

*Appendix K*  
*Vertebrate Fauna Survey Report*

**VERTEBRATE FAUNA SURVEY**  
**COBURN MINERAL SAND PROJECT**



**Prepared for URS Australia Pty Ltd on behalf of Gunson Resources Limited**

**By Ninox Wildlife Consulting**

**May 2005**

## EXECUTIVE SUMMARY

This report has been prepared for Gunson Resources Limited and describes the results of vertebrate fauna surveys of the Coburn Mineral Sand (CMS) Project Area. The Project Area is situated near the Shark Bay World Heritage Property and its current land use is pastoral.

The main study objectives of this study were to:

- ♦ assess the potential of the habitats in the Project Area to support a range of fauna species;
- ♦ produce an inventory of the vertebrate fauna recorded in the Project Area;
- ♦ review vertebrate fauna considered to be rare, threatened, vulnerable or geographically restricted;
- ♦ assess the relationships between vertebrate fauna and the vegetation communities of the Project Area in order to clearly identify any habitats of significance;
- ♦ review the zoogeographic region as a whole and assess the regional and local conservation status of the Project Area;
- ♦ based on all the above, assess the potential impact of mining and associated infrastructure on vertebrate fauna; and,
- ♦ produce a comprehensive analysis suitable for integration with the reports on landform, soils, flora and vegetation.

The size and complexity of the study area and the condition of the access tracks were such that the fauna survey area had to be divided into two distinct zones. The northern sector of the Project Area, which was situated mainly within Hamelin Station, was sampled during September 2003. The southern sector (mainly Coburn Station) was sampled in April and October 2004. All three surveys included trapping and systematic bird observations in a total of 19 sampling locations within the proposed mining section of the Project Area. The significance of the habitats along two potential access roads and associated camp sites was also assessed.

The surveys resulted in seven native mammal species, 45 reptile species and 61 bird species being recorded in the total CMS Project Area. Six introduced mammal species were also recorded. Of the 113 native species recorded, 88 were recorded in the southern sector of the Project Area and 97 in the northern sector.

Most of the non-volant, native mammal species that occur naturally in nearby sections of the Shark Bay mainland have been recorded in the CMS Project Area. Given the number of native mammal species that once occurred in the Shark Bay region but are now considered extinct on the Australian mainland, very few additional species could be expected to occur in the CMS Project Area. Therefore, it has been concluded that the CMS Project Area has minimal regional significance to native mammals.

No rare mammals were recorded during the surveys of the CMS Project Area. While many mammals were once known to occur in the Shark Bay region, they now occur only on islands off the mid-west coast of Western Australia. While none of these species is known to occur naturally on the adjacent mainland, several have been reintroduced to Peron Peninsula and Heirisson Prong following a fox and cat control program. However, it is extremely unlikely that these animals are present in the CMS Project Area.

No frogs were recorded in the Project Area although extensive trapping has occurred in a variety of habitats. Most frogs require surface water to breed although there are some exceptions to this rule. As no surface water is present within the CMS Project Area, only five species of frog may occur, one

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within the proposed mining area and four along the two proposed access roads, but none of these is considered rare, threatened or vulnerable.

The reptile fauna is diverse as a consequence of the Shark Bay area being located at the meeting point of three natural regions: the south-western, northern and Ereman (inland) region. This results in many species being at either their northern, southern or western limits of their distribution. The results of the three surveys of the CMS Project Area firmly place the reptile fauna into the category of high diversity representative of the Shark Bay region.

While no rare reptiles were recorded during the surveys of the CMS Project Area, one python and three skinks which are listed on either the *Commonwealth Environment Protection and Biodiversity Conservation Act* (EPBC Act, 2000), the *Wildlife Conservation Act* (1950) or CALM's Priority Fauna list, could potentially occur in the habitats of the CMS Project Area.

- The Woma is known from four disjunct populations including one from the Peron Peninsula, Shark Bay. The three northern Woma populations are listed as Other Specially Protected Fauna under the Wildlife Conservation Act (1950). There is a possibility that this species could occur in the CMS Project Area.
- The Hamelin Skink (*Ctenotus zasticus*) is listed as Vulnerable under the Threatened Fauna section of the Wildlife Conservation Act (1950) and the Commonwealth EPBC Act. It was not recorded during the surveys in the Project Area. This skink is only known to occur on Hamelin Pool and Coburn Stations where it appears to favour open eucalypt woodlands with spinifex on red sands. The known locations of *Ctenotus zasticus* are approximately 12 kilometres to the east of the proposed mining area and three of these locations were visited in order to compare them with similar habitats within the Project Area. The vegetation at the three locations consists of different species of *Eucalyptus* and *Triodia* to that present in the proposed mining area. In particular the *Triodia ?plurinervata* has a very different growth habit, forming the characteristic maze structure ideal for reptiles whereas *Triodia danthonioides* within the proposed mining area forms large, very dense clumps, often on raised humps of sand. However, vegetation community E5 which is present along the northern access road option is adjacent to one of the locations where this rare skink has been found. Therefore, while this skink may occur along this northern access road corridor it appears unlikely that it will occur within the proposed mining area.
- The Skink *Lerista humphriesi* is listed as Priority 2 on CALM's Priority Fauna list. It is known from semi-arid sandplains between Shark Bay and the Murchison. It is possible that this skink occurs throughout the shrublands on sand within the Project Area.
- The Skink *Lerista maculosa* is listed as Priority 1 on CALM's Priority Fauna list. It is known only from two localities south and south-east of Hamelin Pool. However the taxonomic status of this reptile appears to be in doubt.

The bird fauna of the Shark Bay area reflects the dry climate, physiographic uniformity and scarcity of fresh water and woodlands. Despite this, the area has a moderately rich bird fauna as, like reptiles, some birds are at the northern or southern limits of their distribution. Some of the birds observed during the study are known to be more common to the east and south-east of the Shark Bay area. In particular some are extremely common throughout the Western Australian Goldfields. While some of the more wide-ranging birds of prey and migratory cuckoos were not observed during this survey, most of the Passerine birds that could be expected to occur in the habitats present in the Project Area have been recorded. Based on these results, the bird fauna can be said to be representative of the local area.

Five birds listed under the various Commonwealth and/or State rare, threatened or vulnerable lists are known to occur in the general area. Two of these were recorded in the CMS Project Area.

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- The Malleefowl, was recorded and is listed as Vulnerable under the Commonwealth EPBC Act and Threatened under the Western Australian Wildlife Conservation Act (1950). Although no birds were seen, fresh footprints were noted and abandoned nest mounds were relatively common.
- The Peregrine Falcon is listed as Other Specially Protected Fauna under the Wildlife Conservation Act (1950). This bird is known as a scarce visitor to the Shark Bay region but was not recorded during the survey.
- The Australian Bustard is listed as Priority 4 on CALM's Priority Fauna list. Uncommon in the Shark Bay region and nomadic, this bird could occur periodically in the more open habitats of the Project Area.
- Major Mitchell's Cockatoo (*Cacatua leadbeateri*) is listed as Other Specially Protected Fauna under the Wildlife Conservation Act (1950). This cockatoo is unlikely to occur in the Project Area as it requires large trees and permanent water nearby.
- The Rainbow Bee-eater (*Merops ornatus*) is protected under the Japan/Australia Migratory Bird Agreement (JAMBA). Described by Storr (1990) as a scarce breeding visitor to the Shark Bay region, very few individuals were observed during the survey and no signs were found of their breeding burrows.
- The Thick-billed Grasswren is listed as Vulnerable on the EPBC Act and Priority 4 on CALM's Priority Fauna list but was not recorded during the surveys of the Project Area. Given the extensive surveys for this bird in the general area and the amount of survey work completed to date in the CMS Project Area, it is unlikely that the Thick-billed Grasswren is a resident of the current study area.

While there is no individual habitat of regional significance within the CMS Project Area, two habitats stand out as being of some local significance. The eucalypt woodlands support a greater range of species of reptiles and birds than the shrublands. These woodlands are mainly situated in the northern sector of the Project Area. The larger trees in these woodlands provide nesting and roosting hollows for a large range of mammals, reptiles and birds. Tree hollows are scarce in the sandplains and *Acacia* shrublands that are the most common vegetation communities in the Shark Bay region, therefore, competition for these hollows is likely to be great. The S3 shrubland community in the southern sector of the CMS Project Area also seems to be of local significance in that it supports a large variety and substantially higher population of reptiles than other vegetation communities.

The northern access road option runs from the mining area for approximately 40 km along the fenceline between Hamelin and Coburn Stations. It transects two main soil types and overlying vegetation. For about 13 km from the western end of the proposed access road assessment, the vegetation communities (fauna habitats) are very similar to those in the proposed mining area. From this more easterly point and out to the North West Coastal Highway (NWC Hwy), the habitats change to clay sands with stony or rocky outcropping that support various *Acacia* shrublands where the impact of grazing by both sheep and goats was more evident. The proposed camp site is also located in these *Acacia* shrublands on clay sands. While *Acacia* shrubland communities on clay sands are less diverse they are likely to support a somewhat different range of fauna species to those of the dense shrublands and eucalypt woodlands on the deep sands of the proposed mining area there will be a large range of species that are in common between the two.

Most of the preferred southern access road traverses very similar vegetation to that assessed for the northern route although the representation of the various vegetation communities varies. The shrublands typical of the proposed mining area are more extensive than in the northern route. Therefore, it seems likely that the majority of the fauna species that could be present will be most similar to that of the proposed mining area. The proposed alternative camp site is also situated within these shrublands which have been comprehensively sampled for fauna in the proposed mining area;

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therefore it is unlikely that many additional species would be found in this location that have not been recorded during the 2003 and 2004 sampling.

The effect of mine development on fauna can be divided into three primary areas of impact. These are:

- ◆ clearing for exploration grid lines and drill pads;
- ◆ removal of vegetation for mining;
- ◆ changes to drainage patterns and subsequent effects on adjacent vegetation and fauna habitats (not applicable to the CMS Project Area).

While most birds, larger mammals and reptiles will be able to avoid the impact of clearing for exploration, mining and construction of infrastructure, most small mammals, reptiles and burrowing frogs will unavoidably be killed by the large machinery used for vegetation removal and ground preparation, or by exposure to predators. While the local impact on individual animals is high, the clearing will have very little impact on the species overall. Exploration drilling and future mining should be carefully managed to avoid unnecessary and widespread damage to fauna habitats through clearing or damage to vegetation where this is not essential for safe operations.

In order to minimise the impact on vertebrate fauna, a series of general recommendations are given below.

- ◆ Avoidance of unnecessary clearing of vegetation beyond that strictly required.
- ◆ Windrows of topsoil, log debris and leaf litter formed during clearing should be retained, as they create extremely good microhabitat for a large range of fauna, particularly reptiles.
- ◆ Rapid commencement of rehabilitation works in cleared areas such as laydown sites, access tracks and grid lines where these are no longer required.
- ◆ All subcontracting teams are adequately briefed and made aware of the environmental constraints imposed on the project and themselves.
- ◆ Firearms, trail bikes and pets should be excluded from the Project Area.
- ◆ Adequate rubbish disposal procedures should be applied, especially for food refuse, in order to discourage scavenging by crows, foxes and feral cats. Large numbers of these animals can have an adverse impact on other fauna.
- ◆ Regular spot-checks for breaches of sound environmental practises are carried out by delegated individuals so that problems can be anticipated or rectified at an early stage.
- ◆ Consideration to preparing a brief handout on sound environmental practices which will be given to all members of subcontracting teams and permanent employees during site induction. The pamphlet should cover relevant aspects defined above.
- ◆ A penalty system for breaches of sound environmental practices should be introduced.

Site specific recommendations depend on the method of mining in a particular Project Area. Progressive mining along a shallow, linear ore body requires different rehabilitation techniques to those in an open, ever-deepening pit, with the associated tailings and overburden. In addition, the composition and structure of the overlying vegetation and presence of rare fauna may necessitate more detailed plans for rehabilitation and management techniques.

In addition, safety requirements for the project should include a fire management system to prevent the spread of wildfire through the adjacent country. Many of the points made above will assist in the maintenance of a healthy vertebrate fauna population in the country surrounding the mining area.

However, some animals, particularly those considered rare, threatened or vulnerable may require particular attention.

The CMS project is based on a shallow, linear ore body, with processing taking place within the mining depression. This will allow for progressive rehabilitation to take place as mining progresses from south to north.

If safety procedures allow, the following rehabilitation procedures should be followed.

- ◆ Prior to clearing as much seed as possible should be collected for later rehabilitation.
- ◆ Rehabilitation should be structured to encourage the return of fauna by providing micro-relief and dense vegetation cover. This may be achieved, particularly in temporary laydown areas, by:
  - leaving patches or strips of vegetation;
  - placing equipment on flattened shrubbery rather than clearing;
  - retention of root stock in the ground by shallow scraping during essential temporary clearing; and,
  - retaining stockpiled vegetation debris in windrows. Windrows and flattened vegetation provide substantial microhabitat and increased humidity for small vertebrates. They also provide a trap for windblown seed and protection for seedlings following germination. Placement of windrows across the prevailing wind direction may reduce erosion and facilitate rehabilitation success.
- ◆ As much and as soon as possible, vegetation cleared from the leading edge of mining should be placed on the ground in areas to be rehabilitated. Any seeds that are present will be protected by this mulch and rapid germination should follow initial rains. Both the mulch and new growth will provide habitat for ground-dwelling fauna relatively quickly.
- ◆ Rehabilitation should be protected from introduced herbivores such as rabbits, goats and sheep.
- ◆ Those plants believed to be important sources of food for birds are given priority in plant selection for rehabilitation. It was discussed that a range of flowering plants could be of particular importance to birds in the CMS Project Area, allowing them to move throughout the area as different food resources became available. Without these resources it is possible that the bird population of the area could decline.
- ◆ A feral predator control program should be implemented.

As part of the management of the Project Area consideration should be given to monitoring of vertebrate fauna. This should be arranged to gain sufficient data to assess the progress and success of rehabilitation and to monitor the adjacent country for any possible impact from mining on fauna populations. Therefore, permanent fauna sampling sites should be established in association with flora and vegetation monitoring plots. A sampling program should be designed in consultation with CALM in order to adequately address any vertebrate fauna issues that may arise during the environmental assessment process and to prepare guidelines for future monitoring. This may include further baseline sampling to more fully document the vertebrate fauna of the area and to clarify their habitat use.

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	Steve Giles	Assisting Zoologist (spring 2004)
<b>Reporting</b>	Jan Henry	

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Ninox Wildlife Consulting is very grateful to all of the staff at URS Australia Pty Ltd for the excellent support given at all stages of this project. Libby Mattiske of Mattiske Consulting Pty Ltd has patiently provided data as requested on vegetation communities, mapping, plant flowering times and identifications. Geoff and Daphne Brockman of Coburn Station were also very helpful during the field work under sometimes trying conditions.

## 1 INTRODUCTION

This report has been prepared for Gunson Resources Limited and describes the results of vertebrate fauna surveys of the Coburn Mineral Sand (CMS) Project Area. The Project Area is situated near the Shark Bay World Heritage property and its current land use is pastoral. The Project Area consists of the proposed mining area over the Amy Zone heavy mineral sand deposit, a camp site and an access road running eastwards from Amy Zone to the North West Coastal (NWC) Hwy.

The flora and vegetation is described in Mattiske Consulting Pty Ltd (2005) who also prepared the vegetation map. This map has been modified to show the systematic sampling sites used during this survey of the vertebrate fauna of the CMS Project Area (Figure 1).

### 1.1 Study Objectives

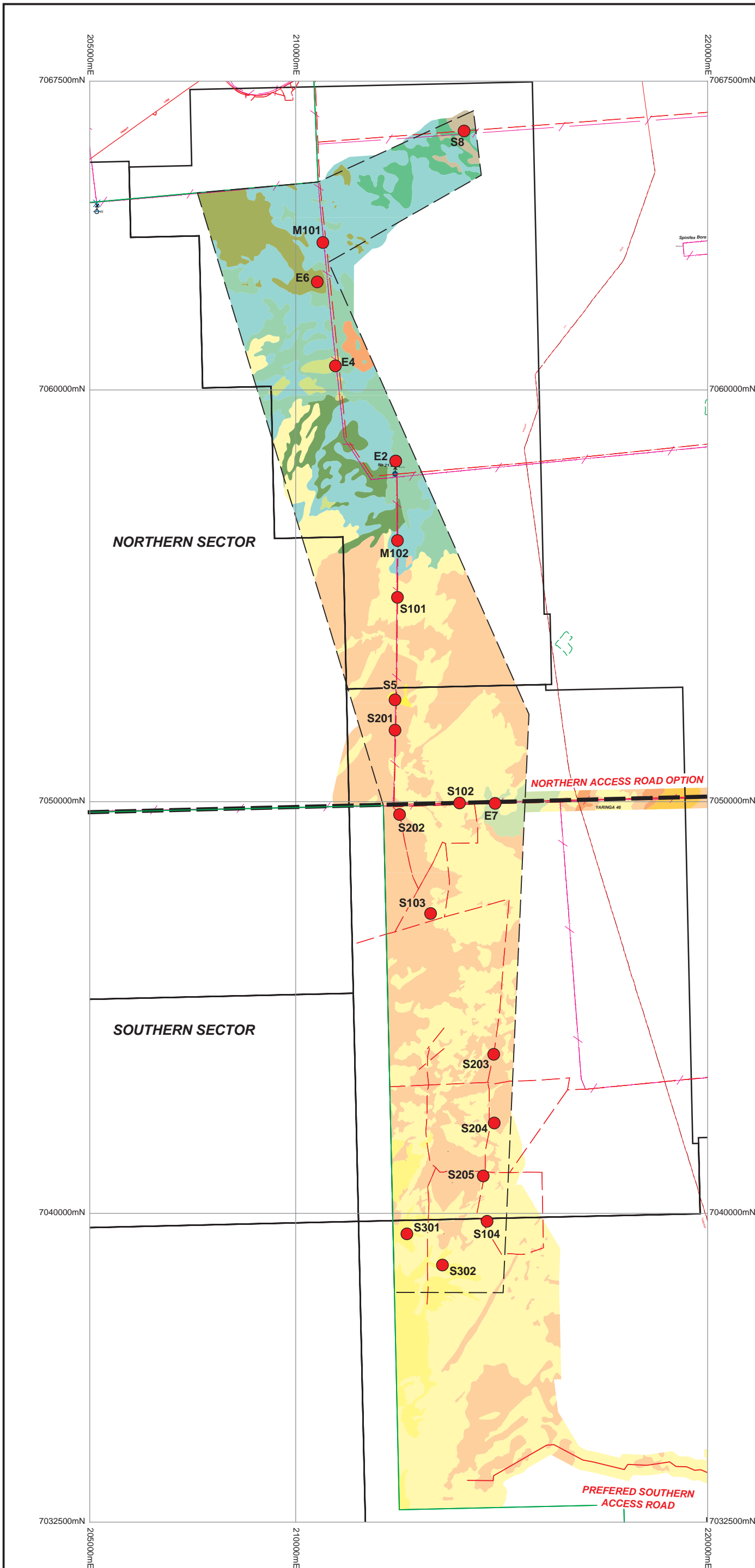
The main study objectives of this study were to:

- assess the potential of the habitats in the Project Area to support a range of fauna species;
- produce an inventory of the vertebrate fauna recorded in the Project Area;
- review vertebrate fauna considered to be rare, threatened, vulnerable or geographically restricted;
- assess the relationships between vertebrate fauna and the vegetation communities of the Project Area in order to clearly identify any habitats of significance;
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- based on all the above, assess the potential impact of mining and associated infrastructure on vertebrate fauna; and,
- produce a comprehensive analysis suitable for integration with the reports on landform, soils, flora and vegetation.

### 1.2 Nomenclature, Taxonomy and Distribution Patterns

The following literature sources have been used to discuss nomenclature, taxonomy, historical and current fauna distribution patterns and other relevant details used in this report:

- Birds:** Barrett *et al.* (2003); Johnstone and Storr (1998 and 2004).  
**Mammals:** Strahan (1998). **Bats:** Churchill (1998)  
**Amphibians:** Tyler *et al.* (2000).  
**Reptiles:** Cogger (1992); Storr *et al.* (1983); Storr *et al.* (1990); Storr *et al.* (1999); Storr *et al.* (2002); Wilson and Swan (2003).



**LEGEND**

**Eucalyptus Woodlands**

- Community E1:**  
Low Open Woodland of *Eucalyptus selachiana* and *Eucalyptus roycei* with occasional emergent *Banksia ashbyi* over *Calothamnus formosus* subsp. *formosus* and *Acacia ramulosa* var. *ramulosa* over *Lamarchea hakeifolia* var. *brevifolia*, *Malleostemon pedunculatus* and *Melaleuca eulobata* over *Triodia danthonioides*.
- Community E2:**  
Low Open Woodland of *Eucalyptus selachiana* and *Eucalyptus fruticosa* with occasional emergent *Eucalyptus mannensis* subsp. *vespertina* and *Eucalyptus roycei* over *Acacia ramulosa* var. *ramulosa*, *Acacia ligulata* and *Eremophila maitlandii* over mixed annual species.
- Community E3:**  
Low Open Woodland of *Eucalyptus fruticosa* and *Eucalyptus obtusiflora* subsp. *obtusiflora* over *Acacia xiphophylla*, *Acacia ramulosa* var. *ramulosa* and *Acacia ligulata* over mixed Chenopod species.
- Community E4:**  
Low Open Woodland of *Eucalyptus selachiana* and *Eucalyptus ?eudesmioides* over *Acacia ramulosa* var. *ramulosa*, *Acacia roycei*, *Acacia ligulata* and *Grevillea gordoniana* over *Baeckea* sp. *Nanga* (pn) over *Triodia danthonioides*.
- Community E5:**  
Low Open Woodland of *Eucalyptus obtusiflora* subsp. *obtusiflora* over *Acacia ramulosa* var. *ramulosa* and *Acacia galeata* over *Ptilotus obovatus* var. *obovatus* and *Triodia plummeri*.
- Community E6:**  
Low Open Woodland of *Eucalyptus mannensis* subsp. *vespertina* over *Acacia ramulosa* var. *ramulosa* over *Rhagodia latifolia* subsp. *latifolia* over mixed annual species.
- Community E7:**  
Low Open Woodland of *Eucalyptus selachiana* over *Calothamnus formosus* subsp. *formosus* and *Acacia ligulata* over *Lamarchea hakeifolia* var. *brevifolia* over *Triodia danthonioides*.

**Shrublands**

- Community S1:**  
Tall Shrubland of *Calothamnus formosus* subsp. *formosus* and *Hakea stenophylla* subsp. *notialis* with occasional emergent *Eucalyptus selachiana*, *Eucalyptus roycei* and *Eucalyptus mannensis* subsp. *vespertina* with *Banksia ashbyi* over *Acacia ligulata* and *Lamarchea hakeifolia* over *Triodia danthonioides* in sands.
- Community S2:**  
Tall Open Shrubland of *Calothamnus formosus* subsp. *formosus*, *Hakea stenophylla* subsp. *notialis* and *Acacia ligulata* with occasional emergent *Eucalyptus selachiana*, *Eucalyptus roycei* and *Eucalyptus mannensis* subsp. *vespertina* with *Banksia ashbyi* over *Lamarchea hakeifolia* var. *brevifolia* and *Baeckea* sp. *Nanga* (pn) over *Triodia danthonioides*.
- Community S3:**  
Low Open Shrubland of *Acacia ligulata* and *Hakea stenophylla* subsp. *notialis* with occasional emergent *Eucalyptus selachiana* and *Eucalyptus roycei* over *Baeckea* sp. *Nanga* (pn) and *Stenanthemum complicatum* over *Triodia danthonioides*.
- Community S4:**  
Tall Open Shrubland of *Grevillea gordoniana* and *Acacia ligulata* with occasional emergent *Eucalyptus selachiana* over *Melaleuca eulobata*, *Baeckea* sp. *Nanga* (pn) and *Adenanthos acanthophyllus* over *Triodia danthonioides*.
- Community S5:**  
Low Open Shrubland of *Acacia subrigida* (P2) with occasional emergent *Eucalyptus ?eudesmioides* and *Eucalyptus roycei* with *Banksia ashbyi* over *Malleostemon pedunculatus* over *Triodia danthonioides*.
- Community S6:**  
Low Open Shrubland of *Acacia longispinea* with occasional emergent *Eucalyptus mannensis* subsp. *vespertina* over *Melaleuca leiopyxis* and *Melaleuca eulobata* over *Malleostemon pedunculatus* over *Triodia danthonioides*.
- Community S7:**  
Tall Open Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *Acacia ramulosa* var. *ramulosa* over *Eremophila maitlandii* over *Ptilotus obovatus* var. *obovatus*.
- Community S8:**  
Tall Open Shrubland of *Acacia xiphophylla*, *Acacia drepanophylla* (P3) and *Acacia ramulosa* var. *ramulosa* over *Chenopodium gaudichaudianum* and *Scaevola spinescens*.
- Community S9:**  
Tall Open Shrubland of *Acacia xiphophylla* and *Acacia drepanophylla* (P3) over *Acacia grasbyi*, *Acacia tetragonophylla* and *Senna glutinosa* subsp. *chataleiniana* over *Ptilotus obovatus* var. *obovatus*.
- Community S10:**  
Tall Open Shrubland of *Physopsis chrysophylla* (P3) and *Acacia rostellifera* over *Calothamnus formosus* subsp. *formosus* and *Mirbella* sp. *Denham* (pn) over *Triodia danthonioides*.

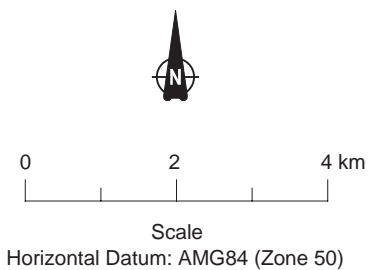
**Mosaic Community**

- Community M1**  
Mosaic of patches of a Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia ligulata* and *Acacia roycei* with occasional emergent *Eucalyptus selachiana*, *Eucalyptus roycei*, *Eucalyptus mannensis* subsp. *vespertina* and *Eucalyptus obtusiflora* subsp. *obtusiflora* over *Eremophila maitlandii* and *Lamarchea hakeifolia* subsp. *brevifolia* over mixed annual species, with patches of a Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa* and *Acacia roycei* over *Melaleuca leiopyxis* and *Malleostemon pedunculatus* over mixed annuals in sands.

**Fauna Site**

**NOTES**

Horizontal Datum: AMG84 (Zone 50)



**GUNSON RESOURCES LIMITED**

**COBURN MINERAL SANDS PROJECT AREA VERTEBRATE FAUNA SAMPLING SITES**



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Author: J. Henry, E.M.M.	Scale: 1:100000
Drawn: CAD Resources - www.cadresources.com.au	Figure: 1
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CAD Ref: j1031fauna.dgn	Date: Mar 2005 Rev: B A3

Other relevant data sources include: Storr, G.M. (1990); Storr and Harold (1990); Baynes (1990); Sanders and Harold (1990); Burbidge et al. (2000); McKenzie, Hall and Muir (2000); Johnstone *et al.* (2000); McKenzie and Muir (2000); and McKenzie, Rolfe, Aplin, Cowan and Smith (2000).

### **1.3 Study Limitations**

This fauna study was initially based on an extensive literature review covering the general area, a data search of relevant Government databases such as the Western Australian Museum (WAM) and the Department of Conservation and Land Management (CALM).

A spring survey of the northern sector of the Project Area (mainly on Hamelin Station) and an autumn survey of the southern sector (mainly Coburn Station) were undertaken within the CMS Project Area. Following these surveys an additional spring survey was undertaken in the southern sector of the Project Area. All three surveys included trapping, using a variety of sampling techniques, and systematic bird observations. However, without seasonal sampling over several years and under a range of climatic conditions, a degree of uncertainty remains as to the range of species that may actually occur in the Project Area. This is particularly so in areas of unpredictable rainfall such as the Shark Bay region. Therefore the presence of some rare species, the status of undescribed species or significant geographic range extensions will remain unknown. However, given the number of surveys over two seasons, the range of sampling techniques and level of skill and experience of the field personnel, it can be stated that the approach has complied with the Environmental Protection Authority (EPA) Guidance Statement No. 56 (EPA 2004).

### **1.4 Definition of Terms**

Prior to any discussion of the significance of vertebrate fauna or their habitats a definition of terms may be required. This Section of the document describes the various Commonwealth and State Acts that cover rare, threatened and vulnerable vertebrate fauna species and was correct at the time of the preparation of this document. However, as changes are made to both State and Commonwealth legislation and new treaties are entered into, all current documentation regarding rare, threatened and vulnerable fauna should be periodically reviewed for any changes to the status of these animals in a given area.

Additionally, in any discussion of rare, threatened or vulnerable species, several aspects require clarification before the significance of these species can be considered in context of the development and operation of a mining project. These are outlined below.

- ♦ Rare fauna are an understandably sensitive issue and there is a tendency to view all such high-profile species as being of equal importance. However, the most important factor to take into account is whether a rare species is resident or not. Resident, habitat-specific fauna are much more susceptible to the influences of disturbance than nomadic or migratory species.
- ♦ Not all rare species are equally susceptible to disturbance. Some rare species such as the Peregrine Falcon can accommodate the high levels of disturbance present in urban and rural environments, while others, such as the Southern Brown Bandicoot or

Quenda (*Isoodon obesulus fusciventer*), persist in the face of lower-level disturbance such as partially cleared land, as long as patches of dense remnant vegetation remain.

- ◆ The concept of species rarity is a dynamic process considerably influenced by the level of survey work carried out in a particular location. An improved understanding of distribution patterns over time can lead to modifications in the status of a rare animal such that it can subsequently be judged to be more common and widespread or, alternatively, rarer or more geographically restricted than originally thought. Therefore, listing of species, in many cases, tends to act as a temporary, albeit essential, safeguard until a better understanding of population, distribution and biology is obtained.

#### ***1.4.1 Protected Species - Commonwealth***

In 1974, Australia signed the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As a result, an official list of endangered, vulnerable or presumed extinct species was constructed (Schedule 1) and is regularly updated (*Endangered Species Protection Act 1992*).

In July 2000 this Act was replaced by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which retained the schedule of threatened species of the Act it replaced.

The vertebrate fauna listed on the current schedule differs from the two State lists, although there are several species that appear on both, for example, the Chuditch, and Baudin's and Carnaby's Black-Cockatoos. There are six parts to the EPBC Act covering species that are:

- ◆ extinct;
- ◆ extinct in the wild;
- ◆ critically endangered;
- ◆ endangered;
- ◆ vulnerable;
- ◆ conservation dependent.

#### ***1.4.2 Protected Species - Western Australia***

Currently in Western Australia, rare or endangered species are protected by the *Wildlife Conservation Act (1950)*. The various schedules defined under this act are:

- ◆ Declared Threatened Fauna - fauna that is ranked as presumed extinct, critically endangered, endangered or vulnerable;
- ◆ Conservation Dependent Fauna; and
- ◆ Other Specially Protected Fauna.

This Act is periodically reviewed and the current list of protected fauna was published in the Government Gazette, WA as the *Wildlife Conservation (Specially Protected Fauna) Notice*



2003. However, as Burbidge (2004) acknowledges, this Act is now outdated and a Biodiversity Conservation Bill is currently being prepared for introduction to Western Australia's Parliament.

### ***1.4.3 Priority Species - Western Australia***

A 1997 review of the International Union for Conservation of Nature and Natural Resources (IUCN) criteria for threatened species resulted in the deletion of several species from Western Australia's *Wildlife Conservation (Specially Protected Fauna) Notice 2003*. Some of these species have been placed on the CALM Priority Fauna List and require further monitoring.

Priority Fauna List classifies species as:

- Priority 1 - taxa with few, poorly known populations on threatened lands;
- Priority 2 - taxa with few, poorly known populations on conservation lands;
- Priority 3 - taxa with several, poorly known populations, some on conservation lands;
- Priority 4 - taxa in need of monitoring.

The Priority Fauna List does not confer any additional legal protection to the species listed apart from the normal protection afforded to most native animals. It does, however, indicate the need for vigilance during the construction and commissioning of development projects to manage native vegetation and rehabilitation so that Priority species, should they occur, do not meet the IUCN Criteria for listing on the Threatened Species List.

### ***1.4.4 International Agreements***

A range of shorebirds are listed under the Japan-Australia (JAMBA) and China-Australia (CAMBA) Migratory Bird Agreements. Most of the species listed on the JAMBA and/or CAMBA agreements are associated with coastal shores or inland saline wetlands and may not be relevant to the current Coburn Project Area. However, some land birds are also listed on these international treaties and these species are discussed in this report.

### ***1.4.5 Significant Fauna Habitats***

Australia-wide, a small number of Threatened Ecological Communities (TECs) has been defined under Commonwealth legislation. However, while not defined under any legislation, some fauna habitats within a proposed mining area may be defined as locally significant because they:

- ◆ support rare or vulnerable species;
- ◆ support specialised or habitat specific fauna;
- ◆ are regionally or locally uncommon; or
- ◆ are restricted in area.

Although not protected under any State or Commonwealth legislation, in the interests of good project management, where possible, conservation of such locations within a project area will

provide the basis for the fauna component of an environmental management plan to be put in place for the duration of a project.

## **2 SAMPLING SITES AND METHODS**

The size and complexity of the study area and the condition of the access tracks were such that the fauna survey had to be divided into two distinct zones. The northern sector of the Project Area, which was situated mainly within Hamelin Station, was sampled during September 2003. The southern sector (mainly Coburn Station) was sampled in April 2004. This demarcation lies on AMG reference 7 050 000mN as shown on Figure 1.

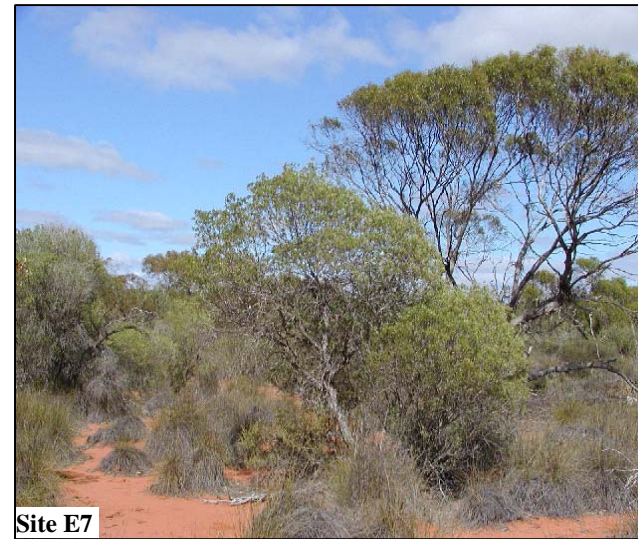
Systematic sampling of the northern sector was conducted in spring between 15 and 21 October 2003. The systematic sampling sessions conducted in the southern sector took place in autumn between 9 and 15 April and spring between 29 October and 3 November 2004. In order to judge whether potential differences in results were seasonal or inherent variations in the habitats of the two sectors of the CMS Project Area, three traplines on the boundary between Hamelin and Coburn Stations were sampled in all three surveys. The sites used for systematic sampling of vertebrate fauna are described in Table 1 which indicates when each site was surveyed. Plates 1 to 5 show the vegetation community encompassing each trapline. More detailed descriptions are available in Matiske Consulting Pty Ltd (2005).

While individual sampling sites were established in discrete vegetation communities within the Project Area, duplicate sites were located in the dominant vegetation communities. Sampling was conducted by two teams of two personnel in each field survey. In each team one person was responsible for the clearing of traplines, identification, marking and safe release of animals while the second team member conducted systematic bird sampling.

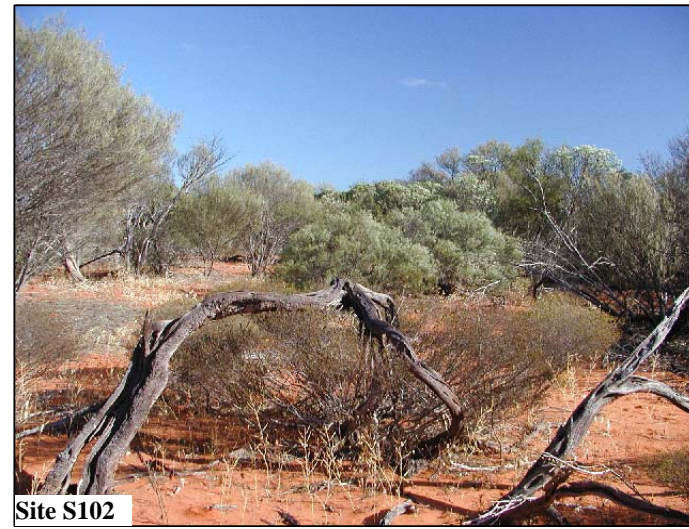
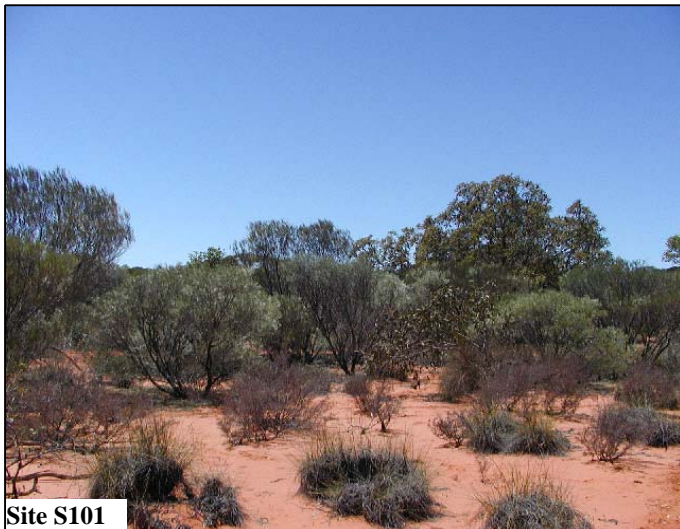
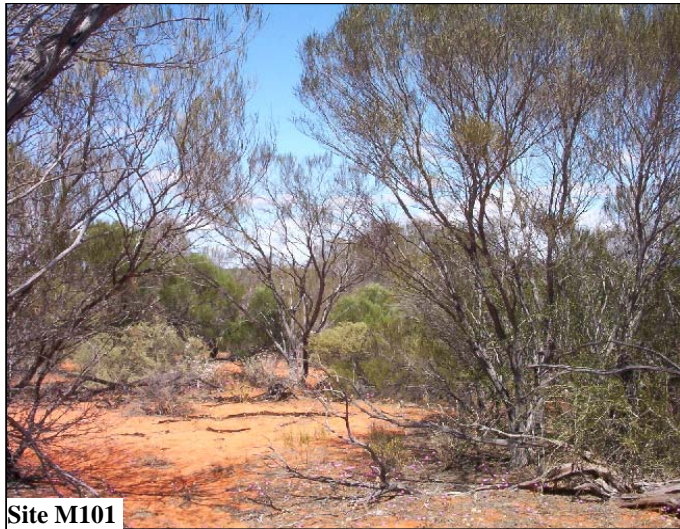
### ***2.1.1 Mammals, Amphibians and Reptiles***

Experience throughout Western Australia has shown that without sampling in several seasons and over several years, compiling a complete inventory of small mammals, amphibians and reptiles is not possible. However, a range of procedures was used to maximise capture rates in the shorter term and these techniques are described below.

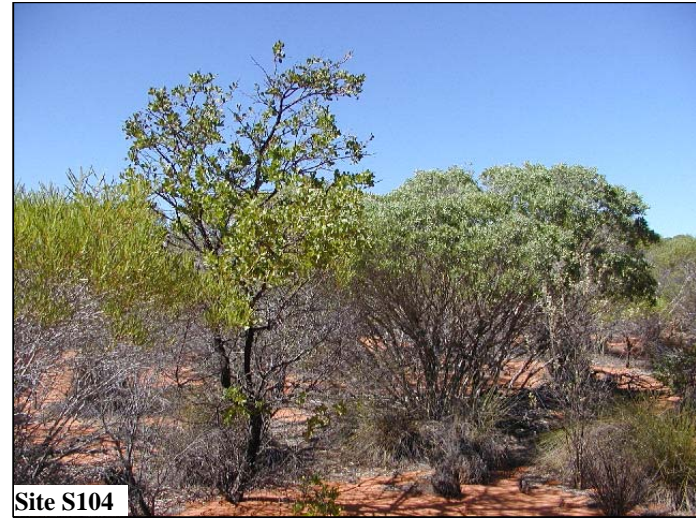
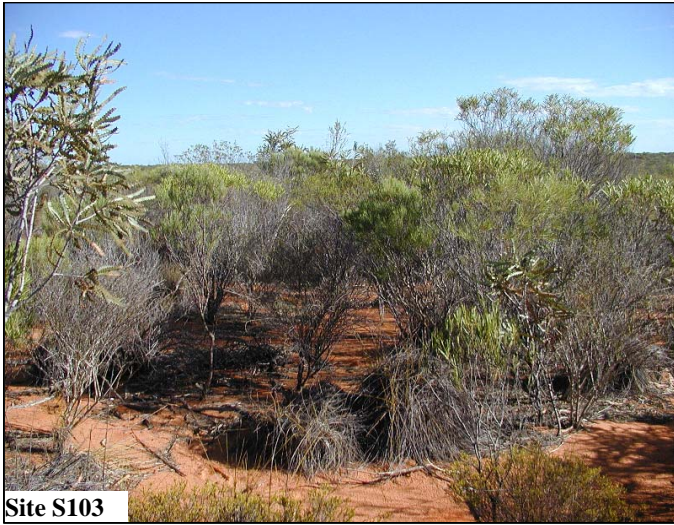
The study was based on 19 intensive sampling sites (Figure 1). An AMG grid reference was recorded at each sampling location using a GPS unit to enable trapline positions to be accurately mapped. Within each site a mammal, amphibian and reptile trapline was established which consisted of 10 pitfall traps (20 litre plastic drums) bisected across the top by 10 metres of flywire drift-fence 300mm high. The traps were arranged in two lines of five traps each. Surface traps in each site consisted of 10 medium Elliott box traps and two cage traps (580 x 230 x 230 mm) which were placed in association with the pitfall traps. Two additional 10 metre fence lines in each sampling location included four flywire funnel traps. Plate 6 shows each trap type used in each survey. Traplines were monitored over six consecutive nights during all three surveys and were checked each morning. At the end of every sampling period all traps were removed.



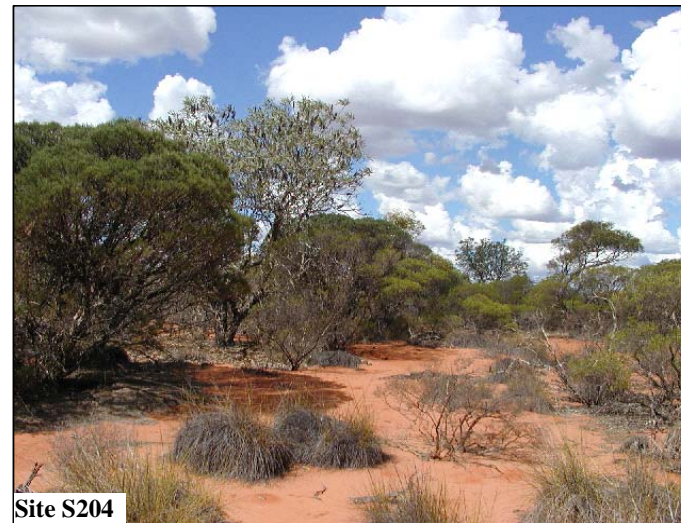
**Plate 1 Fauna sampling sites E2, E4, E6 and E7.**



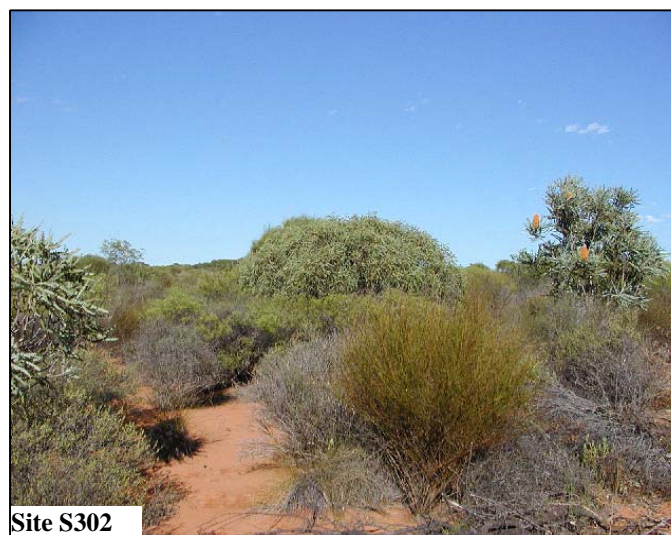
**Plate 2 Fauna sampling sites M101, M102, S101 and S102.**



**Plate 3 Fauna sampling sites S103, S104, S201 and S202.**



**Plate 4 Fauna sampling sites S203, S204, S205 and S5.**



**Plate 5 Fauna sampling sites S8, S301 and S302**

**Table 1** Site codes, brief descriptions and AMG's for the 19 sites established and sampled in the CMS Project Area. (Easting and northing coordinates are given as AGD 84.) Photographs of each sampling site are shown in Plates 1 to 5.

Site Code	Easting	Northing	Season Sampled	Description
<b>Eucalyptus Woodlands</b>				
E2	212 426	7 058 270	Spring	Low Open Woodland of <i>Eucalyptus selachiana</i> and <i>Eucalyptus fruticosa</i> with occasional emergent <i>Eucalyptus mannensis</i> subsp. <i>vespertina</i> and <i>Eucalyptus roycei</i> over <i>Acacia ramulosa</i> var. <i>ramulosa</i> , <i>Acacia ligulata</i> and <i>Eremophila maitlandii</i> over mixed annual species in sands = Matiske plant community E2.
E4	211 011	7 060 564	Spring	Low Open Woodland of <i>Eucalyptus selachiana</i> and <i>Eucalyptus ?eudesmioides</i> over <i>Acacia ramulosa</i> var. <i>ramulosa</i> , <i>Acacia roycei</i> , <i>Acacia ligulata</i> and <i>Grevillea gordoniana</i> over <i>Baeckea</i> sp. Nanga (pn) over <i>Triodia danthonioides</i> in sands = Matiske plant community E4.
E6	210 809	7 062 424	Spring	Low Open Woodland of <i>Eucalyptus mannensis</i> subsp. <i>vespertina</i> over <i>Acacia ramulosa</i> var. <i>ramulosa</i> over <i>Rhagodia latifolia</i> subsp. <i>latifolia</i> over mixed annual species in sands = Matiske plant community E6.
E7	214 843	7 049 953	Spring x 2 Autumn	Low Open Woodland of <i>Eucalyptus selachiana</i> over <i>Calothamnus formosus</i> subsp. <i>formosus</i> and <i>Acacia ligulata</i> over <i>Lamarchea hakeifolia</i> var. <i>brevifolia</i> over <i>Triodia danthonioides</i> in sands = Matiske plant community E7.
<b>Shrublands</b>				
S101	212 470	7 054 962	Spring	Tall Shrubland of <i>Calothamnus formosus</i> subsp. <i>formosus</i> and <i>Hakea stenophylla</i> subsp. <i>notialis</i> with occasional emergent <i>Eucalyptus selachiana</i> , <i>Eucalyptus roycei</i> and <i>Eucalyptus mannensis</i> subsp. <i>vespertina</i> with <i>Banksia ashbyi</i> over <i>Acacia ligulata</i> and <i>Lamarchea hakeifolia</i> over <i>Triodia danthonioides</i> in sands = Matiske plant community S1.
S102	213 975	7 049967	Spring x 2 Autumn	
S103	213 095	7 047 280	Autumn Spring	
S104	214 645	7 039 805	Autumn Spring	
S201	212 417	7 051 734	Spring	Tall Open Shrubland of <i>Calothamnus formosus</i> subsp. <i>formosus</i> , <i>Hakea stenophylla</i> subsp. <i>notialis</i> and <i>Acacia ligulata</i> with occasional emergent <i>Eucalyptus selachiana</i> , <i>Eucalyptus roycei</i> and <i>Eucalyptus mannensis</i> subsp. <i>vespertina</i> with <i>Banksia ashbyi</i> over <i>Lamarchea hakeifolia</i> var. <i>brevifolia</i> and <i>Baeckea</i> sp. Nanga (pn) over <i>Triodia danthonioides</i> in sands = Matiske plant community S2.
S202	212 520	7 049 689	Spring x 2 Autumn	
S203	214 810	7 043 860	Autumn Spring	
S204	214 820	7 042 195		
S205	214 550	7 040 905		
S301	212 700	7 039 500	Autumn	Low Open Shrubland of <i>Acacia ligulata</i> and <i>Hakea stenophylla</i> subsp. <i>notialis</i> with occasional emergent



Site Code	Easting	Northing	Season Sampled	Description
S302	213 560	7 038 745	Spring	<i>Eucalyptus selachiana</i> and <i>Eucalyptus roycei</i> over <i>Baeckea</i> sp. Nanga (pn) and <i>Stenanthemum complicatum</i> over <i>Triodia danthonioides</i> in sands = Mattiske plant community S3.
S5	212 412	7 052 472	Spring	Low Open Shrubland of <i>Acacia subrigida</i> (P2) with occasional emergent <i>Eucalyptus ?eudesmioides</i> and <i>Eucalyptus roycei</i> with <i>Banksia ashbyi</i> over <i>Malleostemon pedunculatus</i> over <i>Triodia danthonioides</i> in sands = Mattiske plant community S5.
S8	214 093	7 066 232	Spring	Tall Open Shrubland of <i>Acacia xiphophylla</i> , <i>Acacia drepanophylla</i> (P3) and <i>Acacia ramulosa</i> var. <i>ramulosa</i> over <i>Chenopodium gaudichaudianum</i> and <i>Scaevola spinescens</i> in clay sands = Mattiske plant community S8.
				<b>Mosaics</b>
M101	210 661	7 063 584	Spring	Mosaic of patches of a Tall Open Shrubland of <i>Acacia ramulosa</i> var. <i>ramulosa</i> , <i>Acacia ligulata</i> and <i>Acacia roycei</i> with occasional emergent <i>Eucalyptus selachiana</i> , <i>Eucalyptus roycei</i> , <i>Eucalyptus mannensis</i> subsp. <i>vespertina</i> and <i>Eucalyptus obtusiflora</i> subsp. <i>obtusiflora</i> over <i>Eremophila maitlandii</i> and <i>Lamarchea hakeifolia</i> subsp. <i>brevifolia</i> over mixed annual species, with patches of a Tall Open Shrubland of <i>Acacia ramulosa</i> var. <i>ramulosa</i> and <i>Acacia roycei</i> over <i>Melaleuca leiopyxis</i> and <i>Malleostemon pedunculatus</i> over mixed annuals in sands = Mattiske plant community M1.
M102	212 468	7 056 337		



**Elliott Trap**



**Cage Trap**



**Funnel Trap(s)**



**Pitfall Trap with drift-fence line  
(Elliott trap on one end of drift-fence line)**

**Plate 6 The various trapping techniques used in the vertebrate fauna survey of the CMS Project Area.**

The trapline layout used in this study is shown in Figure 2 and total trapping effort is shown in Table 2. All details of captured animals were recorded on field data sheets and the animals were released near their point of capture as soon as possible.

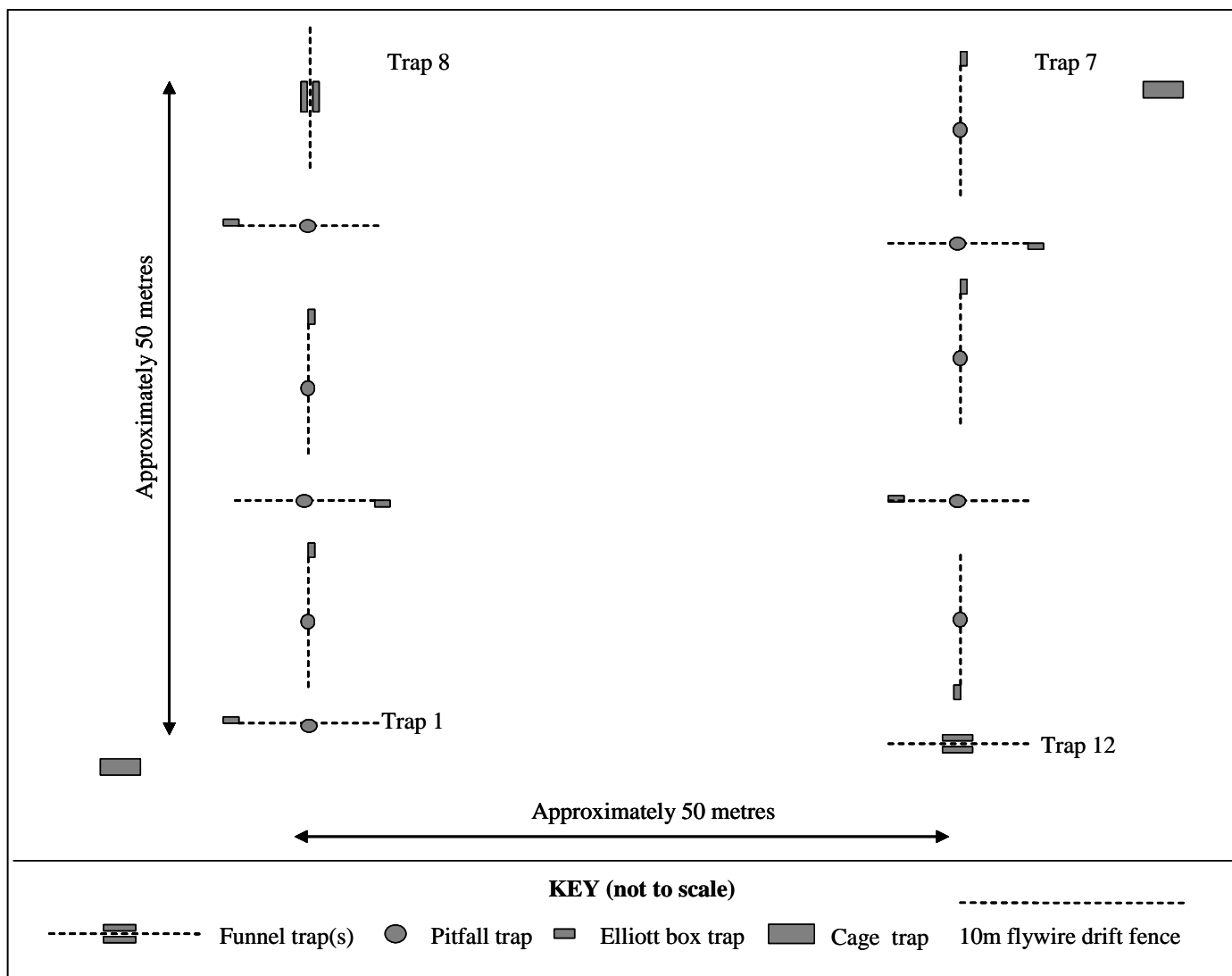


Figure 2 Diagram showing the layout of the 19 traplines sampled in spring 2003, autumn and spring 2004 in the CMS Project Area.

**Table 2 Summary of fauna sampling effort undertaken in the CMS Project Area during spring 2003, autumn and spring 2004.**

Sampling Method	No. of Trap-nights	Sampling Method	Hrs
Pit traps	1,860	Bird area search (minimum)	105
Elliott traps	1,860	Hand-foraging (minimum)	19
Funnel traps	744	<b>Total number of search hours</b>	<b>124</b>
Cage traps	372		
<b>Total number of trap-nights</b>	<b>4,836</b>		

### 2.1.2 Birds

The vegetation community surrounding each fauna trapline was searched in order to record all birds utilising the habitat. The observer moved slowly through each habitat for approximately 45 minutes each day for five days in each seasonal survey, identifying and counting all bird species seen and heard. Sampling times in the various locations were staggered in order to minimise the effects of variations in weather and the peak activity periods of birds. Teams were also rotated daily between the two sets of sites to compensate for any observer bias. The resulting data allow for direct comparisons between the various habitats. Specific searches were also made to document any breeding species in each habitat.

While systematically monitoring a site over a set number of days, it is inevitable that some birds will be recorded on several occasions. Examples are highly territorial birds such as Fairy-wrens, inquisitive species such as Grey Fantails which sometimes follow the observer, nesting birds or flocking species such as cockatoos and Tree Martins which may remain in a localised area for an extended period. This over-recording unavoidably results in an exaggerated figure of relative abundance for some species. To overcome this difficulty, the daily data from the 19 sites were scanned to ascertain the specific day when the highest number of individuals for each species in every site was recorded. The total for this day was selected as being a reliable index of the relative abundance of birds on a site-by-site and seasonal basis.

### 2.1.3 All faunal groups

Time was spent conducting intensive hand-foraging within each fauna sampling site. This consisted of raking leaf litter, searching under log debris and any additional fauna microhabitat that was present in the area. In addition, all sites were searched for signs of the presence of particular animals. Identifiable signs included footprints, scats and diggings.

Bats are best sampled where a concentrating effect occurs, such as narrow watercourses and flyways. While there are no watercourses within the Project Area, the tracks and gridlines throughout the area provided a large assortment of possible bat flyways. Therefore, an automatic bat trap was set in a position that was considered suitable. The trap was left in position for five nights in each survey and checked every morning. As bat sampling cannot be effectively carried out in the systematic sampling sites, data were to be added to the area inventory.

#### 2.1.4 *Proposed Access Road and Camp Site*

The fauna habitats present along the first proposed access road from the mining area to the NWC Hwy was assessed for its conservation significance during spring 2003. This access road runs along the fenceline between Hamelin and Coburn Stations for approximately 40 km from west to east. A potential camp site is approximately 1 km west of the junction of this proposed access road and the NWC Highway. The hand-foraging techniques described in Section 2.1.3 and bird observations were conducted in the various habitats that occurred along this route and camp site. It is understood that this northern road option is not included in the Proponents definition of CMS Project Area, however the results from this northern road option have been included in the CMS Project Area definition for this report.

A second, alternative access road (now the preferred access road) and camp site some 16 km south of the first proposed route have not been assessed on the ground. The information recorded during the three field surveys described in the following Sections, along with the vegetation descriptions provided by Matiske Consulting Pty Ltd was deemed sufficient for this assessment of the vertebrate fauna habitats along this preferred road alignment and alternative camp site. This preferred access road runs between the southern end of the proposed mining area and the NWC Hwy for approximately 45 km, with a camp site approximately 5 km east of the proposed mining area (see Matiske Consulting Pty Ltd [2005] for more precise mapping).

#### 2.1.5 *Report Preparation*

Following a summary of the total results of the three surveys conducted to date in the CMS study area, the remaining discussion of results has been prepared in two Sections dealing with the southern and northern sectors of the study area separately. Should the project be granted approval, mining will commence in the southern sector. Therefore this sector of the Project Area has been discussed first and Section 3.1 details the results of two seasonal surveys conducted in April and November 2004. The northern sector was surveyed during October 2003 and the results of this survey are discussed in Section 3.2. Comparison of the spring results within the two sectors has been made in Section 3.3.

### 3 RESULTS

Seven native mammal species, 45 reptile species and 61 bird species are known to occur in the total CMS Project Area (Appendix 1). Table 3 shows the number of species recorded in the southern and northern sectors and the total for the whole CMS Project Area.

**Table 3** *Summary of vertebrate fauna species known to occur in the southern and northern sector of the CMS Project Area.*

<b>Number of Species</b>	<b>Southern Sector</b>	<b>Northern Sector</b>	<b>Total</b>
Native mammals	5	4	7
Reptiles	31	38	45
Birds	52	55	61
<b>Total</b>	<b>88</b>	<b>97</b>	<b>113</b>
Introduced mammals	6	6	6

### 3.1 Southern Sector of the CMS Project Area

The vegetation in the southern sector of the CMS Project Area consists of three main shrubland communities and one small area of eucalypt woodland (Figure 1). Table 1 describes the systematic sampling sites, and photographs of each site are shown in Plates 1 to 5. The total vertebrate fauna inventory from both surveys is presented in Appendix 1.

#### 3.1.1 Native Mammals

Five native mammal species were recorded during this autumn and spring survey (Table 4). These consisted of two marsupials, the Little Long-tailed Dunnart (*Sminthopsis dolichura*) and Hairy-footed Dunnart (*Sminthopsis hirtipes*) and two rodents, the Spinifex Hopping Mouse (*Notomys alexis*) and Sandy Inland Mouse (*Pseudomys hermannsburgensis*). Only footprints and scats of large kangaroos were seen during these surveys. As three species of kangaroo could potentially occur in the general area (Appendix 3a), no confirmed identification of these signs could be made.

**Table 4** List of native mammals recorded in the 10 systematic sites sampled in autumn and spring 2004 in the CMS Project Area. (Sites E7, S102 and S202 were also sampled in spring 2003 and those results are presented in Section 3.2.1.) S = Signs: counted as one individual.

	Site Code	E7	S102	S103	S104	S202	S203	S204	S205	S301	S302
<b>NATIVE MAMMALS</b>											
<b>DASYURIDAE</b>											
<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart		3	2				1			
<i>Sminthopsis hirtipes</i>	Hairy-footed Dunnart	1		2				1			
<b>MACROPODIDAE</b>											
<i>Macropus</i> sp.	Unidentified Kangaroo	S	S	S	S	S	S	S	S	S	S
<b>MURIDAE</b>											
<i>Notomys alexis</i>	Spinifex Hopping-mouse		1	2	2						
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse	2		2		2		2	2		1
	<b>Number of Species</b>	<b>3</b>	<b>3</b>	<b>5</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>1</b>
	<b>Number of Individuals</b>	<b>4</b>	<b>5</b>	<b>9</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>5</b>	<b>3</b>	<b>2</b>	<b>2</b>

Both the number of species and abundance of native mammals were low, with five species and nine individuals being the maximum recorded in any one site. However, it is likely that most species would be recorded throughout the Project Area given additional sampling following several good seasons. Appendix 1 shows that no native mammal species was added to the southern sector of the study area inventory during the spring 2004 survey.

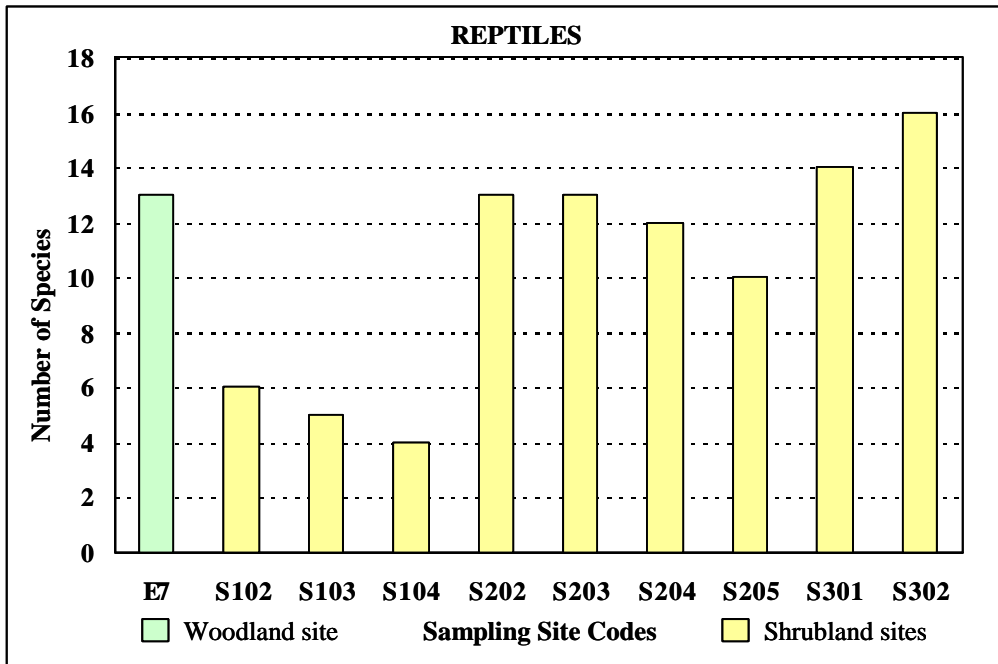
#### 3.1.2 Amphibians and Reptiles

No amphibians and 31 species of reptile were recorded as a result of the two seasonal surveys in the southern sector of the CMS Project Area (Table 5). Of these, 23 species were recorded during the autumn survey and 27 during the spring 2004 survey. Six reptile species were unique to the autumn survey and nine species were added to the species list for the southern sector of the Project Area during the spring 2004 survey.

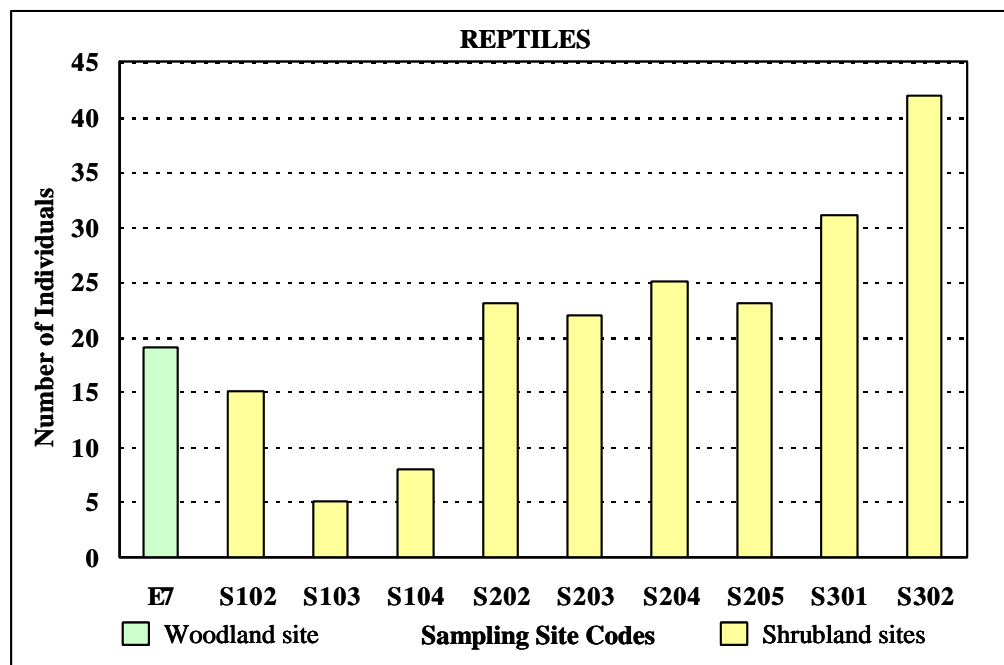
Table 5 shows that no single reptile species was captured in every site although the dwarf skink *Menetia greyii* was captured in eight of the 10 sites. Twenty of the 31 species were recorded in less than half of the 10 sites and many were represented by single individuals in a number of the sites. The species richness and abundance of individual reptiles in the 10 sampling sites have been graphed in Figures 3 and 4.

**Table 5** List of reptiles recorded in the 10 systematic sites sampled in autumn and spring 2004 in the southern sector of the CMS Project Area. (Sites E7, S102 and S202 were also sampled in spring 2003, see Section 3.2.2.) S = Signs: counted as one individual.

Site Code	E7	S102	S103	S104	S202	S203	S204	S205	S301	S302
<b>REPTILES</b>										
<b>GEKKONIDAE (Geckos)</b>										
<i>Diplodactylus alboguttatus</i>					1		1	4	4	4
<i>Diplodactylus klugei</i>						1		1		1
<i>Diplodactylus pulcher</i>	3	3			2	2	1	1	1	
<i>Gehyra variegata</i>	2				2	2	1		2	4
<i>Heteronotia binoei</i>					3	3				
<i>Nephrurus levis occidentalis</i>	2			3		3	2	1		1
<i>Strophurus michaelsoni</i>	1				2	1			2	3
<i>Strophurus strophurus</i>										1
<b>PYGOPODIDAE (Legless Lizards)</b>										
<i>Delma butleri</i>							1			
<i>Pygopus n nigriceps</i>	1	1			1			1		
<b>AGAMIDAE (Dragons)</b>										
<i>Ctenophorus m maculatus</i>	2	8			1		11	7	9	15
<i>Ctenophorus scutulatus</i>						2	1			
<i>Moloch horridus</i>							1			
<i>Pogona m minor</i>		1		2		1			1	1
<b>SCINCIDAE (Skinks)</b>										
<i>Ctenotus fallens</i>	2			1	2		2	5	2	3
<i>Cyclodomorphus celatus</i> (?)					1					
<i>Lerista kendricki</i>	1				3	2	1	1	1	1
<i>Lerista lineopunctulata</i>									1	1
<i>Lerista planiventralis decora</i>					1				1	
<i>Lerista praepedita</i>					3					
<i>Menetia greyii</i>	1	1	1	2		2	1		1	2
<i>Menetia surda cresswelli</i>	1	1	1			1			1	
<i>Morethia lineoocellata</i>								1	2	2
<i>Tiliqua occipitalis</i>						1				
<b>VARANIDAE (Monitors)</b>										
<i>Varanus caudolineatus</i>			1							
<i>Varanus eremius</i>			1		1		2			
<i>Varanus gouldii</i>						S				S
<b>ELAPIDAE (Venomous Snakes)</b>										
<i>Neelaps bimaculatus</i>	1									
<i>Parasuta monachus</i>								1		1
<i>Pseudonaja modesta</i>	1		1							1
<i>Simoselaps littoralis</i>	1								3	
<b>Number of Species</b>	<b>13</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>13</b>	<b>13</b>	<b>12</b>	<b>10</b>	<b>14</b>	<b>16</b>
<b>Number of Individuals</b>	<b>19</b>	<b>15</b>	<b>5</b>	<b>8</b>	<b>23</b>	<b>22</b>	<b>25</b>	<b>23</b>	<b>31</b>	<b>42</b>



*Figure 3 Reptile species richness recorded in each of the 10 systematic sampling sites surveyed during autumn and spring 2004 in the southern sector of the CMS Project Area.*



*Figure 4 Reptile abundance recorded in each of the 10 systematic sampling sites surveyed during autumn and spring 2004 in the southern sector of the CMS Project Area.*



It can be seen from Figure 3 that the sites located in S1 vegetation (S102, S103, S104) had very low species richness when compared to all other sites. These sites all had only six or less species whereas those sites in S3 vegetation (S301 and S302) had particularly high species richness (16 and 14 species respectively). The remaining sites in S2 and E7 vegetation had between 13 and 11 species. While the reasons for this discrepancy are highly speculative, it is possible that one of the main determining factors in S1 vegetation is the time since fire with the resulting very dense but immature vegetation, low cover of leaf litter and other woody debris. It is also possible that the time since fire and changed vegetation structure has resulted in changes in species composition and abundance of invertebrates which has influenced the vertebrate fauna population.

The pattern of abundance of individuals throughout the 10 sites shown in Figure 4 is very similar to the pattern of species richness. Sites in S3 vegetation had high abundance, closely followed by all other S2 vegetation sites and the *Eucalyptus* woodland site E7. Site S302 had a particularly high number of individuals with 42 reptiles. While sites in S1 vegetation all had low numbers of reptiles, sites S103 and S104 had extremely low numbers with only five and eight reptiles respectively.

### 3.1.3 Birds

Appendix 1 shows that a total of 52 species of bird was recorded during the autumn and spring surveys of the southern sector of the CMS Project Area. Of these, 40 species were recorded in autumn and 44 in spring 2004. Eight species were recorded only in autumn and 12 species were added to the inventory of the southern sector of the study area in spring 2004.

Forty-nine of the bird species, 13 Non-passerines and 36 Passerines, were recorded during systematic sampling in the 10 sites (Table 6) and these data have been used in the following analyses.

**Table 6** *List of birds recorded in the 10 systematic sites sampled in autumn and spring 2004 in the southern sector of the CMS Project Area. (Numbers are the maximum daily count for each species. Sites E7, S102 and S202 were also sampled in spring 2003 and those results are presented in Section 3.2.3.) S = Signs: counted as one individual; + indicates male with dependent young.*

	SITE CODES	E7	S102	S103	S104	S202	S203	S204	S205	S301	S302
<b>NON-PASSERINE BIRDS</b>											
<b>CASUARIIDAE</b>											
<i>Dromaius novaehollandiae</i>	Emu	2+	2	1		S	S		S	1	S
<b>MEGAPODIIDAE</b>											
<i>Leipoa ocellata</i>	<sup>1</sup> Malleefowl			S		S	S	S	S	S	S
<b>ACCIPITRIDAE</b>											
<i>Aquila morphnoides</i>	Little Eagle									1	1
<b>FALCONIDAE</b>											
<i>Falco berigora</i>	Brown Falcon							1	1		
<i>Falco cenchroides</i>	Nankeen Kestrel			2							
<b>COLUMBIDAE</b>											
<i>Phaps chalcoptera</i>	Common Bronzewing			1		2	1				

	SITE CODES	E7	S102	S103	S104	S202	S203	S204	S205	S301	S302
<b>PSITTACIDAE</b>											
<i>Cacatua roseicapilla</i>	Galah	6	7				2		6	8	4
<i>Platycercus zonarius</i>	Australian Ringneck	4		1	1		2	5	2	2	
<i>Platycercus varius</i>	Mulga Parrot	2	3	2							
<b>CUCULIDAE</b>											
<i>Chrysococcyx osculans</i>	Black-eared Cuckoo								1		
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo	1	1						1		
<b>AEGOTHELIDAE</b>											
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar									1	
<b>MEROPIDAE</b>											
<i>Merops ornatus</i>	Rainbow Bee-eater			1							
<b>PASSERINE BIRDS</b>											
<b>MALURIDAE</b>											
<i>Malurus splendens</i>	Splendid Fairy-wren	4		1					3		1
<i>Malurus lamberti</i>	Variiegated Fairy-wren	4	3	4	6		2	6	2	5	10
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren	3									2
<b>PARDALOTIDAE</b>											
<i>Pardalotus striatus</i>	Striated Pardalote	2				1	1	1	1	5	4
<b>ACATHIZIDAE</b>											
<i>Sericornis frontalis</i>	White-browed Scrubwren	3	2	2	1	2		2		2	4
<i>Pyrrholaemus brunneus</i>	Redthroat	2	2	2	2				1		2
<i>Smicrornis brevirostris</i>	Weebill	20		2	1	6	2	10	6	4	3
<i>Gerygone fusca</i>	Western Gerygone					1					1
<i>Acanthiza apicalis</i>	Broad-tailed Thornbill	4	3	4	2	8	4	8	3	4	6
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	10		2		4	2	2	6	5	
<b>MELIPHAGIDAE</b>											
<i>Lichmera indistincta</i>	Brown Honeyeater		4			2	16	4	10		4
<i>Lichenostomus virescens</i>	Singing Honeyeater	4	4	6	8	8	8	12	6	4	10
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater	1	4		3			2	10		1
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	2			2	4	3	2	6		8
<i>Phylidonyris albifrons</i>	White-fronted Honeyeater		8	8	1	8	12	15	10	4	12
<i>Manorina flavigula</i>	Yellow-throated Miner				2						
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	6	2	6	2	10	16	8	8	3	4
<i>Epthianura tricolor</i>	Crimson Chat		6								
<b>PETROICIDAE</b>											
<i>Microeca fascianus</i>	Jacky Winter	1									
<i>Petroica goodenovii</i>	Red-capped Robin						1				
<i>Eopsaltria australis</i>	Yellow Robin						2		1		
<i>Drymodes brunneopygia</i>	Southern Scrub-robin	2	6	4	3	3	4	2		2	6
<b>POMATOSTOMIDAE</b>											
<i>Pomatostomus superciliosus</i>	White-browed Babbler	7	4	3	2	5	2	4	6	10	4
<b>CINCLOSOMATIDAE</b>											
<i>Psophodes occidentalis</i>	Western Wedgebill						1				
<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush									1	1
<b>PACHYCEPHALIDAE</b>											
<i>Oreoica gutturalis</i>	Crested Bellbird	1	1	1	2	1	2	2	1	1	2
<i>Pachycephala pectoralis</i>	Golden Whistler	1	1	1	2	2	2	2	2		1
<i>Pachycephala rufiventris</i>	Rufous Whistler	4	1	1	2	1	2	2	2	1	1
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	1	1	1	2	2	4	2	2	2	2

	SITE CODES	E7	S102	S103	S104	S202	S203	S204	S205	S301	S302
<b>DICRURIDAE</b>											
<i>Rhipidura fuliginosa</i>	Grey Fantail						1				
<i>Rhipidura leucophrys</i>	Willie Wagtail	1	2		1	1	2	2	1	1	1
<b>CAMPEPHAGIDAE</b>											
<i>Lalage tricolor</i>	White-winged Triller							1	1		2
<b>CRACTICIDAE</b>											
<i>Cracticus torquatus</i>	Grey Butcherbird	2	2		1	2	2	1	1	1	1
<b>CORVIDAE</b>											
<i>Corvus bennetti</i>	Little Crow	4	2	1	2	4	2			2	2
<b>ZOSTEROPIDAE</b>											
<i>Zosterops lateralis</i>	Grey-breasted White-eye					3					
<b>PASSERIDAE</b>											
<i>Taeniopygia guttata</i>	Zebra Finch					5					
	<b>Number of Species</b>	<b>28</b>	<b>23</b>	<b>24</b>	<b>21</b>	<b>25</b>	<b>28</b>	<b>24</b>	<b>29</b>	<b>24</b>	<b>30</b>
	<b>Number of Individuals</b>	<b>104</b>	<b>71</b>	<b>58</b>	<b>48</b>	<b>87</b>	<b>99</b>	<b>97</b>	<b>102</b>	<b>72</b>	<b>102</b>

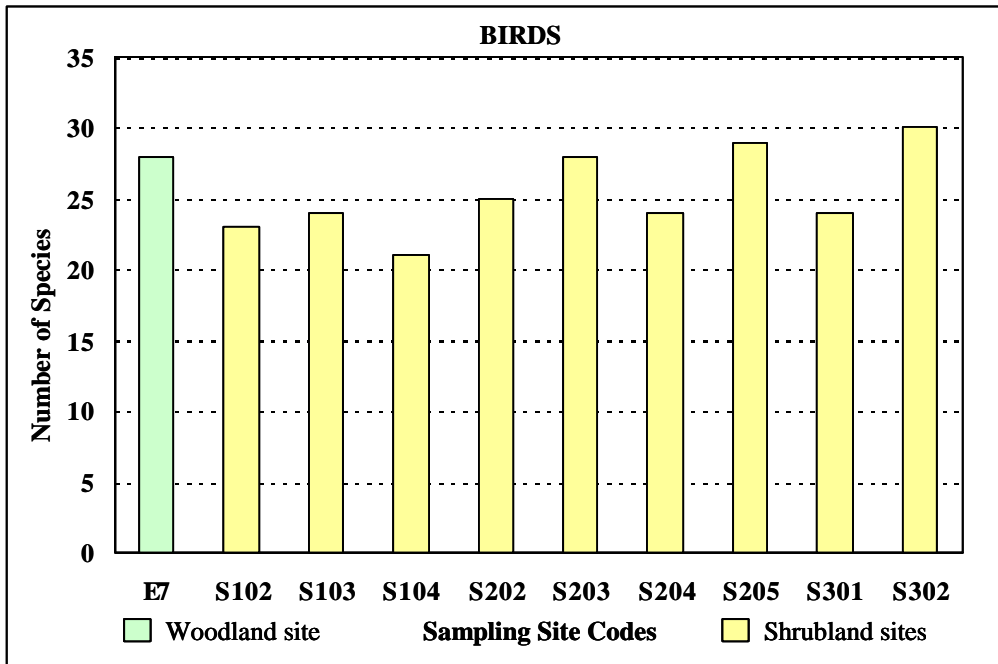
1 - Protected under the EPBC Act and Wildlife Conservation Act.

Only seven bird species were recorded in all 10 sampling sites. These were: Rufous Whistler; Grey Shrike-thrush; Crested Bellbird; White-browed Babbler; Broad-tailed Thornbill; Spiny-cheeked and Singing Honeyeaters. All of these birds are common and widespread throughout much of Western Australia, particularly arid areas. Twenty-three species were recorded in less than half of the 10 sampling sites.

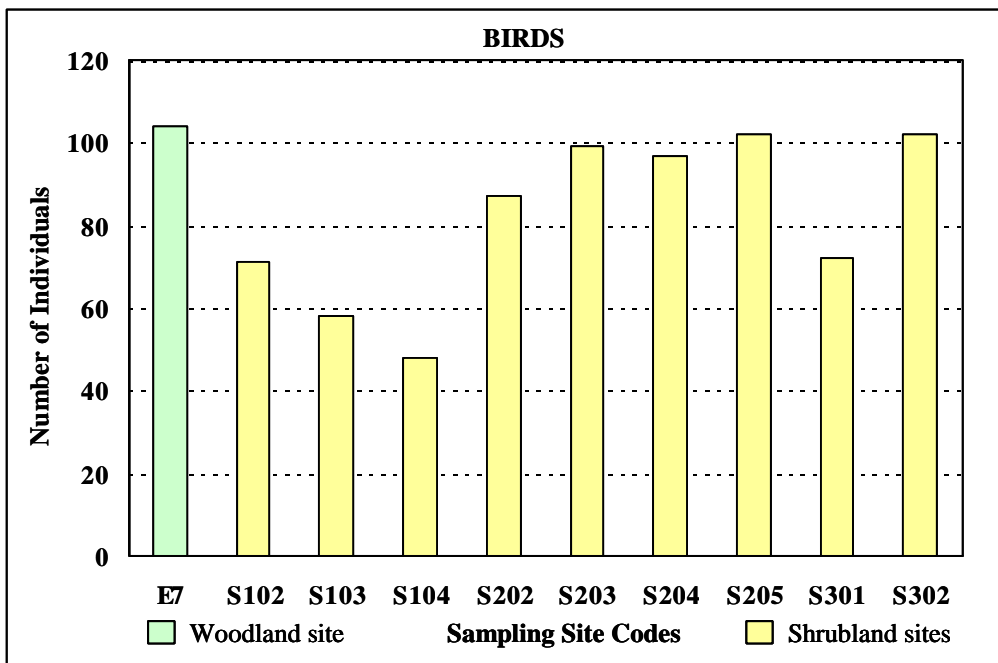
The presence of the rare Malleefowl was detected throughout this southern sector of the Project Area. Although no birds were observed, fresh Malleefowl footprints were noted in sites S103, S203 and S204. The distribution of nesting mounds was widespread and their condition ranged from very old, degraded mounds to relatively fresh, probably from last breeding season. The Malleefowl is discussed in more detail in Section 2.3.

Based on the information given in Table 6, the graph showing bird species richness is presented in Figure 5. Four sites have between 28 and 30 species of bird although there is nothing to link these sites in terms of vegetation composition or structure. These are: S302; S205; S203 and E7. All other sites had between 21 and 25 species of bird, the lowest number being recorded from site S104. While there is no distinct pattern of bird species richness to habitat, the data show a trend towards a higher number of species where the vegetation is more open and mature.

As discussed previously, bird abundance has been calculated on the highest daily count for each species over the whole sampling period. This number is then taken as the best index of abundance of birds. Based on this index, sites E7, S302, S205 and S203 all have very similar abundance of birds with between 104 and 99 individuals. In general, Figure 6 shows that the pattern of bird abundance matched that of the bird species richness, with the more open and mature vegetation having the higher number of birds and the low, dense S1 vegetation having lower numbers of birds. While this may initially appear to be result of differences in visibility, both ornithologists are skilled in the identification of birds from their distinctive calls, reducing the sampling variability between vegetation communities.



*Figure 5 Bird species richness recorded in each of the 10 systematic sampling sites surveyed during autumn and spring 2004 in the southern sector of the CMS Project Area.*



*Figure 6 Bird abundance recorded in each of the 10 systematic sampling sites surveyed during autumn and spring 2004 in the southern sector of the CMS Project Area. (Based on the maximum daily count for each species.)*

### 3.1.4 Introduced Fauna

Six species of introduced mammals were recorded during autumn and spring 2004 in the southern sector of the CMS Project Area (Table 7). Most of these were only noted by the presence of scats and/or tracks although a small herd of goats was observed in site S301. Three herbivores (rabbit, camel and goat) and three carnivores (dog/dingo, fox and cat) were recorded during the autumn survey. While the herbivores did not appear to be particularly common in the study sites, fresh tracks of the three carnivores were regularly noted in some sites and a fox was seen in site S205. Two feral cats were captured and were humanely destroyed.

**Table 7** List of introduced mammals recorded in the 10 systematic sites sampled in autumn and spring 2004 in the southern sector of the CMS Project Area. (Sites E7, S102 and S202 were also sampled in spring 2003 and those results are shown in Section 3.2.4.) S = Signs: counted as one individual.

	Site Code	E7	S102	S103	S104	S202	S203	S204	S205	S301	S302
<b>LEPORIDAE</b>											
<i>Oryctolagus cuniculus</i>	Rabbit	1	S	S	S	1	S				S
<b>CANIDAE</b>											
<i>Canis sp.</i>	Feral Dog/Dingo					S	S		S		S
<i>Vulpes vulpes</i>	Red Fox				S			S	1	S	S
<b>FELIDAE</b>											
<i>Felis catus</i>	Feral Cat			S		1		S		S	1
<b>CAMELIDAE</b>											
<i>Camelus dromedarius</i>	One-humped Camel	S				S		S			
<b>BOVIDAE</b>											
<i>Capra hircus</i>	Goat	S				S	S			4	
	<b>Number of Species</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>5</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>4</b>

## 3.2 Northern Sector of the CMS Project Area

The vegetation in the northern sector of the CMS Project Area consists of a variety of Eucalyptus woodlands, mixed shrublands and mosaic communities (see Mattiske Consulting Pty Ltd 2005 for more detail). It can be seen from Figure 1 that this northern sector has greater diversity of vegetation communities than the southern sector, particularly within the woodlands which are relatively extensive. This northern sector also includes S8 vegetation which occurs on heavier sandy clay soils.

This northern sector of the Project Area was surveyed in October 2003 and the total vertebrate fauna inventory from this season is presented in Appendix 1. In summary, four native mammal species, 38 reptile species and 55 bird species were captured or observed during this sampling period. Five introduced or feral mammal species were also recorded. Each faunal group is discussed in more detail in the following sections.

Three sites (S102, S202 and E7) were surveyed in all three seasonal sampling periods. This was done in order to ensure that major differences in results between the southern and northern sectors of the study area on a seasonal basis could be more readily identified as realistic or as a vagary of sampling.

### 3.2.1 Native Mammals

Native mammal results were extremely poor with only the Sandy Inland Mouse (*Pseudomys hermannsburgensis*) captured. Two species of kangaroo were seen, the Euro (*Macropus robustus*) and Red Kangaroo (*Macropus rufus*). Characteristic diggings of the Echidna (*Tachyglossus aculeatus*) were noted in four of the 12 sampling sites but none were captured or observed. No small marsupials were captured during this spring 2003 sampling period.

The abundance of individuals was also very low with only three Sandy Inland Mice being captured and only single individuals of the two kangaroo species being seen.

### 3.2.2 Amphibians and Reptiles

No amphibians were captured, seen or heard during the course of this survey. However, reptile results were extremely high with 38 species being recorded comprising seven geckos, three legless lizards, four dragons, 16 skinks, three monitors and five elapid (venomous) snakes (Appendix 1). Thirty-five of these reptile species were captured during systematic sampling in the 12 sites (Table 8) and these results have been used in the following analysis of species diversity and habitat use.

Table 8 shows that no single species of reptile was recorded in every site although some, such as the geckos *Diplodactylus pulcher* and *Nephrurus levis occidentalis*, were abundant as were the skinks *Lerista kendricki* and *Lerista muelleri*. Nine species were extremely uncommon and were represented by single individuals only.

Each site varied greatly in the species that made up this total and no site had greater than 37% of the total reptile species recorded during systematic sampling.

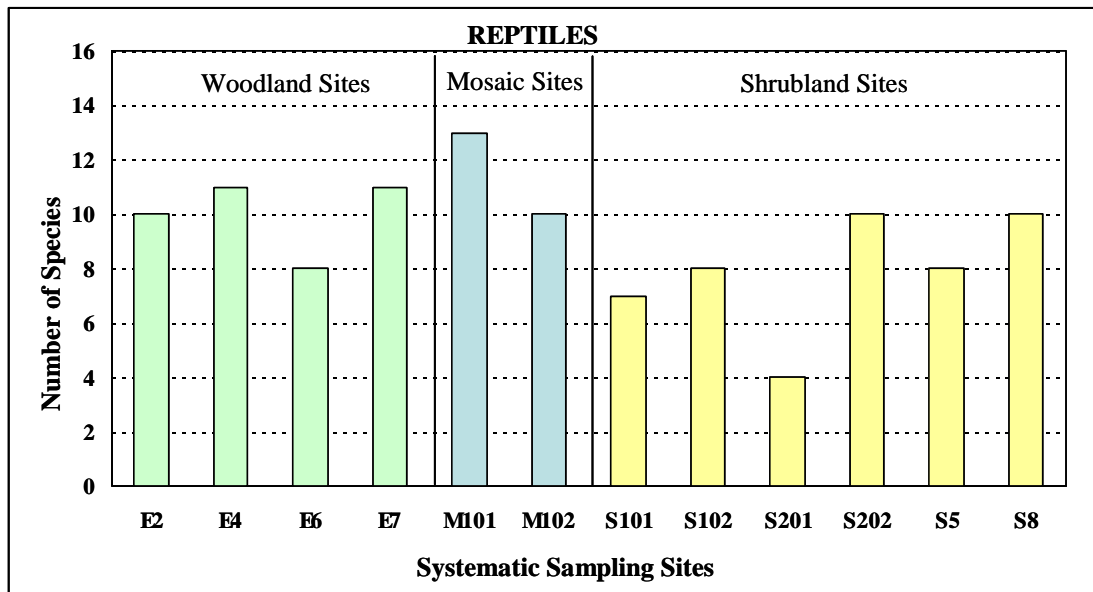
**Table 8** List of reptiles recorded in the 12 systematic sites sampled in spring 2003 in the northern sector of the CMS Project Area. (Sites E7, S102 and S202 were also sampled in autumn and spring 2004 and those results are shown in Section 3.1.2.)

Site Code	Eucalypt Woodlands				Mosaics		Shrublands					
	E2	E4	E6	E7	M101	M102	S101	S102	S202	S201	S5	S8
<b>REPTILES</b>												
<b>AGAMIDAE</b>												
<i>Ctenophorus m maculatus</i>	1									4		1
<i>Ctenophorus scutulatus</i>	1	1	1		2		1					
<i>Pogona m minor</i>								1				
<b>GEKKONIDAE</b>												
<i>Diplodactylus alboguttatus</i>		2				4		1	1			2
<i>Diplodactylus pulcher</i>	3	1		2	1	3	3	1		2	4	
<i>Diplodactylus squarrosus</i>												5
<i>Strophurus strophurus</i>		2				1						
<i>Gehyra variegata</i>			1	1	2						1	5
<i>Heteronotia binoei</i>									1			
<i>Nephrurus levis occidentalis</i>			2	2	9	1		2		1		4
<b>PYGOPODIDAE</b>												
<i>Aprasia smithi</i>					1							
<i>Delma butleri</i>				1								

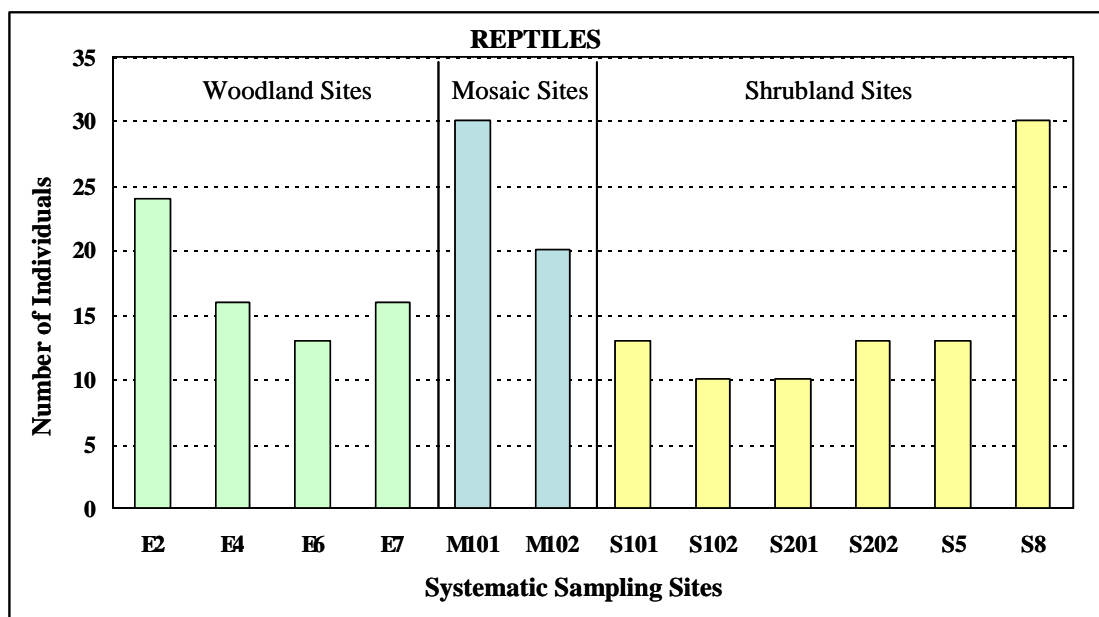
Site Code	Eucalypt Woodlands				Mosaics		Shrublands					
	E2	E4	E6	E7	M101	M102	S101	S102	S202	S201	S5	S8
<i>Pygopus n nigriceps</i>		4	1	1	1			1	1			2
<b>SCINCIDAE</b>												
<i>Ctenotus alleni</i>				1			1				1	
<i>Ctenotus fallens</i>				2			2		3			
<i>Ctenotus schomburgkii</i>	2											1
<i>Cyclodomorphus celatus</i>		1		1	2							
<i>Egernia depressa</i>												1
<i>Lerista kendricki</i>	6		1		6	3	2	1	2			1
<i>Lerista lineopunctulata</i>					2				1			
<i>Lerista macropisthopus fuscipes</i>					1							
<i>Lerista muelleri</i>	7		2									9
<i>Lerista planiventralis decora</i>						2						
<i>Lerista praepedita</i>	1	1		1	1				1		1	
<i>Lerista varia</i>									1			
<i>Menetia surda cresswelli</i>				3			1	2	1	3	1	
<i>Menetia greyii</i>		1	3			2			1		2	
<i>Morethia obscura</i>			2									
<b>VARANIDAE</b>												
<i>Varanus eremius</i>		1					3					
<i>Varanus gouldii</i>				1		1						
<b>ELAPIDAE</b>												
<i>Neelaps bimaculatus</i>	1											
<i>Pseudechis australis</i>						1						
<i>Brachyuropis approximans</i>		1			1							1
<i>Simoselaps bertholdi</i>	1				1	2		1			1	
<i>Simoselaps littoralis</i>	1	1										
<b>Number of Species</b>	<b>10</b>	<b>11</b>	<b>8</b>	<b>11</b>	<b>13</b>	<b>10</b>	<b>7</b>	<b>8</b>	<b>10</b>	<b>4</b>	<b>8</b>	<b>10</b>
<b>Number of Individuals</b>	<b>24</b>	<b>16</b>	<b>13</b>	<b>16</b>	<b>30</b>	<b>20</b>	<b>13</b>	<b>10</b>	<b>13</b>	<b>10</b>	<b>13</b>	<b>30</b>
<b>Number of Species per Vegetation Community</b>	<b>25</b>				<b>19</b>		<b>24</b>					

The species richness of reptiles in each site has been graphed in Figure 7. This graph shows that in general, the woodland and mosaic habitats have higher species richness than the shrubland sites. In total, the four woodland sites had 25 species, the two mosaic sites had 19 species and the six shrubland sites had 24 species. Therefore, in terms of representation of vegetation communities, the mosaic vegetation was the richest in reptiles in this northern sector of the Project Area.

Site M101 had the highest number of reptiles with 13 species, and two woodland sites (E4 and E7) had 11. At least one site within all three major vegetation communities had 10 species while site S201 had the lowest with only four species. Of the shrubland communities, sites S202 and S8 had more species of reptile than any of the other sites.



**Figure 7** Reptile species richness recorded in each of the 12 systematic sampling sites surveyed during spring 2003 in the northern sector of the CMS Project Area.



**Figure 8** Reptile abundance recorded in each of the 12 systematic sampling sites surveyed during spring 2003 in the northern sector of the CMS Project Area.

The abundance of individual reptiles has been graphed in Figure 8. Two sites had very high abundance of reptiles: M101 and S8 with 30 individuals each. Site E2 had 24 and site M102 had 20 individuals. All other sites had between 16 and 10 animals.

The two mosaic sites (M101 and M102), the woodland site E2 and the shrubland site S8 are notable with both a high species richness and abundance of individuals. Sites E4, E7 and



S202 were relatively low in species but had a high abundance of individuals. The remaining sites (E6, S101, S102, S201 and S5) had a low number of species and 16 or less individual reptiles, with the lowest number from sites S102 and S201 with only 10 animals in each.

### 3.2.3 Birds

Of the total 55 species of bird observed during the spring survey, 48 were recorded during sampling of the 12 systematic sites: 13 Non-passerines and 35 Passerines (Table 9). Two species, the Broad-tailed Thornbill and Singing Honeyeater, were recorded in 11 of the 12 sites. Fourteen species were represented by less than five individuals in total throughout the survey. Signs (old nesting mounds) of the Malleefowl were noted in the two mosaic site (M101 and M102). This species is discussed in detail in Section 3.8.

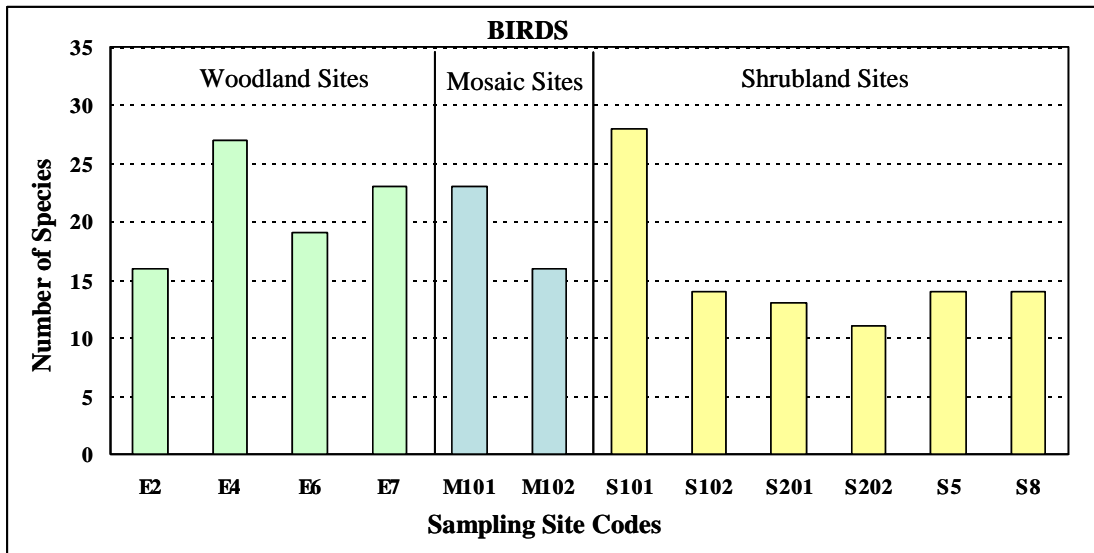
**Table 9** List of birds recorded in the 12 systematic sites sampled in spring 2003 in the northern sector of the CMS Project Area. (Numbers are the maximum daily count for each species. Sites E7, S102 and S202 were also sampled in autumn and spring 2004 and those results are shown in Section 3.1.3.)

		Eucalypt Woodlands				Mosaics		Shrublands					
Site Code		E2	E4	E6	E7	M101	M102	S101	S102	S201	S202	S5	S8
<b>NON-PASSERINE BIRDS</b>													
<b>CASUARIIDAE</b>													
<i>Dromaius novaehollandiae</i>	Emu		S		S	2		S	2	S	1		S
<b>MEGAPODIIDAE</b>													
<i>Leipoa ocellata</i>	<sup>1</sup> Malleefowl					S	S						
<b>ACCIPITRIDAE</b>													
<i>Accipiter fasciatus</i>	Brown Goshawk				1								1
<b>FALCONIDAE</b>													
<i>Falco berigora</i>	Brown Falcon		1		1				1				
<i>Falco cenchroides</i>	Australian Kestrel							1					
<b>COLUMBIDAE</b>													
<i>Phaps chalcoptera</i>	Common Bronzewing	1		2				1					1
<i>Ocyphaps lophotes</i>	Crested Pigeon						1						
<i>Geopelia cuneata</i>	Diamond Dove	1											
<b>PSITTACIDAE</b>													
<i>Cacatua roseicapilla</i>	Galah	6			2			10					9
<i>Nymphicus hollandicus</i>	Cockatiel							4					
<i>Platycercus zonarius</i>	Australian Ringneck				3	1		4		1		2	
<i>Platycercus varius</i>	Mulga Parrot	2		2	2					4			2
<b>CUCULIDAE</b>													
<i>Chrysococcyx osculans</i>	Black-eared Cuckoo		1	1		1		1					
<b>MEROPIDAE</b>													
<i>Merops ornatus</i>	Rainbow Bee-eater										1		
<b>PASSERINE BIRDS</b>													
<b>MALURIDAE</b>													
<i>Malurus splendens</i>	Splendid Fairy-wren	4	4	6		20							
<i>Malurus lamberti</i>	Variiegated Fairy-wren		3		6		4	6	4	6	5		
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren	4				5		10	3				
<b>PARDALOTIDAE</b>													
<i>Pardalotus striatus</i>	Striated Pardalote	1	3		1							1	

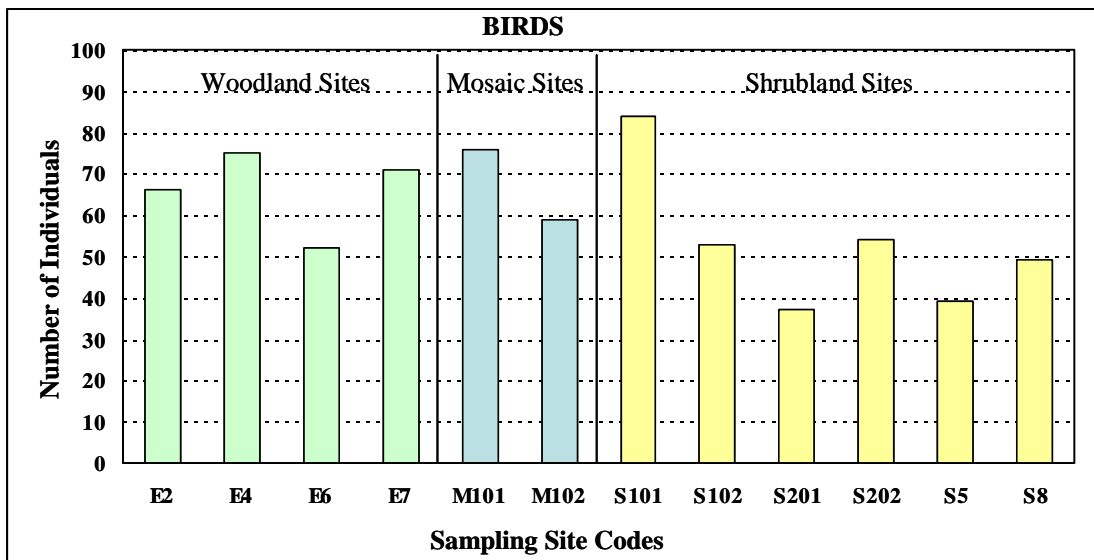
Site Code	Eucalypt Woodlands				Mosaics		Shrublands								
	E2	E4	E6	E7	M101	M102	S101	S102	S201	S202	S5	S8			
<b>ACATHIZIDAE</b>															
<i>Sericornis frontalis</i>	White-browed Scrubwren			1	2			1							
<i>Smicrornis brevirostris</i>	Weebill			20	8	10	10	4		2	6	6			
<i>Gerygone fusca</i>	Western Gerygone					1									
<i>Acanthiza apicalis</i>	Broad-tailed Thornbill			3	3	3	4	4	4	1	2	8	4	3	
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill			10	4	8	4	6				8	4	10	
<b>MELIPHAGIDAE</b>															
<i>Lichmera indistincta</i>	Brown Honeyeater				4			6	6	1			4		
<i>Certhionyx variegatus</i>	Pied Honeyeater				2		3	1							
<i>Lichenostomus virescens</i>	Singing Honeyeater			2	6	1	1	3	2	3		3	3	2	4
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater						2	3	15	6	4				
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater				2										
<i>Phylidonyris albifrons</i>	White-fronted Honeyeater				2		8	6	10	4	12	8	15	6	
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater			4	8	2	8	3	2	4	2	4	6	4	6
<i>Epthianura tricolor</i>	Crimson Chat				2	2	4			2	10				
<b>PETROICIDAE</b>															
<i>Petroica goodenovii</i>	Red-capped Robin			3	2	2		1	1						
<i>Drymodes brunneopygia</i>	Southern Scrub-robin				2	2			2	6					
<b>POMATOSTOMIDAE</b>															
<i>Pomatostomus superciliosus</i>	White-browed Babbler								2	4	4	4	4	1	8
<b>CINCLOSOMATIDAE</b>															
<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush				2										
<i>Psophodes occidentalis</i>	Western Wedgebill					2		1	4	4	1			1	
<b>PACHYCEPHALIDAE</b>															
<i>Oreica gutturalis</i>	Crested Bellbird				1	1		1		1		1			
<i>Pachycephala pectoralis</i>	Golden Whistler				1	2	1	2	2	1					
<i>Pachycephala rufiventris</i>	Rufous Whistler				2	2	1	2	2	2				1	1
<i>Colluricincla harmonica</i>	Grey Shrike-thrush							1	1	1		1	1	2	1
<b>DICRURIDAE</b>															
<i>Rhipidura leucophrys</i>	Willie Wagtail									1		1			
<b>CAMPEPHAGIDAE</b>															
<i>Lalage tricolor</i>	White-winged Triller				1	2				1	6				
<b>ARTAMIDAE</b>															
<i>Artamus cinereus</i>	Black-faced Woodswallow				4		4								
<b>CRACTICIDAE</b>															
<i>Cracticus torquatus</i>	Grey Butcherbird			1			1			1				1	1
<b>CORVIDAE</b>															
<i>Corvus bennetti</i>	Little Crow			2	2	1	2			1		2		3	
<b>HIRUNDINIDAE</b>															
<i>Hirundo nigricans</i>	Tree Martin			3	2						1				
<b>ESTRILDIDAE</b>															
<i>Taeniopygia guttata</i>	Zebra Finch				2					2					
<b>MOTACILLIDAE</b>															
<i>Anthus australis</i>	Richard's Pipit							1							
<b>Number of Species</b>				<b>16</b>	<b>27</b>	<b>19</b>	<b>23</b>	<b>23</b>	<b>16</b>	<b>28</b>	<b>14</b>	<b>13</b>	<b>11</b>	<b>14</b>	<b>14</b>
<b>Number of Individuals</b>				<b>66</b>	<b>75</b>	<b>52</b>	<b>71</b>	<b>76</b>	<b>59</b>	<b>84</b>	<b>53</b>	<b>37</b>	<b>54</b>	<b>39</b>	<b>49</b>
<b>Number of Species per Vegetation Community</b>				<b>39</b>				<b>27</b>			<b>37</b>				

1 - Protected under the EPBC Act and Wildlife Conservation Act.

As for reptiles, the eucalypt woodland sites were, overall, slightly richer in bird species than the mosaic and shrubland sites with 39 species recorded in woodland sites, 27 in mosaic sites and 37 in shrubland sites. However, as discussed in Section 3.2.2, in terms of representation of vegetation communities, the mosaic vegetation is the richest in bird species in this northern sector of the Project Area. One shrubland site (S101) and one woodland site (E4) stand out with 28 and 27 species of bird respectively (Figure 9).



**Figure 9** Bird species richness recorded in each of the 12 systematic sampling sites surveyed during spring 2003 in the northern sector of the CMS Project Area.



**Figure 10** Bird abundance recorded in each of the 12 systematic sampling sites surveyed during spring 2003 in the northern sector of the CMS Project Area. (Based on maximum daily count for each species.)

The bird species richness from the 12 systematic sites has been graphed in Figure 9 which shows that five of the six shrubland sites had less than 15 species present during the survey. As mentioned previously, the shrubland site S101 had the highest species richness with 28 and the Eucalyptus woodland site E4 also had a high number of species with 27. The Eucalyptus woodland and mosaic sites E7 and M101 also had relatively high species richness with 23 species in each.

Figure 10 shows that the picture of abundance of individuals is not so clear, although three of the shrubland sites had less than 50 individuals; site S101 had the highest abundance with 84 birds. All other sites ranged from a low of 52 birds in site E6 to 76 birds in site M101.

### 3.2.4 Introduced Fauna

Table 10 shows that all of the introduced animals recorded during this spring survey were noted by signs such as tracks and/or scats. Two herbivores (rabbit and camel) and three carnivores (dog/dingo, fox and cat) were recorded.

**Table 10** List of introduced mammals recorded in the 12 systematic sites sampled in spring 2003 in the northern sector of the CMS Project Area. (Sites E7, S102 and S202 were also sampled in autumn and spring 2004 and those results are shown in Section 3.1.4.)

Vegetation Community		Eucalypt Woodlands				Mosaics		Shrublands					
Site Code		E3	E4	E6	E7	M101	M102	S101	S102	S201	S202	S5	S8
<b>LEPORIDAE</b>													
<i>Oryctolagus cuniculus</i>	Rabbit			S	S			S	S	S	S		
<b>CANIDAE</b>													
<i>Canis</i> sp.	Dog/Dingo		S								S	S	
<b>CANIDAE</b>													
<i>Vulpes vulpes</i>	Red Fox	S											S
<b>FELIDAE</b>													
<i>Felis catus</i>	Feral Cat									S	S		
<b>CAMELIDAE</b>													
<i>Camelus dromedarius</i>	One-humped Camel				S						S		
	<b>Number of Species</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>4</b>	<b>1</b>	<b>1</b>

None of the introduced predators (carnivores) appears to be particularly common or widespread in the northern sector of the Project Area and only a single One-humped Camel appears to be present in the vicinity of sites E7 and S202.

### 3.3 Total CMS Project Area – Spring 2003 and 2004

In order to discuss the CMS Project Area as a whole, and make legitimate comparisons between the southern and northern sampling sites, only the spring 2003 and spring 2004 results have been used in the following discussion. Three sites (E7, S102 and S202) were approximately at the mid-point of the study area and were sampled in both years. This was done in order to ensure that differences in results from the two years could be realistically assessed. The two sets of data from spring 2003 and 2004 in these sites have been assessed

separately. Appendix 2a and b show the data from all sites that were surveyed during these two spring sampling sessions. Note that, for various reasons, site S104 in the southern sector of the CMS Project Area was not re-sampled in spring 2004 resulting in 18 sites being used in the following analysis of the total CMS Project Area.

### **3.4 Native Mammals**

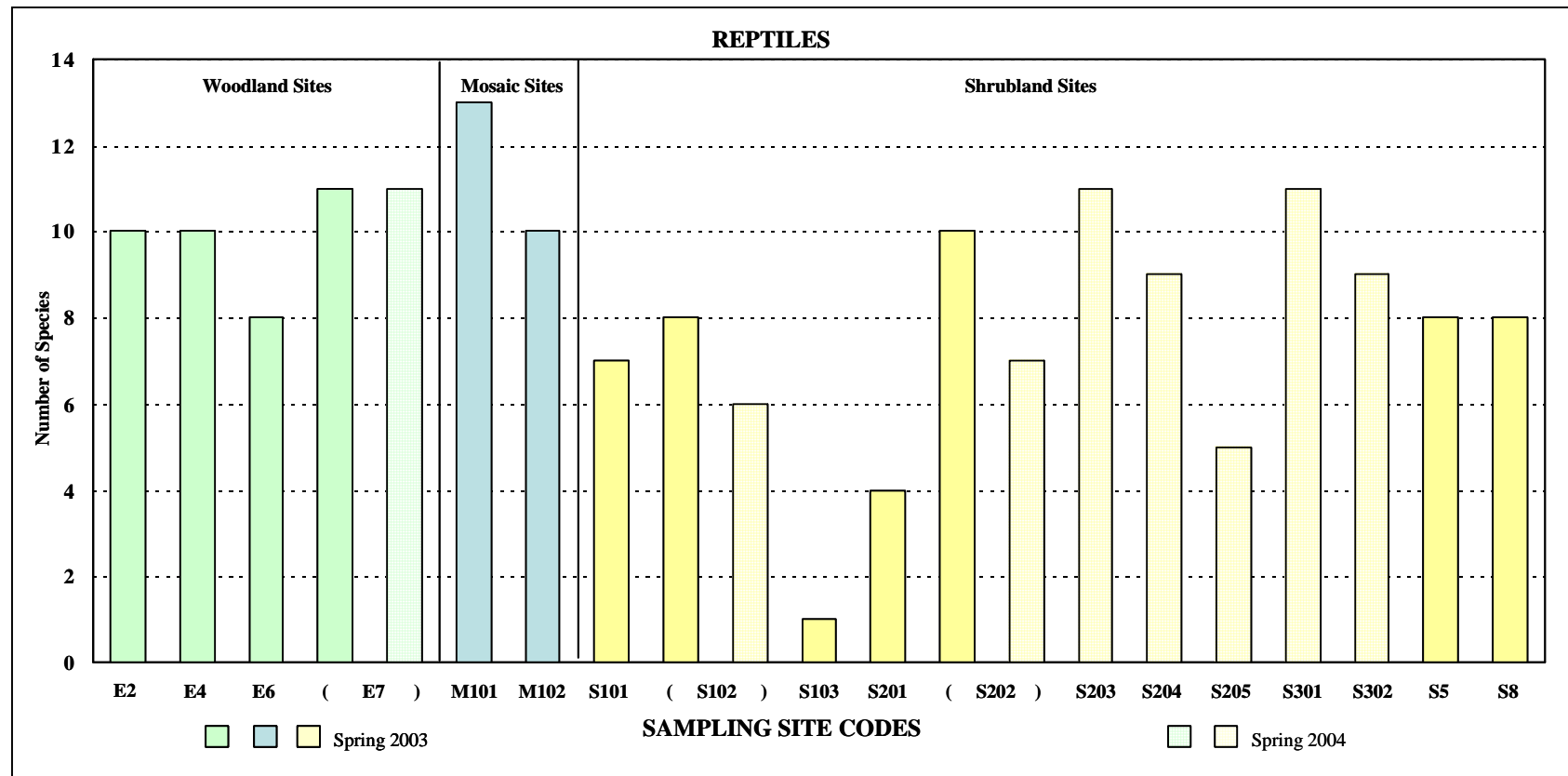
Six species of native mammal were recorded in the 18 sites shown in Appendix 2a. None was common with three species being the maximum recorded in any one site. The number of individuals was also very low throughout the CMS Project Area with three individual mammals being the maximum recorded from any one site.

### **3.5 Reptiles**

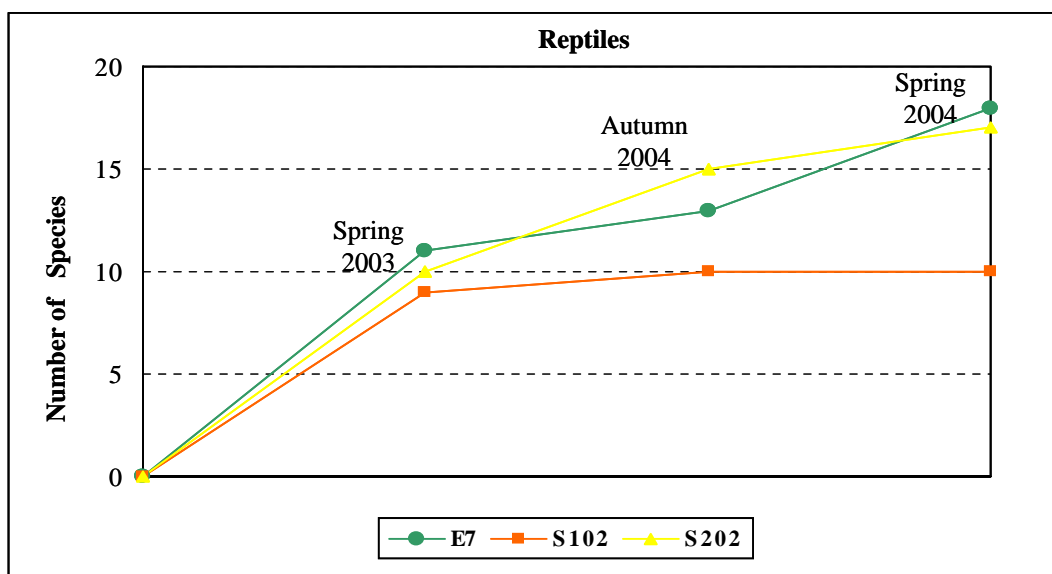
Forty species of reptile were recorded in the 18 sites shown in Appendix 2a during the spring surveys. The results have been graphed in Figure 11 which shows that, overall, the woodland and mosaic sites were richer in species than most shrubland sites. However, there were large discrepancies between sites within the same vegetation community. For example, site S102 had eight species while S103 had only one. Similarly, site S203 had 11 species while site S205 had only five. Both sites within S3 vegetation were moderately rich in species as were the two unusual shrublands S5 and S8. All of these sites had eight or more species of reptile.

However, there is only a low number of species in each site relative to the total number of species recorded overall, i.e. the maximum number of species in any one site is less than 33% of the total recorded during both spring surveys. This indicates that either the distribution of reptile species through the vegetation communities of the CMS Project Area is very patchy or that further survey work would add more species to each of the sampling sites.

In order to explore the potential of the vertebrate fauna sites within the CMS Project Area to support additional reptile species, the chart shown in Figure 12 has been constructed from the reptile data accumulated over the three seasonal surveys that have been conducted in three of the sites. It can be seen from this chart that two of the three sites were still accumulating new species by the close of the third survey. This was most dramatic in site E7 which accumulated five species during the spring 2004 sampling period.



*Figure 11 Reptile species richness recorded in each of the 18 systematic sampling sites surveyed during spring 2003 and 2004 in the CMS Project Area.*



*Figure 12 Accumulation of reptile species in site E7, S102 and S202 over the three seasonal surveys conducted in the CMS Project Area.*

The total reptile data collected so far indicates that the S1 shrubland vegetation is relatively low in species but the Eucalyptus woodlands and S2 shrubland vegetation generally have a higher species richness of reptiles. From Figure 12 it seems likely that these particular vegetation communities could support a greater range of reptiles than so far recorded and that additional species would be captured in many of the sites with further sampling.

### 3.6 Birds

Fifty-three species of bird were observed in the 18 sites surveyed in spring 2003 and 2004 (Appendix 2b). The maximum number of species recorded in any one site was 28 in S101. Two other sites, the woodland site E4 and the tall shrubland site S205 also had relatively high species richness with 27 and 25 species respectively. However, Figure 13 shows that there appears to be no significant pattern of bird species distribution through the 18 sampling sites in spring.

The lowest number of species in any site was the 11 species observed in site S202 in spring 2003. However, in spring 2004, this site had 23 species. The number of species in site S102 increased slightly in spring 2004 to 17 from 14 in spring 2003 and the number of species in E7 had dropped slightly from 23 in spring 2003 to 21 in spring 2004. Significantly the accumulation of new species in these three sites continued to rise as shown in Figure 14 which has been constructed from all of the data from three surveys in these three sites.

While the total list of species for the CMS Project Area is extensive, the majority were recorded during the first survey in spring 2003. Only four species were added to the area inventory during the second survey and two during the third survey. Therefore, the rapid accumulation of species in the three sites shown in Figure 14 indicates that there is a great deal of movement of birds between sites (vegetation communities) rather than additional species moving into the general area. This almost certainly reflects what is flowering within each individual site, providing pollen, nectar and invertebrate food resources.

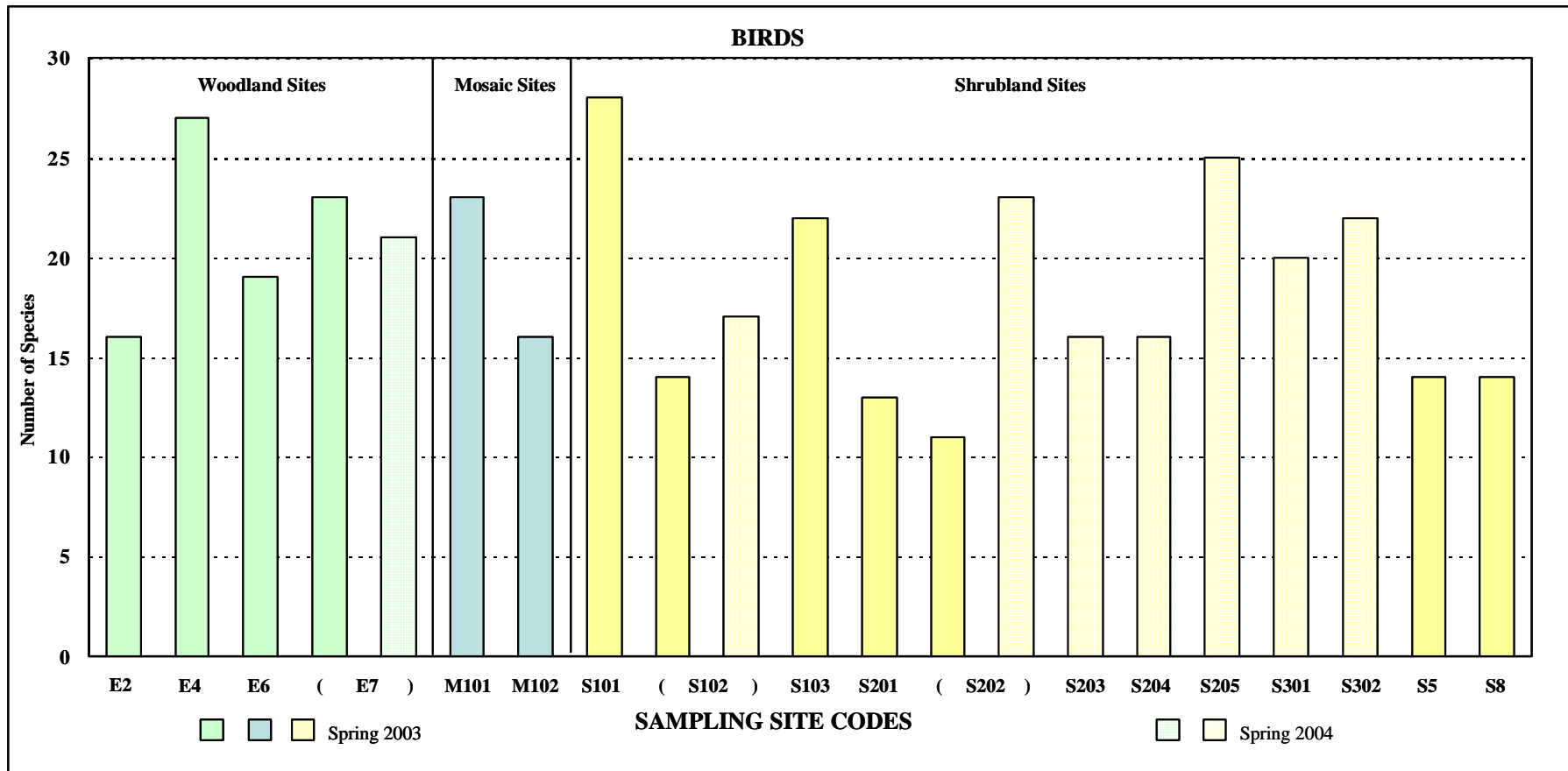
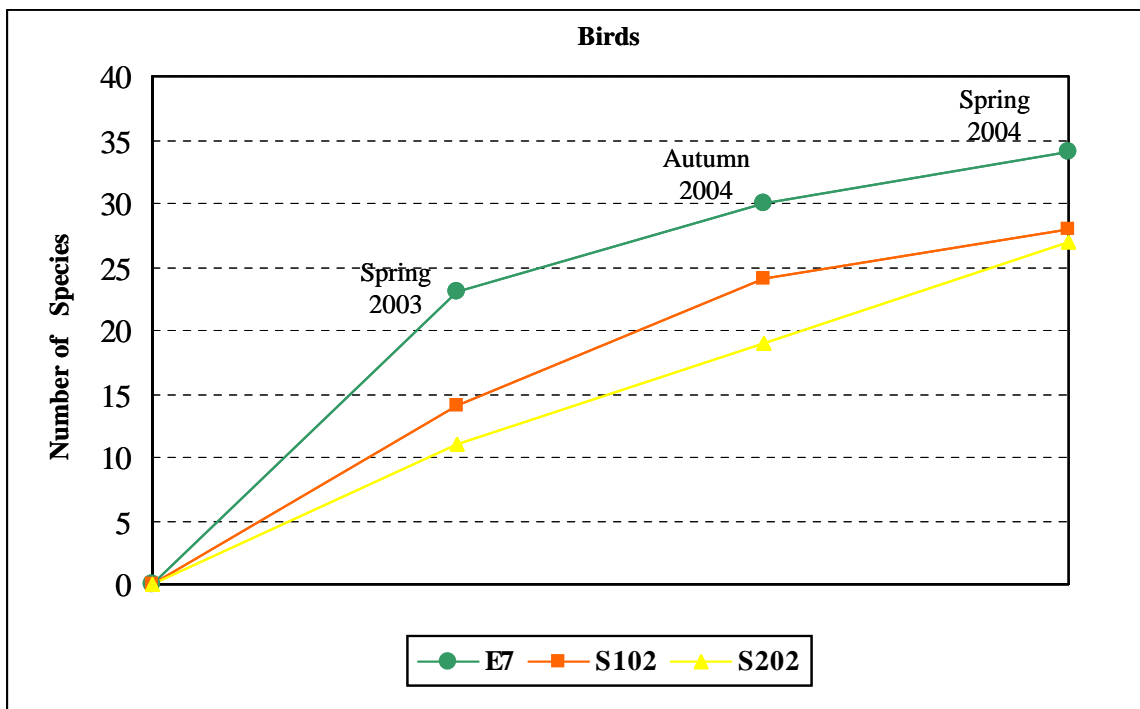


Figure 13 Bird species richness recorded in each of the 18 systematic sampling sites surveyed during spring 2003 and 2004 in the CMS Project Area.

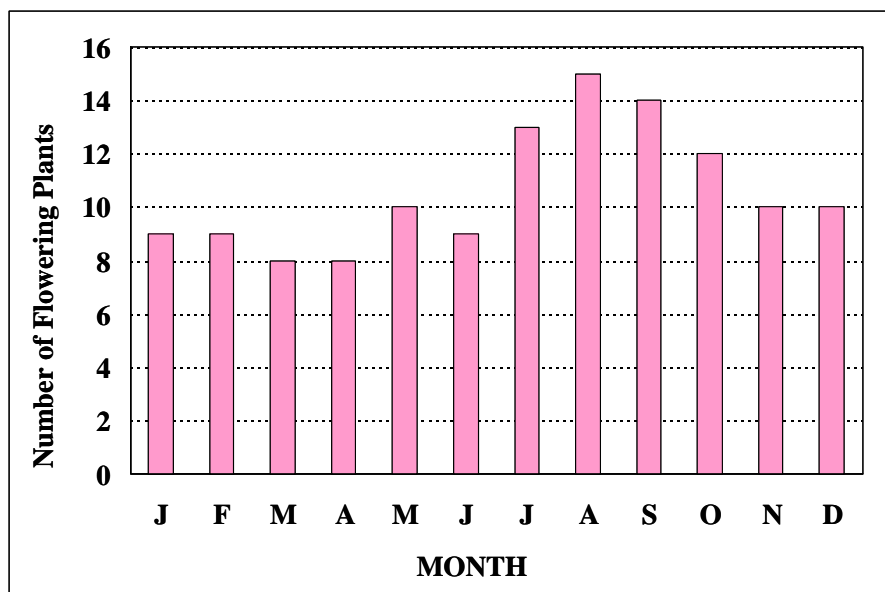




**Figure 14** Accumulation of bird species in site E7, S102 and S202 over the three seasonal surveys conducted in the CMS Project Area.

Figure 15 has been prepared from data provided by Matiske Consulting Pty Ltd. The development of these flowering times has been extracted from field observations within the CMS Project Area by Matiske Consulting Pty Ltd and CALM's FloraBase (Western Australian Herbarium 2005). These potential flowering times may vary somewhat depending on local conditions, particularly rainfall, and therefore, act as a guide only.

Figure 15 shows the number of plants potentially flowering in each month of the year, with only those plants believed to be a feeding resource for birds used. This has been based on actual records of birds seen feeding on and within these plants and the previous experience of the ornithologists involved in this current project. This has resulted in a selection of 26 plants, both shrubs and trees, and includes the various *Adenanthos*, *Banksia*, *Calothamnus*, *Eucalyptus*, *Grevillea*, *Hakea* and *Melaleuca* species recorded in the CMS Project Area (Appendix 4).



**Figure 15 Monthly number of flowering plant species in the CMS Project Area that are likely to be important to birds.**

It can be seen from Figure 15 that there is potentially substantial flowering in every month of the year with a peak in the winter and early spring months between July and September. While some plants such as *Calothamnus blepharospermus* and *Eucalyptus selachiana* have a restricted flowering time from January to February and March respectively, others potentially have an extended flowering period. For example, *Banksia ashbyi* may flower between February and September and could also flower in December; *Grevillea eriostachya* could flower at any time of year and *Grevillea stenobotrya* may flower between April and November.

While it is not known exactly how important these plants are to birds in the CMS Project Area, previous experience of Ninnox Wildlife Consulting throughout the State has resulted in data that shows that most of the plants within these genera provide a feeding resource to many species of birds, either directly with nectar and pollen or indirectly with invertebrates that are feeding on the flowers. It is almost certain that this range of flowering plants encourages bird movement within the CMS Project Area as discussed above, and this has implications for rehabilitation should mining proceed (see Section 6.2.1).

### **3.7 Proposed Access Road and Camp Site**

#### **3.7.1 Northern Route and Camp**

The first proposed access road runs from the mining area for approximately 40 km along the fenceline between Hamelin and Coburn Stations. It transects two main soil types and overlying vegetation. For about 13 km from the western end of the proposed access road assessment (approximately 215 500mE to 227 500mE), the vegetation communities (fauna habitats) of the proposed access road are very similar to those in the proposed mining area (see Mattiske Consulting Pty Ltd 2005). From this more easterly point and out to NWC Hwy, the habitats change to clay sands with stony or rocky outcropping that support various *Acacia* shrublands. These include patches of habitat similar to fauna site S8 in the north-eastern

sector of the proposed mining area. The impact of grazing by both sheep and goats was more evident in these *Acacia* shrubland communities on clay sands than in the woodland and shrubland communities on deep sands further west. The proposed camp site is also located in these *Acacia* shrublands on clay sands.

While the habitats along this section of the proposed access road and within the camp site are less diverse (mainly vegetation communities S7, S8 and S9) they are likely to support a somewhat different range of fauna species to those of the dense shrublands and eucalypt woodlands on the deep sands of the proposed mining area. However, there will be a large range of species which do not have any particular habitat requirements that are in common between the two.

Although no trapping was conducted along this proposed access road route or camp site location, several species of bird were recorded that were not observed within the main study area. These included four birds of prey: Collared Sparrowhawk; Little Eagle; Wedge-tailed Eagle and Australian Hobby. The more open habitats along this section advantage these hunting birds. Also recorded along this route were the Australian Owlet Nightjar, Jacky Winter and Masked Woodswallow. None of these were recorded in the proposed mining area. No additional native mammals or reptiles were observed along the proposed access road or within the camp site.

### **3.7.2 Preferred Southern Route and Camp**

The southern route has been assessed on the basis of vertebrate fauna information gathered during the 2003 and 2004 surveys of the CMS Project Area and details of the vegetation communities provided by Matiske Consulting Pty Ltd.

Most of the proposed southern access road traverses very similar vegetation to that assessed for the northern access road although the representation of the various vegetation communities varies. There is less of the S8 and S9 *Acacia* shrublands and more of the S1 and S2 shrublands and Eucalyptus woodlands such as E6. Therefore it seems likely that the majority of the fauna species that could be present will be most similar to that of the proposed mining area.

The proposed alternative camp site is situated within S1 and S2 shrublands which have been comprehensively sampled for fauna in the CMS Project Area; therefore it is unlikely that many additional species would be found in this location that have not been recorded during the 2003 and 2004 sampling.

## **3.8 Rare Fauna**

While no rare mammals, amphibians or reptiles were recorded during any of the seasonal surveys, one bird, the Malleefowl, was recorded in several locations. Section 3.8.1 discusses in detail this bird and others that could potentially occur in the CMS Project Area.

### 3.8.1 Birds

Six birds listed under the various Commonwealth and/or State rare, threatened or vulnerable lists are known to occur in the general area. Two species, the Malleefowl and Rainbow Bee-eater, were recorded in the CMS Project Area.

#### 3.8.1.1 Malleefowl (*Leipoa ocellata*)

The Malleefowl, recorded during the survey by old nest mounds and fresh footprints, was once common and widespread in the semi-arid zone, mainly in mallee and *Acacia* scrublands, especially north and east of the mulga-eucalypt line (Johnstone and Storr 1998). Currently, this bird is listed as Vulnerable under the Commonwealth EPBC Act and Threatened under the Western Australian Wildlife Conservation Act (1950).

The threatening processes listed on CALM's website ([www.calm.wa.gov.au](http://www.calm.wa.gov.au)) include clearing of habitat, increased frequency of fire, competition with introduced herbivores including stock and feral animals, and increased predation by exotic animals such as foxes, cats and dogs. However, Johnstone and Storr (1998) point out that some Malleefowl populations, particularly in the far north-west of its former range, were extinct before the arrival of the fox, indicating that destruction or degradation of habitat is probably the main cause of decline of this species.

Although no birds were actually seen, the Malleefowl was recorded by the distinctive and fresh footprints in sites S103 and S203 (see Figure 1). A large number of nesting mounds were noted throughout the study area, although these were more common in the southern sector of the Project Area. Many of these nesting mounds were very old and, of the more recent mounds, some may have been used during the previous breeding season. In a number of sites as many as four mounds were present in close proximity to one another. Plate 7 shows a Malleefowl nest in site S103. This particular nesting mound had fresh footprints in and around its base during the spring 2004 survey.

Malleefowl breed between August and April with the female laying eggs in the large mound excavated by the male. The male tends the nest, regulating the internal temperature, until the chicks hatch. CALM reports that the average number of chicks to a nest is 16. They leave the nest unaided, taking up to 15 hours to dig their way out. Malleefowl chicks receive no parental care and the mortality rate may be as high as 80%.

The CMS Project Area lies within the north-western limits of the current known distribution of this large bird. As discussed earlier, the detection of fresh footprints and large numbers of nesting mounds indicated that these birds were more common in the southern sector of the Project Area. However, given the presence of foxes, feral cats and wild dogs, it is unknown how frequently successful breeding of Malleefowl occurs.



*Plate 7 Malleefowl nesting mound located in Site S103.*

#### 3.8.1.2 Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon was not recorded during the survey but is almost certain to occur occasionally. Storr (1990) lists it as a scarce visitor to the Shark Bay region. The Peregrine Falcon occurs Australia-wide and has no particular habitat preference although numbers in the Western Australian Goldfields appear to be increasing as it adapts to nesting and roosting on the artificial 'cliffs' in abandoned mine pits (personal observations). It is listed as Other Specially Protected Fauna under the Wildlife Conservation Act (1950).

#### 3.8.1.3 Australian Bustard (*Otis australis*)

The Australian Bustard is listed as Priority 4 on CALM's Priority Fauna list. Not recorded during the survey, this bird is uncommon in the Shark Bay region (Storr 1990) and nomadic. This bird could occur periodically in the more open habitats of the Project Area.

#### 3.8.1.4 Major Mitchell's Cockatoo (*Cacatua leadbeateri*)

Listed as Other Specially Protected Fauna under the Wildlife Conservation Act (1950), Major Mitchell's Cockatoo is unlikely to occur in the Project Area as it requires large trees and permanent water nearby. Storr (1990) considers this bird to be locally extinct in the Shark Bay region.

### 3.8.1.5 Rainbow Bee-eater (*Merops ornatus*)

Protected under the Japan/Australia Migratory Bird Agreement (JAMBA) the Rainbow Bee-eater was recorded during the spring survey in the northern sector of the Project Area. Described by Storr (1990) as a scarce breeding visitor to the Shark Bay region, very few individuals were observed during the survey and no signs were found of their breeding burrows. These burrows are excavated in soils that are soft enough for digging yet firm enough to support a burrow (Morcombe 2003).

### 3.8.1.6 Thick-billed Grasswren (*Amytornis t. textilis*)

The Thick-billed Grasswren was not recorded during any of the surveys of the CMS Project Area. Currently listed as Vulnerable on the EPBC Act and Priority 4 on CALM's Priority Fauna list, this grasswren was once widespread in the southern arid zone but is now considered to be extinct except in the Shark Bay area. This bird is considered common in the northern portion of the Peron Peninsula and is moderately common at Woodleigh Station and north-east of Hamelin Station (Johnstone and Storr 2004). It favours dense *Acacia* shrubs, particularly where there is substantial Cottonbush (*Ptilotus obovatus*) and woody debris providing cover.

Introduced herbivores, particularly rabbits, are thought to be the main reason for the decline of this species. Given the extensive surveys for this bird in the general area and the amount of survey work completed to date in the CMS Project Area, it is unlikely that the Thick-billed Grasswren is a resident of the current study area.

## **3.8.2 Native Mammals**

No rare mammals were recorded during the three seasonal surveys of the CMS Project Area. While many mammals were once known to occur in the Shark Bay region, they now occur only on islands off the mid-west coast of Western Australia. These include the Western Barred Bandicoot (*Perameles bougainville*), Burrowing Bettong (*Bettongia lesueur*), Rufous Hare-wallaby (*Lagorchestes hirsutus*), Banded Hare-wallaby (*Lagostrophus fasciatus*) and Shark Bay Mouse (*Pseudomys fieldi*). None of these species is known to occur naturally on the adjacent mainland, although several have been reintroduced to Peron Peninsula and Heirisson Prong following a fox and cat control program. However, it is extremely unlikely that these animals are present in the CMS Project Area.

## **3.8.3 Amphibians and Reptiles**

While no rare frogs or reptiles were recorded during the 2003 and 2004 surveys of the Project Area, one python and three skinks which are listed on either the Wildlife Conservation Act (1950) or CALM's Priority Fauna list, could potentially occur in the habitats of the CMS Project Area. These are discussed in the following Sections with details on their habitat preferences (when known) and distribution.

### 3.8.3.1 Woma (*Aspidites ramsayi*)

This python is known from four disjunct populations including one from the Peron Peninsula, Shark Bay (Storr *et al.* 2002). The three northern Woma populations are listed as Other Specially Protected Fauna under the Wildlife Conservation Act (1950). Because of its possible isolation, the Peron Peninsula population is considered to be particularly vulnerable. This python inhabits woodlands and shrublands, often with an understorey of spinifex. It shelters in mammal and reptile burrows or hollow logs. There is a possibility that this species could occur in the CMS Project Area.

### 3.8.3.2 Hamelin Skink (*Ctenotus zasticus*)

The Hamelin Skink (*Ctenotus zasticus*) is listed as Vulnerable under the Threatened Fauna section of the Wildlife Conservation Act (1950) and the Commonwealth EPBC Act. This skink was discovered in 1983 and is only known to occur on Hamelin Pool and Coburn Stations where it appears to favour open eucalypt woodlands with spinifex (*Triodia*) on red sands. Only seven specimens are lodged in the Western Australian Museum and these are listed in Table 11 with their museum registration numbers, capture location and dates.

**Table 11** *Western Australian Museum records of the Hamelin Skink (Ctenotus zasticus).*

<b>TAXON:</b> <i>Ctenotus zasticus</i>
Western Australian Museum REG NO: R81784 SITE: 15KM NNW COBURN LAT/LONG: 26°35`00"S 114°14`00"E COLLECTION DATE: 20/11/1983
Western Australian Museum REG NO: R81783 SITE: 15KM NNW COBURN LAT/LONG: 26°35`00"S 114°14`00"E COLLECTION DATE: 20/11/1983
Western Australian Museum REG NO: <b>R84300 (Holotype)</b> SITE: 16 KM S OF HAMELIN POOL LAT/LONG: 26°32`00"S 114°13`00"E COLLECTION DATE: 07/08/1983
Western Australian Museum REG NO: R82733 SITE: 16 KM S OF HAMELIN POOL HOMESTEAD LAT/LONG: 26°34`00"S 114°14`00"E COLLECTION DATE: 26/11/1983
Western Australian Museum REG NO: R82732 SITE: 16 KM S OF HAMELIN POOL HOMESTEAD LAT/LONG: 26°34`00"S 114°14`00"E COLLECTION DATE: 26/11/1983
Western Australian Museum REG NO: R92313 SITE: 12KM SSW HAMELIN POOL HOMESTEAD LAT/LONG: 26°31`43"S 114°09`56"E COLLECTION DATE: 14/08/1985
Western Australian Museum REG NO: R96550 SITE: 22KM NNW COBURN HOMESTEAD LAT/LONG: 26°31`00"S 114°13`00"E COLLECTION DATE: 24/05/1986

The CMS Project Area is situated on the western sector of both Coburn and Hamelin Stations and, following the three seasonal fauna surveys conducted during spring 2003, 2004 and autumn 2004, several locations were identified as being potentially suitable habitat for *Ctenotus zasticus*. This habitat is represented in the northern sector of the Project Area in vegetation communities E4 and E7 but the skink was not recorded during any of the surveys.

The known locations of *Ctenotus zasticus* are approximately 12 kilometres to the east of the CMS Project Area. Three of these locations were assessed between 6 and 8 September 2004 in association with E.M Mattiske of Mattiske Consulting Pty Ltd. This was done in order to compare the eucalypt over spinifex habitat in these locations with the similar habitats within the CMS Project Area. A second visit was made to these sites during the final field survey (October/November 2004) but no specimens of *Ctenotus zasticus* were observed or captured by hand although several other lizards, mainly dragons, were seen active.

The vegetation and soil descriptions shown in Table 12 are of the three known *Ctenotus zasticus* locations visited during the habitat assessment and, for comparison, the vegetation community descriptions of the two potential habitats within the proposed mining area are also shown. Plate 8 shows one of the locations visited during this habitat assessment. Plates 9 and 10 show the *Eucalyptus* over *Triodia* habitat (E4 and E7) within the proposed mining area.

**Table 12** *Habitat descriptions of three of the known Hamelin Skink (Ctenotus zasticus) locations the potential habitats within the CMS Project Area.*

<b><i>Ctenotus zasticus</i> Locations</b>	
Site 1 - 3	Low Open Woodland of <i>Eucalyptus obtusiflora</i> subsp. <i>obtusiflora</i> over <i>Acacia ramulosa</i> var. <i>ramulosa</i> and <i>Acacia galeata</i> over <i>Ptilotus obovatus</i> var. <i>obovatus</i> and <i>Triodia ?plurinervata</i>
<b>Coburn Mineral Sand Project Area</b>	
Community E4	Low Open Woodland of <i>Eucalyptus selachiana</i> and <i>Eucalyptus ?eudesmioides</i> over <i>Acacia ramulosa</i> var. <i>ramulosa</i> , <i>Acacia roycei</i> , <i>Acacia ligulata</i> and <i>Grevillea gordoniana</i> over <i>Baeckea</i> sp. Nanga (pn) over <i>Triodia danthonioides</i> .
Community E7	Low Open Woodland of <i>Eucalyptus selachiana</i> over <i>Calothamnus formosus</i> subsp. <i>formosus</i> and <i>Acacia ligulata</i> over <i>Lamarchea hakeifolia</i> var. <i>brevifolia</i> over <i>Triodia danthonioides</i> .





**Plate 8 *Ctenotus zasticus* habitat.**



**Plate 9 Site E4.**



**Plate 10 Site E7.**

There is a very brief habitat description of *Triodia* and *Eucalyptus* on red sand given in Storr (1984) and Storr *et al.* (1999). However, the vegetation at the three locations visited during this assessment consists of different species of *Eucalyptus* and *Triodia* to that present in the proposed mining area. In particular the *Triodia* has a very different growth habit, forming the characteristic maze structure ideal for reptiles whereas *Triodia danthonioides* within the proposed mining area forms large, very dense clumps, often on raised humps of sand. This difference can be seen between Plate 8 and Plates 9 and 10. In addition, very loose soil and a deep cover of leaf litter occurs under each eucalypt tree in the known locations, a micro-habitat favoured by many species of reptile. This was not so apparent in vegetation communities E4 and E7.

However, vegetation community E5 which is present along the northern access road option is very similar to the known *Ctenotus zasticus* habitat and is close to one of the locations where this rare skink has been found. The northern access road option intersects a very extensive area of vegetation community E5 although there is substantial clearing east to west along the existing fenceline. This area is also bisected north to south along the Hamelin - Coburn track.

The vegetation communities E4 and E7 that are present within the proposed mining area differ significantly from the known habitat of *Ctenotus zasticus* approximately 12 kilometres to the east. Therefore, given the very restricted distribution of this rare skink, it appears unlikely that it will occur within the proposed mining area.

There is a strong possibility that the Hamelin Skink could be present in vegetation community E5 which is present along the northern access road option. However, there is existing disturbance due to historical clearing for access tracks along fence lines and between Hamelin Pool and Coburn Stations. Provided that additional clearing for widening of this track for

haulage is kept to the minimum required for safety, there should be little impact on the Hamelin Skink.

### 3.8.3.3 The Skink *Lerista humphriesi*

This skink is known from semi-arid sandplains between Shark Bay and the Murchison. It is listed as Priority 2 on CALM's Priority Fauna list. It is possible that this skink occurs throughout the shrublands on sand within the Project Area.

### 3.8.3.4 The Skink *Lerista maculosa*

Known only from two localities south and south-east of Hamelin Pool, this skink is listed as Priority 1 on CALM's Priority Fauna list. However the taxonomic status of this reptile appears to be in doubt and it is likely that it will be synonymised with *Lerista uniduo* (K. Aplin pers. com.).

## **4 LOCAL SIGNIFICANCE**

A large range of vertebrate fauna species were once common and widespread on the Australian mainland but are now confined to the islands and peninsulas of Shark Bay. These have been discussed in detail in relation to petroleum industry impacts in the Shark Bay World Heritage Property (URS 2000). Some species, mainly mammals, have been translocated to Peron Peninsula and Heirisson Prong where control measures for introduced predators may be most effective. However, many of these relict or endemic species are unlikely to occur in the vicinity of the CMS Project Area due to the lack of predator control and pressure from introduced grazing animals. Therefore, the following sections discuss the local significance with reference to data extracted from Burbidge *et al.* (2000) which describes the results from a wide-ranging survey of the Carnarvon Basin. Only data from the nearby quadrats such as Nanga, Nerren Nerren and the eastern quadrats of Zuytdorp were used for this comparison. Records from the Western Australian Museum collections for the general area were also used and the results from this 2003 and 2004 survey have been listed. All of these data have been used in the following sections in order to assess the local significance of the CMS Project Area.

### **4.1 Native Mammals**

Most of the native mammals (excluding bats) that are currently known from nearby sections of the Shark Bay mainland have been recorded in the CMS Project Area (Appendix 3a). One native rodent, the Ash-grey Mouse (*Pseudomys albocinereus*) has not been recorded but will almost certainly occur. While the Western Grey Kangaroo (*Macropus fuliginosus*) has not been recorded, the Red Kangaroo (*Macropus rufus*) was recorded in the CMS Project Area but not during the Carnarvon Basin survey of Nanga, Nerren Nerren and Zuytdorp. Based on the results of the CMS Project Area study, the recorded ground-dwelling mammal fauna can be said to be representative of the local area.

No bats were recorded during this survey of the CMS Project Area although six species were recorded in the nearby sections of the Carnarvon Basin (Appendix 3a). These bats were

recorded following the establishment of a reference library of bat call sequences compiled during the course of the Carnarvon Basin study. As no ideal locations for bat sampling were present in the CMS Project Area, this technique was considered not suitable for this current study. Some of the species recorded during the Carnarvon Basin study require caves for daytime roosting and are therefore unlikely to occur in the CMS Project Area. However, a small range of bats may use the eucalypt woodlands in the northern sector of the Project Area which are likely to provide roosting sites in any hollow branches that are present.

## 4.2 Amphibians

The CMS Project Area is situated on the western sectors of Hamelin Pool and Coburn Stations just south of Shark Bay. This location falls within the south-west corner of the arid zone as defined in Tyler *et al.* (2000). This area is characterised by low, irregular rainfall and may be subject to both northern and southern weather patterns. Tyler *et al.* (2000) make their climatic/geographic division for the frog fauna of Western Australia based on the 350 mm rainfall isohyet because of the limited overlap between the three faunal zones involved.

No frogs were recorded during the three seasonal surveys conducted to date in the Project Area, although extensive trapping has occurred in a variety of habitats. Most frogs require surface water to breed although there are some exceptions to this rule. As no surface water is present within the CMS Project Area, only a small range of species may occur.

Listed below are the four frog species that are known to occur in the general area with notes on their habitat requirements (where known) and likely presence within the CMS Project Area. The information has been extracted from Tyler *et al.* (2000) and Cogger (1992). None of these species are considered rare, threatened or vulnerable.

Sandhill Frog (*Arenophryne rotunda*): the Sandhill Frog is locally abundant but has a restricted range from Kalbarri to Shark Bay, including Dirk Hartog Island (Roberts 1990). Within this range it is only found in the coastal sand dunes where it occupies a burrow, emerging at night to feed. It does not require surface water. When active, it is readily captured by pitfall traps, and may also be detected by the distinctive tracks it leaves in the sand. This small frog was recorded from Edel Land and Zuytdorp during sampling for the Carnarvon Basin study (McKenzie *et al.* 2000). The Sandhill Frog could occur in suitable habitat throughout the CMS Project Area.

Humming Frog (*Neobatrachus pelobatooides*): the Humming Frog occurs in the south-west areas of the State with the exception of the deep south-west corner. It is also known to occur in some western sections of the arid zone. This frog was only recorded at Zuytdorp during the Carnarvon Basin study. The sandy soils of the CMS Project Area are unlikely to support this species but it could occur along the proposed northern and southern access roads where the clay sand soils may provide ephemeral waterlogged areas suitable for breeding.

Wilsmore's Frog (*Neobatrachus wilsmorei*): this frog occurs in the western sectors of the arid zone, extending south-east into the Paynes Find and Kalgoorlie areas. It generally inhabits areas subject to seasonal flooding. It has been recorded between the Minilya and Wooramel Rivers and at Zuytdorp during the Carnarvon Basin study. The sandy soils of the proposed mining area are unlikely to support this species but it could occur along the proposed northern and southern access roads where the clay sand may provide temporary waterlogged areas suitable for breeding. A single individual of this species was located by exploration personnel

in habitat as described above adjacent to the Coburn Station access road approximately 100 metres from the NWC Hwy.

Gunther's Toadlet (*Pseudophryne guentheri*): this small frog is common throughout the south-west of Western Australia and the western edge of the arid zone and was recorded at Meedo and Zuytdorp during the Carnarvon Basin study. It is usually found in damp soil under rocks, logs and other vegetation debris. Eggs are laid in breeding tunnels in damp soil following rainfall in late summer or early winter. Development of tadpoles takes place within the burrow and they emerge at an advanced stage of development when these tunnels are flooded. There is a slight possibility that this species occurs within the CMS Project Area, most likely along the proposed northern and southern access roads where clay sand soils are present.

The potential diversity of the frog fauna of the CMS Project Area is considered to be low due to the unreliable nature of the rainfall and lack of surface water. Three of the four species that could occur may be restricted to clay soil areas along the proposed access road. The Sandhill Frog (*Arenophryne rotunda*), could occur in suitable habitat throughout the proposed mining area, particularly where it is closest to the coastal sand dunes.

### 4.3 Reptiles

The reptile fauna is diverse with eight species being added to the local area inventory which includes selected sampling locations from the Carnarvon Basin study and WA Museum records (Appendix 3b). These include: the gecko *Diplodactylus klugei*; the legless lizard *Delma butleri*; the dragon *Ctenophorus nuchalis*; the skinks *Ctenotus p. pantherinus*, *Egernia depressa* and *Tiliqua occipitalis*; and the small snakes *Brachyuropis approximans* and *Parasuta monachus*.

Based on the records from the Carnarvon Basin study (Nanga, Nerren Nerren and eastern Zuytdorp quadrats), Western Australian Museum and the results of the 2003 and 2004 study of the CMS Project Area, 71 reptiles are known to occur in the local area. Fifty-three were recorded in the Carnarvon Basin quadrats mentioned above and 45 in the CMS study.

Given additional sampling, it is likely that most of the species listed in Appendix 3b, and several others whose historical distribution patterns include the Shark Bay area, would be recorded in the CMS Project Area. Four of these reptiles are discussed in Section 3.8.3 as being rare, threatened or vulnerable and by definition the presence of these animals would be difficult to confirm because of their scarcity.

Storr and Harold (1990) discuss the diversity of frog and reptile fauna in the Shark Bay area which is located at the meeting point of three natural regions: the south-western, northern and Eremean or inland region. This results in many species being at either their northern, southern or western limits of their distribution. Those species at the northern limits of their distribution include the gecko *Diplodactylus michaelsoni*, the legless lizard *Pygopus lepidopodus*, the skink *Ctenotus fallens* and the small snake *Neelaps bimaculatus*. Those at the southern limits include the gecko *Strophurus strophurus* and the small snake *Brachyuropis approximans*. Those at their western limits include the gecko *Diplodactylus pulcher*, the dragon *Ctenophorus scutulatus*, the legless lizard *Delma butleri*, the skink *Egernia depressa*, the monitor *Varanus eremius* and the small snake *Parasuta monachus*. A small range of reptiles are very restricted in their distribution, including the worm lizard *Aprasia smithi* and the skink *Ctenotus alleni*. All of these animals were recorded in the CMS Project Area.

The results of the spring and autumn surveys of the CMS Project Area firmly place the reptile fauna into the category of high diversity representative of the Shark Bay region.

#### **4.4 Birds**

Storr (1990) discusses the bird fauna of the Shark Bay area in terms of its dry climate, physiographic uniformity and scarcity of fresh water and woodlands. Despite this, the area has a moderately rich bird fauna as, like reptiles, some birds are at the northern or southern limits of their distribution. Those at their northern limits include species such as the Yellow Robin, Golden Whistler, Striated Pardalote and Brown-headed Honeyeater. While these species were recorded during the CMS Project Area study, none of the birds listed in Storr (1990) as at their southernmost limits were observed.

Some of the birds observed during the study are known to be more common to the east and south-east of the Shark Bay area. In particular some are extremely common throughout the Western Australian Goldfields. These birds include the Mulga Parrot, Blue-breasted Fairy-wren, Redthroat, Grey-fronted and White-fronted Honeyeaters, Southern Scrub-robin and Crested Bellbird.

While some of the more wide-ranging Non-passerine birds such as some of the birds of prey and the migratory cuckoos were not observed during the CMS Project Area survey, most of the Passerine birds that could be expected to occur in the habitats present in the Project Area have been recorded (Appendix 3c). Based on these results, the bird fauna can be said to be representative of the local area.

#### **4.5 Habitats of Significance**

While there is no individual habitat of regional significance within the CMS Project Area, two habitats stand out as being of some local significance. The data show that the eucalypt woodlands support a greater range of species of reptiles and birds than the shrublands. These woodlands are mainly situated in the northern sector of the Project Area. The larger trees in these eucalypt woodlands provide nesting and roosting hollows for a large range of fauna species, including mammals, reptiles and birds. Tree hollows are scarce in the sandplains and *Acacia* shrublands that are the most common vegetation communities in the Shark Bay region, therefore, competition for these hollows is likely to be great.

The S3 shrubland community in the southern sector of the CMS Project Area (sites S301 and S302) also seems to be of local significance in that it supports a large variety and substantially higher population of reptiles than other vegetation communities. Site S302, in particular, also has a high species richness of birds with a relatively high abundance.

## 5 CONCLUSIONS

Given the number of native mammal species that once occurred in the Shark Bay region but are now considered extinct on the Australian mainland, very few additional species could be expected to occur in the CMS Project Area. Appendix 3a shows that only a number of bat species and one native rodent were recorded during the Carnarvon Basin study that have so far not been recorded in the CMS Project Area. However, the extremely low number of individuals captured during this current study was surprising. Therefore, it has been concluded that the CMS Project Area has minimal regional significance to native mammals.

While no frogs have been recorded during sampling in the CMS Project Area, four species could potentially occur in some of the habitats present, mainly along the two proposed access roads. All of these frog species are common and widespread, therefore it has been concluded that the CMS Project Area has no regional significance to frogs.

Of the 71 reptile species shown in Appendix 3b, 45 have been recorded in the CMS Project Area compared to 53 in the Carnarvon Basin sampling areas nearby. However, 13 species recorded in this current study were not recorded during the Carnarvon Basin study and nine species were recorded in that latter study but have not been captured in the CMS Project Area. Storr and Harold (1990) state that few parts of Western Australia have so diverse a herpetofauna as the Shark Bay area. They attribute this to the location of the area at the meeting point of three natural regions and climatic zones. The diversity of reptiles captured during this study of the CMS Project Area is extremely high reflecting this mingling of south-western and arid adapted animals and the range of habitats present in the Project Area.

Sixty-one species of bird were recorded in total in the CMS Project Area compared to 78 species recorded in the Carnarvon Basin sites chosen for comparative purposes. Many of the differences in the area inventories can be attributed to annual fluctuations resulting from previous seasonal conditions. Many bird species are nomadic, especially the honeyeaters, and may appear in large numbers to feed in a localised area when particular plants are in flower. Several of the bird species recorded in the CMS Project Area are also at the northern limits of their distribution. Based on the data from three seasonal surveys, the birds of the study area are considered representative of the Shark Bay Region.

Several authors including Thompson and Thompson (2002) and How (1998) discuss the need for extensive sampling in both temporal and spatial scales in order to more fully document the biodiversity of the fauna of an area. In addition, Cowan and How (2004) conclude that short-term studies infrequently encounter threatened and/or rare ground-dwelling vertebrate fauna species and therefore do not provide adequate information to assist land managers. As a result, a major change in land use requires that the issue of impact on rare, threatened or vulnerable species be addressed as if they are present. In terms of land disturbance such as mining, this invariably relies on the rapid and expert rehabilitation of land following mineral extraction. Rehabilitation techniques are explored more fully in Section 6.2.

The presence of the rare Malleefowl requires particular attention. The large number of breeding mounds in combination with the presence of three introduced predators (fox, dog/dingo and cat) gives cause for concern that breeding of this bird may not be altogether successful. While some management actions have been discussed in Section 6, a detailed management plan for the Malleefowl within the CMS Project Area has been prepared by URS Australia Pty Ltd.

## **6 MANAGEMENT RECOMMENDATIONS**

### **6.1 General Recommendations**

In general, the effect of mine development on fauna can be divided into three primary areas of impact. These are:

- ◆ clearing for exploration grid lines and drill pads;
- ◆ removal of vegetation for mining;
- ◆ changes to drainage patterns and subsequent effects on adjacent vegetation and fauna habitats (not applicable to the CMS Project Area).

While most birds, larger mammals and reptiles will be able to avoid the impact of clearing for exploration, mining and construction of infrastructure, most small mammals, reptiles and burrowing frogs will unavoidably be killed by the large machinery used for vegetation removal and ground preparation, or by exposure to predators. While the local impact on individual animals is high, the clearing will have very little impact on the species overall. Exploration drilling and future mining should be carefully managed to avoid unnecessary and widespread damage to fauna habitats through clearing or damage to vegetation where this is not essential for safe operations.

In order to minimise the impact on vertebrate fauna, a series of general recommendations are given below.

- ◆ Avoidance of unnecessary clearing of vegetation beyond that strictly required.
- ◆ Windrows of topsoil, log debris and leaf litter formed during clearing should be retained, as they create extremely good microhabitat for a large range of fauna, particularly reptiles.
- ◆ Rapid commencement of rehabilitation works in cleared areas such as laydown sites, access tracks and grid lines where these are no longer required.
- ◆ All subcontracting teams are adequately briefed and made aware of the environmental constraints imposed on the project and themselves.
- ◆ Firearms, trail bikes and pets should be excluded from the Project Area.
- ◆ Adequate rubbish disposal procedures should be applied, especially for food refuse, in order to discourage scavenging by crows, foxes and feral cats. Large numbers of these animals can have an adverse impact on other fauna.
- ◆ Regular spot-checks for breaches of sound environmental practises are carried out by delegated individuals so that problems can be anticipated or rectified at an early stage.
- ◆ Consideration to preparing a brief handout on sound environmental practices which will be given to all members of subcontracting teams and permanent employees during site induction. The pamphlet should cover relevant aspects defined above.
- ◆ A penalty system for breaches of sound environmental practices should be introduced.



## **6.2 Site Specific Recommendations**

Site specific recommendations depend on the method of mining in a particular Project Area. Progressive mining along a shallow, linear ore body requires different rehabilitation techniques to those in an open, ever-deepening pit, with the associated tailings and overburden. In addition, the composition and structure of the overlying vegetation and presence of rare fauna may necessitate more detailed plans for rehabilitation and management techniques.

In addition, safety requirements for the project should include a fire management system to prevent the spread of wildfire through the adjacent country. Many of the points made in Sections 6.1 and 6.2 will assist in the maintenance of a healthy vertebrate fauna population in the country surrounding the mining area. However, some animals, particularly those considered rare, threatened or vulnerable may require particular attention and these are discussed in Section 6.2.2.

### **6.2.1 Rehabilitation**

The CMS project is based on a shallow, linear ore body, with processing taking place within the mining depression. This will allow for progressive rehabilitation to take place as mining progresses from south to north.

If safety procedures allow, the following rehabilitation procedures should be followed.

- ◆ Prior to clearing as much seed as possible should be collected for later rehabilitation.
- ◆ Rehabilitation should be structured to encourage the return of fauna by providing micro-relief and dense vegetation cover. This may be achieved, particularly in temporary laydown areas, by:
  - leaving patches or strips of vegetation;
  - placing equipment on flattened shrubbery rather than clearing;
  - retention of root stock in the ground by shallow scraping during essential temporary clearing; and,
  - retaining stockpiled vegetation debris in windrows. Windrows and flattened vegetation provide substantial microhabitat and increased humidity for small vertebrates. They also provide a trap for windblown seed and protection for seedlings following germination. Placement of windrows across the prevailing wind direction may reduce erosion and facilitate rehabilitation success.
- ◆ As much and as soon as possible, vegetation cleared from the leading edge of mining should be placed on the ground in areas to be rehabilitated. Any seeds that are present will be protected by this mulch and rapid germination should follow initial rains. Both the mulch and new growth will provide habitat for ground-dwelling fauna relatively quickly.

- ◆ Rehabilitation should be protected from introduced herbivores such as rabbits, goats and sheep.
- ◆ Those plants believed to be important sources of food for birds are given priority in plant selection for rehabilitation (Appendix 4). It was shown in Section 3.6 that a range of flowering plants could be of particular importance to birds in the CMS Project Area, allowing them to move throughout the area as different food resources became available. Without these resources it is possible that the bird population of the area could decline.
- ◆ A feral predator control program should be implemented.

## 6.2.2 *Management of Vertebrate Fauna*

As part of the management of the Project Area consideration should be given to monitoring of vertebrate fauna. This should be arranged to gain sufficient data to assess the progress and success of rehabilitation and to monitor the adjacent country for any possible impact from mining on fauna populations. Therefore, permanent fauna sampling sites should be established in association with flora and vegetation monitoring plots. A sampling program should be designed in consultation with CALM in order to adequately address any vertebrate fauna issues that may arise during the environmental assessment process and to prepare guidelines for future monitoring. This may include further baseline sampling to more fully document the vertebrate fauna of the area and to clarify their habitat use.

### 6.2.2.1 Malleefowl

The National Recovery Plan for Malleefowl (Benshemesh 2000) lists 18 actions that if carried out would secure existing populations and possibly result in an increase in distribution to former surviving habitat. The discussion and recommendations in that Plan related to the following actions:

- ◆ secure habitat;
- ◆ reduce the deleterious effect of introduced herbivores;
- ◆ reduce fire threats;
- ◆ reduce predation;
- ◆ describe the current distribution of the species;
- ◆ monitor the abundance of the species;
- ◆ describe the habitat requirements of the Malleefowl;
- ◆ promote community involvement.

In line with these objectives, the Malleefowl Preservation Group (MPG) has, since 2000, been working with WMC Resources Ltd at Yeelirrie Station to protect and enhance the conservation of Malleefowl in arid areas (Sanders *et al.* 2003). Yeelirrie Station is some 400 km east of the CMS Project Area. The methods developed for this Yeelirrie baseline study and monitoring have provided a structure for other researchers to adapt to the habitats present in other areas.

It is recommended that a similar assessment and monitoring program is established in the CMS Project Area in order to protect the existing Malleefowl population. In particular, the plant species and food requirements essential to the preservation of Malleefowl within the Project Area need to be ascertained prior to any significant clearing of the vegetation as the project proceeds. This will enable suitable strategies to be put in place during clearing and rehabilitation to maintain the existing population of Malleefowl.

It is also recommended that an attempt to enhance this population is undertaken by a predator control program which should be established in consultation with CALM. This program will assist in offsetting the impacts from mining and associated activities on Malleefowl and their habitat.

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## 7 REFERENCES

- Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). The new atlas of Australian birds. Birds Australia, Victoria.
- Baynes, A. (1990). The mammals of Shark Bay, Western Australia. *In: Research in Shark Bay*. Report of the Franco-Australe Bicentenary Expedition Committee. Eds: P.F. Berry, S.D. Bradshaw, B.R. Wilson. Western Australian Museum.
- Benshemesh, J. (2000). *National Recovery Plan for Malleefowl*. Department of Environment and Heritage.
- Burbidge, A.A. (2004). *Threatened animals of Western Australia*. Dept. of Conservation and Land Management.
- Burbidge, A.H., Johnstone, R.E., Fuller, P.J. and Stone, P. (2000). Terrestrial birds of the southern Carnarvon Basin, Western Australia: contemporary patterns of occurrence. *In: Biodiversity of the southern Carnarvon Basin*. Eds: Allan H. Burbidge, Mark, S. Harvey and N.L. McKenzie. Rec. West. Aust. Mus. Suppl. No. 61
- Churchill, S. (1998). *Australia Bats*. New Holland Publishers (Australia) Pty Ltd.
- Cogger, H.G. (1992). *Reptiles and amphibians of Australia*. Reed Books, Chatswood, NSW, Australia.
- Cowan, M.A. and How R.A. (2004). Comparison of ground vertebrate assemblages in arid Western Australia in different seasons and decades. *Rec. West. Aust. Mus.* 22:2.
- How, R.A. (1998). Long-term sampling of a herpetofaunal assemblage on an isolated urban bushland remnant, Bold Park, Perth. *Jour. Roy. Soc. West. Aust.* 81:3.
- Johnstone, R.E., Burbidge, A.H. and Stone, P. (2000). Birds of the southern Carnarvon Basin, Western Australia: distribution, status and historical changes. *In: Biodiversity of the southern Carnarvon Basin*. Eds: Allan H. Burbidge, Mark, S. Harvey and N.L. McKenzie. Rec. West. Aust. Mus. Suppl. No. 61
- Johnstone, R.E. and Storr, G.M. (1998). *Handbook of Western Australian Birds Volume 1 - Non-passerines (Emu to Dollarbird)*. Western Australian Museum.
- Johnstone, R.E. and Storr, G.M. (2004). *Handbook of Western Australian Birds Volume II - Passerines (Blue-winged Pitta to Goldfinch)*. Western Australian Museum.
- Mattiske Consulting Pty Ltd (2005). Flora and vegetation studies in the proposed mineral sands mine Coburn and Hamelin Stations – Shark Bay. Unpublished report prepared for URS on behalf of Gunson Resources Ltd.
- McKenzie, N.L., Hall, N. and Muir, W.P. (2000). Non-volant mammals of the southern Carnarvon Basin, Western Australia. *In: Biodiversity of the southern Carnarvon Basin*. Eds: Allan H. Burbidge, Mark, S. Harvey and N.L. McKenzie. Rec. West. Aust. Mus. Suppl. No. 61
- McKenzie, N.L. and Muir, W.P. (2000). Bats of the southern Carnarvon Basin, Western Australia. *In: Biodiversity of the southern Carnarvon Basin*. Eds: Allan H. Burbidge, Mark, S. Harvey and N.L. McKenzie. Rec. West. Aust. Mus. Suppl. No. 61

**REFERENCES – Continued.**

- McKenzie, N.L., Rolfe, J.K., Aplin, K., Cowan, M. and Smith, L.A. (2000). Herpetofauna of the southern Carnarvon Basin, Western Australia. *In: Biodiversity of the southern Carnarvon Basin*. Eds: Allan H. Burbidge, Mark, S. Harvey and N.L. McKenzie. Rec. West. Aust. Mus. Suppl. No. 61
- Morcombe, M. (2003). *Field Guide to Australian Birds*. Steve Parish Publishing Pty Ltd, QLD, Australia.
- Roberts, J.D. (1990). The biology of *Arenophryne rotunda* (Anura: Myobatrachidae): a burrowing frog from Shark Bay, Western Australia. *In: Research in Shark Bay*. Report of the Franco-Australe Bicentenary Expedition Committee. Eds: P.F. Berry, S.D. Bradshaw, B.R. Wilson. Western Australian Museum.
- Sanders, A. Benshemesh, J. and the Malleefowl Preservation Group (2003). WMC Operation Malleefowl Mulga to Mallee Research Project A report on Community searches for and monitoring of Malleefowl at Yeelirrie Station, August 2003. Report to Western Mining Corporation.
- Sanders, A. and Harold, G. (1990). *Search for the Shark Bay Mouse Pseudomys praeconis at Shark Bay on the Western Australian mainland*. Unpublished report prepared for World Wildlife Fund and Department of Conservation and Land Management.
- Storr, G.M. (1984). A new *Ctenotus* (Lacertilia:Scincidae) from Western Australia. *Rec. West. Aust. Mus.* 11.
- Storr, G.M. (1990). Birds of the Shark Bay area, Western Australia. *In: Research in Shark Bay*. Report of the Franco-Australe Bicentenary Expedition Committee. Eds: P.F. Berry, S.D. Bradshaw, B.R. Wilson. Western Australian Museum.
- Storr, G.M. and Harold, G. (1990). Amphibians and reptiles of the Shark Bay area, Western Australia. *In: Research in Shark Bay*. Report of the Franco-Australe Bicentenary Expedition Committee. Eds: P.F. Berry, S.D. Bradshaw, B.R. Wilson. Western Australian Museum.
- Storr, G.M., Smith, L.A. and Johnstone, R. E. (1983). *Lizards of Western Australia. Vol. II. Dragons and Monitors*. West. Aust. Mus. Perth.
- Storr, G.M., Smith, L.A. and Johnstone, R.E. (1990). *Lizards of Western Australia. Vol. III. Geckos and Pygopods*. West. Aust. Mus. Perth.
- Storr, G.M., Smith, L.A. and Johnstone, R.E. (1999). *Lizards of Western Australia. Vol I. Skinks*. West. Aust. Mus. Perth.
- Storr, G.M., Smith, L.A. and Johnstone, R.E. (2002). *Snakes of Western Australia*. Western Australian Museum, Perth.
- Strahan, R. (ed) (1998). *The Mammals of Australia. The National Photographic Index of Australian Wildlife*. Australian Museum / Reed New Holland. New Holland Publishers Pty Ltd.
- Thompson, G.G. and Thompson, S.A. (2002). Terrestrial fauna surveys: why when and how much? *In: "The boundary fence and beyond"*. Proceedings of 2002 workshop on Environmental Management in Arid and Semi-arid Areas, Goldfields Environmental Management Group, Boulder, Western Australia.

**REFERENCES – Continued.**

- Tyler, M.J., Smith, L.A. and Johnstone, R.E. (2000). *Frogs of Western Australia*. West. Aust. Mus. Perth.
- URS (formerly LeProvost Dames and Moore) 2000. Shark Bay World Heritage property. Draft working paper on environmental values, cultural uses and petroleum industry impacts. Unpublished report prepared for the Environmental Protection Authority and Environment Australia.
- Western Australian Herbarium (2005). FloraBase. Department of Conservation and Land Management. <http://www.calm.wa.gov.au>
- Wilson, S.K. and Swann, G. (2003). *A complete guide to reptiles of Australia*. Reed New Holland, Australia.

**APPENDIX 1** *Total list of vertebrate fauna species recorded in CMS Project Area. Individual totals for each trip and each section of the Project Area are also shown. (S = Signs: tracks; scats; 1 – protected under the EPBC Act and Wildlife Conservation Act.)*

COBURN MINERAL SAND PROJECT AREA		Northern Sector	Southern Sector	
SEASON/YEAR		Spring 03	Autumn 04	Spring 04
TRIP NUMBER		1	2	3
<b>CASUARIIDAE</b>				
<i>Dromaius novaehollandiae</i>	Emu	X	X	X
<b>MEGAPODIIDAE</b>				
<i>Leipoa ocellata</i>	<sup>1</sup> Malleefowl	S	S	S
<b>ACCIPITRIDAE</b>				
<i>Accipiter fasciatus</i>	Brown Goshawk	X	X	
<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk	X		
<i>Aquila morphnoides</i>	Little Eagle	X		X
<i>Aquila audax</i>	Wedge-tailed Eagle	X	X	
<b>FALCONIDAE</b>				
<i>Falco berigora</i>	Brown Falcon	X	X	X
<i>Falco cenchroides</i>	Australian Kestrel	X		X
<i>Falco longipennis</i>	Australian Hobby	X		
<b>COLUMBIDAE</b>				
<i>Phaps chalcoptera</i>	Common Bronzewing	X	X	X
<i>Ocyphaps lophotes</i>	Crested Pigeon	X		
<i>Geopelia cuneata</i>	Diamond Dove	X		
<b>PSITTACIDAE</b>				
<i>Cacatua roseicapilla</i>	Galah	X	X	X
<i>Nymphicus hollandicus</i>	Cockatiel	X		
<i>Platycercus zonarius</i>	Australian Ringneck	X	X	X
<i>Platycercus varius</i>	Mulga Parrot	X	X	X
<b>CUCULIDAE</b>				
<i>Chrysococcyx osculans</i>	Black-eared Cuckoo	X	X	X
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo			X
<b>AEGOTHELIDAE</b>				
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	X	X	
<b>MEROPIDAE</b>				
<i>Merops ornatus</i>	Rainbow Bee-eater	X		X
<b>MALURIDAE</b>				
<i>Malurus splendens</i>	Splendid Fairy-wren	X	X	X
<i>Malurus lamberti</i>	Variiegated Fairy-wren	X	X	X
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren	X		X
<b>PARDALOTIDAE</b>				
<i>Pardalotus striatus</i>	Striated Pardalote	X	X	X
<b>ACATHIZIDAE</b>				
<i>Sericornis frontalis</i>	White-browed Scrubwren	X	X	X
<i>Gerygone fusca</i>	Western Gerygone	X	X	
<i>Smicromis brevirostris</i>	Weebill	X	X	X
<i>Acanthiza apicalis</i>	Broad-tailed Thornbill	X	X	X
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	X	X	X
<i>Pyrrholaemus brunneus</i>	Redthroat		X	X
<b>MELIPHAGIDAE</b>				

COBURN MINERAL SAND PROJECT AREA		Northern Sector	Southern Sector	
SEASON/YEAR		Spring 03	Autumn 04	Spring 04
TRIP NUMBER		1	2	3
<i>Lichmera indistincta</i>	Brown Honeyeater	X		X
<i>Certhionyx variegatus</i>	Pied Honeyeater	X		
<i>Lichenostomus virescens</i>	Singing Honeyeater	X	X	X
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater	X	X	X
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	X	X	X
<i>Phylidonyris 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
<i>Epthianura tricolor</i>	Crimson Chat	X		X
<b>PETROICIDAE</b>				
<i>Microeca fascianus</i>	Jacky Winter	X	X	
<i>Petroica goodenovii</i>	Red-capped Robin	X		X
<i>Eopsaltria australis</i>	Yellow Robin		X	X
<i>Drymodes brunneopygia</i>	Southern Scrub-robin	X	X	X
<b>POMATOSTOMIDAE</b>				
<i>Pomatostomus superciliosus</i>	White-browed Babbler	X	X	X
<b>CINCLOSOMATIDAE</b>				
<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush	X		X
<i>Psophodes occidentalis</i>	Western Wedgebill	X	X	
<b>PACHYCEPHALIDAE</b>				
<i>Oreoica gutturalis</i>	Crested Bellbird	X	X	X
<i>Pachycephala pectoralis</i>	Golden Whistler	X	X	X
<i>Pachycephala rufiventris</i>	Rufous Whistler	X	X	X
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	X	X	X
<b>DICRURIDAE</b>				
<i>Rhipidura fuliginosa</i>	Grey Fantail		X	
<i>Rhipidura leucophrys</i>	Willie Wagtail	X	X	X
<b>CAMPEPHAGIDAE</b>				
<i>Lalage tricolor</i>	White-winged Triller	X		X
<b>ARTAMIDAE</b>				
<i>Artamus personatus</i>	Masked Woodswallow	X		
<i>Artamus cinereus</i>	Black-faced Woodswallow	X		X
<b>CRACTICIDAE</b>				
<i>Cracticus torquatus</i>	Grey Butcherbird	X	X	X
<b>CORVIDAE</b>				
<i>Corvus bennetti</i>	Little Crow	X	X	X
<b>HIRUNDINIDAE</b>				
<i>Hirundo nigricans</i>	Tree Martin	X		
<b>ZOSTEROPIDAE</b>				
<i>Zosterops lateralis</i>	Grey-breasted White-eye			X
<b>ESTRILDIDAE</b>				
<i>Taeniopygia guttata</i>	Zebra Finch	X	X	
<b>MOTACILLIDAE</b>				
<i>Anthus australis</i>	Richard's Pipit	X		
<b>Total Number of Species per Trip</b>		<b>55</b>	<b>40</b>	<b>44</b>
<b>Total Number of Species per Section</b>		<b>55</b>	<b>52</b>	
<b>Total Number of Species per CMS Project Area</b>		<b>61</b>		



COBURN MINERAL SAND PROJECT AREA		Northern Sector	Southern Sector	
SEASON/YEAR		Spring 03	Autumn 04	Spring 04
TRIP NUMBER		1	2	3
<b>NATIVE MAMMALS</b>				
<b>TACHYGLOSSIDAE</b>				
<i>Tachyglossus aculeatus</i>	Echidna	X		
<b>DASYURIDAE</b>				
<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart		X	X
<i>Sminthopsis hirtipes</i>	Hairy-footed Dunnart		X	
<b>MACROPODIDAE</b>				
<i>Macropus robustus</i>	Euro	X		
<i>Macropus rufus</i>	Red Kangaroo	X		
<i>Macropus sp.</i>	Unidentified Kangaroo Species		X	X
<b>MURIDAE</b>				
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse	X	X	X
<i>Notomys alexis</i>	Spinifex Hopping-mouse		X	X
<b>Total Number of Species per Trip</b>		<b>4</b>	<b>5</b>	<b>4</b>
<b>Total Number of Species per Section</b>		<b>4</b>	<b>5</b>	
<b>Total Number of Species per CMS Project Area</b>		<b>7</b>		
<b>REPTILES</b>				
<b>GEKKONIDAE</b>				
<i>Diplodactylus alboguttatus</i>		X	X	X
<i>Diplodactylus klugei</i>				X
<i>Strophurus michaelsoni</i>			X	X
<i>Diplodactylus pulcher</i>		X	X	X
<i>Diplodactylus squarrosus</i>		X		
<i>Strophurus strophurus</i>		X	X	X
<i>Gehyra variegata</i>		X	X	X
<i>Heteronotia binoei</i>		X	X	
<i>Nephrurus levis occidentalis</i>		X	X	X
<b>PYGOPODIDAE</b>				
<i>Aprasia smithi</i>		X		
<i>Delma butleri</i>		X		X
<i>Pygopus n. nigriceps</i>		X	X	X
<b>AGAMIDAE</b>				
<i>Ctenophorus nuchalis</i>		X		
<i>Ctenophorus m. maculatus</i>		X	X	X
<i>Ctenophorus scutulatus</i>		X	X	X
<i>Moloch horridus</i>				X
<i>Pogona m. minor</i>		X	X	X
<b>SCINCIDAE</b>				
<i>Ctenotus alleni</i>		X		
<i>Ctenotus fallens</i>		X	X	X
<i>Ctenotus p. pantherinus</i>		X		
<i>Ctenotus schomburgkii</i>		X		
<i>Cyclodomorphus celatus</i>		X	X	X (?)
<i>Egernia depressa</i>		X		
<i>Lerista kendricki</i>		X	X	X
<i>Lerista lineopunctulata</i>		X	X	X
<i>Lerista macropisthopus fuscipes</i>		X		

COBURN MINERAL SAND PROJECT AREA		Northern Sector	Southern Sector	
SEASON/YEAR		Spring 03	Autumn 04	Spring 04
TRIP NUMBER		1	2	3
<i>Lerista muelleri</i>		X		
<i>Lerista planiventralis decora</i>		X		X
<i>Lerista praepedita</i>		X		X
<i>Lerista varia</i>		X		
<i>Menetia surda cresswelli</i>		X	X	X
<i>Menetia greyii</i>		X	X	X
<i>Morethia lineoocellata</i>			X	X
<i>Morethia obscura</i>		X		
<i>Tiliqua occipitalis</i>				X
<b>VARANIDAE</b>				
<i>Varanus caudolineatus</i>		X		X
<i>Varanus eremius</i>		X	X	X
<i>Varanus gouldii</i>		X	X	
<b>ELAPIDAE</b>				
<i>Neelaps bimaculatus</i>		X		X
<i>Pseudechis australis</i>		X		
<i>Pseudonaja modesta</i>			X	
<i>Parasuta monachus</i>			X	
<i>Brachyuropsis approximans</i>		X		
<i>Simoselaps bertholdi</i>		X		
<i>Simoselaps littoralis</i>		X	X	X
<b>Total Number of Species per Trip</b>		<b>38</b>	<b>22</b>	<b>27</b>
<b>Total Number of Species per Section</b>		<b>38</b>	<b>31</b>	
<b>Total Number of Species per CMS Project Area</b>		<b>45</b>		
<b>INTRODUCED MAMMALS</b>				
<b>LEPORIDAE</b>				
<i>Oryctolagus cuniculus</i>	Rabbit	S	X	X
<i>Canis sp.</i>	Dog/Dingo	S	S	
<i>Vulpes vulpes</i>	Red Fox	S	S	X
<b>FELIDAE</b>				
<i>Felis catus</i>	Feral Cat	S	S	X
<b>CAMELIDAE</b>				
<i>Camelus dromedarius</i>	One-humped Camel	S	S	S
<b>BOVIDAE</b>				
<i>Capra hircus</i>	Goat		X	X
<b>Total Number of Species per Trip</b>		<b>5</b>	<b>6</b>	<b>5</b>
<b>Total Number of Species per Section</b>		<b>5</b>	<b>6</b>	
<b>Total Number of Species per CMS Project Area</b>		<b>6</b>		

**APPENDIX 2a Mammal and reptile fauna recorded during the spring 2003 and spring 2004 surveys of the northern and southern sectors of the CMS Project Area.**

	Sampling Site Code	E2	E4	E6	E7	M101	M102	S101	S102	S103	S201	S202	S203	S204	S205	S301	S302	S5	S8	
	Trip Number	1	1	1	1	3	1	1	1	1	3	3	1	1	3	3	3	3	1	1
<b>NATIVE MAMMALS</b>																				
<b>TACHYGLOSSIDAE</b>																				
<i>Tachyglossus aculeatus</i>	Echidna		S		S		S												S	
<b>DASYURIDAE</b>																				
<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart								3	1				1						
<b>MACROPODIDAE</b>																				
<i>Macropus robustus</i>	Euro						1													
<i>Macropus rufus</i>	Red Kangaroo																			1
<i>Macropus</i> sp.	Unidentified Macropus Species				S					S							S			
<b>MURIDAE</b>																				
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse			1	1					2	1	1		1	1		1			
<i>Notomys alexis</i>	Spinifex Hopping-mouse											1								
	<b>Number of Species</b>	-	1	1	1	2	1	1	-	-	1	3	1	1	1	-	2	1	1	1
<b>REPTILES</b>																				
<b>GEKKONIDAE</b>																				
<i>Diplodactylus alboguttatus</i>			2				4		1			1		1	1	4	4			2
<i>Diplodactylus klugei</i>													1		1		1			
<i>Strophurus michaelsoni</i>					1							1	1			2	3			
<i>Diplodactylus pulcher</i>		3	1		2	1	3	3	1	2		2		1	1		1		4	
<i>Diplodactylus squarrosus</i>																				5
<i>Strophurus strophurus</i>			2				1										1			
<i>Gehyra variegata</i>				1	1	1	2							1	1				1	5
<i>Heteronotia binoei</i>												1								
<i>Nephrurus levis occidentalis</i>				2	2	2	9	1	2		1			2	1		1			4
<b>PYGOPODIDAE</b>																				
<i>Aprasia smithi</i>						1														
<i>Delma butleri</i>				1										1						
<i>Pygopus n. nigriceps</i>			4	1	1		1		1	1		1			1				2	

	Sampling Site Code	E2	E4	E6	E7	M101	M102	S101	S102	S103	S201	S202	S203	S204	S205	S301	S302	S5	S8		
	Trip Number	1	1	1	1	3	1	1	1	1	3	3	1	1	3	3	3	3	3	1	1
<b>AGAMIDAE</b>																					
<i>Ctenophorus m. maculatus</i>		1			1				4		4			4	7	4	8	14			
<i>Ctenophorus scutulatus</i>		1	1	1			2	1						1							
<i>Moloch horridus</i>														1							
<i>Pogona m. minor</i>									1	1											
<b>SCINCIDAE</b>																					
<i>Ctenotus alleni</i>					1			1											1		
<i>Ctenotus fallens</i>					2	1		2				3	2		2	1	1	2			
<i>Ctenotus schomburgkii</i>		2																			1
<i>Cyclodomorphus celatus</i>			1		1		2														
<i>Cyclodomorphus sp.</i>													1								
<i>Lerista kendricki</i>		6		1		1	6	3	2	1			2	3	2	1		1			1
<i>Lerista lineopunctulata</i>							2						1					1			
<i>Lerista macropisthopus fuscipes</i>							1														
<i>Lerista muelleri</i>		7		2																	9
<i>Lerista planiventralis decora</i>								2						1				1			
<i>Lerista praepedita</i>		1	1		1		1						1	3							1
<i>Lerista varia</i>													1								
<i>Menetia surda cresswelli</i>					3	1		1	2	1		3	1		1			1			1
<i>Menetia greyii</i>			1	3		1		2		1			1		1					2	2
<i>Morethia lineoocellata</i>																		1	1		
<i>Morethia obscura</i>				2																	
<i>Tiliqua occipitalis</i>														1							
<b>VARANIDAE</b>																					
<i>Varanus caudolineatus</i>											1										
<i>Varanus eremius</i>			1					3													1
<i>Varanus gouldii</i>					1			1													
<b>ELAPIDAE</b>																					
<i>Neelaps bimaculatus</i>		1				1															
<i>Pseudechis australis</i>								1													
<i>Brachyurophis approximans</i>			1				1														1

	Sampling Site Code	E2	E4	E6	E7	M101	M102	S101	S102	S103	S201	S202	S203	S204	S205	S301	S302	S5	S8			
	<b>Trip Number</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>
<i>Simoselaps bertholdi</i>		1					2		1												1	
<i>Simoselaps littoralis</i>		1	1		1												2					
	<b>Number of Species</b>	<b>10</b>	<b>10</b>	<b>8</b>	<b>11</b>	<b>11</b>	<b>13</b>	<b>10</b>	<b>7</b>	<b>8</b>	<b>6</b>	<b>1</b>	<b>4</b>	<b>10</b>	<b>7</b>	<b>11</b>	<b>9</b>	<b>5</b>	<b>11</b>	<b>9</b>	<b>8</b>	<b>10</b>
<b>INTRODUCED MAMMALS</b>																						
<b>LEPORIDAE</b>																						
<i>Oryctolagus cuniculus</i>	Rabbit				1				S	S		1								S		
<i>Oryctolagus cuniculus</i>	Rabbit			S	S			S	S		S	S										
<b>CANIDAE</b>																						
<i>Canis sp.</i>	Dog/Dingo		S										S								S	
<i>Vulpes vulpes</i>	Red Fox																				S	
<i>Vulpes vulpes</i>	Red Fox																					S
<b>FELIDAE</b>																						
<i>Felis catus</i>	Feral Cat										S	S	1						S	1		
<b>CAMELIDAE</b>																						
<i>Camelus dromedarius</i>	One-humped Camel				S							S	1		S							
<b>BOVIDAE</b>																						
<i>Capra hircus</i>	Goat				S																	
	<b>Number of Species</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>4</b>	<b>3</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>1</b>

**APPENDIX 2b Avifauna recorded during the spring 2003 and spring 2004 surveys of the northern and southern sectors of the CMS Project Area.**

	Sampling Site Code	E2	E4	E6	E7	M101	M102	S101	S102	S103	S201	S202	S203	S204	S205	S301	S302	S5	S8
	Trip Number	1	1	1	1 3	1	1	1	1 3	3	1	1 3	3	3	3	3	3	1	1
<b>CASUARIIDAE</b>																			
<i>Dromaius novaehollandiae</i>	Emu		S		S 1	S		S	2	1	S	1 1	1		1	1			S
<b>MEGAPODIIDAE</b>																			
<i>Leipoa ocellata</i>	Malleefowl					S	1			1		1		1		1			
<b>COLUMBIDAE</b>																			
<i>Geopelia cuneata</i>	Diamond Dove	1																	
<i>Phaps chalcoptera</i>	Common Bronzewing	1		2				1		1		2							1
<i>Ocyphaps lophotes</i>	Crested Pigeon						1												
<b>ACCIPITRIDAE</b>																			
<i>Accipiter fasciatus</i>	Brown Goshawk				1														1
<i>Aquila morphnoides</i>	Little Eagle															1	1		
<b>FALCONIDAE</b>																			
<i>Falco berigora</i>	Brown Falcon		1		1				1						1				
<i>Falco cenchroides</i>	Australian Kestrel							1		2									
<b>PSITTACIDAE</b>																			
<i>Cacatua roseicapilla</i>	Galah	6			2 6			10	7						6	2	2		9
<i>Nymphicus hollandicus</i>	Cockatiel							4											
<i>Platycercus zonarius</i>	Australian Ringneck				3 4	1		4		1	1			5	2	2		2	
<i>Platycercus varius</i>	Mulga Parrot	2		2	2 2						4								2
<b>MEROPIDAE</b>																			
<i>Merops ornatus</i>	Rainbow Bee-eater									1		1							
<b>CUCULIDAE</b>																			
<i>Chrysococyx osculans</i>	Black-eared Cuckoo		1	1		1		1							1				
<i>Chrysococyx basalis</i>	Horsfield's Bronze-Cuckoo				1				1						1				
<b>HIRUNDINIDAE</b>																			
<i>Hirundo nigricans</i>	Tree Martin	3	2						1										
<b>DICRURIDAE</b>																			
<i>Rhipidura leucophrys</i>	Willie Wagtail							1			1	1		2	1				

	Sampling Site Code	E2	E4	E6	E7	M101	M102	S101	S102	S103	S201	S202	S203	S204	S205	S301	S302	S5	S8
	Trip Number	1	1	1	1 3	1	1	1	1 3	3	1	1 3	3	3	3	3	3	1	1
<b>PETROICIDAE</b>																			
<i>Petroica goodenovii</i>	Red-capped Robin	3	2	2		1	1						1						
<i>Eopsaltria australis</i>	Yellow Robin												2		1				
<b>PACHYCEPHALIDAE</b>																			
<i>Pachycephala pectoralis</i>	Golden Whistler		1	2	1	2	2	1		1		2	2		1				
<i>Pachycephala rufiventris</i>	Rufous Whistler		2	2	1 4	2	2	2		1 1		1	2	2	1	1	1	1	1
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				1	1	1	1		1 1	1	1	2	2	1	2	2	2	1
<i>Oreoica gutturalis</i>	Crested Bellbird		1	1	1	1		1		1 1	1	1		1	1	1	1		
<b>CAMPEPHAGIDAE</b>																			
<i>Lalage tricolor</i>	White-winged Triller		1	2				1	6						1	1		2	
<b>CINCLOSOMATIDAE</b>																			
<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush		2														1	1	
<b>PETROICIDAE</b>																			
<i>Drymodes brunneopygia</i>	Southern Scrub-robin		2	2	2		2	6		6	4		2	2	2		2	2	
<b>POMATOSTOMIDAE</b>																			
<i>Pomatostomus superciliosus</i>	White-browed Babbler				7		2	4	4	2	3	4	4	5	1		6	10	2
<b>MELIPHAGIDAE</b>																			
<i>Epthianura tricolor</i>	Crimson Chat		2	2	4			2	10	6									
<b>ACATHIZIDAE</b>																			
<i>Gerygone fusca</i>	Western Gerygone			1															
<i>Smicronis brevirostris</i>	Weebill	20	8	10	10	20	4				1	2	6	6		10	6	4	3
<i>Acanthiza apicalis</i>	Broad-tailed Thornbill	3	3	3	4	4	4	4	1	2	3	2		4	4	4	6	2	3
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	10	4	8	4	10	6						8	4	2		6	5	4
<i>Sericornis frontalis</i>	White-browed Scrubwren				1		2			1	2	2		2					4
<i>Pyrrholaemus brunneus</i>	Redthroat					2				2	1						1		2
<b>MALURIDAE</b>																			
<i>Malurus splendens</i>	Splendid Fairy-wren	4	4	6			20				1								
<i>Malurus lamberti</i>	Variiegated Fairy-wren		3		6	1		4	6	4	3	4	6	5		6	2	5	10
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren	4				3	5		10	3									2
<i>Artamus cinereus</i>	Black-faced Woodswallow		4		4														
<b>ZOSTEROPIDAE</b>																			

	Sampling Site Code	E2	E4	E6	E7	M101	M102	S101	S102	S103	S201	S202	S203	S204	S205	S301	S302	S5	S8	
	<b>Trip Number</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1 3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1 3</b>	<b>3</b>	<b>1</b>	<b>1 3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	
<i>Zosterops lateralis</i>	Grey-breasted White-eye											3								
<b>MELIPHAGIDAE</b>																				
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater		2		2							4	3				8			
<i>Phylidonyris albigularis</i>	White-fronted Honeyeater		2		8	6	10	4	12	8	8	8	15	8	12	15	10	4	12	6
<i>Lichmera indistincta</i>	Brown Honeyeater		4			6	6	1	4				2	16	4	10		4	4	
<i>Certhionyx variegatus</i>	Pied Honeyeater		2		3	1														
<i>Lichenostomus virescens</i>	Singing Honeyeater	2	6	1	1 1	3	2	3	4	6	3	3	8	8	12	6	4	6	2	4
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater				2	3	15	6	4						5					
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	4	8	2	8 6	3	2	4	2 2	6	4	6	10	16	8	8	2	2	4	6
<b>MOTACILLIDAE</b>																				
<i>Anthus australis</i>	Richard's Pipit					1														
<b>PASSERIDAE</b>																				
<i>Taeniopygia guttata</i>	Zebra Finch		2					2												
<b>CORVIDAE</b>																				
<i>Corvus bennetti</i>	Little Crow	S	2	1	2 4			S	2		1	4	2			2	2	3		
<b>CRACICIDAE</b>																				
<i>Cracticus torquatus</i>	Grey Butcherbird	1			1 2			1					2			1	1	1	1	
<b>CINCLOSOMATIDAE</b>																				
<i>Psophodes occidentalis</i>	Western Wedgebill			2		1	4	4	1										1	
<b>PARDALOTIDAE</b>																				
<i>Pardalotus striatus</i>	Striated Pardalote	1	3		1								1		1			1		
	<b>Number of Species</b>	<b>16</b>	<b>26</b>	<b>18</b>	<b>23 21</b>	<b>22</b>	<b>16</b>	<b>27</b>	<b>14 17</b>	<b>22</b>	<b>13</b>	<b>11 23</b>	<b>16</b>	<b>16</b>	<b>25</b>	<b>20</b>	<b>22</b>	<b>14</b>	<b>14</b>	



**APPENDIX 3a** *List of native mammals known to have occurred in the vicinity of the Coburn Mineral Sand Project Area. Based on data extracted from McKenzie and Muir (2000) and McKenzie et al. (2000a).*

**Key**

- CB - Carnarvon Basin (data from sites located in Nanga [NA], Nerren Nerren [NE] and the eastern portion of Zuytdorp [ZU]).
- CMS - Coburn Mineral Sand Project Area.
- WAM - Historical Western Australian Museum records from the general area.

	Record Source	CB	CMS	WAM
<b>TACHYGLOSSIDAE</b>				
<i>Tachyglossus aculeatus</i>	Echidna	X	X	
<b>DASYURIDAE</b>				
<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart	X	X	X
<i>Sminthopsis hirtipes</i>	Hairy-footed Dunnart	X	X	
<b>MACROPODIDAE</b>				
<i>Macropus fuliginosus</i>	Western Grey Kangaroo	X		
<i>Macropus robustus</i>	Euro	X	X	
<i>Macropus rufus</i>	Red Kangaroo		X	
<b>VESPERTILIONIDAE</b>				
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	X		
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	X		
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat	X		
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat	X		
<b>MOLOSSIDAE</b>				
<i>Mormopterus planiceps</i>	Southern Freetail-bat	X		
<i>Nyctinomus australis</i>	White-striped Freetail-bat	X		
<b>MURIDAE</b>				
<i>Notomys alexis</i>	Spinifex Hopping-mouse	X	X	
<i>Pseudomys albocinereus</i>	Ash-grey Mouse	X		X
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse	X	X	X
	<b>Number of Species</b>	<b>14</b>	<b>7</b>	<b>3</b>

**APPENDIX 3b** *List of amphibians and reptiles known to have occurred in the vicinity of the CMS Project Area. Based on data extracted from McKenzie et al. (2000b).*

**Key**

- CB - Carnarvon Basin (data from sites located in Nanga [NA], Nerren Nerren [NE] and the eastern portion of Zuytdorp [ZU]).  
 CMS - Coburn Mineral Sand Project Area.  
 WAM - Historical Western Australian Museum records from the general area.

	Record Source	CB	CMS	WA M
<b>AMPHIBIANS</b>				
<b>MYOBATRACHIDAE</b>				
<i>Neobatrachus pelobatoides</i>		X		
<i>Neobatrachus wilsmorei</i>		X		
<i>Arenophryne rotunda</i>		X		X
<i>Pseudophryne guentheri</i>		X		
	<b>Number of Species</b>	<b>4</b>	<b>-</b>	<b>1</b>
<b>REPTILES</b>				
<b>GEKKONIDAE</b>				
<i>Crenadactylus ocellatus horni</i>		X		X
<i>Diplodactylus alboguttatus</i>		X	X	X
<i>Diplodactylus klugei</i>			X	
<i>Diplodactylus ornatus</i>		X		X
<i>Diplodactylus pulcher</i>		X	X	X
<i>Diplodactylus squarrosus</i>		X	X	X
<i>Nephrurus levis occidentalis</i>		X	X	X
<i>Rhynchoedura ornata</i>		X		X
<i>Strophurus michaelsoni</i>			X	X
<i>Strophurus s. spinigerus</i>		X		
<i>Strophurus strophurus</i>		X	X	X
<i>Gehyra variegata</i>		X	X	X
<i>Heteronotia binoei</i>		X	X	X
<b>PYGOPODIDAE</b>				
<i>Aprasia smithi</i>			X	X
<i>Delma australis</i>		X		X
<i>Delma butleri</i>			X	
<i>Lialis burtonis</i>		X		X
<i>Pletholax gracilis edelensis</i>		X		
<i>Pygopus lepidopodus</i>		X		
<i>Pygopus n. nigriceps</i>		X	X	X
<b>AGAMIDAE</b>				
<i>Ctenophorus maculatus badius</i>		X		
<i>Ctenophorus m. maculatus</i>		X	X	X
<i>Ctenophorus nuchalis</i>			X	
<i>Ctenophorus reticulatus</i>		X		
<i>Ctenophorus rubens</i>				X
<i>Ctenophorus scutulatus</i>		X	X	X
<i>Moloch horridus</i>		X	X	X
<i>Pogona m. minor</i>		X	X	X
<i>Rankinia a. adelaidensis</i>		X		
<i>Rankinia p. parviceps</i>		X		
<b>SCINCIDAE</b>				

	Record Source	CB	CMS	WA M
<i>Cryptoblepharus carnabyi</i>		X		X
<i>Cryptoblepharus plagiocephalus</i>				X
<i>Ctenotus alleni</i>		X	X	
<i>Ctenotus australis</i>		X		X
<i>Ctenotus fallens</i>		X	X	X
<i>Ctenotus p. pantherinus</i>			X	
<i>Ctenotus schomburgkii</i>		X	X	X
<i>Ctenotus zastictus</i>				X
<i>Cyclodomorphus celatus</i>		X	X	X
<i>Egernia depressa</i>			X	
<i>Lerista connivens</i>		X		X
<i>Lerista elegans</i>		X		X
<i>Lerista humphriesi</i>		X		X
<i>Lerista kendricki</i>		X	X	X
<i>Lerista lineopunctulata</i>		X	X	X
<i>Lerista macropisthopus fuscipes</i>		X	X	X
<i>Lerista muelleri</i>		X	X	X
<i>Lerista planiventralis decora</i>		X	X	X
<i>Lerista praepedita</i>		X	X	X
<i>Lerista uniduo (maculosa)</i>		X		X
<i>Lerista varia</i>		X	X	X
<i>Menetia greyii</i>		X	X	X
<i>Menetia surda cresswelli</i>		X	X	X
<i>Morethia butleri</i>		X		
<i>Morethia lineocellata</i>		X	X	
<i>Morethia obscura</i>		X	X	X
<i>Tiliqua occipitalis</i>			X	
<b>VARANIDAE</b>				
<i>Varanus caudolineatus</i>			X	X
<i>Varanus eremius</i>		X	X	
<i>Varanus gouldii</i>		X	X	
<b>TYPHLOPIDAE</b>				
<i>Ramphotyphlops leptosoma</i>				X
<b>ELAPIDAE</b>				
<i>Brachyuropsis approximans</i>			X	
<i>Demansia calodera</i>		X		X
<i>Furina ornata</i>		X		
<i>Neelaps bimaculatus</i>		X	X	
<i>Parasuta monachus</i>			X	
<i>Pseudechis australis</i>			X	X
<i>Pseudonaja modesta</i>			X	X
<i>Pseudonaja nuchalis</i>				X
<i>Simoselaps bertholdi</i>		X	X	X
<i>Simoselaps littoralis</i>		X	X	X
	<b>Number of Species</b>	<b>53</b>	<b>45</b>	<b>49</b>

**APPENDIX 3c** *List of terrestrial birds known to have occurred in the vicinity of the CMS Project Area. Based on data extracted from Burbidge et al. (2000).*

**Key**

- CB - Carnarvon Basin (data from sites located in Nanga [NA], Nerren Nerren [NE] and the eastern portion of Zuytdorp [ZU]).  
 CMS - Coburn Mineral Sand Project Area.  
 WAM - Historical Western Australian Museum records from the general area.

	Record Source	CB	CMS	WAM
<b>CASUARIIDAE</b>				
<i>Dromaius novaehollandiae</i>	Emu	X	X	X
<b>MEGAPODIIDAE</b>				
<i>Leipoa ocellata</i>	Malleefowl	X	X	X
<b>ACCIPITRIDAE</b>				
<i>Elanus caeruleus</i>	Black-shouldered Kite	X		
<i>Elanus scriptus</i>	Letter-winged Kite	X		
<i>Accipiter fasciatus</i>	Brown Goshawk	X	X	
<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk	X	X	
<i>Aquila morphnoides</i>	Little Eagle	X	X	
<i>Aquila audax</i>	Wedge-tailed Eagle	X	X	
<i>Circus assimilis</i>	Spotted Harrier	X		
<b>FALCONIDAE</b>				
<i>Falco berigora</i>	Brown Falcon	X	X	X
<i>Falco cenchroides</i>	Australian Kestrel	X	X	
<i>Falco longipennis</i>	Australian Hobby		X	X
<b>COLUMBIDAE</b>				
<i>Phaps chalcoptera</i>	Common Bronzewing	X	X	
<i>Ocyphaps lophotes</i>	Crested Pigeon	X	X	X
<i>Geopelia cuneata</i>	Diamond Dove	X	X	
<b>PSITTACIDAE</b>				
<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo	X		
<i>Cacatua roseicapilla</i>	Galah	X	X	X
<i>Nymphicus hollandicus</i>	Cockatiel		X	
<i>Platycercus zonarius</i>	Australian Ringneck	X	X	X
<i>Platycercus varius</i>	Mulga Parrot	X	X	X
<i>Melopsittacus undulatus</i>	Budgerigar	X		
<b>CUCULIDAE</b>				
<i>Cuculus pallidus</i>	Pallid Cuckoo	X		
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	X		
<i>Chrysococcyx osculans</i>	Black-eared Cuckoo	X	X	
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo	X	X	
<b>PODARGIDAE</b>				
<i>Podargus strigoides</i>	Tawny Frogmouth	X		
<b>AEGOTHELIDAE</b>				
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	X	X	X
<b>MEROPIDAE</b>				
<i>Merops ornatus</i>	Rainbow Bee-eater	X	X	X
<b>MALURIDAE</b>				
<i>Malurus splendens</i>	Splendid Fairy-wren	X	X	X
<i>Malurus lamberti</i>	Variiegated Fairy-wren	X	X	X
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren	X	X	

	<b>Record Source</b>	<b>CB</b>	<b>CMS</b>	<b>WAM</b>
<i>Malurus leucopterus</i>	White-winged Fairy-wren	X		
<b>PARDALOTIDAE</b>				
<i>Pardalotus striatus</i>	Striated Pardalote	X	X	
<b>ACATHIZIDAE</b>				
<i>Sericornis frontalis</i>	White-browed Scrubwren	X	X	
<i>Calamanthus campestris</i>	Rufous Fieldwren	X		
<i>Pyrrholaemus brunneus</i>	Redthroat	X	X	X
<i>Smicrornis brevirostris</i>	Weebill	X	X	
<i>Gerygone fusca</i>	Western Gerygone	X	X	
<i>Acanthiza apicalis</i>	Broad-tailed Thornbill	X	X	
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	X	X	X
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	X		
<i>Aphelocephala leucopis</i>	Southern Whiteface	X		
<b>MELIPHAGIDAE</b>				
<i>Lichmera indistincta</i>	Brown Honeyeater	X	X	
<i>Certhionyx niger</i>	Black Honeyeater	X		
<i>Certhionyx variegatus</i>	Pied Honeyeater	X	X	
<i>Lichenostomus virescens</i>	Singing Honeyeater	X	X	
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater	X	X	
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	X	X	X
<i>Phylidonyris albifrons</i>	White-fronted Honeyeater	X	X	
<i>Phylidonyris melanops</i>	Tawny-crowned Honeyeater	X		
<i>Manorina flavigula</i>	Yellow-throated Miner	X	X	
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	X	X	
<i>Epthianura tricolor</i>	Crimson Chat	X	X	
<b>PETROICIDAE</b>				
<i>Microeca fascianus</i>	Jacky Winter		X	
<i>Petroica goodenovii</i>	Red-capped Robin	X	X	
<i>Petroica cucullata</i>	Hooded Robin	X		
<i>Eopsaltria australis</i>	Yellow Robin	X	X	
<i>Drymodes brunneopygia</i>	Southern Scrub-robin	X	X	X
<b>POMATOSTOMIDAE</b>				
<i>Pomatostomus superciliosus</i>	White-browed Babbler	X	X	
<b>CINCLOSOMATIDAE</b>				
<i>Psophodes occidentalis</i>	Western Wedgebill	X	X	
<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush	X	X	
<b>NEOSITTIDAE</b>				
<i>Daphoenositta chrysoptera</i>	Varied Sittella	X		
<b>PACHYCEPHALIDAE</b>				
<i>Oreoica gutturalis</i>	Crested Bellbird	X	X	
<i>Pachycephala pectoralis</i>	Golden Whistler	X	X	
<i>Pachycephala rufiventris</i>	Rufous Whistler	X	X	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	X	X	
<b>DICRURIDAE</b>				
<i>Rhipidura fuliginosa</i>	Grey Fantail	X	X	
<i>Rhipidura leucophrys</i>	Willie Wagtail	X	X	
<b>CAMPEPHAGIDAE</b>				
<i>Lalage tricolor</i>	White-winged Triller	X	X	
<b>ARTAMIDAE</b>				
<i>Artamus personatus</i>	Masked Woodswallow	X	X	
<i>Artamus cinereus</i>	Black-faced Woodswallow	X	X	
<b>CRATICIDAE</b>				

	<b>Record Source</b>	<b>CB</b>	<b>CMS</b>	<b>WAM</b>
<i>Cracticus torquatus</i>	Grey Butcherbird	X	X	
<i>Cracticus nigrogularis</i>	Pied Butcherbird	X		
<b>CORVIDAE</b>				
<i>Corvus bennetti</i>	Little Crow	X	X	
<i>Corvus coronoides</i>	Australian Raven	X		
<b>HIRUNDINIDAE</b>				
<i>Cheramoeca leucosternum</i>	White-backed Swallow	X		
<i>Hirundo neoxena</i>	Welcome Swallow	X		
<i>Hirundo nigricans</i>	Tree Martin	X	X	
<b>ZOSTEROPIDAE</b>				
<i>Zosterops lateralis</i>	Grey-breasted White-eye	X	X	
<b>DICAEIDAE</b>				
<i>Dicaeum hirundinaceum</i>	Mistletoebird	X		
<b>PASSERIDAE</b>				
<i>Taeniopygia guttata</i>	Zebra Finch	X	X	
<b>MOTACILLIDAE</b>				
<i>Anthus australis</i>	Richard's Pipit	X	X	
	<b>Number of Species</b>	<b>78</b>	<b>61</b>	<b>16</b>

**APPENDIX 3d** *List of introduced mammals known to have occurred in the vicinity of the CMS Project Area. Based on data extracted from McKenzie et al. (2000a).*

**Key**

- CB - Carnarvon Basin (data from sites located in Nanga [NA], Nerren Nerren [NE] and the eastern portion of Zuytdorp [ZU]).
- CMS - Coburn Mineral Sand Project Area.
- WAM - Historical Western Australian Museum records from the general area.

	Record Source	CB	CMS	WA M
<b>MURIDAE</b>				
<i>Mus musculus</i>	House Mouse	X		X
<b>LEPORIDAE</b>				
<i>Oryctolagus cuniculus</i>	Rabbit	X	X	
<b>CANIDAE</b>				
<i>Canis f. familiaris</i>	Feral Dog		X	
<i>Vulpes vulpes</i>	Red Fox	X	X	
<b>FELIDAE</b>				
<i>Felis catus</i>	Feral Cat	X	X	
<b>CAMELIDAE</b>				
<i>Camelus dromedarius</i>	One-humped Camel		X	
<b>BOVIDAE</b>				
<i>Capra hircus</i>	Goat	X	X	
<i>Ovis aries</i>	Sheep	X		
	<b>Number of Species</b>	<b>6</b>	<b>6</b>	<b>1</b>

**APPENDIX 4** *List of 26 selected plant species believed to be a feeding resource for birds and potential flowering periods during the year. (1 - denotes the month that species been recorded as flowering from field studies or CALM's FloraBase records.)*

Plant Species	Months of the Year											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Adenanthos acanthophyllus</i>				1	1	1	1					1
<i>Banksia ashbyi</i>		1	1	1	1	1	1	1	1			1
<i>Beaufortia aestiva</i>	1	1	1			1	1	1	1	1	1	1
<i>Beaufortia sprengelioides</i>							1	1	1	1	1	
<i>Brachychiton gregorii</i>	1										1	1
<i>Calothamnus blepharospermus</i>	1	1					1					
<i>Calothamnus formosus</i> subsp. <i>formosus</i>								1	1	1	1	1
<i>Calothamnus quadrifidus</i>						1	1	1	1	1	1	1
<i>Eucalyptus eudesmioides</i>		1	1	1	1							
<i>Eucalyptus fruticosa</i>	1	1	1	1	1							
<i>Eucalyptus mannensis</i> subsp. <i>vespertina</i>				1	1	1	1	1	1	1		
<i>Eucalyptus obtusiflora</i> subsp. <i>obtusiflora</i>	1	1	1	1	1							
<i>Eucalyptus roycei</i>	1	1	1									
<i>Eucalyptus selachiana</i>			1									
<i>Grevillea acacioides</i>					1	1	1	1	1			
<i>Grevillea eriostachya</i>	1	1	1	1	1	1	1	1	1	1	1	1
<i>Grevillea gordoniana</i>								1	1	1	1	1
<i>Grevillea rogersoniana</i> (P3)								1	1	1		
<i>Grevillea stenobotrya</i>				1	1	1	1	1	1	1	1	
<i>Grevillea stenostachya</i> (P3)							1	1	1			
<i>Hakea stenophylla</i> subsp. <i>notialis</i>					1	1	1	1				
<i>Melaleuca campanae</i>											1	
<i>Melaleuca eleuterostachya</i>	1						1	1	1	1	1	1
<i>Melaleuca eulobata</i>										1		
<i>Melaleuca leiopyxis</i>								1	1	1		
<i>Melaleuca sapientes</i>	1	1										1
<b>Total</b>	<b>9</b>	<b>9</b>	<b>8</b>	<b>8</b>	<b>1</b>	<b>9</b>	<b>13</b>	<b>15</b>	<b>14</b>	<b>12</b>	<b>10</b>	<b>10</b>