey, 2002).

Introduced species

In addition to these conservation levels, species that have been introduced are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Explanation of threatening processes.

Potential impacts of proposed developments upon fauna values can be related to threatening processes. This is recognised in the literature and under the EPBC Act, in which threatening processes are listed (see [Appendix 4](#)~~Appendix 4~~). Processes that may impact fauna values are discussed below. Rather than being independent of one another, processes are complex and often interrelated. They are the mechanisms by which fauna can be affected by development. Impacts may be significant if large numbers of species or large proportions of populations are affected.

Loss of habitat affecting population survival

Clearing for a development can lead to habitat loss for a species with a consequent decline in population size. This may be significant if the smaller population has reduced viability. Conservation significant species or species that already occur at low densities may be particularly sensitive to habitat loss affecting population survival.

Loss of habitat leading to population fragmentation

Loss of habitat can affect population movements by limiting movement of individuals throughout the landscape as a result of fragmentation. Obstructions associated with the development, such as roads, pipes and drainage channels, may also affect movement of small, terrestrial species. Fragmented populations may not be sustainable and may be sensitive to effects such as reduced gene flow.

Degradation of habitat due to weed invasion leading to population decline

Weed invasion can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

Increased mortality can occur during project operations; for example from roadkill, animals striking infrastructure and entrapment in trenches. Roadkill as a cause of population decline has been documented for several medium-sized mammals in eastern Australia (Dufty, 1989; Jones, 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Scheick and Jones, 1999; Cleverger and Waltho, 2000; Jackson and Griffin, 2000).

Increased mortality of common species during development is unavoidable and may not be significant for a population. However, the cumulative impacts of increased mortality of conservation significant species or species that already occur at low densities may have a significant impact on the population.

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced

predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species. Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread and major.

Changes to flow regime across the landscape may alter vegetation and may lead to habitat degradation or loss, affecting fauna. For example, Mulga has a shallow root system and relies on surface sheet flow during flood events. If surface sheet flow is impeded, Mulga can die (Kofod 1998), which may impact on a range of fauna associated with this vegetation type.

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Gill *et al.* 1981; Fox 1982; Letnic *et al.* 2004; Bamford and Roberts 2003). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1998). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich and Longcore 2006). Effects can include impacts on predator-prey interactions, changes to mating and nesting behaviour, and increased competition and predation within and

between invertebrates, frogs, birds and mammals. The death of very large numbers of insects has been observed around some remote mine sites and attracts other fauna, notably native and introduced predators (M.Bamford pers. obs). The abundance of some insects can decline due to mortality around lights, although this has previously been recorded in fragmented landscapes where populations are already under stress (Rich and Longcore 2006). Artificial night lighting may also lead to disorientation of migratory birds. Aquatic habitats and open habitats such as grasslands and dunes may be vulnerable to light spill.

Appendix 3. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the *Western Australian Wildlife Conservation Act 1950*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the *WA Wildlife Conservation Act 1950*

Schedule 1	Rare and Likely to become Extinct.
Schedule 2	Extinct.
Schedule 3	Migratory species listed under international treaties.
Schedule 4	Other Specially Protected Fauna

WA Department of Environment and Conservation Priority species (species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands. Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 4.	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).
Priority 5	

Appendix 4. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 19 key threatening processes listed by the federal Department of Environment (DoE, 2011):

- Competition and land degradation by feral/unmanaged Goats (*Capra hircus*);
- Competition and land degradation by feral Rabbits (*Oryctolagus cuniculus*);
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*);
- Incidental catch (bycatch) of Sea Turtles during coastal otter-trawling operations within Australian waters north of 28 degrees South;
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations;
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis;
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris;
- Invasion of northern Australia by Gamba Grass and other introduced grasses;
- Land clearance;
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants;
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean;
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases;
- Predation by exotic rats on Australian offshore islands of less than 1000km² (100,000ha);
- Predation by feral Cats (*Felis catus*);

- Predation by the European Red Fox (*Vulpes vulpes*);
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (*Sus scrofa*);
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species;
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*); and
- The reduction in the biodiversity of Australian native fauna and flora due to the imported Red Fire Ant, *Solenopsis invicta*.

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, the DoE has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action will reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action will disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action will interfere with the recovery of the species?

Appendix 5. Fauna recorded or expected to occur in the survey areas during October 2013 (Tables 1 to 5).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. Results do not include returned marine species. These are:

- Database searches = Birds Australia Database, EPBC Protected Matters Search Tool and NatureMap
- KML Surveys = Bamford Consulting Ecologists surveys undertaken for Karara Mining Limited since 2004
- Minjar (APM, 2012) = Minjar Gold Fauna Assessment conducted by APM

Table 1. Significant Invertebrates expected to occur and recorded in the survey areas.

Species Name	Common Name (Conservation status)	Data Base Searches	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
<i>Idiosoma nigrum</i>	Shield-backed Trapdoor Spider (CS1)		X	-	X	X	X	X	X	X	X	X	X	-	X	X	X
<i>Aganippe aff castellum</i>	"Mt Mulgine Trapdoor Spider"											X	X	X	X	X	
Total Species Expected: 2			1	0	1	1	1	1	1	1	1	1	1	0	1	1	1
Total Species Recorded: 2																	

Note: New Target 2 also referred to as New Target 20. New Target 13 also referred to as New Target 6.

Table 2. Frogs expected to occur and recorded in the survey areas.

Species Name	Common Name (Conservation status)	Data Base Searches	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target2	New Target 13	Allentown	New Target 5	Wolf
Hylidae (Tree frogs)																	
<i>Cyclorana platycephala</i>	Water-holding Frog																
Myobatrachidae (Ground frogs)																	
<i>Opisthodon spenceri</i>	Spencer's Frog	X															
<i>Neobatrachus centralis</i>	Desert Trilling Frog																
<i>Neobatrachus kunapalari</i>	Kunapalari Frog																
<i>Neobatrachus pelobatoides</i>	Humming Frog																
<i>Neobatrachus sutor</i>	Shoemaker Frog																
<i>Neobatrachus wilsmorei</i>	Wilsmore's Frog	X															
<i>Pseudophryne occidentalis</i>	Western Toadlet	X	X														
Total Species Expected:8		3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

1. The Inland Tree-Frog *Litoria rubella* has been recorded at Minjar Camp and is reported from Badja Station homestead, but is almost certainly introduced at these locations and there is no suitable habitat for the species in the survey areas.
2. Outside and adjacent to Allentown project area, a freshwater pool along a drainage line contained tadpoles of the Orange-crowned toadlet (*Pseudophryne occidentalis*) and a range of aquatic invertebrates.

Table 3. Reptiles expected to occur and recorded in the survey areas.

Species Name	Common Name (Conservation status)	Data Base Searches (DPaW)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinng	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
Gekkonidae (geckoes)																	
<i>Diplodactylus granariensis</i>	Western Stone Gecko		X	X													
<i>Diplodactylus pulcher</i>			X	X													
<i>Lucasium maini</i>																	
<i>Lucasium squarossum</i>			X														
<i>Nephrurus vertebralis</i>																	
<i>Oedura marmorata</i>	Marbled Velvet Gecko																
<i>Oedura reticulata</i>	Reticulated Velvet Gecko (CS3)		X														
<i>Rhynchoedura ornata</i>	Beaked Gecko	X	X														
<i>Strophurus assimilis</i>	Thorn-tailed Gecko																
<i>Underwoodisaurus milii</i>	Barking Gecko		X														
<i>Gehyra punctata</i>		X															
<i>Gehyra variegata</i>	Variiegated Dtella	X	X	X													
<i>Heteronotia binoei</i>	Bynoe's Gecko	X	X	X											X		
Pygopodidae (legless lizards)																	
<i>Delma australis</i>			X														
<i>Lialis burtonis</i>	Burton's Legless Lizard		X	X													
<i>Pygopus lepidopodus</i>	Common Scaly-foot																
<i>Pygopus nigriceps</i>	Hooded Scaly-foot	X															
Agamidae (dragon lizards)																	
<i>Caimanops amphiboluroides</i>	Mulga Dragon (CS3)	X	X														
<i>Ctenophorus cristatus</i>	Ornate Crevice-Dragon																
<i>Ctenophorus maculatus</i>	Spotted Military Dragon			X													
<i>Ctenophorus nuchalis</i>	Central Netted Dragon		X														
<i>Ctenophorus reticulatus</i>	Western Netted Dragon	X	X		X												
<i>Ctenophorus scutulatus</i>	Lozenge-marked Dragon	X	X	X						X				X			X
<i>Moloch horridus</i>	Thorny Devil		X														
<i>Pogona minor</i>	Western Bearded Dragon	X	X	X											X		
Varanidae (monitors or goannas)																	
<i>Varanus caudolineatus</i>	Stripe-tailed Monitor		X	X									X	X			
<i>Varanus giganteus</i>	Perentie		X														
<i>Varanus gouldii</i>	Sand Goanna		X	X													

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaW)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windanne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
<i>Varanus tristis</i>	Black-headed Monitor		X	X													
<i>Varanus panoptes</i>	Yellow-spotted Monitor		X	X	X	X	X	X	X								
Scincidae (skink lizards)																	
<i>Cryptoblepharus buchananii</i>	Buchanan's snake-eyed skink	X	X					X							X		X
<i>Cryptoblepharus plagiocephalus</i>	Fence Skink	X	X	X													
<i>Ctenotus mimetes</i>			X			X											
<i>Ctenotus schomburgkii</i>		X	X														
<i>Ctenotus severus</i>		X															
<i>Ctenotus uber</i>		X	X	X													
<i>Cyclodomorphus branchialis</i>	Gilled Slender Blue-tongue (CS1)	X	X														
<i>Egernia depressa</i>		X	X	X				X							X		
<i>Egernia stokesii badia</i> check sites	Western Spiny-tailed Skink (CS1)	X	X														
<i>Eremiascincus richardsonii</i>	Broad-banded Sand-swimmer	X	X	X													
<i>Liopholis inornata</i>	Desert Skink																
<i>Lerista gerrardii</i>			X														
<i>Lerista macropisthopus</i>																	
<i>Lerista kingi</i>		X	X														
<i>Lerista nicholli</i>		X															
<i>Lerista timida</i>			X												X		
<i>Menetia greyii</i>	Common Dwarf Skink	X	X	X											X		X
<i>Morethia butleri</i>		X	X														
<i>Morethia obscura</i>	Dusky Morethia																
<i>Tiliqua occipitalis</i>	Western Blue-tongue		X	X													
Typhlopidae (blind snakes)																	
<i>Ramphotyphlops australis</i>	Southern Blind Snake																
<i>Ramphotyphlops hamatus</i>			X														
<i>Ramphotyphlops waitii</i>	Beaked Blind Snake		X	X													
Boidae (pythons)																	
<i>Antaresia stimsoni</i>	Stimson's Python		X														
<i>Morelia spilota</i>	Carpet Python (CS1)																

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaW)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windanne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
Elapidae (front-fanged snakes)																	
<i>Brachyuropis semifasciata</i>		X															
<i>Demansia psammophis</i>	Yellow-faced Whipsnake		X														
<i>Suta fasciata</i>	Jan's Banded Snake	X															
<i>Parasuta monachus</i>	Gwardar		X	X													
<i>Pseudechis australis</i>	Ringed Brown Snake		X														
<i>Pseudechis butleri</i>	Yellow-spotted Mulga Snake	X	X														
<i>Pseudonaja mengdeni</i>			X	X													
<i>Pseudonaja modesta</i>	Mulga Snake	X	X			X											
<i>Pseudonaja nuchalis</i>	Monk Snake	X															
<i>Simoselaps bertholdi</i>	Moon Snake		X														
<i>Furina ornata</i>	Rosen's Snake			X													
Total Species Expected:66		27	41	22	2	3	1	3	1	1	0	0	1	2	6	0	3

Table 4. Birds expected to occur and recorded in the survey areas.

Species Name	Common Name (Conservation status)	Data Base Searches (DPaw,BA)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
CASUARIIDAE (Cassowaries and emus)																	
<i>Dromaius novaehollandiae</i>	Emu	X	X	X										X			X
MEGAPODIIDAE (Megapodes)																	
<i>Leipoa ocellata</i>	Malleefowl (CS1)	X	X	X	X	X	X		X	X	X		X		X	X	X
PHASIANIDAE (Pheasants and allies)																	
<i>Coturnix pectoralis</i>	Stubble Quail	X															
ANATIDAE (Swans, geese and ducks)																	
<i>Chenonetta jubata</i>	Australian Wood Duck		X														
<i>Tadorna tadornoides</i>	Australian Shelduck		X														
<i>Anas superciliosa</i>	Pacific Black Duck	X		X													
<i>Anas gracilis</i>	Grey Teal	X	X	X													
PODICIPEDIDAE (Grebes)																	
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe	X	X														
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe			X													
ARDEIDAE																	
<i>Egretta novaehollandiae</i>	White-faced Heron		X														
THRESKIORNITHIDAE																	
<i>Threskiornis spinicollis</i>	Straw-necked Ibis		X														
COLUMBIDAE (Pigeons and doves)																	
<i>Phaps chalcoptera</i>	Common Bronzewing	X	X	X			X										
<i>Ocyphaps lophotes</i>	Crested Pigeon	X	X	X													
<i>Geopelia cuneata</i>	Diamond Dove	X	X														
PODARGIDAE (Australian frogmouths)																	
<i>Podargus strigoides</i>	Tawny Frogmouth	X	X	X													
CAPRIMULGIDAE (Nightjars and allies)																	
<i>Eurostopodus argus</i>	Spotted Nightjar	X	X	X				X				X					
AEGOTHELIDAE (Owlet-nightjars)																	
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	X	X	X													
APODIDAE (Typical swifts)																	
<i>Apus pacificus</i>	Fork-tailed Swift (CS1)																
ACCIPITRIDAE (Osprey, hawks and eagles)																	
<i>Elanus axillaris</i>	Black-shouldered Kite	X															
<i>Lophoictinia isura</i>	Square-tailed Kite		X	X													

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaw,BA)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		X														
<i>Milvus migrans</i>	Black Kite		X														
<i>Haliastur sphenurus</i>	Whistling Kite	X		X	X												
<i>Circus assimilis</i>	Spotted Harrier	X															
<i>Accipiter fasciatus</i>	Brown Goshawk	X	X	X													
<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk	X	X	X													
<i>Aquila audax</i>	Wedge-tailed Eagle	X	X	X	X			X									X
<i>Hieraetus morphnoides</i>	Little Eagle		X														
FALCONIDAE (Falcons)																	
<i>Falco berigora</i>	Brown Falcon	X	X	X													X
<i>Falco longipennis</i>	Australian Hobby	X	X														
<i>Falco hypoleucos</i>	Grey Falcon (CS2)																
<i>Falco subniger</i>	Black Falcon																
<i>Falco peregrinus</i>	Peregrine Falcon (CS1)		X	X													
<i>Falco cenchroides</i>	Nankeen Kestrel	X	X	X													
RALLIDAE (Rails, gallinules and coots)																	
<i>Gallinula ventralis</i>	Black-tailed Native-hen	X															
OTIDIDAE (Bustards)																	
<i>Ardeotis australis</i>	Australian Bustard (CS2)	X	X	X													
BURHINIDAE (Stone-curlews)																	
<i>Burhinus grallarius</i>	Bush Stone-curlew (CS2)	X	X														
CHARADRIIDAE (Lapwings, plovers and dotterels)																	
<i>Charadrius melanops</i>	Black-fronted Dotterel	X															
<i>Charadrius australis</i>	Inland Dotterel	X															
<i>Vanellus tricolor</i>	Banded Lapwing	X	X														
TURNICIDAE (Button-quails)																	
<i>Turnix velox</i>	Little Button-quail	X	X														
<i>Turnix varia</i>	Painted Button-quail		X														
CACATUIDAE (Cockatoos)																	
<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo	X	X	X							X						
<i>Eolophus roseicapilla</i>	Galah	X	X	X								X		X			X
<i>Cacatua pastinator</i>	Western Corella																

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaw,BA)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
<i>Cacatua sanguinea</i>	Little Corella	X															
<i>Cacatua leadbeateri</i>	Major Mitchell's Cuckatoo (CS1)	X	X	X													
<i>Nymphicus hollandicus</i>	Cockatiel	X	X	X													
PSITTACIDAE (Parrots)																	
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet		X														
<i>Polytelis anthopeplus</i>	Regent Parrot (CS3)	X	X	X													
<i>Barnardius zonarius</i>	Australian Ringneck	X	X	X							X			X	X		X
<i>Psephotus varius</i>	Mulga Parrot	X	X	X		X											
<i>Melopsittacus undulatus</i>	Budgerigar	X	X	X													
<i>Neosephotes bourkii</i>	Bourke's Parrot	X	X	X													
<i>Neophema splendida</i>	Scarlet-chested Parrot (CS3)																
CUCULIDAE (Old world cuckoos)																	
<i>Cuculus pallidus</i>	Pallid Cuckoo	X	X	X													
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo																
<i>Chrysococcyx osculans</i>	Black-eared Cuckoo	X	X	X											X		
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo	X	X	X													
<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo		X														
STRIGIDAE (Hawk owls)																	
<i>Ninox novaeseelandiae</i>	Southern Boobook		X														
TYTONIDAE (Barn owls)																	
<i>Tyto alba</i>	Barn Owl																
HALCYONIDAE (Kingfishers)																	
<i>Dacelo novaeguineae</i>	Laughing Kookaburra																
<i>Todiramphus pyrrhopygia</i>	Red-backed Kingfisher	X	X	X													
<i>Todiramphus sanctus</i>	Sacred Kingfisher																
MEROPIIDAE (Bee-eaters)																	
<i>Merops ornatus</i>	Rainbow Bee-eater (CS1)	X	X	X							X						
CLIMACTERIDAE (Australo-Papuan treecreepers)																	
<i>Climacteris rufa</i>	Rufous Treecreeper (CS3)	X	X														
PTILINORHYNCHIDAE																	
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird	X															

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaw,BA)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
MALURIDAE (Fairy-wrens, emu-wrens and grasswrens)																	
<i>Malurus splendens</i>	Splendid Fairy-wren	X	X	X			X			X		X	X	X	X		X
<i>Malurus lamberti</i>	Variegated Fairy-wren	X	X	X				X									
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren																
<i>Malurus leucopterus</i>	White-winged Fairy-wren	X	X	X													
PARDALOTIDAE (Pardalotes, scrubwrens, thornbills and allies)																	
<i>Pardalotus striatus</i>	Striated Pardalote	X	X	X								X				X	X
<i>Sericornis frontalis</i>	White-browed Scrubwren	X															
<i>Hylacota cauta</i>	Shy Heathwren (CS2)																
<i>Calamanthus campestris</i>	Rufous Fieldwren (CS2)																
<i>Pyrrholaemus brunneus</i>	Redthroat (CS3)	X	X	X	X		X	X		X	X	X		X	X		X
<i>Drymodes brunneopygi</i>	Southern Scrub-robin (CS3)		X														
<i>Smicronis brevirostris</i>	Weebill	X	X	X							X			X	X	X	X
<i>Gerygone fusca</i>	Western Gerygone	X	X	X													
<i>Acanthiza apicalis</i>	Inland Thornbill	X	X	X			X										X
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	X	X	X	X		X		X	X				X	X		
<i>Acanthiza robustirostris</i>	Slaty-backed Thornbill	X	X	X													
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	X	X	X													
<i>Aphelocephala leucopsis</i>	Southern Whiteface	X	X	X													
MELIPHAGIDAE (Honeyeaters)																	
<i>Anthochaera carunculata</i>	Red Wattlebird	X	X	X													
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	X	X	X	X	X	X		X	X	X	X	X		X	X	X
<i>Manorina flavigula</i>	Yellow-throated Miner	X	X	X										X		X	
<i>Lichenostomus virescens</i>	Singing Honeyeater	X	X	X	X	X		X	X		X			X			X
<i>Lichenostomus leucotis</i>	White-eared Honeyeater		X														
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	X															
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater																
<i>Melithreptus brevirostris</i>	Brown-headed		X	X										X			

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaw,BA)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
	Honeyeater																
<i>Lichmera indistincta</i>	Brown Honeyeater	X	X	X													
<i>Phylidonyris albifrons</i>	White-fronted Honeyeater	X	X	X													
<i>Conopophila whitei</i>	Grey Honeyeater (CS3)	X															
<i>Certhionyx niger</i>	Black Honeyeater	X	X														
<i>Certhionyx variegatus</i>	Pied Honeyeater	X	X	X													
<i>Epthianura tricolor</i>	Crimson Chat	X		X													
<i>Epthianura aurifrons</i>	Orange Chat																
<i>Epthianura albifrons</i>	White-fronted Chat	X															
POMATOSTOMIDAE (Babblers)																	
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	X		X													
<i>Pomatostomus superciliosus</i>	White-browed Babbler (CS2)	X	X	X	X	X						X					
CINCLOSOMATIDAE (Quail-thrushes and allies)																	
<i>Psophodes occidentalis</i>	Chiming Wedgebill	X															
<i>Cinclosoma castanotum</i>	Chestnut Quail-thrush	X	X	X			X										
<i>Cinclosoma castaneothorax</i>	Chestnut-breasted Quail-thrush	X		X													
NEOSITTIDAE (Sittellas)																	
<i>Daphoenositta chrysoptera</i>	Varied Sittella	X	X	X		X											
CAMPEPHAGIDAE (Cuckoo-shrikes and trillers)																	
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	X	X	X												X	
<i>Coracina maxima</i>	Ground Cuckoo-shrike	X															
<i>Lalage sueurii</i>	White-winged Triller	X	X	X													
PACHYCEPHALIDAE (Whistlers, shrike-thrushes and allies)																	
<i>Oreica gutturalis</i>	Crested Bellbird (CS2)	X	X	X	X	X			X	X	X	X	X	X			
<i>Pachycephala inornata</i>	Gilbert's Whistler (CS3)		X	X								X					
<i>Pachycephala pectoralis</i>	Golden Whistler (CS3)	X	X														X
<i>Pachycephala rufiventris</i>	Rufous Whistler	X	X	X	X		X			X	X	X		X			X
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	X	X	X	X		X		X	X		X	X	X	X		X
ARTAMIDAE (Woodswallows, butcherbirds and allies)																	

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaw,BA)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
currawongs)																	
<i>Artamus personatus</i>	Masked Woodswallow	X	X	X													
<i>Artamus superciliosus</i>	White-browed Woodswallow	X															
<i>Artamus cinereus</i>	Black-faced Woodswallow	X	X	X		X											
<i>Artamus minor</i>	Little Woodswallow	X	X	X													
<i>Cracticus torquatus</i>	Grey Butcherbird	X	X	X							X						X
<i>Cracticus nigrogularis</i>	Pied Butcherbird	X	X	X										X			
<i>Gymnorhina tibicen</i>	Australian Magpie	X	X	X								X					
<i>Strepera versicolor</i>	Grey Currawong	X	X	X				X						X			
DICRURIDAE (Monarchs, fantails and drongos)																	
<i>Myiagra inquieta</i>	Restless Flycatcher																
<i>Grallina cyanoleuca</i>	Magpie-lark	X		X													
<i>Rhipidura albiscapa</i>	Grey Fantail	X	X	X													
<i>Rhipidura f. albicauda</i>	White-tailed Fantail		X							X							
<i>Rhipidura leucophrys</i>	Willie Wagtail	X	X	X	X												
CORVIDAE (Crows and allies)																	
<i>Corvus coronoides</i>	Australian Raven	X	X														
<i>Corvus bennetti</i>	Little Crow	X	X														X
<i>Corvus orru</i>	Torresian Crow	X	X	X	X		X	X			X	X			X		
PETROICIDAE (Robins)																	
<i>Microeca leucophaea</i>	Jacky Winter		X														
<i>Petroica multicolor</i>	Scarlet Robin (CS3)		X														
<i>Petroica goodenovii</i>	Red-capped Robin	X	X	X								X				X	
<i>Melanodryas cucullata</i>	Hooded Robin	X		X													
<i>Eopsaltria griseogularis</i>	Western Yellow Robin (CS3)		X	X											X		X
SYLVIIDAE (Old world warblers)																	
<i>Cinclorhamphus mathewsi</i>	Rufous Songlark	X	X														
<i>Cinclorhamphus cruralis</i>	Brown Songlark	X															
ZOSTEROPIDAE (White-eyes)																	
<i>Zosterops lateralis</i>	Silvereye	X															
HIRUNDINIDAE (Swallows and martins)																	

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Species Name	Common Name (Conservation status)	Data Base Searches (DPaw,BA)	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Tickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
<i>Cheramoeca leucosternum</i>	White-backed Swallow	X	X	X													
<i>Hirundo neoxena</i>	Welcome Swallow	X	X	X		X									X		
<i>Hirundo nigricans</i>	Tree Martin	X	X	X													
<i>Hirundo ariel</i>	Fairy Martin	X	X	X													
DICAEDAE (Flowerpeckers)																	
<i>Dicaeum hirundinaceum</i>	Mistletoebird	X	X														
PASSERIDAE (Sparrows, weaverbirds, waxbills and allies)																	
<i>Taeniopygia guttata</i>	Zebra Finch	X	X	X													
MOTACILIDAE (Old world wagtails and pipits)																	
<i>Anthus novaeseelandiae</i>	Richard's Pipit	X	X	X													
Total Species Expected:146		109	106	85	12	8	10	7	5	8	11	14	4	15	12	5	18

Table 5. Mammals expected to occur and recorded in the survey areas.

Species Name	Common Name (Conservation status)	Data Base Searches	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Trickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
TACHYGLOSSIDAE (Echidnas)																	
<i>Tachyglossus aculeatus</i>	Echidna	X	X	X			X	X	X	X							X
DASYURIDAE (Dasyurids)																	
<i>Antechinomys laniger</i>	Kultarr (CS3)	X	X														
<i>Ningauai ridei</i>	Wongai Ningauai																
<i>Pseudantechinus woolleyae</i>	Woolley's Pseudantechinus (CS3)		X					X									X
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart																
<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart		X														
MACROPODIDAE (Kangaroos, wallabies)																	
<i>Macropus fuliginosus</i>	Western Grey Kangaroo		X														
<i>Macropus robustus</i>	Euro, Biggada		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Macropus rufus</i>	Red Kangaroo, Marlu	X	X	X	X												
PHALANGERIDAE (brush-tailed possums)																	
<i>Trichosurus vulpecula</i>	Common Brush-tailed Possum (CS3)		X														
BURRAMYIDAE (Pygmy possums)																	
<i>Cercartetus concinnus</i>	Western Pygmy-possum																
EMBALLONURIDAE (Sheathtail bats)																	
<i>Taphozous hilli</i>	Hill's Sheathtail-bat																
VESPERTILIONIDAE (Vespertilionid bats)																	
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		X														
<i>Chalinolobus morio</i>	Chocolate Wattled Bat																
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat		X														
<i>Nyctophilus timoriensis</i>	Greater Long-eared Bat																
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat																
<i>Scotorepens greyii</i>	Little Broad-nosed Bat		X														
<i>Vespadelus baverstocki</i>	Inland Forest Bat		X														
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat	X															
<i>Vespadelus regulus</i>	Southern Forest Bat																
MOLOSSIDAE (Freetail bats)																	
<i>Mormopterus sp. Listed as Species 3 by Adams et al. (1988).</i>	Inland Freetail-bat																

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Species Name	Common Name (Conservation status)	Data Base Searches	KML Surveys	Minjar (APM, 2012)	Monte Christo	Gnow's Nest	Allegro	Goblin	Trickford	South Windinne	South Island	Goatsville	New Target 2	New Target 13	Allentown	New Target 5	Wolf
<i>Mormopterus sp. Listed as Species 4, population O by Adams et al. (1988).</i>	Western Freetail-bat																
<i>Tadarida australis</i>	White-striped Freetail-bat	X	X														
MURIDAE (Rats and mice)																	
<i>Mus musculus</i>	House Mouse		X	X													
<i>Notomys mitchellii</i>	Mitchell's Hopping-mouse		X	X													
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse		X														
LEPORIDAE (Rabbits and hares)																	
<i>Oryctolagus cuniculus</i>	Rabbit		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CANIDAE (Dogs and foxes)																	
<i>Canis lupus</i>	Dog/Dingo		X														
<i>Vulpes vulpes</i>	Red Fox		X														
FELIDAE (Cats)																	
<i>Felis catus</i>	Cat		X														
BOVIDAE (Horned ruminants)																	
<i>Capra hircus</i>	Goat		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Total Species Expected:32		6	20	7	4	3	4	4	4	4	3	3	3	3	3	3	5

Appendix 6. Locations of Shield-Backed Trapdoor Spider quadrats surveyed in October 2013.

All GPS coordinates are Zone 50J.

Monte Christo

Quadrat Number	Easting	Northing	Spider burrows per quadrat
MC1.1	485594	6840425	0
MC1.2	485595	6840327	26
MC1.3	485596	6840229	27
MC1.4	485598	6840131	0
MC2.1	485388	6840158	0
MC2.2	485376	6840397	0

Gnow's Nest

Quadrat Number	Easting	Northing	Spider burrows per quadrat
GN1.1	487450	6837959	0
GN1.2	487488	6837863	4
GN1.3	487534	6837768	0
GN1.4	487556	6837672	6
GN1.5	487615	6837590	5
GN2.1	487450	6837519	2
GN2.2	487412	6837613	0
GN2.3	487351	6837689	13

Allegro

Quadrat Number	Easting	Northing	Spider burrows per quadrat
A1.1	491397	6815188	1
A1.2	491357	6815281	0
A1.3	491317	6815372	0
A1.4	491279	6815475	0
A1.5	491234	6815563	0
A2.1	491522	6815772	0
A2.2	491562	6815681	2
A2.3	491604	6815593	4
A2.4	491649	6815503	3
A2.5	491693	6815413	0

Goblin

Quadrat Number	Easting	Northing	Spider burrows per quadrat
G1.1	497351	6808918	0
G1.2	497452	6808925	1
G1.3	497552	6808934	8
G1.4	497662	6808943	0
G1.5	497763	6808951	0
G2.1	497749	6808780	0
G2.2	497666	6808725	0
G2.3	497585	6808669	1
G2.4	497506	6808617	13
G2.5	497416	6808557	0

Tickford and Tickford Haul Road

Quadrat Number	Easting	Northing	Spider burrows per quadrat
T1.1	494175	6806574	1
T1.2	494175	6806673	1
T1.3	494169	6806787	12
T1.4	494175	6806888	4
T1.5	494176	6806991	0
T1.6	494174	6807095	0
T1.7	494169	6807094	8
THR1.1	494696	6806880	0
THR1.2	494595	6806880	0
THR1.3	494496	6806874	0
THR1.4	494412	6806863	0

South Windinne and South Windinne Haul Road

Quadrat Number	Easting	Northing	Spider burrows per quadrat
SW1.1	494034	6804613	0
SW1.2	493936	6804612	0
SW1.3	493837	6804611	1
SW1.4	493738	6804612	0
SW1.5	493634	6804607	0
SW2.1	493691	6804973	2

Quadrat Number	Easting	Northing	Spider burrows per quadrat
SW2.2	493791	6804975	1
SW2.3	493884	6804999	0
SW2.4	493987	6804979	8
SW2.5	494083	6804982	0
SWH1.1	494657	6804823	0
SWH1.2	494547	6804823	6
SWH1.3	494453	6804800	0
SWH1.4	494344	6804799	4
SWH1.5	494239	6804794	0

South Island

Quadrat Number	Easting	Northing	Spider burrows per quadrat
SI 1.1	496579	6792555	1
SI 1.2	496555	6792656	12
SI 1.3	496533	6792754	3
SI 1.4	496511	6792851	3
SI 1.5	496488	6792949	0

Goatsville

Quadrat Number	Easting	Northing	Spider burrows per quadrat
GV1.1	497851	6773957	0
GV1.2	497909	6774041	0
GV1.3	497957	6774130	0
GV1.4	498009	6774224	0

New Target 2 (also NT20)

Quadrat Number	Easting	Northing	Spider burrows per quadrat
NT2 1.1	499242	6773590	0
NT2 1.2	499241	6773495	0
NT2 1.3	499241	6773388	0
NT2 1.4	499239	6773288	0
NT2 1.5	499240	6773188	0

New Target 13 (NT6)

Quadrat Number	Easting	Northing	Spider burrows per quadrat
NT13 1.1	500301	6773426	0
NT13 1.2	500306	6773526	0
NT13 1.3	500304	6773630	0
NT13 1.4	500304	6773727	0
NT13 1.5	500325	6773824	0

Allentown

Quadrat Number	Easting	Northing	Spider burrows per quadrat
AT 1.1	497131	6772419	3
AT 1.2	497241	6772410	16
AT 1.3	497341	6772403	0
AT 1.4	497441	6772397	5
AT 1.5	497554	6772387	0
AT 2.1	497577	6772747	7
AT 2.2	497504	6772814	2
AT 2.3	497513	6772837	0
AT 2.4	497415	6772873	9
AT 2.5	497430	6772892	3

New Target 5

Quadrat Number	Easting	Northing	Spider burrows per quadrat
NT5 1.1	495322	6771197	0
NT5 1.2	495313	6771149	5
NT5 1.3	495302	6771101	0
NT5 1.4	495289	6771052	2
NT5 1.5	495275	6771006	0

Wolf

Quadrat Number	Easting	Northing	Spider burrows per quadrat
W1.1	496898	6770815	0
W1.2	496998	6770801	0
W1.3	497100	6770778	1
W1.4	497190	6770751	0

Quadrat Number	Easting	Northing	Spider burrows per quadrat
W2.1	497061	6770865	0
W2.2	497066	6770971	0
W2.3	497079	6771071	0
W3.1	496518	6770486	0
W3.2	496617	6770490	10
W3.3	496725	6770490	0

Appendix 7. Malleefowl observations.

Survey Area	Mound Name	Zone	Easting	Northing	Width (m)	Height (m)	Depth (m)	Comments*
Monte Christo	MM MC1	50J	485587	6840419	5	0.1	0.5	Very old, inactive
Allegro	MM AL1	50J	491615	6815492	12	0.5	0	Old, inactive
Allegro	MM AL2	50J	491290	6815568	7	0.4	0	Old, inactive
Allegro	MM AL3	50J	491428	6815406	-	-	-	Old, inactive
South Island	MM SI1	50J	496462	6792854	12	1	0	Very old, inactive
Tickford	MM T1	50J	494193	6806685	6	1	0.6	Old, inactive
Tickford	MM T2	50J	494188	6806958	6	1	0.2	Moderately old, inactive
Tickford	MM T3	50J	494250	6806749	15	0.5	0	Very old, inactive
Tickford	MF Track	50J	494352	6807036	-	-	-	-
Gnow's Nest	MM GN1	50J	487513	6837782	11	1	0.5	Old, inactive
New Target 5	MM NT5 1	50J	495347	6771056	13	0.5	0	Old, inactive
New Target 5	MM NT5 2	50J	495437	6771060	4	0.5	0.1	Old, inactive
South Windinne	MM SW1	50J	493746	6804617	10	0.7	0.1	Very old, inactive
South Windinne	MM SW2	50J	494151	6805007	-	-	-	Old, inactive
South Windinne	MM SW3	50J	494072	6805516	-	-	-	Old, inactive
Allentown (outside site)	MM AL1	50J	497005	6772116	-	-	-	Old, inactive
Allentown (outside site)	MM AL2	50J	496644	6772073	10	0.6	-	Old inactive
Target 15 Haul Road	MM T15 1	50J	495046	6768245	6	0.4	0.05	Old, inactive
Target 15 Haul Road	MM T15 2	50J	495173	6768234	25	1.5	0	Very old, inactive
Wolf	MM W1	50J	496349	6770432	-	-	-	Old, inactive
Wolf	MM W2	50J	497195	6771033	-	-	-	Old, inactive
Wolf	MM W3	50J	497186	6771022	10	0.2	0	Old, inactive

Wolf	MM W4	50J	497179	6770795	10	-	-	Old, inactive
Wolf	MM W5	50J	497201	6770787	3	-	0.4	Moderately old, inactive
New Target 2 (NT20)	MM T2 1	50J	499442	6773188	-	-	-	Old, inactive
Sunbeam	MM SU1	50J	503187	6796599	3	0.2	-	Very old, inactive
Track to Goatsville	MM 1	50J	497532	6774795	-	-	-	Old, inactive
Track to Allentown	MM 1	50J	497005	6772116	-	-	-	Old, inactive
Track to Allentown	MM 2	50J	496644	6772073	-	-	-	Old, inactive
Sprite	MF Feather	50J	496348	6796531	-	-	-	-

*The age of each mound was classified according to the criteria listed below (based upon personal observation J.Turpin and M.Bamford).

Active: Fresh scratchings, loose soil and mound dug out in preparation for the breeding season or mounded for breeding. Mounds containing abundant but weathered plant material and shell fragments have been used regularly over at least the previous few years.

Recently used (1-5 years): No signs of very recent activity, such as scratchings. Soil surface compacted and little plant material present. However, mound slopes still steep and no plants growing in mound.

Moderately old (5-20 years): No recent activity, soil compacted and no plant material. Surface of mound showing some weathering, such as loose soil and debris accumulating in central depression, and some plant colonisation possibly present.

Old (20-100 years): Mound moderately to very weathered, often with a veneer of gravel on the slopes because of removal of fine materials from the surface. Some bushes growing on mound.

Very old (100+ years): Mound very weathered, with profile low and central depression poorly defined. Bushes and even small trees growing on mound

Appendix 8. Records of other conservation significant species.

Survey Area	Common Name	Species Name	Status	Evidence	Zone	Easting	Northing
New Target 15 Haul Road	Western Spiny-tailed Skink	<i>Egernia stokesii badia</i>	CS1	Scats	50J	494914	6768270
New Target 15 Haul Road	Western Spiny-tailed Skink	<i>Egernia stokesii badia</i>	CS1	Scats	50J	494992	6768212
New Target 15 Haul Road	Western Spiny-tailed Skink	<i>Egernia stokesii badia</i>	CS1	Scats	50J	494864	6768188
Goblin	Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>	CS3	Scats	50J	497574	6808651
Paradise	Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>	CS3	Scats	50J	502246	6771019
Sunbeam	Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>	CS3	Scats	50J	502706	6797184
Wolf	Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>	CS3	Scats	50J	496456	6770321

Appendix 9. Background information of conservation significant species.

Malleefowl (Leipoa ocellata)

The Malleefowl is listed as Vulnerable under the EPBC Act and under Schedule 1 (Rare or Likely to Become Extinct) of the Wildlife Conservation Act. In Western Australia, Malleefowl occur mainly in shrubs and thickets of Mallee, Boree (*Melaleuca lanceolata*) and Bowgada (*Acacia linophylla*), and also other dense litter-forming shrublands including Mulga (*Acacia aneura*) Shrublands (Johnstone and Storr, 2004). The species' distribution was once larger and less fragmented, but the widespread clearing of suitable habitat, coupled with the degradation of habitat by fire and livestock, and fox predation, have reduced Malleefowl numbers considerably. The Malleefowl previously inhabited a large part of arid inland Western Australia however has undergone a dramatic range reduction in the region. Malleefowl are known to occur in the Karara area and may be still declining due to predation pressure and habitat degradation by fire. Around Minjar and Karara the species' is closely associated with the slopes of hills as the heavy soils of the surrounding plains appear unsuitable for mound construction (Bamford, 2008).

Shield-backed Trapdoor Spider (Idiosoma nigrum)

The Shield-backed Trapdoor Spider is listed under Schedule 1 (fauna that is rare or is likely to become extinct) of the Wildlife Conservation Act and is ranked as Vulnerable by DPaW. It is confined to the northern Wheatbelt and adjacent parts of the Murchison. Previous studies in the Karara area by BCE have found the species to be widespread and common on the mid to lower slopes of many hills in the local area including Karara Ridge, Blue Hills and Mungada (Bamford and Metcalf, 2008). Recent studies carried out by BCE suggest that the highest abundance of burrows are found on the mid and lower slopes, with no burrows found on the crests of ridges. The greatest proportion of burrows was found in soils that were cobbles with gravel and loam (Huang and Bamford 2011).

Western Spiny-tailed Skink (Egernia stokesii badia)

The Western Spiny-tailed Skink is listed as Endangered under the EPBC Act and under Schedule 1 of the Wildlife Conservation Act. This species occurs in the Murchison region and in the Wheatbelt, from Mullewa south to Kellerberrin. In the Wheatbelt this species has been recorded from eucalypt woodlands, including from the Morawa area. How *et al.* (2003) located several populations of the Western Spiny-tailed Skink in the Karara region, from Buntine Nature Reserve, Perenjori town, Bowgada Nature Reserve north-east of Morawa and south of Rothsay. It occurs in eucalypt woodland with "considerable numbers of large fallen logs over 25 cm in diameter" (How *et al.* 2003), with intact understorey vegetation around the logs where it shelters. The Western Spiny-tailed Skink lives in small groups and each group has a single characteristic faecal pile ('latrine') that is usually located outside occupied logs (How *et al.* 2003). The presence of these faecal piles has been previously used to survey for this species in the Mid-West and Murchison regions (How *et al.* 2003). Harris and Bamford (2008) have recorded it in york gum woodland throughout the Karara and Mungada area.

Major Mitchell's Cockatoo (Cacatua leadbeateri)

The Major Mitchell's Cockatoo is listed under Schedule 4 (Other Specially Protected Fauna) of the Wildlife Conservation Act. This species is sporadically distributed through arid and semi-arid Australia and may occur in woodland, sparsely timbered grasslands and shrublands and rocky outcrops (DPaW Threatened and Priority Fauna Database 2008). In previous surveys, this species was recorded on numerous occasions in eucalypt woodland in the Minjar and Karara area, and there was one sighting along the Minjar Haul Road in September 2013.. Major Mitchell's Cockatoo is considered likely to occur within eucalypt woodland and birds will almost certainly visit the area to forage. This species breeds in large tree hollows on the flats. In the past, Karara and Lochada Stations were known to be popular with poachers targeting the eggs and chicks of this species (N. Hamilton pers.comm.), so the region is a known breeding area. The increased presence of mining companies in the area has the potential to discourage poaching activity though mine personnel reporting suspicious activities.

Gilled Slender Blue-tongue (Cyclodomorphus branchialis)

The Gilled Slender Blue-tongue is listed under Schedule 1 of the Wildlife Conservation Act. It has a restricted distribution, confined to the Midwest coast from the Murchison River to the Irwin River and inland to Mt Magnet (Bush *et al.*, 2007). This species is only known from a few locations, recorded from loamy soils in wattle woodlands and rocky areas (Bush *et al.*, 2007). The Gilled Slender Blue-tongue has been recorded by BCE on the Karara ridge (August 2006) and the Mungada ridge. Other records (2 further specimens, M. Bamford unpub. data) are all from rocky habitat, suggesting that the species may be restricted to such environments. Wilson and Swan (2008), however, suggest that it occurs on heavy red soils. The Gilled Slender Blue-tongue has a restricted distribution which may be disjunct due to the pattern of habitat availability.

Appendix 10. Locations of conservation significant species recorded during September surveys.

Figures 17 – 26. Note: Figures are only provided where conservation significant species were recorded (Table 20).



Figure 16. Location of conservation significant species recorded at Paradise City.

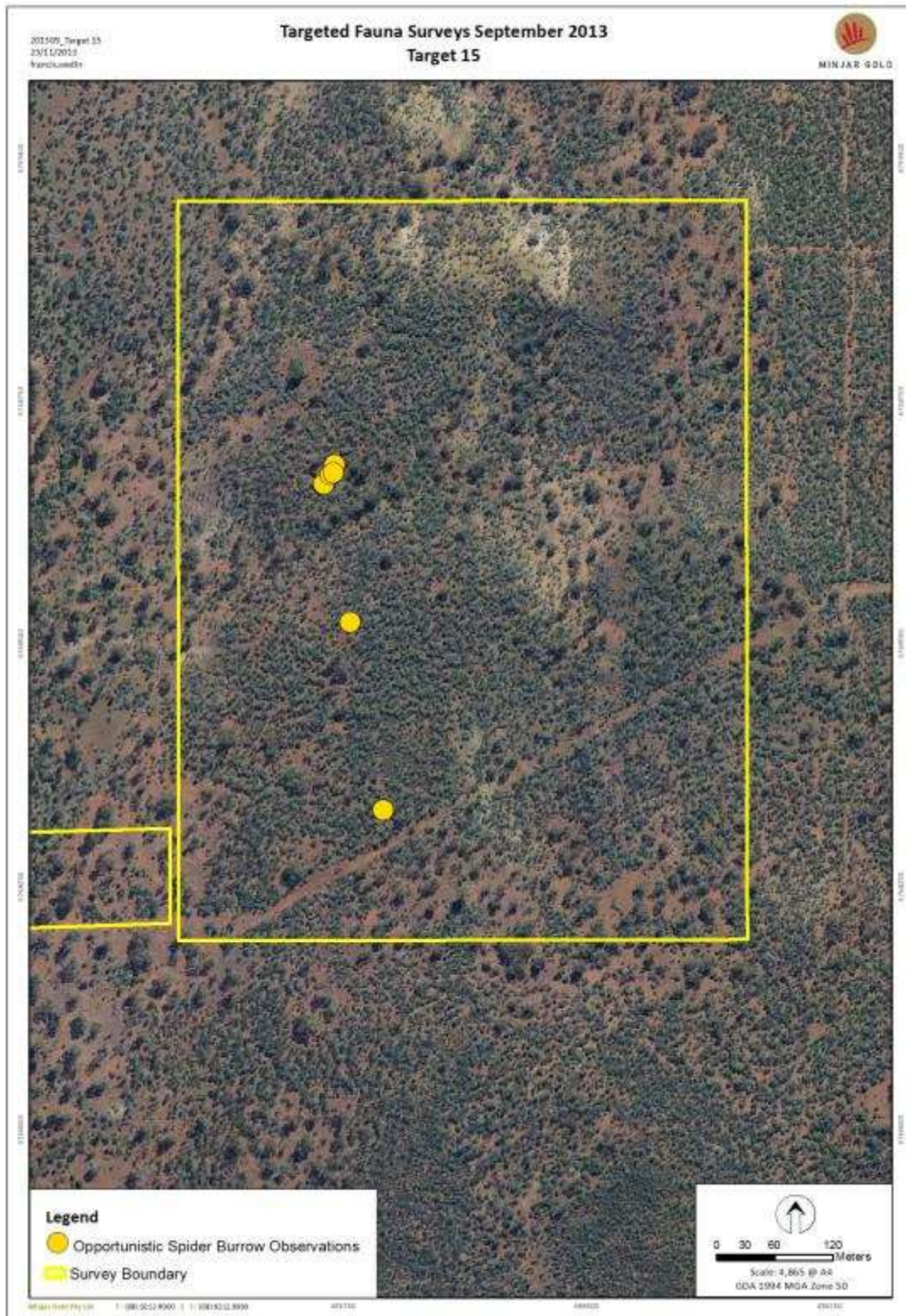


Figure 17. Location of conservation significant species recorded at New Target 15.

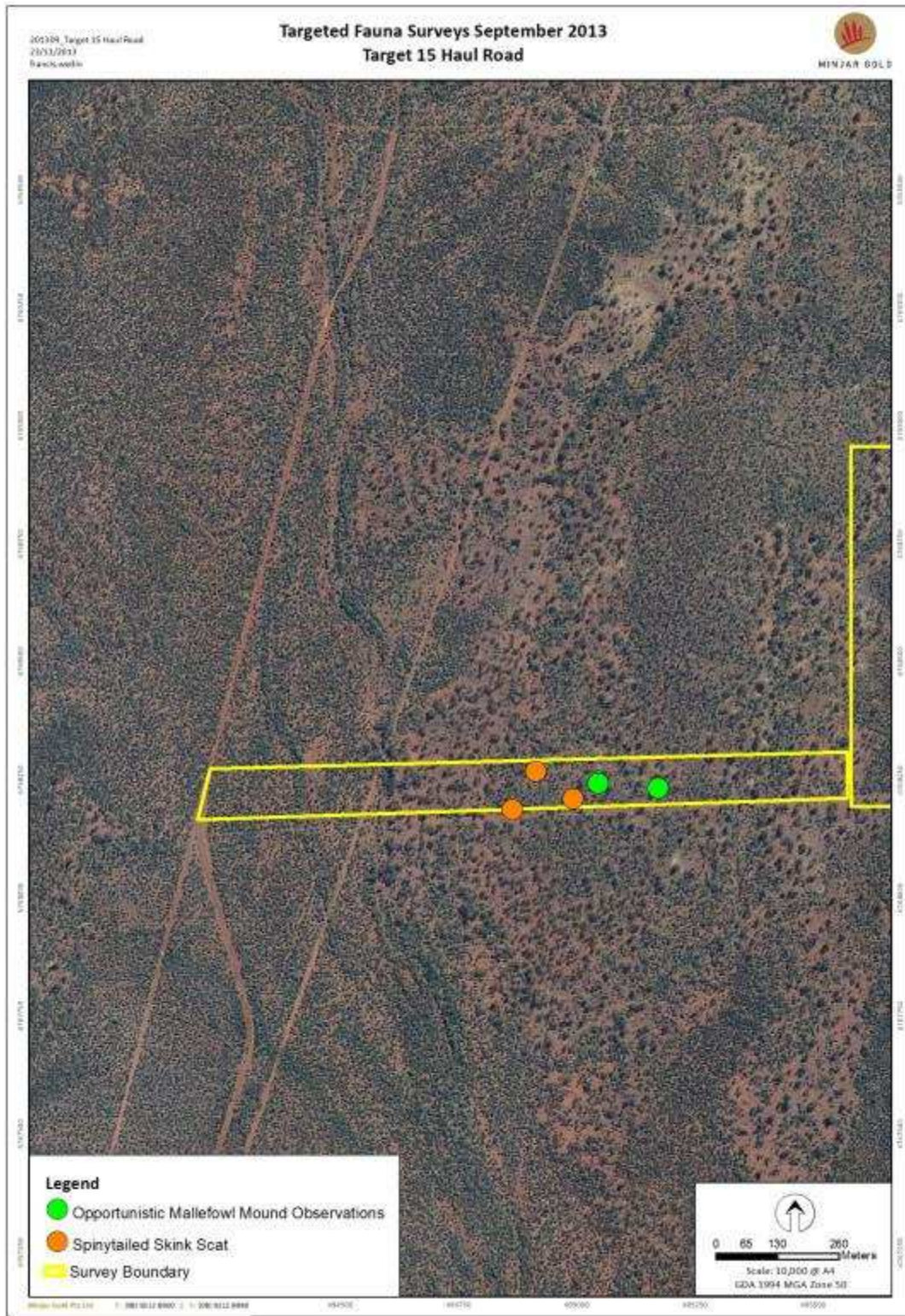


Figure 18. Location of conservation significant species recorded at New Target 15 Haul Road.



Figure 19. Location of conservation significant species recorded at Bugeye North.



Figure 20. Location of conservation significant species recorded at Sprite.

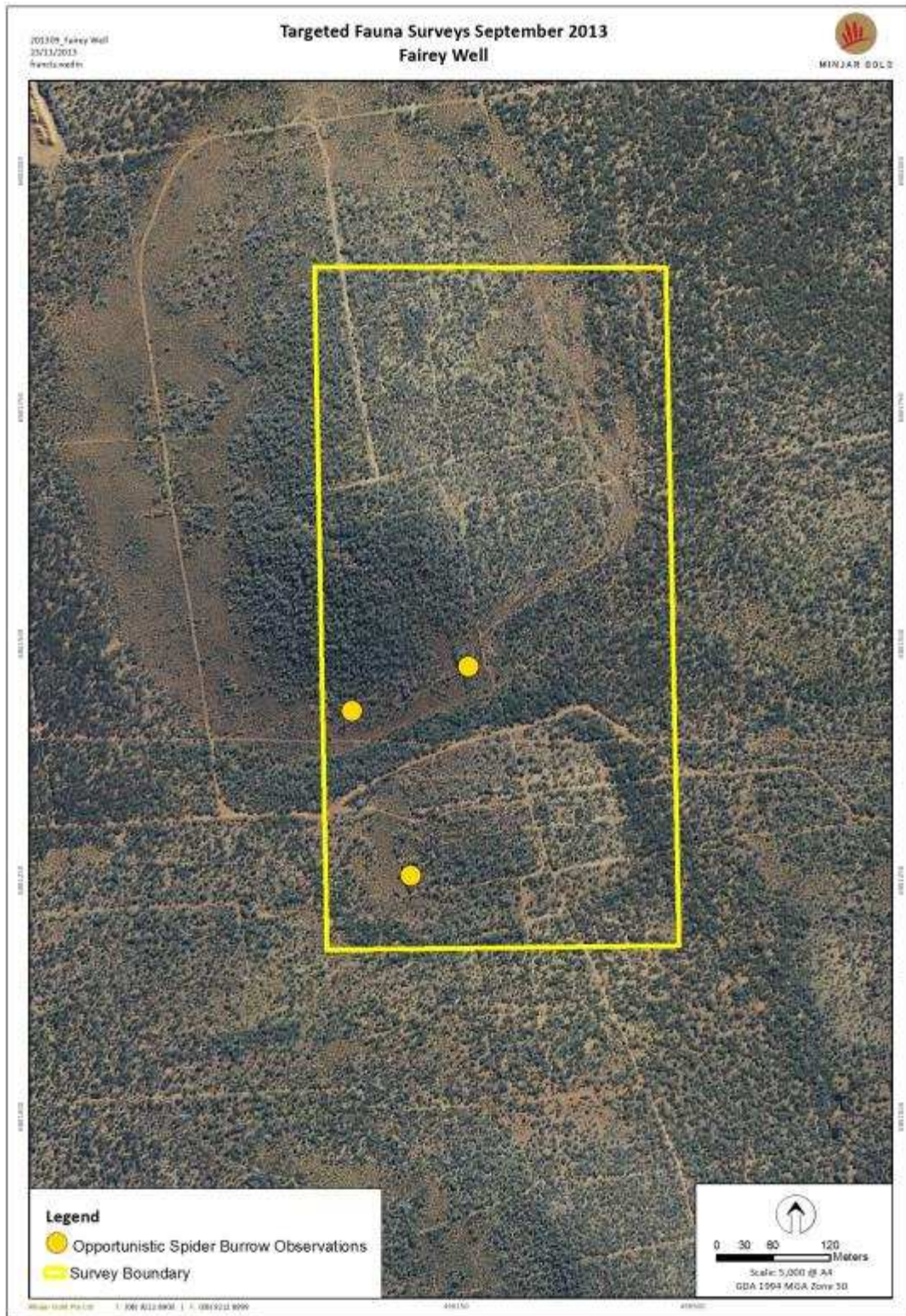


Figure 21. Location of conservation significant species recorded at Fairey Well.

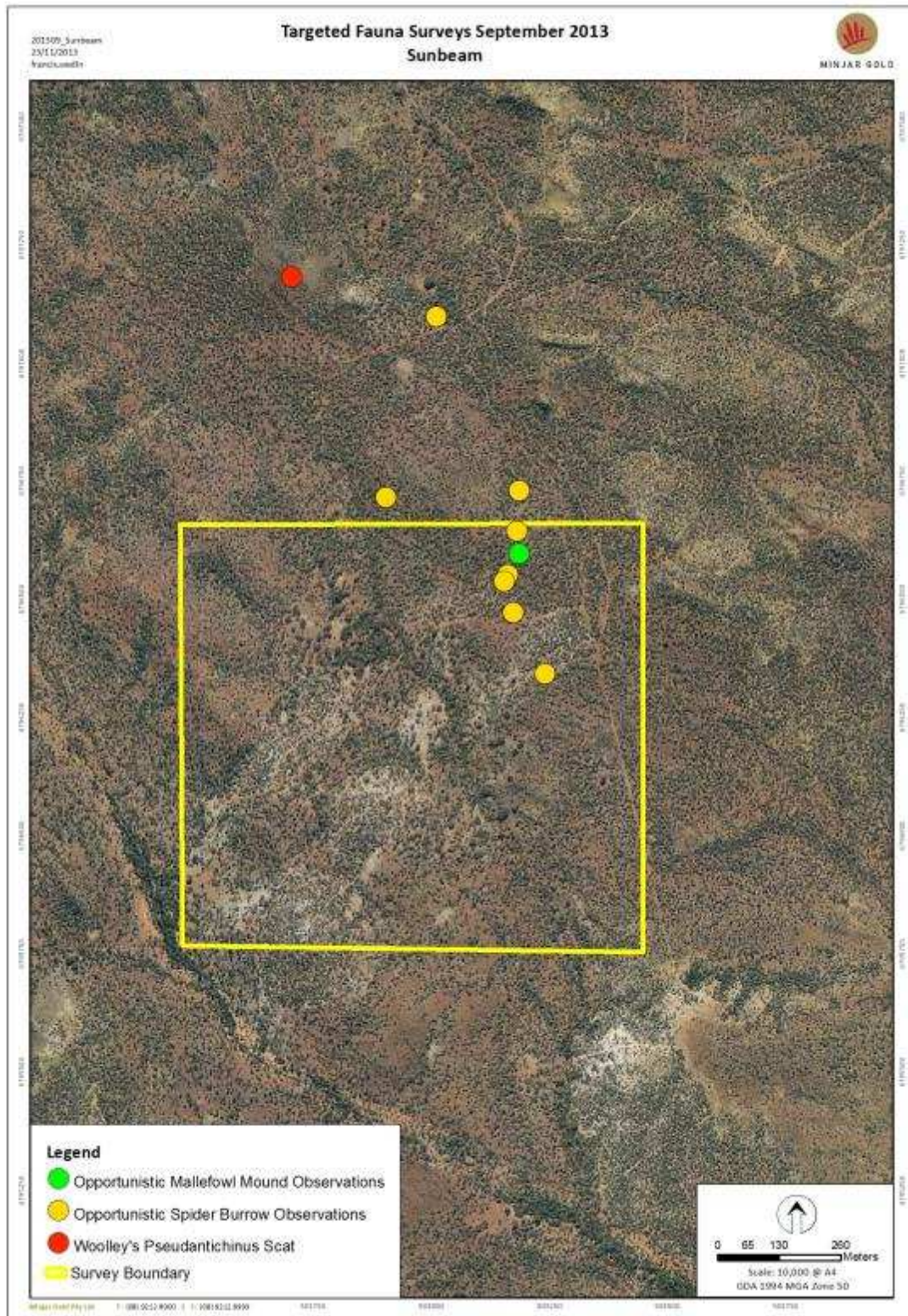


Figure 22. Location of conservation significant species recorded at Sunbeam.



Figure 23. Location of conservation significant species recorded at New Target 25.

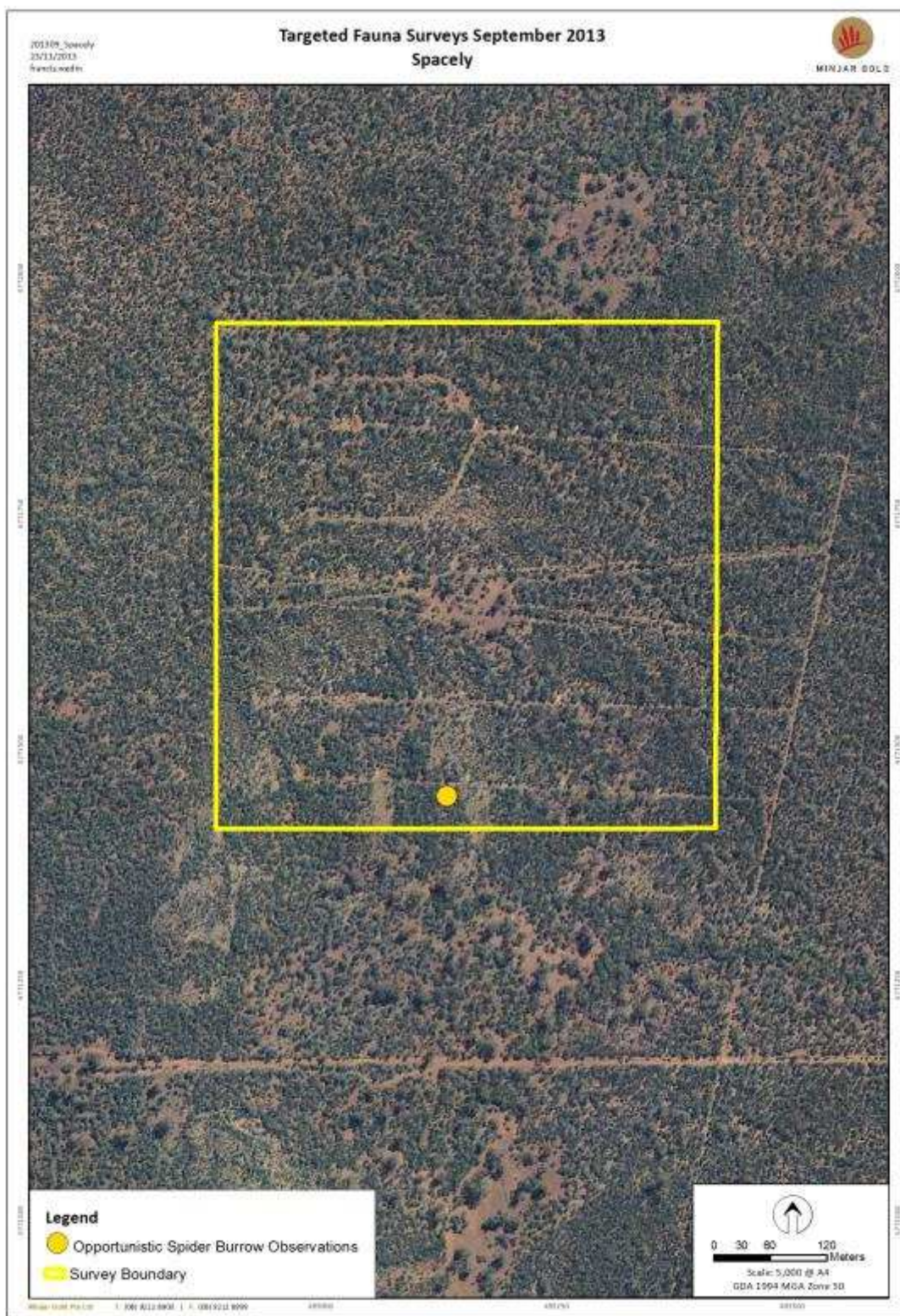


Figure 24. Location of conservation significant species recorded at Spacely.



Figure 25. Location of conservation significant species recorded at Beryl West.

Appendix 11. Fauna recorded in the survey areas during September 2013 (Tables 1 to 5).

- NT – New Target
- HR – Haul Road

Table 1. Significant Invertebrates recorded in the survey areas (September 2013).

Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Idiosoma nigrum</i>	Shield-backed Trapdoor Spider (CS1)		X					X			X	X		X	X	X
<i>Aganippe aff castellum</i>	“Mt Mulgine Trapdoor Spider”				X											
Total Species Recorded: 2		0	1	0	1	0	0	1	0	0	1	1	0	1	1	1

Table 2. Frogs recorded in the survey areas (September 2013).

Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
Hylidae (Tree frogs)																
<i>Cyclorana platycephala</i>	Water-holding Frog															
Myobatrachidae (Ground frogs)																
<i>Opisthodon spenceri</i>	Spencer's Frog															
<i>Neobatrachus centralis</i>	Desert Trilling Frog															
<i>Neobatrachus kunapalari</i>	Kunapalari Frog															
<i>Neobatrachus pelobatoides</i>	Humming Frog															
<i>Neobatrachus sutor</i>	Shoemaker Frog															
<i>Neobatrachus wilsmorei</i>	Wilsmore's Frog															
<i>Pseudophryne occidentalis</i>	Western Toadlet				X											
Total Species Recorded: 1		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Notes:

1. The Inland Tree-Frog *Litoria rubella* has been recorded at Minjar Camp and is reported from Badja Station homestead, but is almost certainly introduced at these locations and there is no suitable habitat for the species in the survey areas.

Table 3. Reptiles recorded in the survey areas (September 2013).

Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT7 HR	NT5- Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Bery West
Gekkonidae (geckoes)																
<i>Diplodactylus granariensis</i>	Western Stone Gecko															
<i>Diplodactylus pulcher</i>																
<i>Lucasium maini</i>																
<i>Lucasium squarossum</i>																
<i>Nephrurus vertebralis</i>																
<i>Oedura marmorata</i>	Marbled Velvet Gecko															
<i>Oedura reticulata</i>	Reticulated Velvet Gecko (CS3)															
<i>Rhynchoedura ornata</i>	Beaked Gecko															
<i>Strophurus assimilis</i>	Thorn-tailed Gecko															
<i>Underwoodisaurus milii</i>	Barking Gecko															
<i>Gehyra punctata</i>																
<i>Gehyra variegata</i>	Variegated Dtella															
<i>Heteronotia binoei</i>	Bynoe's Gecko															
Pygopodidae (legless lizards)																
<i>Delma australis</i>																
<i>Lialis burtonis</i>	Burton's Legless Lizard															
<i>Pygopus lepidopus</i>	Common Scaly-foot															
<i>Pygopus nigriceps</i>	Hooded Scaly-foot															
Agamidae (dragon lizards)																
<i>Caimanops amphiboluroides</i>	Mulga Dragon (CS3)															
<i>Ctenophorus cristatus</i>	Ornate Crevice-Dragon															
<i>Ctenophorus maculatus</i>	Spotted Military Dragon															
<i>Ctenophorus nuchalis</i>	Central Netted Dragon															
<i>Ctenophorus reticulatus</i>	Western Netted Dragon								X		X					
<i>Ctenophorus scutulatus</i>	Lozenge-marked Dragon				X						X					
<i>Moloch horridus</i>	Thorny Devil															
<i>Pogona minor</i>	Western Bearded Dragon										X					
Varanidae (monitors or goannas)																
<i>Varanus caudolineatus</i>	Stripe-tailed Monitor															
<i>Varanus giganteus</i>	Perentie															
<i>Varanus gouldii</i>	Sand Goanna															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Varanus tristis</i>	Black-headed Monitor															
<i>Varanus panoptes</i>	Yellow-spotted Monitor									X		X				
Scincidae (skink lizards)																
<i>Cryptoblepharus buchananii</i>	Buchanan's snake-eyed skink							X			X					
<i>Cryptoblepharus plagiocephalus</i>	Fence Skink															
<i>Ctenotus mimetes</i>					X											
<i>Ctenotus schomburgkii</i>									X							
<i>Ctenotus severus</i>																
<i>Ctenotus uber</i>																
<i>Cyclodomorphus branchialis</i>	Gilled Slender Blue-tongue (CS1)															
<i>Egernia depressa</i>									X							
<i>Egernia stokesii badia</i> check sites	Western Spiny-tailed Skink (CS1)			X												
<i>Eremiascincus richardsonii</i>	Broad-banded Sand-swimmer															
<i>Liopholis inornata</i>	Desert Skink															
<i>Lerista gerrardii</i>																
<i>Lerista macropisthopus</i>																
<i>Lerista kingi</i>																
<i>Lerista nicholli</i>																
<i>Lerista timida</i>																
<i>Menetia greyii</i>	Common Dwarf Skink															
<i>Morethia butleri</i>																
<i>Morethia obscura</i>	Dusky Morethia				X											
<i>Tiliqua occipitalis</i>	Western Blue-tongue															
Typhlopidae (blind snakes)																
<i>Ramphotyphlops australis</i>	Southern Blind Snake															
<i>Ramphotyphlops hamatus</i>																
<i>Ramphotyphlops waitii</i>	Beaked Blind Snake															
Boidae (pythons)																
<i>Antaresia stimsoni</i>	Stimson's Python															
<i>Morelia spilota</i>	Carpet Python (CS1)															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
Elapidae (front-fanged snakes)																
<i>Brachyuropis semifasciata</i>																
<i>Demansia psammophis</i>	Yellow-faced Whipsnake															
<i>Suta fasciata</i>	Jan's Banded Snake															
<i>Parasuta monachus</i>	Gwardar															
<i>Pseudechis australis</i>	Ringed Brown Snake															
<i>Pseudechis butleri</i>	Yellow-spotted Mulga Snake															
<i>Pseudonaja mengdeni</i>																
<i>Pseudonaja modesta</i>	Mulga Snake										X					
<i>Pseudonaja nuchalis</i>	Monk Snake															
<i>Simoselaps bertholdi</i>	Moon Snake															
<i>Furina ornata</i>	Rosen's Snake															
Total Species Recorded: 11		0	0	1	3	0	0	1	3	1	5	1	0	0	0	0

Table 4. Birds recorded in the survey areas (September 2013).

Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
CASUARIIDAE (Cassowaries and emus)																
<i>Dromaius novaehollandiae</i>	Emu	X		X												
MEGAPODIIDAE (Megapodes)																
<i>Leipoa ocellata</i>	Malleefowl (CS1)			X		X			X			X				
PHASIANIDAE (Pheasants and allies)																
<i>Coturnix pectoralis</i>	Stubble Quail															
ANATIDAE (Swans, geese and ducks)																
<i>Chenonetta jubata</i>	Australian Wood Duck															
<i>Tadorna tadornoides</i>	Australian Shelduck															
<i>Anas superciliosa</i>	Pacific Black Duck															
<i>Anas gracilis</i>	Grey Teal															
PODICIPEDIDAE (Grebes)																
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe															
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe															
ARDEIDAE																
<i>Egretta novaehollandiae</i>	White-faced Heron															
THRESKIORNITHIDAE																
<i>Threskiornis spinicollis</i>	Straw-necked Ibis															
COLUMBIDAE (Pigeons and doves)																
<i>Phaps chalcoptera</i>	Common Bronzewing	X														
<i>Ocyphaps lophotes</i>	Crested Pigeon															
<i>Geopelia cuneata</i>	Diamond Dove															
PODARGIDAE (Australian frogmouths)																
<i>Podargus strigoides</i>	Tawny Frogmouth				X											
CAPRIMULGIDAE (Nightjars and allies)																
<i>Eurostopodus argus</i>	Spotted Nightjar															
AEGOTHELIDAE (Owlet-nightjars)																
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar															
APODIDAE (Typical swifts)																
<i>Apus pacificus</i>	Fork-tailed Swift (CS1)															
ACCIPITRIDAE (Osprey, hawks and eagles)																
<i>Elanus axillaris</i>	Black-shouldered Kite															
<i>Lophoictinia isura</i>	Square-tailed Kite															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard															
<i>Milvus migrans</i>	Black Kite															
<i>Haliastur sphenurus</i>	Whistling Kite															
<i>Circus assimilis</i>	Spotted Harrier															
<i>Accipiter fasciatus</i>	Brown Goshawk															
<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk			X												
<i>Aquila audax</i>	Wedge-tailed Eagle	X														
<i>Hieraetus morphnoides</i>	Little Eagle															
FALCONIDAE (Falcons)																
<i>Falco berigora</i>	Brown Falcon												X			
<i>Falco longipennis</i>	Australian Hobby															
<i>Falco hypoleucos</i>	Grey Falcon (CS2)															
<i>Falco subniger</i>	Black Falcon															
<i>Falco peregrinus</i>	Peregrine Falcon (CS1)															
<i>Falco cenchroides</i>	Nankeen Kestrel															
RALLIDAE (Rails, gallinules and coots)																
<i>Gallinula ventralis</i>	Black-tailed Native-hen															
OTIDIDAE (Bustards)																
<i>Ardeotis australis</i>	Australian Bustard (CS2)															
BURHINIDAE (Stone-curlews)																
<i>Burhinus grallarius</i>	Bush Stone-curlew (CS2)															
CHARADRIIDAE (Lapwings, plovers and dotterels)																
<i>Charadrius melanops</i>	Black-fronted Dotterel															
<i>Charadrius australis</i>	Inland Dotterel															
<i>Vanellus tricolor</i>	Banded Lapwing															
TURNICIDAE (Button-quails)																
<i>Turnix velox</i>	Little Button-quail															
<i>Turnix varia</i>	Painted Button-quail															
CACATUIDAE (Cockatoos)																
<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo															
<i>Eolophus roseicapilla</i>	Galah							X								
<i>Cacatua pastinator</i>	Western Corella															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Cacatua sanguinea</i>	Little Corella															
<i>Cacatua leadbeateri</i>	Major Mitchell's Cockatoo (CS1)															
<i>Nymphicus hollandicus</i>	Cockatiel															
PSITTACIDAE (Parrots)																
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet															
<i>Polytelis anthopeplus</i>	Regent Parrot (CS3)															
<i>Barnardius zonarius</i>	Australian Ringneck			X			X			X						
<i>Psephotus varius</i>	Mulga Parrot															
<i>Melopsittacus undulatus</i>	Budgerigar															
<i>Neosephotus bourkii</i>	Bourke's Parrot															
<i>Neophema splendida</i>	Scarlet-chested Parrot (CS3)															
CUCULIDAE (Old world cuckoos)																
<i>Cuculus pallidus</i>	Pallid Cuckoo															
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo															
<i>Chrysococcyx osculans</i>	Black-eared Cuckoo				X											
<i>Chrysococcyx basalis</i>	Horsfield's Bronze- Cuckoo															
<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo															
STRIGIDAE (Hawk owls)																
<i>Ninox novaeseelandiae</i>	Southern Boobook				X											
TYTONIDAE (Barn owls)																
<i>Tyto alba</i>	Barn Owl															
HALCYONIDAE (Kingfishers)																
<i>Dacelo novaeguineae</i>	Laughing Kookaburra															
<i>Todiramphus pyrrhopygia</i>	Red-backed Kingfisher															
<i>Todiramphus sanctus</i>	Sacred Kingfisher									X						
MEROPIIDAE (Bee-eaters)																
<i>Merops ornatus</i>	Rainbow Bee-eater (CS1)															
CLIMACTERIDAE (Australo-Papuan treecreepers)																
<i>Climacteris rufa</i>	Rufous Treecreeper (CS3)															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
PTILINORHYNCHIDAE																
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird															
MALURIDAE (Fairy-wrens, emu-wrens and grasswrens)																
<i>Malurus splendens</i>	Splendid Fairy-wren				X				X		X					
<i>Malurus lamberti</i>	Variegated Fairy-wren															
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren															
<i>Malurus leucopterus</i>	White-winged Fairy-wren															
PARDALOTIDAE (Pardalotes, scrubwrens, thornbills and allies)																
<i>Pardalotus striatus</i>	Striated Pardalote									X						
<i>Sericornis frontalis</i>	White-browed Scrubwren															
<i>Hylacota cauta</i>	Shy Heathwren (CS2)															
<i>Calamanthus campestris</i>	Rufous Fieldwren (CS2)															
<i>Pyrrholaemus brunneus</i>	Redthroat (CS3)	X	X		X			X	X		X					
<i>Drymodes brunneopygi</i>	Southern Scrub-robin (CS3)															
<i>Smicronis brevirostris</i>	Weebill			X	X			X	X	X						
<i>Gerygone fusca</i>	Western Gerygone															
<i>Acanthiza apicalis</i>	Inland Thornbill												X			
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	X		X	X	X	X	X		X			X			
<i>Acanthiza robustirostris</i>	Slaty-backed Thornbill															
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill															
<i>Aphelocephala leucopsis</i>	Southern Whiteface	X								X						
MELIPHAGIDAE (Honeyeaters)																
<i>Anthochaera carunculata</i>	Red Wattlebird															
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	X			X		X		X	X	X	X				
<i>Manorina flavigula</i>	Yellow-throated Miner			X									X			
<i>Lichenostomus virescens</i>	Singing Honeyeater				X				X							
<i>Lichenostomus leucotis</i>	White-eared Honeyeater															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater															
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater															
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater															
<i>Lichmera indistincta</i>	Brown Honeyeater															
<i>Phylidonyris albifrons</i>	White-fronted Honeyeater								X							
<i>Conopophila whitei</i>	Grey Honeyeater (CS3)															
<i>Certhionyx niger</i>	Black Honeyeater															
<i>Certhionyx variegatus</i>	Pied Honeyeater															
<i>Epthianura tricolor</i>	Crimson Chat															
<i>Epthianura aurifrons</i>	Orange Chat															
<i>Epthianura albifrons</i>	White-fronted Chat															
POMATOSTOMIDAE (Babblers)																
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler															
<i>Pomatostomus superciliosus</i>	White-browed Babbler (CS2)												X			
CINCLOSOMATIDAE (Quail-thrushes and allies)																
<i>Psophodes occidentalis</i>	Chiming Wedgebill															
<i>Cinlosoma castanotum</i>	Chestnut Quail-thrush								X							
<i>Cinlosoma castaneothorax</i>	Chestnut-breasted Quail-thrush															
NEOSITTIDAE (Sittellas)																
<i>Daphoenositta chrysoptera</i>	Varied Sittella															
CAMPEPHAGIDAE (Cuckoo-shrikes and trillers)																
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike					X										
<i>Coracina maxima</i>	Ground Cuckoo-shrike															
<i>Lalage sueurii</i>	White-winged Triller															
PACHYCEPHALIDAE (Whistlers, shrike-thrushes and allies)																
<i>Oreoica gutturalis</i>	Crested Bellbird (CS2)	X						X	X	X	X	X				
<i>Pachycephala inornata</i>	Gilbert's Whistler (CS3)															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Pachycephala pectoralis</i>	Golden Whistler (CS3)															
<i>Pachycephala rufiventris</i>	Rufous Whistler				X					X		X				
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	X	X		X		X	X	X							
ARTAMIDAE (Woodswallows, butcherbirds and currawongs)																
<i>Artamus personatus</i>	Masked Woodswallow															
<i>Artamus superciliosus</i>	White-browed Woodswallow															
<i>Artamus cinereus</i>	Black-faced Woodswallow															
<i>Artamus minor</i>	Little Woodswallow															
<i>Cracticus torquatus</i>	Grey Butcherbird			X	X		X	X								
<i>Cracticus nigrogularis</i>	Pied Butcherbird			X												
<i>Gymnorhina tibicen</i>	Australian Magpie															
<i>Strepera versicolor</i>	Grey Currawong							X					X			
DICRURIDAE (Monarchs, fantails and drongos)																
<i>Myiagra inquieta</i>	Restless Flycatcher															
<i>Grallina cyanoleuca</i>	Magpie-lark															
<i>Rhipidura albiscapa</i>	Grey Fantail															
<i>Rhipidura f. albicauda</i>	White-tailed Fantail									X						
<i>Rhipidura leucophrys</i>	Willie Wagtail															
CORVIDAE (Crows and allies)																
<i>Corvus coronoides</i>	Australian Raven															
<i>Corvus bennetti</i>	Little Crow															
<i>Corvus orru</i>	Torresian Crow	X							X							
PETROICIDAE (Robins)																
<i>Microeca leucophaea</i>	Jacky Winter															
<i>Petroica multicolor</i>	Scarlet Robin (CS3)															
<i>Petroica goodenovii</i>	Red-capped Robin									X						
<i>Melanodryas cucullata</i>	Hooded Robin															
<i>Eopsaltria griseogularis</i>	Western Yellow Robin (CS3)															
SYLVIIDAE (Old world warblers)																
<i>Cinclorhamphus mathewsi</i>	Rufous Songlark															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Cinclorhampus cruralis</i>	Brown Songlark															
ZOSTEROPIDAE (White-eyes)																
<i>Zosterops lateralis</i>	Silvereye															
HIRUNDINIDAE (Swallows and martins)																
<i>Cheramoeca leucosternum</i>	White-backed Swallow															
<i>Hirundo neoxena</i>	Welcome Swallow															
<i>Hirundo nigricans</i>	Tree Martin															
<i>Hirundo ariel</i>	Fairy Martin															
DICAEIDAE (Flowerpeckers)																
<i>Dicaeum hirundinaceum</i>	Mistletoebird															
PASSERIDAE (Sparrows, weaverbirds, waxbills and allies)																
<i>Taeniopygia guttata</i>	Zebra Finch															
MOTACILIDAE (Old world wagtails and pipits)																
<i>Anthus novaeseelandiae</i>	Richard's Pipit															
Total Species Recorded: 35		10	2	9	12	3	5	8	11	11	4	4	6	0	0	0

Table 5. Mammals recorded in the survey areas (September 2013).

Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Wolf HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
TACHYGLOSSIDAE (Echidnas)																
<i>Tachyglossus aculeatus</i>	Echidna									X	X					
DASYURIDAE (Dasyurids)																
<i>Antechinomys laniger</i>	Kultarr (CS3)															
<i>Ningauai ridei</i>	Wongai Ningauai															
<i>Pseudantechinus woolleyae</i>	Woolley's Pseudantechinus (CS3)	X														
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart															
<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart															
MACROPODIDAE (Kangaroos, wallabies)																
<i>Macropus fuliginosus</i>	Western Grey Kangaroo															
<i>Macropus robustus</i>	Euro, Biggada	X	X	X	X	X	X	X	X	X						
<i>Macropus rufus</i>	Red Kangaroo, Marlu															
PHALANGERIDAE (brush-tailed possums)																
<i>Trichosurus vulpecula</i>	Common Brush-tailed Possum (CS3)															
BURRAMYIDAE (Pygmy possums)																
<i>Cercartetus concinnus</i>	Western Pygmy-possum															
EMBALLONURIDAE (Sheathtail bats)																
<i>Taphozous hilli</i>	Hill's Sheathtail-bat															
VESPRTLIONIDAE (Vespertilionid bats)																
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat															
<i>Chalinolobus morio</i>	Chocolate Wattled Bat															
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat															
<i>Nyctophilus timoriensis</i>	Greater Long-eared Bat															
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat															
<i>Scotorepens greyii</i>	Little Broad-nosed Bat															
<i>Vespadelus baverstocki</i>	Inland Forest Bat															
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat															
<i>Vespadelus regulus</i>	Southern Forest Bat															
MOLOSSIDAE (Freetail bats)																
<i>Mormopterus sp. Listed as Species 3 by Adams et al. (1988).</i>	Inland Freetail-bat															

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Species Name	Common Name (Conservation status)	Paradise City	NT 15	NT15 HR	Goats-Altwn HR	NT13-NT2 HR	NT5-Woif HR	Bugeye North	Sprite	NT26	Fairey Well	Sunbeam	Keranne	NT25	Spacely	Beryl West
<i>Mormopterus sp. Listed as Species 4, population O by Adams et al. (1988).</i>	Western Freetail-bat															
<i>Tadarida australis</i>	White-striped Freetail-bat															
MURIDAE (Rats and mice)																
<i>Mus musculus</i>	House Mouse															
<i>Notomys mitchellii</i>	Mitchell's Hopping-mouse															
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse															
LEPORIDAE (Rabbits and hares)																
<i>Oryctolagus cuniculus</i>	Rabbit	X	X	X	X	X	X	X	X	X						
CANIDAE (Dogs and foxes)																
<i>Canis lupus</i>	Dog/Dingo															
<i>Vulpes vulpes</i>	Red Fox															
FELIDAE (Cats)																
<i>Felis catus</i>	Cat															
BOVIDAE (Horned ruminants)																
<i>Capra hircus</i>	Goat	X	X	X	X	X	X	X	X	X						
Total Species Recorded: 5		4	3	3	3	3	3	3	3	4	1	0	0	0	0	0