BEAGLE BAY
BIG TREE COUNTRY TROPICAL TIMBER PLANTATION PROJECT

Fauna Assessment Survey

March 2004

ecologia
ENVIRONMENT

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In 2001 a 4 ha trial plantation of Teak and Indian Sandalwood was established and the progress of the trial tropical timber plantation indicates that the venture is economically viable. The Proponents therefore now propose the development of a 900 ha plantation. The development will be progressively implemented over a three year period. The infrastructure required for this development is largely already in place and any expansion will constitute the upgrade of existing facilities.

A development of this magnitude requires environmental approval from the State, and *ecologia* Environment were commissioned by the Proponents to undertake a terrestrial vertebrate fauna assessment survey to document the fauna of the region and facilitate formal assessment of the conservation value of the project area.

Methodology

The fauna survey of the proposed project area was carried out by *ecologia* Environment from the 19th – 26th March 2003. The project was timed to coincide with the late wet season; the most opportune time to record amphibians and a greater variety of birds.

Mammal, reptile and amphibian fauna were collected using a variety of trapping and opportunistic collection techniques. Birds were recorded by systematic censusing and opportunistic recording. Secondary evidence and opportunistic sightings of species were also recorded.

Results

Habitats
The habitat of the project area is uniform in profile from east to west, comprising savannah woodlands, specifically 'Pindan woodland' typical of the red sand plains of the Dampier Peninsula.

Fauna Community
Systematic sampling and opportunistic collecting within the proposed plantation area yielded 105 vertebrate species, including 65 birds, 28 reptiles, four amphibians and eight mammals (six native and two introduced). The highest species richness within the study area was recorded from Site 3, with a total of 60 species, including five mammals, 41 birds and 14 herpetofauna species.

An estimated 193 vertebrate fauna species may potentially occur in the study area. This comprises 17 native and six introduced mammals, 110 birds, 52 reptiles and eight frog species. Of the

species that may potentially occur in the project area, 54 % were recorded during the current survey.

Mammals
Representative species of most of the major mammal groups were captured or observed during the survey, including marsupials, such as the Northern Brushtail Possum, and placental mammals, such as vespertilionid bats and rodents. The record of the Northern Brushtail Possum (*Trichosurus vulpecular arnhemensis*) was a significant record for the project area, as due to the influence of fire and feral predation, individuals are seldom seen. The Kimberley or Yellow-lipped Cave Bat (*Vespadelus douglasorum*) was also a significant record as this species is generally associated with cave formations and there are no caves in the local area.

Birds
The highest species richness was recorded was from Site 3, with a total of 41 species. Some of the most speciose families were the Meliphagidae (honeyeaters; eight species), Columbidae (pigeons and doves; four species), Cuculidae (parasitic cuckoos; four species) and Psittacidae (Lorikeets and Parrots; five species).

Species of interest recorded during the survey include the Bush Stone-curlew (*Burhinus grallarius*) and Australian Bustard (*Ardeotis australis*). The thick Pindan woodland throughout is not preferred by these two species and the individuals observed were most likely transients moving through the project area.

Herpetofauna
Over half of the herpetofauna species expected to occur in the project area were captured during the current survey, and vouchers of most species were lodged with the WA Museum for formal identification. Of the 32 herpetofauna species captured, seven species represented first records for either the entire Dampier Peninsula, or at least the northern half of the Peninsula, highlighting the lack of survey work previously undertaken. The species recorded comprised five geckos, one pygopod, nine skinks, three elapid snakes, five dragons, two varanids, one blind snake and two pythons. Four amphibians, *Cyclorana australis*, *Litoria caerulea*, *Litoria rubella* and *Uperoleia talpa* were also recorded from the project area.

Feral Fauna
Two species of feral fauna were recorded in the project area during the course of the field survey the Feral Cat (*Felis catus*) and Donkey (*Equus asinus*).

Fauna of Conservation Value
The Rainbow Bee-eater (*Merops ornatus*) is a migratory species covered under the international JAMBA (Japan Australia Migratory Bird Agreement) Agreement and was recorded from the project area. The Fork-tailed Swift (*Apus pacificus*) is listed under both the JAMBA and CAMBA (China Australia Migratory Bird Agreement) Agreements and was found within the project area.

The Bush Stone-curlew (*Burhinus grallarius*) and Australian Bustard (*Ardeotis australis*) are Department of Conservation and Land Management Priority species which were also recorded from within the project area.

The Kimberly or Yellow-lipped Cave Bat (*V. douglassorum*), the agamid, *Diporiphora pindan*, and the skinks, *Lerista griffinii* and *Morethia storri* are all either endemic to the Dampierland

biogeographic region or have very limited distributions, or individuals captured are representatives of populations broadly disjunct from other conspecifics.

1.0 INTRODUCTION

1.1 BEAGLE BAY – BIG TREE COUNTRY PROJECT

1.1.1 Background

In 2000 Beagle Bay Community Inc. and Capricorn Timber Pty Ltd entered into an agreement to establish a tropical timber plantation of Teak (*Tectona grandis*), Indian Rosewood (*Dalbergia latifolia*), Indian Sandalwood (*Santalum album*) and African Mahogany (*Khaya senegalensis*) within the Beagle Bay Aboriginal Reserve. The proposed area for development is located approximately 12 km SE from the Beagle Bay Community, on the Dampier Peninsula, Western Australia (Figure 1.1).

In 2001 a 4 ha trial plantation of Teak and Indian Sandalwood was established. The trial plantation suggests that the venture is both economically viable and environmentally sustainable. The Proponent therefore proposes the development of a 900 ha plantation. The development will be progressively implemented over a three year period. The infrastructure required for this development is largely already in place and any expansion will constitute the upgrade of existing facilities.

1.1.2 Location

The proposed area for development is located approximately 12 km SE of the Beagle Bay Community, on the Dampier Peninsula. Beagle Bay lies 120 km by road north of Broome, Western Australia (Figure 1.1). The plantation site is low-lying (approximately 70 m above sea level) and relatively flat. Soils are characteristic of the Yeeda Land System (Speck *et al.* 1964). The vegetation is relatively uniform in profile and no surface water expressions, vine thickets or other vegetation of significant conservation value or interest have been identified within the project area (*ecologia* 2004).

1.2 OBJECTIVES

A development of this magnitude requires environmental approval from the State, and *ecologia* Environment were commissioned by the Proponents to undertake a terrestrial vertebrate fauna assessment survey of the project area to and facilitate formal assessment of the conservation value of the project area. The field survey was conducted during March 2003, and represented a period of post-wet season fauna sampling.

The survey was carried out in accordance with EPA (Environmental Protection Authority) requirements for biological inventory and assessment. Qualitative data and selected quantitative data were collected for all vertebrate fauna species occurring within and adjacent to the intended development area.

The survey detailed in this report:

1. Provides baseline information on the terrestrial vertebrate fauna of the proposed project area; and
2. Assesses potential environmental impacts arising from the proposed development.

Additionally this report provides:

A) An inventory of:
- vertebrate species, including recent published and unpublished records;
- essential fauna resources; and
- records of species which might be expected to occur, but whose presence is as yet unrecorded.

B) A review of:
- biologically significant species including rare fauna; and
- introduced exotic or declared pest species and their impact.

C) An assessment of:
- the relationships between habitat and fauna; and
- the regional and local conservation value of the fauna within the project area.

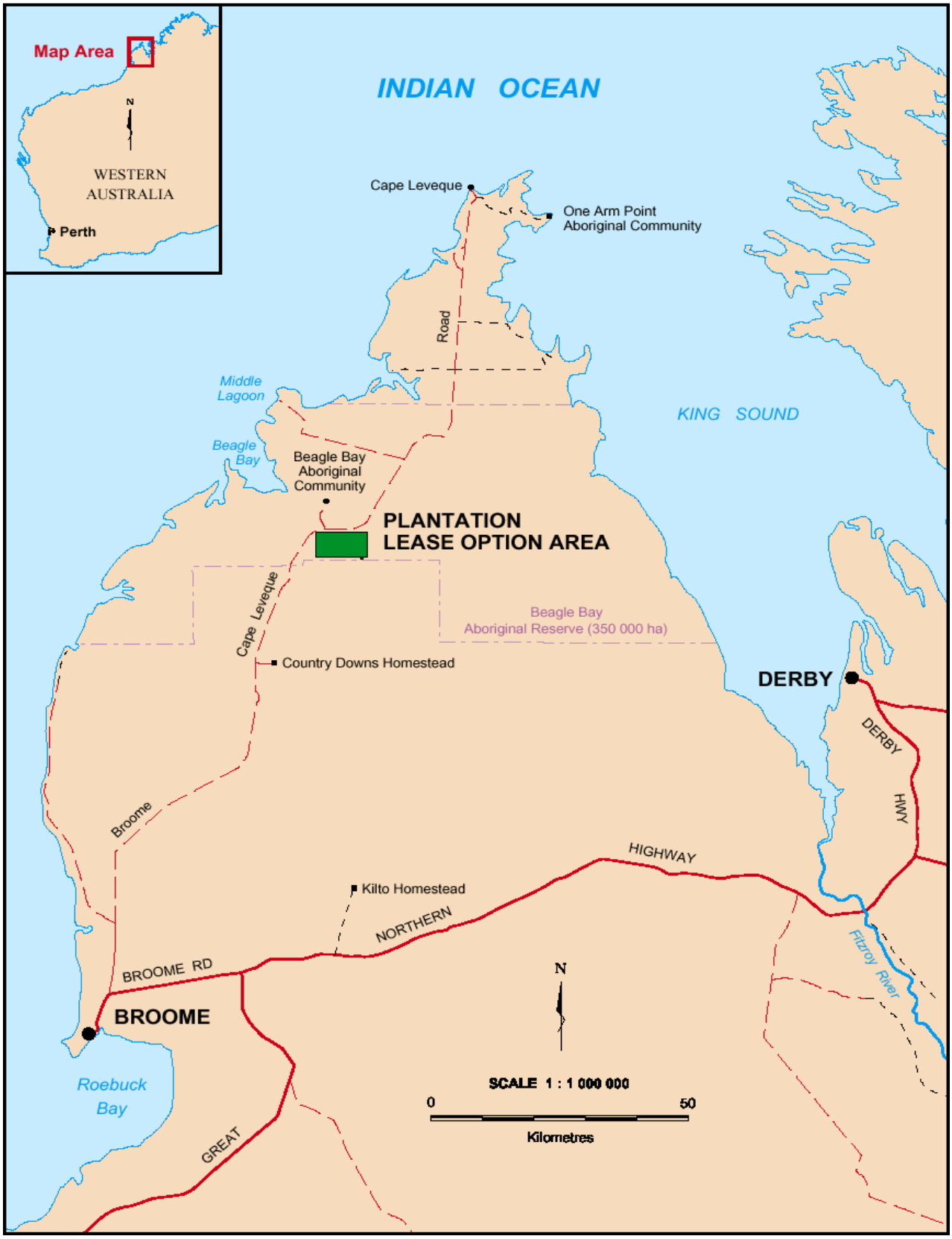

Figure 1.1 Location of Plantation Lease Area within the Dampier Peninsula

2.0 EXISTING ENVIRONMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 Climate

The Dampier Peninsula has a distinct tropical climate with a wet season from December to March, during which almost all the annual rainfall is received and humidity is high (Kenneally *et al.* 1996). Rainfall in the Dampier Peninsula ranges from 596 mm/yr at Broome to 768 mm/yr at Cape Leveque (Table 2.1) (Bureau of Meteorology 2003). Beagle Bay lies midway between these two sites and receives an average of 725 mm of rainfall annually.

Daytime temperatures are high throughout the year, particularly during the months prior to the wet season when maxima greater than 40 ºC are common (Bureau of Meteorology 2003). Night-time minimum temperatures are also normally high throughout the year.

Table 2.1: Summary of climatic data for Dampier Peninsula

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Daily Maximum Temperature (° C)													
BME	33.3	32.9	33.9	34.2	31.5	29.1	28.8	30.3	31.8	32.9	33.5	33.8	32.2
CL	31.9	31.6	32.2	32.5	30.4	27.9	27.4	28.5	29.9	31.1	32.0	32.4	30.6
Mean Daily Minimum Temperature													
BME	26.2	25.9	25.4	22.5	18.2	15.3	13.6	15.0	18.4	22.3	25.0	26.4	21.2
CL	26.1	26.0	26.0	25.2	22.5	20.0	18.8	19.8	21.9	24.1	25.8	26.6	23.5
Mean Rainfall (mm)													
BME	176.1	176.4	98.0	27.9	30.0	19.3	5.0	1.6	1.5	1.4	8.4	50.8	596.3
CL	210.0	198.3	137.3	46.9	47.4	20.8	12.2	2.0	1.1	1.7	6.3	84.4	768.4
Mean no. rainy days													
BME	11.2	11.3	7.6	2.7	2.6	1.9	1.1	0.6	0.8	0.5	1.2	5.3	46.7
CL	11.9	10.7	8.2	3.0	2.1	1.5	0.8	0.4	0.3	0.4	1.0	4.7	44.9

Broome (BME): Latitude: -17.9492 S
Longitude: 122.2336 E
Elevation: 7.0 m
Data from Bureau of Meteorology (2003)]

Cape Leveque (CL): Latitude: -16.3972 S
Longitude: 122.9264 E
Elevation: 25.0 m

2.1.2 Geology and Soils

The Dampier Peninsula is located within the Fitzroy Trough, a major subdivision of the greater sedimentary Canning Basin. The Canning Basin contains Quaternary sandplains or relatively low hills and alluvia with local outcrops of Phanerozoic sandstone and reef limestone which were laid down upon a Precambrian basement during various epochs. The area is underlain by approximately 8,000 m of sedimentary rock including several extensive sandstone formations. No faulting or folding has been observed in the rock formations of the Dampier Peninsula.

Soils are remarkably uniform across the Dampier Peninsula. The dominant soil profile in the area is the Yeeda Land System (Speck *et al.* 1964), comprising low lying Quaternary sandplains or relatively low hills, featuring deep red sandy soils of the Cockatoo family (commonly referred to as Pindan). Towards the northern end of the Peninsula, where rainfall is higher, the red aeolian sandplains grade into yellowish-grey sandplains.

The Broome sandstone comprises lithified to unconsolidated fine to coarse grained sandstone with local beds of conglomerate, siltstone and shale. The top of the sandstone lies approximately 40 m below the surface and is overlain in downward order by up to 20 m of superficial silty sand (Pindan) overlying a 20 m thick lateritic profile of ferruginised sandstone and siltstone developed on, and underlain by the Broome Sandstone. In the project area the Broome Sandstone extends to a depth of about 250 m below surface, has a saturated thickness of about 200 m, extending beneath the project area within a radius of 30 km (Rockwater 2004).

It is possible that broad doming took place in the central part of the Peninsula during the Tertiary, and this may have diverted the ancestral Fitzroy River from a previous course toward Roebuck Bay to its present outlet to King Sound.

2.1.3 Hydrogeology

The project site is located in the Kimberley-Canning Groundwater Management Area. It is underlain by the Broome Sandstone, which is a regional unconfined aquifer with some areas of confined (pressure) water near discharge areas and beneath confining layers of siltstone and shale. At the proposed plantation site the water table lies approximately 55 m below the surface. Groundwater in the aquifer flows north towards Bobby's Creek. It has a low salinity of less than 250 mg/L (total dissolved salts), which may increase with depth.

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 Vegetation

The Dampier Peninsula lies in the Dampier Botanical District within the Northern Botanical Province (Beard, 1979a).

The study area comprises savannah woodlands which, on the red sand plains of the Dampier Peninsula, are also termed 'Pindan woodland' (Kenneally *et al*. 1996). These woodlands generally consist of Eucalypts of medium height with a middle layer of tall shrubs of variable densities and a ground layer dominated by mixed dense grasses. The woodlands are generally co-dominated by scattered to open Darwin Box (*Eucalyptus tectifica*) and Ochre Bloodwood (*Corymbia dampieri*), together forming a canopy about 8-12 m high. A sparse layer of small trees/tall shrubs typically occurs below, with the common species being *Acacia tumida, A. platycarpa, Brachychiton diversifolius, Bauhinia* (previously *Lysiphyllum*) *cunninghamii, Dolichandrone heterophylla, Ehretia saligna, Erythrophleum chlorostachys*, *Ficus opposita, Hakea macrocarpa, H. arborescens, Grevillea pyramidalis* and *G. refracta, Terminalia* spp. and *Persoonia falcata.* The understorey is dominated by grasses, such as *Triodia schinzii, Sorghum stipoideum, Chrysopogon pallidus* and *Heteropogon contortus,* and a few shrubs, such as *Carissa lanceolata, Distichostemon hispidulus, Trichodesma zeylanica, Acacia adoxa* and *Solanum cunninghamii* (Kenneally *et al.* 1996).

Whilst the species composition within the site is relatively homogeneous, localised variations in the structure occur, almost certainly in response to the fire regime, with more frequently burnt areas impoverished in the shrub/low tree stratum.

2.2.2 Fire History

Fire is a conspicuous element of the environment on the Dampier Peninsula. Traditional aboriginal burning practices were low intensity, small-scale fires occurring across a range of habitats, creating a mosaic effect of patchy burns. However, fire regimes are changing dramatically, with a propensity for hot, intensive and broad-scale late dry season fires. In 1995 approximately 27 % of the Kimberley was affected by fire, and this increased to 34 % in 2000 (Climate Action Network Australia 2003).

Although bushfires are recognised as an important factor in the modification of vegetation structure and floristics, fires that are too intense (canopy scorching), or occur too frequently, in any given area can contribute to a decrease in species richness and diversity (McKenzie 1983; Russell-Smith *et al.* 2003). Without sufficient time to regenerate, larger species, such as *Eucalyptus* and *Acacia* spp., are lost to the dominance of annuals, such as *Sorghum* spp. (Russell-Smith *et al.* 2003). Conversely, if fire is inhibited completely, there is a general decrease in the diversity of both annuals and larger perennials that require fire to set seed (Russell-Smith *et al.* 2003). Moreover, larger species, such as *Acacia* spp., can be overcome by parasitic mistletoes such as *Lysiana spathulata* and *Dendrophthoe acacioides* (Kenneally *et al.* 1996). However, it needs to be appreciated that, just as fire can cause species decline, it can also promote an increase in the richness of fire dependent species.

Given the extent of habitat modification of the Dampierland biogeographic region, as a result of fire and other historic variables (natural and non-natural), there is little or no opportunity to create the pre-European landscape, the components of which are not well documented (Start 2003). Therefore, the present landscapes should be viewed as being as worthy of conservation as the traditional landscapes may have been. Conservation objectives should aim at preserving the biodiversity that is present, rather than attempting to recreate the historic faunal assemblages (*e.g.* hoping for the return of critical weight range mammal fauna that is deleteriously influenced by fire) (Start 2003).

Nevertheless, the fire-regeneration cycle in Pindan generally spans five to seven years, and if a low to moderate fire regime (4 – 7 years) is maintained in a tropical savannah, woody vegetation will remain structurally stable (Russell-Smith *et al.* 2003; Start 2003; Williams *et al.* 2003). During the first few years of this regeneration cycle, sub-shrubs, grasses, and ephemeral and perennial vines diversify and proliferate in the first few years. These are succeeded by trees greater than two metres tall that regenerate from burnt saplings (Williams *et al.* 2003).

2.2.3 Previous Biological Surveys

Previous fauna surveys on the Dampier Peninsula are few. The only study relevant to this proposal is a broad-scale survey by McKenzie (1983) for the (then) Department of Fisheries. A dry season bird survey for the project area was conducted by Swann (2003) for Tropical Timber Plantations and the results have been included in the current report. The information from these surveys has been supplemented by opportunistic collecting by amateur herpetologists, much of which is lodged at the Western Australian Museum (WAM).

2.2.4 Landuse History

Aboriginal occupation of the Dampier Peninsula may date back as far as 27,000 years (O' Connor 1989). Over that period, and until recent times, Aboriginal family groups camped at favourable sites throughout the Peninsula on a semi-nomadic basis, relying mainly on coastal resources for their survival (Kenneally *et al* 1996).

The first tangible reference to Australian Aborigines was made by William Dampier in 1868 when he encountered the Bardi people (Bindon 1978). These people occupied the Cape Leveque area from Cape Borda in the west to Cygnet Bay/Cunningham Point in the east.

According to Bindon (1978), on the western side of the Dampier Peninsula, between Cape Borda and Sandy Point and extending across the Peninsula to encompass Goodenough and Disaster Bay, live the Nyul Nyul. Their territory previously extended further South of Disaster Bay, but their occupation of this land was usurped by the Nimanburu, who occupy the Fraser River drainage basin near the head of King Sound (Bindon 1978). Remnants of these groups can be located in Broome, Beagle Bay and Derby. There is currently little exploration of their traditional lands by these people, unlike the Bardi, whose occupational history of tribal lands is virtually unbroken.

To the west of the Nimanburu lies the country of the Djabera Djabera. Their coastal territory extends from Beagle Bay in the north, to Coulomb Point in the South. There were only a handful of these people alive in 1953 when Tindale (1974) examined the area. No people from this group were located during the survey performed in 1978 (Bindon 1978).

The Beagle Bay Community was started as a Catholic mission that came under the control of Trappist Monks around 1890 (Moncrief 2001). After ten years under the Trappists, in 1901 the mission was officially placed in the care of German Pallotine Monks (Moncrief 2001). Beagle Bay was, and to a certain degree, still is, traditionally home to the Nyul Nyul people. Beagle Bay has in the past few decades, become well known for its church, more specifically its mother-of-pearl shell altar built entirely by hand by the monks and Aboriginal people (Moncrief 2001).

Beagle Bay is one of a number of such communities in Western Australia, previously used as a home for separated Indigenous children (known as the Stolen Generation), and is now currently administered by those same children (Moncrief 2001).

European land-use has been mainly centred on cattle production, when the Beagle Bay Community ran a commercial beef production business. The Wanganut Land system, which characterises the project area, is classified as having low potential for pastoral activities due to its limited carrying capacity (2-4 cattle units per km^2). The land use plan for the old Waterbank station located to the south of Beagle Bay identified Pindan soils in this region as having potential for more intensive forms of agriculture (Anon. 2000).

2.2.5 Trial Tropical Timber Plantation

A 4 ha trial tropical timber plantation was established in 2001, and records indicate that native fauna are utilising this modified habitat (John Brennan, pers. com.). For example, birds are utilising trees for nest sites and Red-winged Parrots (*Aprosmictus erythropterus*) have been observed feeding on the *Sesbanias* (John Brennan, pers. com.). The Proponents have incorporated into the plantation design the cultivation of two native Kimberly tree species as hosts for the plantation Sandalwoods. Despite the absence of a trapping grid established in the trial plantation area, a number of reptile species (lizards, snakes) were opportunistically located during foot transects and night censuses. Common high order predators such as the Frilled-neck lizard (*Chlamydosaurus kingii*) and less common species, including the only record for the current survey of the Black-headed python (*Aspidites melanocephalus*), have been recorded in the trial area. There has also been some regrowth of grasses, groundcovers and other shrub species, all of which are preserved in the rows between the plantation trees.

Fauna use of the trial plantation indicates that, over time, native fauna will utilise the exotic plantation plots. To what extent the newly establishing species assemblage will represent the historical fauna of the site will depend on the habitat heterogeneity of the mature plantation plots. Whatever the case, the plantation plots will exclude some fauna that are dependant on mature Eucalypts for roosting, such as the Red-tailed Black Cockatoo (*Calyptorhynchus banksii*) and the Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*). This potential loss of roost sites will likely be offset by greater food availability to these species that will result from the reduced fire frequency in the plantation site. Bark-dwelling herpetofauna and bats that roost diurnally under exfoliating bark, will also have limited potential for recolonisation into the plantation plots. However, ground-dwelling mammals and herpetofauna, and avifauna dependant on mid-storey shrubs, would be expected to recolonise from the boundaries of the plantation plots, as the growth of plantation timber should not completely exclude the growth of native ground cover and lower strata species.

3.0 SURVEY METHODOLOGY

3.1 SURVEY PROGRAMME

A vertebrate fauna assessment survey of the proposed plantation site was conducted by *ecologia* Environment between the 19th and 26th March 2003. This survey period was selected as the late wet season is an opportune time to record amphibians and a greater variety of migratory birds (G. Swann, pers. comm.).

3.2 SITE SELECTION

Following a preliminary reconnaissance, detailed survey sites were chosen as being either:

(i) Representative of vegetation associations;

(ii) Areas of conservation value or ecological sensitivity; and

(iii) Areas of environmental impact arising from the proposed development.

The location and number of sites surveyed is summarised in Table 3.1 with the "Criteria for Selection" related to those criteria listed above. Fauna survey sites were also located to encompass a broad cross section of the project area (Figure 3.1). However, specific site selection and grid dispersal was somewhat restricted by limited vehicle access.

Table 3.1 Fauna Survey Site Locations (datum – WGS84)

Site	Location		Description	Criteria for Selection
1	0469865	8113784	Pindan Woodland	i, ii, iii
2	0469382	8112324	Pindan Woodland	i, ii, iii
3	0474738	8114594	Pindan Woodland	i,ii
4	0464404	8116563	Pindan Woodland	i, ii, iii
5	0468850	8111900	Pindan Woodland	i, ii, iii
6	0463811	8111156	Pindan Woodland	i,ii

460000mE
465000mE
470000mE
475000mN
8120000mN
8115000mN
8110000mN
Beagle Bay 1.5 km
Beagle Bay Access Road
To Cape Leveque
To Cape Leveque
Airstrip
Seismic Line
BROOME CAPE LEVEQUE ROAD
OLD CAPE LEVEQUE ROAD
SITE
Vincent Well
5000 ha Lease Option Area
ACCESS ROAD
Wildlife Corridors
Plantation Development Site
Teak 100 ha
Teak
Teak
Sandalwood
Sandalwood
Sandalwood
Teak
Sandalwood
Mahogany
Sandalwood
Mahogany
Sandalwood
Mahogany
Sandalwood
Teak
Trial Lease Area
ROAD
CAPE LEVEQUE
Fence Line
Country Downs Station
N
1:50 000
0
2.5
Kilometres
MAP GRID of AUSTRALIA
GRID BASED ON TRANSVERSE MERCATOR PROJECTION

Legend
- Flora Survey Location Sites

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Client: TROPICAL TIMBER PLANTATIONS PTY LTD

Project: BEAGLE BAY PROJECT
PROPOSED STAGE 2 EXPANSION

BEAGLE BAY PLANTATION
FAUNA SITE LOCATIONS

A3

Date: January 2004
Scale: 1:50 000
Rev. No. 2 (16-1-2004)
Plan No. BB-03

3.3 SAMPLING METHODS

The methodology adopted for the current survey was formulated in context with the EPA's Draft Guidance Statement No. 56: Guidance Statement for Terrestrial Fauna Surveys for Environmental Impact Assessment. Table 3.2 details the EPA's criteria for determining design and adequacy and how the current survey met those criteria.

Table 3.2 Factors influencing the design and intensity of the Beagle Bay Big Tree Country Fauna Assessment Survey

Factors influencing design	Intensity and design of current survey
Bioregion and level of existing knowledge	Dampierland is seldom surveyed. Hence, the objective was to undertake a baseline survey for the project area.
Landform characteristics	The landform units were uniform throughout the project area and are well represented in regions. Sampling was only conducted in and adjacent to the proposed impact area.
Lifeforms, life cycles, types of fauna and season	The survey was undertaken in the late wet season to target all vertebrate fauna, including amphibians. Pre-existing avifauna data from dry season survey work has been incorporated into this report.
Species accumulation curves	Monitoring of species accumulation indicated that the sample duration was adequate.
Number of habitats	Habitats throughout the project area were uniform. Hence, six replicate sites were deemed sufficient.
Climatic constraints	Climatic factors limited the options for systematic trapping grid design. More compact Goldfields style grids were selected over larger Pilbara style grids to facilitate rapid clearance, and to minimise trap deaths.
Sensitivity of environment to impact	Initial impact in the plantation area will occur, with some edge and ongoing effects. However, there are opportunities for limited regeneration of native vegetation over the life of the project. A baseline survey was deemed most appropriate to estimate loss of native fauna.
Size and shape of impact area	Not relevant.
Scale and impact	Broadscale impact. However, the extent of impact is minimal when considering the extent of the vegetation type to be lost in the region (Pindan vegetation).

The inventory of fauna was carried out using a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling refers to data methodically collected over a fixed time period in a discrete vegetation community type, using an equal or standardised sampling effort. The resulting information can be analysed statistically, facilitating comparisons within and among sites and between seasons. Opportunistic sampling includes data collected non-systematically within and outside fixed sampling sites.

3.3.1 Systematic Data

Fauna trapping was undertaken using a standardised trapping format. The objective of this baseline survey was to enable the compilation of a fauna species inventory for the project area. As the vegetation and habitats of the project area are uniform, six sites were deemed sufficient. Site or grid placement was dictated by access, with four grids placed within the boundary of the 5,000 ha lease option area, and a further two grids placed outside the lease option area in case the lease boundaries are altered in the future. The grid format comprises two parallel outer rows of 10 Elliot traps each at 20 m intervals, and two inner parallel rows of 5 pit traps at 40 m intervals. Each parallel row was spaced approximately 25 m apart. Hence, the each grid covered an area of approximately 100 x 200 m.

At all systematic survey sites, a combination of trapping, opportunistic searching and bird censusing was conducted:

- *Mammal, Reptile and Amphibian Fauna*

(1) Pit-trap and drift fence: PVC pipe (16 cm diameter, minimum 35 cm deep) and 20 L plastic buckets (30 cm diameter, 40 cm deep) were set into the ground. Each pit was subtended by a five metre flywire drift fence (30 cm high) and baited with a bait of rolled oats and peanut paste (Universal bait).

(2) Elliott box traps: Within each systematic site, two parallel lines of 10 medium sized Elliott box traps (9 x 9 x 32 cm) were arranged, and baited with Universal Bait.

(3) Microhabitat Searching: Sites were hand searched for cryptic species. Foraging techniques included identification of active animals, raking leaf and bark litter drifts, raking bulldozer spoil heaps along existing tracks and survey lines, over-turning logs and stones, searching beneath the bark of dead trees, breaking open old logs, stumps and dead free-standing trees, investigating burrows and recording tracks, diggings and scats. A minimum of 1.5 person hours were spent at each site.

(4) Spotlighting: Some sites were searched at night using head torches and hand held spotlights for nocturnal species, such as geckos, snakes and nocturnal birds.

Within the project area the combination of 6 person fauna survey sites resulted in a total of 360 pit trap and 720 Elliott trap nights. A total of 25.5 person hours were spent searching microhabitats within the 6 systematic sites (Table 3.3).

• *Bird Fauna*

Censuses were used to survey the avifauna present at each of the six fauna sites. The duration of each census was 20 minutes. Each site was censused during the periods between 0500 hr and 1000 hr and 1500 hr to 1830 hr. During the 20 minute census, ornithologists confined their search to within and adjacent the site. Censuses involved recording the number of individuals of each species observed at a site. The ornithologists covered as much ground as possible within each site by walking throughout each site. A total of 30.5 hours were spent undertaking avifauna censuses within the project area (Table 3.3). Opportunistic sightings around the greater project area also contributed to the number of bird species recorded.

Table 3.3 Survey Effort

Site number	Pit trap nights	Elliott trap Transects	Avifauna Censusing	Microhabitat Searching
1	70	140	3hrs	2hrs
2	70	140	4hrs 20min	5hrs 55min
3	70	140	4hrs	1hr 30min
4	70	140	4hrs 40min	3hrs 40min
5	70	140	3hrs 40min	6hrs
6	70	140	5hrs 20min	2hrs 30min
Opp			5hrs 30min	4hrs
TOTAL	**420**	**840**	**30 hrs 30 min**	**25 hrs 35 min**

3.3.2 Non-systematic Data

To supplement the systematic sampling outlined in Section 3.3.1, the presence of all vertebrate species were assessed *via*:

(1) Secondary evidence: Tracks, diggings, scats, burrows and nests were recorded where possible for the species responsible.

(2) Opportunistic sightings: The presence of species was recorded while searching, travelling and during trap establishment within the project area during the day and night.

• *Bat Fauna*

Bat mist netting was undertaken on several nights over the duration of the project at one fixed location. The site was a small dam located adjacent the site camp. With a lack of open water across the project area, many species were attracted to this water body, making it an ideal location for netting. All of the species recorded during the survey were recorded as captures in the mist net. A total of 7.25 hours were spent mist-netting.

Bat echolocation calls were detected using an Anabat system (Titley Electronics, Ballina, NSW). This consists of an Anabat detector that is able to transform ultrasonic bat echolocation calls for analysis with computer software (Analook and Anabat, URL: <http://users.lmi.net/corben/anabat.htm>). The transformed calls were stored on minidiscs (Sony Premium) using a Sony MZ-R900 Minidisc Recorder and played back through a ZCAIM (Zero-Crossings Analysis Interface Module) onto a PC. Anabat 6.3g

was used to download files and Analook 4.9g used to analyse call characteristics. Anabat recording was undertaken at a variety of sites across the project area, however no calls were detected.

3.4 TAXONOMY AND NOMENCLATURE

Field identification of vertebrate species was based on the following field guides:

Mammals	. . . .	Strahan (1995)	Skinks	. . . .	Storr *et al.* (1999)
Bats	. . . .	Churchill (1998)	Agamids	. . . .	Storr *et al.* (1983)
Birds	. . . .	Slater *et al.* (1991)	Varanids	. . . .	Storr *et al.* (1983)
. . . .		Simpson and Day (1996)	Snakes	. . . .	Storr *et al.* (1986)
Geckos	. . . .	Storr *et al.* (1990)	Reptiles	. . . .	Cogger (1992)
Pygopods	. . . .	Storr *et al.* (1990)	Amphibians	. . . .	Tyler *et al.* (2000)

In most cases, fauna species were identified in the field. Where the taxonomy of specimens was not conclusive, or for species that are known to exhibit significant morphological variation, or those taxa not yet fully described, vouchers were lodged with WA Museum. In this report, nomenclature is based on the WA Museum Faunabase (www.museum.wa.gov.au/faunabase) and the Birds Australia (2003) for the avifauna.

3.5 DATA ANALYSIS

3.5.1 Species richness

The number of species present (species richness) is the most simplistic representation of species diversity and is the indicator of diversity for this survey.

3.5.2 Multivariate Analysis

Systematic fauna survey site similarity based on species composition for the various vertebrate groups was assessed by constructing cluster dendrograms using the computer program Systat. This objective method was considered suitable to detect faunal assemblages present in the project area.

While a detailed discussion of the algorithms and parameters of the analysis is beyond the scope of this report, it is relevant to appreciate that the analyses utilise species composition by site data to compute similarity between sites (Hill 1979; Wilkinson 1989).

SYSTAT

Systat™ is a statistical analysis package which includes a cluster analysis component. The cluster analysis detects natural groupings of data and summarises the hierarchical relationships within the dataset by producing a quantitative index of similarity for each site relative to every other site, thus facilitating a hierarchical ordering of sites based on the composition of faunal assemblages. It does not provide any indication as to how species are distributed within this hierarchy.

Dendrograms were constructed using the Pearson correlation complete linkage method (Wilkinson 1989) utilising presence-absence and abundance data for particular taxonomic groups (birds, reptiles) and for the combined fauna data set.

3.6 ZOOGEOGRAPHY AND BIOGEOGRAPHY

Several zoogeographic regions are recognised in continental Australia. In Western Australia regions can be most broadly defined as the mesic Bassian region of the south-west, the Torresian region of subtropical northern Western Australia, and the arid Eyrean region (Figure 3.2).

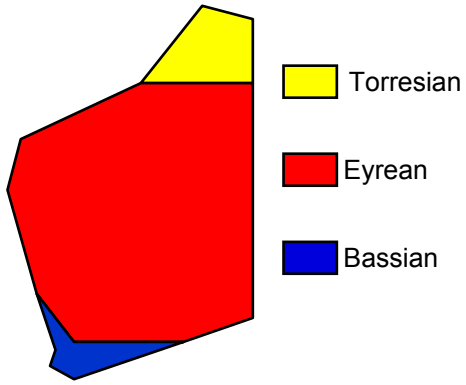

Figure 3.2 Western Australia's Zoogeographic Regions

On a finer scale, the Interim Biogeographic Regionalisation for Australia places the continent into 85 biogeographic regions based on characteristics of climate, fauna, vegetation, landforms and geology (IBRA Version 5.1). In Western Australia, there are 26 regions, and the project area falls within Dampierland (Thackway and Cressell 1995) and into the subdivision of Dampierland (3) under the revised Version 5.1 (Environment Australia 2000) (Figure 3.3).

This subregion is described as Quaternary sandplain overlying Jurassic and Mesozoic sandstones with Pindan Hummock Grassland on hills.

Species that are endemic to a particular bioregion may be considered of higher conservation value than cosmopolitan species. There are exceptions where cosmopolitan species, such as the Peregrine Falcon (*Falco peregrinus*) are in decline.

Where a biological inventory survey reveals a high level of endemism across a broad range of taxa, it is usually interpreted that the area may have high conservation value. In such instances, the physical characteristics of the region may be unique and impose strong influences or selective pressures on the resident fauna, such that the fauna occurring may be dependant on those characteristics that are not present in other areas. In this instance, loss of habitat can result in a significant loss of fauna diversity in a regional or state context.

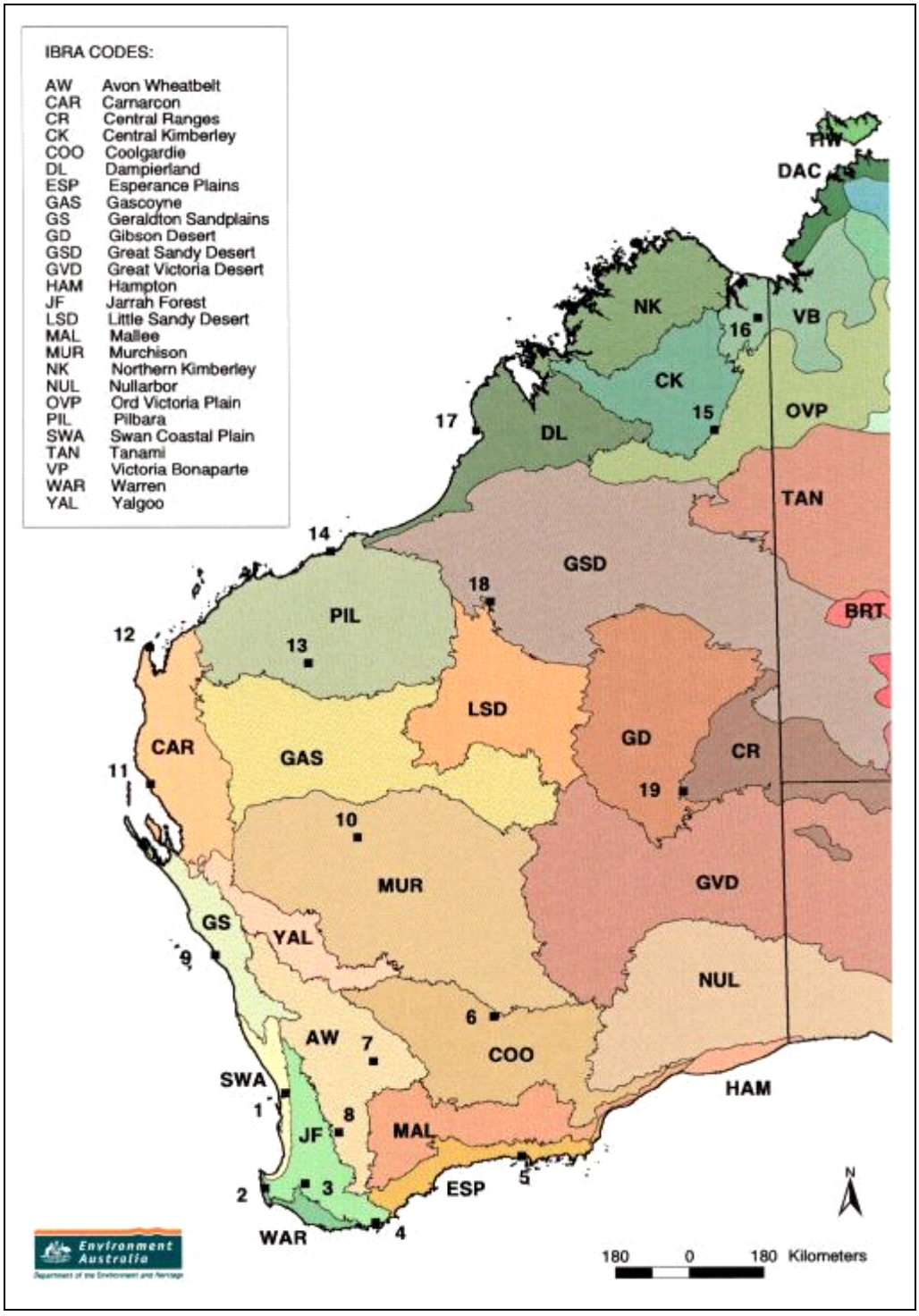

Figure 3.3 Map of Western Australia, showing the IBRA regions
(source: www.deh.gov.au/parks/nrs/ibra/version5-1/wa.html).

The number of species within each vertebrate group with affinities to the broad zoogeographic regions were calculated and expressed as a percentage of the total number of species within each group. The distribution ranges of the species recorded during the survey were also considered in context with the boundary of the Dampierland biogeographic region so an assessment could be made on the conservation value of the project area.

4.0 VERTEBRATE FAUNA

4.1 VERTEBRATE FAUNA WITHIN THE STUDY AREA

Systematic sampling and opportunistic collecting within the proposed plantation area yielded 105 vertebrate species, including 65 birds, 28 reptiles, four amphibians and eight mammals (six native and two introduced) (Table 4.1, Appendix A). The timing of the survey during the wet season assured the representation of amphibians in the capture records and substantially increased the diversity of avifauna recorded.

Table 4.1 Number of vertebrate fauna species recorded in the project area.

SPECIES	TOTAL
Native mammals	**6**
Introduced mammals	**2**
Birds	**65**
Reptiles	**28**
Frogs	**4**
TOTAL	**105**

Despite the described habitat similarity of the six systematic sites, the number of species recorded in each site varies greatly. The significance of this difference is tested using chi-squared (X^2) analysis, where the expected number of species in each site was the total number of species recorded for the project area. Despite the fact that it took more time to locate the total number of species, it is a fair assumption that all 105 species located across the project area could occur in one site. The chi-square test reveals that the number of species identified in each site differs between the six sites, and that this difference is significant ($X^2_5 - 215.46$, $P < 0.001$).

If the habitats within the sites are the same, and the associated species richness for these sites is different, then it is necessary to assess the outcomes of the survey and attempt to identify the divergence in fauna diversity across the site. Possible influences on site diversity are investigated in the following sections.

4.1.1 Fauna Habitat Composition and Use

Different parts of the project area may support different faunal assemblages, which will influence species richness. However, on the basis of landform units and vegetation associations present, the habitat of the project area is characterised as uniform for the red sand plains of the Dampier Peninsula (Kenneally *et al*. 1996). Pindan woodlands generally consist of eucalypts of medium height with a middle layer of tall shrubs of variable densities and a ground layer dominated by mixed dense grasslands (Plates 1 and 2). It is possible to examine the similarity of the species assemblages across the six sites using cluster analysis, where sufficient data have been collected to perform the analysis.

Plate 1 Site 3

Plate 2 Site 1

Fauna Communities

Cluster analysis of the fauna survey data enables any site groupings which correspond fairly closely with vertebrate fauna utilisation of habitats to be determined, i.e. is there a determinable difference between community composition that is relatively stable within habitats, but which varies between habitats?

In order to adequately investigate fauna community composition, it is necessary to take into account a series of factors. The first is that differences between site groupings based on species composition across vertebrate assemblages may reflect different environmental conditions prevailing on constituent species between sites. Different subsets of physical and biological factors affect the distribution and abundance of mammal species to those that affect either the avifauna or herpetofauna.

To account for this factor, each fauna group is analysed separately. Specifically, we would assume that in general, substrate is a major factor affecting the ecological distribution of reptiles, although vegetation may provide substrate in the form of bark, hollows and leaf litter. The avifauna is expected to be influenced primarily by vegetation, including both its structure and composition (*e.g.* Eucalypt woodland *versus Acacia* shrubland). Surface geology, landform and soil type will determine the nature of the vegetation, hence this will influence fauna communities.

The cluster analysis for the avifauna data does not indicate groupings based on site (Figure 4.1). As can be seen from Figure 4.1 there is a high degree of similarity of avifauna species recorded at each of the survey sites. More than half the species were recorded at three or more sites. Fourteen species were recorded at all sites and only 10 species were recorded at only one site.

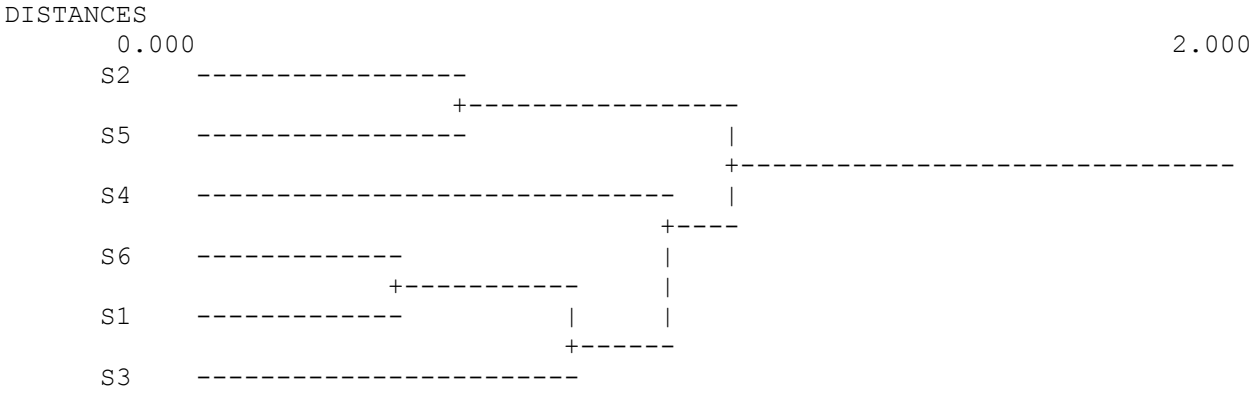

Figure 4.1 Cluster analysis of avifauna survey sites
(Based on presence/absence data, complete linkage method).

Examination of the dendogram based on site similarity in relation to reptile presence/absence also shows little differentiation of reptiles across the survey sites (Figure 4.2).

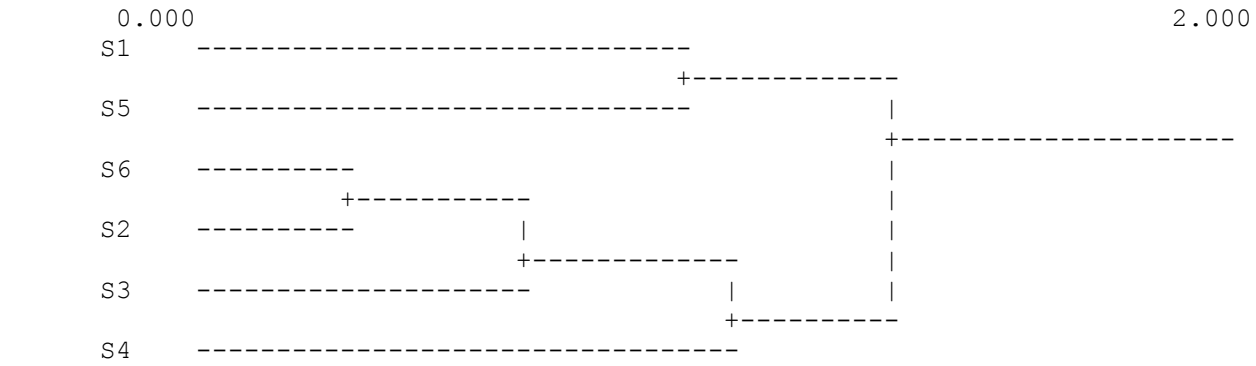

Figure 4.2 Cluster analysis of reptile survey sites
(Based on presence/absence data, complete linkage method).

4.1.2 Site Specific Survey Effort

If it is assumed that the sites were the same in terms of fauna habitat, then it can be reasonably expected that the difference in results were attributable to differences in survey effort across sites. This may apply to avifauna censusing and opportunistic searching, but does not apply to trapping effort, which was the same at all sites (Table 3.1)

Considering the results of the survey (diversity and number of species *vs* search effort), survey effort does not appear to influence the number of species recorded at each site (Table 3.1 *vs* Table 4.2). For example, the highest species richness within the study area was recorded from Site 3, with a total of 60 species, including five mammals, 41 birds and 14 herpetofauna. The highest herpetofauna species richness was recorded in Site 3, yet this site received the least opportunistic search time. The number of birds recorded was also the highest for the project area, yet the avifauna census time was comparable with all other sites.

Table 4.2 Number of mammal, bird and herpetofauna species across the systematic trapping sites.

Site	# Mammal species	# Bird species	# Herpetofauna species	Total number of species
1	2	28	10	**40**
2	2	33	10	**45**
3	5	41	14	**60**
4	0	36	7	**43**
5	0	24	8	**32**
6	1	35	9	**45**

4.1.3 Sampling Adequacy

The probable reason for the divergence in capture records across the six sites is attributed to sampling adequacy. Species accumulation curves for the three major vertebrate groups are approximately asymptotic (Figure 4.3). Though the graph indicates a point of diminishing return in terms of new species for sampling effort, the peak on the final day of avifauna censusing and the gradual rising trend of the herpetofauna and mammal curves indicates that a longer survey would have resulted in a higher species richness and, most likely, aligned the species richness of all of the sites.

Potential species lists have been prepared for the project area based on a search of the available literature, information obtained from the Western Australian Museum (WAM) fauna database, unpublished information relevant to the area, a previous ornithological survey (Swann 2003) and knowledge of known habitat preferences. On this basis an estimated 193 vertebrate fauna species may potentially occur in the study area. This comprises 17 native and 6 introduced mammals, 110 birds, 52 reptiles and eight frog species. It is unlikely that all potentially occurring vertebrate fauna species would be recorded within the project area during the course of a single fauna survey due to temporal and spatial variations in population numbers.

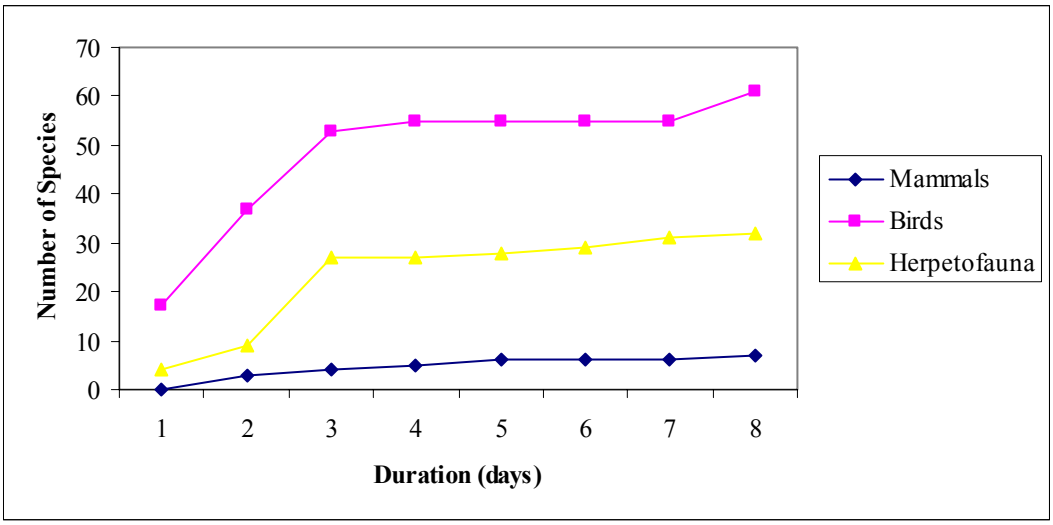

Figure 4.3 Species accumulation curves for vertebrate fauna surveyed within the project area.

The current survey has documented over 54 % of the species known to occupy the Dampierland biogeographic region, and contributed to the WAM collection of vertebrate fauna, with the lodgement of at least seven new reptile species for the region. Though the taxonomy of mammals is fairly well defined, new species of reptiles are being described every year (Aplin *et al.* 2001). Baseline survey data such as those derived from the current survey, in relatively unstudied areas such as the Dampierland biogeographic region contribute significantly to the knowledge of fauna biodiversity. This is particularly important in areas such as the Dampierland biogeographic region, where there is a high level of short-range endemism (WAM Faunabase 2004).

4.2 FAUNA RECORDED

4.2.1 Mammals

Representative species of each of the major mammal groups were recorded in the project area, including marsupials, placental mammals, vespertilionid bats, rodents and introduced fauna (Appendix B1). The deficit between species observed (eight species) in the current survey and those previously recorded (23 species) is primarily due to the under representation of bats (eight potential species not recorded), introduced species (four species not recorded) and marsupials (two species not recorded). Moreover, there is a relative paucity of mammal species that may potentially occur within the area due to the uniformity of habitat, the effects of changing fire regimes, and the predation pressure from feral animals. All of these factors contribute to a decline in mammal diversity, particularly for species falling within the Critical Weight Range (CWR) of 35 – 5500 g, which are more susceptible to decline (Burbidge and McKenzie 1989).

Although up to 13 bat species may occur in the project area, only three species were recorded during the course of the survey. All of these individuals were captured by mist-netting, and no calls were recorded. Individuals of the Hoary Wattled Bat (*Chalinolobus nigrogriseus*), Little Broad-nosed Bat (*Scotorepens greyii*) and Kimberley or Yellow-lipped Cave Bat (*Vespadelus douglasorum*) were recorded (Appendix B1). By night, all species are likely to forage over a variety of habitat types. During the day the Hoary Wattled and Little Broad-nosed Bat frequently roost in dead hollow limbs of Eucalypts (Churchill 1998). Conversely, the Kimberley or Yellow-lipped Cave Bat (*Vespadelus douglasorum*) is a cave dweller, and a record of this species in the middle of the Dampier Peninsula is unusual. The individuals captured during the current survey would have either been transients, or they may have been roosting among the

camp buildings. Alternatively, the species may not actually be cave-dependant, as described by Strahan (1995).

The Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*) was another significant record for the project area. Although this species is not priority listed or Scheduled by the Department of Conservation and Land Management (CALM), it has suffered declines across parts of its natural range, despite being common in urbanised areas (T. Start, CALM, pers. comm.). The declines are very likely due to altered fire regimes on the Peninsula coupled with the influence of feral predation. The Northern Brushtail Possum forages across a variety of habitats, but depends upon the presence of mature Eucalypts with hollows for roosting, many of which are lost during intense dry season wildfires.

Only two species of native rodents may occur within the proposed project area, and both were recorded during the current study. The Delicate Mouse (*Pseudomys delicatulus*) has a predominantly Torresian distribution, occurring throughout northern Australia and down the east coast to southern Queensland (Strahan 1995). Four individuals were recorded during this survey and was the most widespread mammal recorded within the study area. The Western Chestnut Mouse (*Pseudomys nanus*) inhabits areas where there is a dense ground cover of tussock grasses, often beneath the low eucalypt woodland characteristic of much of northern Australia. Two individuals were recorded during this survey.

Two introduced mammals were recorded during the survey, the Feral Cat (*Felis catus*) and Donkey (*Equus asinus*).

The mammal species recorded, and in particular, those species vouchered during the survey have highlighted the lack of mammal survey work in the general Beagle Bay area, and have contributed to the inadequate diversity of samples that the WAM has for this area.

4.2.2 Avifauna

Sixty one bird species from 33 families were recorded throughout the project area (Appendix B2). The highest species richness recorded was from Site 3, with a total of 41 species; although all sites were relatively similar in overall species richness. Some of the most speciose families were the Meliphagidae (honeyeaters; eight species), Columbidae (pigeons and doves; four species), Cuculidae (parasitic cuckoos; four species) and Psittacidae (Lorikeets and Parrots; four species).

Species that were widespread in the project area (recorded at all sites) included Varied Lorikeet (*Psitteuteles versicolor*), Rainbow Lorikeet (*Trichoglossus haematodus*), Red-winged Parrot (*Aprosmictus erythropterus*), Red-backed Fairy-wren (*Malurus melanocephalus*), Brown Honeyeater (*Lichmera indistincta*), Rufous-throated Honeyeater (*Conopophila rufogularis*), Black-chinned Honeyeater (*Melithreptus gularis*), Jacky Winter (*Microeca leucophaea*), Rufous Whistler (*Pachycephala rufiventris*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*), Pied Butcherbird (*Cracticus nigrolgularis*), Long-tailed Finch (*Poephila acuticauda*) and Grey-crowned Babbler (*Pomatostomus temporalis*).

Four nocturnal species were recorded in the project area; Boobook Owl (*Ninox novaeseelandiae*), Tawny Frogmouth (*Podargus strigoides*), Australian Owlet-nightjar (*Aegotheles cristatus*) and Bush-stone Curlew (*Burhinus grallarius*).

Several species were only recorded opportunistically and not at systematic survey sites within the project area. These included Bush Stone-curlew (*B. grallarius*), Crested Pigeon (*Ocyphaps lophotes*), Little Button Quail (*Turnix velox*), Magpie Lark (*Grallina cyanoleuca*) and Pallid Cuckoo (*Cuculus pallidus*).

Species of interest recorded during the survey include the Bush Stone-curlew (*B. grallarius*) and Australian Bustard (*Ardeotis australis*). These two species typically avoid the thick ground storey vegetation that is common in the project area, and the records were most likely of transients rather than individuals occupying the project area (George Swann pers. com.). The recording of the Little Bronze-cuckoo (*Chrysococcyx minutillus*) would normally be regarded as significant, as this species is associated with mangroves and vine thickets (Johnstone and Storr 1998). However, this species has been sited throughout the Peninsula and inland Kimberley, as well as coastal areas (George Swann, pers. com.). Therefore, and similar to *V. douglasorum*, this species may not be as habitat specific as is usually thought.

4.2.3 Herpetofauna

A total of 32 herpetofauna species were recorded from the six sites within the project area (Appendix B3). This included five geckos, one pygopod, nine skinks, three elapid snakes, five dragons, two varanids, one blind snake and two pythons. Four Amphibians, *Cyclorana australis*, *Litoria caerulea*, *L. rubella* and *Uperoleia talpa* were also recorded from the project area. Some of the more widespread species included *Diporiphora pindan*, *Tiliqua scincoides intermedia* and *Lerista griffinii*. Bynoe's Gecko (*Heteronotia binoei*), *Diplodactylus stenodactylus* and *Gehyra pilbara* were the most abundant species recorded during the survey. Species recorded from a single specimen during the survey included *Carlia tricantha, Ctenotus inornatus, Diporiphora magna, Varanus gouldii, V. scalaris, Pygopus nigriceps, Aspidites melanocephalus, Antaresia stimsoni* and *Furina ornata*. A total of seven species have not previously been vouchered from the area and lodged with WAM, indicating how poorly this area has been surveyed in the past. Of these seven records, two species (*A. melanocephalus* and *P. nigriceps*) were collected opportunistically as single records from the project area. Though the taxonomy of mammals is fairly well defined, new reptile species are being described every year (Aplin *et al.* 2001). Baseline survey data, such as those derived from the current survey, in relatively unstudied areas such as the Dampierland biogeographic region, contribute significantly to the knowledge of fauna biodiversity.

Species of note collected during this survey include *Rhynchoedura ornata* which has not previously been vouchered from the Dampier Peninsula, *Morethia storri* which is restricted to Dampier Peninsula, *Diphoriphora magna, Uperoleia talpa* and *Varanus gouldii* (all of which are not commonly collected on the Dampier Peninsula).

4.2.4 Feral Fauna

Two species of feral fauna were recorded in the project area during the course of the field survey: the Feral Cat (*Felis catus*) and Donkey (*Equus asinus*). Two feral cats were sighted opportunistically in the project area. Donkeys were recorded at Sites 1 and 3.

Feral Donkeys survive in a wide range of semi-arid and arid environments. The Donkey is considered to be an agricultural and environmental pest, as they compete with stock and native grazers for food resources (Strahan 1995). Regular culling is the most commonly employed method of control.

4.3 BIOGEOGRAPHIC AFFINITIES

Most of the recorded fauna have distributions predominantly in the Eyrean sub-region, a biogeographic region which extends over much of arid central and Western Australia (Beard 1979b). Only 25 % have distributions which are predominantly Torresian (distributed across the north of Australia).

Two mammal species have Torresian endemic distributions; Hoary Wattled Bat (*Chalinolobus nigrogriseus*) and Kimberley or Yellow-lipped Cave Bat (*Vespadelus douglasorum*). The range of vouchered specimens of *V. douglasorum* is predominantly in the Dampierland biogeographic region, but also extends across the western-most margin of the Central Kimberley and into the Northern Kimberley.

Eleven species of herpetofauna captured during the survey are Torresian endemics. These were *Cyclorana australis, Litoria caerulea, Uperoleia talpa, Ctenotus inornatus, Lerista griffinii, Morethia storri, Tiliqua scincoides intermedia, Chlamydosaurus kingii, Diporiphora pindan, D. magna* and *Aspidites melanocephalus*. Of the reptile species captured or recorded during the survey 41 % have more than 90 % of their range occurring within the Torresian region. Where the species occur in Western Australia, *U. talpa, L. griffinii, M. storii* and *D. pindan* all have distributions limited to Dampierland. However, both *L. griffinii* and *M. storri* occupy other biogeographic regions in the Northern Territory.

In contrast, most of the avifauna have wide ranging distributions. Only fifteen species recorded are endemic to the Torresian sub-region (24 %): Varied Lorikeet (*Psitteuteles versicolor*), Rainbow Lorikeet (*Trichoglossus haematodus*), Red-winged Parrot (*Aprosmictus erythropterus*), Little Bronze-cuckoo (*Chrysococcyx minutillus*), Brush Cuckoo (*Cacomantis variolosus*), Red-backed Fairy-wren (*Malurus melanocephalus*), Yellow-tinted Honeyeater (*Lichenostomus flavescens*), Rufous-throated Honeyeater (*Conopophila rufogularis*), White-throated Honeyeater (*Melithreptus albogularis*), Little Friarbird (*Philemon citreogularis*), Great Bowerbird (*Chlamydera nuchalis*), Long-tailed Finch (*Poephila acuticauda*), White-throated Gerygone (*Gerygone olivacea*), Leaden Flycatcher (*Myiagra rubecula*) and Olive-backed Oriole (*Oriolus sagittatus*). Most of these species have distributions that extend beyond the boundaries of the Dampierland biogeographic region, into regions such as the Central and Northern Kimberley. Hence, they are dependant on a wider range of habitats than those in the project area. This clearly indicates the widespread origin of the avifauna and the lesser dependence and adaptiveness related specifically to this area. However, the Little Bronze-cuckoo, White-throated Gerygone and the Leaden Flycatcher all have been recorded predominantly within the boundaries of Dampierland, at least where the species occur in Western Australia.

4.4 SURVEY LIMITATIONS AND CONSTRAINTS

According to the Draft EPA Guidance Statement No. 56 for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2003), fauna surveys may be limited by the following:

- Competency/experience of the consultant carrying out the survey;
- Scope (what fauna groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions, *e.g.* pitfall trapping in waterlogged soils);
- Proportion of fauna identified, recorded and/or collected;

- Sources of information *e.g.* previously available information (whether historic or recent) *vs* new data;
- The proportion of the task achieved and further work which might be needed;
- Timing/weather/season/cycle;
- Disturbances (*e.g.* fire, flood, accidental human intervention etc) which affected results of survey;
- Intensity (in retrospect was the intensity adequate);
- Completeness (*e.g.* was the relevant area fully surveyed);
- Resources (*e.g.* degree of expertise available in animal identification to taxon level);
- Remoteness and/or access problems; and
- Availability of contextual (*e.g.* biogeographic) information on the region.

An assessment of these aspects is detailed in Table 4.3 below.

Table 4.3: Fauna Survey Constraints

Aspect	Constraint (yes/no); Significant, moderate or negligible	Comment
Competency/experience of the consultant carrying out the survey	No	All members of survey team have had appropriate training, experience and mentoring in vertebrate fauna identification and vertebrate fauna assemblage surveys. Senior personnel have specific training in fauna identification and zoogeography. The Fauna Field Survey project leader has undertaken other similar projects in the Kimberley region (Ord Stage 2 M2 for the Department of Resource Development).
Scope	Yes - moderate	The trapping and collection regime accounted for all vertebrate fauna species types. Trapping and opportunistic sighting revealed an adequate sample of herptiles and terrestrial mammals. Avifauna censusing adequately sampled birds of the project area. Bat recording techniques were employed. However, the number of species identified was lower than expected (10/13 species not recorded). Sampling of bats during the survey was limited by the inability to use characteristics of their echolocation calls to identify species. Due to the large amount of insect activity during the survey, background noise inhibited clear recordings required for analysis. Mist netting was only undertaken over one water-body, which concentrated activity and resulted in the capture of three species.
Proportion of fauna identified, recorded and/or collected	Yes - moderate	A total of 54 % of the species potentially occurring in the project area were recorded, and several captures represented new records for WAM. Bird assemblages fluctuate as a result of various biological and physical factors, such as habitat and season. The wet season survey data was supplemented by dry season survey data for the same area (Swann 2003, included in this report). A complete inventory of vertebrate species present would only be achieved by multiple surveys representing all seasons, and this was beyond the obligation of the proponent.
Sources of information e.g. previously available information (whether historic or recent) vs. new data	No	Wildlife of the Dampier Peninsula, South-west Kimberley, Western Australia (McKenzie 1983)
The proportion of the task achieved and further work which might be needed	No	Although further survey work would likely lead to a larger species list, it is unlikely to add to the knowledge of the area's conservation significance. This is due to the homogenous nature of the project area.

Aspect	Constraint (yes/no); Significant, moderate or negligible	Comment
		The conservation value of the area has already been demonstrated by the number of new records for the area.
Timing/weather/season/cycle	No	The timing of the survey was late wet season and weather conditions were generally warm to hot. These conditions are particularly conducive to reptiles which are active in warm weather, and this is reflected by the large number of reptile species recorded.
Disturbances which affected results of survey	No	No disturbances took place during the survey.
Intensity (in retrospect was the intensity adequate)	No	Intensity of trapping effort was adequate as indicated by the species accumulation curve (Section 4.2) and the proportion of potential species that were captured.
Completeness	No	Due to the uniform nature of the project area, 6 survey sites was adequate for a baseline data set of the vertebrate fauna.
Resources	No	Voucher specimens of amphibians, reptiles and mammals were identified by Mr B. Maryan and Ms N. Cooper of the Western Australian Museum.
Remoteness and/or access problems	No	Some access limitations. However, due to the uniformity of the project area, this is not considered to be a constraint of the survey.
Availability of contextual (e.g. biogeographic) information on the region	No	WA Museum fauna database, Department of Conservation and Land Management lists and Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway & Cresswell 1995)

5.0 RARE AND SPECIALLY PROTECTED FAUNA

All vertebrate fauna species are protected by law under Commonwealth and State Legislation, though rare or threatened fauna are afforded greater protection under the same legislation. At the national level, fauna are protected under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). Within Western Australia rare fauna are listed under the *Western Australian Wildlife Conservation Act* 1950. International Agreements include the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA) which cover migratory species of avifauna, particularly transequatorial waders. In addition, fauna are protected under the April 1991 Australian and New Zealand Environment and Conservation Council (ANZECC) convention.

Beyond considering the legislative protection of any species as a determinant of conservation value, the level of endemism must also be considered.

5.1 SPECIES PROTECTED BY INTERNATIONAL AGREEMENTS

Three international agreements address components of the Australian fauna, with a focus on protecting migratory species. These three agreements are JAMBA, CAMBA and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). Of the species listed under these agreements, five may potentially occur in the project area and two of these were recorded. These include:

Recorded		
Rainbow Bee-eater	*Merops ornatus*	JAMBA
Fork-tailed Swift	*Apus pacificus*	JAMBA/CAMBA
Potentially Occur		
White-bellied Sea Eagle	*Haliaeetus leucogaster*	*CAMBA*
Yellow Wagtail	*Motacilla flava*	*JAMBA/CAMBA*
Oriental Cuckoo	*Cuculus saturatus*	*JAMBA/CAMBA*

5.2 COMMONWEALTH EPBC ACT

Schedule 1 of the EPBC ACT contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Extinct, Extinct in the wild and Conservation Dependent.

Classification of species under the EPBC Act is as follows:

Critically Endangered	The species is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.

Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Extinct	A species is presumed extinct if it has not been located in the last 50 years, or it has not been located in the last 10 years despite thorough searching.
Extinct in the wild	The species is only known to survive in cultivation, in captivity or as a naturalised population well outside its past range or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a timeframe appropriate to its life cycle and form.
Conservation Dependent	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Three species listed under the EPBC Act potentially occur within the project area, as follows:

Gouldian Finch *Erythrura gouldiae*

The Gouldian Finch (*Erythrura gouldiae*) is listed as Endangered under the EPBC Act. Gouldian Finches occupy two different regions of the landscape on an annual cycle; tropical north during the dry season, and the arid interior during the wet season. Generally the species occupies Eucalypt woodlands with a grassy understorey, adjacent clearings and the edge of mangrove communities. Trees provide nesting sites while feed mainly comprises native grasses, including soft Spinifex, Cockatoo Grass and Golden Beard Grass (Lewis 2001). Individuals are also usually closely associated with water (Blakers *et al.* 1984). The Gouldian Finch was not recorded during the current survey.

Given the propensity of this species to feed on, and occupy, grassy habitats, altered fire regimes such as is the case on the Dampier Peninsula may have contributed to reduced numbers of Gouldian Finches in this region, as has occurred with other congeners (Franklin 1999). This is most likely due to the change in composition of grasses, from perennial to annual species (Start 2003).

Red Goshawk *Erythrotriorchis radiatus*

The Red Goshawk (*Erythrotriorchis radiatus*) is listed as Vulnerable under the EPBC Act. A rare inhabitant of well-wooded country, this species nests in large trees and preys largely on birds but also reptiles and mammals. This species is unlikely to suffer any threatening processes associated with the plantation project. The Red Goshawk was not recorded during the current survey.

Bilby *Macrotis lagotis*

The Bilby (*Macrotis lagotis*) is listed as Vulnerable under the EPBC Act. Historically, the Bilby was distributed over 70 % of continental Australia. Now the species only occupies 20 % of its former range. Records indicate that the species may still occur in the southern Kimberley, and therefore habitats within the project area may support individuals, despite the fact that no individuals were located during the survey. Seven of the last 27 vouchers of this species collected between 1950 and 1999 have been collected on the Dampier Peninsula. This is a CWR mammal, and declines would most certainly be associated with altered fire regimes, habitat modification since European settlement, and an increase in predation by feral species.

5.3 WA WILDLIFE CONSERVATION ACT

Classification of rare and endangered fauna under the WA Wildlife Conservation (Specially Protected Fauna) Notice 2003 recognises four distinct schedules. For the purposes of the Act, all taxa of the fauna;

a) specified in Schedule 1, being fauna which are rare or likely to become extinct, are declared to be fauna that is in need of special protection";

b) specified in Schedule 2, being fauna which are presumed to be extinct, are declared to be fauna that is in need of special protection;

c) specified in Schedule 3, being birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection; and

d) specified in Schedule 4, being declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned in paragraphs (a), (b) and (c).

Scheduled species recorded or may possibly occur in the project area are detailed in the following sections.

5.3.1 Schedule 1 Species

Bilby *Macrotis lagotis*
See Section 5.2.

Red Goshawk *Erythrotriorchis radiatus*
See Section 5.2.

Gouldian Finch *Erythrura gouldiae*
See Section 5.2.

5.3.2 Schedule 4 Species

Peregrine Falcon *Falco peregrinus*
The Peregrine Falcon is widely distributed throughout Australia. It is nomadic, sedentary, or partly so, and prefers coastal or inland cliffs and gorges, timbered watercourses, plains and open woodlands. Its status is considered to be "generally uncommon, probably declining in settled regions; still well established in remote areas" (Pizzey 1983). Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. The Peregrine Falcon was not recorded during the current survey.

5.4 CALM PRIORITY FAUNA

Species on the CALM Priority Fauna list include those removed from the scheduled fauna list and other species known from only a few populations or in need of monitoring. Four Priority Codes are recognised:

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

Taxa which are known from few specimens or sight records from one or a few localities, on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Two Taxa with few, poorly known populations on conservation lands.

Taxa which are known from few specimens or sight records from one or a few localities, on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

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

Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Four 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 if present circumstances change. These taxa are usually represented on conservation lands.

The details of Priority Fauna that may be found or were recorded in the project area are:

Priority 1 - Little North-western Mastiff Bat *Mormopterus loriae cobourgiana*
This species occurs along the northwest coast and is known to roost in mangroves. It has the potential to occur in the project area, but only as a transient possibly roosting in trees whilst moving across the peninsula. This species was not recorded during the current survey.

Priority 4 - Bush Stone-curlew *Burhinus grallarius*
Bush Stone-curlews generally inhabit open woodland areas with a leaf litter layer providing camouflage on which they rely for predator avoidance. Habitats within the project area are not ideal for this species, due to the density of ground cover.

However, as it is a ground dwelling species, populations can be influenced by fire (Blakers et al. 1984). As a consequence individuals may utilise suboptimal habitats if favourable habitat is sparse. Two individuals were observed during the survey period.

Priority 4 - Australian Bustard *Ardeotis australis*
This species is uncommon and may occur in open or lightly wooded grasslands. Similarly to the Bush Stone-curlew, the Bustard will occupy habitats with a denser ground storey either temporarily, or if better habitat is limited. One individual was observed during the survey period.

Priority 4 - Grey Falcon *Falco hypoleucos*
This species inhabits lightly timbered riverine plains. It may occur within the plantation site. The Grey Falcon was not recorded during the survey.

Priority 2 - *Simoselaps minimus* (elapid snake)
This species has only been recorded on the Dampier Peninsula and little is known about its biology. *Simoselaps minimus* was not recorded during the current survey.

Priority 2 - *Lerista separanda* (skink)
Very few specimens of this skink have been collected and little is known about its biology. *Lerista* is one particular genus that is under intense revision by the WA Museum. *Lerista separanda* was not recorded during the current survey.

5.5 SPECIES OF REGIONAL OR LOCAL SIGNIFICANCE

Due to the isolation of the Dampier Peninsula, this part of the Dampierland biogeographic region supports a number of endemic fauna. Endemism is an important conservation consideration, as not enough is known about many endemics to warrant listing these species as Schedule or Priority fauna worthy of special protection. However, their endemism makes them vulnerable to threatening processes, such as fire and feral predation. Therefore, listing under legislation should not be the only conservation consideration in environmental impact assessment.

Species of regional or local significance include those that have restricted or disjunct distributions, restricted habitat requirements, taxonomic uncertainty or have been recently discovered.

Kimberley or Yellow-lipped Cave Bat *Vespadelus douglasorum*
Vespadelus douglasorum currently has a distribution mapped in the west Kimberley district and has not previously been recorded as far west as the Beagle Bay Project Area. This species is a sandstone/limestone cave dweller, which has not been extensively studied. These bats have previously been caught within woodlands (Churchill 1998), but records in the project area are quite disjunct from rocky landforms that may support cave formations. Disturbances associated with the plantation practices may eliminate this species from the local area, if it inhabits woody roosts. However, as the individuals were all captured adjacent the plantation site 'camp', it may be that they were, in fact, roosting in buildings.

Diporiphora pindan
Diporiphora pindan has a distribution mapped within Dampierland and the adjacent coast. This species is apparently restricted to Pindan Woodland (Cogger 1992).

Morethia storri
In Western Australia, the distribution of this species is limited to the Dampier Peninsula. Other populations occur across the top of the Northern Territory. This level of endemism in a small vertebrate may lead to spatial variation in phenotype or even genotype. Morphometric and genetic material from

the specimens vouchered during the current survey need to be compared with material from Northern Territory specimens to identify the presence or extent of phenotypic or genotypic variation.

Lerista griffinii
This species of *Lerista* has a similar potential to *M. storri* for conspecific population divergence and vouchers should be treated accordingly.

6.0 CONSERVATION SIGNIFICANCE

The significance of the biota of the project area has been assessed at four spatial scales; international / national, state, regional and local. The project area comprises a small portion of the ubiquitous Pindan habitat distributed along the Dampier Peninsula and does not contain any distinct landforms or fauna habitats.

6.1 INTERNATIONAL/NATIONAL SIGNIFICANCE

Fauna species whose conservation is dependent, because of their migration patterns, on the action of other nations as well as Australia's, are of international significance. Such considerations are recognised by State legislation, Federal legislation and also International treaties. In addition, endangered animals are listed and their conservation status reviewed by the respective States in which they occur. Recommendations from these reviews are passed on to higher bodies (*i.e.* State to Federal and Federal to International Union for the Conservation of Nature - IUCN).

The Fork-tailed Swift (*Apus pacificus*), Rainbow Bee-eater (*Merops ornatus*), White-bellied Sea Eagle (*Haliaeetus leucogaster*) and Yellow Wagtail (*Motacilla flava*) are migratory bird species protected under international agreements (CAMBA and JAMBA), that occur within the project area (refer to Section 5). All species are abundant and widespread and require no specific management in Australia.

National significance refers to those features of the environment which are recognised under legislation as being of importance to the Australian community. Species scheduled under the EPBC Act are regarded as nationally significant. No species scheduled under the EPBC Act were recorded in the project area. The Gouldian Finch (*Erythrura gouldiae*) and Red Goshawk (*Erythrotriorchis radiatus*), which are listed as Endangered and Vulnerable under the EPBC Act respectively, may possibly occur within the area. However, as impacts associated with plantation practices are confined and the species distributions are widespread, the project is unlikely to significantly impact these species.

There are no fauna species or fauna habitats of national or international significance within the study area that are likely to be impacted by the proposed development.

6.2 STATE SIGNIFICANCE

State significance refers to those features of the environment that are recognised under State legislation as of importance to the Western Australian community; in particular, species scheduled under the *Wildlife Conservation Act*. Habitats which exhibit such a level of significance will contain either specific habitat dependent fauna or high biodiversity and are poorly represented elsewhere. If a species or habitat is poorly represented in conservation reserves, its conservation significance is increased. Below is a list of species of State significance (refer to Section 6.3 for details).

Red Goshawk *Erythrotriorchis radiatus*
Gouldian Finch *Erythrura gouldiae*
Peregrine Falcon *Falco peregrinus*

The significance of the area to populations of these species is quite variable. The Peregrine Falcon occurs at low densities throughout Australia, but requires rocky ranges and upland areas for inaccessible cliff nesting sites. This species will, however, nest in large mature trees. As a consequence, loss of

vegetation in the project area may influence localised habitat availability. However, on a regional scale the size of the impact area is not large when considered in context with the extent of woodland on Pindan soils.

Gouldian Finches may potentially occur in the project area. However, records have declined in the region due to changing fire regimes and the influence of fire on ground storey vegetation assemblages. Though impacts from the plantation will result in the loss of natural vegetation, fire management within and adjacent to the project area may reduce fire frequency and intensity, possibly providing a haven for local individuals. In addition, the presence of permanent water i.e. drippers, dams *etc*. may attract Gouldian Finches to the area. However, it cannot be presumed that individuals, if they are present, will utilise the plantation plots or adjacent habitat corridors.

The Red Goshawk occurs at low densities and is infrequently encountered. Any records would be significant since this species is now uncommon. This species was not recorded during the survey and is unlikely to be impacted by the project.

No threatened vertebrate fauna ecological communities are known from the project area and no species of state significance are likely to be impacted by the development.

6.3 REGIONAL SIGNIFICANCE

Regional significance addresses the representation of species and habitats at a regional biogeographic level. Species or habitat types that are endemic to the Beagle Bay area and whose known distributions are limited or unknown are considered regionally significant. The project area encompasses habitats and vegetation associations which are widespread throughout the region. Some of the species listed in the CALM priority list are considered regionally significant because of limited knowledge about their distribution, restricted distribution and/or poor representation within existing conservation reserves.

Fauna species of regional significance include the following (details are outlined in Section 6.4.):

Little North-western Mastiff Bat *Mormopterus loriae cobourgiana*
Bush Stone-curlew *Burhinus grallarius*
Australian Bustard *Ardeotis australis*
Grey Falcon *Falco hypoleucos*
Simoselaps minimus
Lerista separanda

Although the majority of these species potentially occur in the project area (and some were located during the survey), the project is unlikely to significantly impact any of the above species, as the project will result in the clearing of less than 0.001 % of the Dampier Peninsula. Given the limited habitat diversity and the widespread occurrence of the habitat type/vegetation associations, there does not appear to be any features of regional significance within the project area.

6.4 LOCAL SIGNIFICANCE

Species are of local significance when their presence is confined to a specialised habitat type that is not common within the local area and whose disturbance or removal may lead to local extinction.

Diporiphora pindan, Morethia storri, Lerista griffinii and *Vespadelus douglasorum* are all species identified during the survey that are local endemics. However, they all occupy the woodland on Pindan soil habitat that is well represented across the Peninsula. Therefore, the number of individuals lost through impacts associated with the plantation is likely to be small compared with the number of individuals occupying the region. Nevertheless, if an opportunity arises, more sampling of these species should be undertaken and specimens should be compared with those vouchered from other locations to quantify the effect of endemism on phenotypic variation. This may contribute to an appreciation for the conservation value of the Peninsula and its biodiversity.

Areas of local ecological significance are defined as habitats, landforms, vegetation associations or locations which support or have the capacity to support species of local conservation significance, or which are in better condition than other locations. Based on these criteria the project area is not of local conservation or ecological significance. The habitat of the project area is well represented in the region.

6.5 BIODIVERSITY

Australia has an international obligation to maintain biological diversity (biodiversity). The Commonwealth government has initiated the National Strategy for the Conservation of Biological Diversity, which incorporates elements of the National Strategy for Ecologically Sustainable Development (NSESD). Biological diversity (biodiversity) relates to the richness of the biota at a local, regional, state, national or even global level, and includes all components of the environment, from bacteria to insects, plants, and vertebrate fauna. Biodiversity can be thought of as existing at several levels, including genetic, population and species (or taxon) diversity. This study examines biodiversity at the species and population level, and places it within a local, regional and national context.

The extant vertebrate fauna of the study area as a whole has been described in detail in previous sections of this report. A total of 105 vertebrate fauna species were recorded during the survey, comprising six native and two introduced mammals, 65 bird species, 28 reptiles and four amphibians. While this is not likely to be a comprehensive list of the vertebrate fauna species inhabiting the area, it suggests that a diverse array of fauna species utilise the area. Based on known species distributions and other information pertaining to the fauna of the area, additional species expected to occur in the project area would include several species of microchiropteran bats, marsupials, birds, several additional species of elapids, skinks and frogs.

One of the major issues from a biodiversity perspective is whether individual species would be restricted to the particular habitat of the project area. Pindan woodlands dominate the project area, but are widespread throughout the Dampier Peninsula. The 900 ha plantation represents less than 0.001 % of the Dampier Botanical District. Therefore, none of the species identified within the survey are likely to be significantly impacted by the project.

Part of the purpose of the biogeographic regionalisation of Australia (Thackway & Cresswell 1995) was to examine the representation of ecosystems within conservation reserves at a bioregional level to ensure that the biodiversity of each bioregion was maintained. Within the Dampierland bioregion there are few areas managed for flora and fauna conservation at the present time. The level of reservation status of the Dampierland Bioregion is 1-5 % which is described as low to moderate (Thackway & Cresswell 1995). Accordingly, the EPA recommends the highest level of assessment for projects likely to impact the natural habitats within this region. Consequently the current survey was undertaken and the outcome has contributed to the knowledge of terrestrial vertebrate fauna in the area.

The Point Coulomb Nature Reserve is the nearest conservation area to the project area and protects a variety of habitats. The habitat type present in the project area is well represented in the reserve. Issues and processes that have been identified as important to conservation planning and management in the future include the extinction of critical weight range mammals, wildfire, grazing and feral animals.

7.0 ENVIRONMENTAL IMPACTS

A project of this scope raises potential issues for the local fauna. These issues include:

- Loss of natural vegetation and fauna through clearing;
- Indirect loss of fauna and fauna habitat from ongoing plantation practices; and
- Influence on the dynamics of invertebrate pests (native termites) and other fauna.

1. *Clearing: Loss of fauna and fauna habitat*

The single most widespread environmental impact arising from the project will be the clearing of native vegetation and consequent loss of fauna and habitat. Birds are generally highly mobile, and only a few relatively sedentary species (*e.g.* Fairy-wrens) and nocturnal roosting species (*e.g.* Australian Owlet-nightjar) may suffer mortality during initial clearing. With the exception of macropods and goannas, the majority of mammals, reptiles and amphibians will be lost in areas of direct impact (*i.e.* each of the 100 or 50 ha plantation plots). Daytime tree hollow dwellers, such as bats may also be lost.

2. *Plantation Practices: Indirect loss of fauna and fauna habitat*

Though the fauna assessment was made over an area greater than 50 km^2, the total area proposed for clearing is approximately 9 km^2. The habitat within the project area is very uniform. Therefore, it can be reasonably extrapolated that if 20 % of the local area is cleared for plantation cropping, then approximately 20 % of the fauna will be displaced into adjacent habitat. This displacement will result in an exceedance of the carrying capacity for the local area, resulting in a reduction of available resources (*e.g.* microhabitat and prey) for all of the animals in the area, and death of surplus individuals that cannot re-establish a niche, or maintain the niche they presently occupy. The outcome will be either that same species assemblage will establish a new equilibrium, based on the original carrying capacity of the area, or the excess pressure of local clearing will disrupt the interactions of all species, resulting in the displacement of less robust species groups or even trophic levels. Whatever the case, loss of fauna will continue beyond the initial period of clearing until equilibrium is obtained, probably within a year.

The layout of the plantation has been designed to incorporate habitat corridors between plantation plots. As clearing is to be staged over time, mobile species may relocate to these habitat corridors. Those individuals or species that are able to persist will be able to recolonise the plantation plots once the plot has become established. The life-form of the plantation timber species and the structure of the mature plantation plots will permit recolonisation of local vegetation throughout the ground and mid-story of the plantation plots. Therefore, the resultant mixture of exotic and native vegetation, once mature, should comprise a vegetation unit not too dissimilar from the current native woodland. It is expected that over time some displaced fauna will utilise the plantation plots, as is evident by the number of species captured in the trial plot, including the Black-headed Python (*Aspidites melanocephalus*).

Introduced plant species successfully and rapidly invade areas cleared of native vegetation or otherwise disturbed by humans. Weeds that propagate in newly cleared land have the potential to spread to adjacent habitat corridors that will not be disturbed by clearing. If weeds become established in these habitat corridors, the habitat value for native fauna is reduced. A weed management plan will be formulated for the site which will reduce the impact of weeds in the plantation area.

An increase in human activity is often associated with an increase in the abundance of introduced species such as the Feral Cat (*Felis catus*) which in turn, increases the predation pressure on small critical weight range mammals, small reptiles and birds (Kinnear 1993; Bamford 1995). Plantation and irrigation practices may increase the abundance of small mammals, particularly granivorous rodents, which increase the amount of prey available for feral predators. It is not possible to predict whether the relative numbers of predator and prey will establish a stable equilibrium over the life of the project, or whether the increase in feral predators will result in local extinction of small native species.

3. *Invertebrate Pests (native termites): Influence on the dynamics of local populations*

Evidence of the Giant Northern Termite (*Mastotermes darwiniensis*) has been noted within the proposed plantation site (Willing and Dureau 2000). Willing and Dureau (2000) also noted two active colonies of the Spinifex Termite (*Nasutitermes triodiae*) during their survey. As many of the plantation trees are susceptible to termite attack, baiting for termites will be required. This has the potential to impact the dynamics of the local vertebrate fauna population.

7.1 SIGNIFICANT FAUNA

In addition to the broad-scale consideration of impacts to the existing fauna communities, the impact on species that have been identified as being of special conservation significance needs to be specifically addressed. The Rainbow Bee-eater (*Merops ornatus*) and Fork-tailed Swift (*Apus pacificus*) are protected under international agreements and were recorded within the project area. The proposal is likely to have a minimal impact on these species, and therefore do not require special management.

Though not listed as a Scheduled or Priority species, the Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*) is a significant record for the project area. No specimens have previously been lodged with the WAM for the Dampier Peninsula, and as this is an arboreal species that occupies woodlands, local populations can decline with frequent fire events.

The occurrence of the Kimberley or Yellow-lipped Cave Bat (*Vespadelus douglasorum*) was also of note for the project area given that this species is known to be a strict cave-dweller (Strahan 1995). Museum records show that this species has not been previously vouchered from the Dampier Peninsula and the extent of its distribution ends on the mainland side of King Sound, to the west. Hence, this record represents a significant range extension for the species.

In addition to those species previously described, the current survey recorded two mammals, seven reptiles and one amphibian from the Dampier Peninsula that have not previously been vouchered with the WAM. A further two species were examples of populations broadly disjunct from neighbouring conspecifics. This reinforces the lack of scientific attention and number of previous terrestrial fauna surveys around the study site.

All vertebrate fauna within the project area will be impacted by the proposed development, largely as a result of clearing of native vegetation. This impact will largely be the displacement of fauna from the project area to adjacent areas, which will result in an accedence of the carrying capacity for the local area and the subsequent death of surplus individuals. The clearing of the project area will have the greatest impact on localised species with small distributions (such as *Simoselaps minimus, Lerista separanda* and *Morethia storri*), although all impacted species may recolonise the project area in time.

8.0 STUDY TEAM

The Beagle Bay Fauna Assessment Survey described in this document was planned, coordinated and executed by:

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Project Staff

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Belinda Barnett	BSc. (Hons) Zool.	Zoologist
Alexander Larcombe	BSc. (Env) (Hons) Zool.	Environmental Scientist
Pat Cullen		Research Assistant

In addition;

Mr B. Maryan and Ms N. Cooper of the Western Australian Museum kindly confirmed identifications of voucher specimens of amphibians, reptiles and mammals.

PERMITS

The Beagle Bay Fauna Assessment Survey was conducted under the authorisation of the following licence issued by the Department of Conservation and Land Management to:

J. Bull, *ecologia* Environmental Consultants
"Licence to take fauna for scientific purposes"
Licence Number: SF004142, valid to 4th April 2003.

9.0 REFERENCES

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APPENDIX A

Fauna species observed or that may potentially occur in the Beagle Bay Project area.

A1 – Mammals
A2 - Avifauna
A3 - Herpetofauna

Key to Abbreviations

+ : Species potentially occurring
X : Species recorded
GS: Species recorded by George Swann (Swann 2003).
* : Introduced / feral species

APPENDIX A1: Mammal species observed or potentially occurring in the Beagle Bay Project area.

SPECIES	COMMON NAME	PRESENCE (observed)
MACROPODIDAE		
Macropus agilis	Agile Wallaby	+
Onychogalea unguifera	Northern Nailtail Wallaby	+
THYLACOMYIDAE		
Macrotis lagotis	Bilby	+
PHALANGERIDAE		
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum	X
PTEROPODIAE		
Pteropus alecto	Black Flying-fox	+
Pteropus scapulatus	Little Red Flying-fox	+
EMBALLONURIDAE		
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	+
VESPERTILIONIDAE		
Chalinolobus gouldii	Gould's Wattled Bat	+
Chalinolobus nigrogriseus	Hoary Wattled Bat	X
Miniopterus schreibersii	Common Bentwing Bat	+
Nyctophilus arnhemensis	Arnhem Land Long-eared Bat	+
Nyctophilus bifax daedalus	North Queensland / Northwestern Long-eared Bat	+
Scotorepens greyii	Little Broad-nosed Bat	X
Vespadelus douglasorum	Kimberley Cave / Yellow-lipped Bat	X
MOLOSSIDAE		
Mormopterus loriae cobourgiana	Little Northern Freetail-bat	+
MURIDAE		
Mus domesticus	*House Mouse	+
Pseudomys delicatulus	Delicate Mouse	X
Pseudomys nanus	Western Chestnut Mouse	X
Rattus rattus	*Black Rat	+
CANIDAE		
Canis lupus	*Dingo	+
FELIDAE		
Felis catus	*Feral Cat	X
EQUIDAE		
Equus asinus	*Donkey	X
BOVIDAE		
Bos taurus	*European Cattle	+
Total species observed		**8**
Total species potential		**23**

APPENDIX A2: Avifauna species observed or potentially occurring in the Beagle Bay Project area.

FAMILY	SPECIES	COMMON NAME	PRESENCE (observed)
PHASIANIDAE			
	Coturnix ypsilophora	Brown Quail	+
ACCIPITRIDAE			
	Elanus axillaris	Black-shouldered Kite	+
	Lophoictinia isura	Square-tailed Kite	+
	Hamirostra melanosternon	Black-breasted Buzzard	+
	Milvus migrans	Black Kite	X
	Haliastur sphenurus	Whistling Kite	+
	Accipiter fasciatus	Brown Goshawk	X, GS
	Accipiter cirrhocephalus	Collared Sparrowhawk	X, GS
	Erythrotriorchis radiatus	Red Goshawk	+
	Hieraaetus morphnoides	Little Eagle	+
	Aquila audax	Wedge-tailed eagle	+
	Circus assimilis	Spotted Harrier	+
RALLIDAE			
	Gallirallus philippensis	Buff-banded Rail	+
FALCONIDAE			
	Falco berigora	Brown Falcon	X, GS
	Falco cenchroides	Australian Kestrel	GS
	Falco longipennis	Australian Hobby	+
	Falco hypoleucos	Grey Falcon	+
	Falco peregrinus	Peregrine Falcon	+
	Falco subniger	Black Falcon	+
GRUIDAE			
	Grus rubicunda	Brolga	+
OTIDIDAE			
	Ardeotis australis	Australian Bustard	X
TURNICIDAE			
	Turnix maculosa	Red-backed Buton Quail	+
	Turnix pyrrhothorax	Red-chested Button-quail	+
	Turnix velox	Little Button-quail	X
BURHINIDAE			
	Burhinus grallarius	Bush Stone-curlew	X
COLUMBIDAE			
	Ocyphaps lophotes	Crested Pigeon	X, GS
	Geopelia cuneata	Diamond Dove	X
	Geopelia striata	Peaceful Dove	X, GS
	Geopelia humeralis	Bar-shouldered Dove	X
CACATUIDAE			
	Calyptorhynchus banksii	Red-tailed Black Cockatoo	GS
	Eolophus roseicapilla	Galah	X, GS
	Cacatua sanguinea	Little Corella	+
	Nymphicus hollandicus	Cockatiel	+
PSITTACIDAE			
	Trichoglossus haematodus	Rainbow Lorikeet	X, GS
	Psitteuteles versicolor	Varied Lorikeet	X
	Aprosmictus erythropterus	Red-winged Parrot	X, GS
	Melopsittacus undulatus	Budgerigar	+
CUCULIDAE			
	Cuculus saturatus	Oriental Cuckoo	+
	Cuculus pallidus	Pallid Cuckoo	X, GS
	Cacomantis variolosus	Brush Cuckoo	X, GS
	Chrysococcyx basalis	Horsfield's Bronze	X, GS

FAMILY	SPECIES	COMMON NAME	PRESENCE (observed)
		Cuckoo	
	Chrysococcyx lucidus plagosus	Golden Bronze Cuckoo	+
	Chrysococcyx minutillus	Little Bronze-cuckoo	X
	Scythrops novaehollandiae	Channel-billed Cuckoo	+
CENTROPODIDAE			
	Centropus phasianinus	Pheasant Coucal	X, GS
STRIGIDAE			
	Ninox connivens	Barking Owl	+
	Ninox novaeseelandiae	Boobook Owl	X, GS
TYTONIDAE			
	Tyto alba	Barn Owl	+
PODARGIDAE			
	Podargus strigoides	Tawny Frogmouth	X
CAPRIMULGIDAE			
	Eurostopodus argus	Spotted Nightjar	+
AEGOTHELIDAE			
	Aegotheles cristatus	Australian Owlet-nightjar	X
APODIDAE			
	Apus pacificus	Fork-tailed Swift	X
ALCEDINIDAE			
	Ceyx azurea	Azure Kingfisher	+
HALCYONIDAE			
	Dacelo leachii	Blue-winged Kookaburra	X, GS
	Todiramphus pyrrhopygia	Red-backed Kingfisher	+
	Todiramphus sanctus	Sacred Kingfisher	X, GS
MEROPIDAE			
	Merops ornatus	Rainbow Bee-eater	X, GS
CORACIIDAE			
	Eurystomus orientalis	Dollarbird	+
CLIMACTERIDAE			
	Climacteris melanura	Black-tailed Treecreeper	X, GS
MALURIDAE			
	Malarus lamberti assimilis	Variegated Fairy-wren	+
	Malurus melanocephalus	Red-backed Fairy-wren	X, GS
PARDALOTIDAE			
	Gerygone olivacea	White-throated Gerygone	X
	Smicrornis brevirostris	Weebill	X
	Pardalotus striatus	Striated Pardalote	X
MELIPHAGIDAE			
	Lichmera indistincta	Brown Honeyeater	X, GS
	Lichenostomus virescens	Singing Honeyeater	X, GS
	Lichenostomus flavescens	Yellow-tinted Honeyeater	X, GS
	Lichenostomus unicolor	White-gaped Honeyeater	+
	Melithreptus albogularis	White-throated Honeyeater	X, GS
	Melithreptus gularis	Black-chinned Honeyeater	X, GS
	Philemon citreogularis	Little Friarbird	X, GS
	Certhionyx pectoralis	Banded Honeyeater	GS
	Conopophila rufogularis	Rufous-throated Honeyeater	X, GS
	Manorina flavigula	Yellow-throated Miner	+
PETROICIDAE			
	Melanodryas cucullata	Hooded Robin	X
	Microeca leucophaea	Jacky Winter	X, GS
POMATOSTOMATIDAE			
	Pomatostomus temporalis	Grey-crowned Babbler	X, GS

FAMILY	SPECIES	COMMON NAME	PRESENCE (observed)
NEOSITTIDAE			
	Daphoenositta chrysoptera	Varied Sittella	X, GS
PACHYCEPHALIDAE			
	Pachycephala rufiventris	Rufous Whistler	X, GS
	Colluricincla harmonica	Grey Shrike-Thrush	X, GS
DICRURIDAE			
	Myiagra ruficollis mimakae	Broad-billed Flycatcher	+
	Myiagra rubecula	Leaden Flycatcher	X, GS
	Myiagra inquieta	Restless Flycatcher	X
	Rhipidura fuliginosa	Grey Fantail	+
	Rhipidura leucophrys	Willie Wagtail	X, GS
	Rhipidura rufiventris	Northern Fantail	+
	Grallina cyanoleuca	Magpie-lark	X, GS
CAMPEPHAGIDAE			
	Coracina novaehollandiae	Black-faced Cuckoo-shrike	X, GS
	Lalage sueurii	White-winged Triller	X, GS
ORIOLIDAE			
	Oriolus sagittatus	Olive-backed Oriole	X, GS
ARTAMIDAE			
	Artamus leucorynchus	White-breasted Woodswallow	+
	Artamus personatus	Masked Woodswallow	GS
	Artamus cinereus	Black-faced Woodswallow	X, GS
	Artamus minor	Little Woodswallow	X, GS
	Cracticus nigrolgularis	Pied Butcherbird	X, GS
CORVIDAE			
	Corvus orru	Torresian Crow	X, GS
	Corvus bennetti	Little Crow	X
PTILONORHYNCHIDAE			
	Chlamydera nuchalis	Great Bowerbird	X, GS
ALAUDIDAE			
	Mirafra javanica	Singing Bushlark	+
MOTACILLIDAE			
	Anthus novaeseelandiae	Richard's Pipit	+
	Motacilla flava	Yellow Wagtail	+
PASSERIDAE			
	Taeniopygia guttata	Zebra Finch	+
	Taeniopygia bichenovii	Double-barred Finch	+
	Poephila acuticauda	Long-tailed Finch	X, GS
	Erythrura gouldiae	Gouldian Finch	+
DICAEIDAE			
	Dicaeum hirundinaceum	Mistletoebird	X, GS
HIRUNDINIDAE			
	Hirundo rustica	Barn Swallow	+
	Hirundo nigricans	Tree Martin	X
	Hirundo ariel	Fairy Martin	+
SYLVIIDAE			
	Cincloramphus mathewsi	Rufous Songlark	+
	Cisticola exilis	Golden-headed Cisticola	+
Total species observed			**65**
Total species potential			**110**

APPENDIX A3: Herpetofauna species observed or potentially occurring in the Beagle Bay Project area.

TAXONOMIC GROUP	SPECIES	PRESENCE (observed)
AMPHIBIANS		
HYLIDAE		
Pelodryadinae		
	Cyclorana australis	X
	Litoria caerulea	X
	Litoria nasuta	+
	Litoria rothii	+
	Litoria rubella	X
MYOBATRACHIDAE		
Limnodynastinae		
	Limnodynastes ornatus	+
	Notaden nichollsi	+
Myobatrachinae		
	Uperoleia talpa	X
REPTILES		
AGAMIDAE		
Amphibolurinae		
	Chelosania brunnea	+
	Chlamydosaurus kingii	X
	Ctenophorus nuchalis	+
	Diporiphora magna	X
	Diporiphora pindan	X
	Diporiphora spp.	X
	Lophognathus gilberti gilberti	+
	Pogona minor mitchelli	X
GEKKONIDAE		
Diplodactylinae		
	Diplodactylus conspicillatus	+
	Diplodactylus stenodactylus	X
	Oedura rhombifera	+
	Rhynchoedura ornata	X
	Strophurus ciliaris aberrans	X
Gekkoninae		
	Gehyra pilbara	X
	Heteronotia binoei	X
PYGOPODIDAE		
	Delma tincta	+
	Lialis burtonis	+
	Pygopus nigriceps	X
SCINCIDAE		
Lygosominae		
	Carlia munda	X
	Carlia rufilatus	+
	Carlia triacantha	X
	Cryptoblepharus carnabyi	X
	Cryptoblepharus plagiocephalus	+

TAXONOMIC GROUP	SPECIES	PRESENCE (observed)
	Ctenotus colletti	+
	Ctenotus inornatus	X
	Ctenotus serventyi	X
	Glaphyromorphus isolepis	X
	Lerista apoda	+
	Lerista bipes	+
	Lerista griffini	X
	Lerista separanda	+
	Menetia maini	+
	Morethia storri	X
	Notoscincus ornatus wotjulum	+
	Tiliqua multifasciata	+
	Tiliqua scincoides intermedia	X
VARANIDAE		
	Varanus brevicauda	+
	Varanus gouldii	X
	Varanus scalaris	X
	Varanus tristis tristis	+
TYPHLOPIDAE		
	Ramphotyphlops diversus	X
BOIDAE		
Pythoninae		
	Antaresia stimsoni	X
	Aspidites melanocephelus	X
	Liasis olivaceus olivaceus	+
COLUBRIDAE		
Colubrinae		
	Dendrelaphis punctulata	+
ELAPIDAE		
Hydrophinae		
	Brachyurophis roperi	X
	Demansia olivacea	+
	Furina ornata	X
	Pseudechis australis	+
	Pseudonaja nuchalis	X
	Simoselaps minimus	+
	Suta punctata	+
Total amphibian species observed		**4**
Total reptile species observed		**28**
Total herpetofauna species potential		**60**

APPENDIX B

Locations of Specimens recorded in the Beagle Bay Project area.

B1: Mammal
B2: Avifauna
B3: Herpetofauna

APPENDIX B1: Mammal Records for the Proposed Project area.

Sites		**1**	**2**	**3**	**4**	**5**	**6**	**Opportunistic**
Species	**Common Name**							
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum							2
Chalinolobus nigrogriseus	Hoary Wattled Bat			1				20
Scotorepens greyii	Little Broad-nosed Bat			1				1
Vespadelus douglasorum	Kimberley Cave Bat							2
Pseudomys delicatulus	Delicate Mouse	2	1	1			1	1
Pseudomys nanus	Western Chestnut Mouse		1	1				
Felis catus	Feral Cat							2
Equus asinus	Donkey	1		2				
Total Species		**2**	**2**	**5**	**0**	**0**	**1**	**6**

APPENDIX B2: Avifauna Records for the Proposed Project area.

	Sites	1	2	3	4	5	6	Opportunistic
Species	**Common Name**							
Accipiter cirrhocephalus	Collared Sparrowhawk			2				2
Accipiter fasciatus	Brown Goshawk			1			1	4
Aegotheles cristatus	Australian Owlet-nightjar		1	1	1	1		3
Aprosmictus erythropterus	Red-winged Parrot	3	1	3	5	14	5	1
Apus pacificus	Fork-tailed Swift		7		6	13	4	2
Ardeotis australis	Australian Bustard			1				
Artamus cinereus	Black-faced Woodswallow	17	5	3		3	5	10
Artamus minor	Little Woodswallow			1	18			13
Burhinus grallarius	Bush-stone Curlew							2
Cacomantis variolosus	Brush Cuckoo			2	4		6	
Centropus phasianinus	Pheasant Coucal			2	2			1
Chlamydera nuchalis	Great Bowerbird			3				
Chrysococcyx basalis	Horsfield's Bronze Cuckoo		1		3			8
Chrysococcyx minutillus	Little Bronze-cuckoo		1					
Climacteris melanura	Black-tailed Treecreeper	4				3		2
Colluricincla harmonica	Grey Shrike-Thrush	1		8	5		5	8
Conopophila rufogularis	Rufous-throated Honeyeater	15	20	6	10	13	2	29
Coracina novaehollandiae	Black-faced Cuckoo-shrike	8	10	19	9	10	16	4
Corvus bennetti	Little Crow				3		1	
Corvus orru	Torresian Crow				3			
Cracticus nigrolgularis	Pied Butcherbird	8	10	28	21	1	31	20
Cuculus pallidus	Pallid Cuckoo							1
Dacelo leachii	Blue-winged Kookaburra	1		1	5		2	2
Daphoenositta chrysoptera	Varied Sittella	8	7	3			9	
Dicaeum hirundinaceum	Mistletoe Bird		2		1	5		2
Eolophus roseicapilla	Galah	1					1	7
Falco berigora	Brown Falcon	2	6	2	3		5	
Geopelia cuneata	Diamond Dove		1					
Geopelia humeralis	Bar-shouldered Dove	2		9	1	1	6	
Geopelia striata	Peaceful Dove	2		23	4		18	14
Gerygone olivacea	White-throated Gerygone	3	4		3	7		6
Grallina cyanoleuca	Australian Magpie Lark							4
Hirundo nigricans	Tree Martin			2				
Lalage sueurii	White-winged Triller	3	2	9			1	2
Lichenostomus flavescens flavescens	Yellow-tinted Honeyeater			21	13		10	18
Lichenostomus virescens	Singing Honeyeater		3				17	13
Lichmera indistincta	Brown Honeyeater	22	98	26	126	30	88	72
Malurus melanocephalus	Red-backed Fairy-wren	12	6	15	11	16	17	18
Melanodryas cucullata	Hooded Robin			1				
Melithreptus albogularis	White-throated Honeyeater		3	4				
Melithreptus gularis laetior	Black-chinned Honeyeater	4	4	5	4	4	6	4
Merops ornatus	Rainbow Bee-eater				19		2	
Microeca leucophaea	Jacky Winter	8	2	10	2	4	1	4
Milvus migrans	Black Kite				2	1	1	
Myiagra inquieta	Restless Flycatcher			3	2			1

	Sites	**1**	**2**	**3**	**4**	**5**	**6**	**Opportunistic**
Species	**Common Name**							
Myiagra rubecula concinna	Leaden Flycatcher			1				
Ninox novaeseelandiae	Southern Boobook		1					2
Ocyphaps lophotes	Crested Pigeon							5
Oriolus sagittatus	Olive-backed Oriole		1	1	2		5	2
Pachycephala rufiventris	Rufous Whistler	12	7	15	24	18	4	16
Pardalotus striatus	Striated Pardalote	12	4	4	9		10	16
Philemon citreogularis	Little Friarbird	28	10	42	19		89	40
Podargus strigoides	Tawny Frogmouth		2			5		
Poephila acuticauda	Long-tailed Finch	6	8	8	5	44	2	21
Pomatostomus temporalis	Grey-crowned Babbler	10	12	32	38	12	55	31
Psitteuteles versicolor	Varied Lorikeet	1	3	7	2	1	2	
Rhipidura leucophrys	Willie Wagtail	6	5	16		1	6	10
Smicrornis brevirostris	Weebill	10	6	8		3	7	11
Todiramphus sanctus sanctus	Sacred Kingfisher			2	2			3
Trichoglossus haematodus rubritorquis	Rainbow Lorikeet	10	7	21	6	23	30	8
Turnix velox	Little Button Quail							2
	Total Species	**28**	**33**	**41**	**36**	**24**	**35**	**43**

APPENDIX B3: Herpetofauna Records for the Proposed Project area.

Sites	**1**	**2**	**3**	**4**	**5**	**6**	**Opportunistic**
Species							
Cyclorana australis							5
Litoria caerulea				1			8
Litoria rubella							1
Uperoleia talpa			1				1
Chlamydosaurus kingii					1		2
Pogona minor mitchelli	2		1	1			2
Diporiphora pindan		5	2	1	2	2	
Diporiphora spp.	2	4			1	1	4
Diporiphora magna			1				
Diplodactylus stenodactylus	2	1	1			1	16
Heteronotia binoei	30						26
Diplodactylus ciliaris aberrans							4
Rhynchoedura ornata	1						9
Gehyra pilbara	9	4	1			3	5
Pygopus nigriceps							1
Carlia munda			1	1	1	2	2
Cryptoblepharus carnabyi			3	2			
Cryptoblepharus plagiocephalus			1				
Ctenotus inornatus		1					
Ctenotus serventyi		2	3	2		5	1
Glaphyromorphus isolepis					1		1
Lerista griffini	2	3	1		1	2	1
Morethia storri		1	2			1	
Tiliqua scincoides intermedia	1	1	1		1	1	
Varanus gouldii		1	1				
Varanus scalaris				1			
Ramphotyphlops diversus	1				1		
Aspidites melanocephalus							1
Antaresia stimsoni							1
Furina ornata							1
Pseudonaja nuchalis							3
Brachyurophis roperi	2						6
Total species	**10**	**10**	**14**	**7**	**8**	**9**	**22**

APPENDIX C

Specimens previously collected from the Beagle Bay Area and lodged with the Western Australian Museum.

C1: Mammals
C2: Reptiles

Search Coordinates:

16º 45'S - 17º 30'S
122º 00'E - 123º 00' E

APPENDIX C1: Mammal species lodged with the Western Australian Museum from the project area and surrounds prior to the current 2003 survey.

SPECIES	COMMON NAME
THYLACOMYIDAE	
Macrotis lagotis	Bilby
PTEROPODIDAE	
Pteropus scapulatus	Little Red Flying-fox
EMBALLONURIDAE	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat
VESPERTILIONIDAE	
Chalinolobus gouldii	Gould's Wattled Bat
Chalinolobus nigrogriseus	Hoary Wattled Bat
Nyctophilus arnhemensis	Arnhem Land Long-eared Bat
Nyctophilus bifax daedalus	North Queensland / Northwestern Long-eared Bat
Scotorepens greyii	Little Broad-nosed Bat
Vespadelus douglasorum	Kimberley Cave Bat / Yellow-lipped Bat
MURIDAE	
Mus domesticus	*House Mouse
Pseudomys delicatulus	Delicate Mouse
Pseudomys nanus	Western Chestnut Mouse
Rattus rattus	*Black Rat

APPENDIX C2: Herpetofauna species lodged with the Western Australian Museum from the project area and surrounds prior to the current survey.

AMPHIBIANS

HYLIDAE
Pelodryadinae
Cyclorana australis
Litoria caerulea
Litoria nasuta
Litoria rothii
Litoria rubella

MYOBATRACHIDAE
Limnodynastinae
Limnodynastes ornatus
Notaden nichollsi
Myobatrachinae
Uperoleia talpa

REPTILES

LIZARDS
AGAMIDAE
Chelosania brunnea
Chlamydosaurus kingii
Ctenophorus nuchalis
Diporiphora pindan
Lophognathus gilberti gilberti
Pogona minor mitchelli

GEKKONIDAE
Diplodactylinae
Diplodactylus conspicillatus
Diplodactylus stenodactylus
Oedura rhombifera
Rhynchoedura ornata
Strophurus ciliaris aberrans

Gekkoninae

Gehyra pilbara

Heteronotia binoei

PYGOPODIDAE

Delma tincta

Lialis burtonis

Pygopus nigriceps

SCINCIDAE

Lygosominae

Carlia munda

Carlia rufilatus

Carlia triacantha

Cryptoblepharus carnabyi

Cryptoblepharus plagiocephalus

Ctenotus colletti

Ctenotus inornatus

Ctenotus serventyi

Glaphyromorphus isolepis

Lerista apoda

Lerista bipes

Lerista griffini

Lerista separanda

Menetia maini

Morethia storri

Notoscincus ornatus wotjulum

Tiliqua multifasciata

Tiliqua scincoides intermedia

VARANIDAE

Varanus brevicauda

Varanus gouldii

Varanus scalaris

Varanus tristis tristis

SNAKES

TYPHLOPIDAE

Ramphotyphlops diversus

BOIDAE

Pythoninae

Antaresia stimsoni

Liasis olivaceus olivaceus

COLUBRIDAE

Colubrinae

Dendrelaphis punctulata

ELAPIDAE

Hydrophinae

Brachyurophis roperi

Demansia olivacea

Furina ornata

Pseudechis australis

Pseudonaja nuchalis

Simoselaps minimus

Suta punctata

APPENDIX D

Voucher Specimens from the current survey lodged with the Western Australian Museum

D1: Mammals
D2: Reptiles

APPENDIX D1: Mammal voucher specimens lodged with the Western Australian Museum.

REG #	GENUS	SPECIES	SUBSPECIES	LATITUDE	LONGITUDE	SITE #	FLD #
54213	*Chalinolobus*	*nigrogriseus*		17°04`41"S	122°42`40"E	CAMP	EBBM01
54214	*Chalinolobus*	*nigrogriseus*		17°04`41"S	122°42`40"E	CAMP	EBBM02
54215	*Chalinolobus*	*nigrogriseus*		17°04`41"S	122°42`40"E	CAMP	EBBM03
53737	*Scotorepens*	*greyii*		17°03`09"S	122°45`45"E	SITE3	EBBM10
53738	*Scotorepens*	*greyii*		17°02`02"S	122°44`46"E	CAMP	EBBM06
53735	*Vespadelus*	*douglasorum*		17°04`41"S	122°42`40"E	CAMP	EBBM04
53736	*Vespadelus*	*douglasorum*		17°04`41"S	122°42`40"E	CAMP	EBBM05
53733	*Pseudomys*	*delicatulus*		17°04`23"S	122°42`44"E	SITE 2	EBBM08
54216	*Pseudomys*	*delicatulus*		17°03`09"S	122°45`45"E	SITE 3	EBBM09
53732	*Pseudomys*	*nanus*		17°03`09"S	122°45`45"E	SITE3	EBBM11
53734	*Pseudomys*	*nanus*		17°04`24"S	122°42`44"E	SITE 2	EBBM07

APPENDIX D2: Herpetofauna voucher specimens lodged with the Western Australian Museum.

REG #	GENUS	SPECIES	SUBSPECIES	LATITUDE	LONGITUDE	DATE OF CAPTURE	SITE #
112996	*Antaresia*	*stimsoni*	*stimsoni*			23/03/2003	DL2
112994	*Brachyurophis*	*roperi*		17°03`35"S	122°43`00"E	19/03/2003	1
151779	*Brachyurophis*	*roperi*		17°03`35"S	122°43`00"E	19/03/2003	1
112949	*Carlia*	*munda*		17°04`36"S	122°42`26"E	22/03/2003	5
151797	*Carlia*	*munda*		17°03`09"S	122°45`45"E	21/03/2003	3
151817	*Carlia*	*munda*		17°04`41"S	122°42`40"E	22/03/2003	CAMP
151776	*Chlamydosaurus*	*kingii*		17°04`36"S	122°42`26"E	20/03/2003	5
151795	*Cryptoblepharus*	*carnabyi*		17°03`09"S	122°45`45"E	21/03/2003	3
151802	*Cryptoblepharus*	*carnabyi*		17°03`09"S	122°45`45"E	22/03/2003	3
151807	*Cryptoblepharus*	*carnabyi*		17°03`09"S	122°45`45"E	21/03/2003	3
151811	*Cryptoblepharus*	*plagiocephalus*		17°02`05"S	122°39`55"E	21/03/2003	4
112982	*Ctenotus*	*inornatus*		17°04`23"S	122°42`44"E	25/03/2003	2
112985	*Ctenotus*	*inornatus*		16°59`00"S	122°40`00"E	25/03/2003	
112945	*Ctenotus*	*serventyi*		17°05`01"S	122°39`35"E	22/03/2003	6
151796	*Ctenotus*	*serventyi*		17°05`01"S	122°39`35"E	22/03/2003	6
151806	*Ctenotus*	*serventyi*		17°04`23"S	122°42`44"E	21/03/2003	2
151808	*Ctenotus*	*serventyi*		17°04`23"S	122°42`44"E	23/03/2003	2
151815	*Ctenotus*	*serventyi*		17°05`01"S	122°39`35"E	24/03/2003	6
112978	*Cyclorana*	*australis*		17°04`41"S	122°42`40"E	20/03/2003	CAMP
151772	*Cyclorana*	*australis*		17°03`09"S	122°45`45"E	21/03/2003	3
151773	*Cyclorana*	*australis*		17°04`41"S	122°42`40"E	20/03/2003	CAMP
112964	*Diplodactylus*	*stenodactylus*		17°03`35"S	122°43`00"E	19/03/2003	1
112965	*Diplodactylus*	*stenodactylus*		17°03`35"S	122°43`00"E	19/03/2003	1
112974	*Diplodactylus*	*stenodactylus*		17°05`01"S	122°39`35"E	20/03/2003	6
112979	*Diplodactylus*	*stenodactylus*		17°03`35"S	122°43`00"E	20/03/2003	1
151798	*Diplodactylus*	*stenodactylus*		17°03`35"S	122°43`00"E	21/03/2003	1
151801	*Diplodactylus*	*stenodactylus*		17°03`09"S	122°45`45"E	22/03/2003	3
112950	*Diporiphora*	*pindan*		17°04`36"S	122°42`26"E	22/03/2003	5
112961	*Diporiphora*	*pindan*		17°04`23"S	122°42`44"E	20/03/2003	2
112975	*Diporiphora*	*pindan*		17°03`35"S	122°43`00"E	20/03/2003	1
112984	*Diporiphora*	*pindan*		17°04`36"S	122°42`26"E	22/03/2003	5
112986	*Diporiphora*	*pindan*		17°04`23"S	122°42`44"E	20/03/2003	2
151777	*Diporiphora*	*pindan*		17°05`01"S	122°39`35"E	24/03/2003	6
151800	*Diporiphora*	*pindan*		17°03`09"S	122°45`45"E	22/03/2003	3
112947	*Diporiphora*	*sp.*		17°03`09"S	122°45`45"E	23/03/2003	3
112948	*Diporiphora*	*sp.*		17°03`35"S	122°43`00"E	22/03/2003	1
112971	*Diporiphora*	*sp.*		17°04`36"S	122°42`26"E	22/03/2003	5
151786	*Diporiphora*	*sp.*		17°04`23"S	122°42`44"E	22/03/2003	2
151816	*Diporiphora*	*sp.*		17°04`23"S	122°42`44"E	21/03/2003	2
112995	*Furina*	*ornata*		17°03`35"S	122°43`00"E	21/03/2003	1
112946	*Gehyra*	*pilbara*		17°04`23"S	122°42`44"E	21/03/2003	2
112966	*Gehyra*	*pilbara*				21/03/2003	DL1
112967	*Gehyra*	*pilbara*		17°04`41"S	122°42`40"E	20/03/2003	CAMP
112970	*Gehyra*	*pilbara*		17°05`01"S	122°39`35"E	21/03/2003	6
112990	*Gehyra*	*pilbara*		17°04`23"S	122°42`44"E	20/03/2003	TRIAL PLAN
151792	*Gehyra*	*pilbara*		17°03`35"S	122°43`00"E	21/03/2003	1

REG #	GENUS	SPECIES	SUBSPECIES	LATITUDE	LONGITUDE	DATE OF CAPTURE	SITE #
151805	*Gehyra*	*pilbara*		17°04`23"S	122°42`44"E	21/03/2003	2
151791	*Glaphyromorphus*	*isolepis*		17°04`36"S	122°42`26"E	22/03/2003	5
151803	*Glaphyromorphus*	*isolepis*		17°04`41"S	122°42`40"E	19/03/2003	CAMP
112968	*Heteronotia*	*binoei*				21/03/2003	DL1
112969	*Heteronotia*	*binoei*				21/03/2003	DL1
112973	*Heteronotia*	*binoei*		17°02`05"S	122°39`55"E	21/03/2003	4
112976	*Heteronotia*	*binoei*				21/03/2003	DL1
112977	*Heteronotia*	*binoei*				21/03/2003	DL1
112988	*Heteronotia*	*binoei*				21/03/2003	DL1
112989	*Heteronotia*	*binoei*				21/03/2003	DL1
151789	*Heteronotia*	*binoei*				21/03/2003	DL1
151790	*Heteronotia*	*binoei*				21/03/2003	DL1
151804	*Heteronotia*	*binoei*				21/03/2003	DL1
151778	*Lerista*	*griffini*		17°04`23"S	122°42`44"E	26/03/2003	2
151784	*Lerista*	*griffini*		17°05`01"S	122°39`35"E	21/03/2003	6
151785	*Lerista*	*griffini*		17°05`01"S	122°39`35"E	21/03/2003	6
151787	*Lerista*	*griffini*		17°04`36"S	122°42`26"E	22/03/2003	5
151788	*Lerista*	*griffini*		17°03`35"S	122°43`00"E	23/03/2003	1
151794	*Lerista*	*griffini*		17°04`23"S	122°42`44"E	22/03/2003	2
151799	*Lerista*	*griffini*		17°04`23"S	122°42`44"E	21/03/2003	2
151812	*Lerista*	*griffini*		17°03`09"S	122°45`45"E	23/03/2003	3
151813	*Lerista*	*griffini*		17°03`35"S	122°43`00"E	21/03/2003	1
151782	*Litoria*	*caerulea*		17°03`35"S	122°43`00"E	22/03/2003	1
151780	*Morethia*	*storri*		17°04`23"S	122°42`44"E	21/03/2003	2
151783	*Morethia*	*storri*		17°03`09"S	122°45`45"E	22/03/2003	3
151793	*Morethia*	*storri*		17°05`01"S	122°39`35"E	23/03/2003	6
112999	*Pogona*	*minor*	*mitchelli*	17°04`36"S	122°42`26"E	23/03/2003	5
113000	*Pogona*	*minor*	*mitchelli*	17°03`35"S	122°43`00"E	23/03/2003	1
151770	*Pogona*	*minor*	*mitchelli*	17°03`35"S	122°43`00"E	21/03/2003	1-Feb
151818	*Pygopus*	*nigriceps*		17°03`35"S	122°43`00"E	21/03/2003	1
112027	*Ramphotyphlops*	*diversus*		17°03`35"S	122°43`00"E	23/03/2003	1
112993	*Ramphotyphlops*	*diversus*		17°04`36"S	122°42`26"E	21/03/2003	5
112962	*Rhynchoedura*	*ornata*		17°04`23"S	122°42`44"E	20/03/2003	TRIAL PLAN
112963	*Rhynchoedura*	*ornata*		17°04`23"S	122°42`44"E	20/03/2003	TRIAL PLAN
112972	*Rhynchoedura*	*ornata*		17°03`35"S	122°43`00"E	19/03/2003	1
112983	*Rhynchoedura*	*ornata*		17°03`35"S	122°43`00"E	19/03/2003	1
112987	*Rhynchoedura*	*ornata*		17°03`35"S	122°43`00"E	22/03/2003	1
151814	*Rhynchoedura*	*ornata*		16°59`00"S	122°40`00"E	21/03/2003	
112980	*Strophurus*	*ciliaris*	*aberrans*	17°03`35"S	122°43`00"E	22/03/2003	1
112991	*Strophurus*	*ciliaris*	*aberrans*	17°02`05"S	122°39`55"E	22/03/2003	4
112992	*Strophurus*	*ciliaris*	*aberrans*	17°03`35"S	122°43`00"E	22/03/2003	1
112997	*Tiliqua*	*scincoides*	*intermedia*	17°04`23"S	122°42`44"E	21/03/2003	2
112998	*Tiliqua*	*scincoides*	*intermedia*	17°04`36"S	122°42`26"E	22/03/2003	5
151775	*Uperoleia*	*sp.*		16°59`00"S	122°40`00"E	21/03/2003	
151810	*Uperoleia*	*sp.*				21/03/2003	DL2
112981	*Uperoleia*	*talpa*				21/03/2003	DL2
151774	*Uperoleia*	*talpa*		17°03`09"S	122°45`45"E	25/03/2003	3
151771	*Varanus*	*gouldii*		17°05`01"S	122°39`35"E	21/03/2003	6