Kintyre Project Area

Fauna observations from site visit, October 2007

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INTRODUCTION

The Kintyre project area lies in the far eastern Pilbara, just north of the Rudall River National Park in the Trainor bio-region, that lies between the Little Sandy and Great Sandy Deserts,, and intensive fauna investigations were undertaken in the region in the late 1980s and early 1990s (Hart, Simpson and Associates 1994). Information on fauna of the project area was reviewed by Bamford (2007) to update species listed in terms of taxonomy and changes in conservation legislation. As part of this review, an extended site inspection was undertaken in order to familiarise the consultant with the site and to collect some fauna observations, with particular emphasis on searching for signs of significant species. For example, the Bilby *Macrotis lagotis* was found in the region after the comprehensive surveys that were completed by the early 1990s, and it was important to determine if this species had moved into the impact areas in the intervening years.

This report is effectively a supplement to Bamford (2007).

METHODS

Site inspection

The site inspection was undertaken from 22-26 October 2007. Field personnel from Bamford Consulting Ecologists were Mike Bamford (BSc. Hons, PhD) and Ian Harris (B. Sc.). Jeff Wilkie and Matthew Roberts from Canning Resources provided logistical support and two representatives of the Traditional Owners were present. While most fauna work was by observation only, some searching for and capture of reptiles was carried out under Licence to Take Fauna for Scientific Purposes SF006013.

The approach to the site inspection involved visiting as much of the project area as possible. Major proposed development areas (pit, waste, and tailings areas, etc) were examined by foot traverse, sections of Yandicooge Creek from the existing access road as far south as 405 880E, 7 529 090N were visited, and observations were made at North Bore and on hills and breakaways both north and south of the proposed development areas. A claypan and its surrounds were visited by foot traverse and observations were also made at the base camp (408 170E, 7 535 420N) which, although outside the lease area, still provided relevant information since the landscape was similar to much of that in the development area. Key locations that were visited are listed in Table 1.

All foot traverses, inspections of locations and even when driving enabled opportunistic observations on fauna and fauna habitats to be made. Opportunistic observations included sightings of bird and reptiles, notes on evidence of mammals, such as burrows and scats, and provided the opportunity for the collection of short range endemic invertebrates. Because Hart, Simpson and Assoc. (1994) collected important records of mammals (both locally extinct and extant) from owl pellets collected in a cave, some attention focussed on searching for owl roosts and material was colleted from a roost in a cave at 403 756E, 7 530 584N.

In addition to opportunistic observations made during foot traverses and when driving between locations, trapping and spotlighting were carried out. Trapping consisted of the deployment of 22 Elliott traps (suitable for catching small mammals and some reptiles) from the ore body area along the access road towards the Telfer-Talawanna Track road. Traps were placed at 100m intervals, were baited with universal bait and were operated for 3 nights, giving a total trapping effort of 66 trapnights. Locations are presented in Table 2. Spotlighting took place on three evenings between the campsite and the ore body area and involved driving slowly (15-20kph) just after sunset, watching for animals in the beam of the headlights. Total distance traversed while spotlighting was 36km.

Searching for reptiles and invertebrates under loose earth and branches alongside the access track was carried out in the late afternoon of 27th October. Recordings of bat echolocation calls were made at the campsite on the night of 25th October but have yet to be analysed.

Table 1. Key locations visited during site inspection.

Base camp (outside lease). Eucalypt-lined seasonal watercourse	408 170E, 7 535 420N
Ore body area (start point of foot-traverses)	404 654E, 7 529 683N
Points walked to from ore body area	404 000E, 7 529 700N 405 100E, 7 529 600N 404 895E, 7 528 170N 404 350E, 7 528 091N 405 470E, 7 529 550N
Caves and breakaways targeted in search for Owl roosts and fauna associated with this habitat	404 780E, 7 530 785N, 404 670E, 7 530 800N. 403 756E, 7 530 584N
Locations along watercourses where observations made	Yandicooge Creek: 405 810E, 7 530 84N and 405 880E, 7 529 090N Wartarra Creek: 402 764E, 7 532 927N
Claypan	407 800E, 7 531 100N
North Bore	approx. 400 000E, 7 536 000N

Table 2. Locations (Zone 51, UTM datum WGS84) of Elliott traps, sampled from 23-26 October.

1	404 833	7 530 750
2	404 875	7 530 866
3	404 875	7 530 961
4	404 951	7 531 004
5	405 032	7 531 063
6	405 081	7 531 142
7	405 051	7 531 237
8	404 979	7 531 293
9	405 071	7 531 376
10	405 158	7 531 391
11	405 234	7 531 409
12	405 346	7 531 411
13	405 450	7 531 440
14	405 544	7 531 475
15	405 646	7 531 491
16	405 745	7 531 504
17	405 837	7 531 516
18	405 945	7 531 530
19	406 039	7 531 546
20	406 136	7 531 565
21	406 229	7 531 586
22	406 331	7 531 605

General description of project area and fauna habitats

The proposed pit areas and associated development lie on a sandy-loam plain surrounded by low, rocky hills, with the seasonal Yandicooge Creek just to the east. Vegetation on the plain is largely acacia shrubland over spinifex hummock grassland (*Triodia* spp.). In areas of heavier clay soils and along watercourses, spinifex is replaced by speargrass (*Sorghum* spp.) and other grasses, with eucalypts present. The rocky hills and their slopes support spinifex hummock grassland with few shrubs. Hart, Simpson and Assoc. (1994) provide detailed descriptions of vegetation.

The rocky hills are small outliers of the Throssel Range and have many small caves and overhangs, sufficient for owl roosts and nests of extinct stick-nest rats, but no deep caves that may be major roosts for bats. Watercourses are seasonal but must occasionally flow very strongly, with gravel beds *ca*. 50m wide.

Areas disturbed by exploration activity carried out in the late 1980s and early 1990s were deep-ripped when exploration ceased, and have rehabilitated to a great extent. They are

difficult to detect from the ground except where evidence of deep-ripping remains, but can be seen in aerial photography.

OBSERVATIONS ON FAUNA

Invertebrates of conservation significance

Only opportunistic collection of potentially significant invertebrates (eg. millipedes, land snails and scorpions) was carried out, and no specimens were found. Conditions were probably too dry for millipedes and snails to be active, but often snail shells and exoskeleton remains of millipedes are found when undertaking this sort of searching. Snail shells in particular are very easy to find, making it likely that land snails are absent from the project area. Scorpions are undoubtedly present and inactive burrows were found, but no specimens were collected. In general, the project area lacked the sort of mesic refugia, such as deep gorges or persistent waterholes, that can be expected to support populations of short range endemic invertebrates.

Freshwater fish

Bamford (2007) thought that at least one species of freshwater fish may be present in the watercourses when these contain water, but these systems ere dry at the time of the site inspection.

Amphibians

Hart, Simpson and Associates (1994) recorded five frog species, with two additional species known from the general area (Bamford 2007), but no frogs were observed during the site inspection. The watercourses clearly do contain pools that may persist for several months after heavy rainfall events, and it is likely that breeding by frogs is concentrated in such areas.

Reptiles

Hart, Simpson and Associates (1994) recorded 66 reptile species, with 23 additional species known from the general area on the basis of literature and databases (Bamford 2007). Fifteen species were recorded during the site inspection (Table 3). Two of these species, the blind snake *Ramphohtyphlops hamatus* and Rosen's Snake *Suta fasciata* were not recorded by Hart, Simpson and Assoc. (1994). *R. hamatus* was also not included in the literature review by Bamford (2007), although is known to occur as far east as Jiggalong (Storr *et al.* 2002). Although the specimen was confidently identified in the field on the basis of head morphology and mid-body scale count, in retrospect it should probably have been retained and lodged with the WA Museum for confirmation of its identity. *R.. hamatus* is similar to *R. pilbarensis* (known to occur as far east as Balfour Downs, Storr e*t al.* 2002).

Bamford (2007) presents a complete list of reptiles recorded or expected in the Kintyre project area (with the exception of *R. hamatus*) and discusses the single species of conservation significance likely to be present, the priority 2 skink *Lerista macropisthopus remota*. This species was not recorded by Hart, Simpson and Assoc. (1994) and was not found during the 2007 site visit, so may well not be present. Habitats for reptiles that lie within the development areas are generally widespread.

Birds

Hart, Simpson and Associates (1994) recorded 92 bird species, with 27 additional species known from the general area on the basis of literature and databases (Bamford 2007). This list excludes a number of species known from the general area as vagrants, such as some waterbirds. Forty species were observed during the site inspection (Table 4) with two of these, the Barn Owl and Tawny Frogmouth, previously included on the basis of the literature only.

All bird species observed or expected to occur in the project area are listed by Bamford (2007), and species of conservation significance are discussed. The site visit recorded three species of conservation significance also recorded previously: the Grey Falcon (Priority 4), Australian Bustard (Priority 4) and Rainbow Bee-eater (Migratory under EPBC Act). The significance of the project area for these three species is discussed by Bamford (2007): the Grey Falcon often occurs along eucalypt-lined watercourses (outside impact areas) while the other two species are widespread.

Mammals

Hart, Simpson and Associates (1994) present information on the mammal assemblage of the project area from their own observations and from the analysis of recent and sub-fossil remains in an owl deposit. They report on 30 species, with a further 9 species expected to be present on the basis of the literature (Bamford 2007). The site inspection recorded 12 species (Table 5) with one of these, the Lesser Stick-nest Rat, not recorded previously. This species is extinct, which may be why it was excluded from previous reports, but evidence of its nests in small caves was found at several locations. Note that owl pellets collected from a cave have not yet been examined for skeletal material of mammals.

Bamford (2007) discusses the mammal species of conservation significance recorded by Hart Simpson and Associates (1994) or that are expected to occur in the project area. The site inspection focussed on searching for evidence of a number of these species and the following observations were made:

- Northern Quoll. Recorded by Hart, Simpson and Assoc. (1994) only as recent material in owl pellets. During the site inspection, however, scats (faecal pellets) were found at north bore and on a breakaway about 1km south of the ore body. It seems likely that the species is resident in moderate numbers. It is usually associated with rocky landscapes in the Pilbara, so occurs outside areas of direct

impact but as noted by Bamford (2007), could be vulnerable to roadkill and introduced predators.

- Bilby. Reported anecdotally from the region in 1998. Sandy loam soils supporting acacia shrubland is occupied by the species in the Great Sandy Desert (pers. obs) and such habitat is widespread in the project area, including around the ore body. However, no evidence of the species was found during the site inspection so it seems unlikely that there is a resident population.
- Orange Leaf-nosed Bat. No caves suitable for this species appear to be present in the project area, but as noted by Bamford (2007), individuals may visit the site.
- Spectacled Hare-Wallaby. None observed during the site inspection. Habitat may be suitable but the species is probably locally extinct.
- Ghost Bat. No caves suitable for this species appear to be present in the project area, but as noted by Bamford (2007), individuals may visit the site.
- Western Pebble-mound Mouse. As noted by Hart, Simpson and Assoc. (1994), there are no active mounds in the project area.

In addition to the above species, fresh material of two other rodents, the Western Chestnut Mouse and Pale Field Rat, was found in owl pellets (Hart, Simpson and Assoc. 1994). Owl pellets collected during the 2007 site inspection have not yet been examined. both these species can be caught in Elliott traps, but neither was trapped.

DISCUSSION

The importance of an area for fauna can be assessed on the basis of the presence of significant species, the presence of significant or unusual habitat for fauna, and the presence of a high level of faunal biodiversity.

Significant species

Several significant species are present in the project area, including the Grey Falcon, Australian Bustard, Rainbow Bee-eater and Northern Quoll. A few other species of conservation significance may be present, including short range endemic invertebrates. In general, significant species that are or may be present are widespread, while impact areas are small and in habitats that are neither regionally restricted nor critical to these species. The Northern Quoll is probably of greatest importance, as the population in the area may be the most easterly in the Pilbara region and could be isolated.

Significant or unusual habitats

The landforms, vegetation and habitats in general of the project area are well-represented regionally. Watercourses and rocky hills are the rarest habitats in the area, but they occur extensively nearby and are largely outside impact areas. Watercourses and vegetation dependent upon groundwater may be particularly sensitive to impacts such as water abstraction or other effects on groundwater levels.

Faunal biodiversity

While the fauna is rich, the numbers of species recorded or expected are not unusual (based on previous surveys undertaken in the Pilbara and Great Sandy Desert). Furthermore, it appears that the area may lack large land snails, an important component of the significant fauna in some parts of the Pilbara, and several other species of significance such as the Pilbara Olive Python and some significant mammals. The area also lacks sandy desert habitat that brings with it a suite of sand-adapted species. The faunal assemblage is not unusually rich, but its composition could be important because at least some of the species may occur as outlying populations from the Pilbara.

Impacts and recommendations

Bamford (2007) discusses the significance of impacts from proposed development in the project area and provides recommendations for management.

Table 3. Reptile species observed during the October 2007 site inspection.

Gehyra purpurascens. One at camp (22/10).
Diplodactylus jeanae. One caught spotlighting near camp, 23/10.
Oedura marmorata. Droppings in small caves just north of ore body and skins in several caves in area.
Rhynchoedura ornata. One caught spotlighting on access track into ore body area (23/10).
Ctenophorus isolepis. Seen occasionally in mostly sandy areas.
Varanus gouldii flavirufus (desert race). Few seen and lots of foraging holes.
Varanus eremius. One seen along access track (26/10).
Ctenotus hanloni. One in Elliott trap in spinifex on gravelly-loam (24/10).
Ctenotus pantherinus. One near intersection of access track and Telfer-Talawanna Track Road (23/10) and one seen near ore body (25/10).
Lerista bipes. Characteristic wriggly lines in sand in sandy loam areas around ore body. The only *Lerista* of this type recorded by Ray Hart.
Tiliqua multifasciata. One on Telfer-Talawanna Track Road about 10km south of camp (22/10).
Ramphotyphlops hamatus. One in camp on evening of 24/10.
Antaresia perthensis. Sloughed skins in small cave just north of ore body.
Pseudonaja nuchalis. One seen during spotlighting on access track. Red-brown with glossy black head.
Suta fasciata. One dead and dried-out specimen in cave at 403 756E, 7 530 584N.

Table 4. Bird species observed during the October 2007 site inspection.

1. Spotted Harrier. One to east of ore body (23/10).
2. Brown Falcon. Several seen; one very pale and one very dark. Pair in grove of trees SW of ore body.
3. Grey Falcon. Pair over camp, doing courtship (one with food) at about midday (25/10).
4. Black-shouldered Kite. One in grove of trees SW of ore body.
5. Australian Hobby. One at camp (24/10).
6. Nankeen Kestrel. One at camp (24/10).
7. Australian Bustard. Tracks everywhere. One seen along trapline (26/10).
8. Little Button-quail. Small numbers seen throughout; perhaps more abundant in speargrass alongside watercourses. Some birds appeared to lack the diagnostic pale side to the rump that is usually clearly visible in this species. The possibility exits that these were Chestnut-breasted Button-quail *Turnix pyrrhothorax*, a species thought to be restricted to the Kimberley and Northern Territory until recently recorded in the Pilbara by the Department of Environment and Conservation and WA Museum (A. Burbidge pers. comm.).
9. Crested Pigeon. Single birds at camp (24/10) and at north bore (24/10).
10. Diamond Dove. Several at Desert Queen Baths outside the project area, but probably regularly preent (24/10).
11. Galah. Abundant in flocks of up to 50. Some young birds being fed.
12. Cocketiel. Small flocks (usually <5) seen occasionally, including camp and north bore.
13. Budgerigar. Occasional throughout, but up to 200 around camp (24/10).
14. Horsfield's Bronze-Cuckoo. One calling near trap 4 (26/10).
15. Rainbow Bee-eater. Everywhere and probably breeding.
16. Boobook Owl. One calling near camp (23/10, 25/10).
17. Barn Owl. One roosting in cave @ 403 756E, 7 530 584N (25/10).
18. Spotted Nightjar. One calling W of ore body on evening of 23/10, and one near camp (23/10).
19. Tawny Frogmouth. One near camp in evening of 24/10.
20. White-backed Swallow. One along Yandicooge Creek E of ore body (23/10).
21. Black-faced Cuckoo-shrike. Seen occasionally along creek-lines.
22. White-winged Triller. One (male) in acacia over spinifex on plain just W of ore body (23/10).
23. Rufous Whistler. One at north bore (24/10).
24. White-winged Fairy-wren. Few parties seen in spinifex, including close to ore body.
25. Variegated Fairy-wren. Group, with coloured male, along Yandicooge Creek (23/10).
26. Weebill. Several in eucalypt woodland at north bore (24/10).
27. Spiny-cheeked Honeyeater. Along major creeklines.
28. Yellow-throated Miner. Along major creeklines. Up to 30 around camp in mornings, focusing activity on a single flowering mistletoe.
29. Brown Honeyeater. One at north bore (24/10) and one heard at camp (26/10).

30. White-plumed Honeyeater. In eucalypts along creeklines.
31. Singing Honeyeater. Everywhere.
32. Red-browed Pardalote. Occasional birds in eucalypt areas, including camp, Yandicooge Creek and north bore.
33. Painted Finch. Heard at north bore (24/10).
34. Zebra Finch. Everywhere, with up to 100 around camp constantly.
35. Magpie-lark. Occasional along creeklines.
36. Little Woodswallow. Few around rocky areas.
37. Black-faced Woodswallow. Small group near camp (24/10).
38. Pied Butcherbird. Around camp.
39. Australian Magpie. Two along Telfer-Talawanna Track road about 20km south of camp (26/10).
40. Torresian Crow. Few around camp and pair in ore body area.

Table 5. Mammal species observed during the October 2007 site inspection.

Pseudantechinus woolleyae. Droppings in breakaways throughout, including North Bore, caves just north of ore body.
Northern Quoll. Dropping, presumably of this species, at base of breakaway at north bore (24/10). Also near breakaway south of ore body @ 404 895E, 7 528 170N (25/10).
Euro. Droppings in most caves and breakaways. One seen at north bore (24/10) and two seen near owl cave 403 756E, 7 530 584N (25/10).
Spinifex Hopping-Mouse *Notomys alexis*. Active burrows throughout sandy loams of ore body and surrounds.
Desert Mouse *Pseudomys desertor*. Some feeding signs found (spinifex stalks with distinctive angle cut).
Lesser Stick-nest rat. Old nests, just the shiny tar-like substance, in caves at 403 756E, 7 530 584N and just north of ore body.
Northern Free-tail bat *Chaerophon jobensis*. One over camp on night of 25/10, although recorded call needs to be analysed for confirmation.
Finlayson's Cave Bat *Vespadelus finlaysoni*. One seen in evening at ore body and one in small cave south of ore body @ 404 895E, 7 528 170N (25/10).
Donkey. One heard near old Tracy camp (23/10) and old droppings south of ore body (25/10).
Camel. Everywhere. Groups of 2-3 common. Up to 50 seen on drive up from Talawanna Track (22/10) and again on return (26/10). About 10 near camp on evening of 25/10.
Feral Cat. Tracks everywhere.
Dog/Dingo. Tracks everywhere.

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KINTYRE PROJECT.

FAUNA STUDIES, 1986-1992.

Prepared by

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for

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October 1994

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CONTENTS.

(cont.)

1. SUMMARY.

This report brings together all work carried out on the fauna of the Kintyre site between 1986 and 1992, as well as some relevant information collected for the Rudall Project by CRA Exploration.

Extensive pit trapping and observation of the vertebrate fauna of the Kintyre site was carried out between 1986 and 1989. Although the site was drought affected in 1986, exceptional rains fell in 1987 and 1988 and the fauna increased in abundance in response. This work has produced detailed lists of the species present and considerable information on the use of different habitats. The habitats present at Kintyre are widely replicated regionally.

There has been very little other fauna work carried out in the local area, but regionally it is known that most species are common and widespread. Few rare species are present, and none would be significantly affected by any development of the site. Introduced species are restricted to a suite of mammals which are common regionally.

The species of mammals present both now and in the past was also examined by identifying bones from an owl deposit. This work shows that there may be species still present which have not been found by trapping, but that many other species have been lost as the result of European settlement.

The aquatic invertebrates were also examined in a series of pools after heavy rain. The fauna was diverse but dominated by species typical of ephemeral pools, with a smaller number of species dependent on permanently wet substrates. It is difficult to interpret the results because very little is known about the aquatic fauna either locally or regionally, but it is unlikely that there are any unique elements in the aquatic invertebrate fauna.

2. INTRODUCTION.

Following the discovery of the Kintyre uranium deposit in late 1985 as part of the Rudall Project, environmental studies were commenced by CRA Exploration in April 1986. Eventually the deposit was taken over by Canning Resources Pty Limited, and environmental studies were continued. The Kintyre Project was substantially scaled down after 1988 when Canning Resources became involved in the Hill River Coal Project and some of the environmental studies were never brought to a formal close.

This report brings together all information collected on the fauna for the Kintyre Project, as well as some information collected by CRA Exploration as part of the continuing environmental management of the Rudall Project around the Kintyre Project site.

Specifically this report:

- summarises all fauna collecting and observation work carried out,
- updates and lists the results,
- lists the specimens held in the W.A. Museum,
- discusses introduced species,
- describes the conservation significance of the fauna in relation to the landscape and vegetation, and
- lists the photographs collected and their present storage.

3. METHODS.

A conventional detailed fauna survey using trapping and observation and designed to cover all of the habitats present was carried out in April 1986 (Martinick and Associates 1986). The traps used were:

- pits consisting of 600mm lengths of PVC pipe 160mm in diameter in fenced lines of seven pits,
- Elliott traps, and
- cage or large Elliott traps.

Limited mist netting for bats was also carried out, but no detailed study of bats was made. Other species were observed opportunistically. Bird observations were made systematically, but due to the low numbers of individuals this work was not continued and subsequent observations were made opportunistically

Similar pit trapping programmes and opportunistic observations were also carried out in December 1986 (Martinick and Associates 1987), April 1987 (Martinick and Associates 1987a), December 1987 (Martinick and Associates 1987b), August 1988 (Martinick and Associates 1988), and November 1988 (Martinick and Associates 1988a). All but the last of these were designed primarily to catch certain species required for other studies and were not systematic fauna surveys. The November 1988 survey was a fauna survey which covered areas trapped before to take advantage of favourable weather, and also included habitats not previously trapped adequately.

Pit trapping was the preferred method because it was far more productive than Elliott or cage trapping.

An opportunistic survey of reptiles, aimed primarily at catching snakes, was carried out in June 1989 (Hart, Simpson and Associates, unpublished).

Bird observations were made opportunistically during all trapping programmes as well as other studies. The time and effort put into bird observations varied greatly depending on the other work being carried out.

In December 1987, February 1988 and March 1988 bones deposited by owls were collected from a cave in the Coolbro Hills immediately to the west. These were collected to describe the pre-European mammal fauna and identify other species which might be present but not collected. The bones were identified by an expert, and their significance discussed in a report.

In March 1988 a survey was carried out of aquatic invertebrates in water bodies resulting from heavy rains. The fauna was identified by an expert and its significance discussed in a report.

4. RESULTS.

4.1 Weather.

When environmental studies began in April 1986 the Kintyre site was drought affected. Anecdotal evidence said that no effective rain had fallen for two and a half years. The condition of the vegetation and the low density of the fauna supported this claim. Significant rain fell in the winter of 1986, but there is no record of the amount. Subsequently major rains fell in February 1987, February/March 1988, May 1988 and January 1989. Table 1 (below) shows the rainfall between February 1987 and October 1989.

This pattern of rainfall from drought to exceptionally favourable seasons had a strong impact on the fauna, and affects the interpretation of the results in some cases.

Table 1. Rainfall (mm) at Kintyre, February 1987 to October 1989, from site records.

Month	Rainfall		
	1987	1988	1989
Jan	-	26	85
Feb	126	63	12
Mar	13	196	17
Apr	21	2	0
May	8	148	11
Jun	2	0	3
Jul	0	0	0
Aug	0	13	0
Sep	0	0	0
Oct	0	0	0
Nov	1	0	-
Dec	18	17	-

4.2 Trapping.

Trapping was carried out in a total of 39 sites. These sites are described in Appendix 1. The vegetation units are those used in a parallel revision of the vegetation (Hart, Simpson and Associates 1994). The descriptions of the trapping sites have been taken from the original descriptions, so that the height and density of the vegetation is described as it was when the trap line was installed. Almost all of the Kintyre site was burnt in about 1977-1980, and in some cases the height and density of the vegetation changed significantly over the time that the trapping was carried out. For example, the common shrub Acacia ancistrocarpa grew from an average height of 1.2m in 1986 to 2m in 1991, with a corresponding increase in cover within the more dense stands.

The locations of the trapping sites are shown in Map 1, and Map 1 also shows the extent of the vegetation types. The vegetation follows the topography closely and was the main criterion used to identify the habitats present. Many of the sites were chosen to maximise the chance of catching certain species and were not designed to cover all habitats equally.

Photographs of the trapping sites, if they are available, are listed in Appendix 9.

The frogs, reptiles and small mammals trapped at these sites at each trapping programme are given in Appendix 2 as a set of spread sheet files. Disk versions of these files are given in Appendix 10. The numbers of pit trap lines used varied between trapping programmes, and each line may have been used for various numbers of days. For the six trapping programmes in Appendix 2 the numbers of pit trap line nights (with seven pits in each line night) were 166, 77, 181, 99, 54 and 173 respectively. The names of the animals have been updated from all previous reports. These changes are due to taxonomic changes and the re-identification of specimens in the W.A. Museum. Changes of note are:

> Ctenotus quattuordecimlineatus was not separated from the very similar Ctenotus ariadnae, which also occurs at this site, until November 1988 and all previous results must be assumed to be a mixture of these two species.

Specimens identified as Ctenotus leonhardii in April 1986 by the W.A. Museum were later found to be Ctenotus serventyi.

Diplodactylus jeanae was recognised as a distinct species from Diplodactylus taeniatus.

A specimen identified as Ctenotus colletti (now C. nasutus) was later re-identified as Ctenotus calurus, which is common on the site.

Specimens originally identified as Planigale ingrami were found to be Planigale maculata.

A specimen identified as Zyzomys argurus was re-identified as Pseudomys desertor.

Several small mammal species collected in August and November 1988 were re-identified by the W.A. Museum, and their is now serious doubt about the number of species found and the identity of individuals which were not collected. Many of these identifications are based on skull measurements and there is great difficulty in identifying animals in the field.

Bats were collected in April 1986 by mist netting, and these are shown in the trapping results for April 1986. Taphozous georgianus was also collected immediately to the west of the study area in June 1989.

The trapping results in Appendix 2 could be analysed to show the differences in habitat preferences between species. This has not been carried out because the results are greatly affected by the different trapping effort between sites and the different weather conditions prevailing at different intervals when various trap sites were used.

Subjectively, the trapping sites can be divided into the groups which are listed in Table 2 (next page), although the last two categories are more heterogeneous.

Table 2. Habitat types and trap sites.

Habitat	Trap sites
Stony hills	1, 2, 3, and 36-38.
Dunes	5, 6, 14, 21 and 34.
Sandy plains	16, 26 and 28.
Shrub steppes on silty sands	7, 8, 9, 13#, 15, 17, 18#, 20#, 22*, 23#, 24, 25, and 31.
Drainage lines, shrublands, near rivers, and clay soils	4, 10, 11, 12, 19, 27#, 29#, 30#, 32, 33, 35 and 39.

not burnt in 1977-1980.

* close to a river.

4.3 Opportunistic collecting.

Opportunistic observations of species not recorded in Appendix 2 are listed here:

Frogs

Litoria rubella was found in the Coolbro Hills to the west of the study area in March 1988 and was common at Camp Tracy in 1988 and 1989 where there was permanent water.

Neobatrachus aquilonius was found to be abundant around Yandagooge Creek after heavy rain caused flooding in March 1988, but was not otherwise recorded.

Reptiles

Pogona minor mitchelli was observed near Trap site 26 in November 1988, but no specimen was collected.

Tiliqua fasciata has been seen twice in the north-east corner of the study area, once in September 1986 and once in August 1992, but no specimen was collected.

Varanus giganteus is scarce but widespread throughout the area. It has been seen on Kintyre Hill and in the Yandagooge Hills, and one individual was resident at Camp Tracy for some years. No specimen has been collected.

The snakes Demansia psammophila, Furina ornata and Pseudechis australis were reported from the Kintyre study area by Canning Resources staff in 1987/8.

Mammals:

Fresh droppings of the Echidna (Tachyglossus aculeatus) were found in the Coolbro Hills to the west of the study area in November 1988.

A dead individual of Dasykaluta rosamondae was found in the south-western corner of the study area in August 1988.

The Euro (Macropus robustus) is common and widespread in the stony hills surrounding the study area, and is occasionally seen within the study area.

The Red Kangaroo (Macropus rufus) has been seen only once, to the north of the study area, in April 1986 during drought conditions.

Mounds of stones believed to be the nests of the Pebble-mound Mouse (Pseudomys chapmani) were found south and west of the study area in 1987. These mounds were very old and clearly extinct. It is not known if this species survives locally. There is very little possible habitat on the Kintyre study area itself and this species is unlikely to be present, but there are extensive areas nearby.

The feral cat is widespread although sparse throughout the study area.

The fox has only been reliably recorded once, in 1986 north of the study area, and is clearly rare.

The rabbit has been recorded only once, in August 1992, in the north-eastern corner of the study area.

The camel is common and widespread. It is normally seen in small groups but has been recorded in herds of over 100 individuals.

The dingo is common and widespread throughout the study area.

The species recorded in the opportunistic survey in June 1989 are listed in Table 3 (next page). Most of the species were caught previously in pit trapping or had been seen by opportunistic collecting. Species not previously recorded were:

The gecko Crenadactylus ocellatus horni was found under litter on rocky soil in the south-western corner of the study area. This species is not normally caught by pit trapping because it is able to climb put of the pits. This species is typically found on rocky soils under spinifex. It is widespread from the west coast through central Western Australia to the Northern Territory and South Australia.

The Legless Lizard Delma butleri was found on the edge of a rocky hill near Camp Tracy. This species is widespread in central and northern Western Australia.

Table 3. Fauna species recorded in an opportunistic survey, June 1989.

Geckos
Crenadactlyus ocellatus horni
Diplodactylus elderi
D. stenodactylus
Gehyra pilbara
G. purpurascens
Heteronotia binoei

Legless lizards
Delma borea
D. butleri
D. nasuta
Lialis burtonis

Agamids
Ctenophorus caudicinctus
C. isolepis
C. inermis

Skinks
Ctenotus helenae
C. pantherinus
C. saxatilis
Cyclodomorphus branchialis
Lerista bipes
Menetia greyii
Proablepharus reginae

Snakes
Furina ornata
Pseudonaja nuchalis
Vermicella anomala

Mammals
Pseudomys hermannsburgensis
Sminthopsis youngsoni

The skink Cyclodomorphus branchialis was found on the edge of a rocky hill near Camp Tracy. This species inhabits spinifex and has a similar distribution from the west coast through central Western Australia to the Northern Territory and South Australia.

Summary lists.

An annotated list of all frog, reptile and mammal species recorded is given in Appendix 3, and species represented by specimens in the W.A. Museum are listed in Appendix 4 with the Museum accession numbers.

4.4 Bones from an owl deposit.

Bones were collected from a cave in the Coolbro Hills to the west of Kintyre in March 1988. The location is shown in Map 2. The cave was above a pool ("Pool C") in a valley, and could only be reached by a careful climb of 10m up the rock face. The entrance was lower than the main part of the cave, and this position is typical of that preferred by owls. At its highest the cave was 3.5m tall, and the main part of the cave was 5m deep.

The bones were identified by Dr A. Baynes (W.A. Museum). A complete copy of his report is given in Appendix 5. The different samples listed in the report were taken from different parts of the cave in an attempt to divide up the old and new material. The cave was still actively used by bats as well as owls, and footprints from December 1987 were covered with bat guano by February 1988.

The report describes how the bones are the result of long standing accumulation of prey remains by birds, mainly the Barn Owl, and how this collection gives a very broad survey of the small mammals present in the area. The bones can be divided into older and recent material, and this can be correlated with the original pre-European settlement fauna and the modern surviving fauna.

The results clearly show that numerous species have become extinct recently, but that several species which have not been detected by the surveys described here may still be present in the area.

4.5 Bird records.

The birds recorded at each visit are listed in Appendix 6 as a spread sheet file. A disk version of this file is given in Appendix 10.

The time and effort put into recording birds varied greatly between visits. In general birds were actively sought during the fauna surveys discussed above but were only recorded opportunistically during other studies.

In addition to the species recorded in Appendix 6, some species have reliably been reported by Canning Resources staff. These are:

Pacific Black Duck (Anas superciliosa) recorded in March 1988 in Yandagooge Creek.

Black-winged Stilt (Himantopus himantopus) recorded in September 1988 in a dam at Kintyre.

In addition:

The Silver Gull (Larus novaehollandiae) was seen in 1988 and April 1990 at Kintyre.

The Straw-necked Ibis (Threskiornis spinicollis) was seen in a clay pan just east of Kintyre in June 1989.

The distinctive mud nests of the Fairy Martin (Cecropis ariel) occur in caves throughout the area. The birds have never been seen, but some nests have clearly been occupied very recently and this species is probably a regular visitor.

Other species have been recorded from the Rudall River and sites in the Rudall Project, and most if not all of these can be expected to occur in the Kintyre study area at some time. A complete list of the birds seen in and around the Kintyre area and in the region is given in Appendix 7, with the species recorded from other sites distinguished.

4.6 Aquatic invertebrates.

The aquatic invertebrates collected in March 1988 were identified by an expert (Dr Jenny Davis, Murdoch University). This information and the results of water sampling were discussed in a free-standing report which is reproduced in full in Appendix 8.

The locations of the pools are given in Map 2.

Photographs of the pools are listed in Appendix 9.

Water samples were also collected by Canning Resources staff for other water quality analyses. These were from pools labelled 1, 2 and 3, which are shown as Pools C, E and F in Map 2.

Some material from the 1988 study remained unidentified, but by 1993 no further information had become available and Dr Jenny Davis was of the opinion that no new information was likely to become available (see letter included at the end of Appendix 8).

5. DISCUSSION.

The majority of the vertebrate fauna trapping carried out at Kintyre was carried out to collect particular species for other purposes, but the systematic fauna surveys and these other trapping programmes have provided extensive information on the vertebrate species present. The 39 trap sites used covered all of the habitats present, and many of the minor variations.

The results list five species of frogs, 64 species of reptiles, 81 species of birds and 22 species of mammals recorded from the Kintyre area, and others are known to occur nearby and would be found in the Kintyre area at some time.

These impressive lists are partly due to the weather during the time the trapping was carried out. In April 1986 the site was drought-affected, some rain fell in winter 1986 but very heavy rains fell in early 1987, 1988 and to a lesser extent in 1989 (Table 1). These rains led to a very large increase in the numbers of animals present, and therefore to the chance that they would be captured. The pit trapping results in Appendix 2 clearly show the impact of the good rains in 1987-1989, particularly after allowing for the effect of the different numbers of trap nights used at each time. Between April 1986 and December 1987 or November 1988 there is a relative increase in the yield of animals per trap of about four fold. Many species were not recorded until after these rains had fallen. The birds showed a spectacular increase in abundance after the rain. Birds were very scarce in April 1986, but subsequently became abundant. The Diamond Dove was not recorded at all in April 1986 despite extensive searching, but subsequently became one of the most common species.

While these lists include the great majority of the species present, they do not represent the entire fauna. Some species which undoubtedly occur in the area have not been recorded. For example the Woma (a large python) was seen south of Telfer in 1986, and the small lizard Cryptoblepharus carnabyi was seen at Desert Queen Baths in November 1988, but neither has been seen or trapped at Kintyre. Some species caught at Kintyre are represented by very small numbers of individuals despite the extent of the trapping, and additional species were found as late as June 1989 (Table 3). These results illustrate

the difficulty of catching all species. The results of the study of bones left by owls also suggest that other species are present but have not yet been trapped (Appendix 5), particularly Sminthopsis longicaudatus which would be found on stony hills. New bird species were also recorded at all study times, and other species have been seen regionally.

The small mammals present some taxonomic problems, and it is not entirely clear just how many species are present. The bats have not been surveyed systematically because none of the small species are of conservation interest.

Prior to the trapping programmes carried out at Kintyre very little trapping had been carried out within the entire region, and none locally. Most recorded specimens are from the Canning Stock Route or other well known locations. The results at Kintyre have produced many new and interesting results, particularly in small range extensions. These new results reflect primarily the poor state of knowledge about the vertebrate fauna rather any unusual feature of the site. The habitats present at Kintyre are widely replicated over vast areas, and there are no unique features at the Kintyre site.

The data on species found in each habitat (Appendix 2 and Table 2) is confused by the difference in weather over the time the trapping was carried out.

Different trap sites were used at different times, and the various habitats were not examined equally. The stony hills habitat was examined only in April 1986 and November 1989, and was probably not sampled adequately to determine the habitat preferences of all species. Ctenotus calurus was found mainly west of the Yandagooge, but it is possible that this is an artefact because it happened that these trap sites were used more often after the rains which favoured this species. It was presumably present in other areas during the dry period, but rare or locally extinct over much of the area.

Some species clearly needed time to respond to the improved weather. The seed eating mouse Notomys alexis was not trapped for the first time until December 1987, even though its preferred habitat was trapped extensively before this time in April 1987. After this time it was common. Some of the reptiles not captured until late in the trapping programmes may have been very rare or locally extinct in 1986 and needed time to breed up a significant population. Local extinctions in dry times may explain part of the failure to capture all species despite extensive trapping.

Some species show clear habitat preferences, such as the gecko Oedura marmorata for rocky hills or the gecko Nephrurus levis on sandy soils, but most species were less specific in their preference. The differences in habitat are also confused by the small areas of some habitats. The sand dunes and stony hills are often small areas within larger habitats (Map 1).

The sand dunes at Kintyre tend to be small and poorly developed. They cannot be equated with the dunes found in the true sandy deserts found outside the Paterson Province. Some species typical of these true dune deserts are absent from the dunes at Kintyre. These include Ctenotus brooksi, Nephrurus laevissimus and several species of Lerista. At Kintyre the sand dune habitat is occupied by species which might normally be excluded by these more specialised species.

The bird observations were not interpreted in terms of habitats because the general habitats of the species are well known and species are too mobile to be restricted to within the small areas seen at Kintyre. The species can be considered in terms of groups of species. Some such as the Brown Falcon, Kestrel, Bustard, Galah, Pipit, Black-faced Cuckoo-shrike, Willie Wagtail, Singing Honeyeater, Black-faced Woodswallow, Pied Butcherbird and Crow are resident species which persist in all times. Others such as the Diamond Dove, Budgerigar and Zebra Finch show spectacular increases in abundance in response to rain. Many others show moderate increases in abundance from nearby sources or by long distance immigration. Aquatic species are only present when there is free water, but rapidly occupy any water bodies. A few species such as the Bee-eater and Cuckoos are nomadic.

It is difficult to interpret the results of the vertebrate trapping at Kintyre in a local context because very little other information is available. In a regional context it can be stated that most of the species recorded are common or widespread in similar habitats over very large areas. The results from the study of bones left by owls shows how the mammal fauna has been severely depleted in recent times, but this impact has occurred over all of arid Western Australia and is not unique to this site.

Some of the species recorded at Kintyre have a declared conservation status. These are (at February 1993):

Species declared as likely to become extinct or rare.

The Pebble-mound Mouse (Pseudomys chapmani) has a small chance of being present in the Kintyre study area, although there is a good chance that it still survives nearby. There is very little potential habitat for this species in the Kintyre study area itself, and it is unlikely to be present. Any development could probably easily avoid this habitat if this species was found to be present.

The Grey Falcon (Falco hypoleucos) was recorded once in the Kintyre study area. Neither Storr (1981) or Burbidge and McKenzie (1983) recorded this species, but Blakers, Davies and Reilly (1984) recorded it nearby. This species is found mainly in Eastern Australia but could be seen anywhere. It is found mainly in central and northern Western Australia but is rare. It would be an occasional visitor.

Other species with a declared conservation status may be present, with varying degrees of probability. These include:

Species declared as likely to become extinct or rare.

The Mulgara (Dasycercus cristicauda), a small mammal, which was once common regionally but is now very rare or locally extinct. This species is rare but occurs from the Great Sandy Desert to the Great Victoria Desert and could be found at Kintyre.

The Bilby (Macrotis lagotis) which is now very rare and restricted to small areas of suitable habitat. It is unlikely to occur Kintyre.

Alexandra's Parrot (Polytelis alexandrae) which is nomadic but known to occur in the Great Sandy Desert. It probably favours tree-lined watercourses and other trees. It could be present as a rare and erratic visitor.

Species in need of special protection

The Peregrine Falcon (Falco peregrinus) is a widespread species threatened by agricultural activities and illegal collecting. Although uncommon it is not endangered in Western Australia, particularly in remote areas. It occupies very large areas and is probably present at Kintyre occasionally.

The Pink Cockatoo (Cacatua leadbeateri) is found in woodlands. The southern populations are endangered by loss of breeding trees due to agricultural development, but the northern populations are not regarded as endangered. It is probably present as a rare visitor at Kintyre.

The Woma (Aspidites ramsayi), a large python, has a southern population which is endangered and a northern population which is widespread and not endangered. It is likely to be present at Kintyre at some time.

Although many species of mammals have been lost from the region, the frog, reptile and bird fauna is probably reasonably intact. The mammal species which have been lost are those which have been lost from very large areas of arid Australia as a result of changes brought about by European settlement. The main causes are believed to be the introduction of new predators and changes to fire patterns with the cessation of traditional Aboriginal burning.

There are no introduced frog, reptile or bird species present, but introduced mammals make up a substantial fraction of the mammal fauna. The only common species are the Dingo, House Mouse, Cat and Camel, although the Fox may have been common at times. These animals have probably had a significant impact on the native fauna.

The study of the aquatic invertebrate fauna (Appendix 8) showed that while the fauna was diverse it consisted primarily of species typical of temporary water bodies, with a smaller group of species depending on permanently wet substrates. This is reasonable given that there are no permanent pools in the area and very limited refugia available for animals which depend on permanently wet substrates. It is difficult to interpret the results because very little is known about the aquatic invertebrates of the arid country and almost nothing about the fauna locally or regionally, but it is unlikely that there are any unique elements in the aquatic invertebrate fauna. Muir (1982) reported some collections of aquatic invertebrates from the Rudall River area, but was unable to interpret the results because of the new species encountered and the inability to identify many of the specimens.

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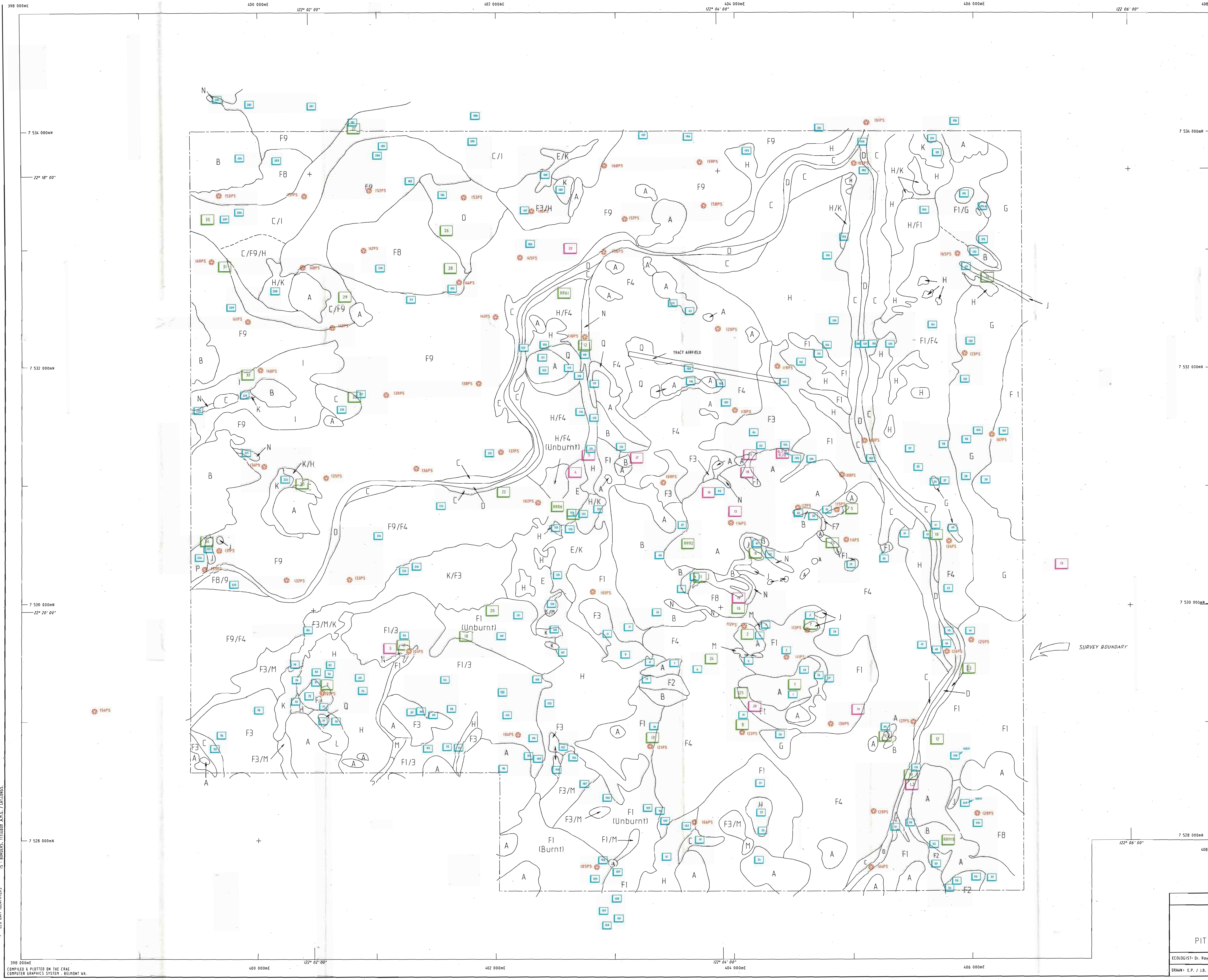


LEGEND

- FAUNA COLLECTION SITES
- REHABILITATION PLOTS
- VEGETATION STUDY SITES
- SOIL/PLANT COLLECTION SITES (now redundant)

LOCALITY INSET

SHEET INDEX

DATUMS
HORIZONTAL A.M.G.
VERTICAL A.H.D.

200 0 200 400 600 800m
1 : 10,000

Hart, Simpson and Associates Pty Ltd REVISED 6/7/94

CRA Exploration Pty.Limited

RUDALL PROJECT
MAP 1

PIT TAPPING SITES OF KINTYRE STUDY AREA

ECOLOGIST: Dr. Ray Hart		REPORT No :
DRAWN: E.P. / J.B. / K.L.	DATE : JULY 1994	PLAN No : WA5012k

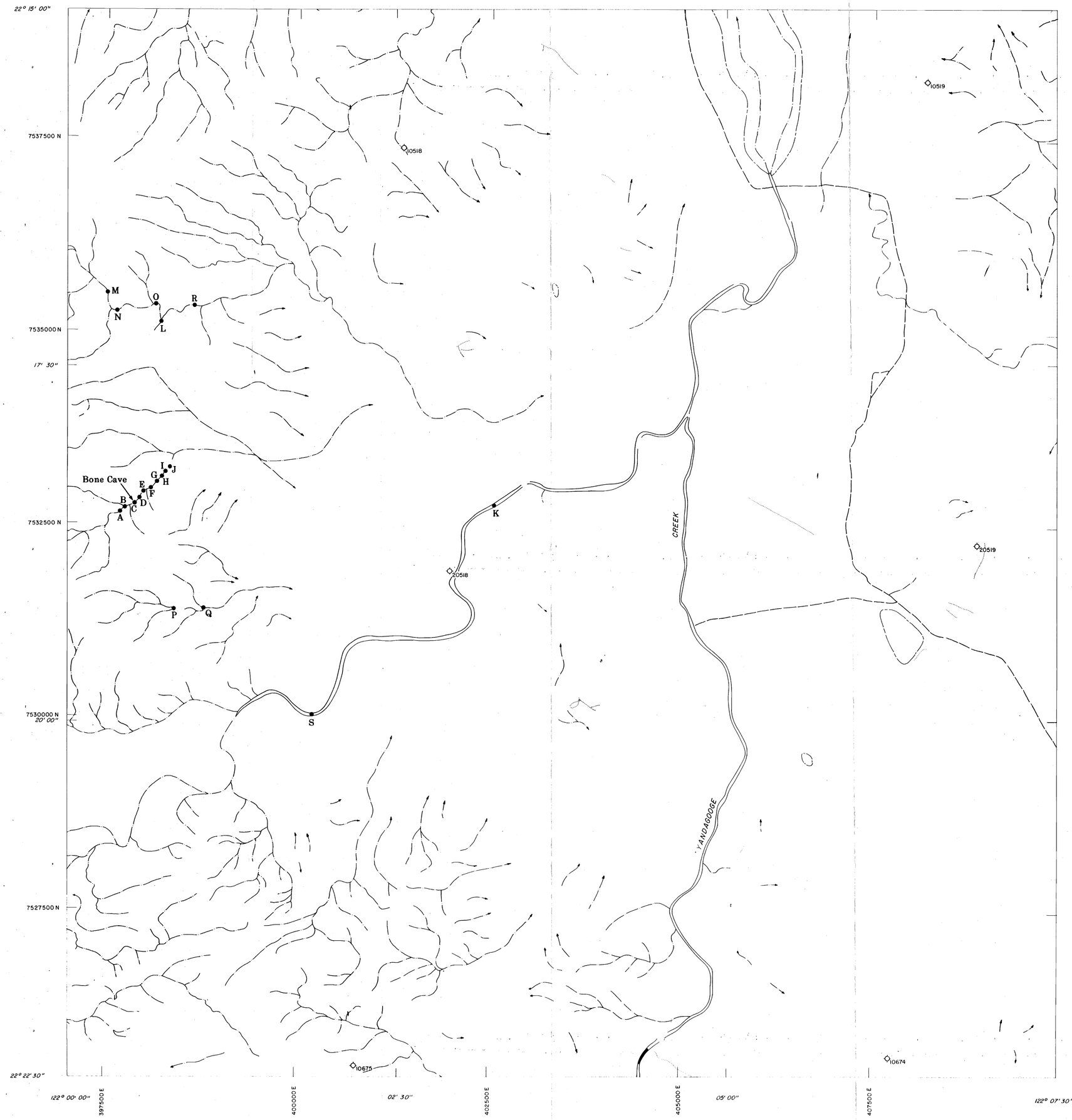
COMPILED & PLOTTED ON THE CRAE COMPUTER GRAPHICS SYSTEM, BELMONT WA.

FILED UNDER: 5012KR
PARAMETER FILE: 1995BRR

THE LAYER CONTENTS ADJACENT SHOW THE FULL RANGE OF INFORMATION STORED IN THIS NAMED FILE.
THE NUMBERS LISTED PRECEDING LAYER CONTENTS INDICATE THE LAYERS PLOTTED ON THIS VERSION OF THE MAP.

15 - BORDERS, TITLEBOX, A.M.G. / LAT.LONGS.

- SOIL / PLANT COLLECTION SITES
- FAUNA COLLECTION SITES
- VEGETATION STUDY SITES
- REHABILITATION PLOTS
- SURVEYED AREA
- ECO UNIT IDENTIFIERS



Photogrammetry and Cartography by
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Produced from Aerial Photography and Control Data supplied by the Division of National Mapping and incorporated in the C.R.A.E. Data Bank

Date of Photography May 1982

Datums Horizontal A.M.G.
Vertical A.H.D.

0 500 1000 1500 2000 2500 metres

LOCALITY

SHEET INDEX

3253/14	3353/2	3353/6
3253/15	3353/3	3353/7
3253/16	3353/4	3353/8

Hart, Simpson and Associates

C.R.A. EXPLORATION PTY. LTD.

KINTYRE PROJECT

MAP 2
Locations of pools (A–S), used in survey of aquatic invertebrates, and cave where bones were collected

DRAWN K.Lynch	REPORT No	SHEET No 3353/5
DATE March, 1993	Scale 1:25,000	PLAN No WA34951p

ENV.06.00.0006
28 of 103

APPENDIX 1. Descriptions of trapping sites. The vegetation units are defined in Hart, Simpson and Associates (1994). The locations are given in Map 1.

Photographs of the sites, where they are available, are listed in Appendix 9.

Trapping site No: 1.

Vegetation unit: Hummock Grass Steppe.

Vegetation:

Stratum/species	Cover	Height
Hakea suberea	<1%	to 3m
Shrubs	<1%	0.3-1.5m
Spinifex	10-20%	0.2-0.4m

Soil: Red brown silty sand, with 50% cover of stones and some massive rock.

Topography: On a small stony hill (Kintyre Hill).

Comments: Installed April 1986, but subsequently accidently destroyed during exploration work in the same year.

Trapping site No: 2.

Vegetation unit: Hummock Grass Steppe.

Vegetation:

Stratum/species	Cover	Height
Shrubs	<1%	<1.5m
Spinifex	30%	0.1-0.25m

Soil: Pale brown, fine and silty, very stony with some massive rock.

Topography: On a small stony hill ("Boundary Hill").

Comments: Installed April 1986, and removed in December.

Trapping site No: 3.

Vegetation unit: Acacia inaequilatera Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs	5%	to 3m
Spinifex	30%	0.3m

Soil: Brown silty sand with 50% stones.

Topography: In a small drainage line in a small stony hill ("Lead Hills" west).

Comments: Installed April 1986.

Trapping site No: 4.

Vegetation unit: Chenopod Dwarf Scrub.

Vegetation:

Strata/species	Cover	Height
Shrubs Atriplex vesicaria (grazed)	5%	0.2m
Grass (grazed)	<1%	0.2m

Soil: Pale brown hard silty clay.

Topography: Flat low-lying area.

Comments: Installed April 1986, and removed in December.

Trapping site No: 5.

Vegetation unit: Sand Dune Complex.

Vegetation:

Strata/species	Cover	Height
Shrubs Hakea suberea Acacia dictyophleba Acacia ligulata Cassia o. oligophylla Grevillea eriostachya Stylobasium spathulatum	1-5%	<1.2m
Spinifex	10%	0.3m

Soil: Deep, loose red sand.

Topography: Sand dune.

Comments: Installed April 1986.

Trapping site No: 6.

Vegetation unit: Sand Dune Complex.

Vegetation:

Strata/species	Cover	Height
Shrubs Hakea suberea Acacia dictyophleba Calytrix carinata Petalostylis cassioides Stylobasium spathulatum	1-5%	<2m
Spinifex	20%	0.3m

Soil: Deep, loose red sand.

Topography: Sand dune.

Comments: Installed April 1986.

Trapping site No: 7.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Hakea suberea	<1%	<3.5m
Shrubs	5-10	1.5m
Spinifex	20%	0.25m

Soil: Red silty sand.

Topography: Flat plain.

Comments: Installed April 1986.

Trapping site No: 8.

Vegetation unit: Mixed Low Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Hakea suberea	<1%	<3m
Shrubs	1-5%	0.5-1m
Spinifex	10-20%	0.2m

Soil: Red silty sand.

Topography: Flat plain.

Comments: Installed April 1986.

Trapping site No: 9.

Vegetation unit: Mixed Low Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Eucalyptus brevifolia	1 only adjacent	10m
Shrubs	1%	1m
Spinifex	10%	0.3m

Soil: Red-brown silty sand.

Topography: Flat plain, but adjacent to some small stony hills and a minor drainage line.

Comments: Installed April 1986.

Trapping site No: 10.

Vegetation unit: Eucalyptus centralis Woodland.

Vegetation:

Strata/species	Cover	Height
Eucalyptus centralis	1%	5-12m
Acacia eriopoda	1%	5m
Shrubs	20%	<2m
Spinifex and other grasses including Cenchrus ciliaris	5%	0.4m

Soil: Pale red sand.

Topography: Fringing a major watercourse (Yandagooge Creek).

Comments: Installed April 1986.

Trapping site No: 11.

Vegetation unit: Drainage Line Complex.

Vegetation:

Strata/species	Cover	Height
Shrubs Acacia ancistrocarpa A. inaequilatera A. ligulata Cassia helmsii C. o. oligophylla	40%	1-5m
Cenchrus ciliaris	30%	0.4m
Spinifex	5%	0.3m

Soil: Red-brown silty sand.

Topography: Minor drainage line in a flat plain.

Comments: Installed April 1986.

Trapping site No: 12.

Vegetation unit: Drainage Line Complex.

Vegetation:

Strata/species	Cover	Height
Eucalyptus camaldulensis E. centralis	1 only Few only	9m 5m
Shrubs Acacia eriopoda A. holosericea A. synchronicea A. ligulata	20%	<4m
Spinifex	10-30%	0.2-0.4m

Soil: Pale brown silty sand.

Topography: Minor drainage line.

Comments: Installed April 1986.

Trapping site No: 13.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs	<10%	2m
Spinifex	30%	0.5m

Soil: Red-brown silty sand.

Topography: Flat plain.

Comments: Installed April 1986. In an area not burnt in the fire of 1977-1980.

Trapping site No: 14.

Vegetation unit: Sand dune Complex.

Vegetation: not recorded in detail, but typical of unit.

Soil: Deep, loose red sand.

Topography: Sand dune.

Comments: Installed December 1986.

Trapping site No: 15.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation: Not recorded in detail, but denser than is typical of the unit.

Soil: Not recorded.

Topography: Flat plain.

Comments: Installed December 1986.

Trapping site No: 16.

Vegetation unit: Grevillea/Acacia Shrub Steppe.

Vegetation: not recorded in detail, but typical of unit. Dominated by Grevillea stenobotrya.

Soil: Red sand.

Topography: Sandy slope.

Comments: Installed December 1986.

Trapping site No: 17.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs	30%	<2m
Spinifex	20%	0.3m

Soil: Hard red silty sand.

Topography: Flat plain.

Comments: Installed April 1987.

Trapping site No: 18

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs Acacia ligulata A. ancistrocarpa Cassia helmsii C. o. oligophylla	30%	<3m
Spinifex	50%	0.4m

Soil: Hard red-brown silty sand.

Topography: Flat plain.

Comments: Installed April 1987. In an area not burnt in the fire of 1977-1980.

Trapping site No: 19.

Vegetation unit: Eucalyptus centralis Woodland.

Vegetation:

Strata/species	Cover	Height
Eucalyptus centralis	1%	8m
Shrubs Rhagodia spinescens Acacia eriopoda Cassia helmsii C. o. oligophylla	20%	<2m
Spinifex	5%	0.4m
Annual grasses	50%	0.3m

Soil: Hard red-brown silty sand.

Topography: Flat near the edge of a major drainage line (Yandagooge Creek).

Comments: Installed April 1987.

Trapping site No: 20.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs	20%	<3m
Spinifex	30%	0.3m

Soil: Hard red-brown silty sand.

Topography: Flat plain.

Comments: Installed April 1987. In an area not burnt in the fire of 1977-1980.

Trapping site No: 21.

Vegetation unit: Sand dune Complex.

Vegetation:

Strata/species	Cover	Height
Shrubs Acacia dictyophleba	<10%	<0.8m
Spinifex	20%	<0.5m

Soil: Deep, loose red sand.

Topography: Sand dune.

Comments: Installed April 1986.

Trapping site No: 22.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe, but within an area mapped as a mosaic of Acacia dictyophleba Shrub steppe and Mixed Low Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs Acacia ligulata Cassia o. oligophylla	5%	<1.2m
Spinifex	20%	0.3m

Soil: Hard red-brown silty sand.

Topography: Flat plain.

Comments: Installed April 1987.

Trapping site No: 23.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs	20%	<1.5m
Spinifex	40%	0.4m

Soil: Hard red-brown silty sand.

Topography: Flat plain.

Comments: Installed April 1987. In an area not burnt in the fire of 1977-1980.

Trapping site No: 24.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe, but within an area mapped as Mixed Low Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs Acacia ancistrocarpa A. dictyophleba A. inaequilatera Cassia o. oligophylla	10%	<1.8m
Spinifex	20-30%	0.3m

Soil: Hard red silty sand.

Topography: Flat plain.

Comments: Installed April 1987.

Trapping site No: 25.

Vegetation unit: Acacia ancistrocarpa and A. ligulata Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs Acacia ancistrocarpa A. ligulata A. dictyophleba	20-30%	<1.5m
Spinifex	20-30%	0.3m

Soil: Red silty sand.

Topography: Flat plain, close to the lower slopes of a stony hill.

Comments: Installed April 1987.

Trapping site No: 26.

Vegetation unit: Mallee Steppe.

Vegetation:

Strata/species	Cover	Height
Mallee Eucalyptus sp. 617	<5%	<2m
Shrubs Acacia ligulata Grevillea eriostachya Petalostylis cassioides	<5%	1m
Spinifex	<10%	0.3m

Soil: Red silty sand.

Topography: Flat sandy plain.

Comments: Installed December 1987.

Trapping site No: 27.

Vegetation unit: Eucalyptus centralis Woodland over Acacia dictyophleba Shrubland.

Vegetation:

Strata/species	Cover	Height
Eucalyptus centralis	1-5%	5-8m
Shrubs	10-20%	2-3m
Spinifex Triodia pungens	30%	0.4m

Soil: Silty red-brown earth.

Topography: In a minor drainage line in a flat plain.

Comments: Installed December 1987.

Trapping site No: 28.

Vegetation unit: Grevillea/Acacia Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs Grevillea stenobotrya Acacia ligulata	20%	1-2m
Spinifex	10%	0.3m

Soil: Silty red sand.

Topography: Flat plain.

Comments: Installed December 1987.

Trapping site No: 29.

Vegetation unit: Eucalyptus centralis Woodland over Acacia dictyophleba Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Eucalyptus centralis	1%	3-6m
Shrubs Acacia dictyophleba Petalostylis cassioides	10%	2m
Spinifex	20%	0.4m

Soil: Hard red-brown silty earth.

Topography: Flat plain, near a stony hill.

Comments: Installed December 1987.

Trapping site No: 30.

Vegetation unit: Eucalyptus centralis Woodland over Acacia dictyophleba Shrubland.

Vegetation:

Strata/species	Cover	Height
Eucalyptus centralis	1%	5-10m
Shrubs Acacia dictyophleba A. holosericea A. tumida	50-70%	2-5m
Spinifex Triodia pungens	1-5%	0.4m
Other grasses (mostly dead)	95%	<0.3m

Soil: Soft red-brown silt.

Topography: In a minor drainage line in a flat plain.

Comments: Installed December 1987.

Trapping site No: 31.

Vegetation unit: Acacia dictyophleba Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Eucalyptus centralis	<1%	4m
Shrubs Acacia dictyophleba	10%	1.5-2.5m
Spinifex	30%	0.3-0.4m

Soil: Hard red silty sand.

Topography: Flat plain.

Comments: Installed December 1987.

Trapping site No: 32.

Vegetation unit: Acacia dictyophleba Shrubland.

Vegetation:

Strata/species	Cover	Height
Shrubs	20%	1.5-2.5m
Spinifex Triodia pungens Plectrachne schinzii	20%	0.3m

Soil: Hard red silty sand.

Topography: Flat plain, near a stony hill.

Comments: Installed December 1987.

Trapping site No: 33.

Vegetation unit: Indeterminate Shrub Steppe, on the junction of areas mapped as Eucalyptus centralis Woodland and Acacia dictyophleba Shrub Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs Acacia ligulata Cassia o. oligophylla	5%	1m
Spinifex	10%	0.3m

Soil: Red silty sand.

Topography: Flat plain, on the margin of a low-lying area.

Comments: Installed December 1987.

Trapping site No: 34.

Vegetation unit: Sand dune Complex.

Vegetation:

Strata/species	Cover	Height
Shrubs Stylobasium spathulatum Acacia ligulata A. dictyophleba	1-5%	1-2.5m
Spinifex Plectrachne schinzii	<10%	0.4m

Soil: Deep, loose red sand.

Topography: Sand dune.

Comments: Installed December 1987.

Trapping site No: 35.

Vegetation unit: Eucalyptus centralis Woodland.

Vegetation:

Strata/species	Cover	Height
Eucalyptus centralis	14	5-8m
Shrubs Acacia ligulata A. ancistrocarpa Cassia o. oligophylla	1%	1-2m
Spinifex Triodia pungens	10%	0.4m

Soil: Hard brown clayey earth.

Topography: At a low point in a flat plain, adjacent to a stony hill.

Comments: Installed December 1987.

Trapping site No: 36.

Vegetation unit: Tree Steppe, within an area mapped as Hummock Grass steppe.

Vegetation:

Strata/species	Cover	Height
Eucalyptus brevifolia	1%	3-6m
Spinifex	20%	0.2m

Soil: Brown silt with 80% stones and much massive rock.

Topography: On a stony slope, at the base of a rocky hill.

Comments: Installed November 1988.

Trapping site No: 37.

Vegetation unit: Tree Steppe, within an area mapped as Hummock Grass steppe.

Vegetation:

Strata/species	Cover	Height
Eucalyptus brevifolia	1%	3-7m
Shrubs Eremophila latrobei Acacia retivenia	<1%	1-2m
Spinifex	20%	0.3m

Soil: Brown silt with almost 100% stones.

Topography: On a stony slope, at the base of a rocky hill.

Comments: Installed November 1988.

Trapping site No: 38.

Vegetation unit: Tree Steppe.

Vegetation:

Strata/species	Cover	Height
Eucalyptus brevifolia	1%	3-6m
Spinifex	20%	0.2m

Soil: Brown silt with almost 100% stones.

Topography: On a stony slope, at the base of a rocky hill.

Comments: Installed November 1988.

Trapping site No: 39.

Vegetation unit: Drainage Line Complex, adjacent to a large area of Tree Steppe.

Vegetation:

Strata/species	Cover	Height
Shrubs Grevillea wickhamii Acacia monticola	20%	2-3m
Grasses Aristida sp. Triodia pungens	30%	0.3m

Soil: Brown silt.

Topography: On the edge of a drainage line at the base of a stony slope.

Comments: Installed November 1988.

APPENDIX 2. Trapping results 1986-1988, as a series of Lotus 123 files. All animals collected at each site at each trapping time are listed.

The trapping sites are described in Appendix 1, and the locations are given in Map 1.

A disk copy of the files is in Appendix 10 as "trap1.wk1" to "trap6.wk1" respectively.

PIT TRAPPING RESULTS, APRIL 1986.

	1	2	3	4	5	6	7	8	9	10	11	12	13	Other	TOTAL
GECKOS															
Diplodactylus ciliaris						1					1	1		2	5
D. conspicillatus							1	2							3
D. stenodactylus					1			1		2					4
Gehyra pilbara/punctata	3	2												2	7
G. purpurascens											1				1
Heteronotia binoei			1							2					3
Nephrurus levis			1												1
Oedura marmorata														4	4
Rhyncoedura ornata								1	2	2					5
LEGLESS LIZARDS															
Delma borea													1		1
Delma nasuta											1		1		2
Delma pax											2				2
Lialis burtonis												1			1
Pygopus nigriceps														1	1
AGAMIDS															
Ctenophorus caudicinctus	3		1												4
Ctenophorus inermis														2	2
Ctenophorus isolepis					1				1						2
Diporiphora winneckei														1	1
Gemmatophora longirostris											1				1
SKINKS															
Ctenotus ariadnae/quatt.					3										3
C. hanloni								2							2
C. helenae							1		1	1	1		3		7
C. pantherinus							1						6		7
C. piankai	2														2
C. saxatilis		1								1	1	1			4
C. serventyi												1			1
Egernia depressa	1														1
Eremiascincus fasciolatus			1		1					1		1			4
Lerista bipes					19	14		4	6	4	9				56
Menetia greyii								1	1				1		3
Morethia ruficauda	1	3													4
GOANNAS															
Varanus acanthurus												1			1
V. gouldii											1			2	3
BLIND SNAKES															
Ramphotyphlops diversus	1														1
R. endoterus						3									3
PYTHONS															
Liasis perthensis														1	1
L. stimsoni														1	1
ELAPID SNAKES															
Pseudonaja modesta														1	1
MAMMALS															
Planigale maculata	1									1		1			3
Pseudantechinus woolleyae			1												1
Sminthopsis youngsoni					1	2		2							5
Chalinolobus gouldii														4	4
Eptesicus finlaysoni									1						1
Scotorepens greyii														3	3

PIT TRAPPING RESULTS, DECEMBER 1986.

	3	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL
GECKOS														
Diplodactylus conspicillatus	7													7
D. stenodactylus		1												1
Gehyra spp.		3	1				1	1			3			9
Heteronotia binoei												1		1
Nephrurus levis		1					1				1			3
Rhyncoedura ornata					2	4	5	1	1	5				18
LEGLESS LIZARDS														
Delma borea										1				1
Pygopus nigriceps					1									1
AGAMIDS														
Ctenophorus caudicinctus	1													1
C. inermis													1	1
C. isolepis		1	1		2						4		2	10
SKINKS														
Ctenotus ariadnae/quatt		1	6			1					3	1	1	13
C. helenae							1	1	1	1				4
C. pantherinus				3				1	2	3		2		11
C. piankai	1					1								2
C. serventyi							1		1					2
Eremiascincus fasciolatus		1									1			2
Lerista bipes		17	20		3	9	4		8	4	5	1	13	84
Menetia greyii				1						1				2
Proablepharus reginae									1					1
GOANNAS														
Varanus acanthurus	1													1
V. brevicauda												1		1
V. eremius												1		1
V. gouldii					1									1
BLIND SNAKES														
Ramphotyphlops sp.		1								1				2
ELAPID SNAKES														
Vermicella anomala		1												1
MAMMALS														
Planigale maculata	2						1							3
Sminthopsis youngsoni					2							2	2	6

PIT TRAPPING RESULTS, APRIL 1987.

	3	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL
FROGS																						
Cyclorana maini						10									22			11				43
Limnodynastes spenceri						99								1	63			1	13			177
Notaden nichollsi	2	12								5		1			9	1	5	3	3			41
GECKOS																						
Diplodactylus conspicillatus	1				5		1		5	4	1	1	1		1			1		1	1	23
D. elderi			1																	1		2
D. jeanae			1																			1
D. stenodactylus					1					2	1		1						1		2	8
Gehyra purpurascens												1						3		1	1	6
Heteronotia binoei										1	1				2			1		1	1	7
Nephrurus levis			2																			2
Rhyncoedura ornata			2	1	4	3	1		2	3	5	3	7	1	17	2		2	6	5	5	69
LEGLESS LIZARDS																						
Delma nasuta									1													1
Lialis burtonis																			1			1
AGAMIDS																						
Ctenophorus inermis			1									1										2
C. isolepis			7		4				3	9	8	15	8		2	1	2	4	4	4	4	75
Diporiphora winneckei																					1	1
SKINKS																						
Ctenotus ariadnae/quatt.		1	7		1				2	3	2	1	2			4			1	2	1	27
C. calurus					1																	1
C. dux										1						1						2
C. grandis					1				3	1	4	1	1	1		1						13
C. hanloni					1				5		6	1	1		1	4			1	1		21
C. helenae							2		6					2		4			7		1	22
C. pantherinus			1	1	1				9		2	2	4	3		3			5		3	34
C. piankai	1								1		1											3
C. saxatilis						1		2	1													4
C. serventyi								2	1						5							8
Eremiascincus fasciolatus		4	4							10			1					1				20
Lerista bipes	1	6	14	1	7		11		1	9	5	12	4	2	7	9	9	4	3	3		108
Menetia greyii					1	1			1											2		5
Notoscincus ornatus													1									1
GOANNAS																						
Varanus acanthurus															1						1	2
V. eremius												1										1
V. gouldii			3	2	2		1				3	4	1	1		1		1	1	1	1	22
BLIND SNAKES																						
Ramphotyphlops endoterus		1												1								2
R. grypus											1											1
R. sp.		2																				2
ELAPID SNAKES																						
Vermicella anomala		1																				1
MAMMALS																						
Planigale maculata	1		1																			2
Pseudantechinus sp.	1												1									2
Sminthopsis youngsoni	1									1	4		1					1				8
Pseudomys hermannsburgensis							3															3
Mus musculus															1							1

PIT TRAPPING RESULTS, DECEMBER 1987.

	16	17	18	20	23	26	27	28	29	30	31	32	33	34	35	TOTAL
FROGS																
Limnodynastes spenceri		1												2		3
Notaden nichollsi	1	2			3			2						3		11
GECKOS																
Diplodactylus conspicillatus	3	4				1	6	2	4		4	2	3			29
D. jeanae							1				1					2
D. stenodactylus	2	2			5	1	1	2	3	1	3	2	4	1	1	28
Heteronotia binoei									2				1			3
Nephrurus levis					2			5						1		8
Rhyncoedura ornata	2	2		1	2	3	1	1	3	1		2	8	11	1	38
LEGLESS LIZARDS																
Delma nasuta			1				1									2
D. pax				1												1
Pygopus nigriceps		1														1
AGAMIDS																
Ctenophorus isolepis	6	2		1		1		7	6	1	2	2	4	3		35
Diporiphora winneckei													1			1
SKINKS																
Ctenotus ariadnae/quatt.				1		1	1	2			4		1	1		11
C. calurus						2		4	1		2	1	5			15
C. grandis			2									1				3
C. hanloni	2		1	2		2		1	4		4	6	5		3	30
C. helenae		1	2		2	1	5	1	1						1	14
C. pantherinus	1		5	9	3	1	1		1		1	3		1	4	30
C. saxatilis										1						1
C. serventyi							1			1		1				3
Egernia striata								1			1					2
Eremiascincus fasciolatus														1		1
Lerista bipes	13	3		4	5		4	4	1		1		3	25		63
Menetia greyii		1								1	1					3
Notoscincus ornatus								1								1
GOANNAS																
Varanus acanthurus									1							1
V. eremius	1	1							10		1	1				14
V. gouldii		3		1	5	1		4	2		4		1	1		22
V. tristis																
BLIND SNAKES																
Ramphotyphlops grypus							2									2
ELAPID SNAKES																
Pseudonaja modesta	1															1
MAMMALS																
Ningaui ?timealeyi										1						1
Planigale maculata		1								2						3
Sminthopsis youngsoni	1	1		2		4		1				3				12
Notomys alexis		1			1	1		1	1		1			2	1	9
Pseudomys hermannsburgensis			1						1		3	1	2			8
Mus musculus					1											1

PIT TRAPPING RESULTS, AUGUST 1988.

	17	18	20	21	22	23	26	27	28	29	30	31	32	33	34	TOTAL
GECKOS																
Diplodactylus stenodactylus											1					1
LEGLESS LIZARDS																
Delma nasuta						1										1
D. pax						1										1
AGAMIDS																
Ctenophorus isolepis				5	3		1			2		2	1	2	3	19
SKINKS																
Ctenotus ariadnae/quatt.	1									1				1		3
C. calurus							1					1		1		3
C. hanloni									1							1
C. pantherinus	4	1		4	1	2	2			4		5	1			24
C. saxatilis											1					1
Lerista bipes				2					1							3
Menetia greyii						1										1
GOANNAS																
Varanus eremius				1											1	2
V. gouldii	1															1
ELAPID SNAKES																
Vermicella anomala															1	1
MAMMALS																
Ningaui ?timealeyi															1	1
Planigale maculata											2					2
Sminthopsis youngsoni	2		3		2		2		2	1		1	2		1	16
Pseudomys desertor													2			2
Pseudomys hermannsburgensis			3	1	5	1				5	2	5	1			23
Notomys alexis	7			2								2			2	13
Mus musculus	2	3		1	1	4	1			2	7	1	4	2		28

PIT TRAPPING RESULTS, NOVEMBER 1988.

	11	13	14	17	18	21	23	25	26	27	28	29	30	31	36	37	38	39	TOTAL
FROGS																			
Notaden nichollsi			2																2
GECKOS																			
Diplodactylus conspicillatus		7		3			2	5		1				1					19
D. elderi													1	1					2
D. jeanae						1													1
D. stenodactylus							2		1			1							4
Gehyra pilbara															5	2	2		9
Gehyra purpurascens										1			1	1				1	4
Heteronotia binoei	1				1				1					2					5
Nephrurus levis				1					1		1								3
Rhyncoedura ornata		5		2			2	1	3					2					15
LEGLESS LIZARDS																			
Delma borea		2			1								2	2					7
D. nasuta								2											2
Lialis burtonis	1									1									2
Pygopus nigriceps								1	1					1					3
AGAMIDS																			
Ctenophorus caudicinctus															1		1		2
C. inermis		1																	1
C. isolepis		10		7			2	11	6		4	1							41
Diporiphora winneckei				1															1
SKINKS																			
Ctenotus ariadnae		1		4			3	3				1		1					13
C. ?ariadnae				2								1		1					4
C. calurus				2					3		4								9
C. grandis				1															1
C. hanloni		3		3			1		1	1	2			2					13
C. helenae	2	4		4	2		1	1		4		1	2	1					22
C. pantherinus		10		7	3		4	6	1	2		1				1			35
C. piankai																2	1		3
C. quattuordecimlineatus			2								1								3
C. saxatilis	1						1						8		1	2		1	14
C. schomburgkii					1														1
C. serventyi																		3	3
Egernia striata											1								1
Eremiascincus fasciolatus			4			1			2										7
Lerista bipes	18			16	4	1	9	1	1	13	3	3	2	5					76
Menetia greyii							1						1	2					4
Morethia ruficauda															1	2			3
Notoscincus ornatus				9															9
Proableparus reginae					2			1											3
GOANNAS																			
Varanus brevicauda		2																	2
V. eremius					1				3		1	1		6					12
V. gouldii	2	1	2	3	1		6	3	6		5	7		2					38
V. tristis												2							2

PIT TRAPPING RESULTS, NOVEMBER 1988.

	11	13	14	17	18	21	23	25	26	27	28	29	30	31	36	37	38	39	TOTAL
PYTHONS																			
Liasis perthensis																1			1
BLIND SNAKES																			
Ramphotyphlops diversus		2																	2
ELAPID SNAKES																			
Pseudonaja modesta				1					1	1									3
Pseudonaja nuchalis												1							1
MAMMALS																			
Ningaui ?timealeyi					1		1		1				2		1	5	1	1	13
Pseudantechinus ?sp.													1		3		6		10
Pseudantechinus woolleyae																	1		1
Sminthopsis youngsoni		2		4			1		3		1	1		3					15
Notomys alexis		3	1	4		5		4	2		3								22
Pseudomys hermannsburgensis	1	5	10		2		3			2		1		11					35
Mus musculus	4	7	3		4		6	2	1	6		5	5			1			44

APPENDIX 3. Annotated list of all frog, reptile and mammal species recorded at or near Kintyre.

Introduced species are identified with an asterisk (*).

FROGS

LEPTODACTYLIDAE

Limnodynastes spenceri was common after rain, and found mainly near rivers.

Neobatrachus aquilonius was found to be abundant on one occasion during flooding near the Yandagooge Creek in March 1988.

Notaden nichollsi was common and widespread, and found mainly on sand dunes, in sandy soils or near water. It can be found after rain or even during humid nights.

HYLIDAE

Cyclorana maini was found to be common in April 1987 after rain, but was found only near rivers.

Litoria rubella occurred in drainage lines in the Coolbro Hills, and at Camp Tracy where there was artificial permanent water.

REPTILES

Geckos GEKKONIDAE

Crenadactylus ocellatus horni was recorded only once, under vegetation on stony ground in the south-western corner of the study area. It is probably more common than this result suggests because it is not readily caught by trapping.

Diplodactylus ciliaris aberrans was only recorded in April 1986 where it was found on sand dunes and in drainage lines. This species lives on bushes and is more widespread than these results suggest because it is not readily trapped.

Diplodactylus conspicillatus was common and widespread, and recorded in almost all habitats except large stony hills.

Diplodactylus elderi was uncommon, but it occurs in spinifex and is probably under-estimated by trapping.

Diplodactylus jeanae was uncommon and occurred mainly on sandy surfaces. It lives in spinifex and is also probably under-estimated by trapping.

Diplodactylus stenodactylus was common and widespread, and recorded in all habitats except stony hills.

Gehyra pilbara was found on stony hills, although it is normally regarded as occurring primarily in termitaria.

Gehyra punctata was uncommon but was found on stony hills which were not studied extensively.

Gehyra purpurascens was widespread, and found mainly around shrubs, trees and rocks.

Heteronotia binoei was common and widespread, and recorded in all habitats except stony hills.

Nephrurus levis pilbarensis was common, and found mainly on dunes or sandy soils.

Oedura marmorata was uncommon, and found only on stony or rocky hills.

Rhynchoedura ornata was common and widespread, and recorded in all habitats except stony hills.

Legless Lizards PYGOPODIDAE

Delma borea was common but almost only within spinifex which had not been burnt in 1977-1980

Delma butleri was recorded only once, near the base of a stony hill near Camp Tracy. It is probably more common than these results suggest.

Delma nasuta was common but mainly within spinifex which had not been burnt in 1977-1980 or drainage lines where there was dense vegetation.

Delma pax was uncommon and recorded mainly within spinifex which had not been burnt in 1977-1980 or drainage lines where there was dense vegetation.

Lialis burtonis was uncommon and recorded mainly within spinifex which had not been burnt in 1977-1980 or drainage lines where there was dense vegetation.

Pygopus nigriceps nigriceps was uncommon but widespread within shrubs over spinifex vegetation.

Dragon Lizards AGAMIDAE

Ctenophorus caudicinctus caudicinctus was not often trapped but was common on stony hills.

Ctenophorus inermis was moderately common in a variety of habitats. It was most often seen perching on grid pegs.

Ctenophorus isolepis isolepis was common and widespread, and recorded in all habitats except stony hills. All individuals are believed to be the subspecies isolepis but gularis occurs further north.

Diporiphora winneckei was uncommon but was found scattered throughout the shrubs over spinifex, but it was not recorded on sand dunes where it would be expected.

Gemmatophora longirostris was recorded only once, in a drainage line. It was also observed in the Coolbro Hills to the west in a drainage line. This species is probably restricted to trees along drainage lines.

Pogona minor mitchelli was recorded only once in the north-western corner of the study area, in November 1988. It appeared to be rare locally, although it is widespread regionally.

Skinks SCINCIDAE

Ctenotus ariadnae was confused with C. quattuordecimlineatus during most of the trapping, but appeared to be common in the flat plains with shrubs over spinifex in less sandy soil than that preferred by C. quattuordecimlineatus.

Ctenotus calurus was common in shrubs over spinifex, particularly on the sandier soils.

Ctenotus dux was only recorded twice, in April 1987, on a sand dune and a long unburnt area of spinifex.

Ctenotus grandis grandis was common and widespread, and recorded in all habitats except stony hills.

Ctenotus hanloni was common and widespread, and recorded in all habitats except sand dunes and stony hills.

Ctenotus helenae was common and widespread, but most common in the more low-lying areas with heavier soil or areas which were long unburnt.

Ctenotus pantherinus ocellifer was common and widespread, and recorded from every habitat.

Ctenotus piankai was moderately common and found in a variety of habitats including stony hills where it would normally be replaced by the very similar C. duricola.

Ctenotus quattuordecimlineatus was confused with the similar C. ariadnae during most of the trapping, but appeared to be common on sand dunes and the sandier soils on the plains.

Ctenotus saxatilis was common on stony hills and in drainage lines.

Ctenotus schomburgkii was recorded only once, in November 1988, in an area of spinifex which was not burnt in 1977-1980. It appears to be rare locally, and may be at the northern limit of its range.

Ctenotus serventyi was common but largely restricted to drainage lines.

Cyclodomorphus branchialis was recorded only once, in June 1989, near the base of a stony hill. This is a widespread species and there is no reason for its apparent rarity locally.

Egernia depressa was recorded only once, on Kintyre Hill in April 1986. It is common and widespread regionally and is probably more common than this result suggests.

Egernia striata was recorded in only two sites in the same general area, and appeared to be rare locally. It is a widespread desert species.

Eremiascincus fasciolatus was common and found mainly on sand dunes or sandy soils.

Lerista bipes was abundant in every habitat except stony hills where it was rare.

Menetia greyii was moderately common in shrubs over spinifex and drainage lines.

Morethia ruficauda exquisita was moderately common on and restricted to stony hills.

Notoscincus ornatus was scarce, being found in only two sites with shrubs over spinifex. This species appears to be rare regionally but more common on the Pilbara coast and in the Kimberleys. It is also very small and easily overlooked, and may be more common than is thought.

Proablepharus reginae was scarce, being found in only three dissimilar sites. This species is widespread in Western Australia but known from only scattered sites. It is small and may be poorly known rather than rare.

Tiliqua multifasciata was seen only twice, in 1986 and 1992, in the north-eastern corner of the study area. This species is large and readily observed, and is widespread regionally.

Monitors VARANIDAE

Varanus acanthurus was uncommon and mainly recorded in drainage lines.

Varanus brevicauda was rare, but recorded in two sites in shrubs over spinifex.

Varanus eremius was widespread and found in all habitats except stony hills.

Varanus giganteus was scarce and restricted to stony hills.

Varanus gouldii was common and found in all habitats except stony hills.

Varanus tristis tristis was scarce and only seen in densely vegetated drainage lines.

Blind Snakes TYPHLOPIDAE

Ramphotyphlops diversus ammodytes was scarce and found on a stony hill and in a patch of spinifex not burnt in 1977-1980.

Ramphotyphlops endoterus was scarce and found on a sand dune and in a patch of spinifex not burnt in 1977-1980.

Ramphotyphlops grypus was scarce and found in a patch of spinifex not burnt in 1977-1980 and in a drainage line.

Pythons BOIDAE

Liasis perthensis was rare and recorded on stony hills.

Liasis stimsoni stimsoni was rare and recorded from a stony hill.

Elapid Snakes ELAPIDAE

Demansia psammophis reticulata was reported in 1987/8.

Furina ornata was reported in 1987/8, and recorded from a stony hill in June 1989.

Pseudechis australis was reported in 1987/8.

Pseudonaja modesta was moderately common and recorded from shrubs over spinifex.

Pseudonaja nuchalis was recorded in 1987/8, from a cast skin and once by trapping in a drainage line.

Vermicella anomala was common but restricted to sand dunes.

MAMMALS

TACHYGLOSSIDAE

The Echidna (Tachyglossus aculeatus) was recorded only from droppings in the Coolbro Hills to the west of the study area. It is probably widespread but scarce.

DASYURIDAE

The Little Red Antechinus (Dasykaluta rosamondae) was recorded only from a dead animal found in the south-western corner of the study area in August 1988. This species is likely to be widespread regionally, although more common in the Pilbara.

The Antechinus are represented by Pseudantechinus woolleyae and unidentified specimens. Their status is uncertain but they were uncommon and restricted to stony hills and drainage lines.

The Lesser Hairy-footed Dunnart (Sminthopsis youngsoni) was common and widespread in all habitats except stony hills, but most common on sand dunes.

The Pilbara Ningaui (Ningaui timealeyi) and an unidentified specimen Ningaui sp. cf timealeyi are of uncertain status but appeared to be widespread in all habitats after two years of good rains.

The Common Planigale (Planigale maculata) was common and widespread in all habitats.

MACROPODIDAE

The Euro (Macropus robustus) was common and widespread in stony hills around the study area, although rarely seen within the study area itself.

The Red Kangaroo (Macropus rufus) was recorded only once north of the study area in April 1986 during very dry conditions. It is probably a casual vagrant through the area.

EMBALLONURIDAE

The Common Sheathtail-bat (Taphozous georgianus) was recorded from a cave immediately to the west of the study area, and is probably common locally.

VESPERTILIONIDAE

Gould's Wattled Bat (Chalinolobus gouldii), the Little Broad-nosed Bat (Scotorepens greyii) and Eptesicus finlaysoni were all caught around the study area, and are probably common locally.

MURIDAE

The Pebble-mound Mouse (Pseudomys chapmani) was present to the west on the evidence of extinct nest mounds, but it is not known if it survives locally. There is very little possible habitat on the study area itself but large areas nearby. This species is known to survive near the Rudall River.

The Desert Mouse (Pseudomys desertor) was trapped only once, in August 1988, in a shrubland. It appears to be rare locally. This species is a very rare Central Australian species with only six specimens in the W.A. Museum prior to this capture, and none since 1975.

The Sandy Inland Mouse (Pseudomys hermannsburgensis) was common and widespread, and recorded from all habitats except stony hills.

The Spinifex Hopping-mouse (Notomys alexis) was common and widespread, and recorded from all habitats except stony hills.

The *House Mouse (Mus musculus) was common and widespread after rain, and recorded in all habitats. It was most common near drainage lines.

LEPORIDAE

The *Rabbit (Oryctolagus cuniculus) was recorded only once, in August 1992, in the north-eastern corner of the study area. This species was clearly rare locally even after rain.

CANIDAE

The *Dingo (Canis familiaris dingo) was common and widespread, and seen in all habitats.

The *Fox (Vulpes vulpes) was reported only once, in 1986, to the north of the study area. This species was clearly rare locally even after rain.

FELIDAE

The *Feral Cat (Felis catus) was widespread but scarce, and was recorded occasionally throughout the study area and regionally.

CAMELIDAE

The *One-humped Camel (Camelus dromedarius) was common and widespread. It was usually seen in small groups but herds of over 100 individuals were seen.

BOVIDAE

*Feral Cattle (Bos taurus) were seen on one occasion in 1988 in the Rudall River. These animals had presumably wandered from pastoral areas to the west after good rains had made this possible. Cattle could conceivably occur at Kintyre by following the Yandagooge Creek.

APPENDIX 4. List of specimens held in the W.A. Museum, with accession numbers.

Species		WAM numbers
Frogs		
LEPTODACTYLIDAE		
Limnodynastes spenceri		R95447
Neobatrachus aquilonius		R98749, 98750
Notaden nichollsi		R95446
Reptiles		
GEKKONIDAE	**Geckos**	
Crenadactylus ocellatus horni		R100988
Diplodactylus ciliaris aberrans		R94762, 94763
D. conspicillatus		R94738
D. elderi		R 95445, 100452
D. jeanae		R95444
D. stenodactylus		R94739, 94773-5
Gehyra pilbara		R94727, 94781, 94783
G. punctata		R94778-80, 94782
G. purpurascens		R94750
Heteronotia binoei		R94748
Nephrurus levis pilbarensis		R94729
Oedura marmorata		R94764
Rhynchoedura ornata		R94744
PYGOPODIDAE	**Legless Lizards**	
Delma butleri		R100987
D. nasuta		R94766
D. pax		R94757, 94776, 94777
Lialis burtonis		R94754
Pygopus nigriceps nigriceps		R94761
AGAMIDAE	**Agamids**	
Ctenophorus c. caudicinctus		R94728, 96252
C. inermis		R94760
C. i. isolepis		R94743
Diporiphora winneckei		R94759
Gemmatophora longirostris		R94749

SCINCIDAE	**Skinks**	
Ctenotus ariadnae		R100443-6
C. calurus		R95442, 97788
C. dux		R95437
C. q. grandis		R95438, 98751
C. hanloni		R94740
C. helenae		R94745
C. pantherinus ocellifer		R94758
C. piankai		R100449
C. quattuordecimlineatus		R94730, 100447,100448
C. saxatilis		R94770-2
C. schomburgkii		R100450
C. serventyi		R94751, 94755, 95439-41
Cyclodomorphus branchialis		R100986
Egernia depressa		R94722
E. striata		R100451
Eremiascincus fasciolatus		R94756
Lerista bipes		R94731-4, 94741, 94747, 94752
Menetia greyii		R94742, 94746
Morethia ruficauda exquisita		R94723, 94726
Notoscincus ornatus		R95443
Proablepharus reginae		R96251, 100442
VARANIDAE	**Goannas**	
Varanus acanthurus		R94753
V. brevicauda		R96248
V. eremius		R96249
V. gouldii		R94769
TYPHLOPIDAE	**Blind Snakes**	
Ramphotyphlops diversus ammodytes		R94724, 100453
R. endoterus		R94735-7
R. grypus		R94436, 97789
BOIDAE	**Pythons**	
Liasis perthensis		R94765
L. stimsoni stimsoni		R94768
ELAPIDAE	**Elapid Snakes**	
Furina ornata		R100983
Pseudonaja modesta		R94767
Vermicella anomala		R96250, 96444, 96782

Mammals

DASYURIDAE	
Dasykaluta rosamondae, Little Red Antechinus	M29330
Pseudantechinus woolleyae, Antechinus	M25772
Pseudantechinus sp.	M29308, 25309, 29325, 29326
Sminthopsis youngsoni, Lesser Hairy-footed Dunnart	M25774, 25777-80, 27892-27907, 29310, 29313-29324
Ningaui timealeyi, Pilbara Ningaui	M27908, 29311
Ningaui sp. cf. timealeyi	M29312
Planigale maculata, Common Planigale	M25773, 25775, 25776
EMBALLONURIDAE	
Taphozous georgianus, Common Sheathtail-bat	M29519
VESPERTILIONIDAE	
Chalinolobus gouldii, Gould's Wattled Bat	M25815-8
Scotorepens greyii, Little Broad-nosed Bat	M25819-21, 36672
Eptesicus finlaysoni,	M25814
MURIDAE Mice	
Pseudomys desertor, Desert Mouse	M29328
P. hermannsburgensis, Sandy Inland Mouse	M26792

APPENDIX 5. Copy of a report by A. Baynes on bones from an owl deposit near Kintyre.

The location of the cave site is given in Map 2.

Report on mammal bone remains collected by R.P. Hart *et al.* in the Kintyre Range, from a cave at 22°18'S., 122°00'E.

After initial sorting by R.P. Hart, the samples of bone were transferred to A. Baynes at the W.A. Museum, where they were prepared and identified. Bat specimens were identified by Barbara A. Jones, who has particular expertise in this group; all other identifications were made by A. Baynes.

All the bones examined appear to have been accumulated in the cave by birds of prey. The most improtant of these are owls, almost certainly the Barn Owl *Tyto alba*. A small contribution may have been made by the Australian Kestrel *Falco cenchroides*. Owls are nocturnal and hunt the small vertebrates which are active at night, particularly mammals; kestrels are diurnal and hunt insects and lizards. The bone samples consist mainly of remains of mammals of a size which could have been preyed upon by Barn Owls - medium-sized species are represented only by juveniles, whereas small species include individuals of all ages. Also, some of the newest material is still contained in boluses covered with dried black mucus which is characteristic of owls of the genus *Tyto*.

Cave sites, such as the one from which this material originated, accumulate material on a continual basis. Thus bones released from a recent owl bolus by insect activity spread onto the floor where they are mixed with older material by the passage of animals across and through the surface of the deposit. As a result, most of the samples presented for identification contained both old and new material.

Colour has been the main criterion used to assess the age of the mammal bones in the Kintyre Range samples. Bones of animals that have died within the last decade or so usually contain some residual fat which gives them a greyish translucent appearance, whereas older bone first becomes opaque and then changes colour through cream and yellow to brown. The rate of change of colour depends upon the environment in which the bone is preserved. The specimens have been divided only into "Old" and "New". New material is considered to have been dropped in the cave by owls in the last few years and therefore to represent species which may still be living in the area; Old material predates New and is of unknown age, but is considered to represent the "original" fauna, i.e. the

fauna that occurred in the area before the animals were affected by the arrival of European man in Australia.

The species identified in the various samples from the cave, and the aggregate Old and New mammal faunas are shown in the Table of Results. The original fauna represented by the Old material is much richer in species and more diverse than the present day fauna represented by the New material. Both faunas contain species which are of interest in themselves. These and the differences between the faunas are discussed below.

The total recorded mammal fauna consists of 32 species, of which 27 are ground mammals (26 native and the introduced House Mouse *Mus musculus*), and five are bats. The ground mammals are small to medium-sized species. Larger species such as plains dwelling Red Kangaroo (*Macropus rufus*) and the rocky hill dwelling Euro (*Macropus robustus*) are not recorded, even though they have almost certainly been continually present in the area throughout the period of accumulation of the cave deposit. As noted above, this size bias is the result of the remains being mainly accumulated by owls.

Owls generally catch everything present, and the sample size is large enough to contain practically all the species whose remains have been dropped in the cave. However, this fauna is probably not all-inclusive. The fact that *Ningaui* sp. cf. *N. ridei* is recorded only in the New fauna and not in the Old, and the distribution of the rarer species among the various samples indicate that chance has played a part in the distribution of the records between the samples, and therefore possibly whether one or two species have been recorded or not. The bat fauna is probably much less complete. Barn Owls do not normally prey on bats, and so the species recorded are probably based on the remains of individuals which have died in the cave.

The original fauna, judged both against the New fauna recorded in the cave and against live mammal faunas found by surveys of the adjacent Sandy deserts, is much richer than any living fauna. This phenomenon is not restricted to the region in which this cave lies, but is general throughout the arid zone, and marks the devastating effect that European man has had upon the native mammal fauna of the deserts (e.g. Morton and Baynes 1985).

The material reported upon here is of particular academic interest because it derives from an area not previously represented by such cave deposit surface material. The fauna is unique in containing the only known case in which the Northern and Western Quolls (*Dasyurus hallucatus* and *Dasyurus geoffroii*) are recorded from the same area. Other noteworthy species include the Pig-footed Bandicoot (*Chaeropus ecaudatus*) which was not previously known to have occurred in the area, and the rare and poorly known Central Rock-rat (*Zyzomys pedunculatus*).

The relative abundances of species in the Old fauna probably reflect the areas of suitable habitats around the cave site.

The New fauna also includes some interesting species. The Long-tailed Dunnart (*Sminthopsis longicaudata*) is a species about which until recently very little was known and which was assumed to be vanishingly rare, but which in fact is moderately widespread in rocky ranges of the north-western arid zone (Burbidge *et al.*, p. 59 in Strahan 1983). The other two important records depend upon rather slim evidence. If the Western Chestnut Mouse (*Pseudomys nanus*) and the Pale field-rat (*Rattus tunneyi*) do occur as living animals in the area, they represent the only known living populations of both species on the mainland of north-western Australia. Both are represented in the New fauna by only one or two specimens which fulfil the necessary criteria to be considered New material. Both species are therefore correspondingly uncertain as members of the present day fauna.

References

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A. Baynes,
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Table of Results

Mammal faunas from the cave in the Kintyre Range at about 22°18'S., 122°00'E.

Species	0	1A	1B	2	3	4	5	6	8	9	Old	New
*Dasyurus geoffroii**	..	..	√.	..	..	..	..	..	..	..	X	..
Dasyurus hallucatus	√.	..	√.	..	..	.√	..	..	..	√.	X	(X)
Dasycercus cristicauda	..	..	√.	..	..	√.	..	..	√.	√.	X	..
Antechinus rosamondae	..	√.	√.	..	.√	.√	..	..	..	..	X	X
Pseudantechinus macdonnellensis	√.	..	√.	..	..	..	..	..	..	√.	X	..
Pseudantechinus woolleyae	√.	..	√.	..	√.	.√	..	.√	..	√.	X	X
Planigale maculata	..	.√	√.	..	√.	..	.√	..	..	..	X	X
Ningaui sp. cf. *N. ridei*	..	.√	..	..	.√	..	..	..	..	..	..	X
Sminthopsis longicaudata	?.	..	√.	..	.√	?.	..	..	..	..	X	X
Sminthopsis youngsoni	√√	.?	?.	..	.√	.?	.√	..	.√	√.	X	X
Antechinomys laniger	..	..	..	..	..	..	..	√.	..	..	X	..
*Chaeropus ecaudatus***	..	..	√.	..	..	..	√.	..	..	√.	X	..
*Isoodon auratus**	√.	..	√.	..	√.	√.	√.	√.	√.	√.	XX	..
*Perameles eremiana***	..	..	√.	..	..	..	..	..	..	..	X	..
Macrotis lagotis	..	..	..	..	..	..	..	..	√.	..	X	..
*Trichosurus vulpecula**	..	..	√.	..	..	..	..	..	..	..	X	..
*Bettongia lesueur**	..	..	√.	..	..	..	..	..	..	..	X	..
Notomys alexis	√√	.√	√√	.√	√√	√√	√√	√.	√.	√.	XX	XXX
*Notomys amplus***	√.	..	√.	..	..	√.	√.	√.	√.	√.	X	..
*Notomys longicaudatus***	√.	..	√.	√.	√.	√.	√.	√.	√.	√.	XX	..
Pseudomys desertor	√.	..	√.	..	..	√.	√.	..	√.	√.	XX	..
Pseudomys hermannsburgensis	√√	.√	√.	.√	√√	√√	√√	√.	√.	√.	XX	XX
Pseudomys nanus	√.	..	√.	..	√.	√.	√√	√.	√.	√.	XX	X
Zyzomys argurus	√.	..	√.	..	..	√.	√√	√.	√.	√.	XX	X
*Zyzomys pedunculatus**	√.	..	√.	..	..	√.	√.	√.	√.	√.	XX	..
ittus tunneyi	√.	..	√.	..	√√	√.	√.	√.	√.	√.	XX	(X)
Mus musculus	√√	.√	.√	.√	.√	√√	√√	..	..	.√	X	XXX
Macroderma gigas	..	..	√.	..	..	..	..	..	..	..	X	..
Taphozous georgianus	√.	..	√.	..	..	..	..	√.	..	..	X	..
Taphozous hilli	..	..	√.	..	..	..	?.	..	..	..	X	..
Chalinolobus gouldii	..	..	..	.?	..	..	..	.√	..	..	X	X
Rhinonicteris aurantius	..	..	√.	..	..	..	..	..	....	..	X	..
Total species											31	14

KEY: * = locally extinct ** = totally extinct
√. = Old fauna only; .√ = New fauna only; √√ = both Old and New faunas
X, XX, XXX = low, intermediate & high abundance
?, (X) = less certain records

APPENDIX 6. Birds recorded at Kintyre.

The birds recorded at each visit are listed as a Lotus 123 file. A disk version is in Appendix 10 as "birds.wk1".

BIRD RECORDS, SURVEY INTERVALS 1986-1989.

	APR '86	SEP '86	DEC '86	APR '87	SEP '87	DEC '87	FEB '88	MAR '88	AUG '88	NOV '88	JUN '89	TOTAL
Emu	x									x		2
Australasian Grebe						x		x				2
Hoary-headed Grebe						x		x				2
Pacific Heron								x				1
White-faced Heron								x				1
Grey Teal								x	x	x		3
Maned Duck								x				1
Black-shouldered Kite							x	x	x	x		4
Whistling Kite							x	x				2
Australian Goshawk				x			x		x			3
Collared Sparrowhawk						x	x					2
Wedge-tailed Eagle					x					x		2
Little Eagle						x						1
Spotted Harrier										x	x	2
Brown Falcon	x	x	x	x		x	x	x	x	x	x	10
Australian Kestrel	x	x	x	x	x	x	x	x		x	x	10
Little Falcon			x						x	x		3
Grey Falcon											x	1
Little Button-quail					x	x	x		x	x		5
Black-tailed Native-hen								x				1
Australian Bustard	x	x	x	x		x	x	x	x	x	x	10
Black-fronted Dotterel						x		x				2
Australian Pratincole										x		1
Crested Pigeon		x	x	x	x	x	x	x	x	x	x	10
Common Bronzewing							x	x		x	x	4
Spinifex Pigeon				x		x	x	x	x	x		6
Diamond Dove		x	x	x	x	x	x	x	x	x	x	10
Galah	x		x	x	x	x	x	x	x	x	x	10
Port Lincoln Ringneck	x			x	x						x	4
Cockatiel				x	x	x	x	x	x	x		7
Budgerigar		x		x	x	x	x	x	x	x	x	9
Pallid Cuckoo		x							x			2
Boobook Owl								x				1
Owlet-nightjar										x		1
Spotted Nightjar				x								1
Red-backed Kingfisher				x	x		x	x	x		x	6
Rainbow Bee-eater	x	x	x		x	x	x	x	x	x	x	10
Singing Bushlark				x								1
White-backed Swallow	x		x	x							x	4
Tree Martin				x				x				2
Richard's Pipit	x	x	x	x	x	x	x	x	x	x	x	11
Black-faced Cuckoo-shrike	x	x		x	x	x	x	x	x	x	x	10
White-winged Triller				x		x	x		x		x	5
Red-capped Robin	x											1
Grey Shrike-thrush							x	x	x	x	x	5
Willie Wagtail	x	x	x	x	x	x	x	x	x		x	10
Spinifexbird					x							1
Rufous Songlark				x					x	x	x	4
Brown Songlark						x		x				2
Variegated Fairy-wren	x											1
White-winged Fairy-wren		x	x		x	x	x	x	x	x	x	9

BIRD RECORDS, SURVEY INTERVALS 1986-1989.

	APR '86	SEP '86	DEC '86	APR '87	SEP '87	DEC '87	FEB '88	MAR '88	AUG '88	NOV '88	JUN '89	TOTAL
Weebill								x				1
Yellow-throated Miner	x	x		x	x	x	x	x	x	x	x	10
Singing Honeyeater	x	x	x	x	x	x	x	x	x	x	x	11
Grey-headed Honeyeater							x	x		x	x	4
Grey-fronted Honeyeater	x			x								2
White-plumed Honeyeater	x	x	x	x	x	x	x	x	x	x	x	11
Black-chinned Honeyeater	x											1
Brown Honeyeater							x	x	x	x		4
White-fronted Honeyeater	x						x					2
Black Honeyeater				x			x					2
Pied Honeyeater										x	x	2
Crimson Chat	x			x		x	x	x	x	x	x	8
Mistletoebird											x	1
Red-browed Pardalote		x				x	x	x	x	x	x	7
Striated Pardalote									x			1
Painted Firetail	x					x	x		x	x		5
Zebra Finch	x	x	x	x	x	x	x	x	x	x	x	11
Australian Magpie-lark	x			x			x	x	x	x	x	7
Masked Woodswallow				x			x			x		3
Black-faced Woodswallow	x	x	x	x	x	x	x	x	x	x	x	11
Little Woodswallow	x		x		x	x	x	x	x	x		8
Pied Butcherbird	x	x	x	x	x	x	x	x	x		x	10
Australian Magpie								x				1
Little Crow										x	x	2
Torresian Crow	x	x	x	x	x	x	x	x	x	x	x	11

APPENDIX 7. Summary of bird records. All species recorded in or around the Kintyre study area or in the region are listed. The species are divided into:

K seen at Kintyre
RR seen at the Rudall River
Reg seen at other sites regionally as part of the Rudall Project.

DROMAIIDAE		
Dromaius novaehollandiae,	Emu	K
PODICIPEDIDAE		
Poliocephalus poliocephalus,	Hoary-headed Grebe	K
Tachybaptus novaehollandiae,	Australasian Grebe	K
ARDEIDAE		
Ardea pacifica,	Pacific Heron	K
A. novaehollandiae,	White-faced Heron	K
PLATALEIDAE		
Threskiornis spinicollis,	Straw-necked Ibis	K
ANATIDAE		
Anas superciliosa,	Pacific Black Duck	K
A. gibberfrons,	Grey Teal	K
Malacorhynchus membranaceus,	Pink-eared Duck	RR
Aythya australis,	White-eyed Duck	RR
Chenonetta jubata,	Maned Duck	K
ACCIPITRIDAE		
Elanus notatus,	Black-shouldered Kite	K
Haliastur sphenurus,	Whistling Kite	K
Accipiter fasciatus,	Brown Goshawk	K
A. cirrhocephalus,	Collared Sparrowhawk	K
Aquila audax,	Wedge-tailed Eagle	K
Hieraaetus morphnoides,	Little Eagle	K
Circus assimilis,	Spotted Harrier	K
FALCONIDAE		
Falco longipennis,	Little Falcon	K
F. hypoleucos,	Grey Falcon	K
F. berigora,	Brown Falcon	K
F. cenchroides,	Australian Kestrel	K
TURNICIDAE		
Turnix velox,	Little Button-quail	K
RALLIDAE		
Gallinula ventralis,	Black-tailed Native-hen	K

OTIDIDAE
Ardeotis australis, Australian Bustard K

CHARADRIIDAE
Charadrius melanops, Black-fronted Dotterel K

RECURVIROSTRIDAE
Himantopus himantopus, Black-winged Stilt K

GLAREOLIDAE
Stiltia isabella, Australian Pratincole K

LARIDAE
Larus novaehollandiae, Silver Gull K

COLUMBIDAE
Geopelia cuneata, Diamond Dove K
Phaps chalcoptera, Common Bronzewing K
Ocyphaps lophotes, Crested Pigeon K
Petrophassa plumifera, Spinifex Pigeon K

CACATUIDAE
Cacatua roseicapilla, Galah K

POLYTELITIDAE
Nymphicus hollandicus, Cockatiel K

PLATYCERCIDAE
Melopsittacus undulatus, Budgerigar K
Barnardius zonarius, Port Lincoln Ringneck K

CUCULIDAE
Cuculus pallidus, Pallid Cuckoo K
Chrysococcyx basalis, Horsfield's Bronze-Cuckoo Reg

STRIGIDAE
Ninox novaeseelandiae, Southern Boobook K

AEGOTHELIDAE
Aegotheles cristatus, Australian Owlet-nightjar K

CAPRIMULGIDAE		
Caprimulgus guttatus,	Spotted Nightjar	K
ALCEDINIDAE		
Halcyon pyrrhopygia,	Red-backed Kingfisher	K
MEROPIDAE		
Merops ornatus,	Rainbow Bee-eater	K
ALAUDIDAE		
Mirafra javanica,	Singing Bushlark	K
HIRUNDINIDAE		
Cheramoeca leucosternum,	White-backed Swallow	K
Cecropis nigricans,	Tree Martin	K
C. ariel,	Fairy Martin	K
MOTACILLIDAE		
Anthus novaeseelandiae,	Richard's Pipit	K
CAMPEPHAGIDAE		
Coracina novaehollandiae,	Black-faced Cuckoo-shrike	K
Lalage sueurii,	White-winged Triller	K
MUSCICAPIDAE		
Petroica goodenovii,	Red-capped Robin	K
Melanodryas cucullata,	Hooded Robin	Reg
Pachycephala rufiventris,	Rufous Whistler	Reg
Colluricincla harmonica,	Grey Shrike-thrush	K
Oreoica gutturalis,	Crested Bellbird	Reg
Rhipidura leucophrys,	Willie Wagtail	K
ORTHONYCHIDAE		
Cinclosoma cinnamomeum,	Cinnamon Quail-thrush	Reg
TIMALIIDAE		
Pomatostomus superciliosus,	White-browed Babbler	Reg

SYLVIIDAE		
Eremiornis carteri,	Spinifexbird	K
Cinclorhamphus mathewsi,	Rufous Songlark	K
C. cruralis,	Brown Songlark	K
MALURIDAE		
Malurus lamberti,	Variegated Fairy-wren	K
M. leucopterus,	White-winged Fairy-wren	K
ACANTHIZIDAE		
Smicrornis brevirostris,	Weebill	K
Acanthiza uropygialis,	Chestnut-rumped Thornbill	Reg
MELIPHAGIDAE		
Acanthagenys rufogularis,	Spiny-cheeked Honeyeater	Reg
Manorina flavigula,	Yellow-throated Miner	K
Lichenostomus virescens,	Singing Honeyeater	K
L. keartlandi,	Grey-headed Honeyeater	K
L. plumulus,	Grey-fronted Honeyeater	K
L. penicillatus,	White-plumed Honeyeater	K
Melithreptus gularis,	Black-chinned Honeyeater	K
Lichmera indistincta,	Brown Honeyeater	K
Phylidonyris albifrons,	White-fronted Honeyeater	K
Certhionyx niger,	Black Honeyeater	K
C. variegatus,	Pied Honeyeater	K
EPHTHIANURIDAE		
Ephthianura tricolor,	Crimson Chat	K
DICAEIDAE		
Dicaeum hirundinaceum,	Mistletoebird	K
PARDALOTIDAE		
Pardalotus rubricatus,	Red-browed Pardalote	K
P. striatus,	Striated Pardalote	K

PLOCEIDAE

Emblema picta,	Painted Firetail	K
Poephila guttata,	Zebra Finch	K

GRALLINIDAE

Grallina cyanoleuca,	Australian Magpie-lark	K

ARTAMIDAE

Artamus personatus,	Masked Woodswallow	K
A. cinereus,	Black-faced Woodswallow	K
A. minor,	Little Woodswallow	K

CRACTICIDAE

Cracticus nigrogularis,	Pied Butcherbird	K
Gymnorhina tibicen,	Australian Magpie	K

CORVIDAE

Corvus bennetti,	Little Crow	K
C. orru,	Torresian Crow	K

APPENDIX 8. Copy of a report by Davis and Whittles on aquatic invertebrates at Kintyre, and subsequent correspondence.

The locations are given in Map 2.

REPORT ON

THE AQUATIC INVERTEBRATE FAUNA OF POOLS IN THE RUDALL RIVER REGION OF THE GREAT SANDY DESERT, W.A.

PREPARED FOR

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SEPTEMBER, 1988

INTRODUCTION

This report describes the macroinvertebrate fauna of pools in a small rocky gorge (approximately 22°20'S 122°E) in the Rudall River region of the Great Sandy Desert, Western Australia. The pools were sampled in March 1988 following a rain event that had occurred approximately seven weeks earlier. The study area falls well within the arid zone and the climate of the area is characterised by extreme seasonal temperature differences and low and erratic rainfall. No rain may fall in some years.

Few studies have been published on the invertebrate fauna of the ephemeral and permanent freshwaters of the Australian arid zone. The fact that the level of taxonomic knowledge of various groups of aquatic invertebrates in Australia is, for the most part, very inadequate and distributional records may reflect only that part of a species total range that has been sampled makes such studies that much more difficult to carry out. However a recent study of the macroinvertebrate fauna of the pools and streams of the George Gill Range in central Australia (Davis, Harrington and Friend, in prep) has provided a good background to this report on the macroinvertebrate fauna of pools in the Great Sandy Desert. In addition it is hoped that this study itself will also provide a contribution to the knowledge of the fauna of arid zone waterbodies.

METHODS

The field sampling programme was undertaken by Dr. Ray Hart. Four twenty second sweeps were taken in each of the pools listed in Table 1, except pool K where so few animals were present that half an hour was spent searching for material. In the laboratory four sweeps were chosen at random (from pools N, P , C, and M) for intensive study and all invertebrates, including the zooplankton, were removed and identified. The remaining sweeps and one sediment sample (27) were examined and all larger invertebrates were removed and identified. No zooplankton were examined in these latter sweeps due to time constraints. The contents of four further samples, which contained adult Odonata and Hemiptera (from pools Q, N, M and near M) were all examined and identified.

All specimens were identified to species level except for the Chironomidae (midges), the Ceratopogonidae (sand flies), the Oligochaeta (worms) and the Hydracarina (water mites).These groups are difficult to identify because of the lack of published keys or descriptions.

RESULTS

Site Description

All the pools sampled were in gorges in a stony plateau except for pool K which was in the bed of a minor river.

Table 1. Description of pools sampled in the Great Sandy Desert in March 1988.

POOL	DIMENSIONS	SUBSTRATE
C	50 X 7 m 1 m deep	Sandy, little mud
E	20 x 8 m 1.8 m deep	Sandy, little mud
F	40 x 10 m 1.5 m deep	Sandy, moderate mud
K	200m long <1 m deep	Very muddy
M	30 x 20 m 2 m deep	Sandy, little mud
N	60 x 10 m 1.7 m deep	Sandy, little mud
P	15 m diameter > 2 m deep	Very muddy
Q	25 x 15 m	Sandy, some mud

Table 2. Nutrient levels and pH of pools sampled in the Great Sandy Desert in March 1988.

POOL	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Phaeophytin (µg/L)	Chlorophyll 'a' (µg/L)	pH
C	57	909	33.38	10.68	6.64
E	83	993	17.36	26.7	6.17
F	41	1120	0.01	21.36	6.18
K		816	10.68	5.34	6.48
M	62	867	0.01	10.68	6.46
N	65	1373	10.68	21.36	6.47
P	38	1449	0.01	5.34	6.2
Q	42	892	13.35	10.68	6.16

Water Chemistry

There was little variation in pH in the pools sampled; values were slightly less than neutral and ranged from 6.16 to 6.64 (Table 2). Nutrient levels indicate that the pools are enriched, but not excessively so. Values of total P ranged from 41-83 µg/L indicating that they were eutrophic but not hypereutrophic (total P > 30µg/L = eutrophic, >100µg/L = hypereutrophic). The pools are also classified as eutrophic on the basis of total nitrogen values. Values of total N ranged from 816 to 1449 µg/L, the criterion for eutrophy ranges from 500 to 15,000 µg/L. Values of chlorophyll *a* ranged from 5.34 to 26 µg/L , the two pools with concentrations of 5.34 µg/L ; pools P and K, were below the criterion for eutrophication, while the remaining pools fell within the range (10 to 500 µg/L) considered to be indicative of eutrophy.

Macroinvertebrate Fauna

Species Richness and Abundance

All the species recorded from the pools and the presence /absence of each species in each pool are given in Table 3. A total of 58 species were recorded from the pools and this number must be considered to be conservative because several taxa, for example the chironomids and the ceratopogonids, were not identified beyond the familial level. Of the larger invertebrates only the notonectid (or backswimmer), *Anisops* nr *nasuta* was common to every pool. Three species of microcrustacea were present in all four sweeps examined for zooplankton. These were the ostracods *Cypretta* nr *minna* and a new ostracod species, and one cladoceran, *Mesocyclops* sp.. Several taxa occurred in only one pool, however further collecting and intensive processing of more samples would undoubtedly reduce the occurence of unique species. Of the four pools from which all size classes were examined, pools M and C were the richest, with 25 and 20 species respectively, while pools P and Q contained fewer species, 14 and 13 respectively. Pool N was the second richest pool with 23 species. Pools E and M were the most depauperate containing only 4 and 5 species respectively.

The Insecta were the dominant class in terms of species number, 33 species were recorded in comparison with 20 species of Crustacea. However the Crustacea were often dominant in terms of abundance of individuals. The numbers of individuals recorded in the 20 second sweeps taken from each of the four pools studied in detail are given in Table1. Each pool was dominated by a different group of crustaceans. Copepods were dominant in pool C, anostracans in pool P, ostracods in pool N and cladocerans in pool M. Pool M was the most diverse with ostracods and conchostracans also occurring in relatively large proportions. Pool N and pool C contained the greatest numbers of invertebrates, 4 764 and 4 395 organisms per 20 second sweep respectively.

Table 3. List of taxa present in pools sampled in the Great Sandy Desert in March 1988. (+ indicates the presence of a taxon in a pool).

TAXON		POOLS								
		*C	E	F	K	*M	nr. M	*N	*P	Q
ANNELIDA										
OLIGOCHAETA		+								
MOLLUSCA										
GASTROPODA										
Planorbidae										
Isodirella sp. A						+				
Isidorella (like but hairy)		+								
ARACHNIDA										
ACARINA		+				+		+		
ARTHROPODA										
CRUSTACEA										
OSTRACODA										
Cyprididae										
Alboa fitzroyi	(Mackenzie)	+				+		+		
Cypretta nr. minna		+				+		+	+	
Cypricercus salinus		+								
Newnhamia fenestrata	King					+		+		
NEW SPECIES		+				+		+	+	
COPEPODA										
Cyclopoida										
Mesocyclops sp.		+				+		+	+	
Calanoida										
Diaptomus lumholzi	Sars	+						+		
CLADOCERA										
Daphniidae										
Ceriodaphnia laticaudata	Müller	+				+		+		
Daphnia sp.		+								
Chydoridae										
?Biapertura sp.		+								
Moinidae										
Moina nr. mongolica	Daday					+				
Cladoceran unidentified sp.								+		
CONCHOSTRACA										
Limnadopsis sp. 1					+	+				
Limnadopsis sp. 2							+			
Limnadia sp. 1					+				+	
Limnadia sp. 2										+
ANOSTRACA										
Anostraca sp.A			+	+			+			
Branchinella sp. 1					+					
Branchinella sp. 2									+	+
Branchinella sp. 3									+	
INSECTA										
ODONATA										
Anisoptera										
Aeshnidae										
Hemianax papuensis (L)	(Burmeister)	+		+			+			
Libellulidae										
Orthetrum caledonicum	(Brauer)					+		+		
Orthetrum migratum	Lieft					+				+

		*C	E	F	K	*M	nr.M	N	*P	*Q
Zygoptera										
Coenagrionidae										
Ischnura pruinescens/heterostic	(Burmeister)					+				
Lestidae										
Austrolestes sp. (L)		+		+				+		
Austrolestes leda					+					
Austrolestes annulosus	(Selys)									+
Megapodagriidae							+			
Argiolestes sp. (L)										
Corduliidae (L)					+	+				
HEMIPTERA										
Hemiptera spp. juv.		+		+				+		
Corixidae	(Hale)/									
Agraptocorixa parvipunctata/hu	Hungerford				+	+		+		
Micronecta robusta	Hale	+	+	+				+	+	+
Notonectidae										
Anisops nr. nasuta	Fieber	+	+	+	+	+	+	+	+	+
Nepidae										
Laccotrephes tristis						+				
Ranatra sp.							+			
DIPTERA										
Chironomidae		+				+		+	+	
Ceratopogonidae								+		
TRICHOPTERA										
Ecnomidae										
Ecnomus sp.								+		
COLEOPTERA										
Gyrinidae										
Gyrinidae sp. (L)				+						+
Macrogyrus (Tribolominimus) gouldi?					+				+	+
Dytiscidae										
Eretes sp. (L)					+				+	+
Eretes australis	(Erichson)	+				+			+	+
Rhanticus congestes (L)	(Klug)								+	+
Rhanticus congestes	(Klug)	+		+		+		+		+
Hyphydrus sp. (L)						+		+		+
Hyphydrus elegans	(Montrouzier)					+		+		
Hyphydrus lyratus	Schwartz					+				+
Necterosoma sp. (L)		+				+		+		
Necterosoma penicillatus	(Clark)					+				
Antiporus sp.								+		
Hydrochidae										
Hydrochus sp.					+					
Hydrophilidae (L)			+							
Curculionidae (L)									+	
Scarabaeoidea										
Psammodius sp. (T)									+	

* = one sweep from each of these pools was examined for zooplankton

Table 4. The number and percentage composition of taxa occuring in selected samples from pools in the Great Sandy Desert.

TAXON	Pool M Sweep 1		Pool C Sweep 3		Pool P Sweep 3		Pool N Sweep 4	
	Numbers	% Comp	Numbers	% Comp	Numbers	% Comp	Numbers	% Comp
Oligochaetes	0	0.00	33	0.75	0	0.00	0	0.00
Gastropods	33	1.93	3	0.07	0	0.00	0	0.00
Ostracods	385	22.54	77	1.75	6	0.29	2301	48.30
Copepods	89	5.21	3884	88.37	240	11.44	1551	32.56
Cladocera	621	36.36	358	8.15	0	0.00	718	15.07
Conchostraca	2	0.12	0	0.00	1	0.05	0	0.00
Anostraca	0	0.00	0	0.00	1782	84.98	0	0.00
Arachnida	106	6.21	7	0.16	0	0.00	1	0.02
Odonata	1	0.06	0	0.00	0	0.00	0	0.00
Hemiptera	12	0.70	5	0.11	2	0.10	49	1.03
Diptera	440	25.76	20	0.46	55	2.62	126	2.64
Trichoptera	0	0.00	0	0.00	0	0.00	2	0.04
Coleoptera	19	1.11	8	0.18	11	0.52	16	0.34
TOTAL	1708	100.00	4395	100.00	2097	100.00	4764	100.00

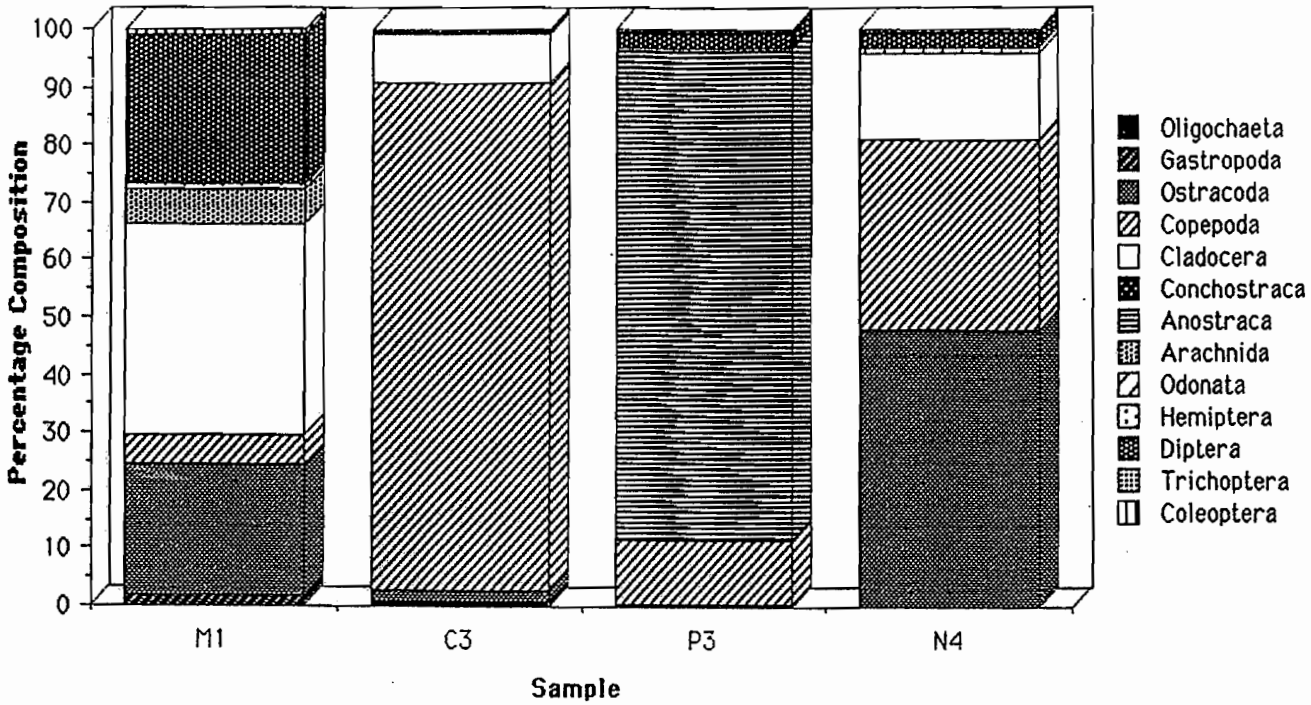

Figure 1. The percentage composition of taxa occuring in selected samples from pools in the Great Sandy Desert.

Species composition

Oligochaeta

Oligochaetes were recorded from only one pool, C, and no species determination has been made. This group would be expected to be under-represented in the samples collected because the method of collection, sweep-netting, would penetrate only a few centimetres into the pool bed.

Mollusca

Two species of gastropod from the genus *Isidorella* were collected from pools C and M respectively. This genus has been recorded from Victoria, South Australia, New South Wales and central Australia (Smith and Kershaw, 1979). These gastropods are probably able to survive dry periods buried in mud.

Hydracarina

Water mites were collected from pools C, M and N. No species determinations were made but specimens have been sent to Mark Harvey at the Museum of Victoria for identification.

Cladocera

Five species of cladocerans (water fleas) have been determined, two of which appear similar to published descriptions for *Ceriodaphnia laticaudata* and *Moina mongolica* respectively (Smirnov and Timms, 1983). However because some characters differ from those described for each species our specimens have been designated as "near" each species. Examination of this material by expert taxonomists is now required to determine whether or not these specimens represent new species. Although the genera present are widespread throughout Australia, the species *Moina mongolica* had previously only been recorded from Lake Eyre.

Copepoda

Copepods were one of the most abundant groups recorded at the pools.Two species were present; *Mesocyclops* sp. and *Diaptomus lumholzi.* The genus *Mesocyclops* is widespread throughout Australia. *D. lumholzi* is considered to have a northern distribution and has been recorded from north Queensland, the Northern Territory and the Kimberleys (Bayly, 1966).

Ostracoda

Ostracods were often one of the most abundant taxa in the pools and five species were recorded from the area, one of which appears to be a new species and has been sent to Dr Patrick De Deckker at ANU for description. *Alboa fitzroyi* had previously only been recorded from the north Kimberley region by McKenzie (1966) and from the George Gill Range, central Australia, by Davis, Harrington and Friend. *Newnhamia fenestrata* and

Cypricercus salinus have predominantly southern distributions but together with *Cypretta* nr *minna* were all recorded from waterbodies in central Australia by Davis, Harrington and Friend (in prep.).

Conchostraca

Four species of conchostracans from two genera, *Limnadopsis* and *Limnadia* were recorded from the pools.Williams (1980) noted that *Limnadopsis* occurs in NSW, SA, NT and WA and that *Limnadia* is widespread throughout the southern half of Australia. He notes that they are by no means common animals and generally occur in temporary waterbodies. Their eggs are resistant to dessication and the time from hatching to maturity may be extremely short. Specimens were first collected in central Australia by the Horn Expedition in the late 1800's.

Anostracans

Anostracans (fairy shrimps) together with notostracans (tadpole shrimps) are the most primitive of all the living Crustacea (Williams 1980). Three species of *Branchinella* plus an undetermined species occurred in the pools. *Branchinella* is generally found in temporary freshwaters and has eggs that are resistant to dessication, a feature characteristic of many other Crustacea collected from this area.

Notostraca

Notostracans (tadpole shrimps) were not collected as part of this study but they had been observed in some of the pools several weeks earlier. These crustaceans are most commonly associated with freshwater habitats that periodically dry up, and have resistant eggs that are easily wind dispersed because of their small size (Williams 1980).

Odonata

Eight species of Odonata were recorded from the area, five as adults and three as larvae. All species appeared to be fairly widespread in distribution. The dragonflies *Hemianax papuensis* and *Orthetrum caledonicum* have been recorded from all regions of Australia except Tasmania. *Orthetrum migratum* appears to be restricted to the northern and inland regions of Australia. Amongst the damselflies,*Ishnura heterosticta* also occurs everywhere except Tasmania while *I. pruinescens* has a northern distribution. *Austrolestes annulosus* has a southern and inland distribution. *A. leda* has a southern distribution and does not appear to have been recorded from inland Australia before. Members of the genus *Argiolestes* appear to be more restricted in their distribution than the preceding species and this genus does not appear to have previously been recorded from the arid zone (A. Watson, unpublished records).

Hemiptera

The two corixids recorded from the pools both appear to be fairly widespread in distribution. However, *Micronecta robusta* had previously

only been recorded from localities in southern Australia, including southern Western Australia. *Agraptocorixa parvipunctata /halei* possessed characters found in both *A .parvipunctata* and *A .halei.* These species have been recorded from WA, Qld, Vic, NSW and NT respectively (Knowles, 1974).

Specimens of the notonectid (backswimmer) *Anisops* nr *nasuta* possessed the same distinctive cephalic protrusion described for this species but the peg number on the stridulatory comb was 21 instead of 14. *A. nasuta* had previously been recorded from north Qld, NT, and NW Cape and Yardie Creek in WA (Lansbury, 1969).

Two species of water scorpion (Nepidae) were recorded from the pools; *Laccotrephes tristis* occurs throughout Australia and species of *Ranatra* are also common in both western and eastern Australia (Williams,1980).

Coleoptera

The dytiscids (diving beetles) were the richest family recorded from the pools. The taxonomy and distribution of the Dytiscidae are comparatively well known (Watts, 1978). Ten species of dytiscids (diving beetles) were recorded from the pools. *Hyphydrus lyratus, Hyphydrus elegans* and *Rhanticus congestes* have all been recorded from localities to the north of Australia (China, New Caledonia and India respectively). These species together with *Eretes australis* and *Necterosoma penicillatus* appear to be widely distributed throughout Australia. *H. lyratus* and *R. congestes* are both considered to have northern distributions. *Antiporus* is a southern genus that also occurs in New Zealand. *Antiporus bakewelli* has been recorded from Millstream WA.

Two gyrinids, a hydrochid, a hydrophilid, a curculionid and a scarab were also recorded from the pools.

Diptera

Neither the chironomids (midges) or ceratopogonids (sandflies) were identified to species level due to the lack of published keys. Ceratopogonids were present in low numbers only, but chironomids were abundant in pool M and to a lesser extent in pools P and N.

Trichoptera

Only one species of trichopteran (caddisfly), an Ecnomid, was present in the pools. Specimens of this species, which may be new, have been sent for identification to a specialist taxonomist, David Cartwright, in Melbourne.

DISCUSSION

The aquatic fauna recorded from the pools of the Rudall River region, in the Great Sandy Desert, appears to be composed of species that would be expected to occur in temporary bodies of freshwater in Australia's arid zone. The dominance of crustaceans, in terms of abundance, and the presence of groups such as conchostracans, anostracans and notostracans may be considered especially typical of ephemeral freshwaters. These groups have eggs that are resistant to dessication and are capable of completing their life cycle within a fairly short timespan. Some of the insect groups recorded from the pools such as the dragonflies and diving beetles are strong fliers and may travel long distances over arid land to colonise waterbodies created after rain. However the presence of less mobile and less dessication resistant groups such as the oligochaetes and chironomids suggests that a reservoir of permanent water (or at least a permanently damp substrate) must also exist within the area. Pools C, M and N in particular appear to contain more permanent water on the basis of their species composition.

For many of the species recorded here this study represents a significant extension of their previously known ranges of distribution. The area appears to represent a region of faunal mixing in that species with predominantly northern distributions, predominantly southern distributions and with arid zone affinities are all present.

Several new species were present in the samples and more are likely to be discovered if further taxonomic effort is directed to some groups, for example the oligochaetes and the chironomids, and if further sampling was undertaken. However it is impossible to say whether or not these species are unique to these pools because of the poor state of knowledge of the species composition of waterbodies of the region and the arid zone in general.

On the basis of the total number of species recorded from the pools (58) the area appears to be fairly rich in species. Although this total is less than the total (87) recorded from wetlands in the Perth region and from the George Gill Range in central Australia (114) (Davis and Rolls 1987; Davis,Harrington and Friend, in prep) using the same sampling methods. A direct comparison is not valid because the latter waterbodies were sampled on more than one occasion. Further sampling of the Great Sandy Desert pools will undoubtedly reveal more species. The highest number of species recorded from one pool on one occasion, 25 from pool M, does compare favourably with the maximum numbers collected from a Perth wetland (32 from Thomsons Lake) and from the George Gill Range (37 from Stokes Creek).

It is difficult to say whether or not the species present in the pools may have been a source of food to the aboriginal inhabitants of the area without interviewing people who had followed a traditional lifestyle in the region. However the lack of any recorded use of macroinvertebrates or zooplankton elsewhere in Australia as a food source suggests that they are unlikely to have been an important component in the diet of the inhabitants of this area. Pastor Peter Bulla, who had lived near the freshwaters of the George Gill Range in central Australia as a child was interviewed with regard to this

matter by one of us (JAD) in 1987. He could not recall eating any of the aquatic invertebrates shown to him but he did note that the arrival of swarms of notonectids (backswimmers) was considered to indicate impending rain.

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Hart Simpson and Associates Pty. Ltd.
324 Onslow Road
Shenton Park 6008

Attention Ray Hart

Dear Ray

This letter is to let you know that we have not received any additional taxonomic information on specimens obtained from the aquatic biology survey of pools in the Great Sandy Desert in March 1988. Given the time that has elapsed since that study it is unlikely that further information will come to hand, however, if it does I will forward it to you as soon as received.

yours sincerely

Jenny Davis

Dr Jenny Davis
Lecturer in Aquatic Ecology

March 15, 1993

APPENDIX 9 A list of the photographs available of sites used in fauna studies.

A partial set of photographs from the Kintyre environmental studies is preserved as a single set covering vegetation, rehabilitation and fauna studies.

Only parts of some rolls deal with the Kintyre Project, but each roll is numbered independently and consecutively. The rolls are:

Roll	Subject
1.	Rehabilitation plots June 1987 (part).
	Vegetation mapping June 1987 (part).
2.	Vegetation mapping June 1987 (part).
3.	Vegetation mapping June 1987 (part).
	Rehabilitation plots June 1987 (part).
4.	Rehabilitation plots June 1987 (part).
5.	Pit trapping sites 26-35 December 1987.
6.	Pools considered for aquatic invertebrates sampling, February 1988 (part).
7.	Pools considered for aquatic invertebrates sampling, February 1988 (part).
	Rehabilitation plots February 1988 (part).
8.	Rehabilitation plots February 1988 (part).
9.	Rehabilitation plots February 1988 (part).
10.	Pools used in aquatic invertebrates sampling, March 1988.
	Rehabilitation plots March 1988 (part).
11.	Rehabilitation plots March 1988 (part).
12.	Rehabilitation plots March 1988 (part).
13.	Rehabilitation plots August 1988 (part).
14.	Rehabilitation plots August 1988 (part).
15.	Rehabilitation plots August 1988 (part).
16.	Pit trapping sites 36-39 November 1988.
17.	Rehabilitation plots June 1989 (part).
18.	Rehabilitation plots June 1989 (part).
19.	Rehabilitation plots June 1989 (part).

The surviving photographs of sites used in fauna studies are listed below.

Pit trapping sites.

The photographs of sites 1-25 have been lost, and they were not included in the original reports.

Photographs of the following sites are preserved:

Trapping site.	Photograph (Roll/photograph)	Date
26	5/16	December 1987
27	5/17	December 1987
28	5/18	December 1987
29	5/19	December 1987
30	5/20	December 1987
31	5/21	December 1987
32	5/22	December 1987
33	5/23	December 1987
34	5/24	December 1987
35	5/25	December 1987
36	16/34	November 1988
37	16/35,36	November 1988
38	16/32	November 1988
39	16/33	November 1988

Pools considered in aquatic invertebrates survey.

Photographs of all pools are preserved:

Pool	Photograph	Date
A	6/17	February 1988
B	6/18	February 1988
C	6/19, 20	February 1988
D	6/21	February 1988
E	6/22	February 1988
F	6/23	February 1988
G	6/24, 25	February 1988
H	6/26	February 1988
I	6/27	February 1988
J	6/28	February 1988
K	6/29	February 1988
L	6/35	February 1988
M	6/36	February 1988
N	6/37, 7/1	February 1988
O	7/2	February 1988
P	7/39	February 1988
Q	7/4	February 1988
P	10/1	March 1988
Q	10/2	March 1988
M	10/3	March 1988
N	10/4	March 1988
C	10/5	March 1988
E	10/6	March 1988
F	10/7	March 1988
K	10/8	March 1988

APPENDIX 10. Disk copies of the Lotus 123 files of pit trapping results and bird observations at Kintyre, 1986-1989.

The files are:

trap1.wk1	Pit trapping April 1986
trap2.wk1	Pit trapping December 1986
trap3.wk1	Pit trapping April 1987
trap4.wk1	Pit trapping December 1987
trap5.wk1	Pit trapping August 1988
trap6.wk1	Pit trapping November 1988
birds.wk1	Bird observations

Cameco Australia Pty Ltd

Targeted fauna survey for the proposed Kintyre haul route

Prepared by: Bamford Consulting Ecologists

August 2011

Date	Revision	Description	Author	Approved
14/08/11	1	Draft Report	CE, MB	
28/10/11	**2**	**Final Report**	**NH**	

Executive Summary

Cameco Australia Pty Ltd (Cameco) proposes to develop the Kintyre Uranium Project, located approximately 270 km north-east of Newman, 90 km south of Telfer and just north of the Karlamilyi National Park, Western Australia. As part of the environmental impact assessment Bamford Consulting Ecologists was engaged by Cameco to conduct a targeted significant fauna survey along a proposed haul road route. The total length of the unsealed road is approximately 90 km, which includes an upgrade (widening) of the existing access track from the Kintyre project north for approximately 60 km. The road then deviates west of the existing Telfer track for 30 km until the road meets the Telfer-Marble Bar road.

This report presents the results of the targeted fauna survey conducted from the 24th to 30th June 2011. It is intended to provide government agencies with the information needed to assess the significance of impacts under State and Commonwealth legislation. The impact assessment process effectively has three components:

1. Values - The identification of fauna values of the site. These include the range of fauna habitats present, the composition of the fauna assemblage including the presence of significant species, and the distribution of that fauna assemblage across the landscape.

2. Impacts - The identification of ecological processes that maintain the fauna assemblage and how these processes may interact with the proposed development, and therefore what impact the proposed development may have on the fauna.

3. Management - The identification of management recommendations to minimise effects on these ecological processes.

Several methods were employed to detect the presence of significant fauna during the survey and include transect searches by foot, car and helicopter. Other techniques included motion-sensitive cameras in areas of suitable habitat, micro-chiropteran bat call detection and opportunistic searching.

Searches along the proposed route identified several clusters of Bilby activity including two active burrows, tracks and foraging holes of varying age (old to very recent). Searches identified two active and two recently active mulgara burrows. This species is uncertain but most likely to be the Brush-tailed Mulgara which is listed as Priority 4 by DEC. Numerous feral animal (cats, dogs and camels) tracks were recorded along the proposed route and general region.

Transect surveys were also conducted at North Bore road, approximately 3.6 km north-west of the Kintyre camp. Two active Bilby burrows and a recently active burrow including several fresh tracks and foraging holes were recorded on the east side of North Bore road. A motion-sensitive camera was placed at the active burrow and recorded a single individual. Numerous

old tracks and foraging holes were also recorded indicating that the resident Bilby had been living and foraging in this area for at least several months.

The presence of the Bilby and mulgara are of greatest interest, as both are listed under State and Commonwealth legislation. Both species have similar habitat requirements, occurring on red sandy loam soils that support spinifex and *Acacia* shrublands. They are thus potentially widespread in the region but are probably presently scarce along the proposed haul road because of impacts from extensive recent fires and predation by feral species. These species are not restricted to habitats within the proposed haul route. With the exception of these two mammal species together with the Australian Bustard and Bush Stone-curlew (both listed as Priority 4 by DEC), no other conservation significant species were recorded during the survey.

Ecological processes that may impact upon fauna values as a result of the proposed haul road are identified and discussed. Management recommendations based on impacts to ecological processes are provided in the report.

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1 INTRODUCTION

1.1 Background

Cameco Australia Pty Ltd (Cameco) proposes to develop the Kintyre Uranium Project, located approximately 270 kilometres (km) north-east of Newman, 90 km south of Telfer and just north of the Karlamilyi National Park, Western Australia. As part of the environmental impact assessment Bamford Consulting Ecologists (BCE) was engaged by Cameco to conduct a targeted significant fauna survey along a proposed haul road route.

This report presents the results of the targeted fauna survey conducted from the 24th to 30th June 2011. Regional information has also been sourced from previous studies undertaken by Hart, Simpson and Associates (1994) and BCE (2007, 2010a, 2010b). It is intended to provide government agencies with the information needed to assess the significance of impacts under State and Commonwealth legislation. The impact assessment process effectively has three components:

1. Values - The identification of fauna values of the site. These include the range of fauna habitats present, the composition of the fauna assemblage including the presence of significant species, and the distribution of that fauna assemblage across the landscape.

2. Impacts - The identification of ecological processes that maintain the fauna assemblage and how these processes may interact with the proposed development, and therefore what impact the proposed development may have on the fauna.

3. Management - The identification of management recommendations to minimise effects on these ecological processes.

1.2 Study objectives

The objectives of the fauna survey were to search for conservation significant fauna species within the proposed haul route to determine local occurrence. In addition, searching in adjacent areas would provide a contextual perspective in relation to locally occurring species and their habitat. Based on discussions between BCE, Cameco and the Department of Environment and Conservation (DEC), the survey was to focus on:

- Significant species that could be found along the proposed haul road route such as Bilby, Northern Quoll and mulgara. Other species of interest included rock-wallabies, possums, Northern Marsupial Mole, hare-wallabies and Giant Desert Skink (see Section 2.4 for species names).

- Bats that can be detected with the Anabat system.

1.3 Previous studies

Previous fauna survey work within the Kintyre tenement was undertaken in the 1980s and early 1990s (Hart, Simpson and Associates 1994). This involved a survey equivalent to Level 2 intensity (*sensu*. EPA Guidance Statement 56, EPA 2004), and provided details of the vertebrate fauna assemblages occurring within the site.

However the conservation status of some locally occurring species has been upgraded since the original survey in the 1980s, such as the Northern Quoll. Conservation status changes of some locally occurring species have also come about due to the establishment of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and upgrading of the Western Australian *Wildlife Conservation Act 1950* (Wildlife Conservation Act) after the original survey. In addition, fauna survey techniques not available during the original survey are now accessible such as the use of motion-sensitive camera and ultrasound bat detection technologies, which have shown to be highly effective in the detection of conservation significant species (Bamford Consulting Ecologists 2010a).

Further targeted surveys for conservation significant fauna within the Kintyre mine tenements were conducted in July 2010 (Bamford Consulting Ecologists 2010a). This survey focused on a number of conservation significant fauna and included the help of Martu Traditional Owners. The surveys found that Bilbies, mulgara and a species of rock-wallaby occur in the area.

Overall, the fauna of both the Telfer and the Kintyre areas has been well-studied because of a history of exploration and mining activities over the last 30 years. Therefore, the fauna assemblages present are well-understood. What matters with respect to the proposed haul road is identifying where there are specific fauna values and how these might be impacted and therefore managed effectively.

2 BACKGROUND

2.1 Project description

The Kintyre Uranium Project is located on the eastern edge of the Pilbara, between the Little Sandy and Great Sandy Deserts, approximately 90 km south of Telfer in the Shire of East Pilbara. The existing access road from Kintyre to Telfer needs to be upgraded and in places realigned to allow for increased traffic usage, and to avoid tenements held by Newcrest Mining for the Telfer Gold Mine. It is understood that Option C was selected as the preferred alignment following an analysis of various route options based on environmental and economic constraints (Figure 2-1). This option includes an upgrade (widening) of the existing access track from Kintyre north for approximately 58.6 km. The road then deviates in a northerly direction west of the existing Telfer track for 30.8 km until the road meets the Telfer-Marble Bar road. Vegetation and soil associations along the new realignment are discussed in Section 4.1. Total

length of the proposed unsealed road is 89.4 km with a 200 metre disturbance zone (total disturbance area: 17.88 km^2). When operational, it is expected that the traffic load will consist of:

- Fuel delivery – 4.3 triple road trains per week.
- Accommodation – 20 light vehicles per week, plus 5 triple road trains per week.
- Process plant – 13.5 triple road trains per week.
- Light/Medium vehicles – 50 movements per week (GHD 2011).

In total, 22.8 triple road trains a week (3.2 per day) and up to 70 light vehicles per week (10 per day) are expected. In addition to the above traffic load, the road will also be used by the public. It is unclear how much traffic the public will contribute to the traffic load.

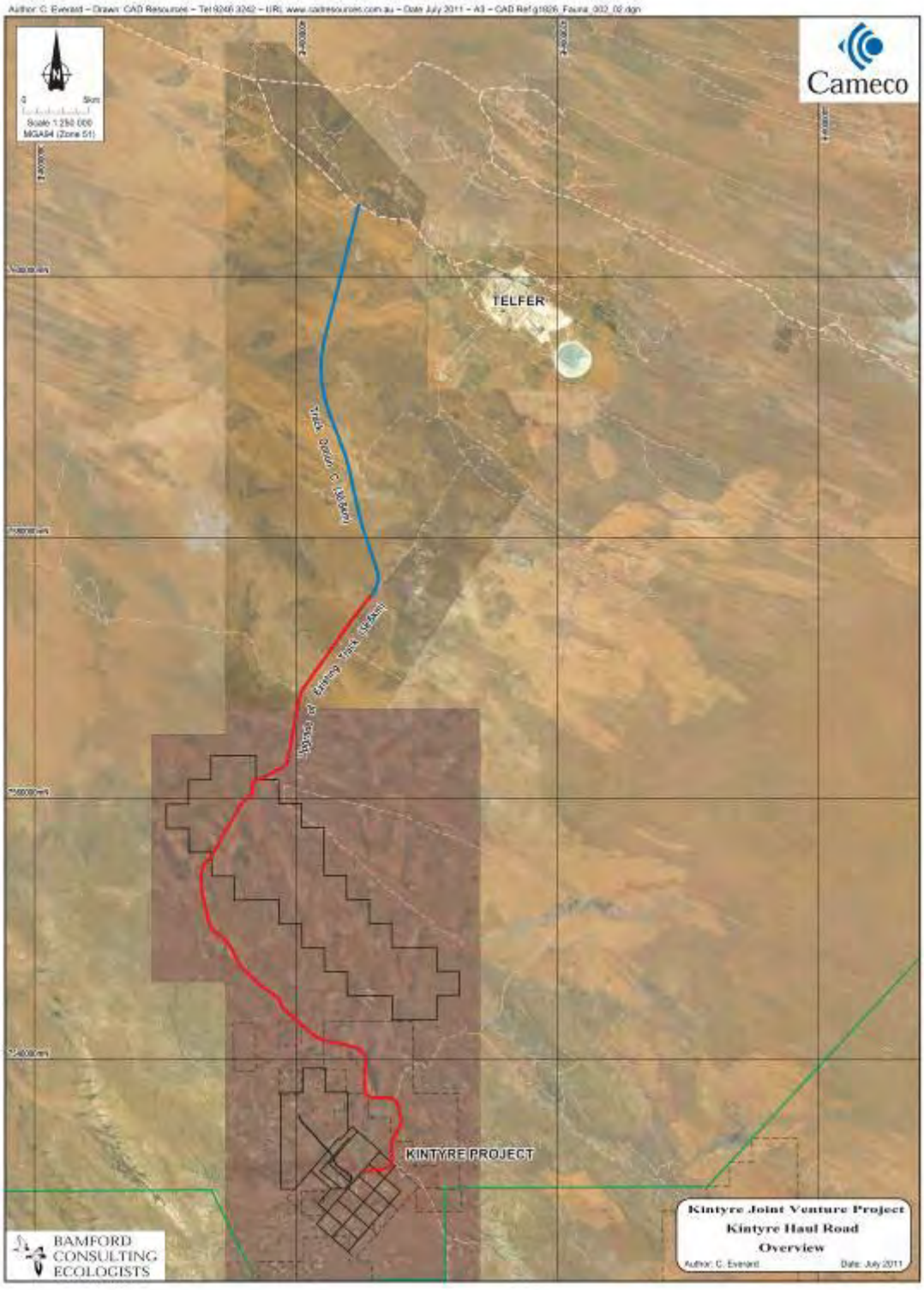

Figure 2-1: Overview of proposed haul road route

2.2 Regional description

The proposed haul route lies within the Rudall subregion (LSD1) of the Little Sandy Desert bioregion (Figure 2-2 below). The regions are described by the Interim Biogeographical Regionalisation for Australia (IBRA) classification system (Environment Australia 2000, McKenzie *et al*. 2003). The Little Sandy Desert bioregion falls within the Bioregion Group 4 classification of bioregions of the Eremaean Botanical Province, defined as 'native vegetation that is largely contiguous but is generally not used for commercial grazing' (EPA 2004).

The general features of the Rudall subregion are summarised by Kendrick (2001, in McKenzie *et al*. 2003). Vegetation comprises:

1. Sparse shrub-steppe over *Triodia basedowii* on stony hills.

2. River Gum communities along drainages and with bunch grasslands on alluvial deposits in and associated with ranges.

3. Extensive areas of tussock grass associated with foot slopes.

4. Extensive *Triodia* hummock grasslands on hills and surrounding plains.

The climate of the subregion is arid with summer rainfall. The subregion is 1,078,070 ha in size and includes headwaters and course of the Rudall River. Dominant land uses in the subregion are Unallocated Crown land, Mining leases, Conservation and the Parnngurr Aboriginal Community near Cotton Creek.

Kendrick (2001) lists several rare features significant to the region. These include:

- The upper Rudall River, draining into Lake Dora – is one of two arid zone rivers, with near permanent wetlands along its course, flowing from uplands across the desert and into a major salt lake within the Little Sandy Desert.

- Small permanent rockhole wetlands associated with ranges and uplands – these are locally significant water sources, with high biological and cultural significance.

- A high number of arid zone reptiles, particularly skink lizards (genera *Ctenotus* and *Lerista*).

- Karlamilyi National Park – part of the national park is contained in the Little Sandy Desert bioregion. Rudall River itself may provide a seasonal refuge to wildlife.

Figure 2-2: IBRA sub regions and project location

The Kintyre area has elements of the adjacent Pilbara region. The Pilbara is a region of high fauna biodiversity with overlapping biogeographic elements from the Kimberley and South-West, as well as contributions from adjacent desert and Murchison, and a high level of endemism. McKenzie *et al.* (2003) provide a detailed description of special values and features of the region with respect to fauna and environments, including significant species and important wetlands.

2.3 Vegetation

Vegetation and Land System mapping has not been conducted for the proposed haul route. Vegetation and Soil Associations (VSAs) identified along the proposed haul route are discussed in Section 4.1. The vegetation of the nearby Karlamilyi National Park is well described and contains three broad landscape types - the Little Sandy Desert in the south-west, a central belt of stony hills and flattish plains, and the Great Sandy Desert to the north-east. The vegetation is described as:

"A mosaic of tree and shrub steppe covering sand dunes and rocky hills. The main variations are around the watercourses, where there are eucalypt tree savanna, depressions with teatree scrub, and small patches of mulga (*Acacia aneura*). Between the sandhills is a mixed shrub of acacias and spinifex, occasionally with tree species, that varies with soil type. *Eucalyptus* tree savanna is restricted to the river flats of the Rudall River and is characterised by river redgum (*E. victorix*) near the waterline, with coolabah (*E. microtheca*) on flats away from the river, creeks and billabongs" (DEC 2010).

2.4 Conservation Significant Fauna

Fauna species of conservation significance that may occur in the proposed route include species identified based on literature, previous fauna survey reports, fauna database searches and previous site visits. Species considered to be of greatest relevance to the project include:

- Brush-tailed Mulgara (*Dasycercus blythi*).
- Crest-tailed Mulgara (*Dasycercus cristicauda*).
- Northern Quoll (*Dasyurus hallucatus*).
- Northern Marsupial Mole (*Notoryctes caurinus*).
- Greater Bilby (*Macrotis lagotis*).
- Great Desert Skink (*Egernia kintorei*).

- Australian Bustard (*Ardeotis australis*).

- Bush Stone-curlew (*Burhinus gallarius*).

A complete list of conservation significant species that are known from the Pilbara region is provided in Table 2-1. Note that all conservation significant species expected to occur in the area are identified, whether or not they were actually recorded during the survey. This is because fauna are highly mobile, often seasonal and frequently cryptic. Therefore, the precautionary approach is taken in that if a significant species is expected to be present and suitable habitat is available, the assumption is made that the species is present or may be present within the life of the project.

Three broad conservation significance categories are used in this report and these are described in detail within Appendix 1.

Table 2-1: Conservation significant fauna expected to occur in the Kintyre area

See Appendix 1 for definition of conservation significance levels CS1, CS2 and CS3.

Scientific name	Common name	EPBC Act	Wildlife Conservation Act	DEC Priority
CONSERVATION SIGNIFICANCE 1 (CS1)				
Liopholis kintorei	Great Desert Skink	Vulnerable	Schedule 1	
Polytelis alexandrae	Princess Parrot	Vulnerable		P4
Pezoporus occidentalis	Night Parrot	Critically Endangered	Schedule 1	
Falco peregrinus	Peregrine Falcon		Schedule 4	
Ardea modesta	Eastern Great Egret	Migratory		
Apus pacificus	Fork-tailed Swift	Migratory		
Merops ornatus	Rainbow Bee-eater	Migratory		
Dasyurus hallucatus	Northern Quoll	Endangered	Schedule 1	
Macrotis lagotis	Greater Bilby	Vulnerable	Schedule 1	
Rhinonicteris aurantius	Orange Leaf-nosed Bat	Vulnerable	Schedule 1	
Notoryctes caurinus	Northern Marsupial Mole	Endangered	Schedule 1	
Dasycercus cristicauda	Crest-tailed Mulgara	Vulnerable		
Pseudomys chapmani	Western Pebble-mound Mouse	Vulnerable		P4
CONSERVATION SIGNIFICANCE 2 (CS2)				
Lerista macropisthopus remota	Burrowing Skink			P2
Ardeotis australis	Australian Bustard			P4
Burhinus grallarius	Bush Stone-curlew			P4
Amytornis striatus	Striated Grasswren			P4
Leggadina lakedownensis	Lakeland Downs Mouse			P4
Sminthopsis longicaudata	Long-tailed Dunnart			P4
Dasycercus blythi	Brush-tailed Mulgara			P4
Lagorchestes conspicillatus leichardti	Spectacled Hare-Wallaby			P3
Macroderma gigas	Ghost Bat			P4
CONSERVATION SIGNIFICANCE 3 (CS3)				
Ninox connivens	Barking Owl			
Stipiturus ruficeps	Rufous-crowned Emu-wren			
Trichosurus vulpecula	Northern Brushtail Possum			
Antechinomys laniger	Kultarr			
Pseudomys nanus Western	Chestnut Mouse			
Rattus tunneyi	Pale Field Rat			

3 METHODS

3.1 Approach to impact assessment

As noted in Section 1.1, the impact assessment process involves the identification of fauna values of a site, the identification of ecological processes that may impact on these fauna values and a discussion of how a proposed development might affect those processes (and therefore impact upon the fauna). Ecological processes that may be affected then guide management recommendations to minimise impacts of the proposed development on fauna. Therefore, the impact assessment process can be examined under the following headings:

- Fauna values.
- Ecological processes that impact these values.
- Management recommendations to minimise effects on these ecological processes.

The identification of fauna values involved targeted transect surveys along the proposed haul route. The purpose of the survey was to gather information from the site, in particular the type and distribution of fauna habitats and significant species, and to assess potential ecological processes that may be impacted upon as a result of the proposal.

Following the collection of field data, an assessment of the potential impacts on fauna was considered and management recommendations provided to seek to minimise and/or mitigate potential impacts. This relies upon the interpretation of ecological processes and the nature of the proposed development. Ecological processes important to impact assessment are identified in the literature and are discussed below (Section 3.7 and Appendix 2).

3.2 Definition of vegetation and soil associations

Vegetation and Soil Associations (VSAs) were assessed during the field investigations (Section 4.1). VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al*. 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types or Floristic Community Types (FCTs), since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types and particularly FCTs may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with Land Systems, Land Types or soil types, but may reflect some of these elements.

3.3 Personnel

The targeted survey was undertaken from the 24th to 30th June 2011. Field personnel from Bamford Consulting Ecologists were:

- Mike Bamford (BSc. Hons. Ph.D).
- Ian Harris (BSc. Hons).
- Robert Browne-Cooper (BSc.).
- Brenden Metcalf (BSc. Hons).
- Jeff Turpin (BSc.).
- Cameron Everard (BSc.).

This report was prepared by Cameron Everard and reviewed by Dr Mike Bamford. Field work was carried out under Licence to Take Fauna for Scientific Purposes SF008092.

3.4 Survey methodology

Several methods were employed to detect the presence of significant fauna throughout the survey and include:

1. Transect searches along proposed haul route.
2. Motion-sensitive cameras.
3. Micro-chiropteran bat call detection.
4. Opportunistic searching.

A list of the fauna species targeted and the detection and search methods used is presented in Table 3-1. These techniques are discussed in detail below.

Table 3-1: Survey methods employed to search for target species and species groups

Species	Transect Searches	Motion Camera	Anabat Detector	Opportunistic Searches
Bilby	X	X		X
Mulgara	X			X
Rock-Wallabies		X		X
Northern Marsupial Mole	X			X
Great Desert Skink	X			X
Micro-chiropteran Bats			X	

3.4.1 Transect searches – Proposed haul route

Targeted transect searching along the proposed haul route was conducted to search for signs of fauna activity including tracks, foraging signs, burrows and scats. A combination of searching methods was employed along the proposed route such as walking, driving and slow low flying with a helicopter. The identification of VSAs that had the potential to support the target fauna species (based on known habitat requirements) were also noted as a part of the transect searches.

When walking, the approach used involved four personnel spaced evenly apart walking along the proposed haul route. Each person used a hand-held GPS to maintain their bearing and spacing to enable thorough coverage of the route. Transect spacing of 25 to 50 m was used to detect evidence of the target species. In the southern section of the road (where the alignment follows the existing haul road), transects were undertaken 50 to 100 m each side of the road. This section was also flown by helicopter with three experienced people spotting. The helicopter was engaged at low speeds (<40 km/h) at 10 to 20 m above the ground to survey for Bilby burrows, foraging holes and tracks. If significant fauna activity was recorded from the helicopter the GPS coordinates were recorded and revisited by foot for further investigation.

The northern section of the route (where the route deviates from the existing Kintyre access road to the Telfer-Marble Bar road) was initially surveyed by helicopter to assess suitable habitat and then to drop personnel off along the route. The last 12 km of the northern section to the Marble Bar road was walked by four people, due to the uncertainty of the locations of aboriginal heritage sites, problems with vehicle accessibility (low rocky ridges) and safety concerns (e.g. four wheel driving at night where there are no tracks).

In areas where driving was possible and the habitat less suitable for target fauna (hard clay flood prone areas of introduced grasses), the route was driven slowly with three experienced personnel scanning the ground for signs of fauna activity. The section of road from 401951E 7592500N north to 402010E 7593453N (approximately 1 km) was not surveyed by car or foot, but instead was flown by helicopter. All evidence of target species was recorded with notes on species, type of activity detected, age of foraging signs and burrows, vegetation and soil characteristics, and photographs were taken.

3.4.2 Transect searches – North Bore road

In addition to the surveys undertaken for the proposed haul route, transects for Bilby and mulgara were conducted on the west and east side of the North Bore road, where a Bilby was previously recorded by Bamford Consulting Ecologists (2010a). These additional surveys not only provide a contextual perspective in relation to the species, but also provide important information on their habitat preferences and range.

3.4.3 Motion-sensitive cameras

Four motion-sensitive infrared cameras were set up in the rock outcrops adjacent to North Bore to target primarily wallabies, quolls and bilbies, but also other fauna that may utilise the outcrops. Bushnell XTL Trophy Cam™ cameras were set to record photograph footage during day or night to detect diurnal and nocturnal activity.

Universal bait consisting of a mixture of rolled oats, peanut butter and sardines was scattered in front of each camera to attract fauna into the field of view. Camera survey effort was a total of 16 camera trap nights representing about 384 hours of constant monitoring. Locations of motion-sensitive cameras are provided in Table 3-2. A motion-sensitive camera was also placed east of the North Bore road following observation of several fresh tracks and Bilby burrows with fresh diggings (Section 4.2.2 and Plate 4-11).

Table 3-2: Motion-sensitive camera locations

Camera No.	Target species	Notes	Easting	Northing
1 – North Bore	Rock-Wallaby	26-30 June (4 nights). Rocky slope at north bore.	400542	7535626
3 – North Bore	Rock-Wallaby	26-30 June (4 nights). Rocky slope at north bore.	400457	7535960
4 – North Bore	Rock-Wallaby	26-30 June (4 nights). Rocky slope at north bore.	400507	7535861
6 – North Bore	Rock-Wallaby	26-30 June (4 nights). Rocky slope at north bore.	400499	7535889
East of North Bore Road	Bilby	28-30 June (2 nights). Entrance to Bilby burrow.	402440	7534017

3.4.4 Micro-chiropteran bat call detection

An Anabat detector was placed at the Kintyre camp for two nights from 28th to 30th June 2011 to record micro-chiropteran bat calls. Calls were detected and recorded using an Anabat II unit in conjunction with an Edirol Audio Recorder. Calls were then played back through a ZCAIM unit into Anabat6 software. AnalookW (V3.3f 2006) and Analyze (V2.3 2000 Jolly) software were used for analysis of call sequences. Species were identified through comparison with the data presented in McKenzie *et al*. (2002).

3.4.5 Opportunistic searching

During the survey period all observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while travelling along the proposed route or searching sand dunes for Northern Marsupial Moles and Great Desert Skinks. No short-range endemic invertebrate searching was conducted along the proposed route as the environment was not considered suitable for these species.

3.5 Limitations of investigations

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. These survey limitations are discussed in the context of the current targeted significant fauna assessment in Table 3-3.

Table 3-3: Survey limitations as outlined by EPA (2004)

Limitation (as per EPA 2004)	BCE comment
Level of survey.	Targeted survey. The survey intensity was deemed adequate to identify significant fauna and habitats occurring in the project area, with local information from previous surveys nearby.
Competency/experience of the consultant(s) carrying out the survey.	BCE has had extensive experience in conducting fauna assessments including the target species relevant to this survey.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	Targeted surveys for conservation significant fauna, particularly those listed under EPBC Act. Opportunistic observations on birds. No trapping conducted, site reconnaissance focused on assessment of habitat.
Proportion of fauna identified, recorded and/or collected.	No vertebrate specimens collected, all vertebrate fauna observed were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous reports on the fauna of the region (Bamford Consulting Ecologists); databases (Birds Australia, DEC NatureMap, Western Australian Museum, EPBC and Bamford Consulting Ecologists).
The proportion of the task achieved and further work which might be needed.	Survey was completed.
Timing/weather/season/cycle.	Survey completed in June 2011. Conditions were good at the time of the survey. However it is the nature of semi-arid environments that some species are nomadic or episodic.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey.	No disturbances affected the survey.
Intensity. (In retrospect, was the intensity adequate?)	The survey intensity was adequate to record significant fauna and fauna habitats.
Completeness (e.g. was relevant area fully surveyed).	Survey was completed. As noted above, it is the nature of semi-arid environments that some species are nomadic or episodic, and as such some species not recorded may be present under different conditions. The habitat assessment allows for such species to be considered.
Resources (e.g. degree of expertise available in animal identification to taxon level).	All vertebrate species were identified to species level.
Remoteness and/or access problems.	A combination of survey techniques was used depending on conditions such as; survey by foot, car and helicopter. Good access across majority of project area.
Availability of contextual (e.g. biogeographic) information on the region.	Regional information was available and was considered.

3.6 Impact assessment – fauna values

3.6.1 VSAs and Habitat

VSAs are described in Section 4.1. Impacts upon significant fauna can be related to proportional impacts upon a VSA; thus a large proportional loss upon a rare VSA can have significant impacts upon fauna.

3.6.2 Fauna Assemblage and Distribution

Fauna assemblage and distribution describe the number of species within an area, their abundance and how they are distributed across the landscape. Generally, a fauna assemblage is not distributed evenly across the landscape or even within one VSA and thus there may be areas of high fauna richness that may be of particular significance. It is also noted that species distribution within VSAs will change over time in response to ecological processes, therefore the absence of a species in one location within a VSA does not preclude it from this area in the future.

3.6.3 Conservation significant fauna

Impacts from the proposed haul route may be significant if species of conservation significance or habitat important for such species are affected. Impacts to populations of conservation significant fauna that already occur at low densities may be significant.

3.7 Impact assessment – ecological processes

3.7.1 Overview

Potential impacts of the proposed haul route upon fauna values can be related to ecological processes. This is recognised by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC, formerly DEWHA), in the literature and in the EPBC Act, in which threatening processes are listed (Appendix 2). Ecological processes that may impact fauna values are identified here, and how the project may affect these processes is discussed in Section 6. Rather than being independent of one another, ecological processes are complex, interrelated and often result in a combination of both direct and indirect impacts. They are the mechanisms by which fauna can be affected by development.

3.7.2 Habitat loss (leading to population decline)

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

3.7.3 Ongoing mortality (leading to population decline)

Increased mortality can occur during project operations; for example from roadkill, animals striking infrastructure and entrapment in trenches. Roadkill as a cause of population decline

has been documented for the Eastern Barred Bandicoot *Peremeles gunni* (Dufty 1989), Eastern Quoll *Dasyurus viverrinus* and Tasmanian Devil *Sarcophilus harrisii* (Jones 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Jackson and Griffen 2000, Scheik and Jones 1999, Clevenger and Waltho 2000).

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

3.7.4 Habitat (population) fragmentation

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

3.7.5 Disturbance

The potential for impacts from dust, noise, light and general disturbance upon fauna are difficult to predict, and consequently are rarely considered or assessed for development projects. Some studies have demonstrated the impact of artificial night lighting on fauna and suggest that lighting has greater impact than noise (Rich and Longcore 2006). These include impacts on predator-prey interactions, changes to mating and nesting behaviour and increased competition and predation within and between invertebrates, frogs, birds and mammals.

3.7.6 Changed fire regimes

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (e.g. Gill *et al*. 1981, Fox 1982, Letnic *et al.* 2004). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals such as Bilby and mulgara. Changes to fire regimes, whether to more frequent or less frequent fires, may affect some fauna species. Development projects within areas of native vegetation may affect fire regimes, and fire management may be considered the responsibility of managers of large tracts of land.

3.7.7 Interactions with other species (feral or over-abundant native species)

Changes in species interactions can occur with development. Introduced species, including the feral Cat (*Felis catus*), feral Dog/Dingo (*Canis lupus*), Fox (*Vulpes vulpes*) and Rabbit (*Oryctolagus cuniculus*) may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by the Fox, and to a lesser extent the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species such as the Rabbit, feral Goat (*Capra hircus*), Camel (*Camelus dromedarius*) and

domestic livestock can also degrade habitats and deplete vegetation that may be a food source for other species.

The provision of fresh water points can also affect the abundance of some native species. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species, with common water-dependent birds often benefiting at the expense of rare water-independent species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species.

Other ecological processes that can impact on fauna but are unlikely to be an issue (if managed effectively) include interruptions to hydrological processes and habitat degradation due to weed invasion. These issues can be managed under standard operating procedures.

3.8 Criteria for impact assessment

While some impacts upon fauna are unavoidable and/or are only of a short-term and localised nature, of concern are long-term, deleterious impacts upon fauna diversity. An assessment of the potential impacts of the project on fauna and habitat was conducted based on the results of the field surveys and the past experience of the authors. The severity of impacts was quantified on the basis of predicted population change as outlined in Table 3-4. Population change can be the result of direct habitat loss and/or impacts upon ecological processes as discussed above.

Table 3-4: Assessment criteria of impacts upon fauna

Severity of impact	Observed impact
Negligible	No population decline
Minor	Short-term population decline (recovery after end of project) within project area, no change in viability of conservation status of population
Moderate	Permanent population decline, no change in viability of conservation status of population
High	Permanent population decline resulting in change in viability or conservation status of population

4 RESULTS

4.1 Vegetation and soil associations

Four broad VSAs were identified during the survey, from high to low in the landscape and include:

1. Low rocky hills supporting spinifex grasslands (*Triodia spp*) and mixed sparse low shrubs.

2. Sand dunes with or without mixed *Acacia* shrubs and spinifex (*Triodia spp*).

3. Red sandy loam plains with or without mixed shrubs (*Acacia*) and spinifex grassland (*Triodia spp*).

4. Claypan drainage areas, some with creek lines of *Eucalyptus spp*, and grasslands of *Triodia spp* or *Cenchrus ciliaris* (buffel grass)

The northern section of the proposed route (Figure 2-1) also abuts a range of rocky hills to the east and although not directly in the disturbance zone, some significant species may exist there. In terms of significant fauna recorded during the survey (Bilby and mulgara) the main VSAs of interest include the red sandy loam plains, sand dunes, and to some extent the claypan drainage areas. The low rocky hills (found in areas to the north of the route) are of less importance to Bilby and mulgara primarily due to the harder substrate. Vegetation found within the proposed haul route is widespread throughout the region and exhibits a mixture of different fire ages. Photographs of the two main VSAs in terms of significant fauna are presented in Plates 4-1 to 4-4.

Plate 4-1: Red sandy loam plains with or without mixed shrubs (*Acacia*) and spinifex grassland (*Triodia spp*)

Plate 4-2: Sand dunes with or without mixed *Acacia* shrubs and spinifex (*Triodia spp*)

Plate 4-3: Sand dunes with *Triodia spp*; this area was searched for Bilby, mulgara and Marsupial Moles; photograph facing north along proposed haul route

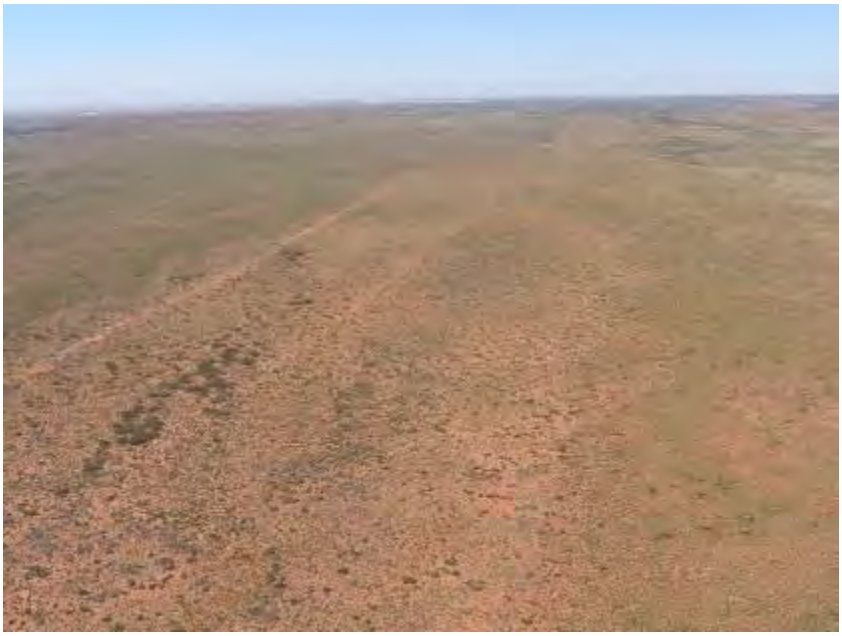

Plate 4-4: Aerial view of the northern section of the proposed haul route. Proposed haul route dissects longitudinal low dunes perpendicularly (left to right in photo)

4.2 Observations of significant species

Many of the significant species expected in the proposed haul route are likely to be widespread, although sparse in the region and not restricted to habitats within the proposed route.

Conservation significant species that are known from the Pilbara region but were not recorded during the survey included the Spectacled Hare-Wallaby (*Lagorchestes conspicillatus leichardtii*), Northern Brushtail Possum (*Trichosurus vulpecular*), Night Parrot (*Pezoporus occidentalis*) and Woma Python (*Aspidites ramsayi*). The lattermost species has been recorded by Bamford Consulting Ecologists approximately 20 kilometres east of the proposed haul road.

Discussion of the species for which the area is likely to be of greatest importance is as follows.

4.2.1 Bilby activity along the proposed haul route

Transect searches along the proposed haul route identified the following Bilby activity (Figure 4-1 and Appendix 3). Searches along the northern section of the proposed route (Option C – 30.8 km) identified two recent tracks and no burrows, foraging holes or scats. Along the southern section (Existing Track - 58.6 km), several clusters of Bilby activity were recorded (Figure 4-1, Enlargements 4 and 5). Two active burrows (395261E 7558732N and 396492E 7560229N) were recorded; one burrow was located in the base of a dry creek bed and the other in open spinifex with *Acacia* shrub. Tracks and foraging holes of varying age (old to very recent) were also found in these areas.

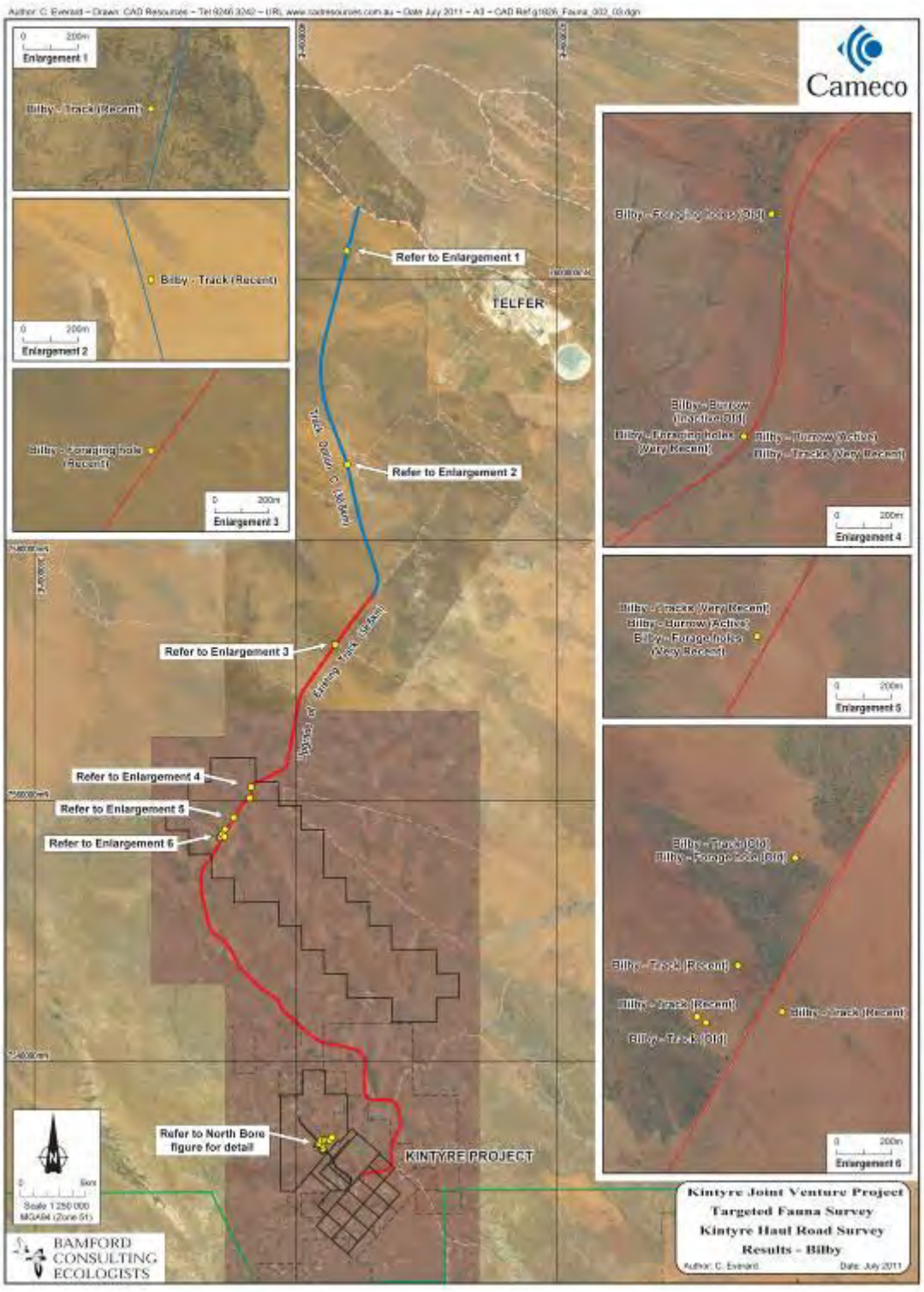

Figure 4-1: Bilby records along the proposed haul route

Most Bilby observations were recorded on red sandy loam plains with spinifex and occasionally with *Acacia* shrubs. No Bilby activity was recorded on the low rocky hills or sand dunes, however it is likely that Bilbies utilise these sand dunes. Interestingly, an active burrow, scats and numerous fresh tracks were recorded in the base of a dry creek bed in tall shrubland over spinifex (Enlargement 4 on Figure 4-1).

Based on these results and given the size of the area searched (>18 km^2), signs of Bilby activity were reasonably low. Two active burrows, several foraging holes and tracks within the proposed haul route suggest that the area is utilised and frequented by a number of individuals, however numbers are minimal and very sparse. Evidence of Bilby activity recorded along the proposed route is provided in Plates 4-5 to 4-10.

Plate 4-5: Bilby scats along proposed haul route

Plate 4-6: Bilby foraging hole along proposed haul route

Plate 4-7: Bilby foraging holes along proposed haul route

Plate 4-8: Bilby burrow along proposed haul route

Plate 4-9: Bilby footprint along proposed haul route

Plate 4-10: Bilby habitat along proposed haul route

4.2.2 Bilby activity at North Bore road

Although not in the proposed haul route footprint, transect surveys for Bilbies were also conducted in the North Bore road area in 2011. This was carried out to obtain further information on the species at a local level and to provide a contextual perspective. Background information provided below has been sourced from Bamford Consulting Ecologists (2010a).

A single Bilby was recorded in 2010 from video footage approximately 3.6 km north-west of the Kintyre mine camp, on the west side of North Bore road (401666E 7533372N). The active animal was recorded over two nights with tracks and foraging holes (Figure 4-2). Active burrows and recent foraging activity were spread over an area of about 8 ha, but activity over the previous several months was spread over an area of about 60 ha. Much of the activity was in vegetation that had not been burnt in 2007 - 2008, however the activity in 2010 was in recently-burnt vegetation of mixed sparse *Acacia* shrubs and stunted *Eucalyptus* woodland over open *Triodia* hummocks on red sandy loam soil.

Further transect surveys were conducted on the west side of North Bore road in June 2011 to determine if the Bilby had persisted in the area. A recent burrow and several foraging holes were noted. Clusters of old foraging sites and tracks were also observed, and were probably recorded in 2010 (Figure 4-3).

In 2011, two active burrows and a recently active burrow including several fresh tracks and foraging holes were recorded on the east side of North Bore road (Figure 4-3). A motion-sensitive camera was placed at the active burrow (Plate 4-11) and recorded a single individual (Plates 4-12 and 4-13). It is possible that the Bilby captured on the motion-sensitive camera in 2011 is the same individual from 2010. Numerous old tracks and foraging holes were also recorded indicating that the resident Bilby had been living and foraging in this area for at least several months. It is assumed that the current local Bilby population is very sparse.

Plate 4-11: Motion-sensitive camera placed at Bilby burrow east of North Bore road

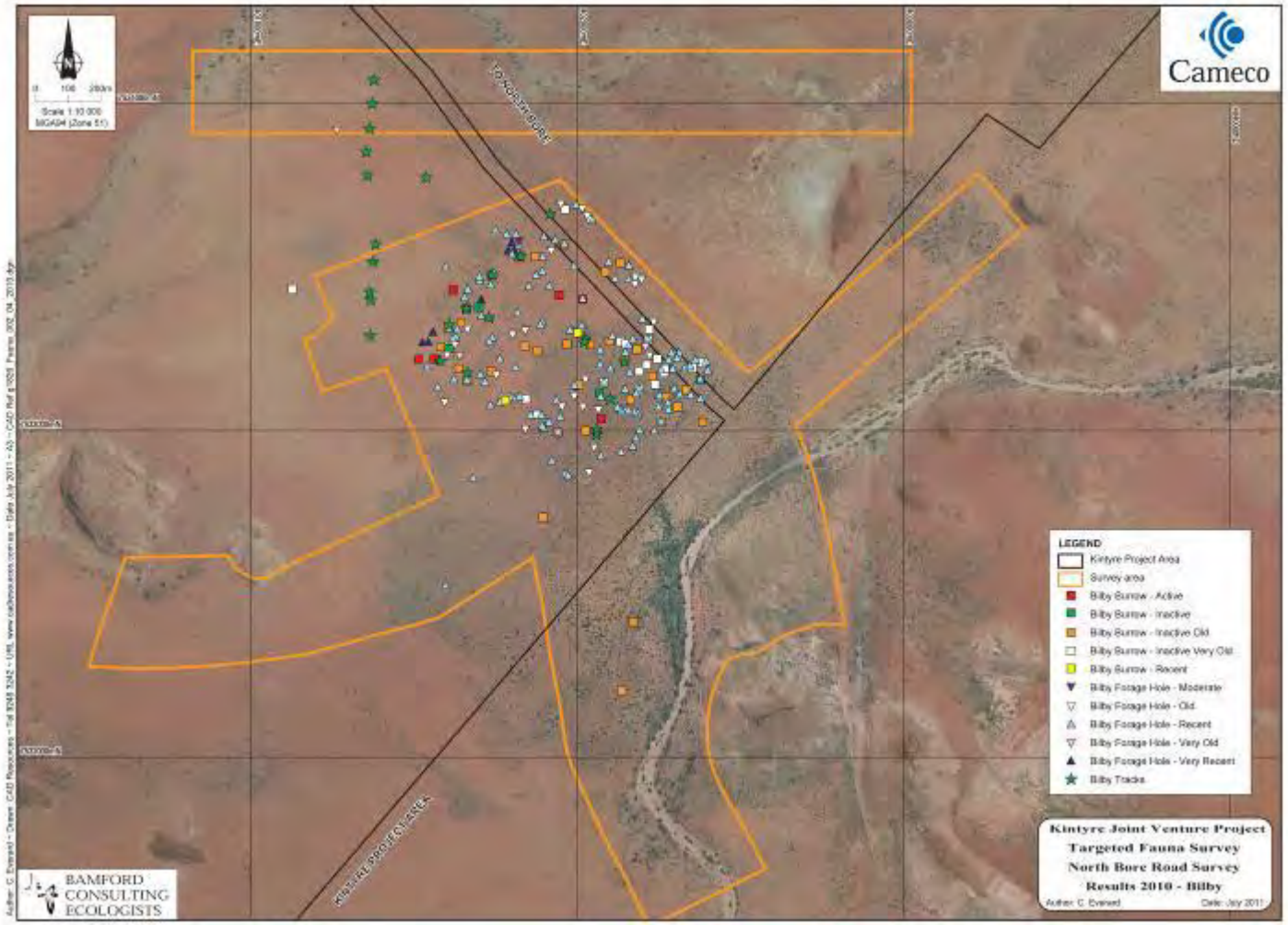

Figure 4-2: Survey area and Bilby locations at North Bore road in 2010 (Bamford Consulting Ecologists 2010a)

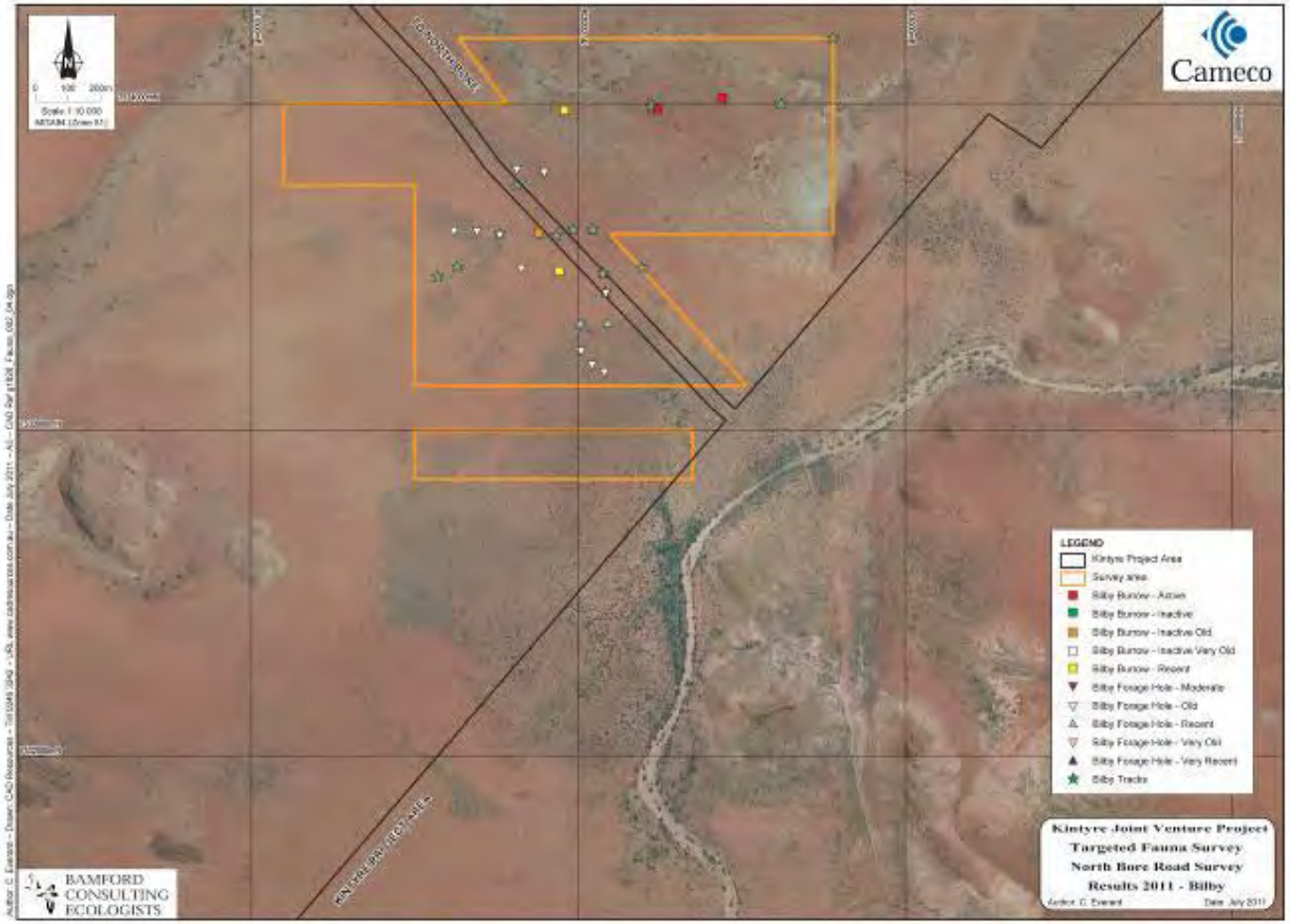

Figure 4-3: Survey area and Bilby locations at North Bore road in 2011

Plate 4-12: Photo of Bilby foraging outside active burrow, east of North Bore road

Plate 4-13: Photo of Bilby foraging outside active burrow, east of North Bore road

All Bilby activity in 2010 and 2011 at the North Bore road site was on red sandy loam soil in sparse *Acacia* shrubs and with occasional stunted Eucalypt over open spinifex which had been burnt in 2007 - 2008. It is interesting to note that the site still supports a single adult Bilby and that this individual has stayed in this area for several years.

Thompson and Thompson (2008) reported on the distribution of foraging activity and burrows of a Bilby in the Pilbara and found an area of activity of 9 ha. This was also in a recently-burnt area and while they were uncertain of the number of animals present, their descriptions and observations made in the present study suggest that they also had a single Bilby. Moseby and O'Donnell (2003) report home range areas for Bilbies as 20 ha (females) and 320 ha (males), but the home range area would be much larger than the area over which an animal might forage in a few nights. Given that the animal recorded at North Bore road foraged over a core area of >100 ha, the individual was probably a male.

Numerous cat tracks were sighted throughout the area in 2011, the implications of feral predators on the Bilby and other conservation significant species are addressed under Species Interactions (Section 6.6).

The Bilby is listed as Vulnerable by Maxwell *et al.* (1996) and under the relevant State and Commonwealth Acts. The species formerly utilised a wide range of habitat types across the continent. Extant populations are restricted to a variety of "tall shrublands, open woodlands, and hummock grasslands" (Maxwell *et al*. 1996). The species appears to remain widespread in the Great Sandy Desert (M. Bamford, pers. obs.) and scattered populations occur across the northern Pilbara, including close to Port Hedland (Thompson and Thompson 2008). In the Great Sandy Desert, the species appears most common in *Acacia* shrublands associated with paleo-drainage lines, where the soils are sandy loams.

In addition to these recent records, the Bilby was recorded from Kintyre in 1998 (Cathy Gupanis, pers. comm.) and old bone material was also found in the owl roost (Hart Simpson and Associates 1994). The 1998 record was south of the ore deposit. Sandy loam soils supporting acacia shrubland is occupied by the species in the Great Sandy Desert (M. Bamford, pers. obs) and such habitat is widespread in the project area, including around the ore body. The Bilby is also reported from around Telfer, 100 km to the north (B. Metcalf, pers. comm.).

4.2.3 Mulgara

Transect searches along the northern section of the proposed route, identified two active mulgara burrows at locations 402262E, 7590468N and 403331E, 7587482N (Figure 4-4, Enlargements 4 and 5), including a recently active burrow at 401975E, 7592301N. A cluster of three inactive mulgara burrows were observed at 403685E, 7601268N and an inactive burrow at 402535E, 7596400N. Along the southern section of the route, a recently active mulgara burrow was recorded at 403516E, 7572596N (Figure 4-4 and Appendix 3).

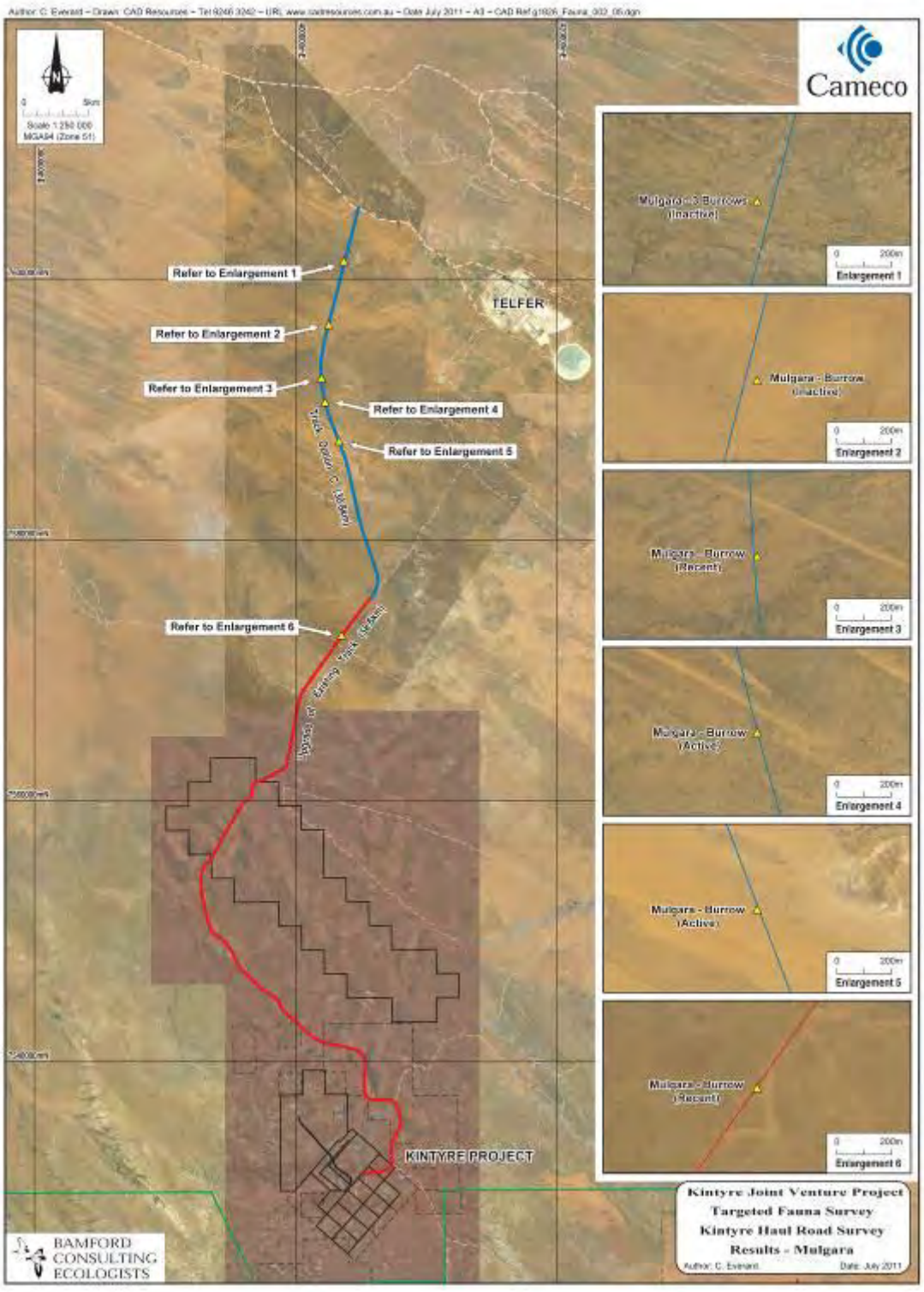

Figure 4-4: Mulgara records along the proposed haul route

Evidence of mulgara within the proposed haul route was minimal (8 records in total), indicating the species is present but in very low numbers. Signs of mulgara activity were generally found in the northern section of the route on the red sandy plains with or without mixed *Acacia* shrubs and spinifex (Plates 4-14 – 4-15).

Plate 4-14: Active mulgara burrow recorded during target searching along proposed haul route

Plate 4-15: Mulgara burrow along proposed haul route

Woolley (2005) recognised two species of mulgara, the Crest-tailed Mulgara *Dasycercus cristicauda* and the Brush-tailed Mulgara *D. blythi*. Prior to this, only the Crest-tailed Mulgara was recognised. Because of the recent re-classification there is some confusion in museum records and under legislation between these species. Only the Crest-tailed Mulgara is recognised under the EPBC Act (as Vulnerable), with the Brush-tailed Mulgara listed only as Priority 4 by the DEC in Western Australia. The re-classification means that the distribution of the two mulgara species is unclear, but in a study based on DNA analyses that pre-dated Woolley (2005), Adams *et al.* (2000) found that all mulgara specimens from South Australia and Western Australia were one taxon. All specimens from Western Australia held in the WA Museum have recently been confirmed as the Brush-tailed Mulgara (M. Cowan, pers. comm.). It is therefore most likely that the species observed along the proposed route is the Brush-tailed Mulgara, listed as Priority 4 by DEC, but the species is recognised only as the Vulnerable Crest-tailed Mulgara under the EPBC Act.

4.2.4 Rock-Wallabies

During the survey period no signs of rock-wallaby activity were recorded, from either along the proposed haul route or from motion-sensitive cameras placed on rocky outcrops at North Bore. It is highly unlikely that this species occurs in the proposed haul route due to a lack of suitable habitat, and therefore, is not likely to be impacted by the proposed haul route.

At a regional level, surveys undertaken by Bamford Consulting Ecologists (2010a) identified scats as those of a rock-wallaby *Petrogale spp* from the rocky hills approximately 15 km north east of the Mine Camp, and approximately 6.3 km northwest of the Mine Camp close to North Bore. The same survey also identified rock-wallaby tracks approximately 24 km east of the Camp in habitat consisting of red sandy loam plain with open *Triodia* and *Acacia* woodland, with nearby rocky hills.

Further sightings of rock-wallabies have been reported by Cameco mine personnel in rocky hills within and around the mine tenement. However, no sightings or motion-sensitive camera footage was recorded to verify species. Two species that could potentially occur are Rothschild's Rock-Wallaby *Petrogale rothschildi* which is a Pilbara endemic but is not of listed conservation significance species, and has a conservation status listing of Secure. The other potentially occurring species is the Black-flanked Rock-Wallaby *P. lateralis*, which is conservation significant, being listed under the Wildlife Conservation Act as Schedule 1 (Vulnerable) and under the EPBC Act as Vulnerable.

The area is located at the north-eastern limit of known distribution of both wallaby species and neither is known from the area based on available databases. Therefore, the occurrence of either rock-wallaby species in this area is important. Confirmation of species identification is important due to the possibility that this species is the conservation significant Black-flanked Rock-Wallaby. Confirmation of species requires a reliable sighting, DNA analysis of a scat or a recording with a motion-sensitive camera.

4.2.5 Northern Marsupial Mole

This species was not recorded during the survey. It was thoroughly searched for along the proposed route, with special attention given to where the route dissected low sandy dunes as this may be suitable habitat for the species. No signs of Northern Marsupial Moles were similarly recorded from Bamford Consulting Ecologists (2010a). Based on the accounts of the Martu Traditional Owners, the Northern Marsupial Mole is known to occur locally although is very rarely recorded. The vegetation and soil associations occurring locally are consistent with potentially suitable habitat of this species. Given the cryptic behaviour of this species it is difficult to confirm presence without intensive searching for tracks.

The Northern Marsupial Mole has been recorded from Nifty mine and the DEC's NatureMap has records of this species 30 km north of Kintyre, 30 km east of the proposed haul route and also approximately 30 km south of the Karlamilyi National Park. This species is likely to occur in the Kintyre region in areas of favourable (sand-dune) habitat.

The Northern Marsupial Mole is listed as Endangered under both the EPBC Act and as Schedule 1 (Endangered) of the Wildlife Conservation Act. This species is poorly-known but has been recorded in sandy soils of the nearby Great Sandy Desert (M. Bamford, pers. obs.). The Northern Marsupial Mole lives underground in sand dunes, inter-dunal flats and sandy soils along river flats. It occasionally comes to the surface, apparently more frequently after rain (Maxwell *et al*. 1996).

4.2.6 Northern Quoll

This species was not recorded during the surveys. It is highly unlikely to be present in the proposed haul route due to the lack of suitable rocky habitat for dens. Any suitable Northern Quoll habitat is well outside the proposed route and therefore the route is unlikely to impact on this species. No evidence such as scat latrines in rocky areas or tracks along creek lines was detected. Motion-sensitive cameras set up around North Bore also failed to detect this species. A few scats thought to be attributable to the Northern Quoll were recorded during a previous fauna survey (Bamford Consulting Ecologists 2007), and the species was recorded by Hart Simpson and Associates (1994) but only from owl pellet material. Elsewhere in the Pilbara, the distribution and abundance of Northern Quoll populations vary temporally depending on annual rainfall, fire frequency and intensity, and feral predator abundance (M. Bamford, unpubl. data).

The Northern Quoll is listed as Endangered under the EPBC Act and under Schedule 1 of the Wildlife Conservation Act. This species inhabits rock crevices, tree hollows and termite mounds. The Northern Quoll is often associated with rocky areas in the Pilbara but also occurs along watercourses (J. Turpin, pers. obs.). The Northern Quoll formerly occurred across much of northern Australia from the Pilbara to Brisbane, but now occurs in a number of fragmented populations across its former range (DSEWPaC 2011), due largely to interaction with the introduced Cane Toad *Bufo marinus*.

4.2.7 Great Desert Skink

No evidence of this species (burrows or scat latrines) was recorded during searches of potentially suitable habitat within the proposed haul route. The Great Desert Skink is listed as Vulnerable under the EPBC Act. It has a scattered distribution and is restricted to sandplain and gravelly habitats in the western deserts region of central Australia (DSEWPaC 2011). It is known to have disappeared from former habitats, particularly in the Gibson Desert and Great Sandy Desert regions.

The Great Desert Skink occupies a variety of habitat types within the Western Desert region, and generally occurs on hummock grass sandplains characterised by a dominant cover of *Triodia spp*. In the Tanami Desert and parts of the Great Sandy Desert, this species also inhabits paleodrainage lines characterised by giant termite mounds and teatree (*Melaleuca spp*.) shrubs (DSEWPaC 2011).

The decline of the Great Desert Skink has been attributed to altered fire regimes and predation by introduced predators. It has been recorded from Karlamilyi National Park (DSEWPaC 2011), but has not been recorded at Kintyre. This species is likely to occur in the Kintyre region in areas of favourable (probably sand plain) habitat.

4.2.8 Orange Leaf-nosed Bat

The Orange Leaf-nosed Bat was not recorded during the survey. The proposed haul route is located well away from potential cave habitat. Searches of rocky hills around the Kintyre project in 2010 did not locate any deep caves or rock crevices potentially suitable as roost sites (Bamford Consulting Ecologists 2010a), and the area had also been searched (unsuccessfully) for such caves in 2007 (Bamford Consulting Ecologists 2007). This species was recorded by Hart Simpson and Associates (1994), but only from owl pellet material found in the Kintyre area. This species may occur in the rocky hills around Kintyre. Further afield there may be caves in the Coolbro Hills that provide suitable habitat.

The Orange Leaf-nosed Bat is classified as Vulnerable by Duncan *et al.* (1999) and under the EPBC Act, and is listed under Schedule 1 of the Wildlife Conservation Act. This bat requires hot (28 – 32 ºC) and very humid (96 – 100%) roost sites in caves and/or mines. Possible threats to the species caused by mining activities have been reported by Duncan *et al*. (1999) including loss of roost sites due to the collapse and flooding of old mines.

4.2.9 Australian Bustard and Bush Stone-curlew

Numerous Australian Bustard tracks were observed along the proposed haul route. This species is classified as Priority 4 by the DEC and Near Threatened by Garnett and Crowley (2000) and is associated with a variety of grassland, grassy woodland and shrubland habitats across Australia, but has declined in the south. This species has been recorded in the Telfer area (Bamford Consulting Ecologists 2010a; Hart, Simpson and Associates 2002). The

Australian Bustard is widespread and probably nomadic in the general region, utilising a wide range of habitats but particularly grasslands and open shrublands.

Tracks of the Bush Stone-curlew tracks were also recorded along the haul route. This species is listed as Priority 4 by the DEC. It is a generally widespread species and is associated with open woodland with a shrubby understorey and grass. The main threats to the survival of both species are a combination of habitat loss/degradation and predation by introduced fauna (e.g. feral cats and foxes).

4.3 Microchiropteran Bats

Nine microbat species are considered to occur in the Little Sandy Desert, based on McKenzie *et al*. (2002). Four of these species were recorded during June 2011 as described in Table 4-1. None of the species recorded are listed as conservation significant.

Table 4-1: Microbat species expected and recorded during June 2011

Species – Expected	Recorded during survey
VESPERTILIONIDAE (evening bats)	
Gould's Wattled Bat *Chalinolobus gouldii*	Yes
Lesser Long-eared Bat *Nyctophilus geoffroyi*	No
Little Broad-nosed Bat *Scotorepens greyii*	No
Finlayson's Cave Bat *Vespadelus finlaysoni*	Yes
EMBALLONURIDAE (sheathtail bats)	
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*	No
Common Sheathtail-bat *Taphozous georgianus*	Yes
MOLOSSIDAE (freetail bats)	
Beccari's Freetail-bat *Mormopterus beccarii*	No
White-striped Freetail-bat *Tadarida australis*	Yes

4.4 Other fauna observations

An annotated species list of all fauna observations is presented in Appendix 4. A total of one frog, 10 reptile, 51 bird and 11 mammal species were recorded. With the exception of the significant species discussed above, most of the fauna species recorded are widespread.

In addition, numerous feral animal (cats, dogs and camels) tracks were recorded along the proposed route and general region.

5 DISCUSSION

The focus of the targeted surveys was to search for conservation significant fauna species such as Bilby and mulgara within the proposed haul route, with the aim of understanding their local occurrence, distribution, abundance, habitat preference and ecological processes that may impact on them as a result of the proposal. Key results obtained from the survey include:

- Presence of Bilby confirmed in the proposed haul route, but species present in extremely low numbers. Two active burrows were identified and several tracks and foraging holes of varying age (old to very recent). Suitable habitat for the species is widespread in the region.

- Presence of single Bilby confirmed east of North Bore road area by motion-sensitive camera. Species also present in very low numbers in this area. Recent (2007 - 2008) extensive fires may be restricting the abundance of this species in this area, although foxes and feral cats also present.

- Presence of mulgara confirmed in the proposed haul route although in very low densities. Two active and two recently active burrows recorded along the route. Species uncertain but most likely to be the Brush-tailed Mulgara which is listed as Priority 4 by DEC. Suitable habitat for the species is widespread in the region. Extensive fires across the region may restrict the abundance of the species.

- In terms of significant fauna present (Bilby and mulgara), the main vegetation and soil associations of interest include the red sandy loam plains, sand dunes and to some extent the claypan drainage areas. The low rocky hills (found in areas to north of the proposed route) are of less interest to Bilby and mulgara primarily due to the harder substrate.

- Rock-wallabies were not recorded in the proposed haul route and there was a lack of suitable habitat along the route. This species was not recorded at North Bore where motion-sensitive cameras had been deployed. A rock-wallaby species was confirmed present in the region (and Kintyre mine area) in 2010. The species is uncertain at this stage, but is most likely Rothschild's Rock-Wallaby which is not of listed conservation significance, but the presence of this species so far east in the Pilbara is of interest.

- Studies reinforced a previous conclusion that the rocky hills in the region are not suitable for significant roosts of the Orange Leaf-nosed Bat.

- Northern Quoll was not recorded in the proposed haul route, but a population may occur in the region following a succession of favourable seasons. Fire history may also be important for this species.

- Several significant species were not found. Both the Northern Marsupial Mole and Great Desert Skink may occur in suitable habitat (sand dune and plains supporting spinifex grassland), but if present are patchily distributed. They are only likely to occur in areas, where suitable soil exists.

- Numerous Australian Bustard and Bush Stone-curlew (Priority 4) tracks and sightings were recorded throughout the proposed haul route and region.

- Presence of four common bat species confirmed.

- Considerable feral activity was noted along the proposed route and at North Bore road, including camels, cat and dog/dingo tracks.

- Whether recorded or not, significant species need to be considered if expected on the basis of distribution and habitat, as species that have not been recorded may be present in other years or seasons.

Of the above results, the presence of the Bilby and mulgara are of greatest interest. The Bilby is listed under both the EPBC and Wildlife Conservation Acts, the mulgara is probably the Brush-tailed Mulgara that is listed as Priority 4 by DEC, but under current recognition DSEWPaC would consider it to be the Crest-tailed Mulgara which is Vulnerable under the EPBC Act. Of the two species, therefore, the Bilby is of greater interest and cause for consideration.

The Bilby and mulgara have similar habitat requirements, occurring on red sandy loam soils that support spinifex and *Acacia* shrublands. They are thus potentially widespread in the greater Kintyre and Rudall River region but are probably scarce because of impacts from extensive recent fires and predation by feral species.

6 IMPACTING PROCESSES AND MANAGEMENT RECOMMENDATIONS

As described in Section 3.7, DSEWPaC outlines a number of processes that may impact upon fauna as a result of the project. These impacting processes include:

- Habitat loss (leading to population decline).

- Ongoing mortality (leading to population decline).

- Habitat (population) fragmentation.

- Disturbance.
- Changed fire regimes.
- Interactions with other species (feral or over-abundant native species).

An assessment of these impacting processes on significant fauna (in particular Bilby and mulgara) and recommended management strategies are provided below. The assigned impact ratings (i.e. negligible, minor, moderate, high and extreme) are outlined in Table 3-4.

6.1 Habitat loss

Impact assessment

Impacts are likely to be minor, as habitats are extensive and the proposed haul route although linear, is relatively small in the regional context.

Management recommendations

Direct mortality of fauna during vegetation clearing and earthworks is inevitable. The loss of habitat from vegetation clearing should be minimised where possible. The permitted clearing area should be clearly delineated to prevent unnecessary clearing of fauna habitat. Where possible, unused disturbed areas should be rehabilitated as soon as practical.

6.2 Ongoing mortality

Impact assessment

Some mortality of fauna is inevitable during operations. The main contributing factor to ongoing mortality is collision with trucks and light vehicles. Small local populations are particularly vulnerable to ongoing mortality (e.g. Bilbies). Even a small numbers of deaths from roadkill can have a major impact on the local population. Impacts from ongoing mortality likely to be minor if correctly managed.

Management recommendations

It is recommended that a traffic management plan be implemented to manage impacts from the increase in traffic. Mortality from collision with vehicles can be reduced through implementing minimum speed limits and education of mine personnel (inductions). In areas of known wildlife activity, signs should be placed to alert drivers. All collisions with fauna should be reported and recorded to the site environmental advisor. In cases where there are high mortality rates especially with significant species, operational procedures and management strategies should be reviewed and changed accordingly.

6.3 Habitat fragmentation

Impact assessment

Impacts from habitat fragmentation are likely to be negligible for the species of concern, as impact areas associated with the proposed haul route are considered low and habitats are extensive. The road is unlikely to present a barrier to the movement of fauna species.

Management recommendations

Any potential effects of fragmentation should be minimised by limiting footprint size of the road and facilitating rehabilitation, where possible. Roads should be designed to allow the movement and dispersal of small, terrestrial species.

6.4 Disturbance

Impact assessment

Impacts of disturbance (light, noise and vibration) are uncertain but are likely to be negligible. Bilby observations at North Bore road during 2010 and 2011 found the species foraging within 50 m of the road, which is used several times a day by the water truck and light vehicles. Mulgara have also been recorded living within 20 m of active haul roads and public roads (M. Bamford, pers. obs.).

Management recommendations

As the impacts of disturbances are poorly understood, a precautionary approach is recommended. Management strategies to reduce impact on fauna from disturbances could include: avoid night works as far as practicable, implement dust suppression and traffic management strategies.

6.5 Fire regimes

Impact assessment

Fire is an important factor in the terrestrial ecology of the region and needs to be managed, both for safety and property protection, and for conservation. Changed fire regimes is a major factor in the decline of a large proportion of Australian mammals (Burbidge and McKenzie 1989), with the main issue being the replacement of mosaic burning of small areas with very extensive but infrequent fires. The Bilby and mulgara in particular are known to be sensitive to changed fire regimes. The most recent fires in the Kintyre region were in summer 2007 - 2008 and were very extensive, with the one Bilby recorded being associated with one of the largest patches of hummock grassland that escaped that fire. Vegetation along the proposed route has a mixture of fire ages. Impacts from changed fire regimes as a result of the project are likely to be minor.

Management recommendations

Fire regimes are unlikely to change as a direct result of the proposed haul route, assuming standard operating procedures such as a system of hot work permits and fire management procedures are followed. Management needs to recognise the ecological role of fire, such as the maintenance of recently-burnt and long-unburnt areas. The Kintyre project may provide Cameco an opportunity to implement a broader landscape scale fire management programme, possibly in conjunction with traditional owners which could create a mosaic of fire ages that would favour rare mammal species.

6.6 Species interactions

Impact assessment

Feral predators may be attracted to areas of disturbance and thus predation and competition pressure could increase. Introduced species such as the Fox and feral Cat may potentially become a concern. Predation by feral species is the second major factor in the decline of Australian mammals, including Bilby and rock-wallabies (Burbidge and McKenzie 1989). The Fox is of greatest concern; Bilbies coexist with feral Cats in the Great Sandy Desert (M. Bamford, pers. obs) and a feral Cat was recorded close to the single Bilby at Kintyre (North Bore road). However, feral Cats have been implicated in the failure of attempts to reintroduce the Bilby (Miller *et al*. 2010). Rock-wallabies persist in the Pilbara despite the increase in Cats in the area. There was evidence of a Fox in the Kintyre region but the species appeared uncommon which may in part be due to the presence of Dingoes. Impacts from increased predation as a result of the proposed haul route are likely to be minor.

Management recommendations

Any conservation or fire management programme to improve the condition of the environment in the region for rare mammals would need to include a predator control strategy. Management of Dingoes would need to be included in this plan, as the presence of Dingoes can suppress the numbers of Foxes and feral Cats, but the Dingo is also an efficient predator. It is recommended that Cameco implements a predator control strategy in consultation with DEC for the Kintyre region. Access to artificial freshwater sources by wildlife should be avoided where possible.

It should be noted that the Kintyre Uranium mine project provides an opportunity for a landscape-scale conservation programme that manages fire and feral species in order to conserve populations of Bilby, mulgara and rock-wallaby. If practical, the programme could incorporate knowledge and resources from the Martu Traditional Owners and Newcrest's Telfer Gold mine.

Overall, impacts on the majority of significant species identified are expected to be minor (for Bilby and Brush-tailed Mulgara) and negligible (for Rock Wallaby, Northern Marsupial Mole,

Northern Quoll, Great Desert Skink and Orange Leaf-nosed Bat) provided management recommendations are followed.

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APPENDIX 1 – DEFINITION OF CONSERVATION SIGNIFICANCE

The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Wildlife Conservation Act 1950 (Wildlife Conservation Act). The Department of Environment and Conservation (DEC) also maintains a list of species it considers to be "Priority". Local populations of some species may be significant even if the species as a whole has no formal recognition. In this report, therefore, three broad conservation significance categories are used:

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

The category of Conservation Significance 1 includes species listed as threatened or migratory under the EPBC Act and/or that are listed under the Wildlife Conservation Act. Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The Wildlife Conservation Act has a list of Schedules (Appendix 5), but also recognizes the IUCN categories.

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

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

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

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3.

APPENDIX 2 – ECOLOGICAL AND THREATENING PROCESSES

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

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

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

(Taken from http://www.wilderness.org.au/articles/wc_science, viewed 30 December 2008)

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 18 key threatening processes listed by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC).

- Competition and land degradation by feral/unmanaged Goats (*Capra hircus*).
- Competition and land degradation by feral Rabbits (*Oryctolagus cuniculus*).
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).

- Incidental catch (bycatch) of Sea Turtles during coastal otter-trawling operations within Australian waters north of 28 degrees South.

- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.

- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.

- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.

- Land clearance.

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.

- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.

- Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha).

- Predation by feral Cats (*Felis catus*).

- Predation by the European Red Fox (*Vulpes vulpes*).

- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (*Sus scrofa*).

- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.

- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).

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

(http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl) (July 2011).

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

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

(taken from Cork S, Sattler P and Alexandra J (2006), 'Biodiversity' theme commentary prepared for the 2006 Australian State of the Environment Committee, Department of the Environment and Heritage, Canberra, http://www.environment.gov.au/soe/2006/publications/commentaries/biodiversity/pressures.html#major-pressures; Viewed: July 2011).

APPENDIX 3 - BILBY AND MULGARA SEARCH DATA

Age of foraging evidence and tracks is categorised as:

Very Recent = previous night or two.

Recent = older than a few days but since rain had fallen three weeks previously.

Old = probably over a month old and rained upon.

Very Old = probably over a year old.

Age of burrows is given as:

Active = used in previous night or two.

Inactive Old = not used for at least a month but still well-formed.

Inactive Very Old = not used for probably over 6 months and beginning to look weathered.

Proposed Haul Route –Bilby

Type - Bilby	Age	Easting	Northing	Comments
Track	Recent	403907	7602157	One
Forage hole	Old	394600	7557824	Two
Track	Old	394600	7557824	One
Track	Recent	394240	7557240	Several
Track	Old	394272	7557218	Several
Track	Recent	394390	7557428	Several
Track	Recent	394552	7557258	Several
Track	Recent	403975	7585780	Two
Forage holes	Very Recent	395261	7558732	Several
Tracks	Very Recent	395261	7558732	Several
Burrow	Active	395261	7558732	One
Burrow	Active	396492	7560229	One burrow in base of creek bed
Tracks	Very Recent	396492	7560229	Several
Burrow	Inactive Old	396492	7560229	One burrow in base of creek bed
Foraging holes	Very Recent	396492	7560229	With scats
Foraging holes	Old	396593	7561047	Two
Foraging hole	Recent	403036	7571972	With old scat

Proposed Haul Route - Mulgara

Type - Mulgara	Age	Easting	Northing	Comments
Burrow	Active	402262	7590468	
Burrow	Active	403331	7587482	
Burrow	Recent	401975	7592301	
Burrow	Recent	403516	7572596	
Burrow	Inactive	403685	7601268	3 burrows
Burrow	Inactive	402535	7596400	

North Bore Road Transects - Bilby

Type - Bilby	Age	Easting	Northing	Comments
Foraging hole	Old	402080	7533180	
Foraging hole	Old	402042	7533202	Scats present
Foraging holes	Old	402009	7533244	Many holes/m^2
Tracks	Recent	401630	7533500	
Foraging hole	Old	401826	7533497	
Burrow	Recent	401942	7533488	Quite fresh earth and tracks
Tracks	Recent	402076	7533480	

Type - Bilby	Age	Easting	Northing	Comments
Tracks	Recent	402195	7533496	Tracks of a young animal
Foraging holes	Old	402084	7533422	
Tracks	Old	402084	7533422	
Foraging holes	Recent	402006	7533324	
Foraging holes	Recent	402090	7533326	
Tracks	Recent	401570	7533470	
Foraging holes	Old	401620	7533612	
Foraging holes	Old	401690	7533611	Foraging holes in a line for 15m
Foraging holes	Old	401760	7533600	
Tracks	Old	401760	7533600	
Burrow	Old	401880	7533604	
Track highway	Old	401933	7533595	Used many times a few months ago
Track highway	Old	401985	7533614	
Tracks	Recent	402044	7533614	
Foraging holes	Old	401896	7533791	10 + foraging diggings
Foraging holes	Old	401812	7533800	11 + foraging diggings
Tracks	Very old	401812	7533750	
Burrow	Recent	401958	7533980	
Tracks	Old	402226	7533992	
Tracks	Very recent	402234	7633990	
Burrow	Very recent	402243	7533982	
Burrow	Very recent	402440	7534017	Motion camera placed 28-30/06/11
Tracks	Recent	402620	7533998	
Tracks	Recent	402779	7534200	

APPENDIX 4 – ANNOTATED FAUNA SPECIES LIST

Frogs and Reptiles

1. *Desert Tree Frog. Litoria rubella.* Seen at North Bore.
2. *Ring-tailed Rock Dragon. Ctenophorus caudicinctus*
3. *Desert Dune Skink. Ctenotus brooksi*
4. *Leopard Skink. Ctenotus pantherinus*
5. *Striped Skink. Ctenotus calurus.* Southern Telfer Road.
6. *Military Dragon. Ctenophorus isolepis.* Seen regularly and many specimens are recent hatchlings.
7. *Pygmy Spiny-tailed Skink. Egernia depressa*
8. *Skink. Notoscincus ornatus*
9. *Black-tailed Monitor. Varanus tristis.* One seen along Telfer Road at about 407900mE, 7546500mN.
10. *Yellow-faced Whip Snake. Demansia psammophis* One active along Telfer Road in acacia over spinifex on red sandy loam at 407500mE, 7534200mN.
11. *Ringed Brown Snake. Pseudonaja modesta.* Adult roadkill on Telfer Road at 405 092mE, 7 574 706mN.

Birds

1. Emu. Tracks along Telfer Rd (30/06).
2. Collared Sparrowhawk. One at North Bore (24/06) and one at Duck Pool (30/06)
3. Whistling Kite. One near north end of Haul Road near Marble Bar Road (25/06).
4. Spotted Harrier. One along haul road route about 5km south of Marble Bar Road (25/06) and one mid-way along option C (26/06) and one near North Bore (27/06).
5. Wedge-tailed Eagle. Telfer rd.
6. Brown Falcon. One along haul road route about 5km south of Marble Bar Road and one near camp (25/06), and one mid-way along option C (26/06).
7. Australian Hobby. One along Creek along Telfer Rd.
8. Spinifex Pigeon. Single bird seen several times along North Bore Road near Circle Road.
9. Diamond Dove. Seen occasionally throughout; usually just single birds but some flocks of 4-5 birds.
10. Crested Pigeon. Ones and twos seen occasionally.
11. Flock Bronzewing. Single juvenile flushed long haul road route about 6km south of Marble Bar road.

12. Galah. Two along Telfer Road around creek about 4km north of camp turnoff (25/06) and three along haul road route near Marble Bar road (26/06).
13. Cockatiel. Flock of about 10 near North Bore (24/06) and flock of about 40 in same area (25/06). Small flocks occasionally elsewhere; occasionally up to 40 birds.
14. Australian Ringneck. Several around creek on Telfer road 4km north of camp turnoff (25/06).
15. Budgerigar. Flocks seen regularly throughout; occasionally 100+ birds.
16. Australian Bustard. Numerous fresh and not so fresh tracks seen throughout. Three flew over Telfer on our arrival (24/06). One in Bilby area (25/06). About 5 birds seen during aerial survey work and three seen along Telfer to Kintyre road at night (26/06). Group of six near First Creek (26/06).
17. Bush Stone-Curlew. Tracks seen at 393124E, 7551455N, along route.
18. Little Button-quail. Seen regularly throughout. Tracks and scrapes everywhere and birds flushed at the rate of one every hundred metres or so during traverses.
19. Blue-winged Kookaburra. Heard along Telfer Road creek
20. Red-backed Kingfisher. One near old camp at water source along Telfer road (26/06).
21. Spotted Nightjar. Few along Kintyre to Telfer Road evening of 26/06.
22. Rainbow Bee-eater. Few around creekline along Telfer Road 4km north of camp turnoff (25/06).
23. Horsfield's Bronze-Cuckoo. One calling in Bilby area (25/06) and 1 along Telfer Road (30/06)
24. White-winged Fairy-wren. At least two parties in Bilby area and few parties elsewhere.
25. Weebill. Common amongst eucalypts along creeklines.
26. Red-browed Pardalote. Along creeklines with eucalypts and occasionally in shrubland areas, but seemed to be less obvious than in 2010.
27. Striated Pardalote. Several calling amongst eucalypts in creek along Telfer Road 4km north of camp turnoff.
28. Yellow-throated Miner. Throughout.
29. Grey-headed Honeyeater. Few along haul road route near Marble Bar road (26/06).
30. Singing Honeyeater. Throughout.
31. Black-chinned Honeyeater. Heard among eucalypts on creek beside Telfer Road 4km north of camp turnoff (25/06).
32. White-plumed Honeyeater. In eucalypts along all watercourses and occasionally elsewhere.
33. Brown Honeyeater. Few amongst eucalypts along creek on Telfer Road, 4km north of camp turnoff.
34. Pied Honeyeater. Few in Bilby area; some doing display flight, and occasionally elsewhere.

35. Black Honeyeater. Few calling throughout.
36. Crimson Chat. Flocks of up to 20 birds seen regularly in drive from Telfer to Kintyre (24/06). Similar flocks seen regularly throughout.
37. Grey Fantail (ssp. *fuliginosa*). Two in woodland at North Bore (26/06).
38. Willie Wagtail. Throughout.
39. Magpie-lark. Throughout including away from creeks.
40. Black-faced Cuckoo-shrike. Two in Bilby area (24/06) and two at creek along Telfer Road, 4km north of camp turnoff (25/06).
41. White-winged Triller. Seen occasionally throughout. No full-coloured males and not calling.
42. Black-faced Woodswallow. Group of three in Bilby area (25/06).
43. Masked Woodswallow. Heard far overhead throughout and occasional flocks close to ground. Several hundred roosting along haul road route close to Marble Bar road (26/06).
44. Australian Magpie. Two near Bilby area (23/06).
45. Torresian Crow. Two seen during drive from Telfer to Kintyre (24/06) and two near North Bore (25/06).
46. Pied Butcherbird. Throughout. Calling.
47. Zebra Finch. Present in small numbers (pairs and groups up to about 6) and seen occasionally. Bird on nest with eggs in Bilby area.
48. Painted Finch. Small group observed at Duck Pool (30/06).
49. Rufous Songlark. Several calling around camp (24/06).
50. Brown Songlark. One calling near camp (24/06) and several along Haul road route.
51. Singing Bushlark. Recorded along proposed haul rd (29/06).

Mammals

Mulgara*. Dasycercus spp*. Two active, 2 recently active and 4 inactive burrows recorded along the haul road route.

Bilby. *Macrotis lagotis*. Signs of recent activity at Bilby area just north of Wartarra Creek, east of the North Bore road. Locations of two active burrows, diggings and some tracks recorded. Motion-sensitive camera recorded an individual outside burrow. Evidence of two active burrows identified in the southern section of haul road route.

Red Kangaroo*. Macropus robustus*. Throughout on basis of scats.

White-striped Freetail Bat*. Tadarida australis*. Heard nightly over camp.

Sheathtail Bat. *Taphozous spp.* Over camp.

Inland Cave Bat*. Vespadelus finlaysoni*. Over camp.

Gould's Wattled Bat*. Chalinolobus gouldii.* Over camp.

Fox. *Vulpes vulpes*. Fresh track at Bilby area (24/06).

Dingo. *Canis lupus dingo*. Throughout.

Feral Cat. *Felis catus.*Fresh and old tracks at Bilby area (24/06) and along Telfer Road.

Camel. *Camelus dromedaries.* Tracks everywhere. Group of approximately 12 on drive from Telfer to Kintyre (24/06). Fresh tracks near North Bore road Bilby area (25/06). Numerous camels recorded from helicopter survey.

APPENDIX 5 – ASSESSMENT OF CONSERVATION STATUS

Categories used in the assessment of conservation status. IUCN categories (based on review by Mace and Stuart, 1994) as used for the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).

- **Extinct**. Taxa not definitely located in the wild during the past 50 years.
- **Extinct in the Wild.** Taxa known to survive only in captivity.
- **Critically Endangered.** Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered**. Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable**. Taxa facing a high risk of extinction in the wild in the medium-term future.
- **Near Threatened.** Taxa that risk becoming Vulnerable in the wild.
- **Conservation Dependent.** Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
- **Data Deficient** (Insufficiently Known). Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
- **Least Concern**. Taxa that are not Threatened.
- Schedules used in the Wildlife Conservation Act 1950 (WA)
- **Schedule 1.** Rare and Likely to become Extinct.
- **Schedule 2.** Extinct.
- **Schedule 3.** Migratory species listed under international treaties.
- **Schedule 4.** Other Specially Protected Fauna.
-

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

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

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

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

- **Priority 4.** Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

- **Priority 5.** Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

TARGETTED FAUNA SURVEY FOR THE KINTYRE URANIUM MINE PROJECT

Bilby recorded during the target survey.

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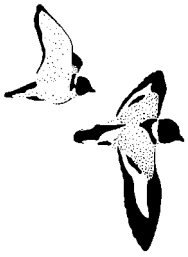

16th October 2010
UPDATED 23rd April 2013

Introduction

The Kintyre Uranium Mine project area is located in the far eastern edge of the Pilbara, approximately 80km south of Telfer, just north of the Rudall River National Park in the Trainor bio-region, and lies between the Little Sandy and Great Sandy Deserts. Bamford Consulting Ecologists (BCE) was engaged by Cameco Pty Ltd to conduct targetted fauna surveys of the project area as part of an Environmental Impact Assessment for the Kintyre Uranium Mine project.

Previous fauna survey work within the project area (mine tenement) was undertaken in the 1980s and early 1990s (Hart, Simpson and Associates 1994). This involved a survey equivalent to level 2 intensity (*sensu.* Guidance Statement 56, Environmental Protection Authortity 2004), and provided details of the vertebrate fauna assemblages occurring within the site. However the conservation status of some locally occurring species has been upgraded since the original survey in the 1980s, such as the Northern Quoll (*Dasyurus hallucatus*), and there is increased interest in invertebrate fauna. Conservation status changes of some locally occurring species have also come about due to the establishment of the Commonwealth EPBC Act 1999 after the original survey. In addition, fauna survey techniques not available during the original survey are now accessible such as the use of motion sensitive camera and ultrasound bat detection technologies, which have shown to be highly effective in the detection of conservation significant species.

Information on fauna of the project area was reviewed by Bamford (2007) to update species listed in terms of taxonomy and changes in conservation legislation. This included an extended site inspection to familiarise the consultant with vegetation-soil associations and fauna habitat characteristics of the site, and to collect some fauna observations, with particular emphasis on searching for signs of significant species.

To provide additional information, a targeted species approach was accepted as an appropriate means to supplement the abovementioned survey for the Kintyre Uranium Mine project following discussions between BCE, Cameco and the DEC. The targeted survey approach focused on a number of conservation significant fauna. The survey included the help of Martu Traditional Owners. These people have experience in tracking and locating local fauna including conservation significant species relevant to this project, as well as having local and historical knowledge of fauna.

Study Objectives

The objectives of the fauna survey were to search for conservation significant fauna species within the Kintyre mine tenement to determine local occurrence, and to search in adjacent areas to obtain a contextual perspective in relation to locally occurring species and their habitat. Based on discusses between BCE, Cameco and DEC, the survey was to focus on:

- Significant species that could be found with the assistance of Martu Traditional Owners) such as Bilby, Northern Quoll, mulgara, rock-wallabies, possums, Northern Marsupial Mole, hare-wallabies and Giant Desert Skink.
- Bats that can be detected with the Anabat system.
- SRE invertebrates.

- Frogs of the genus *Uperoleia* (suggested by DEC to be potentially of taxonomic interest).

Methods

The target survey was undertaken from 26 July to 3 August 2010. Field personnel from Bamford Consulting Ecologists were Mike Bamford (BSc. Hons, PhD), Ian Harris (BSc. Hons) and Robert Browne-Cooper (BSc), assisted by Cameco personnel Kat Zampogna and Christina Rogers. In addition, three representatives of the Martu Traditional Owners, Desmond Taylor, Brian Sailor and George "Shorty" Dunn, were present. Analysis of bat call data was carried out by Brenden Metcalf (BSc, Hons).

Based on known distribution, habitat preferences, and known local occurrence, a number of conservation significant fauna species potentially occur within the Kintyre mine tenement. A list of the fauna species targeted and the detection and search methods used is presented in Table 2. Figure 1 shows the mapped locations of all targeted fauna searches. Field work was carried out under Licence to Take Fauna for Scientific Purposes SF007477.

Transect Searches

Transect searching for the targeted fauna species was carried out to search for signs of fauna activity including tracks, foraging signs, burrows and scats. The approach used involved three to four personnel positioned in a row and each person walking along a designated bearing (easting or northing). Each person used a hand-held GPS to maintain their bearing and spacing to enable thorough coverage of search areas. Transect spacing was 50m for areas where broad sweep searches were used to detect evidence of the target species. Transect searching was carried out in habitat suitable for the Greater Bilby and Mulgara, principally in response to the discovery of signs of a Bilby early during the field trip.

Transect locations were selected based on suitability of habitat (soils and vegetation characteristics, fire history and general condition) for the target species. Transects spacing of 20m was used in areas where signs of a target species were detected and more thorough searching was required. This allowed a more detailed level of searching to detect and map fauna evidence such as foraging signs and burrows. Transects were located within the impact area, within the wider mine tenement area, and within adjacent areas proximal to the mine tenement to obtain a contextual perspective in relation to locally occurring species and their habitat.

All evidence of the target species was logged as a waypoint together with notes on species, type of activity detected, and age of foraging signs and burrow recorded. Figure 1 shows the search transects and camera locations, with the location of significant species evidence on Figure 2 and details of the Bilby records on Figure 3.

Motion Sensitive Cameras

Four motion sensitive infrared cameras were set in locations having suitable habitat in areas where evidence of target species was located such as scats, foraging activity, tracks or burrows. Cameras were Reconyx and Bushnell models and set to record video footage during day or night to detect diurnal and nocturnal activity. Universal bait consisting of a mixture of rolled oats,

peanut butter and sardines was scattered in front of each camera to attract fauna into the field of view. At one camera location (Bilby camera - 4) the bait was peanut butter and rolled oat without sardines. Camera survey effort was a total of 24 camera trap nights representing about 570 hours of constant video monitoring. All camera locations were recorded using hand-held GPS. Refer to Table 1 for data on camera locations.

Table 1. Motion sensitive camera locations

Camera #	Target species	Notes	Easting	Northing
1- Camp	Northern Quoll	27-30 July (3 nights). In small cave on rocky slope to east of bore.	400507	7535882
2 – Camp	Northern Quoll	27-30 July (3 nights). In small cave on rocky slope to east of bore.	400506	7535898
1 - North Bore	Rock Wallaby	27-30 July (3 nights). In small cave on rocky slope to east of bore.	404128	7531148
2 - North Bore	Rock Wallaby	27-30 July (3 nights). In small cave on rocky slope to east of bore.	404073	7531154
3- North Bore	Rock Wallaby	30 July (1 night). Set at grassy base of rocky slope.	400493	7535838
1 – Bilby	Bilby	30July-2 August (3 nights). Set in area of Bilby foraging activity.	402261	7533031
2 – Bilby	Bilby	30July-2 August (3 nights). Set in area of Bilby foraging activity.	402192	7532998
3 – Bilby	Bilby	30July-2 August (3 nights). Set in area of Bilby foraging.	402074	7533037
4 – Bilby	Bilby	31 July- August (2 nights). Set near fresh Bilby burrow, and near numerous fresh tracks and foraging holes.	401666	7533372

Plate 1. Motion sensitive camera set to detect Bilbies.

Micro-chiropteran Bat Call Detection

Bat calls were recorded at two locations on two separate nights:
27/7/2010 - Waratarra Creek (402 700E, 7 532 800N);
2/8/2010 - First Creek (405 200E, 7 531 400N).
The locations were creek beds which are frequently used as flyways and night hunting areas by micro bats (see Figure 1). Calls were detected and recorded using an Anabat II unit in conjunction with an Edirol Audio Recorder. Calls were then played back through a ZCAIM unit into Anabat6 software. AnalookW (V3.3f 2006) and Analyze (V2.3 2000 Jolly) software were used for analysis of call sequences. Species were identified through comparison with the data presented in McKenzie *et al.* (2002) and the author's own call library for the region. Refer to Appendix B for the full report on the Anabat data methodology and results.

Short Range Endemic Invertebrates

Short Range Endemic (SRE) invertebrates had not previously been sampled in the Kintyre area, and the EPA has produced a guidance statement to provide advice on appropriate levels of sampling for a project (Environmental Protection Authority 2009). This advice involves an initial risk assessment based upon the nature of the landscape and therefore the likelihood of the presence of SRE species, and the potential threat from the proposed development upon any SRE fauna that may be present.

The Kintyre project area lies in a landscape of low rocky hills with extensive scree slopes, and broad sandy-loam plains dissected by seasonal watercourses. Both the rocky hills and the plains are very extensive in the region, while the watercourses are parts of a broad drainage system (Figure 1). Such broadly represented environments across the landscape are not conducive to the evolution of SRE invertebrates, which are generally favoured by the presence of fragmented, isolated and often mesic refugia (Harvey 2002). Some of the rocky hills did contain caves which were inspected, both to check for bat roosts and to assess their suitability of SRE invertebrates. Caves in the immediate vicinity of the impact areas were shallow and dry; most were effectively overhangs. Deep and particularly moist caves can provide the right sort of environment for SRE invertebrates, as can very steep, south-facing (therefore cool) slopes, but the rocky hills around the project area did not contain these features. Plate 3 illustrates a typical rocky hill in the area.

The impact area lies mainly over a sandy loam plain but encompasses two small rocky hills. There is intended to be no impact on watercourses. Therefore, the project is likely to affect only well-represented environments.

Despite the conclusion that the likelihood of the presence of SRE invertebrates was low, some searching for and collection of invertebrates was carried out. This focussed on taxa that are known to include SRE species where environments are conducive to their evolution, such as scorpions, land snails, psuedoscorpions, millipedes and slaters (Harvey 2002). Approaches used were:

- Land snails were searched for in rocky environments as in parts of the Pilbara to the west there is a high richness of SRE snail species. However, the Kintyre project area is outside the known range of this group (Solem 1997).
- Leaf-litter was collected from locations that might represent mesic refugia. In total four samples were collected from areas of relatively deep leaf-litter within creek lines and broad valley floor: two from the creek near North Bore (404 050E, 7 531 200N) and two from First Creek (405 200E, 7 531 400N). Samples were sent to Dalcon Environmental for processing and analysis.
- Searching was carried out for mygalomorph spider and scorpion burrows and these were excavated (Plate 2).

Traditional Owner Participation

Martu Traditional Owners participated during the site investigations by assisting in the identification of potentially suitable habitat, identification of track, foraging signs and scats of target fauna species. They also identified locations where historically the target species were known to occur. The Traditional Owners also assisted by sharing information on their knowledge of local fauna providing useful information of the ecology of the target species.

Opportunistic searching

During all site investigations opportunistic searching for target species was undertaken, for example short range endemic invertebrate fauna specimens were collected during Bilby survey transects (Plate 2). This method was also employed where transect searching was not suitable such as searching rocky outcrops for Rock Wallabies and Northern Quolls (Plate 3), and sand dunes for Marsupial Moles and Giant Desert Skinks (Plate 4). Searching for frogs was carried out along creeklines, including at night when frogs might be active.

During opportunistic searching for the target species, all other vertebrate and invertebrate fauna observed was noted. A complete annotated list of these observations is included as Appendix C.

Plate 2. Opportunistic collecting of short range endemic invertebrate fauna (excavating a scorpion burrow).

Plate 3. Habitat opportunistically searched for Northern Quolls and Rock Wallabies.

Plate 4. Habitat opportunistically searched for Marsupial Moles and Giant Desert Skinks.

Table 2. Survey methods employed to search for target species, and species groups.

Species	Transect Searches	Motion Camera	Anabat Detector	Traditional Owner help	Leaf-litter collection	Opportunistic Searches
Northern Quoll (*Dasyurus hallucatus*)		X		X		X
Rock Wallabies (*Petrogale* spp.)		X		X		X
Mulgara (*Dasycercus* spp.)	X			X		X
Bilby (*Macrotis lagotis*)	X	X		X		X
Northern Marsupial Mole *(Notoryctes caurinus*)				X		X
Giant Desert Skink (*Liopholis kintorei*)				X		X
Microchiropteran Bats			X			
Orange Leaf-nosed Bat (*Rhinonicteris aurantius*)						X
Short Range Endemic Invertebrates	X				X	X

N

0 1 2km

Scale 1:100 000
MGA94 (Zone 51)

400000mE 410000mE 420000mE 430000mE

7540000mN

7530000mN

7520000mN

Cameco

NORTH BORE

Rock-wallaby scat on rocky slope

Rock-wallaby scat on rocky slope

Scorpion 5 Urodacus sp

Rock-wallaby tracks

Rock-wallaby tracks

Bilby foraging area

Mygalomorph Spider Aname sp

Scorpion 1 Urodacus sp

Scorpion 2 Urodacus sp

KINTYRE PROJECT

RUDALL RIVER NATIONAL PARK

Two Bilby old foraging holes and a burrow

Scorpion 3 & 4

Mulgara species

DESERT QUEEN BATHS

LEGEND

- Kintyre Project Area
- Existing access track
- Survey track log
- National Park
- Survey Recording - Bilby
- Survey Recording - Bilby foraging area
- Survey Recording - Rock Wallaby Survey
- Recording - Mulgara
- Survey Recording - Scorpion
- Survey Recording - Spider

Kintyre Joint Venture Project

Targeted Fauna Survey

Regional Survey Results

Figure 2

Author: M. Bamford Date: October 2010

BAMFORD CONSULTING ECOLOGISTS

Author: M. Bamford ~ Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ Date October 2010 ~ A3 ~ CAD Ref g1826_Fauna_001_03.dgn

Results

Northern Quoll

This species was not recorded during searches in potentially suitable habitat. No evidence such as scat latrines in rocky areas or tracks along creek lines was detected. Motion cameras did not detect this species. A few scats thought to be attributable to the Northern Quoll were recorded during a previous fauna survey (BCE 2007), and the species was recorded by Hart (1994) but only from Owl Pellet material. The status of the species in the project area is therefore uncertain. Elsewhere in the Pilbara, the distribution and abundance of Northern Quoll populations vary temporally depending on annual rainfall, fire frequency and intensity, and feral predator abundance (M. Bamford unpubl. data).

The Northern Quoll is listed as Endangered under the EPBC Act and under Schedule 1 of the WA Wildlife Conservation Act. This species inhabits rock crevices, tree hollows and termite mounds. The Northern Quoll is often associated with rocky areas in the Pilbara but also occurs along watercourses (J. Turpin, pers. obs.). The Northern Quoll formerly occurred across much of northern Australia from the Pilbara to Brisbane, but now occurs in a number of fragmented populations across its former range (DEWHA, 2010), due largely to interaction with the introduced Cane Toad *Bufo marinus*.

Rock-Wallabies

During the targeted survey scats identified as those of a rock-wallaby *Petrogale* sp. were recorded on rocky hills approximately 15km north east of the Mine Camp, and approximately 6.3 kilometres north west of the Mine Camp close to the location of the North Bore (Plate 5). Tracks identified as those of a rock-wallaby (Plate 6) were identified approximately 24km east of the Camp in habitat consisting of red sandy loam plain with open *Triodia* and *Acacia* woodland, with nearby rocky hills. The Martu Traditional Owner people assisting during this survey confirmed the tracks were those of a rock-wallaby. Table 3 presents GIS locations of data from the target survey.

Sightings of rock-wallabies have been reported by Cameco mine personnel in rocky hills within and around the mine tenement. No sightings or motion camera footage was recorded to verify species. Two species that potentially occur within the mine tenement are Rothschild's Rock-Wallaby *Petrogale rothschildi* which is a Pilbara endemic but is not of listed conservation significance species, and has a conservation status listing of 'secure'. The other potentially occurring species is the Black-flanked Rock-Wallaby *P. lateralis,* which is conservation significant, being listed under the WA Wildlife Conservation Act as Schedule 1 ('vulnerable') and under the Commonwealth EPBC Act as 'vulnerable'.

The project area is located at the north-eastern limit of known distribution of both wallaby species and neither is known from the area based on available databases. Therefore, the occurrence of either rock-wallaby species in this area is important. Confirmation of species identification is important due to the possibility that this species is the Black-flanked Rock Wallaby. Confirmation of species requires a reliable sighting or a recording with a motion-sensitive camera.

Plate 5. Rock-wallaby *Petrogale* sp. scats recorded during the targeted survey.

Plate 6. Rock-wallaby *Petrogale sp* tracks recorded during the targeted survey; forepaw prints on left and hindfoot prints on right.

Table 3. Locations of rock-wallaby evidence

Observation	Easting	Northing
Rock-wallaby tracks	22 17' 03"S	122 20'18"E
Rock-wallaby tracks	428013	7531887
Rock-wallaby scat on rocky slope	416858	7541238
Rock-wallaby scat on rocky slope	400493	7535838
Rock-wallaby scat on rocky slope	400506	7536014

Mulgara species

One active burrow and several inactive burrows were located along the track to Desert Queen Baths at 417371E, 7523846N, approximately 15km south-east of the Mine Camp, (see Plate 7). Transect and opportunistic searches of suitable habitat elsewhere within the mine tenement and in close proximity did not reveal evidence of Mulgara species.

Woolley (2005) recognised two species of mulgara, the Crest-tailed Mulgara *Dasycercus cristicauda* and the Brush-tailed Mulgara *D. blythi*. Prior to this, only the Crest-tailed Mulgara was recognised. Because of the recent re-classification there is some confusion in museum records and under legislation between these species. Only the Crest-tailed Mulgara is recognised under the EPBC Act (as Vulnerable), with the Brush-tailed Mulgara listed only as Priority 4 by the DEC in Western Australia. The re-classification means that the distribution of the two mulgara species is unclear, but in a study based on DNA analyses that pre-dated Woolley (2005),

Adams *et al.* (2000) found that all mulgara specimens from South Australia and Western Australia were one taxon. All specimens from Western Australia held in the WA Museum have recently been confirmed as the Brush-tailed Mulgara (M. Cowan pers. comm.). It is therefore most likely that the species at Kintyre is the Brush-tailed Mulgara, listed as Priority 4 by DEC, but the species is recognised only as the Vulnerable Crest-tailed Mulgara under the EPBC Act.

Plate 7. Active Mulgara burrow recorded during opportunistic target searching.

Bilby

This species was recorded during the target searches approximately 3.6km north west of the Mine camp on the northern side of Waratarra Creek (401666E 7533372N), on camera # 4 via video footage. The video footage shows a single animal active on two nights and tracks and foraging holes indicated that only one animal was present. Comprehensive grid searching around this location recorded numerous freshly dug Bilby burrows, forage holes, Bilby track and scats (Plate 8). Numerous old burrows and forage holes were also recorded indicating that the resident Bilby had been living and foraging extensively in this area for at least several months.

Appendix A presents all Bilby evidence recorded in this area and locations are illustrated on Figure 3. Active burrows and recent foraging activity were spread over an area of about 8 ha, but activity over the previous several months was spread over an area of about 60ha. Much of the activity was in vegetation that had not been burnt in 2007/2008, but the most recent activity was in recently-burnt vegetation. Note that the aerial photography used in Figure 3 does not show the most recent fire history. The evidence included two trackways, perhaps two to four weeks old, where the animal had travelled over a kilometre to the north, and then returned; presumably in the same night. The habitat of this area is mixed sparse *Acacia* and stunted *Eucalyptus* woodland over open *Triodia* hummocks on red sandy loam soil (see Plate 8). Based on these results, this site appears to support a single adult Bilby and the persistence of this animal is related to fire history. The unburnt area was the largest such patch of unburnt vegetation in the region and seems to have escaped the 2007/2008 fire because of the North Bore track and Waratarra Creek.

Thompson and Thompson (2008) reported on the distribution of foraging activity and burrows of a Bilby in the Pilbara and found an area of activity of 9ha. This was also in a recently-burnt area and while they were uncertain of the number of animals present, their descriptions and observations made in the present study suggest that they also had a single Bilby. Moseby and O'Donnell (2003) report home range areas for Bilbies as 20ha (females) and 320ha (males), but the home range area would be much larger than the area over which an animal might forage in a few nights. Given that the animal recorded at Kintyre foraged over a core area of about 60ha, not including the trackway to the north, the individual was probably a male.

Further transect surveys for evidence of Bilbies was undertaken across the region, with a focus on areas that including at least some vegetation not burnt in 2007/2008. One old burrow and several old foraging pits around the base of *Acacia* shrubs were found near the Desert Queen Baths turnoff (see Figure 2). This evidence is believed to be at least several years old. Potentially suitable Bilby habitat occurs extensively within and surrounding the mine tenement however due to the extent of recent fire throughout most of this habitat, is it likely that Bilbies have been temporarily displaced. Therefore these survey results indicate that whilst the local area could potentially support a Bilby population, currently the local Bilby population is very sparse within the mine tenement and wider local area. Additional target survey work following regeneration of the vegetation could potentially confirm a wider occurrence of this species in and around the Kintyre Mine tenement.

One of the motion cameras within the area of Bilby activity recorded an active feral cat approximately 540 metres from the Bilby sighting. Implications of feral predators on the Bilby and other conservation significant species are addressed under Recommendations.

The Bilby is listed as Vulnerable by Maxwell *et al*. (1996) and under the relevant state and commonwealth acts. The species formerly utilised a wide range of habitat types across the continent. Extant populations are restricted to a variety of "tall shrublands, open woodlands, hummock grasslands and sparse forblands" (Maxwell *et al.* 1996).

The species appears to remain widespread in the Great Sandy Desert (M. Bamford pers. obs.) and scattered populations occur across the northern Pilbara, including close to Port Hedland

(Thompson and Thompson 2008). In the Great Sandy Desert, the species appears most common in acacia shrublands associated with paleo-drainage lines, where the soils are sandy loams

In addition to these recent records, the Bilby was recorded from Kintyre in 1998 (Cathy Gupanis, pers. comm.) and old bone material was also found in the owl roost (Hart 1994). The 1998 record was south of the ore deposit. Sandy loam soils supporting acacia shrubland is occupied by the species in the Great Sandy Desert (M. Bamford pers. obs) and such habitat is widespread in the project area, including around the ore body. The Bilby is also reported from around Telfer, 100km to the north (B. Metcalf pers. comm.).

Plate 8. Bilby photos.

Fresh bilby burrow

Fresh bilby scats

Bilby habitat

Fresh forage hole

Fresh Bilby track

Photo of foraging bilby recorded during survey

Northern Marsupial Mole

This species was not recorded during this survey. Based on the accounts of the Martu Traditional Owners, the Marsupial Mole is known to occur locally although is very rarely recorded. The vegetation-soil associations occurring locally are consistent with potentially suitable habitat of this species. Given the cryptic behaviour of this species it is difficult to confirm presence without intensive searching for tracks.

The Northern Marsupial Mole is listed as Endangered under both the EPBC Act and as Schedule 1 (Endangered) of the WA Wildlife Conservation Act. This species is poorly-known but has been recorded in sandy soils of the nearby Great Sandy Desert (M. Bamford pers. obs.). The Northern Marsupial Mole lives underground in sand dunes, inter-dunal flats and sandy soils along river flats. It occasionally comes to the surface, apparently more frequently after rain (Maxwell *et al*. 1996). The Northern Marsupial Mole has been recorded from Nifty mine and NatureMap has records of the Northern Marsupial Mole 30km north of Kintyre and also approximately 30km south of Rudall River National Park. This species is likely to occur in the Kintyre region in areas of favourable (sand-dune) habitat, but probably not in the immediate vicinity of the project development where soils are sandy loams.

Giant Desert Skink

No evidence of this species (burrows or scat latrines) was recorded during target searches of potentially suitable habitat within the mine tenement and adjacent areas. Where the species is present it is usually conspicuous (to experienced observers).

The Giant Desert Skink is listed as Vulnerable under the EPBC Act. It has a scattered distribution and is restricted to sandplain and gravelly habitats in the western deserts region of central Australia (Species Bank 2009). It is known to have disappeared from former habitats, particularly in the Gibson Desert and Great Sandy Desert regions.

The Giant Desert Skink occupies a variety of habitat types within the Western Desert region, generally occur on hummock grass sandplains characterised by a dominant cover of Spinifex grasses *Triodia* species. In the Tanami Desert and parts of the Great Sandy Desert, this species also inhabits paleodrainage lines characterised by giant termite mounds and titree (*Melaleuca sp*.) shrubs (Species Bank 2009).

The decline of the Giant Desert Skink has been attributed to altered fire regimes and predation by introduced predators (Species Bank 2009). It has been recorded from Karlamilyi (Rudall River) National Park (DEC 2010), but has not been recorded at Kintyre. This species is likely to occur in the Kintyre region in areas of favourable (probably sand-dune) habitat, but probably not in the immediate vicinity of the project development where soils are sandy loams.

Orange Leaf-nosed Bat

The Orange Leaf-nosed Bat was not recorded during this survey. Searches of rocky hills did not locate any deep caves or rock crevices potentially suitable as roost sites, and the area had also been searched (unsuccessfully) for such caves in 2007 (Bamford Consulting Ecologists 2007). This species was recorded by Hart (1994), but only from Owl Pellets found in the Kintyre area.

This species may occur in the rocky hills adjacent to the project area and is likely to visit the site (Bamford, 2007). There may be caves in the nearby Coolbro Hills that provide suitable habitat.

The Orange Leaf-nosed Bat is classified as Vulnerable by Duncan *et al.* (1999) and under the EPBC and WCA Acts. This bat requires hot (28 – 32 ºC) and very humid (96 – 100%) roost sites in caves and/or mines. Possible threats to the species caused by mining activities have been reported by Duncan *et al.* (1999) including loss of roost sites due to the collapse and flooding of old mines.

Short Range Endemic Invertebrates (SREs)

Four potential SRE specimens were collected during the survey (Table 4): the scorpion *Urodacus "yashenkoi",* a pseudoscorpion *Oratemnus* sp. and a trapdoor spider *Aname "armigera"*. The scorpions were dug from burrows (see Plate 2) at a depth of almost 1m, while several specimens of the spider were dug from burrows amongst leaf-litter in spinifex on sandy loam with scattered acacia and eucalypt. The pseudoscorpion was found in a leaf-litter sample. Locations are given in Table 4 and are indicated on Figure 2.

Of these species, the scorpion is almost certainly not an SRE, as the specimens were collected from extensive environments that are well-represented in the broader region. Based on advice from Erich Volshenk (pers. comm.) *Urodacus "yashenkoi"* is a complex of undescribed species, nearly all associated with sandy substrates (usually red dunes), with about six species within the complex. The Kintyre specimens came from sandy plains. The range of the complex spans most of Australia, but individual species within the complex have smaller distributions than this.

The mygalomorph spider is widespread in the Pilbara although may be a species complex, so the distribution of the species recorded at Kintyre is uncertain. Both the specimens found, and other burrows probably of this species, were close to creeklines. The distribution of the pseudoscorpion is unknown; the genus is widespread but the undescribed species at Kintyre may be an SRE. Little can be concluded from a single specimen, but as a group, pseudoscorpions are often associated with mesic microhabitats (ie. locations where conditions are relatively moisture within a local context), and it is likely that *Oratemnus* sp. is restricted to creeklines and other locations where moisture concentrates, such as the base of rocky hills.

Table 4. Details on invertebrate specimens.

SRE group	Family	Genus/species	Notes
Pseudoscorpion	Atemnidae	*Oratemnus* sp.	Leaf-litter sample from drainage line near North Bore (404 050E, 7 531 200N) WA Museum ref. 107426
Mygalomorph spider	Nemesiidae	*Aname armigera* group	Two specimens extracted from burrows in loam close to creekline, under a *Corymbia* and in sparse spinifex (around 400 600E, 7 532 500N). WA Museum ref. 107370, 107373
Scorpion	Urodachidae	*Urodacus "yashenkoi"*.	Several specimens collected; very common in spinifex plains on sandy loam soil in region. Locations include: 402 476E, 7 532 642N and 405 526E, 7 532 263N.
Scorpion	Urodachidae	*Urodacus "yashenkoi"*.	Two specimens collected in spinifex plains on sandy loam soil south-west of Kintyre around 413350E, 7 525 800N. Both were juveniles.

Plate 9. Short Range Endemic specimens collected.

Urodacus scorpion

Mygalomorph spider

Microchiropteran Bats

Nine microbat species are considered to occur in the Little Sandy Desert, based on McKenzie *et al.* (2002) (see Table 5). Three of these species were recorded during the Kintyre August 2010 survey as detailed in Table 5. The call parameters recorded for these species are presented in Appendix B. None of the species recorded is listed as conservation significant.

Table 5. Microbat species expected and recorded during the Kintyre August 2010 survey

Species		Recorded during Target Survey
VESPERTILIONIDAE (evening bats)		
Gould's Wattled Bat	*Chalinolobus gouldii*	yes
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	no
Little Broad-nosed Bat	*Scotorepens greyii*	no
Finlayson's Cave Bat	*Vespadelus finlaysoni*	yes
EMBALLONURIDAE (sheathtail bats)		
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	no
Common Sheathtail-bat	*Taphozous georgianus*	no
MOLOSSIDAE (freetail bats)		
Beccari's Freetail-bat	*Mormopterus beccarii*	no
White-striped Freetail-bat	*Tadarida australis*	yes
Northern Freetail Bat	*Chaerephon jobensis*	no

Frogs of the genus *Uperoleia*

No *Uperoleia* spp. frogs were found and none of this genus has been recorded in the region despite the extensive surveys by Hart (1994). It seems likely, therefore, that this genus is not represented in the immediate Kintyre region.

Other fauna observations

An annotated species list of fauna observations is presented in Appendix C. With the exception of the significant species discussed above, most of the fauna species recorded are widespread. The most notable record was of the Bush Stone-curlew at First Creek, where at least one bird was heard on the night of 26th July. There may be a pair present, as the species commonly occurs in pairs. The Bush Stone-curlew is listed as Priority 4 by DEC

Kintyre Joint Venture Project
Targeted Fauna Survey
Kintyre Survey Area
Figure 1

Author: M. Bamford Date: October 2010

N

0 400 800m

Scale 1:40 000
MGA94 (Zone 51)

400000mE 405000mE 410000mE

7535000mN 7530000mN

NORTH BORE

CAMP

KINTYRE PROJECT

Creek Creek Creek Creek

LEGEND

- Kintyre Project Area
- Existing access track
- Survey area
- Motion sensitive camera - Northern Quoll and Rock Wallaby
- Motion sensitive camera - Bilby
- Micro-chiropteran Bat Call Detection (Anabat)
- Fire History - Areas not burnt in 2007/2008

Note - Aerial shown captured May 2007

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Cameco

Author: M. Bamford ~ Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ Date October 2010 ~ A3 ~ CAD Ref g1826_Fauna_001_02a.dgn

Cameco

0 100 200m
Scale 1:10 000
MGA94 (Zone 51)

401000mE
402000mE
403000mE
404000mE
7534000mN
7533000mN
7532000mN

TO NORTH BORE

KINTYRE PROJECT AREA

LEGEND
- Kintyre Project Area
- Survey area
- Bilby Burrow- Active
- Bilby Burrow- Inactive
- Bilby Burrow- Inactive Old
- Bilby Burrow- Inactive Very Old
- Bilby Burrow- Recent
- Bilby Forage Hole - Moderate
- Bilby Forage Hole - Old
- Bilby Forage Hole - Recent
- Bilby Forage Hole- Very Old
- Bilby Forage Hole- Very Recent
- Bilby Tracks

Kintyre Joint Venture Project

Targeted Fauna Survey

Kintyre Survey Results - Bilby

Figure 3

Author: M. Bamford Date: October 2010

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Discussion and Recommendations

The focus of the targeted surveys was upon rare species, with additional work on bats, SRE invertebrates and frogs of the genus *Uperoleia*. Key results obtained were:

- Presence of Bilby confirmed in Kintyre project area but species present in extremely low numbers, with one individual found and evidence (several years old) in a second location. Recent (2007/2008) extensive fires may be restricting the abundance of this species, although Foxes and feral Cats also present. Suitable habitat for the species is widespread in the region.
- Presence of mulgara confirmed outside Kintyre project area. Species uncertain but most likely to be the Brush-tailed Mulgara which is listed as Priority 4 by DEC. Suitable habitat for the species is widespread in the region but recent fires may be restricting the abundance of the species.
- A rock-wallaby species is confirmed present in the region, including within the Kintyre project area. Species uncertain but most likely Rothschild's Rock-Wallaby which is not of listed conservation significance, but the presence of this species so far east in the Pilbara is of interest.
- Presence of several common bat species confirmed.
- Some SRE specimens collected but awaiting identification.
- Studies reinforced previous conclusion that the rocky hills in the region are not suitable for significant roosts of the Pilbara Leaf-nosed Bat.
- Northern Quoll does not appear to be resident but possibility exists of a population in the region that may occupy hills around Kintyre following a succession of favourable seasons. Fire history may also be important for this species.
- Frogs of the genus *Uperoleia* probably do not occur in the Kintyre region.
- Several significant species not found. Both the Northern Marsupial Mole and Giant Desert Skink may occur in suitable habitat (sand-dune and swale country with spinifex grassland) in the region, but if present are patchily distributed and very unlikely to occur in the immediate Kintyre project area, where the soils are unsuitable.
- The significant (Priority 4) Bush Stone-curlew was recorded for the first time despite previous extensive surveys. Although nocturnal, this is a conspicuous species because of its distinctive call, so it is likely that the species had not been present at the time of previous surveys.

Of the above results, the presence of the Bilby, mulgara and rock-wallaby are of greatest interest. The Bilby is listed under both the EPBC and WA Wildlife Conservation Acts, the mulgara is probably the Brush-tailed Mulgara that is listed as Priority 4 by DEC, but under current recognition DEWHA would consider it to be the Crest-tailed Mulgara which is vulnerable under the EPBC Act, and the rock-wallaby is probably Rothschild's Rock-Wallaby which is of local conservation interest but has no formal recognition. Of the three species, therefore, the Bilby is of greatest concern and interest.

The Bilby and mulgara have similar habitat requirements, occurring on sandy-loam soils that support spinifex and acacia shrublands. They are thus potentially widespread in the Kintyre region but are probably scarce because of impacts from extensive recent fires and predation by

feral species. The rock-wallaby occurs on rocky hills and breakaways and appears to be widespread but in low abundance through the region; it is also sensitive to predation by feral species and may also be affected by fire.

The federal Department of Sustainability, Environment, Water, Population and Communities lists a number of impacting processes that allow impacts upon these three species from the proposed Kintyre project to be assessed. These impacting processes are:

- Habitat loss (leading to population decline);
- Ongoing mortality leading to population decline;
- Habitat (population) fragmentation;
- Disturbance;
- Changed fire regimes;
- Interactions with other species (feral or over-abundant native species).

The impact of these processes on the three species can be assessed as outlined below.

Habitat loss

Impacts likely to be minor for all three species, as their habitats are extensive and the project area is small in the regional context.

Ongoing mortality

This can occur as a result of roadkill, to which all three species, but particularly the Bilby and rock-wallaby, are sensitive. Individuals of both are wide-ranging which makes them vulnerable to roadkill. With small local populations, even small numbers of deaths from roadkill can have a major impact

Habitat fragmentation

Impacts likely to be minor for all three species, as impact areas associated with the mine are concentrated and habitats are extensive. Roads are unlikely to present barriers to the movement of these species but large pipelines placed on the ground could disrupt movement of the mulgara.

Disturbance

Impacts of disturbance (light, noise and vibration) are uncertain but will probably be minor. The Bilby found during the 2010 survey had been foraging within 20m of the North Bore track, used several times a day by the water truck and light vehicles. Mulgara have also been recorded living within 20m of active haul roads and public roads (M. Bamford pers. obs.).

Fire regimes

Changed fire regimes is a major factor in the decline of a large proportion of Australian mammals (Burbidge and McKenzie 1989), with the main issue being the replacement of mosaic burning of small areas with very extensive but infrequent fires. The Bilby and mulgara in particular are known to be sensitive to changed fire regimes. The most recent fires in the Kintyre region were in summer 2007/2008 and were very extensive, with the one Bilby recorded being associated with one of the largest patches of hummock grassland that escaped that fire. Fire regimes are unlikely to change as a direct result of the Kintyre project, assuming standard operating procedures such as a system of hot work permits, but the project may provide an

opportunity to implement a landscape scale fire management programme, possibly in conjunction with traditional owners, that could create a mosaic of fire ages that would favour rare mammal species.

Species interactions

Predation by feral species is the second major factor in the decline of Australian mammals, including Bilby and rock-wallabies (Burbidge and McKenzie 1989). The Fox is of greatest concern; Bilbies coexist with feral Cats in the Great Sandy Desert (M. Bamford pers. obs) and a feral Cat was recorded close to the single Bilby at Kintyre, and rock-wallabies persist with Cats in the Pilbara, but feral Cats have been implicated in the failure of attempts to reintroduce the Bilby (Miller *et al.* 2010). There was evidence of a Fox in the Kintyre region but the species appeared uncommon. Any fire management programme to improve the condition of the environment in the region for rare mammals would need to include a feral predator control strategy. Management of Dingoes would need to be included in this plan, as the presence of Dingoes can suppress the numbers of Foxes and feral Cats, but the Dingo is also an efficient predator.

The key proposal from these fauna investigations project is that the Kintyre project provides the opportunity for a landscape scale conservation programme that manages fire and feral species in order to conserve populations of the Bilby, mulgara and rock-wallaby.

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Appendix A – Bilby search data recorded during the survey.

Age of foraging evidence and tracks is: very recent = previous night or two; recent = older than a few days but since rain had fallen three weeks previously; old = probably over a month old and rained upon; very old = probably over a year old. Age of burrows is given as: active = used in previous night or two; inactive old = not used for at least a month but still well-formed; inactive very old = not used for probably over 6 months and beginning to look weathered.

Name	Type	Age	Easting	Northing	Comments
RBC	burrow	Inactive old	402171	7532414	one
RBC	burrow	Inactive old	402137	7532204	two burrows
RBC	burrow	Inactive old	401895	7532735	one
RBC	forage hole	recent	401596	7532524	one
RBC	burrow	Inactive old	401941	7532995	one
RBC	forage hole	recent	401941	7532995	one
RBC	burrow	Inactive old	402025	7532999	one
RBC	forage hole	recent	402059	7532988	one
RBC	track	recent	402059	7532988	one
RBC	forage hole	recent	402060	7533004	one
RBC	track	recent	402060	7533004	one
RBC	burrow	active	402074	7533036	one
RBC	forage hole	recent	402149	7533063	three forage holes
RBC	forage hole	recent	402191	7532999	three forage holes
RBC	burrow	Inactive old	402257	7533026	one
RBC	forage hole	recent	402257	7533026	one
RBC	forage hole	recent	402280	7533062	scat present
RBC	burrow	Inactive old	402307	7533073	one
RBC	burrow	inactive old	402272	7533103	one
RBC	forage hole	recent	402314	7533110	one
RBC	burrow	inactive old	402334	7533125	one
RBC	forage hole	recent	401948	7533040	one
RBC	forage hole	recent	401914	7533024	one
RBC	forage hole	recent	401890	7533045	four forage holes
RBC	burrow	inactive very old	401877	7533049	one
RBC	burrow	inactive very old	401842	7533098	one
RBC	forage hole	recent	401767	7533103	scats present
RBC	forage hole	old	401594	7533088	one
RBC	burrow	inactive old	401662	7533153	one
RBC	forage hole	recent	401662	7533153	one
RBC	forage hole	recent	401717	7533147	one
RBC	forage hole	old	401752	7533172	one
RBC	forage hole	recent	401811	7533192	one
RBC	forage hole	old	402025	7533159	three forage holes
RBC	forage hole	recent	402070	7533201	two forage holes
RBC	forage hole	recent	402082	7533148	two forage holes
RBC	burrow	Inactive very old	402082	7533148	one
RBC	forage hole	recent	402188	7533127	three forage holes
RBC	burrow	inactive very	402188	7533127	one

		old			
RBC	burrow	inactive very old	402238	7533142	one
RBC	burrow	inactive old	402231	7533167	warren with five burrows
RBC	forage hole	recent	402297	7533127	four forage holes
RBC	burrow	inactive	402377	7533156	one
RBC	forage hole	recent	402377	7533156	three forage holes
RBC	forage hole	recent	402312	7533236	one
RBC	forage hole	recent	402289	7533236	five forage holes
RBC	burrow	inactive very old	402217	7533279	one
RBC	forage hole	recent	402217	7533279	two forage holes
RBC	forage hole	recent	402171	7533279	three forage holes
RBC	burrow	inactive very old	402133	7533273	one
RBC	forage hole	recent	402108	7533288	one
RBC	forage hole	recent	402014	7533320	one
RBC	forage hole	recent	401892	7533331	two forage holes
RBC	forage hole	recent	401817	7533359	one
RBC	forage hole	recent	401729	7533345	one
RBC	track	recent	401729	7533345	one
RBC	forage hole	recent	401707	7533351	two forage holes
RBC	forage hole	old	401664	7533312	five forage holes
RBC	forage hole	recent	401632	7533308	three forage holes
RBC	burrow	inactive old	401606	7533312	one
RBC	forage hole	recent	401606	7533312	one
RBC	burrow	active	401660	7533373	one
RBC	track	recent	401660	7533373	one
RBC	burrow	inactive	401697	7533378	one
RBC	burrow	inactive	401738	7533476	one
RBC	track	recent	401738	7533476	one
RBC	forage hole	recent	401738	7533476	four forage holes
RBC	burrow	inactive old	401643	7533329	one
RBC	forage hole	very recent	401558	7533299	one
RBC	forage hole	very recent	401543	7533269	one
RBC	forage hole	very recent	401525	7533268	one
RBC	forage hole	recent	401654	7533406	one
RBC	forage hole	recent	401735	7533445	one
RBC	forage hole	recent	401851	7533440	one
RBC	burrow	active	401945	7533415	one
RBC	burrow	active	402017	7533402	fresh digging
RBC	forage hole	recent	402017	7533402	one
RBC	forage hole	recent	402200	7533340	one
RBC	forage hole	old	402234	7533335	one
RBC	forage hole	recent	402378	7533096	one
RBC	burrow	inactive old	402163	7533095	one
RBC	track	recent	402101	7533096	one
RBC	forage hole	recent	402072	7533102	one
RBC	forage hole	old	401991	7533108	one
RBC	forage hole	recent	401681	7532853	one
RBC	forage hole	recent	401922	7532906	one
RBC	forage hole	old	402052	7532950	one
RBC	forage hole	recent	402180	7532975	one
RBC	forage hole	recent	402236	7532998	one

RBC	burrow	inactive old	402385	7533026	one
RBC	forage hole	recent	402158	7533503	one
RBC	burrow	inactive old	402132	7533514	one
RBC	forage hole	recent	402096	7533515	one
RBC	burrow	inactive old	401961	7533570	one
RBC	forage hole	recent	401961	7533570	one
RBC	forage hole	recent	401932	7533581	one
RBC	forage hole	recent	401898	7533592	one
RBC	forage hole	recent	401812	7533599	one
RBC	forage hole	recent	401783	7533599	scats present
RBC	forage hole	recent	401749	7533613	one
RBC	track	recent	401375	7533517	one
RBC	track	recent	401363	7533924	one
RBC	forage hole	very old	401263	7533922	one
Ian Harris	Foraging	recent	402363	7533214	one
Ian Harris	Foraging	recent	402306	7533220	one
Ian Harris	Foraging	very old	402209	7533259	multiple
Ian Harris	Burrow	inactive old	402183	7533249	one
Ian Harris	Foraging	recent	402159	7533259	one
Ian Harris	Burrow	inactive very old	402148	7533267	collapsed
Ian Harris	Burrow	inactive old	402100	7533274	one
Ian Harris	Tracks	fresh	402024	7533282	previous night
Ian Harris	Burrow	recent	402001	7533299	one
Ian Harris	Foraging	recent	401978	7533306	one
Ian Harris	Foraging	recent	401887	7533322	4 forage, area burnt
Ian Harris	Foraging	very old	401625	7533264	10 forage
Ian Harris	Tracks	fresh	401609	7533323	previous night
Ian Harris	Burrow	inactive old	401581	7533257	one
Ian Harris	Burrow	active	401561	7533220	fresh tracks
Ian Harris	Burrow	active	401513	7533220	fresh tracks and digging
Ian Harris	Foraging	recent	401665	7533431	3 forage
Ian Harris	Foraging	recent	401701	7533456	4 forage
Ian Harris	Foraging	recent	401914	7533440	5 forage
Ian Harris	Foraging	recent	402252	7533106	6 forage
Ian Harris	Foraging	recent	402180	7533111	one
Ian Harris	Foraging	recent	402147	7533125	one
Ian Harris	Burrow	inactive	402068	7533114	one
Ian Harris	Burrow	inactive old	402006	7533140	one
Ian Harris	Foraging	recent	401991	7533137	one
Ian Harris	Foraging	recent	402072	7532920	tracks still recognisable
Ian Harris	Foraging	recent	402134	7532933	one
Ian Harris	Foraging	recent	402170	7532950	one
Ian Harris	Foraging	old	402197	7533465	one
Ian Harris	Foraging	old	402178	7533471	4 forage
Ian Harris	Burrow	inactive old	402086	7533486	one
Ian Harris	Foraging	Very	401920	7533553	5 forage
Ian Harris	Foraging	moderate	401821	7533582	one
Ian Harris	Foraging	recent	401821	7533567	Recent track present
Ian Harris	Burrow	inactive old	401812	7533567	one
Ian Harris	Foraging	Very recent	401799	7533573	5 forage, previous night
Ian Harris	Tracks	moderate	401363	7533423	one
Ian Harris	Tracks	moderate	401917	7533662	one
Ian Harris	Tracks	recent	401353	7533853	last night

Ian Harris	Tracks	Very recent	401377	7534073	2 tracks
M. Bamford	Foraging	recent	401 899	7 533 006	
M. Bamford	Foraging	recent	401 893	7 533 013	
M. Bamford	Foraging	recent	401 823	7 533 103	
M. Bamford	Foraging	recent	401 804	7 533 098	scats present
M. Bamford	Foraging	recent	401 792	7 533 101	scats present
M. Bamford	Foraging	recent	401 777	7 533 090	
M. Bamford	Foraging	recent	401 763	7 533 086	
M. Bamford	Foraging	recent	401 734	7 533 076	
M. Bamford	Foraging	recent	401 572	7 533 132	
M. Bamford	Foraging	recent	401 622	7 533 155	
M. Bamford	Foraging	recent	401 703	7 533 170	
M. Bamford	Foraging	recent	401 763	7 533 217	
M. Bamford	Foraging	recent	402 070	7 533 245	
M. Bamford	Foraging	recent	402 102	7 533 189	
M. Bamford	Foraging	recent	402 161	7 533 177	
M. Bamford	Foraging	recent	402 257	7 533 184	
M. Bamford	Foraging	recent	402 292	7 533 187	
M. Bamford	Foraging	recent	402 330	7 533 190	
M. Bamford	Foraging	recent	402 400	7 533 183	
M. Bamford	Burrow	recent	401 780	7 533 093	
M. Bamford	Burrow	inactive old	401 637	7 533 190	
M. Bamford	Burrow	inactive old	401 738	7 533 181	
M. Bamford	Burrow	inactive old	401 840	7 533 259	
M. Bamford	Burrow	inactive old	401 878	7 533 244	
M. Bamford	Burrow	Inactive old	401 969	7 533	

				266	
M. Bamford	Burrow	Inactive old	402 040	7 533 263	
M. Bamford	Burrow	Inactive old	402 146	7 533 220	
M. Bamford	Burrow	Inactive very old	402 190	7 533 183	
M. Bamford	Burrow	Inactive very old	402 213	7 533 202	
M. Bamford	Burrow	Inactive very old	402 220	7 533 310	
M. Bamford	Burrow	Inactive very old	402 245	7 533 220	
M. Bamford	Burrow	Inactive very old	402 266	7 533 178	
M. Bamford	Burrow	inactive very old	402 268	7 533 190	
M. Bamford	Burrow	inactive very old	402 353	7 533 194	
M. Bamford	Tracks	recent	401 663	7 533 177	
M. Bamford	Tracks	recent	402 145	7 533 211	
M. Bamford	Burrow	inactive very old	402 383	7 533 208	
M. Bamford	Burrow	inactive	401 607	7 533 251	
M. Bamford	Foraging	recent	402 395	7 533 210	
M. Bamford	Foraging	recent	402 346	7 533 196	
M. Bamford	Foraging	recent	402 280	7 533 214	2
M. Bamford	Foraging	old	402 222	7 533 232	group of diggings
M. Bamford	Foraging	recent	402 148	7 533 238	
M. Bamford	Foraging	old	401 840	7 533 309	
M. Bamford	Foraging	old	401 802	7 533 296	
M. Bamford	Foraging	recent	401 739	7 533 283	
M. Bamford	Tracks	very recent	402 022	7 533 271	
M. Bamford	Tracks	very recent	401 580	7 533 213	
M. Bamford	Foraging	recent	401 731	7 533 271	
M. Bamford	Foraging	very old	401 640	7 533	6

				231	
M. Bamford	Foraging	very recent	401 706	7 533 398	
M. Bamford	Foraging	recent	401 628	7 533 285	
M. Bamford	Foraging	recent	401 619	7 533 280	
M. Bamford	Foraging	old	401 601	7 533 233	
M. Bamford	Foraging	very recent	401 576	7 533 213	
M. Bamford	Foraging	recent	401 540	7 533 195	
M. Bamford	Tracks	very recent	401 366	7 533 290	
M. Bamford	Burrow	active	401 620	7 533 430	
M. Bamford	Burrow	inactive very old	401 126	7 533 433	
M. Bamford	Foraging	recent	401 700	7 533 470	
M. Bamford	Foraging	recent	401 745	7 533 479	several
M. Bamford	Foraging	recent	401 874	7 533 475	
M. Bamford	Foraging	recent	401 893	7 533 486	
M. Bamford	Foraging	recent	402 348	7 533 107	
M. Bamford	Foraging	recent	402 278	7 533 083	
M. Bamford	Foraging	recent	402 250	7 533 071	
M. Bamford	Foraging	recent	402 186	7 533 050	
M. Bamford	Foraging	recent	402 175	7 533 055	5
M. Bamford	Foraging	recent	402 157	7 533 060	10
M. Bamford	Foraging	recent	402 135	7 533 060	2
M. Bamford	Foraging	recent	402 123	7 533 070	
M. Bamford	Foraging	old	402 065	7 533 066	
M. Bamford	Foraging	old	402 018	7 533 075	2
M. Bamford	Foraging	old	401 953	7 533 076	2
M. Bamford	Foraging	recent	401 936	7 533	3

				092	
M. Bamford	Foraging	recent	401 857	7 533 046	
M. Bamford	Foraging	old	401 841	7 533 007	
M. Bamford	Foraging	recent	401 963	7 532 867	
M. Bamford	Foraging	recent	401 972	7 532 861	
M. Bamford	Foraging	old	402 036	7 532 874	
M. Bamford	Foraging	old	402 177	7 533 451	
M. Bamford	Foraging	recent	402 159	7 533 462	
M. Bamford	Foraging	recent	402 116	7 533 464	
M. Bamford	Foraging	recent	401 990	7 533 501	
M. Bamford	Foraging	recent	401 894	7 533 531	
M. Bamford	Burrow	Inactive old	401 871	7 533 533	
M. Bamford	Burrow	active	401 822	7 533 532	
M. Bamford	Tracks	very recent	401 827	7 533 533	
M. Bamford	Tracks	old	401 367	7 533 400	
M. Bamford	Foraging	old	402 034	7 533 650	
M. Bamford	Foraging	recent	401 800	7 533 539	5
M. Bamford	Foraging	very recent	401 806	7 533 548	6
M. Bamford	Foraging	very recent	401 788	7 533 548	4
M. Bamford	Foraging	recent	401 597	7 533 500	1
M. Bamford	Burrow	inactive very old	401 962	7 533 678	
M. Bamford	Tracks	old	401 382	7 533 570	
M. Bamford	Foraging	recent	402 045	7 533 646	
M. Bamford	Foraging	old	401 950	7 533 696	
M. Bamford	Foraging	old	402 030	7 533 660	
M. Bamford	Foraging	old	402 015	7 533	

				682	
M. Bamford	Foraging	recent	401 996	7 533 690	
M. Bamford	Tracks	old	401 537	7 533 774	
M. Bamford	Tracks	old	401 357	7 533 780	
M. Bamford	Tracks	old	401 371	7 534 000	two tracks up and back

Appendix B – Bat survey Report.

Analysis of Anabat Data from the Kintyre area (Little Sandy Desert)

Prepared by: Brenden Metcalf (for Bamford Consulting Ecologists)

Introduction

A total of nine microbat species are considered to occur in the Little Sandy Desert, based on the McKenzie *et. al.* (2002) (see Table 1). Three of these species were recorded during the Kintyre August 2010 survey.

Table 1. Microbat species expected and recorded during the Kintyre August 2010 survey

Species		Recorded ?
VESPERTILIONIDAE (evening bats)		
Gould's Wattled Bat	*Chalinolobus gouldii*	+
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	
Little Broad-nosed Bat	*Scotorepens greyii*	
Finlayson's Cave Bat	*Vespadelus finlaysoni*	+
EMBALLONURIDAE (sheathtail bats)		
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	
Common Sheathtail-bat	*Taphozous georgianus*	
MOLOSSIDAE (freetail bats)		
Beccari's Freetail-bat	*Mormopterus beccarii*	
White-striped Freetail-bat	*Tadarida australis*	+
Northern Freetail Bat	*Chaerephon jobensis*	

Methodology

Calls were recorded from an Anabat II unit onto a Marantz Solid State Audio Recorder. These calls were then played back through a ZCAIM unit, into Anabat6 software. AnalookW (V3.3f 2006) and Analyze (V2.3 2000 Jolly) software was used for analysis of call sequences. Four parameters were used to identify species:

Fmax – Maximum frequency (kHz) presented as Mean (± Standard deviation)
Fmin – Minimum frequency (kHz) presented as Mean (± Standard deviation)
Dur – Duration of individual pulses (ms) presented as Mean (± Standard deviation)
Fpeak - Frequency of peak cycles (kHz) presented as Range i.e. minimum - maximum

Species were identified through comparison with the data presented in McKenzie *et. al.* (2002) and the author's own call library for the region.

Results

Three microbat species were recorded during the Kintyre August 2010 field survey, as detailed in Table 1. The call parameters recorded for these species are presented in Table 2 and Figure 1 shows examples of their call structure.

Table 2. Species call parameters from sequences recorded during the Kintyre August 2010 field survey

Seq = number of call sequences analysed, n = total number of pulses analysed from all call sequences; Fmax, Fmin and Dur are all presented as Mean (± Standard deviation), whilst Fpeak is presented as Range (i.e. mininmum – maximum).

Species	Seq, n	Fmax	Fmin	Dur	Fpeak
Gould's Wattled Bat *Chalinolobus gouldii*	2, 17	33.70 (± 1.52)	30.88 (± 1.14)	3.95 (± 1.09)	30.82 – 34.45
Inland Cave Bat *Vespadelus finlaysoni*	2, 17	59.03 (± 4.92)	52.83 (± 0.68)	2.82 (± 0.92)	50.99 – 53.35
White-striped Freetail Bat *Tadarida australis*	2, 25	17.49 (± 2.84)	12.05 (± 1.06)	9.80 (± 2.26)	10.6 – 13.82

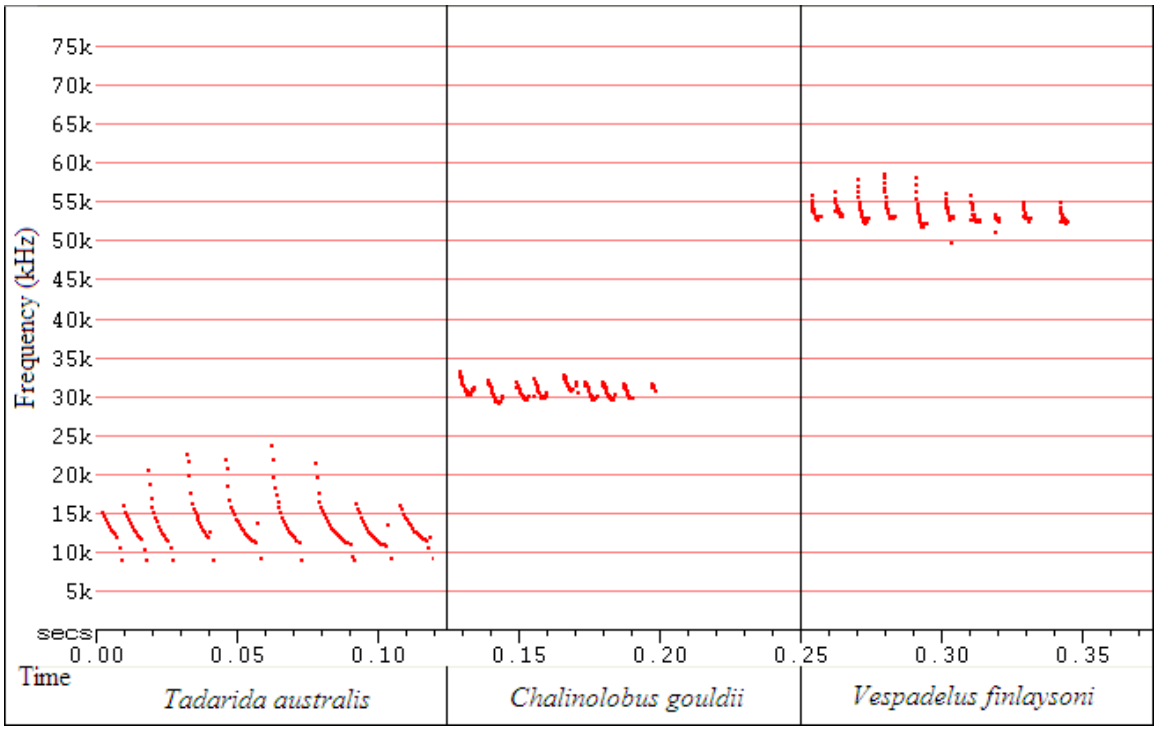

Figure 1. Examples of the call structure for each of the microbat species recorded during the Kintyre August 2010 field survey. Calls are presented with pulses expanded to f6 expansion and time between pulses removed.

References

McKenzie, N.L., Start, A.N. and Bullen, R.D. (2002) Foraging ecology and organization of a desert bat fauna. *Aust. J. Zool*. **50**: 529 – 548.

Appendix C – Annotated Fauna Species List

Annotated species list.

Urodacus sp. One dug from burrow in acacia over spinifex along Wartarra Creek (27/07) and one dug up along First Creek (27/07). Also one dug from drilling area.

Black-tip scorpion. Two dug up in sandy-loam soil supporting spinifex and acacia along track to Desert Queen Baths (28/07). Same species found in similar landscape north-east of Kintyre (29/07).

Aname spp. Adult dug from burrow amongst leaf-litter (no door) on 30/07 at (see RBC). In spinifex on sandy loam with scattered acacia and eucalypt.

Carab beetle. The large, articulated species. Pair dug from what had been a scorpion hole (probably *Urodacus*, but enlarged). The excavated two nearby (5m away) scorpion burrows that had also been enlarged. Both went deeper (to 0.8m compared with about 0.5m) than scorpion burrows, and both had insect larvae that might be of the carabs. In one, a single larva. In other, one larva and two large eggs each containing a single fully-developed larva. Egg about 10mm by 4mm.

Cyclorana maini. One (dead) beside pool in small creek just west of Desert Queen Baths (28/07).

Cyclorana platycephala. Several in a small pool on First Creek (2/08).

Litoria rubella. Seen at North Bore and First Creek.

Platyplectron spenceri. Several found in evening along First Creek (26/07). Active along creek bed. One found just under surface of sand in creek bed during the day; west of Desert Queen Baths (28/07).

Notaden nicholsi. One active at night on First Creek (26/07). Several dug from top of dune north-east of Kintyre (29/07). At depth of up to 40cm but slightly raised patch of sand about 10cm across gives them away!

Reptiles and Frogs

1. *Crenadactylus ocellatus*. One in spinifex clump at Desert Queen Baths (28/07).
2. *Rhynchoedura ornata*. Abundant at night along North Bore track (27/07). Up to 4 in 100m! One dug from burrow in sandy loam at depth of 30cm at first stop along Desert Queen Baths track (28/07). Also one came to entrance of vertical burrow while adjacent scorpion burrow was being excavated in drilling area. About 10 dead or live in an old open pitfall.
3. *Gehyra variegata*. One on tree at night at First Creek (26/07).
4. *Delma nasuta*. One active at night near Wartarra Creek crossing of North Bore track (27/07).
5. *Amphibolurus longirostris*. One in dense speargrass beside creek west of Desert Queen Baths (28/07). One at north-easterly point reached during searching along old CRA tracks north-east of Kintyre.
6. *Ctenophorus caudicinctus*. One caught on rocky rise near small creek just west of Desert Queen Baths (28/07).
7. *Ctenotus saxatilis*. North Bore (27/07) in speargrass along creekline.
8. *Ctenotus pantherinus*. Few seen in spinifex along Wartarra Creek near North Bore Track (27/07). Also seen in Bilby area.

9. *Ctenophorus isolepis*. Several seen at first stop along Desert Queen Baths track (28/07) in spinifex on sandy-loam. Also on 29/07, north-east of Kintyre at 22 14'46"S, 122 07' 47"E (sandplain and spinifex), on sand-dune where rock-wallaby track seen , and on dunes and sandplain at 22 17' 03"S, 122 20' 18"E. Also seen in Bilby area.
10. *Ctenophorus nuchalis*. (Balla-Balla - Martu). One dug from burrow along First Creek in Buffel grass on sandy loam (27/07), and one dug from burrow on plain between dunes north-east of Kintyre at 22 14'46"S, 122 07' 47"E (29/07).
11. *Lerista bipes*. Two dug from sand beside small creek just west of Desert Queen Baths (28/07). On 29/07, in spinifex on sandplain at: 22 14' 46"S, 122 07' 47"E and 22 13' 51"S, 122 08' 19"E.
12. *Morethia ruficauda*. In gorge at Desert Queen Baths (28/07).
13. *Menetia greyi*. One in spinifex along Warratarra Creek near North bore track (27/07).
14. *Varanus eremius*. One dug from burrow in spinifex on sandplain at 22 14' 46"S, 122 07' 47"E. Had recently eaten a very large centipede with a leg still sticking out of its month!
15. *Varanus acanthurus.* Remains of specimen on termite mound just to east of Bilby area.
16. *Pseudechis australis*. Sloughed skink in cave near camp.
17. *Pseudonaja nuchalis*. One dead on Rudall River Road just south of turnoff to Kintyre (2/08)..

Birds

1. Australasian Grebe. One in lower pool of Desert Queen Baths (28/07).
2. Whistling Kite. One on dead camel near Duck Pool (26/07).
3. Wedge-tailed Eagle. Pair over Bilby area (30/07).
4. Nankeen Kestrel. One near Duck Pool (26/07) and one over camp (30/07).
5. Brown Falcon. One on spinifex plain just east of First Creek (28/07). Several seen north-east of Kintyre along old CRA exploration lines (29/07). Both dark and pale morphs.
6. Peregrine Falcon. One at Desert Queen Baths (28/07).
7. Spinifex Pigeon. Courting pair near camp (27/07) and single bird near camp (31/07).
8. Diamond Dove. Seen occasionally throughout.
9. Crested Pigeon. Seen occasionally throughout.
10. Common Bronzewing. One in garden at Telfer (26/07).
11. Galah. Groups of up to 20 seen occasionally around Kintyre and along Desert Queen Baths track. Seen feeding in big grevilleas.
12. Cocketiel. Flock of about 10 over Wartarra Creek near North Bore track (27/07). Flock of about 30 over Bilby area (31/07).
13. Australian Ringneck. Few at North Bore (27/07).
14. Budgerigar. Flocks of just a few birds (<10) seen occasionally throughout.
15. Australian Bustard (Kipara..Martu). Two seen along North Bore track near Camel Creek (27/07) and one in north-east along CRA exploration tracks (29/07). Six in Bilby area (30/07). Fresh and not so fresh tracks seen throughout.
16. Bush Stone-curlew. Heard at First Creek (26/07).
17. Little Button-quail. One flushed in search area off Desert Queen Bath Road (2/08).
18. Red-backed Kingfisher. One to north-east of Kintyre near sand-dune country (29/07) and one just east of Bilby area (31/07).
19. Rainbow Bee-eater. Few around Duck Pool (26/07) and North Bore (27/07). Occasionally throughout.

20. Horsfield's Bronze-Cuckoo. One calling in north-east along CRA tracks (29/07).
21. Boobook Owl. One calling near North Bore track crossing of Wartarra Creek (30/07).
22. Variegated Fairy-wren. North Bore, and along Wartarra Creek near North Bore track (27/07).
23. White-winged Fairy-wren. Party with coloured male seen in north-east along CRA tracks, in area of spinifex on sandplain. Also party with coloured male in Bilby area (30/07).
24. Western Gerygone. Heard in Wartarra Creek at North Bore track (27/07).
25. Weebill. Common amongst eucalypts along creeklines.
26. Red-browed Pardalote. Very common and vocal! Along all creeklines with eucalypts and occasionally in shrubland areas.
27. Striated Pardalote. One calling at Desert Queen Baths (28/07), one calling at North Bore (30/07) and one calling along First Creek (2/08).
28. Spiny-cheeked Honeyeater. Heard along some creeklines with dense acacias.
29. Yellow-throated Miner. Throughout.
30. Singing Honeyeater. Throughout.
31. White-plumed Honeyeater. In eucalypts along all watercourses and occasionally elsewhere.
32. Brown Honeyeater. Mostly amongst eucalypts along creeklines, including at North Bore.
33. Black Honeyeater. Few in acacia shrubland along Wartarra Creek near North Bore track (27/07), and few amongst scattered acacias over spinifex on sandplain north-east (29/07).
34. Crimson Chat. Groups of 2-5 birds in spinifex and shrubs on sand amongst dunes in north-east (29/07). Pair just east of Bilby area (31/07).
35. Grey Shrike-thrush. One in dense woodland around Desert Queen Baths (28/07).
36. Rufous Whistler. One calling in dense acacia thickets along creekline in north-east along CRA tracks (29/07) and one in Bilby area (31/07).
37. Willie Wagtail. Occasionally throughout, but especially along creeklines.
38. Magpie-lark. Occasionally along creeklines. Old neat at Desert Queen Bath.
39. Black-faced Cuckoo-shrike. Two seen near camp (26/07) and one in Bilby area (31/07).
40. White-winged Triller. Seen occasionally.
41. Little Woodswallow. Few over hills around Desert Queen Baths (28/07).
42. Black-faced Woodswallow. Groups of 2-5 birds in spinifex and shrubs on sand amongst dunes in north-east (29/07); with Crimson Chats. Also few at North Bore (30/07).
43. Masked Woodswallow. Flock of about 40 over Desert Queen Baths turnoff (2/08).
44. Torresian Crow. Seen occasionally throughout.
45. Pied Butcherbird. Throughout. Calling.
46. Australian Pipit. Few in area north-east of Kintyre (28/07).
47. Zebra Finch. Few seen near water including North Bore.
48. Painted Finch. Few near dry creek in north-east along CRA tracks and one amongst Zebra Finches just east of Bilby area (31/07).
49. Rufous Songlark. Calling along Wartarra Creek near North Bore track (27/07).
50. Brown Songlark. One calling just east of First Creek (1/08).

Mammals (native and introduced)

Dasycercus sp. Active burrow and several inactive burrows along track to Desert Queen Baths (28/07).

Pseudantechinus ?roryi/wooleyae. Scats amongst rocky hills around camp.

Macrotis lagotis. Area of great activity just north of Wartarra Creek, along North bore track. Probably a single animal. Photos taken at one camera site. Locations of burrows, foraging and tracks recorded in detail. Some old foraging and an old burrow in search area off Desert Queen Baths road (2/08).

Petrogale sp. Rock wallaby tracks at several locations in north east, and scats found in some caves (29/07). Also scats on hills in Kintyre area (eg North bore) and sightings reported. Species uncertain...Rothschild's?

Macropus robustus. Throughout on basis of scats, and two recorded on North Bore Camera 3 (31/07).

Tadarida australis. Heard occasionally over camp and over Wartarra Creek at North Bore track crossing (27/07).

Chalinolobus gouldi. Recorded with bat detector in Kintyre area.

Taphozous spp. Several in small cave at Desert Queen Baths (28/07).

Vespadelus finlaysoni. Several in small cave at Desert Queen Baths (28/07) and recorded with bat detector in Kintyre area.

Vulpes vulpes. Old tracks in sand-dunes north-east of project area (29/07).

Canis lupus dingo. Throughout. Tracks along all roads and several animals seen along Telfer to Kintyre road (26/07).

Feral Cat. Fresh tracks at small creek near Desert Queen Baths (28/07) and old tracks near Bilby area at 402 164E, 7 534 005N. One photographed in Bilby area.

Camel. Tracks everywhere. Mob of 46 on track to Desert Queen Baths (28/07), and 2 in north-east along CRA tracks.

Donkey. Few old tracks seen near North Bore.