

Fauna Assessment of the Mount Martin Mining Lease Area

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EXECUTIVE SUMMARY

The Alacer Gold Corporation (Alacer) proposes to expand existing mining operations at the Mount Martin mine, approximately 32 km south of Kalgoorlie, in the Goldfields region of Western Australia. Mount Martin has been previously mined, containing an open pit, waste dumps and associated infrastructure. Alacer proposes to expand the existing open pit and waste dump at Mount Martin.

As part of the Environmental Impact Assessment for the Project, Bamford Consulting Ecologists (BCE) was commissioned by Alacer to conduct a Level 1 fauna survey (desktop review and fauna assessment) of the Mount Martin Mining Lease – termed the “survey area”. 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, where possible, minimised.

The assessment process involved the following components:

- The identification of fauna values:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Recognition of vegetation and soil associations (VSAs) that provide habitat for fauna;
 - Species of conservation significance; and
 - Ecological processes upon which the fauna depend.
- The review of impacting ecological processes such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - 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.

The identification of fauna values involved a desktop assessment and reconnaissance field survey in February 2012. The desktop survey identified 292 fauna species potentially occurring in the South Kalgoorlie Mount Martin survey area. This comprised six frog, 85 reptile, 166 bird, 25 native mammal and ten introduced mammal species. A total of 47 fauna species were recorded during the field survey. This comprised six reptile, 29 bird, eight native mammal and four introduced mammal species. Three conservation significant fauna species were recorded during the field survey.

Sixteen (16) conservation significant fauna species expected are of particular importance as these species are likely to have resident populations within the survey area (at least on a seasonal basis). Targeted searching did not locate any evidence of the Malleefowl within the survey area, however an old, inactive mound was found outside the project area on the slopes of Mount Martin.

Five major VSAs were identified; of most significance were the greenstone hills - a restricted VSA in the area and are likely to support conservation significant and specialist species. Additionally, large, mature, hollow bearing Eucalypt trees were

identified as providing a significant resource to local fauna and some may contain nesting or roosting sites for conservation significant fauna.

Impacts upon fauna values are generally considered to be only minor, even upon the majority of significant species. This is because of the relatively small footprint of the project which is located mostly within widespread, common and disturbed habitats.

Impacts upon fauna due to the construction and operation of the project may include: fauna mortality, loss of habitat, fragmentation of habitats, increases in feral predators, changes in hydrology, habitat degradation due to weed invasions, changes to the fire regime and unknown impacts of dust, noise, light and disturbance. Most ecological processes are expected to have only negligible or minor impacts, with the exceptions being increased mortality and habitat loss. A number of management measures are recommended to minimise potential impacts.

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1 INTRODUCTION

1.1 Introduction

The Alacer Gold Corporation (Alacer) proposes to expand existing mining operations at the Mount Martin mine, approximately 32 km south of Kalgoorlie, in the Goldfields region of Western Australia. Mount Martin has been previously mined, containing an open pit, waste dumps and associated infrastructure. Alacer proposes to expand the existing open pit and waste dump at Mount Martin.

As part of the Environmental Impact Assessment for the Project, Bamford Consulting Ecologists (BCE) was commissioned by Alacer to conduct a Level 1 fauna survey (desktop review and site inspection) of the Mount Martin area, termed the “survey area”. The Mount Martin survey area lies adjacent to the Mount Martin open pit and covers an area of approximately 175 Ha (see Figure 1). 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, where possible, minimised.

This fauna investigation was conducted during part of a wider fauna assessment of Alacer’s operations. This included Level 1 fauna surveys at Mount Marion (Ghost Crab), Mount Martin, South Kalgoorlie Tailing Storage Facility and the powerline corridor to the South Kalgoorlie operations (see Figure 2).

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. The present fauna impact assessment process includes the components listed below. Descriptions and background information on these values and processes can be found in Appendices 1 to 4.

- The identification of fauna values:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Recognition of vegetation and soil associations (VSAs) that provide habitat for fauna;
 - Species of conservation significance; and
 - Ecological processes upon which the fauna depend.
- The review of impacting ecological processes, with respect to these values and the proposed development, such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - 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.

Figure 1. Mount Martin survey area. Note the Mount Martin survey area lies adjacent to the Mount Martin open pit.



Figure 2. Regional location of the Mount Martin survey area, showing other Alacer survey areas.



2 BACKGROUND

2.1 Regional Description

The Interim Biogeographic Regionalisation of Australia (IBRA) has identified 26 bioregions in Western Australia (Figure 3). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell, 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA, 2004).

The Mount Martin survey area lies within the Coolgardie Bioregion and the Eastern Goldfields Subregion (Coolgardie 3, IBRA, 2008, see Figure 2). The Coolgardie Bioregion falls within the Bioregion Group 2 classification (EPA, 2004). Bioregions within Group 2 have “native vegetation that is largely contiguous but is used for commercial grazing.”

Figure 3 IBRA Subregions in Western Australia. Note the project lies in COO3: Eastern Goldfields Subregion.



Cowan (2001) describes the Eastern Goldfields subregion as:

“The vegetation is of Mallees, Acacia thickets and shrubheaths on sandplains. Diverse Eucalyptus woodlands occur around salt lakes, on ranges, and in valleys. Salt lakes support dwarf shrublands of samphire. Woodlands and Dodonaea shrubland occur on basic graninulites of the Fraser Range. The area is rich in endemic Acacias. The climate is Arid to Semi-arid with 200-300 mm of rainfall, sometimes in summer but usually in winter. The subregional area is 5, 102, 428 ha.”

The dominant land use in this subregion is grazing, with smaller areas of crown reserves, mining, freehold, and conservation. Only 4.35 % of the sub-region is vested within conservation reserves (Cowan, 2001). Cowan (2001) describes the Goldfields Woodlands as having an exceptionally high diversity of Eucalyptus species with as many as 170 species occurring in the bioregion.

2.2 Vegetation Units

The survey area lies within the Coolgardie System. All woodlands in the Coolgardie System have been logged in the past for mining timber and firewood so that stands seen today are secondary growth that has regenerated from seed and coppice (Beard 1972).

Beard (1972, 1975) mapped the Kalgoorlie region including the Mount Martin area. Two vegetation communities were mapped in the Mount Martin area:

1. e8, 13Mi: Salmon Gum (*Eucalyptus salmonophloia*) / *E. le souefii* Woodland;
2. e12, 13Mi: *Eucalyptus torquata* / *E. lesouefii* Woodland;

Beard (1972) describes the vegetation of the region with two sub units occurring in the survey area:

1. Greenstone Ridges supporting a characteristic *Eucalyptus torquata* – *E. le souefii* association. It occurs solely within the Coolgardie System. Both *E. torquata* and *E. le souefii* are co-dominant, abundant and characteristic. Associated trees include *E. clelandii*, *E. campaspe*, *Casuarina pauper* and *Grevillea nematophylla*. There is an open shrub understorey, largely of *Eremophila* spp. (“Broombush”), *Dodonia lobulata*, *Senna cardiosperma* and *Acacia* species, interspersed with *Atriplex nummularia*. Two understorey types, “broombush” or “saltbush” occur on slopes, with broombush appearing on less alkaline soils.
2. Eucalypt Woodlands of the lower slopes and flats consist typically of *Eucalyptus salmonophloia*, often with *E. salubris*, *E. torquata* and *E. longicornis*. *Melaleuca pauperiflora* (boree) occurs as a dominant understorey on heavy, periodically wet soils (Beard, 1972)

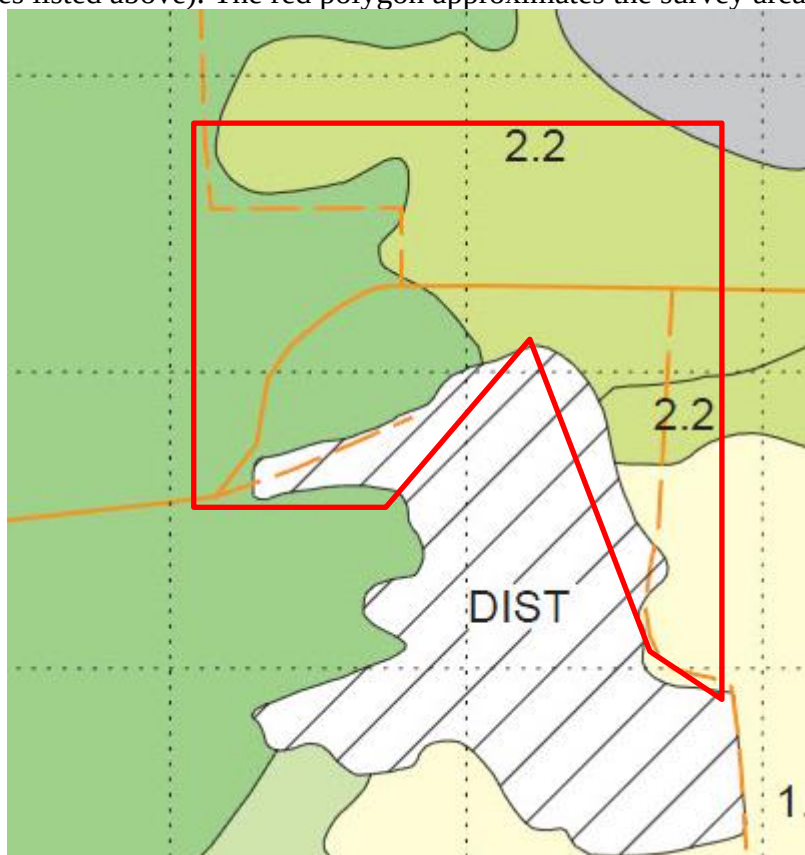
The vegetation of the Mount Martin survey area has also been mapped by Western Botanical (2004) and Alexander Holm and Associates (2011). Western Botanical mapped three vegetation communities across the Mount Martin survey area (see Figure 4):

- 1.1: Woodlands of *Eucalyptus torquata*, *E. lesouefii* with sclerophyll shrubs on subcropping mafic basalt, dolerite, gabbro and felsic porphyry;
- 2.2: Eucalypt Woodlands with sclerophyll understorey on deep alluvial clays and loams; and
- 2.4: Eucalypt Woodlands with *Maireana sedifolia* (Pearl Bluebush).

Alexander Holm and Associates (2011) mapped two units within the Mount Martin survey area:

- 2A: GEHW: Greenstone hill Eucalypt Woodland with halophytic understorey;
- 3B: PXHS: Plain mixed halophyte shrubland.

Figure 4. Vegetation of the Mount Martin Survey Area (Western Botanical survey codes listed above). The red polygon approximates the survey area boundary.



2.3 Soil Landscape Zones

Tille (2006), mapped the Soil Landscapes of the arid interior of Western Australia, including the Kalgoorlie region. Soil landscape zones were mapped according to similarities of landform, vegetation, geology, soils and vegetation. The Mount Martin survey area lies within one soil-landscape zones:

266: Norseman Zone:

Undulating plains and uplands (with some sandplains and salt lakes) on granitic rocks of the Yilgarn Craton. Salmon gum-redwood-merrit-red mallee- gimlet woodland with Acacia-casuarina thickets (and some mulga shrublands and spinifex grasslands).

2.4 Great Western Woodlands

The survey area lies within the Great Western Woodlands, a large tract of Eucalypt Woodland extending from the Wheatbelt to the inland deserts of Western Australia (Watson *et. al.*, 2008). The Great Western Woodlands is the largest remaining intact temperate woodland in the world and extends from Southern Cross to Kalgoorlie and east to Balladonia, and south to near Ravensthorpe. The Great Western Woodlands is one of the very few, large, intact landscapes remaining in temperate Australia and is of Global significance (Watson *et. al.*, 2008).

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, EPA 2010). 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 data 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 size and location of the proposed project Alacer requested a Level 1 fauna assessment. A Level 1 fauna assessment consists of a desktop study and basic ground-truthing through a reconnaissance survey.

Therefore the approach of the present fauna assessment is comprised of the following:

- 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 survey area based on unpublished and published data using a precautionary approach.
- Field survey. The purpose of a reconnaissance survey is to verify the accuracy of the desktop study; to further delineate and characterise the fauna and faunal assemblages present in the target area; and to identify potential impacts.
- Impact assessment. The purpose of the impact assessment is to 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. Recommendations to minimise any impacts of the project on the fauna are then provided.

3.2 Desktop Assessment

3.2.1 Sources of information

Information for this fauna assessment was drawn primarily from the Department of Environment and Conservation (DEC) database NatureMap (DEC, 2012), the Birds Australia Atlas Database (Birds Australia, 2012) and the EPBC Protected Matters Search Tool (SEWPaC, 2012a). All databases were interrogated in January 2012 (see Table 1). This information 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, 1990, 1999 and 2002), birds (Blakers *et al.* 1984, Johnstone and Storr 1998, Johnstone and Storr 2004), and mammals (Churchill 1998, Strahan 1995, Menkhorst and Knight 2001). Results of the desktop assessment provided guidance as to the methodology employed during the reconnaissance survey.

Within the vicinity of the survey area, several fauna surveys and assessments have been conducted (Table 2). These include surveys at St Ives (30 km south-west of Mount Martin – Ninox, 2004, Western Wildlife, 2005, BCE 2010) and at Black Flag (60 km north of South Kalgoorlie Mount Martin - Biological Surveys Committee of Western Australia). The Biological Surveys Committee of Western Australia coordinated an inventory of vegetation, flora and fauna of the Eastern Goldfields, including the Kalgoorlie area (Records of Western Australian Museum, Supplement 41). Species recorded during these surveys are listed in Appendix 5.

Additionally, DEC was consulted for information on the Arid Bronze Azure (*Ogyris subterrestris petrina*) and other threatened butterflies.

Table 1. Sources of information used for desktop assessment

Title	Comments	Area searched / Year
NatureMap	Records of specimens held in the WA Museum. DEC records, Information and records on Threatened and Priority species.	30 53 23S, 121 32 07E - plus 40km buffer
Birds Australia Atlas Database	Records of bird observations in Australia, 1998-2011.	Species list for 1 degree grid cell containing 121.52425E, 30.87308S
EPBC Protected Matters Search Tool	Records on matters protected under the EPBC Act, including threatened species, conservation estate.	30 53 23S, 121 32 07E - plus 10km buffer
St Ives Fauna Assessment	Level 2 Fauna Assessment, conducted at St Ives Gold Mine by Bamford Consulting Ecologists.	2009
St Ives Fauna Survey	Level 2 Fauna Assessment, conducted at St Ives by Western Wildlife.	2006
St Ives Fauna Survey	Level 2 Fauna Assessment, conducted at St Ives by Ninox Wildlife Consulting.	2004
Biological Survey of the Eastern Goldfields	Part 8: Kurnalpi – Kalgoorlie Study Area	1979 - 1981

3.2.2 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 2010*. 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 tables in the appendices.

3.2.3 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. 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. This is because fauna are highly mobile, often seasonal and frequently cryptic. This is particularly important for 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 important 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

The field survey included several components:

1. targeted searching for conservation significant fauna,
2. bird census;
3. bat surveys;
4. use of motion-sensitive cameras;
5. opportunistic fauna survey sites;
6. habitat assessment; and
7. opportunistic observations.

3.3.2 Dates and Personnel

The Mount Martin survey area was visited on 1st and 2nd February 2012 by Mr Jeff Turpin (B.Sc.Zool) and Mr Tim Gamblin (B.Sc.Zool.Cert. Env. Man). The field survey was conducted under DEC Regulation 17 (Licence to take Fauna for Scientific Purposes) licence number SF008429. This fauna assessment document was prepared by Mr Jeff Turpin and Dr Mike Bamford (B.Sc. Hons. Ph.D), and was reviewed by Mr Tim Gamblin.

3.3.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) throughout the survey area were assessed during the desktop review and as part of the field investigations. Within the Mount Martin survey area each major VSA was visited to develop an understanding of major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area.

3.3.4 Targeted searching for conservation significant species

Significant species recorded during the desktop assessment include several that can be found by searching for evidence of their activities (e.g. scats, tracks, diggings, burrows). These included the Malleefowl (which creates distinctive mounds and has distinctive tracks), Trapdoor Spiders (which build distinctive burrows) and *Camponotus terebrans* which have distinctive gallery entrances at the base of certain eucalypts. These provide shelter for the threatened Arid Bronze Azure Butterfly. Searching for evidence of significant fauna was therefore undertaken by walking through habitat considered suitable for such species.

3.3.5 Opportunistic Survey sites

Six opportunistic fauna sites were selected and sampled opportunistically for fauna (Table 2). Sites were selected to sample all VSAs occurring within the survey area. Methods employed at each site included a bird census (see Section 3.3.6), searching for significant fauna, habitat assessment and microhabitat searching for smaller vertebrates and invertebrates. Details of the fauna sites are given in Table 2 (note UTM Zone 51J).

Table 2. Opportunistic fauna survey sites

Site	Easting	Northing	VSA/Habitat
1	374858	6568337	Greenstone hill and adjacent gully
2	374903	6568917	Low stony rises
3	374511	6569559	Eucalypt Woodland
4	373957	6569523	Mixed shrubland / Minor drainage tract
5	373337	6569170	Eucalypt Woodland / Chenopod Plain
6	375728	6567913	Mount Martin

3.3.6 Bird census

Bird censuses were based on the method recommended for the Birds Australia Atlas (2 ha area search for 20 minutes). Bird censuses were conducted at each opportunistic survey site.

3.3.7 Bat surveys

Ultrasonic echolocation calls of bats were recorded with an AnaBat SD1 bat detector, and later processed using AnalookW software (Titley Scientific, Brisbane). Identification of species was assisted by measuring the following echolocation call parameters:

- Fmax Maximum call frequency (kHz)
- Fmin Maximum call frequency (kHz)
- Fc Characteristic frequency (kHz)
- Fpeak Frequency with peak number of cycles (kHz)
- DUR Duration of call (ms)

The AnaBat detector was deployed overnight at two sites (see Table 3).

Table 3. Bat Detector survey Sites (Zone 51J)

Site	Easting	Northing	Date	VSA/Habitat
Bat 1	374832	6568545	1/02/12	Densely vegetated gully adjacent to greenstone hill
Bat 2	373330	6569174	1/02/12	Salmon Gum Woodland over chenopod shrubland

3.3.8 Motion-sensitive cameras

Three motion-sensitive camera sites were established within the survey area to record fauna. Motion cameras were set in three areas - on a rocky outcrop on the crest of a greenstone hill, within Eucalypt Woodland and on the crest of Mount Martin (see Table 4). All cameras were baited with universal bait (sardines, peanut butter, rolled oats).

Table 4. Motion-sensitive camera sites (Zone 51J)

Site	Easting	Northing	Date	VSA/Habitat	# Nights
1	374858	6568337	1/02/12	Rock outcrop, greenstone hill	1
2	373337	6569170	1/02/12	Salmon Gum Woodland over chenopod shrubland	1
3	375728	6567913	1/02/12	Rock outcrop, Mount Martin	1

3.3.9 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.

3.4 Limitations

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during fauna surveying. These survey limitations are addressed for the current survey in Table 5 below.

Table 5. survey limitations as per EPA Guidance Statement 56 (EPA 2004)

Limitation	Comment
Level of survey.	Level 1 (desktop study and reconnaissance survey). survey intensity was deemed adequate due to the size of project and number of fauna surveys previously conducted in the region
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews and site inspections.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	Birds were extensively sampled however due to the nature of the survey, low level sampling was conducted for reptiles, amphibians and mammals.
Proportion of fauna identified, recorded and/or collected.	No species collected, all fauna observed identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous reports on the fauna of the local area (BCE database); databases (BA, DEC, WAM, EPBC); BCE (and other) surveys in nearby areas at St Ives, Black Flag.
The proportion of the task achieved and further work which might be needed.	Site inspection completed.
Timing/weather/season/cycle.	Site inspection conducted during February 2012. Conditions were mild.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No disturbances affected the survey.
Intensity. (In retrospect, was the intensity adequate?)	Survey intensity was low (desktop study and site inspection) however was adequate to satisfy EPA guidelines.
Completeness (e.g. was relevant area fully surveyed).	Desktop study covered survey area and adjacent habitats. Site inspection covered all areas of the project.
Resources (e.g. degree of expertise available in animal identification to taxon level).	All species identified to taxon level.
Remoteness and/or access problems.	No access problems.
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

3.5 Impact Assessment

3.5.1 Fauna values and ecological processes

As outlined in Section 1.2, the impact assessment process involves identifying fauna values and reviewing impacting ecological processes. Fauna values include fauna assemblage and distribution, VSAs, and conservation significant fauna (see Appendix 1). Ecological processes that may impact upon these fauna values are discussed in Appendix 2, with processes specific to this project examined in Section 5.4. While some impacts are unavoidable during a development, of concern are long-term, deleterious impacts upon biodiversity. These are discussed under the following categories:

- VSAs. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.
- Conservation significant fauna. Impacts may be significant if species of conservation importance are affected.
- Processes. Ecological processes are complex and can include hydrology, fire, predator/prey relationships and spatial distribution of a population. Impacts upon ecological processes may be significant if large numbers of species or large proportions of populations are affected.

3.5.2 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 6). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

Table 6. Criteria for impact assessment

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 survey 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 Vegetation and Substrate Associations

Five major VSAs were identified during field investigations. These are:

1. Greenstone hills and ridges supporting Eucalypt Woodlands, with areas of dense *Acacia* spp. and *Allocasuarina* sp.
2. Stony lower slopes and adjacent stony plains supporting Woodlands of *Eucalyptus torquata*, *E. lesouefii* with sclerophyll shrubs;
3. Eucalypt Woodlands with a sclerophyll understorey on deep alluvial clays and loams;
4. Salmon Gum (*Eucalyptus salmonophloia*) Woodland with *Maireana sedifolia*;
5. Minor drainage tracts supporting mixed shrublands on red loam.

In addition to the five VSAs, previously cleared or disturbed areas also occur. VSAs are described below and photographs of each VSA are presented in Plates 1 to 10.

1. Greenstone hills and ridges supporting Eucalypt Woodlands (**Plates 1 to 3**)
 - A series of greenstone hills and ridges occur in the south-east corner of the survey area. These flank Mount Martin, the summit of which lies just to the south-east of the survey area.
 - Vegetation includes Eucalypt Woodlands on the hill slopes with the crests typically supporting dense shrublands of *Acacia* (*Acacia* spp.) and *Allocasuarina* (*Allocasuarina* spp.).
 - The ridge crests contain some minor areas of outcropping, with boulders and small caves.
 - Some minor drainage lines occur in gullies between the ridges and support Eucalypt Woodlands with a dense shrub layer.
2. Stony lower slopes and adjacent stony plains supporting Woodlands of *Eucalyptus torquata*, *E. lesouefii* with sclerophyll shrubs (**Plates 4 to 6**)
 - This VSA occurs adjacent to the greenstone hills and extends north from the south-east corner of the survey area;
 - Vegetation is dominated by Woodlands of *Eucalyptus torquata*, *E. lesouefii* with sclerophyll shrubs. Thickets of Boree (*Melaleuca pauperiflora*) and areas of *Casuarina pauper* occur on minor stony rises.
3. Eucalypt Woodlands with a sclerophyll understorey on deep alluvial clays and loams (**Plate 7 to 8**);
 - This VSA occurs across the northern parts of the survey area and occurs in areas of deep alluvial clays and loams.
 - Vegetation comprises mixed Eucalypt Woodlands (including *Eucalyptus lesouefii*, *Eucalyptus torquata* and *Eucalyptus salmonophloia*) with a variable understorey dominated by non halophytic shrubs (*Melaleuca* spp., *Eremophila* spp., *Acacia* spp.).

4. Salmon Gum (*Eucalyptus salmonophloia*) Woodland with *Maireana sedifolia* **(Plate 9)**
 - Occurs in the north-west of the survey area.
 - Vegetation is dominated by *E. salmonophloia* over Bluebush (*Maireana* species particularly *Maireana sedifolia*) with areas of Saltbush (*Atriplex nummularia*, *A. vesicaria*). The woodland becomes open towards the western boundary.
5. Minor drainage tracts supporting mixed shrublands on red loam **(Plate 10)**
 - A wide, minor drainage tract occurs across the north of the survey area.
 - Vegetation includes shrublands of dense Acacia, Saltbush (*Atriplex* spp.), *Pittosporum angustifolium* and *Eremophila* and *Senna* species.

Plate 1. VSA 1 – Greenstone Hill crest with outcropping, dense shrublands and Eucalypt Woodland.



Plate 2. VSA 1 – Greenstone Hill slope supporting Eucalypt Woodland.



Plate 3. VSA 1 – Gully in between greenstone ridges supporting Eucalypt Woodland and a dense shrub layer.



Plate 4. VSA 2 - low stony rises and undulating stony plains supporting mixed Eucalypt Woodlands with a variable shrub layer.



Plate 5. VSA 2 - low stony rises and undulating stony plains supporting mixed Eucalypt Woodlands with a variable shrub layer.



Plate 6. VSA 2 - Boree (*Melaleuca pauperiflora*) thicket.



Plate 7. VSA 3 - Eucalypt Woodlands with a sclerophyll understorey on deep alluvial clays and loams



Plate 8. VSA 3 - Eucalypt Woodlands with a sclerophyll understorey on deep alluvial clays and loams.



Plate 9. VSA 4 - Loam plains supporting Eucalypt Woodland over mixed shrubs.



Plate 10. VSA 5 - Minor drainage tracts supporting mixed shrublands on red loam.



4.2 Vertebrate Fauna

4.2.1 Overview of fauna assemblage

The vertebrate fauna with the potential to occur (including those also recorded) in the Mount Martin survey area is presented in Appendix 5. The faunal assemblage expected is typical of the Kalgoorlie region. Most fauna species occurring or expected to occur in the survey area are widespread but some species may have restricted or habitat limited distributions, and some fauna species expected have declined in the region. The composition of the vertebrate fauna expected to occur and recorded within the survey area is presented in Table 7 (and see Appendix 5).

The desktop survey identified 292 fauna species potentially occurring in the Mount Martin survey area (Table 7). This comprised six frog, 85 reptile, 166 bird, 25 native mammal and ten introduced mammal species. Thirty two (32) conservation significant species are considered likely to occur within the survey area (either as a resident or as a visitor on seasonal basis, see Table 8). This includes one reptile (1 CS1), 25 bird (11 CS1, 3 CS2, 11 CS3), four mammal (1 CS1, 1 CS2, 2 CS3) and two invertebrate (1CS1, 1 CS2) species.

A total of 47 fauna species were recorded during the field survey (Table 7, see Appendix 6). This comprised six reptile, 29 bird, eight native mammal and four introduced mammal species. Three conservation significant fauna species were recorded during the field survey (Table 9). Evidence of the previous occurrence of a fourth conservation significant species (Burrowing Bettong) was recorded from the survey area, however this species is considered regionally extinct and it is not included in species counts.

Locations of significant species recorded during the survey are provided in Appendix 7. Details of each conservation significant species expected to occur in the survey area are provided in Table 8. Conservation significant fauna species occurring or likely to occur in the survey area are discussed below.

Table 7. Composition of vertebrate fauna expected to occur and recorded in the survey area

Taxon	Total species expected in Mount Martin survey area	Number species recorded		Significant fauna expected (recorded) in survey area			
		Mount Martin	All Alacer Survey Areas				
				CS1	CS2	CS3	INT
Frogs	6	0	0	0	0	0	0
Reptiles	85	6	11	1	0	0	0
Birds	164	29	77	11 (1)	3	11 (2)	0
Native Mammals	25	8		1	1	2	0
Introduced Mammals	10	4	6	-	-	-	10
Invertebrates	NA	-	7	1	1	-	-
Total	292	47		14	5	13	10

Table 8. Conservation status and habitat of conservation significant species expected to occur in the survey Area

Conservation status as described in Appendices 1 and 3. Species listed under “EPBC” and “WA Act” are considered CS1; species listed under “DEC” are considered C2; species listed under “Local” are considered CS3. Species recorded during the field survey are indicated; “L” indicates species that are considered locally significant.

CONSERVATION SIGNIFICANT FAUNA		Conservation Status				Records		Habitat		Expected Status
COMMON NAME	SPECIES NAME	EPBC	WA Act	DEC	Local	Survey Area	Local Area	Type	Present In Survey Area	Survey Area
Reptiles										
Carpet Python	<i>Morelia spilota imbricata</i>		S4				Kalgoorlie, Kambalda	Eucalypt Woodland	Yes	Resident
Birds										
Malleefowl	<i>Leipoa ocellata</i>	VUL	S1			Recorded	Mount Martin	Acacia shrublands, dense woodlands	Yes	Visitor / Resident
Slender-billed Thornbill	<i>Acanthiza iredalei</i>	VUL					Coolgardie	Samphire, Chenopods	Minimal	Unlikely to occur
Peregrine Falcon	<i>Falco peregrinus</i>		S4				St Ives	Rocky ridges, major drainage lines, woodland	Yes	Visitor
Major Mitchell’s Cockatoo	<i>Lophochroa leadbeateri</i>		S4				Coolgardie	Eucalypt Woodland	Yes	Irregular Visitor
Western Rosella	<i>Platycercus icterotis</i>		S1				Kalgoorlie, Coolgardie	Eucalypt and Sheoak Woodlands	Yes	Visitor
Eastern Great Egret	<i>Ardea modesta</i>	MIG	S3				Coolgardie	Wetlands	No	Vagrant
Rainbow Bee-eater	<i>Merops ornatus</i>	MIG	S3				Kalgoorlie	Watercourses, woodland	Yes	Regular Migrant
Fork-tailed Swift	<i>Apus pacificus</i>	MIG	S3				Woolgangie	Aerial	Yes	Irregular Visitor
Common Greenshank	<i>Tringa nebularia</i>	MIG	S3				Kundana	Estuaries, inland lakes, swamps	Minimal	Irregular Visitor

CONSERVATION SIGNIFICANT FAUNA		Conservation Status				Records		Habitat		Expected Status
COMMON NAME	SPECIES NAME	EPBC	WA Act	DEC	Local	Survey Area	Local Area	Type	Present In Survey Area	Survey Area
Wood Sandpiper	<i>Tringa glareola</i>	MIG	S3				Kalgoorlie	Freshwater / Brackish Wetlands	Minimal	Irregular Visitor
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	MIG	S3				Kundana	Coastal and inland wetlands	Minimal	Irregular Visitor
Curlew Sandpiper	<i>Calidris ferruginea</i>	MIG	S3				Kalgoorlie	Wetlands, inland lakes	Minimal	Irregular Visitor
Red-necked Stint	<i>Calidris ruficollis</i>	MIG	S3				Kalgoorlie	Inland mudflats, temporary floodwaters	Minimal	Irregular Visitor
Hooded Plover	<i>Thinornis rubricollis</i>			P4			Lake Yindarlgooda	Inland Lakes	No	Unlikely to occur
Australian Bustard	<i>Ardeotis australis</i>			P4			Credo	Plains	Yes	Visitor
Bush Stone-curlew	<i>Burhinus grallarius</i>			P4			Jilbadji Nature Reserve	Acacia shrublands, Woodlands	Yes	Resident
Crested Shrike-tit	<i>Falcunculus frontatus</i>			P4			Kalgoorlie	Woodland, no recent records	Yes	Vagrant
Shy Heathwren	<i>Hylacola cauta whitlocki</i>			P4			St Ives	Dense mallee shrub thicket	Yes	Resident
Square-tailed Kite	<i>Lophoictinia isura</i>				L		St Ives	Woodland and Heath	Yes	Visitor
Scarlet-chested Parrot	<i>Neophema splendida</i>				L		St Ives	Arid Woodland	Yes	Irregular Visitor
Regent Parrot	<i>Polytelis anthopeplus</i>				L		St Ives	Forest, Woodland	Yes	Resident
Southern Scrub-robin	<i>Drymodes brunneopygia</i>				L		Coolgardie	Mallee, dense shrubs	Yes	Resident
Western Yellow-robin	<i>Eopsaltria griseogularis</i>				L		St Ives, Shirl	Eucalypt Woodland, Forest	Yes	Resident
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>				L		Kalgoorlie	Woodland, Mallee	Yes	Resident

CONSERVATION SIGNIFICANT FAUNA		Conservation Status				Records		Habitat		Expected Status
COMMON NAME	SPECIES NAME	EPBC	WA Act	DEC	Local	Survey Area	Local Area	Type	Present In Survey Area	Survey Area
Rufous Tree-creeper	<i>Climacteris rufus</i>				L		Mount Marion	Woodland with tree hollows	Yes	Resident
Chestnut Quail-thrush	<i>Cinlosoma castanotus</i>				L	Recorded	Kalgoorlie	Woodland, Mallee	Yes	Resident
Gilbert's Whistler	<i>Pachycephala inornata</i>				L		Mt Marion	Mallee, Arid Woodland	Yes	Resident
Yellow-plumed Honeyeater	<i>Lichenostomus ornatus</i>				L	Recorded	Kalgoorlie	Eucalypt Woodland	Yes	Resident
Purple-gaped Honeyeater	<i>Lichenostomus cratitius</i>				L		Kalgoorlie	Eucalypt Woodland	Yes	Resident
Mammals										
Chuditch	<i>Dasyurus geoffroyii</i>	VUL	S1				Southern Cross, Norseman	Woodland, forest, mallee	Yes	Potential Resident
Central Long-eared Bat	<i>Nyctophilus timoriensis</i>			P4			Coolgardie	Woodlands, shrublands	Yes	Resident
Kultarr	<i>Antechinomys laniger</i>				L		Kalgoorlie	Stony plains Open plains	Yes	Visitor
Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>				L		Ora Banda	Rocky Ridges	Yes	Potential Resident
Invertebrates										
Tree-stem Trapdoor Spider	<i>Aganippe castellum</i>			P4			Koolyanobbing	Ironstone ridges, slopes, stony plains	Yes	Unlikely to occur
Arid Bronze Azure	<i>Ogyris subterrestris petrina</i>	*	S1				Lake Douglas	Eucalypt Woodland, smooth barked Eucalypts	Yes	Potential Resident
Inland Hairstreak	<i>Jalmenus aridus</i>			P1			Lake Douglas	<i>Acacia tetragonophylla</i> and <i>Senna nemophila</i>	Yes	Potential Resident
Fairy Shrimp	<i>Branchinella denticulata</i>			P1			Kalgoorlie	Temporary wetlands	No	Unlikely to occur

* Note the Arid Bronze Azure has been nominated for listing under the EPBC Act.

4.2.2 Amphibians

A total of six species of frog may occur in the vicinity of the survey area (Appendix 5). None of the frog species expected is of conservation significance.

4.2.3 Reptiles

A total of 85 reptile species may occur in the vicinity of the Mount Martin survey area (Appendix 5). Six species were recorded during the field survey, including a colony of *Egernia depressa* recorded from a Casuarina tree. The Gould's Goanna (*Varanus gouldii*), *Varanus tristis*, *Ctenophorus cristatus*, Bobtail (*Tiliqua rugosa*) and *Heteronotia binoeii* were also recorded. An additional 5 species were recorded outside the survey area. One reptile species of conservation significance is known from the region and is discussed below (Table 9).

Conservation Significance Level 1 (CS1)

South-west Carpet Python (*Morelia spilota imbricata*)

Morelia spilota imbricata, the south-western race of the Carpet Python is listed under Schedule 4 (Other Specially Protected Fauna) of the Wildlife Conservation Act. *Morelia spilota imbricata* occurs in south-west Western Australia, from Northampton, south to Albany and eastwards to Kalgoorlie. It also occurs in large undisturbed remnant bushland near Perth and the Darling Ranges (Bush *et al.*, 2007). This species occurs in Banksia woodland, Eucalypt Woodland, forests, dense coastal scrub, granite and limestone outcrops and along watercourses (Bush *et al.*, 2007). Carpet Pythons are arboreal, terrestrial, and rock-dwelling and can shelter in burrows made by other animals, hollow tree limbs, or rock crevices. The South-west Carpet Python has declined in distribution due to the loss of habitat (associated with land clearance), and changed fire regimes. Predation by exotic predators (foxes and feral cats) may have also contributed to the decline of python populations (Bush *et al.*, 2007).

There are several records of the Carpet Python from the Kalgoorlie and Kambalda areas (DEC, 2012) and suitable habitat for this species occurs within the Mount Martin survey area. The Carpet Python is considered likely to occur within the survey area.

4.2.4 Birds

A total of 164 bird species may occur in the vicinity of the Mount Martin survey area. Appendix 5 presents the bird assemblage expected to occur and recorded in the survey area. This list includes several species that rely upon wetland environments (e.g. migratory waders, ducks, grebes) that may occasionally use artificial (pools in open pits) or temporary wetlands in the survey area.

The Mount Martin field survey recorded 29 bird species. Three conservation significant species were recorded during the survey. These were:

- Malleefowl (EPBC Vulnerable);
- Chestnut Quail-thrush (Locally significant); and
- Yellow-plumed Honeyeater (Locally significant).

An additional 48 bird species were recorded outside the survey area during concurrent fauna assessment of additional Alacer projects. This included five conservation significant bird species:

- Rainbow Bee-eater (EPBC Migratory), recorded at Mount Marion;
- Eastern Great Egret (EPBC Migratory), recorded at the gorge, Coolgardie;
- Purple-crowned Lorikeet (Locally significant), recorded at Mount Marion;
- Western Yellow-robin (Locally significant), recorded at Shirl; and
- Gilbert's Whistler (Locally significant), recorded at Mount Marion.

Twenty six (26) of the bird species expected are of conservation significance and are discussed below.

Conservation Significance Level 1 (CS1)

Malleefowl (*Leipoa ocellata*)

The Malleefowl is listed as Vulnerable under the EPBC and Wildlife Conservation Act. In Western Australia Malleefowl occur mainly in scrubs and thickets of Mallee (*Eucalyptus* spp.), Boree (*Melaleuca pauperiflora*) and Acacia (particularly *Acacia linophylla* and *Acacia aneura*) and also other dense litter-forming shrublands (Johnstone and Storr 2004).

The Malleefowl previously inhabited most of the Goldfields however has undergone a dramatic range reduction in the region. The widespread clearing of suitable habitat, coupled with the degradation of habitat by fire and livestock, and fox predation has reduced Malleefowl numbers considerably (Johnstone and Storr 2004).

Malleefowl have developed a highly sophisticated method of temperature control for egg incubation. The species constructs distinctive nests that comprise a large mound covering a central core of leaf litter. Nests are typically built in areas of dense vegetation. In the Goldfields region, BCE has recorded mounds within Mallee (*Eucalyptus* spp.), Tammar (*Allocasuarina campestris*) thickets, Sheoak (*Casuarina pauper*) Woodland, Acacia (eg. *Acacia aneura*, *Acacia linophylla*) and Boree (*Melaleuca pauperiflora*) shrublands. Mounds have been constructed on stony, sand or loam substrates.

There are only a few scattered records for the Kalgoorlie region (DEC, 2012). BCE has recorded the species near Leonora (active mound, tracks), Pinjin (mounds and tracks), Carosue Dam (mounds), St Ives (old mounds) and near Norseman (old mounds). However, most records are of old, inactive mounds (with very few active or recently active mounds recorded), indicating a reduction in range and abundance in the region.

Near the survey area, the Malleefowl has been recorded along the Coolgardie – Esperance Highway (sighting in 1995, near Shirl, DEC, 2012). Additionally, old abandoned Malleefowl mounds have been recorded at St Ives within *Melaleuca pauperiflora* thickets (J. Turpin, pers. obs.).

The Malleefowl was recorded during surveying at Mount Martin. One old, inactive Malleefowl mound was found within dense Acacia and Tammar (*Allocasuarina campestris*) shrubland on the slopes of Mount Martin (see Plates 11 and 12). The mound was constructed from the gravelly substrate and had suffered some erosion. However, minimal vegetation growth on the mound itself indicates a more recent age. The details of the Malleefowl mound are described in Appendix 8.

The mound was recorded outside the survey area, approximately 1000 metres to the east of the survey boundary. Areas of suitable Malleefowl habitat were identified within the survey area in the vicinity of this mound. Targeted searching for the Malleefowl was undertaken within the survey area, however no further mounds were located. As suitable habitat occurs within the Mount Martin survey area, the Malleefowl has the potential to be present.



Plate 11. Old, inactive Malleefowl mound recorded at Mount Martin.



Plate 12. Malleefowl habitat recorded at Mount Martin.

Slender-billed Thornbill (*Acanthiza iredalei*)

The Western Slender-billed Thornbill is listed as Vulnerable under the EPBC Act. It occurs in shrubland, typically in areas of saltmarsh dominated by samphire, bluebush (*Maireana* spp.) or saltbush (*Atriplex* spp.) around salt lakes or low heath on sandplain (Pavey 2006). The species occurs in a number of disjunct populations in Western Australia, from Shark Bay to the Nullarbor (Johnstone and Storr 2004). The Western Slender-billed Thornbill is considered uncommon, rare, and in some areas locally extinct, in inland Western Australia. The species is declining in much of its range owing to the degradation of chenopod vegetation by livestock and rabbits (Johnstone and Storr 2004). In the Northern Territory, the western subspecies of the Slender-billed Thornbill is classified as Regionally Extinct (Pavey 2006). This species has been recorded at scattered locations throughout the Murchison and Goldfields, including from Coolgardie (Birds Australia 2012). As the species inhabits samphire amongst the margins of salt lakes it is unlikely to occur within the Mount Martin survey area.

Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is classified as “Specially Protected Fauna” under Schedule 4 of the Wildlife Conservation Act. In addition, DEC has listed the Peregrine Falcon as being a species that is significantly dependant on banded ironstone formation ranges in the region (DEC 2007). This species is found in a variety of habitats, including rocky ledges, cliffs, watercourses, open woodland and acacia shrublands. The distribution of the Peregrine Falcon is often tied to the abundance of prey as this species predares heavily on other birds. The Peregrine Falcon lays its eggs in recesses of cliff faces, tree hollows or in large abandoned nests of other birds (Birds Australia

2012). The Peregrine Falcon mates for life with pairs maintaining a home range of about 20 - 30 km² throughout the year. Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world.

The Peregrine Falcon has been recorded at St Ives (Ninox, 2004) and is likely to occur within the survey area.

Major Mitchell's Cockatoo (*Lophochroa leadbeateri*)

Major Mitchell's Cockatoo is listed under Schedule 4 of the Wildlife Conservation Act. It is sporadically distributed through arid and semi-arid Australia and may occur in sparsely timbered grasslands and shrublands and rocky outcrops (DEC, 2012). In the region this species occurs within Eucalypt Woodland including Salmon Gum Woodland (J. Turpin, pers. obs.). It has been recorded from Coolgardie and may occur within the survey area.

Western Rosella (*Platycercus icterotis xanthogenys*)

The inland subspecies of the Western Rosella, *Platycercus icterotis xanthogenys*, is listed under Schedule 1 of the Wildlife Conservation Act. It inhabits Eucalypt and Sheoak Woodland and scrubs, especially those containing Wandoo (*E. wandoo*), Flooded Gum, Salmon Gum (*E. salmonophloia*), tall mallee and Rock Sheoak (*Allocasuarina huegeliana*). It occurs from Northam and Wongon Hills, inland to the Kambalda region and south to the Stirling Range (DEC, 2009). The Western Rosella has undergone a significant change in distribution and status since 1970. It has declined or become extinct from more than 25 per cent of the shires where it was once found and has disappeared from the northern and eastern parts of its range due to the removal of feeding and breeding habitat (DEC, 2009). It is considered locally extinct within most of the northern and eastern wheatbelt, declining in remaining parts of the wheatbelt, but remains stable in the Goldfields area (Garnett and Crowley, 2000).

The Western Rosella has been recorded from Kalgoorlie and Coolgardie and may periodically occur within the survey area.

Migratory species

The eight migratory species potentially occurring within the South Kalgoorlie Mount Martin survey area are the Fork-tailed Swift (an aerial species), Rainbow Bee-eater (an abundant, ground-nesting species that catches insects on the wing over a range of environments), Eastern Great Egret (a wetland species) and five migratory waders (Wood Sandpiper, Common Greenshank, Curlew Sandpiper, Red-necked Stint and Sharp-tailed Sandpiper) that may occasionally utilise artificial and temporary wetlands in the survey area.

The Rainbow Bee-eater was recorded during the Alacer surveys conducted by BCE. Several individuals were recorded from the Mount Marion and South Kalgoorlie TSF survey areas. The Rainbow Bee-eater is a common species and is likely to occur within the Mount Martin survey area. The Great Egret was observed from a wetland near Coolgardie (the gorge), outside of the survey area.

Conservation Significance Level 2 (CS2)**Australian Bustard (*Ardeotis australis*)**

The Australian Bustard is listed as Priority 4 by the DEC and Near Threatened by Garnett and Crowley (2000). This species is a large, ground-dwelling bird known to occur in open or lightly-wooded country in Australia (extinct in south-eastern Australia) and southern New Guinea. It is nomadic and may range over very large areas, largely dependent on rainfall and hence food availability. This species has been recorded near Kalgoorlie at Credo (Birds Australia, 2012). It may be an occasional visitor to the Mount Martin survey area.

Bush Stone-curlew (*Burhinus grallarius*)

The Bush Stone-curlew is classified as Priority 4 by DEC and Near Threatened by Garnett and Crowley (2000). It is often associated with woodlands and dense shrublands such as Mulga (J. Turpin, pers. obs.).

The Bush Stone-curlew has a widespread distribution, however, has significantly declined in southern parts of its range. It may be present within the survey area, and has been recorded west of the survey area at Jilbadji Nature Reserve (Birds Australia, 2012).

Shy Heathwren (*Hylacola cauta whitlocki*)

The western sub-species of the Shy Heathwren is listed as Priority 4 by DEC. This species inhabits areas of woodland with dense heathy understory. The subspecies whitlocki occurs in heathy woodlands of the south-west of Western Australia (Duncan et. al., 2006). The Shy Heathwren is documented as declining in the Wheatbelt (Saunders & Ingram, 1995) with significant loss of habitat in the south-west Wheatbelt. This species has been recorded from St Ives in the Kambalda area (J. Turpin, pers. obs.).

The proposed project lies near the extreme edge of this species range however there is the potential for the Shy Heathwren to occur within the Mount Martin survey area due to the occurrence of suitable habitat.

Crested Shrike-tit (*Falcunculus frontatus*)

The south-western sub-species of the Crested Shrike-tit is listed as Priority 4 by DEC. This species occurs from north of Perth to Esperance (Birds Australia, 2012) and is an uncommon inhabitant of semi-arid woodlands. The Western Crested Shrike-tit has been historically recorded from the Kalgoorlie area and more recently from the Bremer Range near Norseman (Birds Australia, 2012). It is unlikely to occur within the Mount Martin survey area which appears to lie outside the current known range of this species.

Hooded Plover (*Charadrius rubricollis*)

The Hooded Plover is listed as Priority 4 by DEC. This species frequents the margins and shallows of salt lakes and along coastal beaches, where it forages for invertebrates along the water's edge. The Hooded Plover has been recorded approximately 40km

east of Kalgoorlie at Lake Yindarlgooda (Birds Australia, 2012). Due to a lack of suitable habitat this species is unlikely to occur within the Mount Martin survey area.

Conservation Significance Level 3 (CS3)

Square-tailed Kite (*Lophoictinia isura*)

The Square-tailed Kite is sparsely distributed over much of the Australian mainland, with a few scattered records from the Kalgoorlie region (Birds Australia, 2012). The Square-tailed Kite is a specialised predator of the canopy, foraging primarily over forest, woodland, mallee and heath (Garnett and Crowley, 2000). This species has been recorded at St Ives and is likely to periodically occur within the survey area.

Western Regent Parrot (*Polytelis anthopeplus anthopeplus*)

The Western Regent Parrot occurs in south-west Western Australian, within Eucalypt Woodland and Mallee, nesting in hollows of Eucalypts (particularly *Eucalyptus salmonophloia*) The Regent Parrot has declined over its range due to clearing for agriculture and the decline of suitable nest trees (particularly *Eucalyptus salmonophloia*) due to salinity (Garnett and Crowley, 2000). This species has been recorded at St Ives and is likely to periodically occur within the survey area.

Scarlet-chested Parrot (*Neophema splendida*)

The Scarlet-chested Parrot formerly occurred across the Murchison and into the south-west of Western Australia however has declined in the Goldfields and has not been recorded near the West Australian coast since 1854 (Garnett and Crowley, 2000). Most recent records for the Scarlet-chested Parrot come from arid inland Australia including the Great Victoria Desert. However, BCE recorded this species from the Kambalda area at St Ives, from Mallee over spinifex hummock grassland. This species may be a very rare vagrant or irregular visitor to the survey area.

Western Yellow Robin (*Eopsaltria griseogularis rosinae*)

The inland subspecies of the Western Yellow Robin (*Eopsaltria griseogularis rosinae*) is listed as CS3 because much of this subspecies' habitat has been cleared for agriculture and the subspecies continues to disappear from remnants in the Wheatbelt (Garnett and Crowley, 2000). *E. g. rosinae* occurs in the wheatbelt and the adjacent Mid West and Goldfields, within the 200 - 500mm rainfall zone (in an approximate strip between Shark Bay and the Nullarbor, Birds Australia, 2012). The Western Yellow Robin occurs in the Kalgoorlie area on the extreme edge of its range and is restricted to small areas of favourable habitat (particularly dense shrublands on the lower slopes of hills).

The Western Yellow Robin occurs in Eucalypt woodland, mallee and acacia shrubland. It has been previously recorded at St Ives and was recorded by BCE during the Alacer surveys at Shirl (51J, 330944E, 6574187N, see Plate 13). It has the potential to occur within the dense shrublands in the Mount Martin survey area, particularly those associated with the greenstone hills.



Plate 13. Western Yellow Robin habitat (dense Acacia shrubland) recorded at Shirl.

Southern Scrub-robin (*Drymodes brunneopygi*)

The Southern Scrub-robin is listed as CS3 because of this species' tendency to disappear from fragmented vegetation blocks and its decline in the Wheatbelt region (Garnet and Crowley, 2000). This species occurs in Mallee, dry scrub, heaths, lignum on claypans and coastal tea-tree thickets. It occurs in the Kalgoorlie region at the eastern extreme of its range (Birds Australia, 2012).

The Southern Scrub-robin has been recorded from the region, from near Coolgardie (Birds Australia, 2012). This species may occur within dense vegetation in the Mount Martin survey area, particularly the vegetation associated with the greenstone hills.

Declining Woodland Species

A number of south-west Australian woodland bird species are recognized as declining (Saunders *et al.* 1995, Birds Australia, 2012). These species have lost considerable areas of habitat throughout the Wheatbelt and adjacent Goldfields as a result of large scale habitat clearance and the removal of mature Eucalypt trees.

Listed species include Regent Parrot, Southern Scrub-robin, Purple-crowned Lorikeet, Gilbert's Whistler, Chestnut Quail-thrush, Rufous Tree-creeper, Purple-gaped Honeyeater and Yellow-plumed Honeyeater. These species remain widespread and in some cases abundant in the broader Great Western Woodlands. The retention of these species in their natural abundances is of particular conservation significance as these species are now increasingly absent or rare over much of the Wheatbelt (Duncan *et*.

al., 2006). Gilbert's Whistler, Yellow-plumed Honeyeater and Rufous Treecreeper, reduced to relictual populations in few wheatbelt woodlands, are still relatively common in uncleared tall eucalypt and mallee woodland (Birds Australia, 2012). The Great Western Woodlands hold nationally important populations of a range of declining woodland birds, including the Malleefowl and Chestnut Quail-thrush (Birds Australia, 2012).

The Yellow-plumed Honeyeater was recorded across all Alacer survey areas and was observed to be common within Eucalypt woodland in the Mount Martin survey area. Chestnut Quail-thrush were also recorded from all survey areas, and was recorded at Mount Martin from Eucalypt Woodland on a low stony rise. The Purple-crowned Lorikeet was recorded outside the Mount Martin survey area from Eucalypt Woodland at Mount Marion and the Gilbert's Whistler was also recorded from Eucalypt Woodland at Mount Marion, Shirl and the South Kalgoorlie TSF.

Locations of declining woodland species recorded during the Alacer surveys are listed in Appendix 7.

4.2.5 Mammals

Twenty five (25) native mammal species may occur in the survey area (Appendix 5). The field survey recorded eight native species and four introduced mammal species (see Appendix 5). Four conservation significant mammal species are known from the region and are described below.

Conservation Significance Level 1 (CS1)

Chuditch (*Dasyurus geoffroii*)

The Chuditch is listed under Schedule 1 of the Wildlife Conservation Act, and as Vulnerable under the EPBC Act. It currently survives only in south-western Western Australia, in areas dominated by eucalypt forest or woodland and mallee shrubland (Strahan, 1995) and also persists amongst rocky outcrops. This carnivorous marsupial occupies large home ranges, is highly mobile and appears able to utilise bush remnants and corridors (Orell and Morris, 1994). The Chuditch has been recorded in the Great Western Woodlands region, from Southern Cross (1989), Ghooli (1989), Kambalda and Norseman (1994, DEC, 2012). These records appear to lie near the extreme north and east of the species range (Orell and Morris, 1994). The Chuditch was formerly known from the Kalgoorlie region and may persist in small numbers. Suitable habitat for this species occurs within the Mount Martin survey area however the project lies outside the current known range of this species.

Conservation Significance Level 2 (CS2)

Greater Long-eared Bat (Central Form, *Nyctophilus timoriensis*)

The central form of the Greater Long-eared Bat is listed as Priority 4 by DEC. This species is regarded as locally common in the Coolgardie Bioregion, where it occurs in Eucalypt Woodlands with a tall shrub understorey and roosts in tree hollows. This species also inhabits Mallee and Acacia shrublands and has been found to the fringes of the Nullarbor Plain (DEC, 2012). Suitable habitat for this species occurs within the survey area, which lies within a region where the Greater Long-eared Bat is considered locally common. Several *Nyctophilus* calls were recorded using the bat

detector however identification to species level was not possible. This species is likely to occur within the survey area.

Conservation Significance Level 3 (CS3)

Woolley's Pseudantechinus (*Pseudantechinus woolleyae*)

Woolley's Pseudantechinus occurs in arid Western Australia from the Pilbara south to the Goldfields. This species favours rocky, rugged stony habitats and has been recorded through the Murchison and south to the Kalgoorlie area (DEC, 2012). Woolley's Pseudantechinus is listed as significantly dependent on banded ironstone formations in the region (DEC 2007), and its presence in the survey area would be of conservation interest. Woolley's Pseudantechinus is restricted to rocky ridges and breakaways and is considered habitat limited in the Kalgoorlie region. This species may occur along the rocky ridges within the survey area, as small areas of suitable habitat are present.

Kultarr (*Antechinomys laniger*)

The Kultarr is listed as Data Deficient under the Action Plan for Australia Mammals. This species occurs in arid and semi-arid mallee, shrubland, floodplain and gibber (Strahan, 1995). The Kultarr occurs across central Australia extending into the Great Western Woodlands region (DEC, 2012). It is often associated with stony, granitic plains dominated by Acacia, Eremophila and Senna shrublands (Strahan, 1995). The Kultarr is uncommon over most of its range, and populations appear to fluctuate seasonally (Strahan, 1995). Some eastern populations are now considered extinct. This species may occur periodically within the survey area.

4.3 Significant Invertebrates

Three conservation significant invertebrate species have been recorded in the Kalgoorlie area (DEC, 2012). These are the Arid Bronze Azure Butterfly (*Ogyris subterrestris petrina*), Inland Hairstreak (*Jalmenus aridus*) and the freshwater shrimp *Branchinella denticulata*.

The Arid Bronze Azure Butterfly is listed as Critically Endangered under the Wildlife Conservation Act and is currently being assessed for listing under the EPBC Act (M. Williams, pers. comm.). It is only known from Barbalin Nature Reserve (10km west of Mukinbudin, in the Wheatbelt), however was formerly known from the Lake Douglas area (12 km south-west of Kalgoorlie, 10km west of the powerline corridor, and 25 km north of Mt Marion, see Plate 12).



Plate 12. Arid Bronze Azure habitat – Eucalypt Woodland at Lake Douglas.

Ogyris subterrestris petrina larvae feed on the secretions of its attendant ant (Pale form of *Camponotus terebrans*.) and the eggs are laid on a mallee eucalypt with an ant nest at the base. At Lake Douglas, the Arid Bronze Azure has been recorded from undulating stony rises supporting *Eucalyptus concinna* (see Plate 12). While the species has not been recorded in the Lake Douglas area since 1993 (M. Williams, pers. comm.), it has the potential to persist in the wider area if the associated ants are present. Targeted searching in areas of suitable habitat within the powerline corridor did not locate any *Camponotus* sp. nests.

The Priority 1 Inland Hairstreak has only been recorded from two sites near Lake Douglas, 12 km south-west of Kalgoorlie, DEC, 2012). The larvae have been recorded feeding on *Acacia tetragonophylla* and *Senna* sp, but only in association with the ant *Froggattella kirbii*. Since little is known of this species, this butterfly may occur within the survey area if suitable larval food plants and the associated ant are present.

Seven butterfly species were recorded during the Alacer surveys in February 2012 (see Table 9). Opportunistic surveying for butterflies along the powerline corridor did not locate any *Jalmenus* species.

The freshwater shrimp, *Branchinella denticulata*, is listed as Priority 1 by DEC and Vulnerable under the IUCN. It is only known from an area 17 km north of Kalgoorlie (DEC, 2012).

The Tree-stem Trapdoor Spider, *Aganippe castellum*, is listed as Priority 4 by DEC. This species occurs on the mid to lower slopes of rocky ridges and the adjacent plains, where it builds a distinctive burrow against Eucalypts, Broom bush, Sheoaks and

other shrubs (BCE database). The nearest records to Kalgoorlie come from Koolyanobbing Range (170 km west of Kalgoorlie, DEC, 2012), where the Tree-stem Trapdoor Spider appears to be widespread along the slopes of the Koolyanobbing ridge (BCE database). While suitable habitat for this species occurs along the powerline route, this species is not known from the area and no burrows were recorded during surveying.

No additional invertebrate species of listed conservation significance were recorded during the desktop assessment. Within the proposed disturbance area, there was little of the sort of habitats that might support short-range endemic species. However, in adjacent areas, isolated rocky outcrops and ridges may provide habitat for such species. In general, such habitats appear to lie outside the proposed area of impact.

Table 9. Butterfly species recorded from the Alacer survey areas.

Common name	Species
Lesser Wanderer	<i>Danaus chrysippus</i>
Spotted Jezebel	<i>Delias aganippe</i>
Small Grass-yellow	<i>Eurema smilax</i>
Blotched Dusky-blue	<i>Candalides acaster</i>
Two-spotted Line-blue	<i>Nacaduba biocellata</i>
Caper White	<i>Belenois java</i>
Saltbush Blue	<i>Theclinesthes serpentata</i>

5 IMPACT ASSESSMENT

5.1 Overview of Impacts

The development of the Mount Martin project may adversely impact upon fauna in a number of ways. While some impacts upon fauna are unavoidable during a development project, of concern are long-term, deleterious impacts upon biodiversity. Impacts expected from this project may include the following:

- Death/injury/displacement/disturbance of fauna during clearing and impacts with vehicles/machinery.
- Loss of habitat
- Degradation of fauna habitat
- Obstructions to the movements of terrestrial fauna.
- Altered hydrological processes
- Disturbance of fauna in nearby areas.
- Changes in the abundance of feral species.

Potential impacts from the project upon fauna are considered under the categories outlined in Section 3.5: impacts to VSAs, conservation significant fauna and ecological processes that may affect the fauna assemblage. These are discussed in the following sections. Impact assessment categories are applied as described in Section 3.5.2.

5.2 Vegetation and Substrate Associations

The significance of impacts upon VSAs is related to the fauna they support and the degree of impact from the proposed development. The main VSAs in the survey area are described in Section 4.1 above. The extent and impact on each VSA type can be summarised as follows:

1. Greenstone hills and ridges supporting Eucalypt Woodlands, with areas of dense *Acacia* spp. and *Allocasuarina* sp:

- Representation. A series of greenstone hills and ridges occur in the south-east corner of the survey area. These flank Mount Martin, the summit of which lies just to the south-east of the survey area.
- Conservation Significance for Fauna. Due to its restricted range, this VSA is likely to support a restricted fauna assemblage. Conservation significant species occurring within this habitat type include the Malleefowl, Carpet Python, Western Yellow Robin and Eucalypt Woodland may support several declining woodland species. Additionally, SRE invertebrates may potentially occur.
- Impact. Unknown. Some areas of this VSA are likely to be cleared however the majority of the VSA occurs outside the survey area.
- Impact Assessment. Impacts to this VSA are considered of minor significance providing management measures are in place. This includes avoiding Malleefowl mounds and steep rocky ridges with outcropping. Most of the VSA locally occurs outside of the survey area and is likely to remain undisturbed. However disturbances to this VSA are recommended to be avoided due to the presence of conservation significant fauna and the restricted occurrence of the VSA regionally. This VSA may also support short-range endemic invertebrate and relictual fauna populations.

2. Stony lower slopes and adjacent stony plains supporting Woodlands of *Eucalyptus torquata*, *E. lesouefii* with sclerophyll shrubs:

- Representation. This VSA occurs adjacent to the greenstone hills and extends north from the south-east corner of the survey area. The stony plains are widespread in the region, however, low stony ridges with outcropping have a restricted occurrence.
- Conservation Significance for Fauna. Stony plains supporting Eucalypt Woodlands may support some conservation significant fauna including some declining woodland bird species. Additionally, Carpet Pythons are considered likely to occur.
- Impact. Unknown. Some areas of vegetation are likely to be cleared
- Impact Assessment. Impacts to this VSA are considered of minor significance as the VSA is widespread in the local area, with minor occurrences likely to be disturbed.

3. Eucalypt Woodlands with a sclerophyll understorey on deep alluvial clays and loams:

- Representation. Occurs over much of the northern parts of the survey area and is extensive in the region. A widespread fauna habitat.

- Conservation Significance for Fauna. Eucalypt Woodlands support a number of conservation significant fauna and declining woodland birds. These include Carpet Python, Peregrine Falcon, Major Mitchell's Cockatoo, Western Rosella, Shy Heathwren, Central Long-eared Bat and several CS3 birds such as Regent Parrot, Rufous Tree-creeper, Chestnut Quail-thrush, Gilbert's Whistler and Purple-gaped Honeyeater. Historical disturbance and clearing within this VSA has led to the reduction of large, mature Eucalypt trees. The remaining mature Eucalypt trees contain tree hollows, providing roosting and breeding sites for conservation significant birds and bats.
- Impact. Unknown. Some areas of vegetation are likely to be cleared
- Impact Assessment. Impacts to this VSA are considered to be of minor significance as the VSA is widespread in the local area and a common fauna habitat across the region. However, impacts to large mature trees are considered to be of high significance and thus should be avoided where possible.

4. Salmon Gum (*Eucalyptus salmonophloia*) Woodland with *Maireana sedifolia*:

- Representation. Occurs in the north-west of the survey area and is extensive in the region. A widespread fauna habitat.
- Conservation Significance for Fauna. Eucalypt Woodlands support a number of conservation significant fauna and declining woodland birds. These include Carpet Python, Peregrine Falcon, Major Mitchell's Cockatoo, Western Rosella, Central Long-eared Bat and several CS3 birds such as Regent Parrot, Rufous Tree-creeper, Chestnut Quail-thrush, Gilbert's Whistler and Purple-gaped Honeyeater. Historical disturbance and clearing within this VSA has led to the reduction of large, mature Eucalypt trees. The remaining mature Eucalypt trees contain tree hollows, providing roosting and breeding sites for conservation significant birds and bats.
- Impact. Unknown. Some areas of vegetation are likely to be cleared.
- Impact Assessment. Impacts to this VSA are considered to be of minor significance as the VSA is widespread in the local area and a common fauna habitat across the region. However, impacts to large mature trees are considered to be of high significance and thus should be avoided where possible.

5. Minor drainage tracts supporting mixed shrublands on red loam:

- Representation. A wide, minor drainage tract occurs across the north of the survey area. While locally restricted, occurs throughout the region.
- Conservation Significance for Fauna. May support some conservation significant fauna and declining woodland birds and the Shy Heathwren.
- Impact. Unknown. Some areas of vegetation are likely to be cleared.
- Impact Assessment. Impacts to this VSA are considered to be of minor significance as the VSA is widespread across the region. However, impacts to large mature trees are considered to be of high significance and thus should be avoided.

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, two VSAs within the survey area are regionally restricted and support some conservation significant fauna. They are:

- 1. Greenstone hills and ridges supporting Eucalypt Woodlands, with areas of dense *Acacia* spp. and *Allocasuarina* sp; and**
- 2. Eucalypt Woodlands with large, mature, hollow-bearing trees.**

5.3 Conservation Significant Species

Impacts on conservation significant species are considered to be mostly of low to moderate significance (Table 10). Several conservation significant species are expected to occur within the Mount Martin survey area (three species recorded), however 16 are of particular importance as these species are likely to have resident populations in the area. These include habitat specialists or restricted species:

- Carpet Python (CS1), recorded from Kalgoorlie, likely resident;
- Malleefowl (CS1), recorded from Mount Martin, potential resident;
- Peregrine Falcon (CS1), recorded from St Ives, likely resident;
- Western Rosella (CS1), recorded from Coolgardie, potential resident;
- Major Mitchell's Cockatoo (CS1), recorded from Coolgardie, potential resident;
- Bush Stone-curlew (CS2), recorded from Jilbadji Nature Reserve, potential resident;
- Shy Heathwren (CS2), recorded from St Ives, likely resident;
- Regent Parrot (CS3), recorded from St Ives, likely resident;
- Southern Scrub-robin (CS3), recorded from Coolgardie, potential resident;
- Western Yellow-robin (CS3), recorded from Shirl, likely resident;
- Purple-crowned Lorikeet (CS3) recorded from Mount Marion, likely resident;
- Rufous Tree-creeper (CS3) recorded from Mount Marion, likely resident;
- Chestnut Quail-thrush (CS3), resident;
- Gilbert's Whistler (CS3) recorded from Mount Marion, likely resident;
- Purple-gaped Honeyeater (CS3), recorded from Coolgardie, potential resident
- Central Long-eared Bat (CS2), recorded from Coolgardie, likely resident.

A summary of the potential impacts upon conservation significant species and actions that may minimise these impacts is detailed in Table 10.

Table 10. Potential impacts upon conservation significant species that are expected to occur in the survey area

Criteria for significance of impacts are outlined in Section 3.5.2.

Species Name	Nature and significance of likely impact		Action required
	Nature of impact	Significance	
Carpet Python	Potential loss of habitat and disturbance. Risk of roadkill	Minor (small area of disturbance)	Avoid disturbance to rocky outcrops, rocky ridges and large, mature trees
Malleefowl	Potential loss of habitat and disturbance	Minor (small area of disturbance, no mounds located in Mount Martin survey area)	Avoid disturbance to greenstone hills and dense Acacia shrublands on stony slopes and plains.
Peregrine Falcon	Potential loss of habitat and disturbance	Minor (likely in survey area as occasional visitor, minor loss of habitat)	Avoid disturbance to large, mature Eucalypt trees as these providing potential breeding sites for the species.
Western Rosella	Potential loss of habitat and disturbance	Minor (likely in survey area as occasional visitor, minor loss of habitat)	Avoid disturbance to large, mature Eucalypt trees as these providing potential breeding sites for the species.
Major Mitchell's Cockatoo	Potential loss of habitat and disturbance	Minor (likely in survey area as occasional visitor, minor loss of habitat)	Avoid disturbance to large, mature Eucalypt trees as these providing potential breeding sites for the species.
Bush Stone-curlew	Loss of habitat. Risk of roadkill.	Minor (minor loss of habitat, widespread species present in small numbers)	Avoid disturbance to greenstone hills
Shy Heathwren	Potential loss of habitat and disturbance	Minor (recorded in local area)	Minimise habitat loss.
CS3 Birds	Potential loss of habitat and disturbance	Minor (recorded in local area)	Avoid disturbance to greenstone hills Avoid disturbance to large, mature Eucalypt trees as these providing potential breeding sites Minimise habitat loss and utilise existing tracks to avoid vegetation clearance for the construction of new tracks.
Central Long-eared Bat	Potential loss of habitat and disturbance	Minor (recorded in local area)	Avoid disturbance to large, mature Eucalypt trees as these providing potential breeding sites Minimise habitat loss and utilise existing tracks to avoid vegetation clearance for the construction of new tracks.

5.4 Ecological Processes

Many of the potential impacts of the proposed development upon fauna can be related to ecological processes (Appendices 2 and 4). There are currently 17 key threatening processes listed by the federal Department of Sustainability, Environment, Water, Population and Community (SEWPC 2011, see Appendix 4). Several of these processes may be applicable to the Mount Martin survey area:

- Land clearance;
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases;
- Predation by the Feral Cat;
- Predation by the European Red Fox;
- Competition and land degradation by feral Rabbits; and
- Competition and land degradation by feral/unmanaged Goats.

There are common themes through the ecological processes outlined by Soule *et al.* (2004), the key threatening processes listed by SEWPC 2011 and some of the impacts discussed with respect to threatened species (see Appendix 4). Potential impacts of the proposed project upon the fauna assemblage in the survey area are discussed under the headings of ecological processes below.

5.4.1 Increased mortality

Direct mortality of common species during clearing is unavoidable but can be minimised (see recommendations below). In general, areas to be cleared are small within the context of the regional landscape so mortality during clearing is likely to represent only small proportions of regional populations. However, the viability of species that occur at low population densities in areas adjacent to the survey area may be compromised by ongoing mortality. Ongoing mortality may arise through roadkill. Species occurring at low densities, such as the Malleefowl, may be susceptible to roadkill.

5.4.2 Loss of habitat affecting population survival

The loss of significant habitat may be detrimental to local fauna populations. Of particular significance may be impacts to greenstone hills and mature Eucalypt trees within the survey area (see Section 5.2). These support a number of conservation significant species, contain breeding or roosting sites (tree hollows), are likely to support species with restricted ranges and potentially short-range endemic fauna. To minimise impacts to significant fauna species impacts to the greenstone hills and mature Eucalypt trees should be avoided.

5.4.3 Loss of habitat affecting population movements and gene flow

The survey area contains VSAs that are mostly widespread and extensive in the region. Fragmentation of populations leading to isolation and reduced movement/gene flow should be anticipated to be minimal.

5.4.4 Species interactions, including predators and other feral species

Feral species are a major conservation concern in general but are a small component of the fauna of the survey area, although the Feral Goat and Rabbit were recorded during the survey and are likely to occur throughout the survey area. Vegetation degradation by cattle, goats and rabbits is an increasing issue in the region. Within the survey area there is evidence of grazing degrading vegetation.

Additionally, weed invasion poses a significant threat to the fauna and flora values of the survey area. Several weed species occur in the region. Invasive weed species can replace native species and degrade fauna habitats. Weeds can be spread by vehicles, earthworks and road construction.

5.4.5 Hydroecology

Interruptions of hydroecological processes are a concern where disturbances are associated with the major rivers and riparian vegetation. It is not known if there will be localised or broad scale impacts from the project, or no impacts at all, but this needs to be investigated. Changes in groundwater levels may affect any groundwater dependent ecosystems, which may consequently impact on fauna utilising such areas.

5.4.6 Changes in fire regime

Some conservation significant fauna are particularly susceptible to fire. The incidences of fire may increase with development in an area; local fauna populations may be impacted upon without proper fire management.

5.4.7 Dust, light, noise and disturbance

Impacts of dust, light, disturbance and noise upon fauna are difficult to predict. Due to its location these are already factors influencing the fauna of the site. However increased levels of human visitation may result from the proposed project.

5.5 Summary of impacts

Impacts upon ecological processes are summarised in Table 11. Impacts upon key fauna values (important VSAs and conservation significant fauna of interest) are summarised in Table 12. Most ecological processes are expected to have only negligible or minor impacts, providing management measure are in place. Impacts upon fauna values are generally considered to be only minor, even upon the majority of significant species (see Table 12). This is because of the relatively small footprint of the project which is located within mostly widespread habitats in an already modified landscape.

Table 11. Summary of potential impacts upon ecological processes

Impacting process	Impact
Habitat loss leading to population decline	Minor if disturbances to greenstone hills and mature Eucalypt trees are avoided. Only localised and small areas of habitat loss with minor impact upon significant species anticipated.
Population fragmentation and disruption of movement and gene flow due to habitat fragmentation	Minor. Limited fragmentation or disruption of movement is anticipated as the development lies mostly within continuous and widespread habitats.
Increased mortality leading to population decline; e.g. due to ongoing roadkill	Minor. Increase in vehicular traffic may lead to an increase risk of roadkill of significant species that occur in very low numbers in the area, particularly Malleefowl, Carpet Python, Australian Bustard and Bush Stone-curlew.
Habitat degradation due to weed invasion	Minor. Low risk of weed invasion beyond that current, provided management measures are in place.
Hydrological change	Unknown. Impacts to hydrology are largely unknown. No natural wetland habitats occur within the survey area, however drainage lines may be important habitat for fauna.
Species interactions due to feral or over-abundant native species	Minor to Moderate. There is potential for changes in the abundance of some predators, notably the Dingo, Fox and feral Cat, and this could affect species sensitive to such predators such as the Malleefowl.
Changes in fire regime	Minor. There should be little risk of a change in the fire regime, provided management measures are in place.
Effects of disturbance, dust and light	Minor to Moderate. Some disturbance may result from the effects of dust and light, however disturbances are mostly within widespread fauna habitats supporting few conservation significant species.

Table 12. Summary of possible impacts upon key fauna values.

Fauna Value	Impacts from proposal	Significance of impacts
Fauna assemblage	Small loss of habitat anticipated, that is mostly continuous and widespread in region. Existing tracks may minimise the need for vegetation clearance.	Minor
VSA's	Small losses and generally widespread VSA's. Greenstone hills have a very minimal occurrence within the proposed disturbance area itself. Disturbances to greenstone hills and large mature Eucalypt trees are recommended to be avoided, existing tracks in these areas may also minimise the need for vegetation clearance.	Minor
Carpet Python	Small loss of habitat,	Minor.
Malleefowl	Some possible loss of habitat, disturbance and increased predation pressure. Suitable habitat lies mostly outside area of disturbance.	Minor - Moderate.
Peregrine Falcon	Some loss of potential habitat, potential disturbances to breeding sites however disturbances to large, hollow bearing trees are recommended to be avoided.	Minor.
Western Rosella	Some loss of potential habitat, potential disturbances to breeding sites however disturbances to large, hollow bearing trees are recommended to be avoided	Minor.
Major Mitchell's Cockatoo	Some loss of potential habitat, potential disturbances to breeding sites however disturbances to large, hollow bearing trees are recommended to be avoided	Minor.
Bush Stone-curlew	Possible loss of a small area of habitat.	Minor.
Rainbow Bee-eater	Potential loss of habitat, but a widespread species	Negligible.
Shy Heathwren	Some loss of potential habitat, however existing tracks may minimise the need for vegetation clearance.	Minor.
CS3 Birds	Some loss of potential habitat, potential disturbances to breeding sites however disturbances to large, hollow bearing trees are recommended to be avoided	Minor.
Central Long-eared Bat	Some loss of potential habitat, potential disturbances to breeding sites however disturbances to large, hollow bearing trees are recommended to be avoided	Minor.

5.6 Summary by EPA Guidance

According to criteria set out in the EPA Guidance Statement No. 56, the impacts of the project upon fauna in the survey area can be summarised as given in Table 13.

Table 133. Potential impacts to fauna of the proposal as assessed following the guidance of the EPA's Guidance Statement No. 56. (Terrestrial fauna surveys for environmental impact assessment in Western Australia, EPA 2004)

Factor	Impact and explanation
Degree of habitat degradation or clearing within the local area or region.	Minor (project lies within of a region of continuous habitat, some vegetation clearance has previously occurred within the survey area).
Size/scale of proposal/impact.	Major (>50ha of remnant native vegetation may be disturbed - Bioregion Group 2).
Rarity of vegetation and landforms.	Moderate - Minor (impacted vegetation and landforms are generally extensive in sub-region).
Refugia.	Moderate - Minor (Vegetation types, soils and landforms are generally widespread, however greenstone hills may provide refugia for conservation significant and specialist species)
Fauna protected under international agreements or treaties, Specially Protected or Priority Fauna.	Moderate (faunal assemblage includes species of conservation significance but impacts on these species is expected to be Moderate - Minor).
Size of remnant and condition/intactness of habitat and faunal assemblage.	Minor (survey area and surrounds comprises intact native vegetation).
Ecological linkage.	Minor (vegetation types in survey area are largely continuous).
Heterogeneity or complexity of the habitat and faunal assemblage.	Moderate (The area and/or its immediate surrounds have a similar range of habitats and faunal assemblages relative to the characteristics at the local and regional scale).

6 MANAGEMENT AND MONITORING RECOMMENDATIONS

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

Increased mortality. Some mortality is inevitable during operations as the development will occur within and adjacent to fauna habitat. Sources of ongoing mortality could include collision with vehicles or striking infrastructure.

Loss of habitat. The loss of habitat from vegetation clearing should be minimised where possible. The permitted clearing area should be clearly delineated to prevent the clearing of fauna habitat beyond this area.

Loss of significant VSA habitat is of concern. Disturbances to the greenstone hills and mature Eucalypt trees should be avoided as these may support conservation significant fauna. Management recommendations to reduce habitat loss include:

1. Avoid disturbance to large mature Eucalypt trees where possible;
2. Avoid disturbance to greenstone hills and rocky ridges (minimal areas of this habitat type occur within the Mount Martin survey area – restricted to the south-east corner);
3. Minimise the disturbance footprint as far as practicable, and
4. Clearly delineate the permitted clearing area.
5. Liaises with the Great Western Woodlands Reference Group regarding implications of the clearing proposal on management objectives for these woodlands.

Fragmentation of habitat. Minor habitat fragmentation will result from the proposed project as the Mount Martin corridor already contains two existing Mount Martin s and an associated access track. Potential effects of fragmentation could be minimised by limiting the disturbance footprint size and retaining areas of native vegetation that maintain linkages to adjacent vegetation. Efforts should be made to minimise impacts to linear and restricted habitats – such as rocky ridge and drainage lines.

Species interactions including predation and competition. The presence of feral species, particularly the Feral Cat and Fox, should be discouraged.

Hydrological changes. It is recommended that an understanding of the surface and sub-surface drainage be developed in order to identify the potential for hydrological changes that could potentially impact fauna habitats, and where possible, implement management

actions where it is expected that changes to hydrology may affect significant fauna habitats.

Habitat degradation due to weed invasions. Invasive weed species can replace native species and degrade fauna habitats. Weeds can be spread by vehicles, earthworks and road construction. Weed outbreaks tend to occur on recently disturbed ground such as road sides and drainage channels. A weed prevention and control strategy should be implemented to prevent the spread of weeds in the area.

Changes in fire regime. A fire management plan should be implemented to protect property and infrastructure, and this needs to have regard for the ecological role of fire. There is potential for some conservation benefit through increased fire management in the survey area and surrounds.

Dust, noise, light and disturbance. Disturbances from these factors during the construction are poorly understood, but a precautionary approach is recommended. Management strategies to reduce impact on fauna from disturbances could include avoiding disturbances to important fauna habitats.

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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 (ie. 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 and 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 Environment and Conservation (DEC) 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 Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The Wildlife Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories.

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

In Western Australia, the DEC has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Wildlife Conservation Act but for which the DEC 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 Environmental Protection, now DEC (2000), used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan.

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 (phreatoicidean 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 (INT) 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). Processes that may impact fauna values with respect to mining are discussed below. Processes specific to the project are discussed in Section 5. 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. Impacting processes are outlined below.

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.

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 the Eastern Barred Bandicoot, *Perameles gunni* ((Dufty 1989), Eastern Quoll, *Dasyurus viverrinus* and Tasmanian Devil *Sarcophilus harrisii* ((Jones 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented ((Scheick & Jones 1999; Clevenger & Waltho 2000; Jackson & 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, 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 Fox, and to a lesser extent the feral Cat (Burbidge & 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 (Kofoed 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 (e.g. Letnic *et al.* 2004). 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. 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 & 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 & 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 EPBC Act and the WA Wildlife Conservation Act.

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.

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 Conservation Act, 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.

Priority 4. 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 5. 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).

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.

(Taken from http://www.wilderness.org.au/articles/wc_science)

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 17 key threatening processes listed by the federal Department of Sustainability, Environment, Water, Population and Communities).

- 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;
- Land clearance;
- 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 1000 km² (100,000 ha);

- 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*);
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta*.

(taken from

<http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl>)

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—other such as altered flow regimes affecting riparian vegetation; and
- Pollution.

(taken from Cork S, Sattler P and Alexandra J (2006), 'Biodiversity' theme commentary prepared for the 2006 Australian State of the Environment Committee, Department of the Environment and Heritage, Canberra, <http://www.deh.gov.au/soe/2006/commentaries/biodiversity/index.html>)

In addition to the above processes, the DSEWPac 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 South Kalgoorlie Mount Martin survey area (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. These are:

- NatureMap Database (N): searched January, 2012;
- Birds Australia Database (BA): searched January, 2012;
- Western Australian Museum Fauna Survey (WAM): conducted at Black Flag, 1981, 60km north of South Kalgoorlie Mount Martin ;
- St Ives Fauna Surveys 35km, south-east of South Kalgoorlie Mount Martin (Ninox Wildlife Consulting, 2004, Western Wildlife, 2006, BCE, 2009);

Expected occurrence is primarily based on known species distributions and available habitats. Species recorded during the BCE field surveys are listed under each survey area:

1. South Kalgoorlie TSF;
2. Mount Martin;
3. Mount Marion;
4. South Kalgoorlie Mount Martin ; and
5. Shirl.

TABLE 1. Frogs expected to occur and recorded in the South Kalgoorlie Mount Martin Survey Area.

FROGS	CS	N	WAM	NWC	WW	BCE	Mount Martin
Myobatrachidae (ground-frogs)							
Kunapalri Frog <i>Neobatrachus kunapalari</i>		X		X		X	
Humming Frog <i>Neobatrachus pelobatoides</i>				X			
Shoemaker Frog <i>Neobatrachus sutor</i>		X	X	X			
Goldfields Bull Frog <i>Neobatrachus wilmorei</i>		X	X				
Western Toadlet <i>Pseudophryne occidentalis</i>		X	X	X	X	X	
Total Number of Species Expected: 6		4	3	4	1	2	0

TABLE 2. Reptiles expected to occur and recorded in the South Kalgoorlie Mount Martin survey area. Note: Conservation Status (CS), NatureMap (N), Western Australian Museum (WAM), St Ives Fauna Surveys (NWC, WW, BCE) and Alacer Fauna Surveys are listed.

Reptiles	CS	N	WAM	St Ives			2012 BCE Survey				
				NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
AGAMIDAE											
Mulga Dragon <i>Caimanops amphiboluroides</i>											
Crested Dragon <i>Ctenophorus cristatus</i>		X	X	X	X	X	X	X	X	X	X
Mallee Military Dragon <i>Ctenophorus fordi</i>		X	X	X	X	X					
Western Netted Dragon <i>Ctenophorus reticulatus</i>		X	X	X						X	
Claypan Dragon <i>Ctenophorus salinarum</i>		X	X	X	X	X					
Lozenge-marked Dragon <i>Ctenophorus scutulatus</i>		X	X		X	X					
Thorny Devil <i>Moloch horridus</i>		X	X	X		X					
Bearded Dragon <i>Pogona minor</i>		X	X	X	X	X					
Pebble Dragon <i>Tympanocryptis cephalus</i>		X	X	X							
DIPLODACTYLIDAE											
Clawless Gecko <i>Crenadactylus ocellatus</i>		X	X	X	X						
Western Stone Gecko <i>Diplodactylus granariensis</i>		X	X	X	X						
Beautiful Gecko <i>Diplodactylus pulcher</i>		X	X	X	X						
Main's Ground Gecko <i>Lucasium maini</i>		X	X	X	X						
Beaded Gecko <i>Lucasium damaeum</i>											
Reticulated Velvet Gecko <i>Oedura reticulata</i>		X	X	X	X						
Beaked Gecko <i>Rhynchoedura ornata</i>			X								
Thorn -tailed Gecko <i>Strophurus assimilis</i>		X			X	X					
Jewelled Gecko <i>Strophurus elderi</i>			X		X						
Ring-tailed Gecko <i>Strophurus strophurus</i>											
CARPHODACTYLIDAE											
Pale Knob-tailed Gecko <i>Nephrurus laevisissimus</i>			X	X	X	X					
Barking Gecko <i>Nephrurus milii</i>		X	X			X	X				
Midline Knob-tail <i>Nephrurus vertebralis</i>											
GEKKONIDAE											
Marbled Gecko <i>Christinus marmoratus</i>					X						
Purplish Dtella <i>Gehyra purpurascens</i>			X	X		X					
Tree Dtella <i>Gehyra variegata</i>		X	X	X	X	X	X				X
Bynoe's Gecko <i>Heteronotia binoei</i>		X	X	X	X	X		X		X	X
PYGOPODIDAE											

Reptiles		CS	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
Marble-faced Delma	<i>Delma australis</i>		X	X		X	X					
Unbanded Dema	<i>Delma butleri</i>		X		X	X						
Fraser's Delma	<i>Delma fraseri</i>		X	X	X	X						
Burton's Legless-Lizard	<i>Lialis burtonis</i>		X		X	X	X					
Common Scaly-foot	<i>Pygopus lepidopodus</i>		X		X	X						
Western Hooded Scaly-foot	<i>Pygopus nigriceps</i>		X									
SCINCIDAE												
A skink	<i>Cryptoblepharus australis</i>											
A skink	<i>Cryptoblepharus buehnananii</i>		X	X	X	X						
Southern Mallee Skink	<i>Ctenotus atlas</i>		X	X	X	X	X					
Leonhardi's Ctenotus	<i>Ctenotus leonhardii</i>		X	X	X		X					
Barred Wedge-snouted Ctenotus	<i>Ctenotus schomburgkii</i>		X	X	X	X	X					
Rock Ctenotus	<i>Ctenotus severus</i>											
Spotted Ctenotus	<i>Ctenotus uber</i>			X		X					X	
Spinifex Slender Blue-tongue	<i>Cyclodomorphus melanops</i>		X	X		X						
Pygmy Spiny-tailed Skink	<i>Egernia depressa</i>		X	X					X		X	
Goldfields Crevice Skink	<i>Egernia formosa</i>		X	X	X	X				X		X
Desert Skink	<i>Egernia inornata</i>		X	X		X	X					
Woodland Crevice Skink	<i>Egernia richardi</i>											
Night Skink	<i>Egernia striata</i>											
Broad-banded Sandswimmer	<i>Eremiascincus richardsonii</i>		X	X		X						
Southern Five-toed Mulch Skink	<i>Hemiergis initialis</i>		X	X	X	X						
Four-toed Mulch Skink	<i>Hemiergis peronii</i>		X	X								
South-western Four-toed Lerista	<i>Lerista distinguenda</i>					X	X					
Common Mulch Lerista	<i>Lerista kingi</i>		X	X								
Goldfields Robust Lerista	<i>Lerista picturata</i>		X	X	X							
Common Mulch Lerista	<i>Lerista timda</i>											
Bull-headed Skink	<i>Liopholis multiscutata</i>		X	X	X							
Common Dwarf Skink	<i>Menetia greyii</i>		X	X	X	X	X					
Saltbush Flecked Skink	<i>Morethia adelaidensis</i>		X	X		X						
Woodland Dark Fleck Skink	<i>Morethia butleri</i>		X	X	X	X						
Woodland Flecked Skink	<i>Morethia obscura</i>		X			X	X					
Western Blue-tongue	<i>Tiliqua occipitalis</i>		X	X	X							
Bobtail	<i>Tiliqua rugosa</i>		X	X	X	X		X	X			X
VARANIDAE												
Pygmy Mulga Monitor	<i>Varanus caudolineatus</i>		X	X								

Reptiles		CS	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
Bungarra or Sand Monitor	<i>Varanus gouldii</i>		X	X	X	X	X	X	X	X	X	X
Racehorse Monitor	<i>Varanus tristis tristis</i>		X	X					X			
TYPHLOPIDAE												
Southern Blind Snake	<i>Ramphotyphlops australis</i>		X	X	X	X	X					
Dark-spinned Blind Snake	<i>Ramphotyphlops bicolor</i>		X	X			X					
Prong-snouted Blind Snake	<i>Ramphotyphlops bituberculatus</i>		X	X	X							
Northern Hook-Snouted Blind Snake	<i>Ramphotyphlops hamatus</i>		X	X								
Common Beaked Blind Snake	<i>Ramphotyphlops waitii</i>		X	X								
BOIDAE												
Stimson's Python	<i>Antaresia stimsoni</i>											
Carpet Python	<i>Morelia spilota imbricata</i>	CS1	X	X		X						
ELAPIDAE												
Desert Death Adder	<i>Acanthophis pyrrhus</i>		X									
Narrow-banded Shovel-nosed Snake	<i>Brachyuropsis fasciolata</i>		X	X	X	X						
Southern Shovel-nosed Snake	<i>Brachyuropsis semifasciata</i>		X	X			X					
Yellow-faced Whipsnake	<i>Demansia psammophis</i>		X	X	X	X						
Bardick	<i>Echiopsis curta</i>		X									
Moon Snake	<i>Furina ornata</i>		X	X								
Black-naped Snake	<i>Neelaps bimaculatus</i>		X	X								
Gould's Snake	<i>Parasuta gouldii</i>		X	X	X	X						
Monk Snake	<i>Parasuta monachus</i>		X	X	X	X						
Black-backed Hooded Snake	<i>Parasuta nigriceps</i>											
Mulga Snake	<i>Pseudechis australis</i>		X	X		X						
Dugite	<i>Pseudonaja affinis</i>		X									
Ringed Brown Snake	<i>Pseudonaja modesta</i>		X	X		X						
Western Brown Snake	<i>Pseudonaja mengdeni</i>		X	X	X		X					
Jan's Banded Snake	<i>Simoselaps bertholdi</i>		X	X	X	X						
Rosen's Snake	<i>Suta fasciata</i>		X	X								
Total Number of Species Expected: 85												
Total Recorded during 2012 Alacer Surveys: 11			67	45	41	43	27	5	6	3	6	6

TABLE 3. Birds expected or recorded in the South Kalgoorlie Mount Martin survey area. Note: Conservation Status (CS), Birds Australia (BA), NatureMap (N), Western Australian Museum (M), St Ives Fauna Surveys (NWC, WW, BCE) and Alacer Fauna Surveys are listed.

Birds	C S	B A	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
CASUARIIDAE												
<i>Dromaius novaehollandiae</i> Emu		X	X	X	X	X	X			X	X	X
PHASIANIDAE												
<i>Coturnix pectoralis</i> Stubble Quail		X	X									
MEGAPODIIDAE												
<i>Leipoa ocellata</i> Malleefowl	CS1		X				X		X			
ANATIDAE												
<i>Cygnus atratus</i> Black Swan		X	X									X
<i>Tadorna tadornoides</i> Australian Shelduck		X	X									X
<i>Chenonetta jubata</i> Australian Wood Duck		X	X									X
<i>Anas superciliosa</i> Pacific Black Duck		X	X									X
<i>Anas rhynchotis</i> Australasian Shoveler		X	X									
<i>Malacorhynchus membranaceus</i> Pink-eared Duck		X	X									X
<i>Anas gracilis</i> Grey Teal		X	X	X								X
<i>Anas castanea</i> Chestnut Teal			X									
<i>Aythya australis</i> Hardhead		X	X									
<i>Stictonetta naevosa</i> Freckled Duck		X	X									
<i>Biziura lobata</i> Musk Duck		X	X									
PODICIPEDIDAE												
<i>Tachybaptus novaehollandiae</i> Australasian Grebe		X	X					X				X
<i>Poliocephalus poliocephalus</i> Hoary-headed Grebe		X	X									
COLUMBIDAE												
<i>Phaps chalcoptera</i> Common Bronzewing		X	X	X	X	X	X					
<i>Ocyphaps lophotes</i> Crested Pigeon		X	X	X	X	X	X					X
<i>Geopelia cuneata</i> Diamond Dove								X				
PODARGIDAE												
<i>Podargus strigoides</i> Tawny Frogmouth		X	X	X	X	X		X		X	X	X
EUROSTOPODIDAE												
<i>Eurostopodus argus</i> Spotted Nightjar		X	X									

Birds	C S	B A	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
AEGOTHELIDAE												
<i>Aegotheles cristatus</i> Australian Owlet-nightjar		X	X	X	X		X			X		
APODIDAE												
<i>Apus pacificus</i> Fork-tailed Swift	CS1											
ANHINGIDAE												
<i>Microcarbo melanoleucos</i> Little Pied Cormorant		X	X									
<i>Phalacrocorax sulcirostris</i> Little Black Cormorant		X	X									
PELECANIDAE												
<i>Pelecanus conspicillatus</i> Australian Pelican		X	X									
ARDEIDAE												
<i>Egretta novaehollandiae</i> White-faced Heron		X	X									X
<i>Ardea pacifica</i> White-necked Heron		X										
<i>Ardea modesta</i> Eastern Great Egret	CS1											
PLATALEIDAE												
<i>Threskiornis spinicollis</i> Straw-necked Ibis		X	X									
<i>Platalea flavipes</i> Yellow-billed Spoonbill		X	X									
ACCIPITRIDAE												
<i>Elanus axillaris</i> Black-shouldered Kite		X	X									
<i>Lophoictinia isura</i> Square-tailed Kite	CS3		X			X						
<i>Hamirostra melanosternon</i> Black-breasted Buzzard						X						
<i>Haliastur sphenurus</i> Whistling Kite		X	X	X	X	X						
<i>Milvus migrans</i> Black Kite												
<i>Accipiter fasciatus</i> Brown Goshawk		X	X	X	X	X	X					
<i>Accipiter cirrocephalus</i> Collared Sparrowhawk		X	X		X	X						
<i>Circus assimilis</i> Spotted Harrier			X	X								
<i>Aquila audax</i> Wedge-tailed Eagle		X	X	X	X		X				X	
<i>Hieraaetus morphnoides</i> Little Eagle		X	X		X							
FALCONIDAE												
<i>Falco cenchroides</i> Nankeen Kestrel		X	X	X	X	X						
<i>Falco berigora</i> Brown Falcon		X	X	X	X	X	X	X				X
<i>Falco longipennis</i> Australian Hobby		X	X									
<i>Falco peregrinus</i> Peregrine Falcon	CS1				X							
RALLIDAE												

Birds	C S	B A	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
<i>Fulica atra</i> Eurasian Coot		X	X									
<i>Rallus philippensis</i> Buff-banded Rail												
<i>Porzana pusilla</i> Baillon's Crake												
<i>Porzana tabuensis</i> Spotless Crake												
<i>Porzana fluminea</i> Australian Crake												X
<i>Tribonyx ventralis</i> Black-tailed Native-hen			X									
RECURVIROSTRIDAE												
<i>Recurvirostra novaehollandiae</i> Red-necked Avocet		X	X									
<i>Himantopus himantopus</i> Black-winged Stilt		X	X									X
<i>Cladorhynchus leucocephalus</i> Banded Stilt		X	X									X
OTIDIDAE												
<i>Ardeotis australis</i> Australian Bustard	CS2		X									
BURHINIDAE												
<i>Burhinus grallarius</i> Bush Stone-curlew	CS2											
CHARADRIIDAE												
<i>Charadrius ruficapillus</i> Red-capped Plover		X	X		X							
<i>Elseya melanops</i> Black-fronted Dotterel		X	X					X				
<i>Erythrogonys cinctus</i> Red-kneed Dotterel		X	X									
<i>Thinornis rubricollis</i> Hooded Plover		X	X									
<i>Charadrius australis</i> Inland Dotterel												
<i>Vanellus tricolor</i> Banded Lapwing		X	X									
SCOLOPACIDAE												
<i>Tringa nebularia</i> Common Greenshank	CS1	X	X									
<i>Tringa glareola</i> Wood Sandpiper	CS1	X	X									
<i>Calidris acuminata</i> Sharp-tailed Sandpiper	CS1	X	X									
<i>Calidris ferruginea</i> Curlew Sandpiper	CS1	X	X									
<i>Calidris ruficollis</i> Red-necked Stint	CS1	X	X									
TURNICIDAE												
<i>Turnix velox</i> Little Button-quail			X									X
LARIDAE												
<i>Larus novaehollandiae</i> Silver Gull		X	X									
CACATUIDAE												
<i>Eolophus roseicapillus</i> Galah		X	X	X		X						

Birds	C S	B A	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
<i>Cacatua sanguinea</i> Little Corella		X	X									
<i>Nymphicus hollandicus</i> Cockatiel		X	X	X								
<i>Lophochroa leadbeateri</i> Major Mitchell's Cockatoo	CS1											
PSITTACIDAE												
<i>Glossopsitta porphyrocephala</i> Purple-crowned Lorikeet		X	X	X	X	X	X			X		
<i>Platycercus icterotis</i> Western Rosella	CS1											
<i>Polytelis anthopeplus</i> Regent Parrot	CS3				X	X	X					
<i>Barnardius zonarius</i> Australian Ringneck		X	X	X	X	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>Neophema splendida</i> Scarlet-chested Parrot	CS3						X					
CUCULIDAE												
<i>Chalcites basalis</i> Horsfield's Bronze-Cuckoo		X	X	X	X		X	X				
<i>Chalcites osculans</i> Black-eared Cuckoo		X	X	X	X							
<i>Cacomantis pallidus</i> Pallid Cuckoo		X	X	X	X							
<i>Cacomantis flabelliformis</i> Fan-tailed Cuckoo		X	X									
STRIGIDAE												
<i>Ninox novaeseelandiae</i> Southern Boobook		X	X	X		X						
TYTONIDAE												
<i>Tyto alba</i> Eastern Barn Owl			X									
HALCYONIDAE												
<i>Todiramphus pyrrhopygius</i> Red-backed Kingfisher		X	X	X	X	X				X		
<i>Todiramphus sanctus</i> Sacred Kingfisher		X	X		X			X				
MEROPIIDAE												
<i>Merops ornatus</i> Rainbow Bee-eater	CS1	X	X	X	X	X	X	X		X	X	X
CLIMACTERIDAE												
<i>Climacteris affinis</i> White-browed Treecreeper		X	X	X								
<i>Climacteris rufa</i> Rufous Treecreeper		X	X	X	X	X	X			X		
MALURIDAE												
<i>Malurus splendens</i> Splendid Fairy-wren		X	X						X		X	X
<i>Malurus leucopterus</i> White-winged Fairy-wren		X	X	X	X	X	X		X		X	X
<i>Malurus lamberti</i> Variegated Fairy-wren		X		X								
<i>Malurus pulcherrimus</i> Blue-breasted Fairy-wren		X			X	X			X	X	X	X

Birds	C S	B A	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
ACANTHIZIDAE												
<i>Sericornis frontalis</i> White-browed Scrubwren			X									
<i>Hylacola cauta whitlocki</i> Shy Heathwren	CS2		X		X		X					
<i>Calamanthus campestris</i> Rufous Fieldwren			X			X						
<i>Pyrholaemus brunneus</i> Redthroat		X	X		X	X	X	X	X	X	X	X
<i>Smicrornis brevirostris</i> Weebill		X	X		X	X	X	X	X	X	X	X
<i>Gerygone fusca</i> Western Gerygone			X		X							
<i>Acanthiza chrysorrhoa</i> Yellow-rumped Thornbill		X	X	X	X	X		X			X	X
<i>Acanthiza uropygialis</i> Chestnut-rumped Thornbill		X	X	X	X	X	X	X	X	X	X	X
<i>Acanthiza robustirostris</i> Slaty-backed Thornbill		X		X								
<i>Acanthiza apicalis</i> Inland Thornbill		X	X	X	X	X	X	X	X	X	X	
<i>Aphelocephala leucopsis</i> Southern Whiteface		X	X	X								
PARDALOTIDAE												
<i>Pardalotus punctatus</i> Spotted Pardalote		X	X							X		
<i>Pardalotus striatus</i> Striated Pardalote		X	X	X	X	X	X	X	X	X	X	X
MELIPHAGIDAE												
<i>Certhionyx variegatus</i> Pied Honeyeater			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	X	X	X	X		X	X	X	X	X
<i>Lichenostomus cratitius</i> Purple-gaped Honeyeater	CS3	X	X									
<i>Lichenostomus ornatus</i> Yellow-plumed Honeyeater	CS3	X	X	X	X	X	X	X	X	X	X	X
<i>Lichenostomus plumulus</i> Grey-fronted Honeyeater		X	X	X								
<i>Purnella albifrons</i> White-fronted Honeyeater		X	X	X	X	X	X		X	X		X
<i>Manorina flavigula</i> Yellow-throated Miner		X	X	X	X	X	X	X		X		
<i>Acanthagenys rufogularis</i> Spiny-cheeked Honeyeater		X	X	X	X	X	X	X	X	X	X	X
<i>Anthochaera carunculata</i> Red Wattlebird		X	X	X	X	X	X	X	X	X	X	X
<i>Epthianura albifrons</i> White-fronted Cat		X	X		X							X
<i>Epthianura tricolor</i> Crimson Chat		X	X									
<i>Epthianura aurifrons</i> Orange Chat			X									
<i>Sugomel niger</i> Black Honeyeater			X									
<i>Lichmera indistincta</i> Brown Honeyeater		X	X	X	X	X	X	X	X	X	X	
<i>Melithreptus brevirostris</i> Brown-headed Honeyeater		X	X	X	X	X	X	X	X	X	X	
<i>Phylidonyris nigra</i> White-cheeked Honeyeater				X								

Birds	C S	B A	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
POMATOSTOMIDAE												
<i>Pomatostomus superciliosus</i> White-browed Babbler		X	X	X	X	X		X	X	X		X
PSOPHODIDAE												
<i>Cinclosoma castanotus</i> Chestnut Quail-thrush	CS3	X	X		X	X		X	X	X	X	X
NEOSITTIDAE												
<i>Daphoenositta chrysoptera</i> Varied Sittella		X	X	X	X	X	X	X		X	X	X
CAMPEPHAGIDAE												
<i>Coracina maxima</i> Ground Cuckoo-shrike		X	X	X	X							
<i>Coracina novaehollandiae</i> Black-faced Cuckoo-shrike		X	X	X	X	X	X	X	X	X		X
<i>Lalage sueurii</i> White-winged Triller		X	X	X		X						X
PACHYCEPHALIDAE												
<i>Pachycephala inornata</i> Gilbert's Whistler	CS3	X	X					X		X		X
<i>Pachycephala rufiventris</i> Rufous Whistler		X	X		X	X			X		X	
<i>Pachycephala pectoralis</i> Golden Whistler			X									
<i>Colluricincla harmonica</i> Grey Shrike-thrush		X	X	X	X	X	X	X		X	X	X
<i>Oreoica gutturalis</i> Crested Bellbird		X	X		X	X	X	X	X	X	X	X
ARTAMIDAE												
<i>Artamus personatus</i> Masked Woodswallow			X				X				X	
<i>Artamus cinereus</i> Black-faced Woodswallow		X	X	X	X	X				X		
<i>Artamus cyanopterus</i> Dusky Woodswallow		X	X	X	X	X	X			X		
<i>Artamus minor</i> Little Woodswallow			X									
<i>Cracticus torquatus</i> Grey Butcherbird		X	X	X	X	X	X	X		X		
<i>Cracticus nigrogularis</i> Pied Butcherbird		X	X	X	X	X		X		X	X	
<i>Cracticus tibicen</i> Australian Magpie		X	X	X	X	X	X		X		X	X
<i>Strepera versicolor</i> Grey Currawong		X	X	X	X	X	X		X	X	X	X
RHIPIDURIDAE												
<i>Rhipidura albiscapa</i> Grey Fantail		X		X								
<i>Rhipidura leucophrys</i> Willie Wagtail		X	X	X	X	X	X	X	X	X	X	
CORVIDAE												
<i>Corvus bennetti</i> Little Crow		X	X		X							
<i>Corvus orru</i> Torresian Crow		X	X		X							
<i>Corvus coronoides</i> Australian Raven		X	X	X	X	X	X	X		X	X	X
MONARCHIDAE												

Birds	C S	B A	N	WAM	St Ives			2012 BCE Survey				
					NWC	WW	BCE	TSF	Martin	Marion	Mount	Shirl
<i>Grallina cyanoleuca</i> Magpie-lark		X	X	X	X	X		X				
PETROICIDAE												
<i>Petroica goodenovii</i> Red-capped Robin		X	X	X	X	X	X		X	X	X	
<i>Melanodryas cucullata</i> Hooded Robin		X	X	X								
<i>Microeca fascians</i> Jacky Winter		X	X	X	X	X		X	X	X		
<i>Eopsaltria griseogularis</i> Western Yellow Robin	CS3		X		X							X
<i>Drymodes brunneopygia</i> Southern Scrub-robin	CS3	X										
ZOSTEROPIDAE												
<i>Zosterops lateralis</i> Silveryeye		X	X		X	X	X				X	
MEGALURIDAE												
<i>Cincloramphus mathewsi</i> Rufous Songlark		X	X			X						
<i>Cincloramphus cruralis</i> Brown Songlark		X	X									
HIRUNDINIDAE												
<i>Cheramoeca leucosterna</i> White-backed Swallow		X	X		X	X	X	X				
<i>Hirundo neoxena</i> Welcome Swallow		X	X	X		X		X	X	X		
<i>Petrochelidon ariel</i> Fairy Martin		X										X
<i>Petrochelidon nigricans</i> Tree Martin		X	X	X	X	X	X	X		X		
NECTARINIIDAE												
<i>Dicaeum hirundinaceum</i> Mistletoebird		X		X	X	X	X				X	X
ESTRILDIDAE												
<i>Taeniopygia guttata</i> Zebra Finch		X	X	X								
MOTACILLIDAE												
<i>Anthus novaeseelandiae</i> Australasian Pipit		X	X	X		X	X	X				X
Total Number of Species Expected: 164												
Total Species recorded by BCE 2012: 77		129	140	71	69	63	49	40	29	42	35	48

TABLE 4. Mammals expected to occur and recorded in the South Kalgoorlie Mount Martin survey area.

Mammals	C S	N	WAM	St Ives			2012 BCE Survey				
				NWC	WW	BCE	TSE	Martin	Marion	Mount	Shirl
Tachyglossidae											
<i>Tachyglossus aculeatus</i> Echidna		X	X	X	X	X	X	X	X	X	X
Dasyuridae											
<i>Ningai ridei</i> Ride's Ningai			X		X						
<i>Ningai yvonneae</i> Mallee Ningai		X		X	X	X					
<i>Antechinomys laniger</i> Kultarr											
<i>Pseudantechinus woolleyae</i> Woolley's Pseudantechinus											
<i>Sminthopsis crassicaudata</i> Fat-tailed Dunnart		X	X	X	X						
<i>Sminthopsis dolichura</i> Little Long-tailed Dunnart		X	X	X	X						
<i>Sminthopsis gilberti</i> Gilbert's Dunnart		X									
Burramyidae											
<i>Cercartetus concinnus</i> Western Pygmy Possum		X	X	X	X	X					
Macropodidae											
<i>Macropus fuliginosus</i> Western Grey Kangaroo			X	X	X	X	X	X	X	X	X
<i>Macropus robustus</i> Euro		X	X	X							
<i>Macropus rufus</i> Red Kangaroo				X	X						
Molossidae											
<i>Mormopterus sp. 3</i> Inland Freetail Bat			X				X	X	X	X	X
<i>Mormopterus sp. 4</i> Southern Freetail Bat											
<i>Tadarida australis</i> White-striped Freetail Bat			X		X		X	X	X	X	X
Vespertilionidae											
<i>Chalinolobus gouldii</i> Gould's Wattled Bat		X			X		X	X	X	X	X
<i>Chalinolobus morio</i> Chocolate Wattled Bat		X	X						X		X
<i>Nyctophilus geoffroyi</i> Lesser Long-eared Bat		X	X								
<i>Nyctophilus major</i> Greater Long-eared Bat											
<i>Scotorepens balstoni</i> Inland Broad-nosed Bat			X					X			
<i>Vespadelus regulus</i> Southern Forest Bat		X	X						X		X
<i>Vespadelus baverstocki</i> Inland forest bat		X					X	X	X		
Muridae											
<i>Notomys alexis</i> Spinifex Hopping Mouse											

Mammals	C S	N	WAM	St Ives			2012 BCE Survey				
				NWC	WW	BCE	TSE	Martin	Marion	Mount	Shirl
<i>Notomys mitchelli</i> Mitchell's Hopping Mouse			X		X	X					
<i>Pseudomys bolami</i> Bolam's Mouse		X	X	X	X	X					
<i>Pseudomys hermannsburgensis</i> Sandy Inland Mouse		X	X	X							
Canidae											
INTRODUCED MAMMALS											
<i>Canis lupus</i> Dingo		X				X					X
<i>Vulpes vulpes</i> European Red Fox			X								X
<i>Felis catus</i> Feral Cat		X				X					
<i>Oryctolagus cuniculus</i> Rabbit		X			X	X	X	X	X	X	X
<i>Mus musculus</i> House Mouse		X	X		X	X	X	X		X	X
<i>Capra hircus</i> Goat							X	X	X	X	X
<i>Equus caballus</i> Horse											
<i>Camelus dromedarius</i> Dromedary Camel											
<i>Bos taurus</i> Cattle								X	X	X	X
<i>Ovis aries</i> Sheep											
Total Number of Native Species Expected: 25		14	15	10	14	6					
Total Number of Introduced Species Expected: 10		4	2	0	2	4					

Appendix 6. Species recorded during surveying

Reptiles		2012 BCE Survey				
		TSF	Mt Martin	Mt Marion	Mount Martin	Shirl
AGAMIDAE						
Crested Dragon	<i>Ctenophorus cristatus</i>	X	X	X	X	X
Western Netted Dragon	<i>Ctenophorus reticulatus</i>				X	
CARPHODACTYLIDAE						
Barking Gecko	<i>Nephrurus milii</i>	X				
GEKKONIDAE						
Tree Dtella	<i>Gehyra variegata</i>	X		X		X
Bynoe's Gecko	<i>Heteronotia binoei</i>		X		X	X
SCINCIDAE						
Spotted Ctenotus	<i>Ctenotus uber</i>				X	
Pygmy Spiny-tailed Skink	<i>Egernia depressa</i>		X		X	
Goldfields Crevice Skink	<i>Egernia formosa</i>			X		X
Bobtail	<i>Tiliqua rugosa</i>	X	X			X
VARANIDAE						
Bungarra or Sand Monitor	<i>Varanus gouldii</i>	X	X	X	X	X
Racehorse Monitor	<i>Varanus tristis tristis</i>		X			
Total Recorded during 2012 Alacer Surveys: 11		5	6	3	6	6

Birds		2012 BCE Survey				
		TSF	Mt Martin	Mt Marion	Mount Martin	Shirl
CASUARIIDAE						
<i>Dromaius novaehollandiae</i>	Emu			X	X	X
<i>Leipoa ocellata</i>	Malleefowl		X			?
ANATIDAE						
<i>Cygnus atratus</i>	Black Swan					X
<i>Tadorna tadornoides</i>	Australian Shelduck					X
<i>Chenonetta jubata</i>	Australian Wood Duck					X
<i>Anas superciliosa</i>	Pacific Black Duck					X
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck					X
<i>Anas gracilis</i>	Grey Teal					X
PODICIPEDIDAE						
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	X				X
COLUMBIDAE						
<i>Ocyphaps lophotes</i>	Crested Pigeon					X

Birds		2012 BCE Survey				
		TSF	Mt Martin	Mt Marion	Mount Martin	Shirl
<i>Geopelia cuneata</i>	Diamond Dove	X				
PODARGIDAE						
<i>Podargus strigoides</i>	Tawny Frogmouth	X		X	X	X
AEGOTHELIDAE						
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar			X		
ARDEIDAE						
<i>Egretta novaehollandiae</i>	White-faced Heron					X
ACCIPITRIDAE						
<i>Aquila audax</i>	Wedge-tailed Eagle				X	
FALCONIDAE						
<i>Falco berigora</i>	Brown Falcon	X				X
RALLIDAE						
<i>Porzana fluminea</i>	Australian Crake					X
RECURVIROSTRIDAE						
<i>Himantopus himantopus</i>	Black-winged Stilt					X
<i>Cladorhynchus leucocephalus</i>	Banded Stilt					X
CHARADRIIDAE						
<i>Elseyornis melanops</i>	Black-fronted Dotterel	X				
TURNICIDAE						
<i>Turnix velox</i>	Little Button-quail					X
PSITTACIDAE						
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet			X		
<i>Barnardius zonarius</i>	Australian Ringneck	X	X	X	X	X
CUCULIDAE						
<i>Chalcites basalus</i>	Horsfield's Bronze-Cuckoo	X				
HALCYONIDAE						
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher			X		
<i>Todiramphus sanctus</i>	Sacred Kingfisher	X				
MEROPIIDAE						
<i>Merops ornatus</i>	Rainbow Bee-eater	X		X	X	X
CLIMACTERIDAE						
<i>Climacteris rufa</i>	Rufous Treecreeper			X		
MALURIDAE						
<i>Malurus splendens</i>	Splendid Fairy-wren		X		X	X
<i>Malurus leucopterus</i>	White-winged Fairy-wren		X		X	X
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren		X	X	X	X

Birds		2012 BCE Survey				
		TSF	Mt Martin	Mt Marion	Mount Martin	Shirl
ACANTHIZIDAE						
<i>Pyrrholaemus brunneus</i>	Redthroat	X	X	X	X	X
<i>Smicrornis brevirostris</i>	Weebill	X	X	X	X	X
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	X			X	X
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	X	X	X	X	X
<i>Acanthiza apicalis</i>	Inland Thornbill	X	X	X	X	
PARDALOTIDAE						
<i>Pardalotus punctatus</i>	Spotted Pardalote			X		
<i>Pardalotus striatus</i>	Striated Pardalote	X	X	X	X	X
MELIPHAGIDAE						
<i>Lichenostomus virescens</i>	Singing Honeyeater	X	X	X	X	
<i>Lichenostomus leucotis</i>	White-eared Honeyeater	X	X	X	X	X
<i>Lichenostomus ornatus</i>	Yellow-plumed Honeyeater	X	X	X	X	X
<i>Purnella albifrons</i>	White-fronted Honeyeater		X	X		X
<i>Manorina flavigula</i>	Yellow-throated Miner	X		X		
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	X	X	X	X	X
<i>Anthochaera carunculata</i>	Red Wattlebird	X	X	X	X	X
<i>Epthianura albifrons</i>	White-fronted Cat					X
<i>Lichmera indistincta</i>	Brown Honeyeater	X	X	X	X	
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	X	X	X	X	
POMATOSTOMIDAE						
<i>Pomatostomus superciliosus</i>	White-browed Babbler	X	X	X		X
PSOPHODIDAE						
<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush	X	X	X	X	X
NEOSITTIDAE						
<i>Daphoenositta chrysoptera</i>	Varied Sittella	X		X	X	X
CAMPEPHAGIDAE						
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	X	X	X		X
<i>Lalage sueurii</i>	White-winged Triller					X
PACHYCEPHALIDAE						
<i>Pachycephala inornata</i>	Gilbert's Whistler	X		X		X
<i>Pachycephala rufiventris</i>	Rufous Whistler		X		X	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	X		X	X	X
<i>Oreoica gutturalis</i>	Crested Bellbird	X	X	X	X	X
ARTAMIDAE						
<i>Artamus personatus</i>	Masked Woodswallow				X	

Birds		2012 BCE Survey				
		TSF	Mt Martin	Mt Marion	Mount Martin	Shirl
<i>Artamus cinereus</i>	Black-faced Woodswallow			X		
<i>Artamus cyanopterus</i>	Dusky Woodswallow			X		
<i>Cracticus torquatus</i>	Grey Butcherbird	X		X		
<i>Cracticus nigrogularis</i>	Pied Butcherbird	X		X	X	
<i>Cracticus tibicen</i>	Australian Magpie		X		X	X
<i>Strepera versicolor</i>	Grey Currawong		X	X	X	X
RHIPIDURIDAE						
<i>Rhipidura leucophrys</i>	Willie Wagtail	X	X	X	X	
CORVIDAE						
<i>Corvus coronoides</i>	Australian Raven	X		X	X	X
MONARCHIDAE						
<i>Grallina cyanoleuca</i>	Magpie-lark	X				
PETROICIDAE						
<i>Petroica goodenovii</i>	Red-capped Robin		X	X	X	
<i>Microeca fascians</i>	Jacky Winter	X	X	X		
<i>Eopsaltria griseogularis</i>	Western Yellow Robin					X
ZOSTEROPIDAE						
<i>Zosterops lateralis</i>	Silvereye				X	
HIRUNDINIDAE						
<i>Cheramoeca leucosterna</i>	White-backed Swallow	X				
<i>Hirundo neoxena</i>	Welcome Swallow	X	X	X		
<i>Petrochelidon ariel</i>	Fairy Martin					X
<i>Petrochelidon nigricans</i>	Tree Martin	X		X		
NECTARINIIDAE						
<i>Dicaeum hirundinaceum</i>	Mistletoebird				X	X
MOTACILLIDAE						
<i>Anthus novaeseelandiae</i>	Australasian Pipit	X				X
Total Species recorded by BCE 2012: 77		40	29	42	35	48

Mammals	2012 BCE Survey				
	TSF	Mt Martin	Mt Marion	Mount Martin	Shirl
Tachyglossidae					
<i>Tachyglossus aculeatus</i> Echidna	X	X	X	X	X
Macropodidae					
<i>Macropus fuliginosus</i> Western Grey Kangaroo	X	X	X	X	X
Molossidae					
<i>Mormopterus sp. 3</i> Inland Freetail Bat		X	X	X	X
<i>Tadarida australis</i> White-striped Freetail Bat	X	X	X	X	X
Vespertilionidae					
<i>Chalinolobus gouldii</i> Gould's Wattled Bat	X	X	X	X	X
<i>Chalinolobus morio</i> Chocolate Wattled Bat			X		X
<i>Nyctophilus sp.</i> Lesser Long-eared Bat		X	X		
<i>Scotorepens balstoni</i> Inland Broad-nosed Bat		X			
<i>Vespadelus regulus</i> Southern Forest Bat			X		X
<i>Vespadelus baverstocki</i> Inland forest bat	X	X	X		
INTRODUCED MAMMALS					
<i>Canis lupus</i> Dingo					X
<i>Vulpes vulpes</i> European Red Fox					X
<i>Oryctolagus cuniculus</i> Rabbit	X	X	X	X	X
<i>Mus musculus</i> House Mouse	X	X		X	X
<i>Capra hircus</i> Goat	X	X	X	X	X
<i>Bos taurus</i> Cattle		X	X	X	X
Total Number of Native Species Expected: 25	6	8	9	5	7
Total Number of Introduced Species Expected: 10	3	4	3	4	6

Appendix 7. Locations of conservation significant species recorded during the 2011 survey. (Zone 51J).

Common Name	Species Name	Status	Comments	Species Records	
				Easting	Northing
Within Survey Area					
Malleefowl	<i>Leipoa ocellata</i>	CS1	Old mound, Mount Martin (Mound Profile 1, 3.5m x < 30 cm)	375968	6567793
Chestnut Quail-thrush	<i>Cinclosoma castanotus</i>	CS3	Small party, Mount Martin	374880	6568861
Yellow-plumed Honeyeater	<i>Lichenostomus ornatus</i>	CS3	Several seen	373330	6569174
Greater Region					
Rainbow Bee-eater	<i>Merops ornatus</i>	CS1	Several seen	359443	6581391
Malleefowl	<i>Leipoa ocellata</i>	CS1	Possible old Mound, Shirl (Mound Profile 6, 3.5m x < 30 cm)	332641	6573878
Eastern Great Egret	<i>Ardea modesta</i>	CS1	One individual at “the gorge”	327188	6573186
Rainbow Bee-eater	<i>Merops ornatus</i>	CS1	Several individuals, Mount Martin	360611	6579990
Rainbow Bee-eater	<i>Merops ornatus</i>	CS1	Several individuals, Mount Marion	349039	6561496
Rainbow Bee-eater	<i>Merops ornatus</i>	CS1	Several individuals, TSF	369004	6566337
Western Yellow-robin	<i>Eopsaltria griseogularis</i>	CS3	Three individuals in Acacia shrubland, Shirl	330944	6574187
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>	CS3	Three individuals feeding on flowering Eucalypts, Mount Marion	349423	6561052
Rufous Tree-creeper	<i>Climacteris rufus</i>	CS3	Two individuals, mount Marion	348836	6561439
Rufous Tree-creeper	<i>Climacteris rufus</i>	CS3	Two individuals, Mount Marion	349608	6561568
Chestnut Quail-thrush	<i>Cinclosoma castanotus</i>	CS3	Small party, Mount Martin	360611	6579990
Chestnut Quail-thrush	<i>Cinclosoma castanotus</i>	CS3	Small party, TSF	369089	6566746
Chestnut Quail-thrush	<i>Cinclosoma castanotus</i>	CS3	Small party, Mount Marion	351836	6561289
Gilbert’s Whistler	<i>Pachycephala inornata</i>	CS3	Two observed, Mount Marion	348822	6561476
Australian Spotted Crake	<i>Porzana fluminea</i>	CS3	Uncommon, few records for region, breeding (several juveniles)	335196	6569264

Appendix 8. Malleefowl Records from Alacer Surveys:

One old, inactive Malleefowl mound was found within dense Acacia and Tammar (*Allocasuarina campestris*) shrubland on the slopes of Mount Martin (see Tables below). The mound was constructed from the gravelly substrate and has suffered some erosion. Minimal vegetation growth on the mound itself indicates a more recent age.

Another possible very old Malleefowl mound was recorded from the slopes of a rocky ridge in the Shirl Survey Area. The possible mound was highly eroded and as a result certain identification is difficult. However, the habitat in this area is very suitable for Malleefowl and therefore further searching for further Malleefowl mounds at Shirl is warranted.

Type	Easting	Northing	Habitat		Comments
Mound 1	375968	6567793	Acacia / Tammar / Mallee		Old, inactive mound
Mound 2	332641	6573878	Acacia		Possible old, inactive mound
Mound	Diameter	Height	Central Depression	Mound Substrate	Profile
1	3.5 m	<30 cm	slight	Gravel	Profile 6
2	4 m	<30 cm	none	Gravel / loam	Profile 6

The Malleefowl Mound

Malleefowl have developed a highly sophisticated method of temperature control for egg incubation. This species constructs distinctive nests that comprise a large mound covering a central core of leaf litter. The mound is constructed out of sand, pebbles or small rocks, depending on the habitat available. Mounds have a large central depression which is filled with leaf litter and covered with soil. Eggs are laid within the mound, buried and left to incubate by the heat generated from decomposing leaf litter (Malleefowl Preservation Group, 2008). An adult pair maintain the mound temperature of 32 – 34 degrees by adjusting soil cover to either retain or expel heat from the egg chamber (Malleefowl Preservation Group, 2008).

Malleefowl are monogamous with pair bonds maintained for life (Priddel and Wheeler, 2003). The mound is constructed and maintained by an adult pair over 9 -11 months of the year (Malleefowl Preservation Group, 2008). Nest preparation occurs in autumn and the male will tend the nest through summer until temperatures begin to fall.

Malleefowl mounds range in size and diameter, depending on age and activity however mounds commonly span more than five metres and up to one metre high (DEC, 2012). A pair of Malleefowl will often use the same nest over subsequent seasons however nest fidelity is highly variable. Some Malleefowl pairs have been recorded using the same mound for up to nine years while others relocate seasonally between a cluster of two, three or four mounds (Priddel and Wheeler, 2003). Malleefowl mounds used over many generations can attain a size of over 20 metres (Malleefowl Preservation Group, 2008).

Mound construction and breeding relies heavily on rainfall. Malleefowl have been recorded abandoning mound construction or failing to use a mound during seasons of low rainfall (Priddel and Wheeler, 2003). Breeding Malleefowl tend to be sedentary, as they nest and roost in the same area year after year. Breeding males do not stray far from the nest however birds may range over several kilometres outside the breeding season (DEC, 2012). Malleefowl also require large amounts of leaf litter for egg incubation and so are generally restricted to areas of dense vegetation that have not been burnt for many years.

Established pairs generally breed annually with eggs laid from September to January. The average clutch size is 16 (but may range from 5 to 30) and the incubation period lasts for between 62 and 64 days (DEC, 2012). Malleefowl chicks receive no parental care and as a result chick mortality is high due to predation and exposure (DEC, 2008).

Priddel and Wheeler (2003) studied the nesting activity of Malleefowl within an isolated remnant of mallee in central New South Wales. The maximum longevity recorded for breeding adults was 12 years with an average of 7.5 years. Over a twenty year period the population declined, with large population decreases coincident with years of low rainfall and unsuccessful breeding. The population is predicted to become extinct in the next few years.

Mound Profile

The profile of a Malleefowl Mound changes with breeding activity and age (erosion and vegetation growth). A number of profile stages are classified according to age (Benshemesh et al., 2008) and include:

- Profile 1. Typical crater with raised rims. This is the typical shape of an inactive nest. However the nest may also be active and open.
- Profile 2. Nest fully dugout. The characteristic of this profile is that the crater slopes down steeply, and at the base the sides drop vertically to form a box- like structure with side usually 20 to 30 cm deep. Often, litter will have been raked into windrows, and may have started to enter the nest.
- Profile 3. Nest with litter. This is the next stage after profile 2. Litter will have been raked into the nest by Malleefowl, and thick layers of litter are evident on the surface. There may or may not be sand mixed with the litter at this stage.
- Profile 4. Nest mounded up (no crater). This is the typical profile of an active but unopened Malleefowl nest. The active mound is closed and dome shaped.
- Profile 5. Nest a sandy crater with peak in centre. This is a typical profile of an active nest which is in the process of being closed by Malleefowl.
- Profile 6. Nest low and flat without peak or crater. This mound has not been used for some time and weathering and erosion have ‘flattened’ the original mound.