Blue Hills

Fauna assessment

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Introduction

As part of the Environmental Impact Assessment being carried out for a proposed iron ore mine at Blue Hills, in the Murchison region of Western Australia, Bamford Consulting Ecologists was commissioned by ATA Environmental to undertake a comprehensive fauna survey of the project area. This fauna survey was to consist of a review of available information on fauna of the region and an intensive field survey. This report presents the results of both the information review and the field survey.

The objectives of a comprehensive fauna survey are as follows:

- produce a fauna list, containing both species recorded during the field surveys and species predicted to occur in the project area on the basis of known patterns of distribution and habitats present on the site;
- identify species of conservation significance that are or may be present;
- identify significant or sensitive habitats and locations on the site and;
- make management recommendations to minimise impacts upon fauna.

Methods

Site description

Blue Hills is in Shire of Perenjori in the southern Murchison region at *ca.* 29°09'S, 116°53'E. It is situated approximately 60km northeast of Perenjori and 90km south of Yalgoo. An independent assessment of the vegetation of the lease area is being carried out, but for the purposes of the fauna assessment, the main landform and habitat features are as follows:

- A line of hills, consisting of banded ironstone and some granite, supporting a shrubland and low woodland of *Acacia, Allocasuarina* and Myrtaceae growing in generally shallow rocky-loam soils.
- Foothills and slopes of rocky-loam soils with some low rock outcroppings, supporting a tall shrubland of Narrow-leaf Mulga *Acacia linophylla*. Some eucalypts occur as emergents in this shrubland.
- Plains of red loam soils with very little relief, supporting Narrow-leaf Mulga at variable densities and generally with little understorey. Emergent eucalypts are a significant component of this landform and vegetation type in some areas, generally close to the foothills and in low-lying areas where water may concentrate.
- Low-lying areas of cracking red loam, with some areas of Gilgai formation, supporting a woodland of melaleuca and a shrubland of lignum beneath sparse eucalypts. Such areas were subject to irregular inundation.

Field Survey Programme

Field work took place from 9th to 16th February 2004. The field personnel were Dr M. Bamford, Mr P. Smith, Mr W. Bancroft, Mr A. Maynier and Ms K. Pearce. Work carried out in the field included:

- Systematic trapping for amphibians, reptiles and mammals;
- Censussing for birds in conjunction with systematic trapping;
- Spotlighting for nocturnal reptiles, birds and mammals;
- The use of mist-nets, a harp trap and an ultra-sonic detector for bats;
- Searching for reptiles;
- Collection of macro-invertebrates likely to represent range-restricted species;
- The keeping of opportunistic records at all times.

Methods employed for these components of the field project are described in the following sections.

Weather conditions experienced during the field trip consisted of very hot, dry weather initially, with maxima of >40 °C in the shade, but the study area was influenced by thunderstorms on 13th February. An estimated 15mm rain fell on across most of the area. The following days were relatively cool (maxima 30-35 °C), with mild but very windy nights.

Trapping sites

Systematic trapping for amphibians, reptiles and mammals took place at 5 sites. These sites are described in Table 1. The sites were arranged to sample the range of habitats as described above.

At each sampling site except Site 2, the trapping layout consisted of:

- 10 assisted pitfall traps placed in a transect at approximately 20m intervals, each 28cm in diameter and 40cm deep, with a 25cm high driftfence extending 3m to either side of the pitfall. The pitfalls had drainage holes covered with flywire base to prevent animals from drowning or digging out the bottom. Note that no pitfalls were installed at Site 2 because of the rocky terrain, with the fences used only with funnel traps (see below).
- 20 funnel traps, deployed in pairs with one funnel trap at each end of the driftfence. Funnel traps were approximately 15cm wide and 60cm long, with a funnel entrance of 5cm.
- 10 medium Elliott Traps, with one placed within 5m of each driftfence at most sites, but on each driftfence at Site 2.
- 5 wire cage traps, with one located in the vicinity of every alternate driftfence at each site.

Sampling at each site occurred over a period of five nights within the period 9th-16th February 2004. Trapping effort was therefore:

Sites 1, 3, 4 and 5:	50 pit-trap nights, 100 funnel-trap nights, 50 Elliott trap nights and 25 cage-trap nights.
Site 2:	100 funnel-trap nights, 50 Elliott trap nights and 25 cage-trap nights.

Specimens caught were identified, some basic measurements were taken (weight for all specimens, snout to vent and total length for reptiles), and notes were made on age and reproductive status. Voucher specimens were collected where necessary and were lodged with the WA Museum. All trapping and collection was carried out under a Licence to Take Fauna for Scientific Purposes SF004425.

Bird Censusing

Bird surveys were carried out at each of the five trapping sites on most mornings when the traps were checked within the period 13th-16th February. The order of checking traps was varied so that the bird censussing was not carried out at the same time of day at each site on every morning, although all bird censussing was carried out between 0600 and 0900 hours. During the bird surveys, all birds observed from the trapping site were counted and each bird survey had a duration of 20-30 minutes. Observations on birds were also gathered opportunistically when carrying out other activities or simply moving around the site (see below). It had been intended to carry out structured bird censussing (20 minute searches of 3ha areas, repeated three times in each vegetation type), but this was not carried out because bird densities were extremely low.

Spotlighting

Spotlighting took place on the nights of 13th, 14th and 15th of February and was carried out either on foot using head-torches (referred to as head-torching) or from a vehicle using the vehicle headlights and a hand-held spotlight.

Head-torching was carried out in the vicinity of Site 4 (13th February, 3 people for 45 minutes each), at Site 1 (14th February, 3 people for 45 minutes each) and on the rocky ridge north of site 4 (15th February, 3 people for 45 minutes each). On all occasions, head-torching began half an hour to an hour after sunset, when it was fully dark, and animals seen were counted, identified and, if necessary for identification, captured.

Spotlighting from a vehicle took place on the nights of 14th February (2030-2100 hours, 6.2 km, Site 4 to Site 1 return) and 15th February (2000 to 2100 hours, 4 km, Site 4 to close to site 5 return). Vehicle speed was maintained at approximately 10 kph during spotlighting.

Bat Surveys

Bats were surveyed through the use of one mist-net, a harp-trap, an Anabat II ultrasonic detector, when spotlighting (both visually and aurally) and by searching for roosting sites in caves. The mist-net and harp-trap were set up along a flyway near Site 4 on the nights of 13th and 14th of February, with the mist-net used from sunset until 3 hours after sunset and the harp-trap set up all night. Conditions were poor on both nights, being very windy. The bat detector was left on around camp (near Site 4) for two hours on the evenings of 13th and 14th February. The intention was to record bat calls when they were heard, so that they could be identified later, but the only species detected were recognised at the time.

Searching for roosts was carried out along the main rocky ridge (east and west of Site 3) on 12th and 14th February, with caves and crevices being investigated using torches. Hollow trees were also investigated for bats when carrying out searching for reptiles.

Searching for Reptiles

Searching for reptiles was carried out on the rocky ridge west of Site 2, in Narrow-leaf Mulga near Site 1, in Narrow-leaf Mulga and Eucalypt woodland near Site 4, and in the south of the lease area in open Narrow-leaf Mulga with scattered *Melaleuca*. Searching involved raking through leaf-litter, and turning over rocks and logs, and involved 3 people for at least an hour at each of these locations.

Opportunistic surveys

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds seen while we were travelling between sites or from the camp.

Invertebrate sampling

Although most work focussed on vertebrate species, specimens of mygalomorph spiders, scorpions, centipedes, land snails and isopods were collected opportunistically. These were targeted because within these groups, many species are known to have restricted distributions and the groups are therefore rich in short-range endemics, often associated with relictual and fragmented habitats such as the ironstone ranges in the Murchison. In addition, the expertise exists to identify species within these groups, whereas such expertise is not readily available for most other invertebrate taxa.

Sources of information

Because even an intensive field study cannot be expected to record all species present in an area, particularly when it takes places in only one season, the survey results were supplemented with records from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al.* 2000), reptiles (Storr *et al.* 1983, 1986, 1990 and 1999), birds (Johnstone and Storr 1998), and mammals (Strahan 1995). In addition, specimen records of frogs, reptiles and mammals held by the WA Museum were obtained for the region bounded by 28° 30' to 29° 30'S, and 116° 30' to 117° 30'E. CALM's Threatened Fauna Database was also searched for records from this region. The Threatened Fauna Database includes threatened invertebrates but no threatened invertebrates were listed for the area. Birds Australia's Atlas database was also searched for the area 29° 00' to 30° 00' S and 116° 00' to 118° 00' E.

These sources of information were used to create lists of species expected to occur at the site. As far as possible, expected species are those that are likely to utilise the project area, and such lists exclude species that have been recorded in the general region as vagrants or for which suitable habitat is absent. Particularly among the birds, for example, vagrants can be recorded almost anywhere.

Taxonomy and nomenclature for fauna species used in this report generally follow Aplin and Smith (2001) for amphibians and reptiles, How *et al.* (2001) for mammals and Johnstone (2001) for birds. Alternative names, including common names recommended for national and international use by Christidis and Boles (1994) for birds, are also given.

Assessment of conservation significance

The conservation status of fauna species is assessed under Commonwealth and State Acts such as the *Commonwealth Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999 and the *Western Australian Wildlife Conservation Act* 1950. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994). The *WA Wildlife Conservation Act* 1950 uses a set of Schedules but also classifies species using some of the IUCN categories. These categories and Schedules are described in Appendix One.

The EPBC Act also has lists of migratory species that are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The list of migratory species under the EPBC Act has been revised to include listed species only, thus excluding family listings (DEH, pers comm.). Those species listed in JAMBA are also protected under Schedule 3 of the *WA Wildlife Conservation Act*. In addition, the Department of the Environment and Heritage (DEH, formerly Environment Australia) has supported the publication of reports on the conservation status of most vertebrate fauna species e.g. reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999); while the Threatened Species and Communities Section of Environment Australia has produced a list of Threatened Australian Fauna (Environment Australia 1999), although this list is effectively a precursor to the list produced under the EPBC Act. These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects as this report pre-dates Mace and Stuart's review (1994).

In Western Australia, the Department of Conservation and Land Management (DCLM) has produced a supplementary list of Priority Fauna, being species that are not considered Threatened under the WA Act but for which the Department feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. Levels of Priority are described in Appendix One.

Fauna species included under conservation acts and/or agreements are formally recognised as of conservation significance under state or federal legislation. Species listed only as Priority by CALM, or that are included in publications such as Garnett and Crowley (2000) and Cogger *et al.* (1993) but not in State or Commonwealth Acts, are also of recognised conservation significance. In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur

in breeding colonies, such as some waterbirds, can be considered of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. The WA Department of Environmental Protection (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan.

On the basis of the above comments, three levels of conservation significance are recognised in this report:

- *Conservation Significance (CS) 1*: Species listed under State or Commonwealth Acts.
- *Conservation Significance (CS) 2*: Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by CALM.
- *Conservation Significance (CS) 3*: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

The vertebrate fauna of Blue Hills

Tables 2, 3, 4 and 5 list the vertebrate fauna known from the general region of the Blue Hills area, based on general patterns of distribution, and indicate those recorded by the WA Museum, by the Birds Australia Atlas (birds only), and that were recorded during the field survey. A list of fauna that has become extinct in the area is given in Table 6. The results of the field survey are presented in Tables 8, 9 and 10, while annotated species lists of all species recorded during the June field survey appear in Appendices 2, 3 and 4. The capture records and morphometric data for all captures are in Appendix 5.

Amphibians

Only one frog species, the Trilling Frog, was recorded during the survey and this was represented by a single specimen caught at Site 1. The specimen was distinguished from the similar *Neobatrachus kunapalari* by morphology and colouration, and from *Neobatrachus sutor* by call. Identification of these three species is difficult, however, and is best confirmed by taking a karyotype, which was not done. The Trilling Frog is currently listed as *Neobatrachus centralis* but the population in the Yalgoo/Mt Magnet area is considered to represent a distinct, undescribed species with a restricted distribution in the southern Murchison.

The remaining frog species that may be present (Table 2) are widespread and have broad distributions, in some cases occurring across much of southern Western Australia. The failure to record any of these other species after the rainfall of 13th February was unexpected, but it may have been that the rainfall wasn't sufficient to encourage frogs to emerge from refuges in large numbers. None of the frog species is of conservation significance.

Frogs are likely to occur right across the study area, as there was evidence of seasonal watercourses along the hills as well as broad areas subject to seasonal inundation at Site 5 and in the south of the lease. Surface and sub-surface water movements may be important for the formation and persistence of seasonal wetlands used by frogs for breeding. Therefore, hydrological impacts of mining, roads and other infrastructure may need to be considered in order to minimise adverse impacts upon seasonal wetlands and frogs.

Reptiles

On the basis of available habitats, known distributions and species recorded during the survey, 54 reptile species may occur at Blue Hills (Table 3). Of these, 21 species were recorded during the survey. Species expected but not recorded may be either difficult to find during a short survey (eg. some of the geckoes), they may occur at very low population densities (eg. some of the large snakes) or they may be absent. Of the species expected to be present, 4 are considered to be of conservation significance and are discussed below.

Conservation Significance Level 1

Western Spiny-tailed Skink *Egernia stokesii badia*
The Western Spiny-tailed Skink is classified as Endangered under the EPBC Act, and Vulnerable under the WA Wildlife Conservation Act and by Cogger *et al.* (1993). It is commonly associated with large trees where it shelters under loose bark, in hollow logs and in crevices (Storr *et al.* 1999). It also colonises abandoned buildings and sheds, particularly where sheets of corrugated iron lie on the ground. There were no abandoned buildings in the study area and few large trees, but the species may still be present, probably where large eucalypts grow along the southern slopes of the hills and in the south of the lease. The species is generally associated with the northern Wheatbelt and so may be absent from the Blue Hills, but a population is known from north of Yalgoo in the Murchison and may represent an undescribed species (B. Maryan pers. comm.).

Carpet Python (south-west population) *Morelia spilota imbricata*
The Carpet Python (south-west population) is classified as Specially Protected Fauna under the WA Wildlife Conservation Act, Priority 4 by the DCLM and Vulnerable by Cogger *et al.* (1993). It is often associated with rocky areas (M. Bamford pers. obs.). The study area is at the inland limit of the species' range but it may be present, particularly along the rocky ridge.

Conservation Significance Level 2

Salmon Gum Gecko *Oedura reticulata*
Listed as Rare or Insufficiently Known by Cogger *et al.* (1993) and at the north-eastern edge of its range in the study area. This species is usually readily found by head-torching and was not located even in areas where moderately large, smooth-barked eucalypts were present. Therefore, it may not occur in the study area but, if present, would occur amongst smooth-barked eucalypts on the southern slopes of the hills and in the south of the lease area.

Cyclodomorphus branchialis
Listed as Priority 2 by DCLM. This species was recorded at Sites 2 (rocky ridge) and 3 (slopes of rocky ridge). *C. branchialis* has a restricted distribution in the south-west Murchison and the project area is at the eastern limit of its range.

Conservation Significance Level 3
Caimanops amphiboluroides
Although not included in any lists of threatened or priority species, *C. amphiboluroides* is rarely encountered and the number of specimens caught (3) and seen (2) was unusually high. Most of the specimens were gravid females that were presumably on the ground to lay eggs, but the species otherwise appears to be arboreal. It was not included in the WA Museum database for the area.

The amount of trapping carried out was too limited to be able to confidently compare levels of abundance and species richness of reptiles between sites (Table 7), but it was interesting that Sites 1 (25 captures) and 3 (21 captures) had more specimens than the Sites 4 (10 captures) and 5 (5 captures). Site 2 had only 8 captures but also had fewer traps, with no pitfalls that accounted for 35 (57%) of overall captures across the other sites. Sites 1 and 3 supported the densest vegetation of Narrow-leaf Mulga and this may have been significant. Narrow-leaf Mulga was a smaller component of the vegetation at Site 4, where eucalypts dominated, and the leaf-litter beneath the Mulga appeared to be particularly rich in reptiles. Site 5 had the least vegetation and is probably also prone to occasional flooding, which would not favour reptiles. The general observation can probably be made that reptiles rely heavily on cover, such as leaf-litter, but intensive studies would probably reveal that some species are restricted to particular soil or vegetation types.

The results of hand-searching (Table 8) tend to support the results of trapping, with large numbers of specimens found in areas of Narrow-leaf Mulga on loam plain, especially in the south of the lease. However, hand-searching is a difficult technique to standardise and its main contribution in a brief fauna survey is to record species that are not readily found by other methods. Four species (*Ctenotus schomburgkii, Delma australis, Lerista muelleri* and *Varanus panoptes*) were recorded only during hand-searching.

Birds

On the basis of known species distributions and available habitats, 138 bird species may occur at Blue Hills (Table 4). This includes species, such as some waterbirds, that may be irregular visitors. Many other waterbirds could occur as vagrants in the area but have not been included in the species list. Such species, however, could become regular visitors if, for example, mining activity created water bodies such as dams or flooded mine pits.

Only 33 bird species were observed during the survey, which is a low number given the period of time and number of personnel present, most of whom are experienced at bird identification. This probably reflects low rainfall experienced in the region over the previous several years, as noticeably absent were nomadic species that typically move around the inland opportunistically. Also absent were some migrants that would probably be present only in spring. Many of the species present were residents,

such as thornbills and fairy-wrens, or species that range widely, such as the Australian Raven and Galah.

Bird censussing was attempted but was discontinued after one hour of survey during which time 2 Chestnut-rumped Thornbills were observed in an area of *ca.* 10ha. Observations on birds when checking trapping sites also revealed extraordinarily low levels of abundance (see Table 8).

Two bird species are considered extinct in the region: the Night Parrot and the Thick-billed Grasswren (see Table 6). Both are of Conservation Significance Level 1 and while they are not expected to be present, any possible sightings would be of great interest and should be reported to the Department of conservation and Land Management.

Species expected to be present and of conservation significance are discussed below:

Conservation Significance Level 1

Malleefowl
The Malleefowl is classified as Vulnerable under the EPBC Act, the WA Wildlife Conservation Act and by Garnett and Crowley (2000). It has declined due to clearing for agriculture and predation by Foxes (Garnett and Crowley 2000). No mounds were located despite extensive walking through the area, so it would appear that the species, if present, occurs only at a very low density. The most suitable habitat for the species was west of the southern end of the lease, in an area of eucalypt woodland.

Peregrine Falcon
The Peregrine Falcon is classified as Specially Protected Fauna under the WA Wildlife Conservation Act. Individuals forage widely but nest sites, located either on cliffs or in the abandoned nests of birds such as the Australian Raven, located in large trees, are important. There appeared to be no nests along the rocky ridge of the hills and no falcons present at the time of the survey, but the species may be present in some years. There were Raven or Crow nests in large eucalypts at site 4.

Major Mitchell's Cockatoo
Major Mitchell's Cockatoo is classified as Specially Protected Fauna under the WA Wildlife Conservation Act. Although not observed, suitable habitat was present, particularly areas of mixed eucalypts and mulga, and the species is probably a regular visitor. It may breed in hollows of large eucalypts south of the hills.

Fork-tailed Swift
The Fork-tailed Swift is classified as migratory under the JAMBA, CAMBA and Bonn Convention, and as such is protected under the EPBC Act. Its listing under JAMBA also means it is protected under the WA Wildlife Conservation Act. This is an aerial species that can be expected to be present in the study area on an irregular basis.

Rainbow Bee-eater
The Rainbow Bee-eater is classified as migratory under the JAMBA, CAMBA and Bonn Convention, and as such is protected under the EPBC Act. Its listing under

JAMBA also means it is protected under the WA Wildlife Conservation Act. It was present during the field survey and is probably a regular breeding visitor from September to March annually. It nests in burrows in sandy or sandy-loam soils.

Slender-billed Thornbill
The Slender-billed Thornbill is listed as Vulnerable under the EPBC Act. It is associated with salt lake vegetation such as occurs to the north and south of the project area, but it could move into the project area.

Conservation Significance Level 2
Grey Falcon
The Grey Flacon is listed as Priority 4 by the DCLM. It tends to occur in very open eucalypt woodland and some areas south-west of the lease area may be suitable habitat.

Australian Bustard
The Australian Bustard is classified as Priority 4 by the DCLM and Near Threatened by Garnett and Crawley (2000). Hunting, habitat loss and possibly predation by Foxes have contributed to its decline (Garnett and Crowley 2000). The project area appeared to be of limited suitability for the species, which favours open habitats, but it probably visits the area occasionally.

Bush Stone-curlew
The Bush Stone-curlew is classified as Priority 4 by the DCLM and Near Threatened by Garnett and Crawley (2000). It has declined due to land clearing and predation by Foxes (Garnett and Crowley 2000). Although not recorded it is likely to be present, particularly in areas of eucalypt and mulga on the plain in the south of the lease.

Masked Owl (southern race) *Tyto novaehollandiae novaehollandiae*
The DCLM threatened fauna database contained one record of this species from Golden Grove in 1964. The record was considered to be reliable, but the species is usually associated with woodlands and forests of tall trees and it seems unlikely that it would occur regularly a Blue Hills. The southern race of the Masked Owl is classified as Priority 3 by DCLM.

Shy Heathwren (western) *Hylacola cauta whitlocki*
The Shy Heathwren (western) is classified as Priority 4 by the DCLM and Near Threatened by Garnett and Crowley (2000). Suitable habitat for this taxon is present, particularly along the rocky ridge and lower hills where the vegetation consists of dense shrubs.

Rufous Fieldwren (western wheatbelt) *Calamanthus campestris montanellus*
The Rufous Fieldwren (western wheatbelt) is classified as Priority 4 by the DCLM and Near Threatened by Garnett and Crowley (2000). It tends to occur in low heath and therefore there was little suitable habitat present in the study area.

White-browed Babbler (western wheatbelt) *Pomatostomus superciliosus ashbyi*
The White-browed Babbler (western wheatbelt) is classified as Priority 4 by the DCLM and Near Threatened by Garnett and Crowley (2000). It was recorded during the field survey near Site 4.

Crested Bellbird (southern) *Oreoica gutturalis gutturalis*
The Crested Bellbird (southern) is classified as Priority 4 by the DCLM and Near Threatened by Garnett and Crowley (2000). It was not recorded during the field survey, although it is usually easily detected because of its distinctive call. The frequency of calling in late summer, however, may be low, and as the habitat was suitable the bellbird is almost certainly present. This and the previous three taxa have all suffered habitat loss due to clearing for agriculture, and the significant taxon is the Wheatbelt race. Because of the southerly location of Blue Hills, in each case the race present or that may be present could be the Wheatbelt race, or could be transitional with the more widespread inland form of the species.

Conservation Significance Level 3
Three species recorded during the survey, the Golden Whistler, Scarlet Robin and Rufous Treecreeper, were at the northern limit of their range in the area. The Whistler and Robin were in dense Mulga on the southern slopes of the Blue Hills. It could be speculated that Blue Hills and other ridges in the Murchison could support outlying resident or migratory populations of species that occur mainly to the south of the region. The Treecreeper was in eucalypt woodland just to the south-west of the lease but the birds almost certainly range into similar woodlands within the lease area.

Mammals

On the basis of known species distributions and available habitats, 30 mammal species may occur in the study area, including 4 that are introduced (see Table 5). A further 18 mammal species are considered to be extinct from the region (see Table 6). This high level of extinction is typical for terrestrial mammals in Australia and is due to factors such as predation by Foxes, altered fire regimes and competition for food with domestic livestock (Burbidge and McKenzie 1989).

Few mammals were recorded during the study and even bats were difficult to locate, although conditions were generally poor for detecting bats because of strong winds at night. All the mammal species that were recorded are widespread, although there was abundant evidence of stick-nest rats *Leporillus* spp. in caves along the ridge of blue Hills. These were all abandoned nests and there was no sign of recent occupation. One bat, probably *Vespadelus* sp., was seen in a small cave, but no other usage of caves by bats was documented. Usage may be greater in winter, however, when bats make greater use of shelter that provides them with a constant ambient temperature than they do in summer. The record of the hopping mouse *Notomys mitchelli* is unconfirmed because it was based on burrows that, while distinctive, may not currently be in use by that species. Personnel at Karara Station, however, confirmed that hopping mice are occasionally seen in the region.

Mammal species of conservation significance are discussed below.

Conservation Significance Level 1
All species of Conservation Significance Level 1 that may have occurred in the study area are considered to be at least locally extinct. These are listed in Table 6.

Conservation Significance Level 2
Greater Long-eared Bat (central form)
The Greater Long-eared Bat (central form) is classified as Priority 4 by the DCLM and Lower Risk (Near Threatened) by Duncan *et al.* (1999). This is a tree-roosting bat that may use hollows in eucalypts of the southern slopes and plains south of Blue Hills.

Conservation Significance Level 3
Three species of Conservation Significance Level 3 may be present. The Kultarr is classified as Data Deficient by Maxwell *et al.* (1996) but is not listed elsewhere. Woolley's False Antechinus is known from some locations in the Murchison and its population seems to be fragmented to rocky areas, so an isolated population may occur on the Blue Hills. The Western Pygmy-possum would be at the northern limit of its range in the area and would be confined to areas of eucalypt woodland. The failure to record any of these species does not mean that they are not present, as they could be at low densities or might be easier to detect at other times of the year.

Invertebrates

Although this survey was directed towards developing an understanding of the vertebrate fauna of the study area, some invertebrates were also collected. This collection was confined to groups where the technical expertise exists to enable identification to be carried out, and to groups that are known for their abundance of short-range endemics. These are species with restricted distributions that are often associated with mesic refugia such as rocky hills in the Murchison. Groups that were collected included mygalomorph spiders, isopods (slaters), scorpions, land snails and centipedes. Millipedes also include short-range endemic species, but no millipedes were encountered during the survey.

Specimens have been lodged with the WA Museum but identifications are not yet available. One scorpion, however, was immediately noted to be an undescribed species. Because of inadequate sampling of invertebrates, it is not known if this undescribed scorpion is confined to the Blue Hills or if it occurs in association with rocky hills throughout the Murchison.

Discussion and Conclusions

While a single survey can only be expected to detect the most abundant vertebrate species in an area, the impression gained from the present study is that the Blue Hills supports a depauperate vertebrate fauna. This is partly due to the historical loss of mammals and perhaps the seasonal absence of some birds, but low rainfall over the previous several years was probably also a contributing factor.

The Blue Hills area provides a range of habitats for vertebrate fauna and while Narrow-leaf Mulga on loam soil appeared to be richest in reptiles, all habitats can be

considered to be important. The most significant features of the area with respect to fauna can be summarised as follows:

- Rocky hills and adjacent rocky foothills and slopes. Caves provide seasonal shelter for bats and Euros, while the general habitat can be expected to support species that do not occur in the woodlands and shrublands on the surrounding plains. For example, endemic invertebrates are very likely to be present in the rocky hills, while vertebrate species such as the skink *Cyclodomorphus branchialis* (Priority 2), Golden Whistler and Scarlet Robin may be regionally restricted to the rocky hills and adjacent rocky slopes.
- Eucalypt and Mulga woodlands on loam soils. These appeared to be particularly rich in reptiles, especially where Mulga predominated, but most species are very widespread. An exception may be the dragon *Caimanops amphiboluroides*, which seemed to be unusually abundant in areas of Mulga but is apparently infrequently reported in general fauna surveys. The eucalypts were notable for having many hollow limbs that were being used by Owlet-nightjars and are probably also used by bats and owls.
- Low-lying areas of cracking red loam, with *Melaleuca lignum*. Such areas are probably subject to irregular inundation so may occasionally support waterbirds. While not notable for fauna during the survey, the distinctive soil type may be important for some short-range endemic invertebrates.

With respect to impacts of any proposed mining development upon fauna of the blue Hills region, the following issues should be considered:

- Roads, mining and other developments have the potential to affect surface and sub-surface hydrology in the area. Mulga is usually very sensitive to such impacts, while the most extensive eucalypt woodlands were at the lowest point south-west of the Blue Hills, outside the lease area but probably also sensitive to hydrological impacts.
- Many of the bird, reptile and mammal species in the region shelter in crevices or hollows in shrubs and trees. Even dead trees are valuable habitat and should be protected whenever possible. The collection of firewood should be prohibited.
- Caves in the Blue Hills are important for some fauna and contain historically significant nests of stick-nest rats. Access to these caves by personnel should be controlled.
- Feral animals are present in the area and can have adverse impacts upon native wildlife. Feral animals should not be encouraged.

Table 1.. Description of fauna sampling sites. Map datum used was WGS 84.

Site	Coordinates	Description
1	486 240E, 6 776 107N	Dense shrubland of Narrow-leaf Mulga *Acacia linophylla* on plain of red loam.
2	489 355E, 6 766 668N	Rocky ridge of banded ironstone. Shallow, rocky soil supported a mixed shrubland of *Acacia*, *Allocasuarina* and Myrtaceae species.
3	489 510E, 6 776 392N	Slopes of mixed red loam and rocky soil at base of rocky ridge. Vegetation mainly a dense shrubland of Narrow-leaf Mulga.
4	489 738E, 6 776 082N	Red loam plain supporting a low woodland of woollybutt eucalypts with a mid-storey of Narrow-leaf Mulga. A lot of dead wood on the ground.
5	486 802E, 6 775 651N	Loamy clay soils, forming Gilgai mounds in places, with a low woodland of Melaleuca grading into lignum shrubland with scattered, small eucalypts. Subject to irregular inundation.

Table 2. Amphibians that are expected to occur in the Blue Hills area. Species recorded during the field survey are indicated by (+) and species recorded by the WA Museum are indicated by (WAM). Species not listed by WAM or recorded during the field survey have been included on the basis of general patterns of distribution and habitat suitability.

Species		Status	Recorded
Myobatrachidae (burrowing frogs)			
	Limnodynastes spenceri		WAM
Trilling Frog	*Neobatrachus* aff. *centralis*	+	
Kunapulari Frog	*Neobatrachus kunapalari*		WAM
Humming Frog	*Neobatrachus pelabatoides*		
Shoemaker Frog	*Neobatrachus sutor*		WAM
Wilsmore's Frog	*Neobatrachus wilsmorei*		WAM
Western Toadlet	*Pseudophryne occidentalis*		WAM
Hylidae (tree-frogs)			
Water-holding Frog	*Cyclorana platycephala*		WAM

Table 3. Reptiles that are expected to occur in the Blue Hills area. Species recorded during the field survey are indicated by (+) and species recorded by the WA Museum are indicated by (WAM). Species not listed by WAM or recorded during the field survey have been included on the basis of general patterns of distribution and habitat suitability. Conservation significance is also indicated, as discussed in Methods.

Species		Status	Recorded
Gekkonidae (geckoes)			
	Diplodactylus granariensis		
	Diplodactylus maini		
	Diplodactylus pulcher	+	WAM
	Diplodactylus squarrosus		WAM
Tree Dtella	*Gehyra variegata*	+	WAM
	Gehyra pupurascens		
Bynoe's Gecko	*Heteronotia binoei*	+	WAM
	Nephrurus vertebralis		
	Oedura reticulata	(CS2)	WAM
Beaked Gecko	*Rhynchoedura ornata*		WAM
	Strophurus assimilis		WAM
Pygopodidae (legless-lizards)			
	Delma australis	+	WAM
Burton's Legless-Lizard	*Lialis burtonis*		WAM
Hooded Scaley-foot	*Pygopus nigriceps*		WAM

Table 3 (cont.)

Species		Status	Recorded
Agamidae (dragon lizards)			
	Caimanops amphiboluroides	+	
	Ctenophorus nuchalis (inermis)		WAM
Western Netted Dragon	*Ctenophorus reticulatus*	+	WAM
Lozenge-marked Dragon	*Ctenophorus scutulatus*	+	WAM
Thorny Devil	*Moloch horridus*		WAM
Western Bearded Dragon	*Pogona minor*	+	WAM
Scincidae (skink lizards)			
	Cryptoblepharus carnabyi		WAM
Fence Skink	*Cryptoblepharus plagiocephalus*	+	
	Ctenotus mimetes	+	WAM
	Ctenotus schomburgkii	+	WAM
	Ctenotus severus		WAM
	Ctenotus uber	+	WAM
	Cyclodomorphus branchialis	+ (CS2)	WAM
	Egernia depressa	+	WAM
	Egernia inornata		WAM
Western Spiny-tailed Skink	*Egernia stokesii*	(CS1)	WAM
Narrow-banded Sand-swimmer	*Eremiascincus richardsonii*	+	WAM
	Lerista gerrardii	+	WAM
	Lerista macropisthopus		
	Lerista muelleri	+	WAM
	Lerista nicholsi		WAM
Grey's Skink	*Menetia greyii*	+	WAM
	Morethia butleri	+	WAM
	Morethia obscura		
Blue-tongued Lizard	*Tiliqua occipitalis*		
Varanidae (monitor-lizards)			
	Varanus caudolineatus	+	WAM
Gould's Monitor	*Varanus gouldii*	+	WAM
	Varanus panoptes	+	WAM
Black-tailed Tree Monitor	*Varanus tristis*		WAM
Boidae (pythons)			
Stimson's Python	*Antaresia stimsoni*		
Carpet Python	*Morelia spilota*		

Table 3 (cont.)

Species		Status	Recorded
Typhlopidae (blind-snakes)			
	Ramphotyphlops australis		
	Ramphotyphlops hamatus	+	
	Ramphotyphlops waitii		WAM
Elapidae (front-fanged snakes)			
Yellow-faced Whipsnake	*Demansia psammophis*		
Moon Snake	*Furina ornata*		
Monk Snake	*Parasuta monachus*		WAM
Mulga Snake	*Pseudechis australis*		WAM
Butler's (spotted) Mulga Snake	*Pseudechis butleri*		WAM
Ringed Brown Snake	*Pseudonaja modesta*		WAM
Gwardar	*Pseudonaja nuchalis*		
Jan's Banded Snake	*Simoselaps bertholdi*		WAM
Rosen's Snake	*Suta fasciata*		WAM

Table 4. Birds that are expected to occur in the Blue Hills area. Species recorded during the field survey are indicated by (+), species recorded on the Birds Australia atlas database are indicated by (BA) and species recorded by the WA Museum are indicated by (WAM). Conservation significance is indicated as described in Methods.

Species		Status	Recorded
Dromaiidae (emus)			
Emu	*Dromaius novaehollandiae*	+	BA WAM
Megapodiidae (mound-builders)			
Mallee Fowl	*Leipoa ocellata*	CS1	BA WAM
Phasianidae (pheasants and quails)			
Stubble Quail	*Coturnix pectoralis*		BA
Accipitridae (kites, hawks and eagles)			
Black-shouldered Kite	*Elanus notatus*		BA
Square-tailed Kite	*Lophoictinia isura*		BA
Black Kite	*Milvus migrans*		
Black-breasted Buzzard	*Hamirostra melanosternon*		
Whistling Kite	*Haliastur sphenurus*		BA
Spotted Harrier	*Circus assimilis*		BA
Brown Goshawk	*Accipiter fasciatus*		BA
Collared Sparrowhawk	*Accipiter cirrhocephalus*		BA
Wedge-tailed Eagle	*Aquila audax*	+	BA WAM
Little Eagle	*Hieraaetus morphnoides*		
Falconidae (falcons)			
Peregrine Falcon	*Falco peregrinus*	CS1	BA
Australian Hobby	*Falco longipennis*		BA
Grey Falcon	*Falco hypoleucos*	CS2	
Black Falcon	*Falco subniger*		
Brown Falcon	*Falco berigora*		BA WAM
Nankeen Kestrel	*Falco cenchroides*		BA
Turnicidae (button-quails)			
Painted Button-quail	*Turnix varia*		
Little Button-quail	*Turnix velox*		BA
Rallidae (crakes and rails)			
Black-tailed Native-hen	*Gallinula ventralis*		BA
Otidae (bustards)			
Australian Bustard	*Ardeotis australis*	CS2	BA
Burhinidae (stone-curlews)			
Bush Stone-curlew	*Burhinus grallarius*	CS2	BA
Charadriidae (lapwings and plovers)			
Inland Dotterel	*Charadrius australis*		BA
Banded Lapwing	*Vanellus tricolor*		BA WAM
Columbidae (pigeons and doves)			
Common Bronzewing	*Phaps chalcoptera*	+	BA WAM
Crested Pigeon	*Ocyphaps lophotes*		BA WAM
Diamond Dove	*Geopelia cuneata*		BA

Table 4 (cont.)

Species		Status	Recorded
Cacatuidae (cockatoos)			
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*		BA
Galah	*Cacatua roseicapilla*	+	BA WAM
Western Corella	*Cacatua pastinator*		BA
Cockatiel	*Nymphicus hollandicus*		BA
Little Corella	*Cacatua sanguinea*		BA
Major Mitchell's Cockatoo	*Cacatua leadbeateri*	CS1	BA WAM
Psittacidae (lorikeets and parrots)			
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*		BA
Regent Parrot	*Polytelis anthopeplus*		BA WAM
Budgerigar	*Melopsittacus undulatus*		BA
Australian Ringneck	*Barnardius zonarius*	+	BA WAM
Scarlet-chested Parrot	*Neophema splendida*		
Mulga Parrot	*Psephotus varius*		BA
Bourke's Parrot	*Neophema bourkii*		BA WAM
Cuculidae (cuckoos)			
Pallid Cuckoo	*Cuculus pallidus*		BA
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*		BA
Black-eared Cuckoo	*Chrysococcyx osculans*		BA WAM
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*		BA
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		BA
Strigidae (hawk-owls)			
Southern Boobook Owl	*Ninox novaeseelandiae*		BA
Tytonidae (barn owls)			
Masked Owl	*Tyto novaehiollandiae*	CS2	DCLM
Barn Owl	*Tyto alba*		BA
Podargidae (frogmouths)			
Tawny Frogmouth	*Podargus strigoides*	+	BA WAM
Aegothelidae (owlet-nightjars)			
Australian Owlet-nightjar	*Aegotheles cristatus*	+	BA WAM
Caprimulgidae (nightjars)			
Spotted Nightjar	*Eurostopodus argus*	+	BA
Apodidae (swifts)			
Fork-tailed Swift	*Apus pacificus*	CS1	BA
Halcyonidae (forest kingfishers)			
Red-backed Kingfisher	*Todiramphus pyrrhopygia*		BA
Sacred Kingfisher	*Todiramphus sanctus*		BA
Meropidae (bee-eaters)			
Rainbow Bee-eater	*Merops ornatus*	+ CS1	BA
Climacteridae (treecreepers)			
Rufous Treecreeper	*Climacteris rufa*	+ CS3	BA WAM

Table 4 (cont.)

Species		Status	Recorded
Maluridae (fairy-wrens)			
Splendid Fairy-wren	*Malurus splendens*	+	BA WAM
Variegated Fairy-wren	*Malurus lamberti*		BA
Blue-breasted Fairy-wren	*Malurus pulcherrimus*		BA
White-winged Fairy-wren	*Malurus leucopterus*		BA
Pardalotidae (pardalotes)			
Striated Pardalote	*Pardalotus striatus*		BA WAM
White-browed Scrubwren	*Sericornis frontalis*		BA
Shy Heathwren	*Hylacola cauta*	CS2	
Rufous Fieldwren	*Calamanthus campestris*	CS2	
Redthroat	*Pyrrholaemus brunneus*	+	BA
Weebill	*Smicrornis brevirostris*	+	BA
Western Gerygone	*Gerygone fusca*		BA WAM
Inland Thornbill	*Acanthiza apicalis*	+	BA WAM
Slender-billed Thornbill	*Acanthiza iredalei*	CS1	
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	+	BA WAM
Slaty-backed Thornbill	*Acanthiza robustirostris*		BA WAM
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		BA WAM
Southern Whiteface	*Aphelocephala leucopsis*		BA WAM
Meliphagidae (honeyeaters)			
Red Wattlebird	*Anthochaera carunculata*		BA
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	+	BA WAM
Yellow-throated Miner	*Manorina flavigula*	+	BA WAM
Singing Honeyeater	*Lichenostomus virescens*	+	BA
White-eared Honeyeater	*Lichenostomus leucotis*		BA
Yellow-plumed Honeyeater	*Lichenostomus ornatus*		BA
Grey-fronted Honeyeater	*Lichenostomus plumulus*		BA WAM
Brown-headed Honeyeater	*Melithreptus brevirostris*		BA
Brown Honeyeater	*Lichmera indistincta*		BA
White-cheeked Honeyeater	*Phylidonyris nigra*		BA
White-fronted Honeyeater	*Phylidonyris albifrons*	+	BA
Tawny-crowned Honeyeater	*Phylidonyris melanops*		BA
Grey Honeyeater	*Conopophila whitei*		BA WAM
Black Honeyeater	*Certhionyx niger*		BA
Pied Honeyeater	*Certhionyx variegatus*		BA WAM
Crimson Chat	*Epthianura tricolor*		BA
Orange Chat	*Epthianura aurifrons*		
White-fronted Chat	*Epthianura albifrons*		BA
Petroicidae (Australian robins)			
Jacky Winter	*Microeca leucophaea*		BA
Scarlet Robin	*Petroica multicolor*	+ CS3	
Red-capped Robin	*Petroica goodenovii*	+	BA WAM
Hooded Robin	*Melanodryas cucullata*		BA
Western Yellow Robin	*Eopsaltria griseogularis*	+	BA
Southern Scrub-robin	*Drymodes brunneopygia*		BA

Table 4 (cont.)

Species		Status	Recorded
Pomatostomidae (Australian babblers)			
Grey-crowned Babbler	*Pomatostomus temporalis*		BA
White-browed Babbler	*Pomatostomus superciliosus*	+ CS2	BA WAM
Cinclosomatidae (quail-thrushes and allies)			
Chiming Wedgebill	*Psophodes occidentalis*		BA
Chestnut Quail-thrush	*Cinclosoma castanotus*		BA WAM
Chestnut-breasted Quailthrush	*Cinclosoma castaneothorax*		BA WAM
Neosittidae (sittellas)			
Varied Sittella	*Daphoenositta chrysoptera*		BA WAM
Pachycephalidae (whistlers)			
Crested Bellbird	*Oreoica gutturalis*	+	BA WAM
Gilbert's Whistler	*Pachycephala inornata*		WAM
Golden Whistler	*Pachycephala pectoralis*	+ CS3	BA
Rufous Whistler	*Pachycephala rufiventris*		BA WAM
Grey Shrike-thrush	*Colluricincla harmonica*	+	BA
Dicruridae (flycatchers)			
Restless Flycatcher	*Myiagra inquieta*		
Magpie-lark	*Grallina cyanoleuca*		BA WAM
Grey Fantail	*Rhipidura fuliginosa*		BA WAM
Willie Wagtail	*Rhipidura leucophrys*		BA
Campephagidae (cuckoo-shrikes)			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	+	BA
Ground Cuckoo-shrike	*Coracina maxima*		BA
White-winged Triller	*Lalage sueurii*		BA
Artamidae (woodswallows)			
Masked Woodswallow	*Artamus personatus*		BA
Black-faced Woodswallow	*Artamus cinereus*		BA
Little Woodswallow	*Artamus minor*	+	BA
White-browed Woodswallow	*Artamus superciliosus*		WAM
Grey Butcherbird	*Cracticus torquatus*	+	BA
Pied Butcherbird	*Cracticus nigrogularis*	+	BA WAM
Australian Magpie	*Gymnorhina tibicen*		BA WAM
Grey Currawong	*Strepera versicolor*	+	BA
Corvidae (ravens and crows)			
Australian Raven	*Corvus coronoides*	+	BA WAM
Little Crow	*Corvus bennetti*	+	BA WAM
Torresian Crow	*Corvus orru*		BA WAM
Motacillidae (pipits and true wagtails)			
Richard's Pipit	*Anthus novaeseelandiae*		BA
Passeridae (finches and allies)			
Zebra Finch	*Taeniopygia guttata*		BA
Dicaeidae (flower-peckers)			
Mistletoebird	*Dicaeum hirundinaceum*		BA

Table 4 (cont.)

Species		Status	Recorded
Hirundinidae (swallows)			
White-backed Swallow	*Cheramoeca leucosternus*		BA
Welcome Swallow	*Hirundo neoxena*		BA
Tree Martin	*Hirundo nigricans*		BA
Fairy Martin	*Hirundo ariel*		BA
Sylviidae (Old World warblers)			
Rufous Songlark	*Cincloramphus mathewsi*		BA
Brown Songlark	*Cincloramphus cruralis*		BA
Zosteropidae (white-eyes)			
Silvereye	*Zosterops lateralis*		BA WAM

Table 5. Mammals that are expected to occur in the Blue Hills area. Species recorded during the field survey are indicated by (+) and species recorded by the WA Museum are indicated by (WAM).

Species		Status	Recorded
Tachyglossidae (echidnas)			
Echidna	*Tachyglossus aculeatus*	+	WAM
Dasyuridae (carnivorous marsupials)			
Kultarr or Wuhl-Wuhl	*Antechinomys laniger*		WAM
Ride's Ningaui	*Ningaui ridei*		WAM
Wooley's False Antechinus	*Pseudantechinus woolleyae*	CS3	WAM
Fat-tailed Dunnart	*Sminthopsis crassicaudata*		WAM
Little Long-tailed Dunnart	*Sminthopsis dolichura*	+	WAM
Burramyidae (pygmy-possums)			
Western Pygmy-possum	*Cercartetus concinnus*	CS3	
Macropodidae (kangaroos and wallabies)			
Euro	*Macropus robustus*	+	
Red Kangaroo	*Macropus rufus*	+	WAM
Western Grey Kangaroo	*Macropus fuliginosus*		
Muridae (rodents)			
House Mouse	*Mus musculus*		WAM
Mitchell's Hopping-mouse	*Notomys mitchelli*	+?	
Sandy Inland Mouse	*Pseudomys hermannsburgensis*		WAM
Emballonuridae (sheathtail bats)			
Hill's Sheathtail Bat	*Taphozous hilli*		
Vespertilionidae (evening bats)			
Gould's Wattled Bat	*Chalinolobus gouldii*	+	WAM
Chocolate Wattled Bat	*Chalinolobus morio*		
Lesser Long-eared Bat	*Nyctophilus geoffroyi*		WAM
Greater Long-eared Bat	*Nyctophilus timoriensis*		
Inland Broad-nosed Bat	*Scotorepens balstoni*		
Inland Forest Bat	*Vespadelus baverstocki*		WAM
Inland Cave Bat	*Vespadelus finlaysoni*		WAM
Southern Forest Bat	*Vespadelus regulus*	+?	
Molossidae (freetail bats)			
Inland Freetail Bat	*Mormopterus planiceps* * sp. 3		
Western Freetail Bat	*Mormopterus planiceps* * sp. 4		
White-striped Mastiff Bat	*Tadarida australis*	+	WAM
Canidae (dogs and foxes)			
Dingo	*Canis familiaris dingo*		
Red Fox	*Vulpes vulpes*	+ (Int)	
Felidae (cats)			
Feral Cat	*Felis catus*	+ (Int)	
Bovidae (horned ruminants)			
Goat	*Capra hircus*	+ (Int)	
Leporidae (rabbits)			
European Rabbit	*Oryctolagus cuniculus*	+ (Int)	

* Species boundaries partially revised in Adams *et al.* (1988), with further revision in progress.

Table 6. Vertebrate fauna species considered extinct in the region.

Species		Status
Psitaccidae (parrots and lorikeets)		
Night Parrot	*Pezoporus occidentalis*	CS1
Maluridae (fairy–wrens and allies)		
Thick-billed Grasswren (west)	*Amytornis textilis textilis*	CS2
Dasyuridae		
Chuditch	*Dasyurus geoffroii*	CS1
Red-tailed Phascogale	*Phascogale calura*	CS1
Myrmecobiidae (Numbat)		
Numbat	*Myrmecobius fasciatus*	CS1
Peramelidae (bandicoots and bilbies)		
Marl, Western Barred Bandicoot	*Perameles bougainville*	CS1
Bilby	*Macrotis lagotis*	CS1
Pig-footed Bandicoot	*Chaeropus ecaudatus*	Extinct
Phalangeridae (brushtail-possums)		
Common Brushtail Possum	*Trichosurus vulpecula*	
Potoridae (bettongs and potoroos)		
Burrowing Bettong	*Bettongia lesueur*	CS1
Woylie	*Bettongia penicillata*	CS1
Macropodidae (kangaroos and wallabies)		
Banded Hare-wallaby	*Lagostrophus fasciatus*	CS1
Rufous Hare-wallaby	*Lagorchestes hirsutus*	CS1
Crescent Nailtail Wallaby	*Onychogalea lunata*	Extinct
Black-footed Rock-Wallaby	*Petrogale lateralis*	CS1
Megadermatidae (false vampires)		
Ghost Bat	*Megaderma gigas*	CS2
Muridae (rodents)		
Long-tailed Hopping Mouse	*Notomys longicaudatus*	Extinct
Pale Field Rat	*Rattus tunneyi*	
Wopilkara, Greater Stick-nest Rat	*Leporillus conditor*	CS1
Djooyalpi, Lesser Stick-nest Rat	*Leporillus apicalis*	Extinct
Shark Bay Mouse	*Pseudomys fieldi*	CS1

Table 7. Numbers of captures (excluding recaptures) of frogs, reptiles and mammals on the trapping grids at Sites 1 to 5.

Species	Site 1	Site 2	Site 3	Site 4	Site 5
Amphibians					
Neobatrachus aff. *centralis*	1				
Reptiles					
Diplodactylus pulcher	1		5	1	1
Gehyra variegata	1			3	
Heteronotia binoei		2		1	1
Caimanops amphiboluroides	2		1		1
Ctenophorus scutulatus	6		1		
Ctenophorus reticulatus	1				
Pogona minor			2		
Varanus caudolineatus	2				
Varanus gouldii					1
Cryptoblepharus plagiocephalus			1		
Ctenotus mimetes	5				
Ctenotus uber	5	5	8	1	
Cyclodomorphus branchialis		1	1		
Egernia depressa	1				
Eremiacincus richardsoni				1	1
Lerista gerrardi			1		
Menetia greyii			1	2	
Morethia butleri				1	
Ramphotyphlops hamatus	1				
Mammals					
Sminthopsis dolichura			1	1	3
Number of species	11	3	10	8	6
Number of frog specimens	1				
Number of reptile specimens	25	8	21	10	5
Number of mammal specimens			1	1	3

WA Museum registration numbers of specimens collected:

R154635 *Caimanops amphiboluroides*
R154636 *Ctenophorus scutulatus*
R154637 *Ctenophorus reticulatus*
R154638 *Ctenotus uber uber*
R154639 *Menetia "greyii"* (considered to be a species complex, currently under revision).

Table 8. Numbers of captures of reptiles during hand-searching at each site where hand-searching was carried out.

Species	Site 1	Site 2	Site 4	south of lease
Effort:	1.5 hours	1.5 hours	3 hours	4.5 hours
Gehyra variegata		1	1	
Heteronotia binoei		1	1	
Delma australis	1	1		2
Caimanops amphiboluroides				2
Ctenophorus scutulatus	1		1	4
Ctenophorus reticulatus				2
Varanus panoptes				1
Ctenotus schomburgkii				1
Ctenotus uber				2
Egernia depressa				1
Lerista gerrardi	1		3	3
Lerista muelleri	1			1
Number of species	4	3	4	10

Table 9. Summary of daily bird observations for Sites 1 to 5. Bird records were kept on 4 mornings at each site, so the values represent the number of mornings, out of a maximum of 4, on which each bird species was recorded at each site.

Species	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**
Australian Ringneck					1
Rainbow Bee-eater					1
Splendid Fairy-wren	1		1	1	
Redthroat			2		
Chestnut-rumped Thornbill	1			1	2
Spiny-cheeked Honeyeater					1
Singing Honeyeater	1	1	1	1	
Red-capped Robin					1
Grey Shrike-thrush	1	1	2	1	
Black-faced Cuckoo-shrike					1
Little Woodswallow				1	
Australian Raven					2
Pied Butcherbird					1
Grey Butcherbird	1		1	1	
Number of species:	**5**	**2**	**5**	**6**	**7**
Number of records:	**5**	**2**	**7**	**6**	**9**

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APPENDIX ONE. Categories used in the assessment of conservation status.

Environmental Protection and Biodiversity Conservation (EPBC) Act and the WA Wildlife Conservation Act (categories from IUCN, based on review by Mace and Stuart (1994)).

Extinct. Taxa not definitely located in the wild during the past 50 years.

Extinct in the Wild. Taxa known to survive only in captivity.

Critically Endangered. Taxa facing an extremely high risk of extinction in the wild in the immediate future.

Endangered. Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable. Taxa facing a high risk of extinction in the wild in the medium-term future.

Near Threatened. Taxa that risk becoming Vulnerable in the wild.

Conservation Dependent. Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Data Deficient (Insufficiently Known). Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Least Concern. Taxa that are not Threatened.

WA Department of Conservation and Land Management Priority species (species not listed under the Conservation Act, but for which there is some concern).

Priority 1. Taxa with few, poorly known populations on threatened lands.

Priority 2. Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.

Priority 3. Taxa with several, poorly known populations, some on conservation lands.

Priority 4. Taxa in need of monitoring.

APPENDIX TWO. Capture records and morphometric data for all for frog, reptile and mammal captures caught in the trapping grids at Blue Hills, 10-16 February 2004.

Column abbreviations are:
Trap = trap type (P = pitfall, F = funnel); Wt = Weight (g); Crn = Crown (mm); TL = Tail length (mm); Pes = Pes length (mm); SVL = Snout to vent length (mm); Tot = total length (mm).
Abbreviations in notes are:
npy = no pouch young; lac = lactating; regrown = regrown tail; Ma = male; Fe = female.

A. REPTILES AND AMPHIBIANS

Site	Date	Trap	Species	Wt	SVL	Tot	Notes
1	11/02	P	*D. pulcher*		33	48	
1	11/02	P	*C. amphiboluroides*		91	260	
1	11/02	F	C. scutulatus	7.0	60	212	
1	11/02	P	G. variegata		43	88	
1	12/02	F	*V. caudolineatus*	12.5	115	249	
1	12/02	F	*C. mimetes*				
1	12/02	P	*C. scutulatus*	8.5	62	116	
1	12/02	F	*C. uber*	7.0	75	209	
1	12/02	F	*C. uber*	2.0	49	140	
1	12/02	F	*V. caudolineatus*	2.0	57	101	
1	12/02	P	*C. mimetes*	11.5	90	274	
1	13/02	P	*N.* aff. *centralis*		50		
1	13/02	F	*C. scutulatus*	6.0	62	214	
1	13/02	P	*C. uber*	2.4	52	153	
1	13/02	P	*C. mimetes*	8.5	73	240	
1	13/02	F	*C. reticulatus*	5.1	57	131	
1	13/02	F	*R. hamatus*	14.0	290	300	
1	14/02	F	*C. mimetes*	1.8	43	144	
1	14/02	F	*C. uber*	8.5	75	215	
1	14/02	F	*E. depressa*	34.0	85	115	
1	14/02	F	*C. mimetes*	13.5	85	290	
1	14/02	P	*C. amphiboluroides*	21.0	87	232	gravid
1	14/02	F	*C. uber*	7.4	70	192	regrown
1	15/02	P	*C. scutulatus*	4.0	48	156	
1	15/02	P	*C. scutulatus*	31.0	97	305	
1	15/02	P	*C. scutulatus*	6.5	58	188	
2	11/02	F	*C. uber*	1.5	48	146	
2	12/02	F	*H. binoei*	2.0	44	118	
2	13/02	F	*C. uber*	5.8	59	213	
2	13/02	F	*C. branchialis*	8.4	85	156	
2	14/02	F	*H. binoei*		46	88	
2	14/02	F	*C. uber*	2.0	47	141	
2	14/02	F	*C. uber*				
2	15/02	F	*C. uber*				
3	11/02	P	*D. pulcher*		50	77	Ma

Appendix 2 (cont.)

Site	Date	Trap	Species	Wt	SVL	Tot	Notes
3	11/02	P	*C. amphiboluroides*		86	231	
3	11/02	P	*D. pulcher*		54	81	Ma
3	12/02	P	*C. branchialis*	3.5	71	124	
3	12/02	P	*C. scutulatus*	26.0	93	310	
3	12/02	P	*D. pulcher*	2.5	51	76	Ma
3	12/02	P	*C. uber*	3.5	61	181	
3	12/02	P	*D. pulcher*	3.0	52	79	
3	12/02	F	*P. minor*	9.5	65	193	
3	12/02	P	*C. uber*	3.0	55	97	
3	13/02	P	*L. gerrardi*	2.4	66	125	
3	13/02	F	*C. uber*	3.1	62	182	
3	14/02	P	*C. uber*	4.7	63	192	
3	14/02	P	*C. uber*	2.7	52	153	
3	14/02	P	*M. greyii*		11	26	
3	14/02	F	*P. minor*	7.2	66	193	
3	14/02	P	*C. plagiocephalus*	0.6	31	73	
3	14/02	P	*D. pulcher*	3.8	50	75	Ma
3	14/02	P	*C. uber*	7.8	75	222	
3	14/02	F	*C. uber*	2.7	51	154	
3	15/02	F	*C. uber*	2.7	51	150	
4	12/02	P	*C. uber*	1.0	41	95	
4	12/02	P	*E. richardsonii*	10.0	77	178	
4	12/02	P	*M. greyii*		10	23	
4	13/02	P	*H. binoei*				
4	13/02	P	*D. pulcher*	4.0	46	83	Ma
4	14/02	F	*G. variegata*	1.5	36	76	
4	15/02	P	*M. greyii*		28	60	
4	15/02	P	*M. butleri*		31	75	
4	16/02	F	*G. variegata*	2.5	44	85	
4	16/02	F	*G. variegata*	2.5	44	93	
5	13/02	F	*C. amphiboluroides*	15.0	88	230	
5	13/02	F	*E. richardsonii*	5.2	60	150	
5	15/02	F	*H. binoei*	3.0	46	102	regrown
5	15/02	F	*V. gouldii*	180.0	220	570	
5	16/02	P	*D. pulcher*	3.5	44	81	Ma

B. MAMMALS

Site	Date	Trap	Species	Wt	Crn	TL	Pes	Sex	Notes
3	14/02	P	*S. dolichura*	6.0	23.0	95		Fe	juvenile
4	16/02	P	*S. dolichura*	6.0				Fe	juvenile
5	12/02	P	*S. dolichura*	4.5	22.0	76	13.9	Ma	juvenile
5	12/02	P	*S. dolichura*	12.0	26.7	79		Fe	lac
5	15/02	P	*S. dolichura*	4.0		60		Ma	juvenile