coffey environments
SPECIALISTS IN LIVING AND WORKING PLACES

BAYONET HEAD OUTLINE DEVELOPMENT PLAN AREA - FAUNA ASSESSMENT

Prepared for:

Heath Development Company
Department of Housing
CAMABB Pty Ltd
Dr M Greer
Mr K. Slee
PO Box 381
COTTESLOE WA 6911

Report Date: 22 July 2009
Project Ref: EP2009-035 - V1
Doc: ENVIALBA00547AB
Job: ENVIALBA00547AA, AB, AC

Written/Submitted by:

Paul Mitrovski
Environmental Scientist - Zoology

Written/Submitted by:

Scott Thompson
Senior Environmental Scientist - Zoology

Reviewed/Approved by:

Dr Paul Van Der Moezel
Principal

coffey environments
SPECIALISTS IN LIVING AND WORKING PLACES

22 July 2009

Heath Development Company
Department of Housing
CAMABB Pty Ltd
Dr M Greer
Mr K. Slee
PO Box 381
COTTESLOE WA 6911

Attention: Brian Newman

Dear Brian

RE: Bayonet Head Outline Development Plan Area - Fauna Assessment

Please find attached the Fauna Assessment for the Bayonet Outline Development Plan Area to assist with the Strategic Environmental Assessment of the area.

If you have any further queries about this report, please do not hesitate to contact myself or Dr Paul van der Moezel on (08) 9355 7100.

For and on behalf of Coffey Environments Pty Ltd

Paul Mitrovski
Environmental Scientist - Zoology

cc

Attachment A: Attachments

Coffey Environments Pty Ltd ABN 45 090 522 759
Suite 2, 53 Burswood Road Burswood WA 6100 Australia
PO Box 4223 Victoria Park 6979 Australia
T (+61) (8) 9355 7100 F (+61) (8) 9355 7111 coffey.com

RECORD OF DISTRIBUTION

No. of copies	Report File Name	Report Status	Date	Prepared for:	Initials
1	ENVIALBA00547AB_Fauna Assessment_001_pm_V1	V1	22 July 2009	Heath Development Company	PM
1	ENVIALBA00547AB_Fauna Assessment_001_pm_V1	V1	22 July 2009	Coffey Environments Pty Ltd	PM

CONTENTS

CONTENTS

CONTENTS

CONTENTS

LIST OF ATTACHMENTS

Tables

Figures

LIST OF ATTACHMENTS

Charts

Diagrams

Appendices

EXECUTIVE SUMMARY

Coffey Environments was commissioned by several landowners to undertake a comprehensive Level 2 Vertebrate Fauna Assessment of their landholding referred to as Bayonet Head project area. Bayonet Head project area is the combination of Lots 37, 38 and 39 Elizabeth Street, Lots 2, 3 and 286 Alison Parade, Part of Lot 42 Lower King Road, Lots 1000 and 1001 Lower King Road, Part Lot 1 Yatana Road, Location 476 Sibbald Road and Lot 0 (unmade road reserve). The project area covers approximately 191 hectares (ha), much of which is proposed for residential development.

The objectives of this Level 2 Fauna Risk Assessment were to:

- identify and assess the values and significance of the terrestrial fauna assemblage in the project area and to describe these values in a local and regional context;
- describe and assess the potential direct and indirect impacts that may result from any proposed land use or development on the fauna assemblage and species of conservation significance in the project area; and
- describe measures to be implemented to ensure that the abundance, diversity, geographic distribution and productivity of any impacted conservation significant fauna are maintained.

Seven amphibian species, 13 mammal species, 19 reptiles and 78 bird species were detected during the survey or are likely to occur on site. This included six species listed as conservation significant under the WA *Wildlife Conservation Act 1950* (Forest Red-tailed Black Cockatoo, Carnaby's Black- Cockatoo, Baudin's Black Cockatoo, Southern Brown Bandicoot, Western Ringtail Possum and Western False Pipistrelle) and three species are listed under the *Environment Protection and Biodiversity Conservation* (*EPBC*) *Act 1999* (Forest Red-tailed Black Cockatoo, Carnaby's Black- Cockatoo and Baudin's Black Cockatoo). Due to the low density of Western Ringtail Possums and moderate area of Black Cockatoo feeding area adjacent to the project area, the clearing is considered to be not significant under the *EPBC Act 1999*.

Approximately half of the project area is in a degraded condition due to previous grazing activities. Priority should be given to developing in these areas and retaining as much remnant native vegetation as possible.

The majority of the habitat available on site is proposed to be cleared for development. To minimise potential impacts on fauna and fauna assemblages on site, Coffey Environments recommends that:

- Areas of the Jarrah/Sheoak Woodland (central area and eastern section of project area), Heath Shrubland (western area of project area) and Wetland Mosaic (southern portion of lake and northern section containing weir) habitats should be retained in the project area to provide habitat on site for conservation significant fauna. The areas of habitat retained should ideally be large enough to be viable in the long term and in the form of linkage corridors to connect all fauna habitats and allow free movement;
- The 42 trees identified as containing possible breeding hollows for Black Cockatoos, Masked Owls or Western Ringtail Possums, and the 20 trees containing dreys should be retained;
- As part of the development, a Fauna Management Plan should be prepared that details management and mitigation strategies for all vertebrate fauna affected by the development;

The Fauna Management Plan should include details on:

  - The clearing protocol that should be used as part of the clearing operations;
  - The areas that should be retained as corridors and public open space (POS);
  - Rehabilitation strategies for retained areas and POS;
  - Public consultation and education; and
  - Feral animal control

1 INTRODUCTION

1.1 Background

The landowners of Lots 37, 38 and 39 Elizabeth Street, Lots 2, 3 and 286 Alison Parade, Part of Lot 42 Lower King Road, Lots 1000 and 1001 Lower King Road, Part Lot 1 Yatana Road, Location 476 Sibbald Road and Lot 0 (unmade road reserve), in the City of Albany are planning to develop the area for residential purposes . The lots are between Oyster Harbour and Lower King Road approximately 7km north-east of the Albany CBD (Figure 1). These areas combined have been referred to as the project area.

The project area is located in the northern, eastern and southern portion of the Bayonet Head Outline Development Plan area (BHODP). The BHODP was endorsed by the City of Albany in 2001 as part of the City's overall strategic approach to land use planning designed to allow for 'cohesive and equitable development' of the area 'whilst ensuring that environmental and community priorities are maintained' (Taylor Burrell, 2001).

1.2 Purpose and Scope of Works

The landowners of Lots 37, 38 and 39 Elizabeth Street, Lots 2, 3 and 286 Alison Parade, Part of Lot 42 Lower King Road, Lots 1000 and 1001 Lower King Road, Part Lot 1 Yatana Road, Location 476 Sibbald Road and Lot 0 (unmade road reserve), referred the proposed development of the site to the Environmental Protection Authority (EPA) on 30 September 2008, requesting that the proposed development of the site be assessed as a Strategic Environmental Assessment (SEA). Under s37B(2) of the *Environmental Protection Act 1986* (EP Act) an SEA is a formal level of assessment that allows for conditions to be set on development by the Minister for the Environment. The EPA has determined (November 5th 2008) that the proposal is a strategic proposal under the provisions of the EP Act and should be assessed as an SEA (Assessment No. 1758). Parts of the site have previously been the subject of other environmental assessments (e.g Public Environmental Review and Environmental Review) which are currently being held in abeyance

Coffey Environments (formerly ATA Environmental) was initially commissioned by the Landowners to undertake a Level 1 fauna assessment of the subject land as part of the reporting requirements for subdivision approval. A brief day-time site assessment was undertaken in October 2005 in keeping with the Environmental Protection Authority's (EPA) *Guidance Statement No.56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*, June 2004. Subsequently, Coffey Environments met with John Dell and Gary Whisson of the EPA Service Unit (EPASU) on 10 October 2006 to discuss the scope of works and objectives of the Bayonet Head fauna assessment. On this basis, a bi-seasonal Level 2 fauna survey of Lots 1000, 1001, 476 and Part Lot 1 was conducted in December 2006 and March 2007. In addition, a Level 1 fauna assessment was undertaken in March 2009 on Lots 286, 2, 3, 37, 38, and 39. The methodology of Level 1 and 2 fauna assessments broadly follows that described in the Environmental Protection Authority (EPA) Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002) and Coffey Environments interpretation of Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004).

The objectives of the combined vertebrate fauna assessments were to:

- identify and assess the values and significance of the terrestrial fauna assemblage in the project area and to describe these values in a local and regional context;
- describe and assess the potential direct and indirect impacts that may result from any proposed land use or development on the fauna assemblage and species of conservation significance in the project area; and
- describe measures to be implemented to ensure that the abundance, diversity, geographic distribution and productivity of any impacted conservation significant fauna are maintained.

To achieve these objectives the following scope of works were undertaken:

- a review of the Western Australian Museum (*FaunaBase*) database to identify potential vertebrate fauna in the area;
- a review of the DEC's Threatened and Priority species database to identify potential scheduled and threatened species in the region;
- a search of the Commonwealth government's on-line database to identify fauna species of national environmental significance that are protected under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* potentially occurring in the area;
- a review of the Terrestrial Ecosystems database of published and unpublished literature to provide a list of fauna that have potential to occur in the region;
- spring and summer field surveys incorporating trapping, spotlighting, bat echolocation recordings and opportunistic observations of representative habitats in the project area and similar habitats in the Albany region;
- a hand foraging survey to search for short-range endemic (SRE) invertebrates;
- an inventory of the vertebrate fauna species recorded in the project area during the survey period, including conservation significant species;
- comparison of the fauna assemblages in the project area with other survey sites in the Albany region;
- discussion of the potential impacts of the development on fauna and fauna habitat; and
- development of management recommendations to minimise potential impacts of the development on the fauna in the area.

2 EXISTING ENVIRONMENT

2.1 Location of Project Area

Lots 1000, 1001, 476, 286, 0, 2, 3, 37, 38, 39, Part Lot 1 and part of Lot 42 ('project area') is situated between Lower King Road and Oyster Harbour approximately 7km north-east of the Albany CBD (Figure 1). The project area is bounded by a mixture of residential, woodland, marine and farmland areas. The property sizes and respective landowner are shown in Table 1.

TABLE 1 PROPERTY LOCATION AND LANDOWNER

Property	Lot Area (ha)	Landowner
Part Lot 39 Elizabeth Street, Bayonet Head	18.86	K.L. Slee
Lot 38 Elizabeth St, Bayonet Head	16.76	Lowe Pty Ltd and Department of Housing
Lot 37 Elizabeth St, Bayonet Head	1.56	Lowe Pty Ltd and Department of Housing
Lot 3 Alison Parade, Bayonet Head	15.39	Lowe Pty Ltd and Department of Housing
Lot 2 Alison Parade, Bayonet Head	2.22	M.J. Greer
Lot 286 Alison Parade, Bayonet Head	24.28	Lowe Pty Ltd and Department of Housing
Part of Lot 42, Lower King Road, Bayonet Head	8.6	Lowe Pty Ltd and Department of Housing
Lot 1001 Lower King Road, Bayonet Head	26.62	Lowe Pty Ltd and Department of Housing
Lot 1000 Lower King Road, Bayonet Head	30.97	Lowe Pty Ltd and Department of Housing
Part Lot 1 Yatana Rd, Bayonet Head	26.26	Lowe Pty Ltd and Department of Housing
Location 476 Sibbald Rd	18.61	E.M. & M.B. Cameron
Lot 0	0.96	City of Albany
TOTAL AREA	191.09	

2.2 Land Use History

The project area comprises 191.09ha with approximately half the area covered in native vegetation and the remaining half comprising farmland cleared for pasture. The BHODP area has been subject to various disturbances during its historical land use including clearing, grazing, fires and occasional wood cutting (Taylor Burrell, 2001). A network of tracks and fire breaks pass through the vegetated project area which is used by motorbike riders, walkers and local naturalists.

2.3 Geological and Physiographic Context of Project Area

2.3.1 Climate

The climate of the Albany region is characterised as a warm, dry Mediterranean climate with an annual rainfall of approximately 900mm, although this varies considerably from year to year. Cold fronts are responsible for much of the recorded rainfall, 76% of which occurs between May and October (Table 2). The mean maximum and minimum temperatures in Albany peak in February averaging almost 23°C and 15°C, respectively (Bureau of Meteorology, 2007). The lowest mean daily maximum and minimum temperatures and highest mean number of rainy days occurs in July (Table 2).

TABLE 2: CLIMATE AVERAGES FOR ALBANY

ALBANY 35.03°S, 117.88°E LAST RECORD APRIL 2007												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN DAILY MAX. TEMP (°C)												
22.8	22.9	22.2	20.8	18.5	16.5	15.7	16.2	17.2	18.4	20.3	21.9	19.4
MEAN DAILY MIN. TEMP (°C)												
15.0	15.3	14.6	12.7	10.6	9.0	8.1	8.3	9.2	10.3	12.3	13.9	11.6
MEAN RAINFALL (MM)												
23.7	23.2	38.5	69.0	118.8	132.2	143.6	126.6	101.1	79.6	43.5	29.4	922.4
MEAN NO. OF RAIN DAYS												
3.4	3.4	5.2	7.8	11.1	12.3	13.8	13.0	11.2	9.5	6.3	4.2	101.2

Source: Bureau of Meteorology

2.3.2 Topography

The project area is dominated by a plateau area lying at approximately 40m-45m AHD over the mid-western portion project area and falling away to approximately 20m AHD in the southwest, 26m AHD in the south-east, 10m AHD in the north and 4m AHD in the north-east of the project area. A steep lateritic scarp (32m AHD to 0m AHD over 65 linear metres) separates the project area from Oyster Harbour.

2.3.3 Geology and Soils

A review of the *Environmental Geology Series* maps prepared by the Geological Survey of Western Australia was undertaken to determine the geology of the project area. The project area is located on the Albany Part Sheets 2427 I, 2428 II, 2527 IV and 2528 III (Gozzard, 1989).

The geology of the project area is mapped as comprising predominantly laterite within a gently undulating upland, with the western portion along Lower King Road falling away to a colluvial slope. The northern portion comprises an alluvial plain. The majority of the superficial soils across the project area consist of light grey to white sands (predominantly quartz sand) overlying laterite at variable depths. WAPC Planning Bulletin 64 identifies the southern portion of the project area as having “low to no

known risk of ASS occurring within 3m of natural soil surface (or deeper)" (WAPC, 2003b). The wetland areas on Lot 15 Hooper Road, Lot 3 Alison Parade, Lot 500 Alison Parade, Lot 38 Elizabeth Street and Lot 39 Elizabeth Street have a high risk of actual acid sulfate soils and potential acid sulfate soils less than 3m from the ground surface.

2.4 Biological Context of Project Area

2.4.1 Bioregional Assessment

The project area is located in the Jarrah Forest 2 (Southern Jarrah Forest) subregion of the IBRA regions (Hearn, *et al.,* 2002). The Southern Jarrah Forest subregion is characterised by Jarrah/Marri forest on laterite gravels, and in the eastern part, by Wandoo/Marri woodlands on clayey soils. Eluvial and alluvial deposits support *Agonis* sp. shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species-rich shrublands (Hearn, *et al.,* 2002).

No systematic fauna surveys (vertebrate or invertebrate) have been previously conducted across the bioregion (Hearn *et al.,* 2002), as a consequence, data are sparse and patchy and there are no fauna data for most of the reserves in the region.

Occasional invertebrate studies have mainly been confined to some wetlands and to selected invertebrate taxa. The region has been identified as containing significant relict taxa and their habitat, in particular, for invertebrates; but targeted surveys and assessments have only just begun (Hearn *et al.,* 2002).

2.4.2 Vegetation

The vegetation of the project area has previously been broadly mapped according to rainfall variations and landform/soil properties. Beard (1979) described the vegetation of the Albany area as representative of the Albany System within the Menzies Subdistrict Vegetation Unit, and more specifically mapped the project area as a Jarrah (*Eucalyptus marginata*) and Jarrah-Sheoak (*Allocasuarina fraseriana*) Low Woodland.

Connell and ATA Environmental (2001) conducted a study to investigate the distribution and condition of remnant vegetation in the Albany hinterland. Vegetation mapping for the Albany hinterland, including the Albany municipality, was prepared based on climate, soils and the general landform of the area. The results of this study should be viewed as being a compromise in terms of data depth and geographic breadth. Connell and ATA Environmental (2001) identified two main Vegetation Complexes as occurring within the project area:

- ***Eucalyptus-Casuarina* Low Forest G -** Low *Eucalyptus marginata* / *Eucalyptus decipiens* and *Allocasuarina fraseriana* forest on low tertiary plains (<15m elevation). Soils are leached sands, sometimes yellow, gravelly or swampy. Species include *Callistemon glaucus*, *Beaufortia sparsa*, *Nuytsia floribunda* and *Banksia dryandroides*.
- ***Eucalyptus-Casuarina* Low Forest I -** Low *Eucalyptus marginata* / *Eucalyptus decipiens* and *Allocasuarina fraseriana* forest on low hills (30m-90m). Soils are leached sands. Species include *Lambertia inermis*, *Dasypogon bromeliifolius* and *Xanthosia rotundifolia*.

More detailed surveys by Coffey Environments (2008) identified the following vegetation types within the project area:

- **AfEmOF -** Open Forest of *Allocasuarina fraseriana* and *Eucalyptus marginata* over *Agonis theiformis, Xanthorrhoea brunonis, Xanthorrhoea platyphylla, Anarthria scabra, Acacia lateriticola* and *Dasypogon bromeliifolius* over *Chordifex laxus, Desmocladus fasciculatus, Hypolaena exsulca, Gompholobium knightianum, Conostylis setigera* and *Sphenotoma squarrosum.*
- **AfEmCF -** Closed Forest of *Allocasuarina fraseriana* and *Eucalyptus marginata* over *Agonis theiformis, Bossiaea linophylla* and *Leucopogon racemulosus* over *Dasypogon bromeliifolius*, *Anarthria scabra* and *Anarthria prolifera*.
- **AfEmOCF -** Open to Closed Forest of *Allocasuarina fraseriana* and *Eucalyptus marginata* over *Agonis theiformis, Beaufortia decussata* and *Astartea scoparia* over *Xanthorrhoea brunonis, Dasypogon bromeliifolius, Desmocladus fasciculatus, Lepidosperma squamatum, Anarthria scabra* and *Anarthria prolifera*.
- **AfEsBc -** Open Woodland of *Eucalyptus staeri* and *Allocasuarina fraseriana* over *Banksia coccinea* over *Melaleuca thymoides, Leucopogon glabellus* and *Leucopogon obovatus* over *Dasypogon bromeliifolius, Lyginia imberbis, Anarthria scabra* and *Anarthria prolifera*.
- **AfNfEsOW -** Open Woodland of *Allocasuarina fraseriana, Nuytsia floribunda* and *Eucalyptus staeri* over *Melaleuca thymoides, Agonis theiformis, Jacksonia spinosa, Leucopogon glabellus, Dasypogon bromeliifolius* and *Leucopogon unilateralis* over *Anarthria scabra, Chordifex laxus* and *Hypolaena exsulca*.
- **AfEsNfOW -** Open Woodland of *Eucalyptus staeri, Allocasuarina fraseriana* and *Nuytsia floribunda* over *Evandra aristata, Pericalymma ellipticum* var. *ellipticum, Adenanthos obovatus, Lepidosperma gladiatum, Juncus pauciflorus, Mesomelaena graciliceps, Hypolaena exsulca, Sphenotoma squarrosum* and *Darwinia vestita* over *Anarthria prolifera* and *Lomandra sonderi,* with occasional *Kingia australis.*
- **AfEsOW -** Woodland to Open Woodland of *Eucalyptus staeri* and *Allocasuarina fraseriana* over *Banksia coccinea, Agonis theiformis, Leucopogon glabellus* and *Jacksonia sternbergiana* over *Anarthria scabra* and *Melaleuca thymoides*.
- **AfNfBiBaOF -** Open Forest of *Allocasuarina fraseriana, Nuytsia floribunda, Banksia ilicifolia* and *Banksia attenuate* over Shrubland of *Astartea scoparia* and *Agonis theiformis* over weeds.
- **AsClTOS -** Tall Open Scrub of *Astartea scoparia* and *Callistachys lanceolata* over Sedgeland of *Juncus krausii, Baumea articulata, Lepidosperma gladiatum* and *Hypolaena exsulca*
- **AfLCF -** Low Closed Forest of *Allocasuarina fraseriana* over *Agonis theiformis, Lepidosperma gladiatum* and *Jacksonia furcellata* over *Xanthosia rotundifolia* and *Lepidsperma squamatum.*
- **ClAf -** *Callistachys lanceolata* to 12 metres with occasional *Agonis flexuosa* over *Pteridium esculentum.*
- **ClEm -** *Callistachys lanceolata* and *Eucalyptus marginata* over *Melaleuca viminea* subsp. *viminea* over *Lepidosperma gladiatum, Anarthria gracilis* and *Agonis theiformis* over *Juncus pauciflorus, Chordifex laxus* and *Hypolaena exsulca.*
- **EmAfOF -** Open Forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* with occasional *Eucalyptus staeri* over *Agonis theiformis, Astartea fasciculatus, Allocasuarina humilis, Melaleuca thymoides* and *Xanthorrhoea brunonis* over *Mesomelaena tetragona* and *Anarthria scabra* over *Conostylis setigera, Anarthria prolifera, Schoenus nitens* and *Leucopogon propinquus*.

- **EmAfBgCF -** Closed Forest of *Eucalyptus marginata, Allocasuarina fraseriana* and occasional *Banksia grandis* over *Agonis theiformis, Melaleuca thymoides, Petrophile heterophylla* and *Daviesia preissii* over *Lepidosperma gladiatum, Lepidosperma squamatum* and *Xanthosia rotundifolia.*
- **EmAfF -** Forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* over *Agonis theiformis, Acacia rostellifera* and *Kingia australis* (severely burnt).
- **EmAfW -** Woodland of *Eucalyptus marginata* and *Allocasuarina fraseriana* over *Jacksonia furcellata, Melaleuca thymoides* and *Leucopogon glabellus* over *Dasypogon bromeliifolius, Adenanthos obovatus, Lepidosperma gladiatum* and *Xanthosia rotundifolia* over *Chordifex laxus, Hypolaena exsulca.*
- **EmAfNfOF -** Open Forest of *Eucalyptus marginata, Allocasuarina fraseriana* and *Nuytsia floribunda* over Open Shrubland of *Psoralea pinnata, Acacia myrtifolia, Hibbertia cuneiformis, Xanthorrhoea platyphylla* and *Zantedeschia aethiopica* over *Anthoxanthum odoratum, Sonchus oleraceus, Hypochaeris glabra.*
- **EmAfCF -** Closed Forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* over Tall Open Scrub of *Agonis theiformis* over Open Shrubland of *Leucopogon revolutus, Bossiaea linophylla* and *Xanthorrhoea platyphylla* over Open Sedgeland of *Lepidosperma gladiatum, Lepidosperma squamatum, Anarthria prolifera, Tetraria capillaris* and *Desmocladus fasciculatus* over Open Herbland of *Hibbertia cunninghamii, Tetratheca setigera, Opercularia vaginata* and *Conostylis Setigera.*
- **HfCcOH -** Open Heath of *Homalospermum firmum* and *Cosmelia rubra* over Sedgeland of *Xyris lacera* and *Hypolaena exsulca.*
- **MpLW -** Low Woodland of *Melaleuca preissiana* over Tall Open Scrub of *Astartea scoparia* over Very Open Sedgeland of *Hypolaena exsulca.*
- **C/P** - Cleared/Pasture

The condition of the vegetation was assessed using the scale of Keighery published in *Bush Forever* (Government of Western Australia 2000). The condition of the vegetation within the project area ranges from excellent to completely degraded (Coffey Environments 2008).

3 FAUNA ASSESSMENT METHODOLOGY

3.1 Database Searches

A combined search of the Western Australian Museum (WAM) database, *FaunaBase* and the Terrestrial Ecosystems database were conducted to generate a list of potential bird, reptile, mammal and amphibians in the general Albany region. The *FaunaBase* search area was bounded by latitude 34.75^{o} to 35.00^{o}S, and longitude 117.5^{o} to 118.00^{o}E and the Terrestrial Ecosystems search bounded by a 150 km radius from Albany. Large database search areas are necessary for the Albany region as limited data were available for the specific habitat types available in the project area. Larger search areas also enable a regional fauna list to be compiled so that comparisons among fauna assemblages recorded in a specific habitat can be compared with predicted lists for the broader region.

A search of the DEC's Threatened Fauna database was undertaken to identify potential scheduled and threatened species in the vicinity of the project area. A search of the DEWHA *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* online database was also undertaken for the area 34.75^{o} to 35.00^{o}S, and longitude 117.5^{o} to 118.00^{o}E to identify species of conservation interest to the Commonwealth Government.

Other more general texts were also used to provide supplementary information including Tyler *et al.* (2000) for frogs, Storr *et al.* (1983, 1990, 1999, 2002) for reptiles, Johnstone and Storr (1998; 2004) for birds, and Strahan (2000) for mammals. In addition, a number of published and unpublished reports for fauna surveys have been used to provide a regional context for the small vertebrate assemblages sampled in the survey area.

A search of the Terrestrial Ecosystems database was also conducted to generate a list of species predicted to occur in the Project Area.

Collectively these sources of information were used to generate lists of species expected to utilise the project area and broader Albany region. It should be noted that these lists include species that have been recorded in the general region, but are possibly vagrants at Bayonet Head as they are generally not found in the project area due to a lack of suitable habitat. Vagrants can be recorded almost anywhere. Many of the bird, mammal, reptile and amphibian species have specific habitat requirements that may be present in the general area but not in the specific survey area. Also, the ecology of many of these species is often not well understood and it can sometimes be difficult to indicate those species whose specific habitat requirements are not present in the survey area. As a consequence some species will be included in the lists produced from database searches but will not be present in the actual project area. Where possible these species have been removed from the predicted species lists.

3.2 Taxonomy and Nomenclature

Taxonomy and nomenclature for terrestrial fauna species used in this report are generally based on the WAM list provided early 2008, except for bats, which follow Armstrong and Reardon (2006) and birds, which follow Christides and Boles (2008). Coffey Environments has presumed that the identifications and nomenclature referred to in the Appendices or in reports used to provide local and regional comparative data were correct and has only corrected obvious records where the nomenclature was known to be incorrect or has changed.

3.3 Liaison Prior to Survey

Coffey Environments met with staff from the Department of Environment and Conservation (DEC) on 10 October 2006 to discuss the scope of works and objectives of the Bayonet Head fauna assessment. During that period, the EPA had set the level of assessment for Lot 1000 at 'Public Environmental Review'. Coffey Environments proposed to conduct a bi-season survey in accordance with its interpretation of Guidance Statement No 56 (EPA, 2004) and DEC were satisfied with this approach. The advice of Albany based DEC staff was also sought prior to conducting surveys, and they were satisfied with this suggested approach.

3.4 Regional Context

The project area lies in the Southern Jarrah Forest IBRA sub-region (Hearn *et al*., 2002). Systematic vertebrate fauna survey data were not available for 95% of the subregion and most data are confined to the Perup and Kingston areas (Hearn *et al*., 2002). To prepare a composite list of species that might be found in the area, and the species preferred habitats, the following literature was reviewed:

- Abbott, I. (1999) The avifauna of the forests of south-west Western Australia: changes in species composition, distribution, and abundance following anthropogenic disturbance, *CALMScience Suppl* 5, 1-176.
- ATA Environmental, (2000) *Lot 5779 Down Road, Albany Flora Survey and Fauna Assessment,* Unpublished report for Southern Districts Estates Agency.
- Chapman, A. and Newbey, K.R. (1995) A Vertebrate Fauna Survey and Some Notes on the Vegetation of the Ravensthorpe Range, Western Australia, *CALMScience* 1(4), 465-508.
- Christensen, P., Annels, A., Liddelow, G and Skinner, P. (1985) *Vertebrate Fauna in the Southern Forests of Western Australia A Survey*, Forests Department of Western Australia Bulletin 94.
- *ecologia* Environment (2007) *Albany Iron Ore Project Southdown Magnetite Proposal Terrestrial Vertebrate Fauna Assessment*, Unpublished report for Grange Resources Limited.
- How, R.A., Dell, J. and Humphreys, W.F. (1987) The Ground Vertebrate Fauna of Coastal Areas between Busselton and Albany, Western Australia, *Recordings of the Western Australian Museum* 13(4), 553-574.
- Newbey, K.R. and Chapman, A. (1995) A Biological Survey of the Fitzgerald Area, Western Australia, *CALMScience Supplement* 3, 1-258.
- Orr, K., Danks, A. and Gillen, K. (1995) *Two Peoples Bay Nature Reserve Management Plan*, Department of Conservation and Land Management, Perth.
- Smith, V.W. (1990) The Terrestrial Vertebrate Fauna of the Torndirrup National Park, *Western Australian Naturalist* 18, 82-91.

Of those listed above, the quantitative surveys that are useful for comparative purposes include those by Smith (1990), Newby and Chapman (1995), and *ecologia* Environment (2007).

To allow data collected from the project area to be analysed in a regional context, study sites were also sampled by Coffey Environments at Yakamia and Emu Point. Each of the sites was surveyed using the same protocol as described in Section 3.5. The fauna habitats that were sampled in Albany include:

- **Jarrah/Sheoak Woodland (JSW)** – Jarrah (*E. marginata*) and Sheoak (*A. fraseriana*) Woodland over Shrubland of species such as *A*. *theiformis*, *A. fascicularis*, *A*. *humilis*, *M*. *thymoides* and *Xanthorrhoea brunonis* over a mixed sedgeland.
- **Heath Shrubland (HS)** – Heath containing species such as *A. theiformis*, *Leucopogon glabellus*, *Lepidosperma gladiatum*, *Melaleuca thymoides*, *M*. *bracteosa, Pericalymma ellipticum var*. *ellipticum* and *Beaufortia decussata* with occasional Albany Blackbutt (*Eucalyptus staeri*).
- **Wetland Mosaic (WM)** – Degraded Peppermint (*Agonis flexuosa*) and *Callistachys lanceolata* Woodland over *Pteridium esculentum*.

3.5 Site Selection

The trapping sites were placed in habitats based on previous vegetation assessments (ATA Environmental, 2005; 2006) to ensure representation of the available habitats. Sites were selected on the basis that they are not easily accessed by the public that frequent the area, to minimise equipment theft and interference with the trapping program. The location of the trapping sites are shown in Figure 2 and described below in Table 3. The number of trapping sites varied among the habitat types, but was proportional to the extent of each available habitat type in the project area. Fourteen trapping sites were established within the project area; five sites in the Jarrah/Sheoak Woodland (JSW) habitat, three sites in the Heath Shrubland (HS) habitat and six sites in the Wetland Mosaic (WM) habitat.

TABLE 3: HABITAT DESCRIPTIONS OF THE TRAPPING SITES AT THE PROJECT AREA

JSW – Jarrah (*Eucalyptus marginata*) and Sheoak (*Allocasuarina fraseriana*) woodland over shrubland of species such as *A. theiformis*, *Astartea fascicularis*, *A. humilis*, *M. thymoides* and *Xanthorrhoea brunonis* over a mixed sedgeland.

HS - Heath containing species such as *A. theiformis*, *Leucopogon glabellus*, *Lepidosperma gladiatum*, *Melaleuca thymoides*, *M. bracteosa, Pericalymma ellipticum var. ellipticum* and *Beaufortia decussata* with occasional Albany Blackbutt (*Eucalyptus staeri*).

WM - Degraded Peppermint (*Agonis flexuosa*) and *Callistachys lanceolata* woodland over *Pteridium esculentum*

3.6 Field Based Fauna Assessment

The field based fauna assessment within the project area consisted of:

- Two, seven night trapping programs;
- Systematic avifauna survey;
- Spotlighting survey including bat echolocation survey;
- Targeted tadpole and frog survey;
- Targeted Western Ringtail Possum survey;
- Targeted Black Cockatoo survey; and
- Short range endemic invertebrate survey.

3.6.1 Level 1 Surveys

Coffey Environments initially conducted a Level 1 survey of the project area in 2005. The Level 1 survey consisted of travelling (walking and driving) through the project area and recording fauna habitat types, as well features specific to conservation significant species. Classification of the project area was made during the 2005 survey determining where fauna trapping was needed and where specific targeting of conservation significant species – an extra level 1 – was required. The additional Level 1 survey was carried out in March 2009 within Lots 38, 39, 2, 3, and a section of 286. A Level 1 survey was considered adequate for these lots sites because much of the fauna habitats are highly fragmented and/or degraded. The survey targeted WRP and potential breeding habitat (hollows and dreys) for WRPs, Black Cockatoos and the Masked Owl. Breeding habitat was investigated during the day and spotlighting for WRP was done at night.

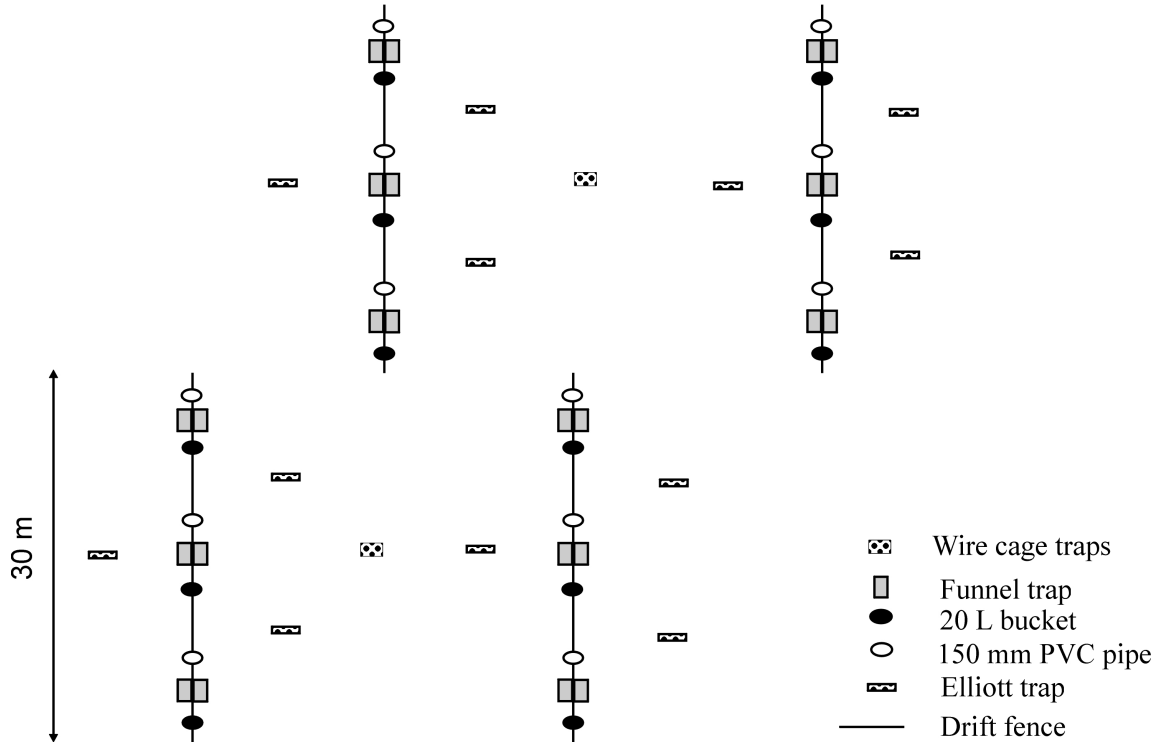
3.6.2 Trapping Program

Project Area

Coffey Environments conducted two seven-night fauna trapping surveys at Bayonet Head from 16-23 December 2006 and 7-14 March 2007. All fauna trapping was conducted under a licence issued to Dr Scott Thompson by the DEC (Licence Number SF 005650). Trapping was conducted in habitat types representative of the project area (Lots 1000, 1001, 476, a section of 286 and Part Lot 1).

A total of fourteen trapping sites were established in the three habitat types within the project area. Each site contained four trap lines. Each trap line contained three 20L PVC buckets, three 150mm by 500mm deep PVC pipes as pit-traps and three pair of funnel traps evenly spaced along a 30m fly-wire drift fence (300mm high; Diagram 1). In addition, three Elliott traps were set adjacent to each drift fence. One wire cage trap was placed between each pair of drift fences. Each trap set for one night is defined as a 'trap night' and represents the trapping effort conducted. The trapping effort for wire cages was less than that of the pit, funnel and Elliott traps as they were used to target larger mammals and reptiles that have larger activity areas.

DIAGRAM 1: TRAP LAYOUT AT EACH SITE



All traps were opened and closed on the same day and left open for a period of seven nights during each of the survey periods. The trapping effort for the project area is shown in Table 4.

TABLE 4: TRAPPING EFFORT (TRAP NIGHTS) IN THE PROJECT AREA

Habitat Type	Site	Trap Type				
		Bucket pit-trap nights	Pipe pit-trap nights	Funnel trap nights	Elliott trap nights	Cage trap nights
Jarrah/Sheoak Woodland - JSW	BH1, BH2, BH6, BH7, BH14	840	840	1680	840	140
Heath Shrubland - HS	BH3, BH10, BH13	336	336	672	336	56
Wetland Mosaic - WM	BH4, BH5, BH8, BH9, BH11, BH12	1008	1008	2016	1008	168
TOTAL	**11284**	**2184**	**2184**	**4368**	**2184**	**364**

Yakamia and Emu Point

Trapping was also conducted simultaneously at Emu Point and Yakamia to provide a regional comparison. At Yakamia there were 12 separate survey sites and at Emu Point there were five separate survey sites. Each trapping site used the same trapping protocol as described above and was surveyed during the period as Bayonet Head. The trapping effort for Emu Point and Yakamia is shown in Table 5. The total trapping effort conducted at all sites by habitat type is shown in Table 6.

TABLE 5: TRAPPING EFFORT (TRAP NIGHTS) IN REGIONAL COMPARATIVE SURVEY SITES

Habitat Type	Site	Trap Type				
		Bucket pit-trap nights	Pipe pit-trap nights	Funnel trap nights	Elliott trap nights	Cage trap nights
Jarrah/Sheoak Woodland - JSW	YK1, YK2, YK3, YK4, YK5, YK6, YK7, YK8, YK9, YK10, YK11, YK12	2016	2016	4032	2016	336
Heath Shrubland - HS	EP1, EP2, EP3, EP4, EP5	840	840	1680	840	140
TOTAL	**14756**	**2856**	**2856**	**5712**	**2856**	**476**

TABLE 6: TRAPPING EFFORT (TRAP NIGHTS) IN HABITATS OF REGION

Habitat Type	Trap Type				
	Bucket pit-trap nights	Pipe pit-trap nights	Funnel trap nights	Elliott trap nights	Cage trap nights
Jarrah/Sheoak Woodland - JSW	3360	3360	6720	3360	560
Heath Shrubland - HS	1344	1344	2688	1344	224
Wetland Mosaic - WM	1008	1008	2016	1008	168
TOTAL	**5712**	**5712**	**11424**	**5712**	**952**

BH – Bayonet Head, YK – Yakamia; EP – Emu Point

3.6.3 Avifauna Surveys

Avifauna surveys were conducted from sunrise for approximately three person hours each morning between 17-22 December 2006 and 7-14 March 2007. All habitats at Bayonet Head were searched during this period and birds were identified by their call or direct observation. Birds were also recorded opportunistically during the survey period by all survey staff.

The area was searched for trees with hollows that may be suitable nesting sites for White-tailed Black Cockatoos (i.e. Carnaby's and Baudin's) or the Masked Owl.

3.6.4 Spotlighting Survey

Spotlighting surveys target a particular suite of fauna such as nocturnal reptiles, mammals and birds (e.g. pythons, rabbits, owls), that often are not readily captured or seen by other means. These opportunistic observations provide useful supplementary data to the trapping program. Large, predominantly nocturnal mammals (e.g. foxes, kangaroos, cats) are often also observed during these searches. The spotlighting searches were also used to search for Western Ringtail Possums.

Spotlighting was conducted for nocturnal fauna on three evenings during the December 2006 survey (19, 21 and 22 December 2006) and four evenings during the March 2007 survey (9-12 March 2007). Spotlighting was undertaken from a slow moving vehicle (~5km/hr) using head torches and a high powered hand-held spot-light. Each survey lasted approximately three hours and all trapping sites were investigated during each evening search. Spotlighting surveys totalled 36 person hours during December 2006 and 36 person hours during March 2007.

3.6.5 Frog Survey

During the discussions regarding the scope of works for the fauna surveys, John Dell from the DEC requested that an additional survey targeting frogs and tadpoles should be conducted within the wetland areas to determine the significance of the project area as a breeding site for frogs. Mr Dell indicated that the timing for the survey must be before mid-November, when the breeding season for most aquatic frog species ceases.

Dr Jessica Oates and Helen Shortland-Jones undertook a survey from the 6-10 November 2006 under the DEC license SF005638 to collect tadpoles and frogs present within any wetland areas within the project area and a number of other sites within Bayonet Head and Yakamia. The presence of each tadpole species will indicate whether the area is used as a breeding site by that particular frog species. The presence of frogs but absence of tadpoles may indicate that the site is used for habitation only. A maximum of ten tadpoles from each field identified species, from each wetland was collected by hand netting with a mesh net in the wetland. These were then transferred to buckets containing water from the same wetland. The tadpoles were transported live back to Perth, where they were then sent to Dr Martin Dziminski at The University of Western Australia for identification. Adult frogs present within or around the wetland areas were either identified in the field or brought back for identification to the WAM.

3.6.6 Western Ringtail Possum Surveys

In addition to the trapping surveys, a targeted assessment was undertaken to estimate the number of Western Ringtail Possums (*Pseudocheirus occidentalis*; WRPs) and their dreys throughout the project area. The assessment was undertaken during both the December 2006 and March 2007 surveys, as well as the March 2009 survey of the project area. Spotlightling for WRPs during the 2006 and 2007 surveys was conducted in conjunction with the trapping surveys. In comparison, the 2009 survey specifically targeted WRPs in areas not trapped.

Daylight drey searches were undertaken during December 2006 and March 2009 and spotlighting surveys were undertaken during all three surveys: December 2006, March 2007 and 2009.

Dreys were classified into one of the following four types:

1) Dense, well-made ball or slightly elongate form with a distinct entrance hole. In this type of drey the possum is completely enclosed;

2) Dense, well-made cup-shaped nest with some material over the top, but the possum is not fully enclosed;

3) Dense, well-made cup-shape nest with an open top. The possum sits deep inside the cup of the drey and may not be visible from the ground; and

4) Platform of twigs, often in a tree or branch fork, with no more than a shallow depression where the possum rests.

3.6.7 Black Cockatoos Survey

A targeted assessment was also undertaken to estimate the quantity and quality of habitats available to Black Cockatoos (*Calyptorhynchus banskii naso, C. baudinii,* and *C. latirostris*) and potential breeding hollows in the project area. This assessment was undertaken during December 2006, March 2007 and March 2009.

3.6.8 Bat Survey

Bat echolocation calls were recorded using an Anabat system. An Anabat recorder was left standing vertically for approximately 3hrs from sunset on 19 December 2006 and 12 March 2007 in the Jarrah/Sheoak Woodland and on 10 March 2007 in the Heath Shrubland in suspected bat fly-ways. Equipment failure meant no data were collected from two other nights of attempted recording. The Anabat data were analysed by Dr Kyle Armstrong (Molhar Pty Ltd). Mini Disc data were downloaded via Sonic Stage software at a rate of 132 bits and converted into Wave format (sampling rate of 44.1 kHz, 16 bit resolution, stereo). Two call parameters were extracted as per the methods of McKenzie and Bullen (2003): Fpeakc: and Q-factor. Other parameters, including duration, minimum frequency and call shape were also examined where necessary to help with identification. Reference material and other information from Fullard *et al.*, (1991) and McKenzie and Bullen (2003) were used for identification. Nomenclature for bat identification follows Armstrong and Reardon (2006).

3.6.9 Invertebrate Survey

Part of the scope of works was to identify invertebrate fauna likely to be short-range endemic (SRE) fauna that are dependant on restricted habitats and found within the project area. After discussions with Dr Mark Harvey from the WAM it was understood that different SRE invertebrates are active at different times of the year and found throughout the Albany area in a variety of habitats. Potential terrestrial SRE taxa in the region include millipedes, snails, onychophorans, mygalomorph (trapdoor) spiders and pseudoscorpions. The South Coast region is relatively well known compared with other regions of the state. Due to the high rainfall of the region, Dr Harvey suggested that pitfall traps utilising ethylene glycol is not suitable because of the dilution of the traps after rain and the prevalence of frogs and other terrestrial vertebrates likely to fall into the traps (Thompson and Thompson, 2008). Dr Harvey suggested that a detailed collecting program could be devised based upon dry pits (checked daily) and intensive hand foraging of selected sites, including digging trapdoor spiders from their burrows.

Dr Harvey suggested that December is not a suitable time of year to search for SREs in the Albany area. Many SRE invertebrates are highly seasonal in their activity patterns, and adult specimens, which are often necessary to make accurate identifications, are usually only present during autumn, winter and spring. However, some trapdoor spiders are adult at other times of the year. Therefore, Coffey Environments conducted an active search for SRE invertebrates during the March 2007 survey. Possible SRE invertebrates that fell into the dry pit-traps were collected and hand foraging was conducted within each habitat type. The active foraging survey consisted of digging out potential trapdoor spider burrows, removing bark from logs and trees, turning over rocks and sorting through leaf litter. All invertebrate samples collected were placed in 90% ethanol and delivered to Dr Harvey for sorting and identification by relevant experts at the WAM. A total of 10 person hours were spent actively foraging for SRE invertebrates within each habitat type in the project area.

3.6.10 Vouchering Specimens

Prior to the field survey, Dr Ric How, Dr Paul Doughty and Mr Brad Maryan from the Western Australian Museum (WAM) were contacted to determine whether there were any species in the region that WAM would require as vouchered specimens. A number of individuals were vouchered with the WAM to confirm identifications. Most individuals were temporarily held in calico bags or plastic tubs and delivered live to the Museum. Where specimens were dead and still in good condition they were frozen and passed onto the Museum.

3.6.11 Animal Ethics

Environmental consultants in WA are currently not required to obtain approval from an established animal ethics committee to undertake terrestrial vertebrate fauna surveys. Nevertheless, the fauna surveying procedures and protocols utilised during this terrestrial vertebrate trapping survey have been approved by the Edith Cowan University Animal Ethics Committee (see http://www.ecu.edu.au/GPPS/ethics/assets /General_Terrestrial_Fauna_Surveys_Protocol.pdf).

To minimise deaths to animals due to bites and stings by invertebrates, traps were cleared daily. Ant powder was placed around and in pit, funnel and Elliott traps where ants were an obvious problem.

3.6.12 Survey Staff

Dr Scott Thompson was the team leader, co-ordinated the trapping survey and was responsible, along with Dr Jessica Oates, for trap clearances and fauna identifications. Field staff included Dr Carl Gosper, Sean Tomlinson, Edward Swinhoe, Chris Clemente, Sean Stankowski, Joel Bunn, Andrew Deakin, Ben Ford and Jeremy Oates. Dr Scott Thompson and Dr Jessica Oates conducted spotlight surveys in December 2006 and March 2007 for WRPs and any opportunistic nocturnal mammals, reptiles and birds which are difficult to trap. They also estimated the quantity and quality of habitats available to WRPs, Black Cockatoos and Masked Owls and potential breeding hollows during the December 2006 and March 2007 surveys.

Frog surveys were carried out by Dr Jessica Oates and Helen Shortland-Jones in November 2006. Anne and Fred Bondin, Dr Carl Gosper and Sean Tomlinson conducted avifauna surveys in the Albany region in December 2006 and March 2007. Dr Kyle Armstrong (Molhar Pty Ltd) was responsible for interpreting the Anabat recordings and subsequent bat identifications.

The initial Level 1 survey of the project area in 2005 was performed by Dr Scott Thompson and Dr Jessica Oates. In March 2009, another Level 1 survey was conducted by Dr Paul Mitrovski and Mr Graeme Finlayson in the remaining project areas where no trapping had been performed. The 2009 survey targeted WRPs and Black Cockatoos and their associated habitats, in addition to classifying remaining fauna habitat and recording opportunistic sightings of vertebrate fauna.

Species accumulation curves were calculated by Dr Graham Thompson (Terrestrial Ecosystems) using the method described in Thompson *et al.* (2007). Mr Brad Maryan and Ms Norah Cooper from the Western Australian Museum identified the herpetofauna and mammal voucher specimens respectively.

3.6.13 Local Environmental Conditions during Survey Periods

Albany is the closest Bureau of Meteorology weather station to the project area. Daily ambient weather conditions in Albany during the survey periods are shown in Table 7.

TABLE 7: DAILY WEATHER DATA FOR SURVEY PERIODS

Date	Min Temp (°C)	Max Temp (°C)	Rainfall (mm)
16/12/06	**13.5**	**23.6**	**2.8**
17/12/06	**18.1**	**22.2**	**0**
18/12/06	**17.5**	**21.1**	**1.2**
19/12/06	**18.0**	**21.6**	**0**
20/12/06	**17.8**	**20.2**	**0**
21/12/06	**16.3**	**19.3**	**0**
22/12/06	**15.5**	**19.9**	**1.4**
23/12/06	**16.0**	**21.5**	**0**
07/03/07	**18.5**	**37.5**	**0**
08/03/07	**21.0**	**35.5**	**0**
09/03/07	**18.0**	**20.2**	**1.0**
10/0307	**15.2**	**19.8**	**3.6**
11/03/07	**15.3**	**20.4**	**0**
12/03/07	**16.0**	**21.3**	**0**
13/03/07	**17.8**	**24.4**	**0.2**
14/03/07	**17.2**	**25.2**	**0**
9/03/09	**16.2**	**24.0**	**0**
10/03/09	**16.8**	**26.0**	**0**
11/03/09	**16.2**	**22.4**	**0**
12/03/09	**16.5**	**19.8**	**0**

3.7 Data Analysis

One of the objectives of the project was to identify and assess the values and significance of the terrestrial fauna assemblage in the project area and to describe these values in a local and regional context. The terrestrial fauna assemblage of the project area is discussed in a local context by comparing the fauna assemblage of the different habitats within the project area with the other habitats surveyed within the Bayonet Head area. The terrestrial fauna assemblage of the project area is discussed in a regional context by comparing the fauna assemblage of the different habitats within the project area with that of the other habitats surveyed within the Albany region, i.e. Yakamia and Emu Point.

The four most common attributes to describe fauna assemblages are species richness, evenness, diversity and relative abundance (Hayek and Buzas, 1997; Magurran 2004) and these have been used to describe assemblage characteristics in this assessment.

3.7.1 Diversity and Evenness

Log series diversity (Fisher's Alpha) was calculated using Colwell's EstimateS V8 software (http://viceroy.eeb.uconn.edu/estimates). Shannon Wiener and Simpson indices scores were also provided for comparison with other reports and were calculated using Colwell's EstimateS V8 software. Smith and Wilson's B measure of evenness was calculated for each of the trapped assemblages by dividing the Shannon-Weiner index score by the natural logarithm of the species richness for each site.

3.7.2 Similarity

Having established that there were differences among the trapped assemblages, Coffey Environments used the Morisita-Horn Similarity index to compare similarity between combinations of sites at Bayonet

Head and among sites surveyed in the region. The Morisita-Horn similarity index was calculated using Colwell's EstimateS V8 software.

3.7.3 Species Accumulation Curves

Species accumulation curves, or collectors' curves, involves plotting the cumulative number of species discovered in a defined sampling area against increasing levels of survey effort (Thompson, *et al*., 2007). Species accumulation curves were prepared using a custom written randomising program (Thompson and Thompson, 2007a), so that the catch was randomised across the number of trapping days. Ten thousand iterations were used to average the curves. A non-linear regression curve was then calculated using the Beta-P model (Thompson *et al.* 2003a) in NLREG software (Sherrod 2001) for each habitat type and the overall trapping survey results. Species accumulation curves were plotted with the ordinate axis as estimated species richness and on the abscissa the number of individuals caught rather than sampling effort to account for difference among surveys in species richness and abundance, and trapping efficiency. Furthermore, Chao 2 calculations with 95% confidence intervals were performed as an additional method to determine expected number of species captures from a trapping site.

3.7.4 Principal Components Analysis

Principal Components Analysis (PCA) was performed using StatisticaXL V1.8 software. This mathematical technique identifies potential patterns in data and expresses the data in such a way as to highlight their similarities and differences. Principal Components Analysis works by reducing the number of variables and helps detect structure in the relationships between variables.

3.8 Limitations

The survey protocol was specifically designed to enable comparisons with other habitat types to be made for both species richness and assemblage composition at Bayonet Head and the regional survey sites. Replicated trapping arrays in each of the available habitat types at Bayonet Head and other regional study sites surveyed in December 2006 and March 2007 provided a better assessment of fauna assemblages. Targeted reconnaissance for conservation significant species, WRP and Black Cockatoos, was conducted throughout the project area (December 2006, March 2007 and March 2009). The survey design and trapping effort was therefore not considered a limitation.

Conclusions and management recommendations regarding the vertebrate fauna assemblage have been made based on the results obtained from this survey, results from other study sites surveyed during the same period in the region, and data from other surveys and unpublished reports conducted in the region. This information has allowed a comparison of fauna assemblages and species diversity at a local and regional level. A two-season survey was conducted as is required by the EPA's *Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56* (EPA, 2004) and based on the advice from DEC staff.

Different trap types sample the small vertebrate assemblage differently (Thompson *et al.,* 2005). Unlike many of the earlier terrestrial fauna surveys undertaken to support Environmental Impact Assessments (EIAs), this trapping program used funnel traps which resulted in a more comprehensive survey of the area (Thompson and Thompson, 2007b). Large reptiles and mammals are infrequently caught in the traps used; however, their size is such that they are more likely to be seen than many smaller cryptic species. Larger nocturnal species are seen while spotlighting.

For most of the survey the weather was fine but fairly cool with maximum ambient temperatures between 19-23℃. The daytime temperatures were typ ical of Albany in December (2006) and March (2007, 2009), with means of 21.8℃, 22.8℃ and 21.1 ℃ respectively. There was two days over 35℃ in March 2007, well above the average temperature of 22.8℃ for the month, and would have resulted in capturing reptile species more active at warmer temperatures. There were also days of light rain during both the December and March surveys, resulting in the frog species present to be active and caught in traps. The nocturnal temperatures during the trapping survey ranged from a minimum of 13-21℃. The nocturnal temperatures were generally warmer than the average of 13.9℃ for December and 15.5℃ for March. The survey results are therefore not likely to be limited by inappropriate weather conditions.

Frogs were caught and observed during the survey as there was some light rain during the survey period. Based on the database search results, frog species potentially caught in the area are not considered to be of significant conservation concern. Some frogs found in the Albany region can only positively be identified in the field using calls. If females and non-calling individuals are captured they can be difficult to identify. Voucher specimens were collected; however, the Western Australian Museum (WAM) staff also had difficulty in identifying some individuals.

Separate and mixed flocks of Carnaby's Black Cockatoos and Baudin's Black Cockatoos have been recorded in the Albany region. Unless the Black Cockatoos are found feeding and the observer gets a clear look at each bird it is not always possible to positively identify or record abundance of each species. Therefore, when observations were ambiguous, results were consolidated as both Black Cockatoos are listed under the Commonwealth *EPBC Act 1999* and as Schedule 1 under the WA *Wildlife Conservation Act 1950*.

Bat recordings using an Anabat recorder were only undertaken for three hours from sunset and any bat species that were active at other times of the night would not have been recorded. On one evening there was 0.2mm of rain which may have affected the operation of the Anabat recorder. Equipment failure also meant no data were collected from two other nights of attempted recording.

Friend *et al*., (1989) reported high captures of scolecophidians (blind snakes) and other fossorial reptiles in freshly disturbed areas, while Pianka reported *Varanus eremius* being attracted to freshly dug soil (E. R. Pianka, University of Texas, pers. comm. 2002). Greenslade (1973) described how using pit-traps immediately after they are dug-in could influence the capture of invertebrates. Soil disturbance as a result of digging in pit-traps prior to the survey could have therefore had an effect on the abundance or fauna assemblage caught. However, as all pits were set up in the same week the differences between each site were considered to be minimal when sites are compared. As a consequence, all pit-traps were set up during early December 2006 and were closed till the survey commenced on 16 December 2006. The pit-traps were also left in the ground between the December and March trapping surveys, so there should have been no dig-in effects during the March 2007 survey.

With the exception of the data collected by Coffey Environments at Emu Point, Yakamia and Bayonet Head, and *ecologia* (2007), there is limited quantitative terrestrial fauna data available for the Albany region. This is a limitation for this assessment when regional comparisons were requested as part of the survey scope of works.

The Wetland Mosaic habitat was surveyed at Bayonet Head and not in the Yakamia or Emu Point surveys. Coffey Environments therefore has limited quantitative information for regional comparisons for this specific habitat type occurring at Bayonet Head.

The EPA *Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56* (EPA, 2004) suggested that fauna

surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 8.

TABLE 8: FAUNA SURVEY LIMITATIONS AND CONSTRAINTS

Possible limitations	Constraint (yes/no); significant, moderate or negligible	Comment
Competency and experience of the consultant (s) carrying out the survey	No	The lead scientists who prepared the report and conducted the field assessments have appropriate training and experience in conducting fauna assessments. Less experienced field staff was supervised by competent scientists.
Scope	No	The survey scope was prepared in consultation with the client and DEC staff, and was designed to satisfy the objectives stated in Section 1.2.
Proportion of fauna identified, recorded and/or collected	Yes Negligible	Based on regional comparisons, desktop review of species found in the south west and species accumulation curves prepared for the trapped fauna assemblage, it is likely that most of the trappable terrestrial fauna and birds have been recorded.
Sources of information	Yes Moderate	Vertebrate fauna information was available using the WAM fauna database and Terrestrial Ecosystems database, surveys conducted at other sites in the region during the same survey period, and published and unpublished reports.
Proportion of the task achieved	No	The survey and assessment fulfils the objectives stated in Section 1.2.
Timing/weather/season/ cycle	No	The timing of the trapping survey was early summer and early autumn. Weather during the survey periods were typical of that experienced in Albany during these two months.
Disturbances which affected results of the survey	No	No significant disturbances took place during the survey which would affect the results or conclusions.
Intensity of survey effort	No	The intensity of the assessment was sufficient for a trapping survey of this type as indicated by species accumulation curves, comparison with similar sized surveys and results from other sites trapped in the region.
Completeness	No	Trapping grids were set up in each of the major habitat types available at Bayonet Head.
Resources	No	Adequate resources were available.
Remoteness and/or access problems	No	There were no access or remoteness issues.
Availability of contextual information on the region	Yes Moderate	WAM fauna database, DEC's Threatened and Priority species database, surveys conducted at other sites in the region during the same survey period and published and unpublished reports.

Negligible – less than 20%, moderate – 20-60%, significant – greater than 60%

4 FAUNA ASSESSMENT RESULTS

4.1 Fauna Habitat

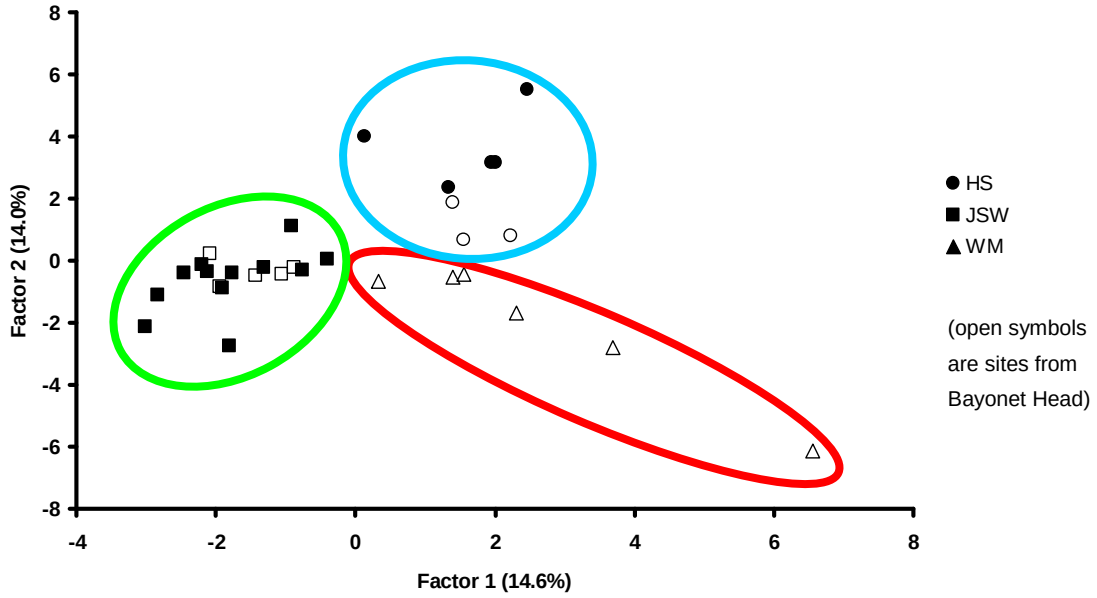
4.1.1 Bayonet Head Project Area

Coffey Environments mapped more than 20 different vegetation communities within the project area. Based on these vegetation surveys and on-ground assessments by experienced fauna personnel, nine fauna habitat types were initially described. However, many were variants and could be classified into four broad fauna habitats identified in the project area (Figure 2). They were:

- Jarrah/Sheoak woodland – (JSW) which includes BH3, BH10 and B13;
- Heath shrubland – (HS) which includes BH1, BH2, BH6, BH7 and BH14;
- Wetland Mosaic – (WM) - which includes BH4, BH5, BH8, BH9, BH11 and BH12; and
- Cleared/Pasture – (C/P) (no trapping conducted).

A PCA was subsequently conducted for the combined vertebrate trapping data and provided supporting evidence (clustering with no overlap) for three fauna habitats (Jarrah/Sheoak Woodland, Heath Shrubland and Wetland Mosaic) (Chart 1). Factor 1 account's for a large portion of variation in the Wetland Mosaic habitat. The pattern and placement of habitat clusters suggests canopy height is likely to be correlated with Factor 1. Jarrah/Sheoak Woodland habitat contains many large, tall trees. Heath Shrubland and Wetland Mosaic habitats have much lower canopies with the occasional medium size tree and are located next to the Jarrah/Sheoak Woodland on the horizontal axis large (no overlap). Finally, two Wetland Mosaic habitat sites are situated furthest right on the horizontal axis and both display the shortest canopy height. Comparatively, Factor 2 explains most variation observed in the Jarrah/Sheoak Woodland and Heath Shrubland habitat. Soil type and moisture content are likely to correlate closely with Factor 2. Heath Shrubland has the driest soil moisture content with sandy soils and lies at the top of the vertical axis. Jarrah/Sheoak Woodland and many Wetland Mosaic sites are located in the middle of the vertical axis with some overlap of Heath Shrubland habitat sites but have a higher soil moisture content and organic component. A Wetland Mosaic habitat site is located lowest on the vertical axis and displayed the highest soil moisture and organic material content of all trapping sites.

CHART 1: PRINCIPAL COMPONENTS ANALYSIS FOR HABITATS



4.1.1.1 Habitat Quality

Fauna habitat within the project area varied from highly degraded to high quality fauna habitat. The habitat condition of the project area is shown in Figure 3 and the descriptions are below.

High quality fauna habitat (1) – These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.

Very good fauna habitat (2) – These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be minimally effected by disturbance.

Good fauna habitat (3) – These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.

Disturbed fauna habitat (4) – These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain weeds or have been damaged by vehicle or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.

Highly degraded fauna habitat (5) – These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. Limited

or no fauna habitat connectivity. Faunal assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance.

Based on these descriptors, approximately half of the fauna habitat (central and south west sections of the project area) is considered to be in very good to excellent condition (Lots 1000, 1001, 476 and Part Lot 1; approximately 112ha) (Figure 3). Fauna habitat assessment of the remaining project area (Lots 37, 38, 39, 2, 3 and 286; approximately 79ha) was conducted in 2009 and varies from large areas of Cleared/Paddock – highly degraded – to small parts of high quality Jarrah/Sheoak Woodland.

Tree Hollows

Throughout the project area, over 40 trees with hollows considered suitable as nesting sites (diameter greater than 200mm) for Black Cockatoos, Masked Owls and WRPs were recorded (Table 9). These trees are considered important habitat for fauna as hollows often take 130 or more years to develop (Saunders *et al.*, 2003). Tree hollow locations tended to be concentrated in two areas: the central and eastern section of the project area. In excess of 20 tree hollows were located in the eastern section while 15 were located in the central section. The high densities of tree hollows located in these two areas indicate they are likely to be key areas of fauna habitat.

TABLE 9: TREE HOLLOW LOCATIONS FROM PROJECT AREA

Location (MGA Zone 50H)		Hollow Number	Tree Species
584794	6129125	1	Jarrah
584783	6129139	multiple	Jarrah
584915	6129314	1	Jarrah (dead)
584914	6129106	1	Jarrah (dead)
585392	6129643	1	Marri (dead)
585355	6129689	1	Marri (dead)
585695	6129739	1	Marri
585762	6129656	multiple	Jarrah
585820	6129660	multiple	Jarrah
585431	6129888	multiple	Marri (dead)
585441	6129704	multiple	Marri (dead)
586302	6129779	multiple	Jarrah (dead)
586232	6129795	1	Jarrah
586247	6129802	1	Jarrah
586264	6129784	1	Jarrah
586288	6129801	1	Jarrah
586302	6129820	1	Jarrah
586332	6129994	1	Jarrah
586326	6129981	1	Jarrah
586326	6129981	1	Jarrah
584794	6129125	1	Jarrah, E. marginata
584783	6129139	multiple	Jarrah, E. marginata
584915	6129314	1	Jarrah, E. marginata (dead)
584914	6129106	1	Jarrah, E. marginata (dead)
585695	6129739	1	Eucalyptus sp.
585820	6129660	1	Eucalyptus sp.
586332	6129994	1	Eucalyptus sp.
584915	6129314	1	Eucalyptus sp.
584914	6129106	1	Eucalyptus sp.
585392	6129643	1	Eucalyptus sp.
585355	6129689	1	Eucalyptus sp.
585762	6129656	1	Eucalyptus sp.
585431	6129888	1	Eucalyptus sp.
585441	6129704	1	Eucalyptus sp.
586302	6129779	1	Eucalyptus sp.
586232	6129795	1	Eucalyptus sp.
586247	6129802	1	Eucalyptus sp.
586264	6129784	1	Eucalyptus sp.
586288	6129801	1	Eucalyptus sp.
586302	6129820	1	Eucalyptus sp.
586326	6129981	1	Eucalyptus sp.
586326	6129981	1	Eucalyptus sp.

4.1.2 Regional Comparison

Trapping was conducted at other sites in the Albany area to provide data for regional comparisons. These sites were at Emu Point and Yakamia, both less than 10km from the Bayonet Head. Habitats at Emu Point and Yakamia included:

- Jarrah/Sheoak Woodland – (JSW) which includes YK1, YK2, YK3, YK4, YK5, YK6, YK7, YK8, YK9, YK10, YK11 and YK12;
- Heath Shrubland – (HS) which includes EP1, EP2, EP3, EP4, and EP5;

The project area contains fauna habitat typically found in the Albany region. Although no Wetland Mosaic fauna habitat was surveyed regionally (unavailable/inaccessible), Jarrah/Sheoak Woodland and Heath Shrubland are commonly found in the greater Albany area. On a regional basis, the south west part of the project area is linked to similar fauna habitat but is dissected by Lower King Road (Figure 2). Furthermore, the easterly section of the project area directly connects fauna habitat from Emu Point in the south to northern habitats of Oyster Harbour. Both of these habitat corridors within the project area are rated as high quality fauna habitat and are considered stands of natural remnant vegetation – comparable to Emu Point and Yakamia.

4.2 Fauna Present

4.2.1 Bayonet Head Project Area

4.2.1.1 Amphibians

Seven amphibian species were recorded from the project area (Table 10). The captured amphibian assemblage included two Hylids (tree frog) and three Myobatrachids (ground-dwelling frogs; Table 10). *Heleioporus eyrei* was the most commonly recorded amphibian (182 individuals). In contrast, only two individual *Litoria adelaidensis* were recorded within the Wetland Mosaic habitat. Most frogs (218 individuals) were recorded within the Wetland Mosaic habitat, suggesting it is an important habitat for frogs. In comparison, approximately 75 individuals were recorded each from Jarrah/Sheoak Woodland and Heath Shrubland. Therefore, permanent water or sufficient ground moisture with associated vegetation appears to be a focal point for frogs.

TABLE 10: AMPHIBIANS, REPTILES AND MAMMALS RECORDED IN THE ALBANY REGION

Taxa/Family	Species	Jarrah/Sheoak Woodland Habitat																	Heath Shrubland Habitat								Wetland Mosaic						Grand Total
		BH1	BH2	BH6	BH7	BH14	Yk1	Yk2	Yk3	Yk4	Yk5	Yk6	Yk7	Yk8	Yk9	Yk10	Yk11	Yk12	BH3	BH10	BH13	EP1	EP2	EP3	EP4	EP5	BH4	BH5	BH8	BH9	BH11	BH12	
Amphibian:																																	
Hylidae	***Litoria adelaidensis***																												1	1		2
	Litoria moorei										1	1	1											1	1	2		1	1	4	6	1	20
Limnodynastidae	***Heleioporus eyrei***	5	5	13	5	11	1	4		2	8	11	13	2	3	1		1	11	14	17	17	13	14	8	12	4	75	1	5	2	14	292
	Limnodynastes dorsalis	3		8	6	1	2	4	1	2	5	3	6	4	2	2		5	1	1	1	1				1	1	4	4	2	3	3	76
Myobatrachidae	***Crinia georgiana***	5	1	4	4	7	11	7	4	1	14	4		1	20	6	5	1		20	7						1	21	7	27	10	15	203
	Crinia pseudinsignifera												2					1		2	2					2			1	1	1		12
	Geocrinia leai																			1		1	1	2				1					6
Reptile																																	
Elapidae	***Echiopsis curta***		2																														2
	Elapognathus coronatus	1	2							1				6	5	3	4	6	2	1	1	8	7		7	4	2			1			61
	Notechis scutatus			1									1										3		1	1	1						8
	Rhinoplocephalus bicolor														1	1																	2
Gekkonidae	***Christinus marmoratus***	1	1	1	1		5	2	4	1	1			1	3	2	7					2						1					33
Pygopodidae	***Aprasia striolata***											1			3		1				1	1			1	2			1				11
Scincidae	***Acritoscincus trilineatum***	5	5	6	7	6	4	6	3	2	5	6	4	18	7	4	9	8	11	10	11	6	12	7	10	6	12	11	15	11	17	5	249
	Ctenotus catenifer	2	1	5		1						1					2	1	10	4	6	20	19	13	22	8	11	6	3	10	1	2	148
	Ctenotus labillardieri	1	1	1																													3
	Egernia kingie										2					1			3	5	2		1	1							1	1	17
	Egernia luctuosa															2													3	1	5		11
	Egernia napoleonis	8	7	3	2	4	5	2				1	3		10	12	1	1	1	2	1	2					5	1		3			74
	Egernia pulchra		1	1	1	3		4				5	1			2	1	1	2	5	8	1	7		2	4			1	3		2	55
	Glaphyromorphus gracilipes				1	1										2			2	1				1	3	1	4	3	5	3	9	1	37
	Hemiergis initialis															2		1			1										1		5
	Hemiergis peronii	7	9	5	14	13	20	10	5	15	16	5	15	7	12	10	15	6	5	12	8	9	7	2	2	7	3	10	3	4	6	11	273
	Lerista microtis	2	1	1	1	1		1	1	3	6	7	1	14		3	1	6	4	1	2	13	23	16	18	14		12	1	3	3	7	166
	Menetia greyii	1												2				2		1							1				1	1	9
	Morethia obscura																		1	1	1			2								1	6
	Tiliqua rugosa			4				1	2		1		2		4	1	1			2	1						8	5	1	4	7	4	48
Varanidae	***Varanus rosenbergi***							1			1		1				1															1	5
Mammal																																	
Dasyuridae	***Sminthopsis griseoventer***						3	10	7	5	11	19	3			1		1				10	2	5	2	7							86
Muridae	***Mus musculus***	1	1	4	2		1	4		3	5	1	1	9	11	6	1	10	2			1	2	3			5	2					75
	Rattus fuscipes	25	62	27	7	43	55	37	10	12	14	27	59	1	33	27	24	7	38	49	49	19	46	41	49	27	63	6	31	21	43	52	1004
	Rattus rattus							1				2						2							1								6
Peramelidae	***Isoodon obesulus***		1										2						2	1			1										7
Tarsipedidae	***Tarsipes rostratus***		1	4	6	1												1	4	3		11	4	2	2	5	4		3	2		1	54
Vespertilionidae	***Chalinolobus gouldii***																																*
	Falsistrellus mackenziei																																*
	Nyctophilus sp.																																*
	Vespadelus regulus																																*
Molossidae	***Tadarida australis***																																*
Pseudocheiridae	***Pseudocheirus occidentalis***																																38
Canidae	***Vulpes vulpes***																																+
Felidae	***Felis catus***																																+
Leporidae	***Oryctolagus cuniculus***																																+
Number of individuals		67	101	88	57	92	107	94	37	47	90	94	115	65	114	88	73	61	99	136	119	122	148	110	129	103	125	159	81	106	117	122	3066
Number of species		14	16	16	13	12	10	15	9	11	14	15	16	11	13	19	14	18	16	20	17	16	15	14	15	16	15	15	16	18	17	17	42

* recorded by echolocation calls; + tracks and scats

4.2.1.2 Reptiles

A total of nineteen species of reptile were trapped from the project area including 15 skinks, 3 elapids and 1 gecko (Table 10). Most reptiles were captured from the Wetland Mosaic habitat (259 individuals) while approximately half that number were recorded each from the Jarrah/Sheoak Woodland and Heath Shrubland. *Acritoscincus trilineatum* and *Hemiergis peronii* were found in all three fauna habitats and made up the majority of reptile recordings (132 and 110 individuals respectively) (Table 10). In comparison, *Echiopsis curta* and *Ctenotus labillardieri* were recorded only from the Jarrah/Sheoak Woodland and *Egernia luctuosa* was found solely in the Wetland Mosaic habitat. Furthermore, *Varanus rosenbergi* was also recorded opportunistically from the Wetland Mosaic habitat.

Within the project area, more species of reptile and slightly more individuals were recorded during the March 2007 survey compared with the December 2006 survey. Species that were caught during the March 2007 survey but not in the December 2006 survey include *Menetia greyii* and *Morethia obscura*, although, one species, *Echiopsis curta* was only recorded in the December 2006 survey (Table 10). Within the project area a number of species including *Elapognathus coronatus*, *Egernia napoleonis* and *Lerista microtis* were recorded in higher numbers during the March 2007 survey and several species including *Glaphyromorphus gracilipes*, *H. peronii* and *Tiliqua rugosa* were recorded in higher numbers during the December survey. These differences may be related to a number of factors, such as the temperatures at which these species are active and timing of their breeding season.

4.2.1.3 Mammals

Four species of mammal were trapped within the project area (Table 10). An additional 9 species, including WRPs, 5 bat species and 3 introduced species were recorded during spotlight and bat surveys (Table 10). A total of 566 individual mammals were captured within the project area, with *Rattus fuscipes* being the most commonly caught species (516 individuals). Two mammal species of conservation significance, the Western Ringtail Possum (*Pseudocheirus occidentalis*) and Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) were recorded within the project area. Another conservation significant species, the Western False Pipistrelle (*Falsistrellus mackenziei*) was also tentatively recorded from bat echolocation surveys.

Within the project area, the number of individuals and species did not differ between the two seasons. Slightly more individuals and species were recorded during the December 2006 survey compared with the March 2007 survey, but this difference is mostly due to one species, *R. fuscipes*.

4.2.1.4 Conservation Significant Mammals

Western Ringtail Possums were found in low numbers (12 individuals) throughout the project area (Table 11). However, Western Ringtail Possums tended to concentrate in two areas within the project area. These areas contained approximately 80% of WRPs and dreys observed and were located in the central and eastern sections of the project area. In total, 20 dreys were recorded and rated as 3 or 4. This indicates that most dreys were of a high quality, and were well formed and maintained instead of a platform of twigs, often in a tree or branch fork, with no more than a shallow depression where the possum rests.

TABLE 11: Western Ringtail Possum Observations

Location (MGA Zone 50H)		WRP/Drey	Drey Rating	Tree Species
586380	6130042	Drey	4	Marri
586448	6130063	Drey	4	Marri
586426	6130058	Drey	4	Marri
586438	6130058	Drey	4	Eucalyptus sp.
586429	6130093	Drey	4	Eucalyptus sp.
586422	6130134	Drey	3	Marri
586418	6130181	Drey	3	Marri
585706	6130156	Drey	3	Jarrah
586399	6130061	WRP	4	Marri
586390	6130082	WRP	3	Peppermint
585698	6130124	WRP	3	Marri
585703	6130126	WRP	3	Eucalyptus sp.
585696	6130135	WRP	2	Peppermint
585610	6129911	Drey	4	Eucalyptus sp.
585606	6129911	Drey	4	Eucalyptus sp.
585691	6130129	Drey	4	Marri
585703	6130122	Drey	4	Marri
585713	6130130	Drey	4	Eucalyptus sp.
585708	6130112	Drey	4	Jarrah
585706	6130127	WRP	2	Jarrah
585668	6130117	WRP	4	Jarrah
585671	6130122	Drey	3	Eucalyptus sp.
586448	6130047	WRP	4	Eucalyptus sp.
584858	6129748	Drey	3	Jarrah
584495	6129746	Drey	2	Peppermint
586402	6129833	Drey	4	Allocasuarina fraseriana
584762	6128921	WRP	4	Eucalyptus sp.
584935	6129439	WRP	4	Eucalyptus sp.
586328	6130000	WRP	3	Eucalyptus sp.
586328	6130000	WRP	3	Eucalyptus sp.
584858	6129748	Drey	2	Eucalyptus sp.
586402	6129833	Drey	4	Eucalyptus sp.

4.2.1.5 Avifauna

Seventy-eight bird species and 10,409 individual birds were recorded in the project area during the December 2006 and March 2007 surveys (Table 12). Three of the species that were recorded, the Australian Pelican, Straw-necked Ibis and Australian White Ibis were seen flying over but did not land within the project area. The White-breasted Robin was abundant in the project area with over 1,400 individuals. Thirteen species were also very common in the project area with over 300 individuals recorded per species.

4.2.1.6 Invertebrates

The following invertebrate species were collected from the pit traps and active foraging in the project area and identified by the staff at the WAM.

Millipedes

Several specimens of *Akamptogonus novarae* (family Paradoxosomatidae) were found in the Wetland Mosaic habitat of the project area. This species is very widespread across south-western Australia and is thought to have been introduced into the region from eastern Australia as early as the late 19 century. Several specimens of the native millipede family Lulomorphidae were found in the Wetland Mosaic habitat. Adult males were lacking from the samples and thus it was not possible to identify the specimens to genus or species level.

Land Snails

All specimens of snails collected from the Wetland Mosaic habitat at Bayonet Head belong to the family Zonitidae and genus *Oxychilus*. This genus is considered to be native to Europe and to have been introduced into north and South America, northern Asia, Japan, New Zealand, South Africa and Australia.

Scorpions

Two species of scorpion were recorded in the Jarrah/Sheoak Woodland habitat within the project area. *Urodacus novaehollandiae* (family Urodacidae) is a large burrowing scorpion that is relatively common in uncleared regions of south-western Australia. Of the three species of the genus *Cercophonius* now recognised from south-western Australia, *C. sulcatus* (family Bothriuridae) is the only species found along the south coast of Western Australia and was recorded from the project area.

Pseudoscorpions

One species of pseudoscorpion was recorded under the bark of trees in the Jarrah/Sheoak Woodland habitat within the project area. *Protogarypinus giganteus* (family Garypinidae) is a bark-dwelling species that occurs over much of the wetter regions of south-western Australia and can be locally common, especially in areas that have remained free of frequent burning regimes.

Mygalomorph Spiders

Two species of mygalomorph (trapdoor) spider were recorded from the Heath Shrublands habitat and these included two female specimens of *Cenistonia tepperi* (family Nemesiidae) and one immature specimen of *Chenistonia "paludigena"* ms. nom. BYM. *Chenistonia tepperi* is a widespread species throughout south-western Australia.

TABLE 12: BIRD SPECIES RECORDED IN THE ALBANY REGION

Family	Species	Common Name	Bayonet Head	Emu Point	Yakamia
Casuariidae	*Dromaius novaehollandiae*	Emu	1		
Phasianidae	*Coturnix pectoralis*	Stubble Quail	1		
Anatidae	*Tadorna tadornoides*	Australian Shelduck	2		
	Chenonetta jubata	Australian Wood Duck	1		
	Anas gracilis	Grey Teal	3		12
	Anas superciliosa	Pacific Black Duck	44	4	21
Columbidae	*Streptopelia senegalensis*	Laughing Dove	306	34	117
	Phaps chalcoptera	Common Bronzewing	15	1	
	Ocyphaps lophotes	Crested Pigeon	1		2
Podargidae	*Podargus strigoides*	Tawny Frogmouth	4		2
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	3		
Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant	1		
	Phalacrocorax sulcirostris	Little Black Cormorant	6	3	1
	Pelecanus conspicillatus	Australian Pelican	12		4
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	21	8	8
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	44		4
	Threskiornis spinicollis	Straw-necked Ibis	3	1	
	Platalea flavipes	Yellow-billed Spoonbill	7	2	1
Accipitridae	*Elanus axillaris*	Black-shouldered Kite			2
	Lophoictinia isura	Square-tailed Kite	3		1
	Haliastur sphenurus	Whistling Kite			5
	Accipiter fasciatus	Brown Goshawk	4		
	Accipiter cirrhocephalus	Collared Sparrowhawk	1		2
	Circus approximans	Swamp Harrier	7		1
	Hieraaetus morphnoides	Little Eagle	10	2	
	Pandion haliaetus	Osprey	23		3
Falconidae	*Falco cenchroides*	Nankeen Kestrel	1		
	Falco longipennis	Australian Hobby	3		
Rallidae	*Porphyrio porphyrio*	Purple Swamphen	3		
	Fulica atra	Eurasian Coot			2
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel		4	
Laridae	*Larus pacificus*	Pacific Gull	8	50	13
	Chroicocephalus novaehollandiae	Silver Gull	54		9
Cacatuidae	*Calyptorhynchus banksii,*	Red-tailed Black Cockatoo	63	12	19
	Calyptorhynchus latirostris	Black Cockatoos	50		
	Calyptorhynchus baudinii	(combined)			
	Eolophus roseicapillus	Galah	2		
Psittacidae	*Eolophus sp.*		63	25	46
	Glossopsitta porphyrocephala	Purple-crowned Lorikeet	2		
	Polytelis alexandrae	Princess Parrot	160	8	32
	Platycercus icterotis	Western Rosella		13	24
	Barnardius zonarius	Australian Ringneck	339	51	96
	Purpureicephalus spurius	Red-capped Parrot	18	13	10
	Neophema elegans	Elegant Parrot			3
Cuculidae	*Chalcites basalis*	Horsfield's Bronze-Cuckoo	19		8
	Chalcites lucidus	Shining Bronze-Cuckoo	5	1	1
	Cacomantis flabelliformis	Fan-tailed Cuckoo	87		16

Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra	1		2
	Todiramphus sanctus	Sacred Kingfisher	4		
Climacteridae	*Climacteris rufa*	Rufous Treecreeper	471	71	279
Maluridae	*Malurus splendens*	Splendid Fairy-wren	853	36	295
	Malurus elegans	Red-winged Fairy-wren	451	21	9
	Stipiturus malachurus	Southern Emu-wren	466	10	107
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren	609	9	140
	Gerygone fusca	Western Gerygone	157		21
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	17	24	43
	Acanthiza inornata	Western Thornbill	659	29	120
	Acanthiza apicalis	Inland Thornbill	73		2
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	3		
	Pardalotus striatus	Striated Pardalote	626	34	97
Meliphagidae	*Acanthorhynchus superciliosus*	Western Spinebill	145	16	49
	Anthochaera carunculata	Red Wattlebird	1		11
	Epthianura albifrons	White-fronted Chat	19		19
	Lichmera indistincta	Brown Honeyeater	770	249	363
	Phylidonyris novaehollandiae	New Holland Honeyeater	3		
	Melithreptus lunatus	White-naped Honeyeater	8		
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	61		1
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-Shrike	334	6	131
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	49	16	31
	Colluricincla harmonica	Grey Shrike-thrush		7	
Artamidae	*Cracticus torquatus*	Grey Butcherbird	311	23	75
	Cracticus tibicen	Australian Magpie	7		19
	Strepera versicolor	Grey Currawong	756	19	293
Rhipiduridae	*Rhipidura fuliginosa*	New Zealand Fantail	21		
	Rhipidura leucophrys	Willie Wagtail	159	15	79
Corvidae	*Corvus coronoides*	Australian Raven	33	2	4
Monarchidae	*Grallina cyanoleuca*	Magpie-Lark	60		5
Motacilidae	*Anthus novaeseelandiae*	Australasian Pipit		26	60
Estrildidae	*Stagonopleura oculata*	Red-eared Firetail	4		
Petroicidae	*Petroica multicolor*	Pacific Robin	17		
	Eopsaltria griseogularis	Western Yellow Robin	40		33
	Eopsaltria georgiana	White-breasted Robin	1459	375	1531
Timaliidae	*Zosterops lateralis*	Silvereye	162	3	6
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	231		53
	Petrochelidon nigricans	Tree Martin	41		34
Total number of birds			10,409	1,244	4,377
Number of bird species			78	38	60

4.2.2 Regional Comparison

4.2.2.1 Amphibians

Six of the seven amphibian species found in the project area were also captured regionally at Yakamia and Emu Point (Table 10). When compared to the project area, similar patterns of amphibian assemblages were found in the two fauna habitats surveyed. Regionally, five species of frogs were

captured from Jarrah/Sheoak Woodland habitat (162 individuals) compared to four within the project area and six amphibian species were found in the Heath Shrubland habitat (76 individuals) compared to five in the project area. *Heleioporus eyrei* was the most common frog species recorded regionally and in the project area. However, *L. adelaidensis* was not recorded from the regional survey areas which is likely due to no surveys being conducted in the Wetland Mosaic.

4.2.2.2 Reptiles

A total of 659 individuals were caught regionally from Yakamia and Emu Point (19 species in total) compared with 530 individuals and 20 reptile species from the project area (Table 10). *Hemiergis peronii* and *Acritoscincus trillineatum* were among the most recorded reptile species from both the project area and regionally (greater than 100 individuals captured each). In addition, a third species (*Lerista microtis*) had recordings of more than 100 individuals. Fauna habitat comparisons revealed similar species of reptiles were captured from the project area and regionally. In the Jarrah/Sheoak Woodland habitat, 12 of the 14 reptile species recorded from the project area were also captured regionally. All Heath Shrubland habitat reptile species recorded from Yakamia and Emu Point were also found in the project area except for *Christinus marmoratus* (Table 10).

4.2.2.3 Mammals

A total of 6 mammal species (666 individuals) were recorded regionally from Yakamia and Emu Point. Four of these species were native (Grey-bellied Dunnart, Honey Possum, Southern Brown Bandicoot and Bush Rat) and two introduced species (House Mouse and Black Rat) (Table 10). Bush rats made up much of the mammal species captures (73%) in the regional areas and the project area. However, Grey-bellied Dunnarts were caught in relatively high numbers from regional areas (86 individuals) but not the project area where they, and black rats, were absent. Fauna habitat types showed high similarity for mammal faunal assemblages. All six mammal species recorded regionally were found in both Jarrah/Sheoak Woodland and Heath Shrubland habitat (Table 10). The same was also observed in the two fauna habitats within the project area.

Western Ringtail Possums were observed from the regional study area (26 individuals). Comparatively, 12 WRPs were recorded from the project area indicating a higher density of WRPs is found regionally at Yakamia and Emu Point. However, the majority of WRPs and dreys were located within two areas from the Jarrah/Sheoak Woodland fauna habitat suggesting the project area does not contain a large area of suitable WRP habitat other than these two areas.

4.2.2.4 Avifauna

Fewer bird species (67) and individuals (5,621) were observed in the regional areas compared to the project area (78 and 10,409 respectively) (Table 12). Equivalent to the project area, the White-breasted Robin was the most abundant bird species with over 1,900 individuals. Conversely, only one species was common at Yakamia and Emu Point with over 300 individuals compared to 13 within the project area (Table 12). Given the size of the area and the fact that most birds moved freely among habitat types, they were not reported based on habitat type. Based on database searches, a total of 150 species of birds may potentially occur in the Albany region. However, database searches include a number of birds associated with marine and freshwater habitats. Species associated with marine habitats are unlikely to inhabit the project area, however, they may flyover.

4.2.3 Comparisons to Historical Regional Surveys

Prior to Coffey Environments survey of the Bayonet Head project area and two regional areas (Yakamia and Emu Point), few surveys had been conducted in the greater Albany region (Table 13). The surveys carried out by Coffey Environments were significantly larger than all other studies performed in the past. Furthermore, many former surveys lacked the diversity of trap types to capture a complete representative of fauna species. Therefore, high confidence in presence and absence of fauna and faunal assemblages is warranted when considering the size and scale (local and regional) of the data presented in this report.

TABLE 13: COMPARISON OF TRAP TYPE AND INTENSITY OF SURVEYS UNDERTAKEN IN REGION

Trap type						Survey location and source
Bucket Pit-trap nights	**Pipe-pit trap nights**	**Funnel trap nights**	**Elliott trap nights**	**Cage trap nights**	**Total trap nights**	
5712	5712	11424	5712	952	28560	This survey
425	425	1700	850	425	3825	Mardo Ave, Australind; ATA Environmental, (2005)
180*		-	500	50	730	Australind; *ecologia* Environmental Consultants, (2001a)
112	168	-	560	140	980	Smiths Beach; *ecologia* Environmental Consultants, (2001b)
50	190	-	525	315	1080	Eagle Bay; Harewood, (2005)
60**			250		310	Cape Naturaliste; How, Dell and Humphreys, (1987)

*Estimate based on conversation with consultant as the exact pit-trap used is not clear.
**Estimate based on personal communication with author.

4.3 Significant Fauna Species Recorded or Predicted to Occur at Bayonet Head

4.3.1 Vertebrate Fauna

The fauna species listed in Table 14 have conservation status under State and/or Commonwealth *EPBC Act 1999* legislation. Each species has either been previously recorded or has been listed as having the potential to occur in the vicinity of Bayonet Head.

Ten threatened species of fauna and fourteen migratory species of birds listed as potentially occurring in the project area were identified under the *EPBC Act 1999* as having national environmental significance and could occur in the Bayonet Head area (Table 14). Threatened and Priority species listed under the Western Australian *Wildlife Conservation Act 1950* and the DEC's Priority Fauna List as potentially occurring in the region are listed in Table 14. Fourteen Schedule 1, two Schedule 4 and five Priority fauna species potentially occur in the vicinity of the project area. Only those migratory species recorded in the database searches are listed in Table 14.

TABLE 14: SIGNIFICANT FAUNA SPECIES RECORDED OR PREDICTED TO OCCUR IN THE REGION

Species	Dec Schedule / priority	Status under commonwealth *epbc act*	Comment
Carnaby's black-cockatoo ***Calyptorhynchus latirostris***	**Schedule 1**	**Endangered**	**Species *recorded* in the project area**
Baudin's black-cockatoo ***Calyptorhynchus baudinii***	**Schedule 1**	**Vulnerable**	**Species *recorded* in the project area**
Forest red-tailed black-cockatoo ***Calyptorhynchus banksii naso***	**Schedule 1**	**Vulnerable**	**Species *recorded* in the project area**
Western ground parrot ***Pezoporus wallicus flaviventris***	**Schedule 1**	**Endangered/ migratory**	**Species *highly unlikely* in the project area**
Western whipbird (western heath) ***Psophodes nigrogularis nigrogularis***	**Schedule 1**	**Endangered**	**Species *unlikely* in the project area**
Western whipbird (western mallee) ***Psophodes nigrogularis oberon***	**Schedule 1**	**Vulnerable**	**Species *unlikely* in the project area**
Dibbler ***Parantechinus apicalis***	**Schedule 1**	**Endangered**	**Species *unlikely* in the project area**
Noisy scrub-bird ***Atrichornis clamosus***	**Schedule 1**	**Vulnerable**	**Species *unlikely* in the project area**
Western bristlebird ***Dasyornis longirostris***	**Schedule 1**	**Vulnerable**	**Species *unlikely* in the project area**
Chuditch, western quoll ***Dasyurus geoffroii***	**Schedule 1**	**Vulnerable**	**Species *possibly* in the project area**
Western ringtail possum ***Pseudocheirus occidentalis***	**Schedule 1**	**Vulnerable**	**Species *recorded* in the project area**
Quokka ***Setonix brachyurus***	**Schedule 1**	**Vulnerable**	**Species *unlikely* in the project area**
Gilbert's potoroo ***Potorous gilbertii***	**Schedule 1**	**Critically endangered**	**Species *unlikely* in the project area**
Southern brush-tailed phascogale ***Phascogale tapaotafa tapaotafa***	**Schedule 1**		**Species *possibly* in the project area**
Carpet python ***Morelia spilota imbricata***	**Schedule 4**		**Species recorded in region and *possibly* found in the project area**
Peregrine falcon ***Falco peregrines***	**Schedule 4**		***Possible* infrequent visitor to the project area**
Masked owl ***Tyto novaehollandiae novaehollandiae***	**Priority 3**		**Species *possibly* in the project area**
Western brush wallaby ***Macropus irma***	**Priority 4**		**Species *unlikely* in the project area**
Western false pipistrelle ***Falsistrellus mackenziei***	**Priority 4**		**Species *recorded* in the project area**
Eastern curlew ***Numenius madagascariensis***	**Priority 4**	**Migratory**	**Species *highly unlikely* in the project area**
Quenda, southern brown bandicoot ***Isoodon obesulus fusciventer***	**Priority 5**		**Species *recorded* in the project area**
Rainbow bee-eater ***Merops ornatus***		**Migratory**	**Species *possibly* in the project area**
White-bellied sea eagle ***Haliaeetus leucogaster***		**Migratory**	**Species *possibly* in the project area**
Grey plover ***Pluvialis squatarola***		**Migratory**	**Species *highly unlikely* in the project area**

The following species descriptions provide a commentary on fauna that are listed in *FaunaBase*, the DEC's Threatened fauna database and DEWHA *EPBC Act 1999* database as being potentially found in the project area.

Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)

This species inhabits the south-west of WA. It is uncommon to common in the subhumid zone and wetter parts of the semiarid zone, with scarce to patchy distribution in the driest parts of its range. Recent surveys suggest it appears to be increasing in relative abundance in the northern Jarrah forest and in the deep south-west and is relatively common in the far south-east of its range (Johnstone *et al.*, 2003). Carnaby's Black Cockatoo breed mainly in the Wheatbelt and move west after breeding. However, it would appear that land clearing may have influenced breeding areas with a shift southwards and westwards (Johnstone *et al.*, 2003). Breeding has recently been recorded in the northern Darling Range at Bindoon, Chittering, Walyunga, The Lakes, the Upper Helena River, near Christmas Tree Well, Karragullen, Serpentine National Park, and Bannister (Johnstone *et al.*, 2003). It has also been recorded breeding on the Swan Coastal Plain at Yanchep, east of Gingin, Mooliabeenee, south of Mandurah, near Bunbury and in the deep south-west at Nannup (Johnstone *et al.*, 2003).

Carnaby's or mixed flocks of Black Cockatoo has been observed feeding on a wide range of foods including the seeds of *Banksia, Hakea, Eucalyptus, Corymbia, Grevillea, Mesomelaena, Pinus* and *Allocasuarina* spp. (Saunders, 1974a; b; 1980). It also feeds on the flowers of *Banksia sessilis, B. lindleyana, B. quercifolia, B. squarrosa, Lambertia inermis, Banksia grandis, Eucalyptus*, *Corymbia, Grevillea* and *Callistemon* spp., the fruiting nut trees, fruiting apples, soft fruits, Plane trees, Liquidambar and the seeds of Corkscrew, *Erodium* spp., and Wild Radish (Johnstone and Storr, 1998; Saunders, 1980; Saunders, 1974b).

Carnaby's Black Cockatoo was recorded foraging in the project area during the December 2006 survey.

Coffey Environments' assessment is that clearing the Jarrah/Sheoak Woodland habitat in the project area is likely to result in a loss of potential foraging habitat for Black Cockatoos.

Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)

Baudin's Black Cockatoo is distributed across the south-western humid and subhumid zones of Western Australia. Between March and September it visits the central and northern Darling Range and adjacent far eastern areas of the Swan Coastal Plain and during the breeding season (September to December) it is found in the deep south-west (Johnstone and Storr, 1998). Baudin's Black Cockatoo breeds in the south-west Jarrah/Marri and Karri forests and Wandoo woodland north to Serpentine, and possibly also further north, with unconfirmed reports near Christmas Tree Well and Hovea (Johnstone *et al.*, 2003). It has also been recorded breeding east to Kojonup, possibly further east to Waychinicup National Park and there are also unconfirmed reports from near Bunbury (Johnstone *et al.*, 2003).

Baudin's Black Cockatoo has been recorded mainly feeding on the seeds of Marri, *Corymbia calophylla* as well as *Eucalyptus* spp., *Banksia grandis, B. littoralis, B. ilicifolia, Hakea undulata, H. prostrata, H. trifurcata,* and *Xanthorrhoea* (Saunders, 1974a; 1974b; 1979; Johnstone and Storr, 1998; Sedgwick, 1964). The species also feeds on the flowers of *Banksia* and *Eucalyptus* spp., the seeds of introduced trees *Macadamia* and *Pinus*, fruiting apples, pears and persimmons, and the seeds of weeds such as *Erodium* spp.

Baudin's or mixed flocks of Black Cockatoo was recorded foraging in the project area during the December 2006 survey only.

Coffey Environments' assessment is that clearing the Jarrah/Sheoak Woodland habitat in the project area is likely to result in a loss of potential foraging habitat for Black Cockatoos.

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)

The Forest Red-tailed Black Cockatoo is endemic to the south-west humid and subhumid zones of Western Australia (Mawson and Johnstone, 1997). It inhabits the dense Jarrah, Karri and Marri forests receiving more than 600mm of annual average rainfall (Saunders *et al.*, 1985). The current distribution of the Forest Red-tailed Black Cockatoo is north of Perth and east to Mount Helena, Christmas Tree Well, North Bannister, Mt Saddleback, Rocky Gully and the upper King River. The movements of this species are irregular (Sedgwick, 1949) and they can now be found on the Swan Coastal Plain at any time of the year. The Forest Red-tailed Black Cockatoo roosts in Jarrah/Marri/Blackbutt habitat on roadsides, paddocks and forest blocks (Johnstone and Kirby, 1999). It appears that they may only breed in the north and east of their range on the margins of the forest (Higgins, 1999) and nest in the large hollows of Marri, Jarrah and Karri (Johnstone and Kirby, 1999).

The Forest Red-tailed Black Cockatoo feeds mainly on the seeds of Marri and Jarrah (90% of diet). Other species used for feeding include Blackbutt, *E. patens*, Albany Blackbutt, *E. staeri*, *Allocasuarina fraseriana*, *Persoonia longifolia* and the introduced Spotted Gum, *E. maculata* and Cape Lilac, *Melia azedarach* (Johnstone and Kirby, 1999).

Forest Red-tailed or mixed flocks of Black Cockatoos were recorded foraging within the project area during the December 2006 survey.

Coffey Environments' assessment is that clearing the Jarrah/Sheoak Woodland habitat in the project area is likely to result in a loss of potential foraging habitat for Forest Red-tailed Black Cockatoos.

Western Ground Parrot (*Pezoporus wallicus flaviventris*)

The Western Ground Parrot is listed as Endangered under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. The Western Ground Parrot was previously found on the coastal plains of south-west Western Australia from Perth to Dongara and Israelite Bay to Augusta. It is now restricted to Fitzgerald River National Park, Cape Arid National Park and Waychinicup-Many Peaks area. The Western Ground Parrot lives in floristically diverse heathlands, where it feeds on fruits, seeds and leaves. Fire is currently the main threat to this subspecies and the more dense populations are found in heath that has not been burnt for at least 35 years.

Coffey Environments' assessment is that the Western Ground Parrot is highly unlikely to be found in the project area due to its highly restricted distribution and that the project area is surrounded by residential and rural development. The proposed development is therefore highly unlikely to have any impact on this species.

Western Whipbird (western heath) (*Psophodes nigrogularis nigrogularis*)

The Western Whipbird is listed as Endangered under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. This subspecies was previously found in the south-west of Western Australia, along the west coast from Perth to Augusta and on the south coast from King George Sound east to at least Two Peoples Bay. It is now restricted to a small area east of Albany between Mt Taylor and Cheyne Beach/Waychinicup River, Two Peoples Bay Nature Reserve and Mt Manypeaks. At Two Peoples Bay, the Western Whipbird (western heath) occurs in dense shrubland with an open overstorey and the structure of the vegetation is more important than floristics. The main threat to this subspecies is fire and it will normally only recolonise an area 4-10 years after being burnt.

Coffey Environments' assessment is that the Western Whipbird (western heath) is unlikely to be found in the project area due to its restricted distribution and its susceptibility to disturbance. The proposed development is therefore highly unlikely to have any impact on this species.

Western Whipbird (western mallee) (*Psophodes nigrogularis oberon*)

The Western Whipbird is listed as Vulnerable under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. This subspecies was previously known from near-coastal areas in south-western Western Australia between Cape Arid and Cape Riche. Its present range includes scattered sub-populations between Munglinup, east of Ravensthorpe west to at least Cape Riche on the coast and inland to Sukey Hill, east of Cranbrook and north to Lake Grace. The largest sub-populations are found in Fitzgerald and Stirling Ranges National Parks. The Western Whipbird (western mallee) is generally found in mallee and heath habitats with dense vegetation. At least half of the Western Whipbird's (western mallee) habitat has been cleared for agriculture.

Coffey Environments' assessment is that the Western Whipbird (western mallee) is unlikely to be found in the project area due to its susceptibility to disturbance, given that the project area is close to residential and rural development. The proposed development is therefore highly unlikely to have any impact on this species.

Dibbler (*Parantechinus apicalis*)

The Dibbler is listed as Endangered under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. Its initial distribution extended along the west coast from Perth north to Shark Bay and along the south coast from Torndirrup to Israelite Bay and as far inland as Peak Charles. The Dibbler is currently known from Whitlock, Escape and Boullanger Islands, Jurien Bay, and Fitzgerald River National Park on the south coast. It has also been recorded in Torndirrup National Park and Waychinicup National Park in recent years. In Fitzgerald River National Park, Dibblers have usually been trapped in dense, historically unburnt vegetation with a thick litter layer and sandy soils. Dibblers typically occupy heath and mallee-heath vegetation communities, where they have been located on the south coast of Western Australia. Threats to the Dibbler include feral cats and foxes, land clearing of important vegetation such as *Banksia* woodlands and kwongan heath, dieback disease that can alter the vegetation structure of a plant community, and frequent fire that may reduce thick vegetation.

Coffey Environments' assessment is that the Dibbler is unlikely to be found in the project area due to its restricted distribution and the proximity of the project area to residential development. The proposed development is therefore highly unlikely to have any impact on this species.

Noisy Scrub-bird (*Atrichornis clamosus*)

The Noisy Scrub-bird is listed as Vulnerable under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. It is endemic to the south-west of Western Australia. There are currently five gradually coalescing sub-populations east from Two Peoples Bay near Albany to Cheyne Beach. It has been successfully reintroduced to Bald Island and the Darling Ranges near Waroona. Noisy Scrub-bird habitat typically contains dense clumps of sedges, shrubs or piles of debris for nesting interspersed with small open areas with a thick accumulation of leaf litter and a well-developed litter fauna for feeding. The disappearance of the Noisy Scrub-bird from most of its former range has been attributed to changes in fire regimes.

Coffey Environments' assessment is that the Noisy Scrub-bird is possibly found in the project area as suitable habitat is present; however it is considered unlikely due to the small size and proximity of the project area to development. The proposed development is therefore unlikely to have any impact on this species.

Western Bristlebird (*Dasyornis longirostris*)

The Western Bristlebird is listed as Vulnerable under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. This species was previously known along the coast from Perth to Augusta, Albany and the eastern end of Fitzgerald River National Park. It is now found east of Albany between Two Peoples Bay Nature Reserve and east of Waychinicup River, and from five locations in the Fitzgerald River National Park. Some birds were translocated in 1999 to Walpole. The Western Bristlebird is terrestrial and sedentary, with a preference for dense low heaths. The Western Bristlebird is particularly vulnerable to habitat destruction or alteration and fire is the main threat, with fires at less than 5-10 year intervals leading to local extinctions.

Coffey Environments' assessment is that the Western Bristlebird is unlikely to be found in the project area due to the small size and proximity of the project area to development and the species susceptibility to disturbance. The proposed development is therefore highly unlikely to have any impact on this species.

Chuditch (*Dasyurus geoffroii*)

The Chuditch is listed as Vulnerable under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. Formerly known from over 70% of Australia, the Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of south-west WA, but they have been found in dry sclerophyll forests, riparian vegetation, beaches and deserts.

The Chuditch is able to utilise bush remnants and corridors and its preferred habitat does occur within the project area. However, the Chuditch was not recorded within the project area during either survey. The proposed development is therefore highly unlikely to have any impact on this species.

Western Ringtail Possum (*Pseudocheirus occidentalis*)

The Western Ringtail Possum (WRP) is listed as Vulnerable under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. The WRP is closely associated with stands of Native Peppermint trees (*Agonis flexuosa*). The leaves of Peppermint trees are the primary food source of the species, but individuals in residential areas may feed on garden plants, fruit and vegetables in compost heaps. Western Ringtail Possums are nocturnal and usually shelter by day in dreys (bird-like nests). These dreys are typically located in the crown of Peppermint trees, but may be

constructed in other tree species, such as *Melaleuca, Banksia*, or Marri and Jarrah trees. Dreys may also be present in hollow trees.

Sixteen WRP dreys and 32 trees with hollows suitable for possums were recorded within the project area (Table 13). Dreys were recorded in Peppermint, Jarrah and Marri trees, as well as several other species of trees that were unable to be identified at the time. WRPs were recorded during each of the December 2006 and March (2007 and 2009) surveys and on Jarrah/Sheoak Woodland and Wetland Mosaic habitats.

Coffey Environments recorded the Western Ringtail Possum in very low densities within the project area and has determined that although clearing of vegetation is likely to result in some loss of habitat for this species, it is considered unlikely to be a significant impact given the species' low density.

Quokka (*Setonix brachyurus*)

The Quokka is listed as Vulnerable under the *EPBC Act 1999* and as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. At the time of European settlement the Quokka was common across the south-west of WA. The current distribution of the Quokka now includes Rottnest and Bald Islands and at least 25 sites on the mainland including Two Peoples Bay, Torndirrup National Park, Mt Manypeaks National Park, Walpole-Nornalup National Park, muddy lakes and swamp areas throughout the south-west forests from Jarrahdale to Walpole. The mainland Quokka generally inhabits densely vegetated coastal heaths, swamps and riverine habitats where they are less vulnerable to predation. The Quokka was not listed in the DEC threatened fauna database search for the area.

Coffey Environments' assessment is that the Quokka was not recorded during the trapping survey and its preferred habitat does not occur within the project area. The proposed development is therefore highly unlikely to have any impact on this species.

Southern Brush-tailed Phascogale (*Phascogale tapaotafa tapaotafa*)

The Southern Brush-tailed Phascogale is listed as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. The present range of this species is believed to have been reduced to 50% of its former range. It is now known from Perth and south to Albany, west of Albany Highway. It occurs in low densities in the northern Jarrah forest with highest densities found in the Perup/Kingston area, Collie River valley, and near Margaret River and Busselton. This subspecies was previously listed as a Priority 3 species but was recently added to the threatened species list as Schedule 1 due to an ongoing decline in its population. This arboreal marsupial has been observed in dry sclerophyll forests and open woodland that contain hollow-bearing trees but a sparse ground cover. Records are less common from wetter forests.

Coffey Environments' assessment is that the Southern Brush-tailed Phascogale possibly occurs in the Jarrah/Sheoak Woodland habitat; however, it was not recorded despite extensive trapping and spotlighting surveys. If present, any clearing of vegetation is likely to result in a loss of habitat for this species.

Carpet Python (*Morelia spilota imbricata*)

The Carpet Python is listed as a Schedule 4 species under the WA *Wildlife Conservation Act 1950*. The Carpet Python is a large snake found across the south-west of Western Australia, from Northampton, south to Albany and eastwards to Kalgoorlie including undisturbed remnant bushland near Perth and the Darling Ranges. This subspecies has been recorded from semi-arid coastal and inland habitats, Banksia woodland, Eucalypt woodlands and grasslands.

Coffey Environments' assessment is that the Carpet Python is likely to occur in the region and possibly in the project area due to suitable habitat, however, it was not recorded during the recent survey. If the Carpet Python is present, clearing of the vegetation is likely to result in a loss of habitat for this species.

Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is listed as a Schedule 1 species under the WA *Wildlife Conservation Act 1950*. The Peregrine Falcon is uncommon, although widespread throughout much of Australia excluding the extremely dry areas and has a wide and patchy distribution. It shows habitat preference for areas near cliffs along coastlines, rivers and ranges and in woodlands along watercourses and around lakes. It favours hilly or mountainous country and open woodlands and may be an occasional visitor to the project area.

Coffey Environments' assessment is that the Peregrine Falcon is possibly an infrequent visitor to the project area, but the potential loss of habitat due to development is unlikely to have an impact on this species.

Masked Owl (*Tyto novaehollandiae novaehollandiae*)

The Masked Owl is listed as a Priority 3 species by the DEC. Little information is available on the Masked Owl; however, it is known from Yanchep east to Yealering, south to Gnowangerup and Albany and occasionally seen north to Geraldton. The Masked Owl inhabits forests and woodlands and nests in tree hollows. It is locally common around Karridale and Manjimup, but is generally uncommon elsewhere.

The Masked Owl was recorded from Green Valley in 2001. Coffey Environments' assessment is that the Masked Owl possibly occurs in the project area with several trees containing potentially suitable nesting hollows observed in the project area (Figure 3). However, the Masked Owl has a large home range and if this species is present, there are likely to be few individuals. Therefore, clearing may force individuals to move to alternative habitats.

Western Brush Wallaby (*Macropus irma*)

The Western Brush Wallaby is listed as a Priority 4 species by the DEC. This species was very common in the early days of settlement, however, its range has been seriously reduced and fragmented and there is a significant decline in abundance in most remaining habitat. It is now distributed across the south-west of Western Australia from north of Kalbarri to Cape Arid. The optimum habitat is open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets.

The Western Brush Wallaby possibly occurs in the project area due to suitable habitat. However, it is Coffey Environments' assessment that given the size of the project area it is considered unlikely to be present as it was not seen during any of the surveys.

Western False Pipistrelle (*Falsistrellus mackenziei*)

The Western False Pipistrelle is listed as a Priority 4 species by the DEC. This bat species lives in hollows in old trees, branches and stumps. It is normally found in colonies of 5 to 30 bats. Western False Pipistrelles are vulnerable to loss of roosting sites in tree hollows and loss of feeding grounds by forestry activities, clearing for agriculture and housing. They live mainly in wet sclerophyll forests of Karri, Jarrah and Tuart.

The Western False Pipistrelle was recorded from Mill Brook Nature Reserve in 1999 and was tentatively identified from the echolocation surveys within the project area. It is Coffey Environments' assessment that if this species occurs within the project area it is likely to be in low numbers due to the small number of hollows for roosting. Clearing of vegetation and the subsequent decline in available prey will have a minor impact on this bat species.

Eastern Curlew (*Numenius madagascariensis*)

The Eastern Curlew is listed as a Priority 4 species by the DEC. The Eastern Curlew is an uncommon visitor to the northern Peel Inlet and southern Leschenault Inlet, but is generally rare to scarce elsewhere. It is mainly found on mudflats and samphire flats in estuaries and also can be found on ocean beaches, reef flats and near-coastal lakes.

The Eastern Curlew was recorded from Albany and Oyster Harbour in 1998. Coffey Environments' assessment is that this species is highly unlikely to occur in the project area due to an absence of suitable habitat.

Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)

The Southern Brown Bandicoot or Quenda is listed as a Priority 5 species by the DEC. Quenda prefer dense scrub (up to one metre high), often in or near swampy vegetation. They will often feed in adjacent forest and woodland that is burnt and in areas of pasture and cropland lying close to dense cover. Major threats to Quenda include habitat fragmentation and loss of habitat on the Swan Coastal Plain and Wheatbelt, fire in fragmented habitat, predation by foxes, predation of young by cats and predation around residential areas by dogs.

Coffey Environments recorded one individual in the Jarrah/Sheoak Woodland habitat at site BH2 and two individuals in the Heath Shrubland habitat at site BH3. It is therefore likely that the Quenda occurs at low densities in all habitats throughout the project area. Any clearing of vegetation is likely to result in a loss of habitat for the Quenda.

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is listed as Migratory under the *EPBC Act 1999*. This species is found across the better-watered parts of Western Australia including islands. It prefers lightly wooded, preferably sandy, country near water. It is a resident, breeding visitor, postnuptial nomad, passage migrant and winter visitor, wintering from the Gascoyne north to Indonesia. It moves south mainly in late September and early October and north from February to April. It is scarce to very common across its range.

Coffey Environments' assessment is that the Rainbow Bee-eater, although possibly occurring but not recorded in the project area, is unlikely to rely on the project area for survival.

White-bellied Sea Eagle (*Haliaeetus leucogaster*)

The White-bellied Sea Eagle is listed as Migratory under the *EPBC Act 1999*. White-bellied Sea Eagles are most commonly found around the coastline; however, they have been reported many kilometres inland.

This species was not recorded during the survey but Coffey Environments' assessment is that the White-bellied Sea Eagle possibly occurs in the project area, however it is considered unlikely to rely on the project area for survival.

Grey Plover (*Pluvialis squatarola*)

The Grey Plover is listed as Migratory under the *EPBC Act 1999*. The Grey Plover is a common migrant from the Arctic and is common along the western and southern coasts of Australia. On the coast it usually inhabits marine shores of estuaries or lagoons on broad, open mudflats, sandy bars or beaches, rock platforms and reef flats of rocky coasts. It can be found inland but still near the coast on margins of salt lakes and swamps.

Coffey Environments' assessment is that the Grey Plover is highly unlikely to occur in the project area due to an absence of suitable habitat.

4.4 Fauna Assemblage Structure

4.4.1 Trap Type

Five trap types were used in this survey with different trap types sampling the small vertebrate assemblages differently (Thompson *et al.,* 2005; Thompson and Thompson, 2007b). Amphibians were predominantly caught in bucket traps (373) with no amphibians caught in cage traps. Most reptiles were caught in funnel traps (471) and bucket pit-traps (586). Most mammals were caught in Elliott traps (749) followed by bucket pit-traps (231) and pipe traps (219). Overall the most successful trap type was a bucket pit-trap (1,075 captures) followed by funnel trap (661 captures). Table 15 provides a comparison of each species caught within the project area and the relative success of each trap type.

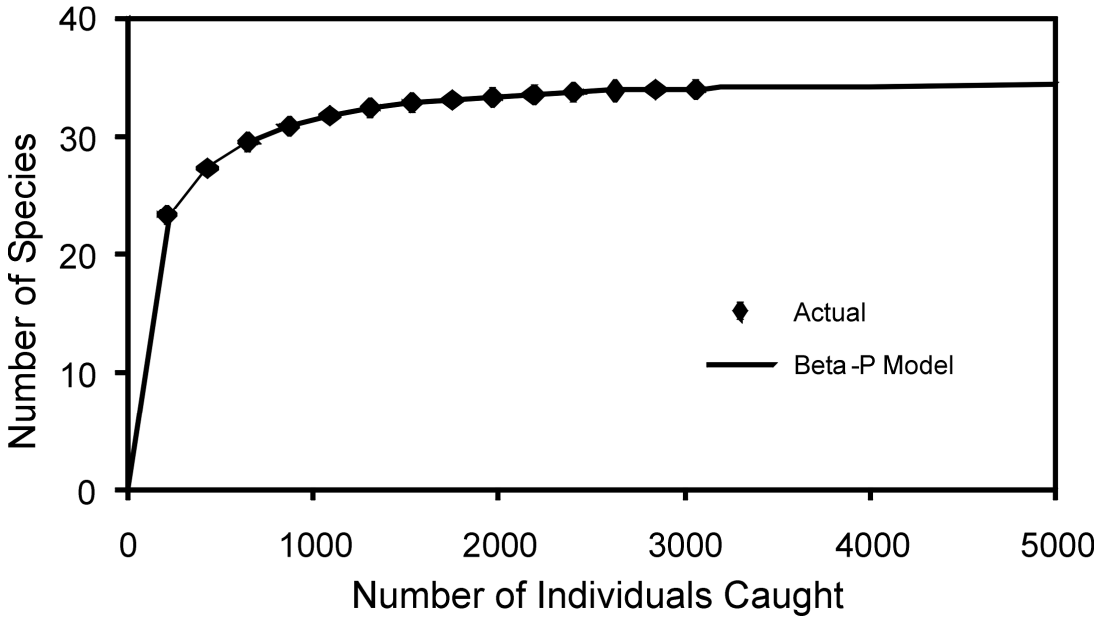
TABLE 15: VERTEBRATE FAUNA CAPTURES PER TRAP TYPE WITHIN THE PROJECT AREA

Family	Species	Common Name	Bucket	Pipe	Funnel	Elliot	Cage
Amphibian							
Hylidae	*Litoria adelaidensis*	Slender Tree Frog	1	1			
	Litoria moorei	Motorbike Frog	6	12	2		
Limnodynastidae	*Heleioporus eyrei*	Moaning Frog	171	94	25	2	
	Limnodynastes dorsalis	Western Banjo Frog	46	20	10		
Myobatrachidae	*Crinia georgiana*	Quacking Frog	136	53	14		
	Crinia pseudinsignifera	Bleating Froglet	7	2	2		
	Crinia sp.		1				
	Geocrinia leai	Ticking Frog	5	1			
Reptiles							
Elapidae	*Echiopsis curta*	Bardick	2				
	Elapognathus coronatus	Crowned Snake	18	5	34	4	
	Notechis scutatus	Tiger Snake	2	1	5		
	Rhinoplocephalus bicolor	Square-nosed Snake		1	1		
Gekkonidae	*Christinus marmoratus*	Marbled Gecko	11	5	17		
Pygopodidae	*Aprasia striolata*		6	4	1		
Scincidae	*Acritoscincus trilineatum*		56	23	166	4	
	Ctenotus catenifer		66	17	65		
	Ctenotus labillardieri		1		2		
	Egernia kingii	King's Skink	1		3	12	1
	Egernia luctuosa	Western Swamp Skink	2		9		
	Egernia napoleonis		20	5	45	4	
	Egernia pulchra		15	1	37	2	
	Glaphyromorphus gracilipes		8	8	21		
	Hemiergis initialis		2	1	2		
	Hemiergis peronii		125	33	114	1	
	Lerista microtis		119	8	39		
	Menetia greyii		5	2	2		
	Morethia obscura		2	2	2		
	Tiliqua rugosa		9	4	18	12	5
Varanidae	*Varanus rosenbergi*	Heath Monitor	1		3	1	
Mammals							
Dasyuridae	*Sminthopsis griseoventer*	Grey-bellied Dunnart	54	29	2	1	
Tarsipedidae	*Tarsipes rostratus*	Honey Possum	35	17	2		
Peramelidae	*Isoodon obesulus*	Southern Brown Bandicoot	1			4	2
Macropodiae	*Macropus fuliginosus*	Western Grey Kangaroo					
Muridae	*Mus musculus*	House Mouse	41	25	2	7	
Muridae	*Rattus fuscipes*	Bush Rat	100	147	16	732	9
Muridae	*Rattus rattus*	Black Rat		1		5	
Total number of individuals			**1075**	**522**	**661**	**791**	**17**
Total number of species			**33**	**28**	**29**	**14**	**4**

4.4.2 Species Accumulation Curves

When all habitat types were combined a total of 34 trappable species of vertebrate fauna (mammals, amphibians and reptiles) and 3,066 individuals were trapped within the regional area. Species accumulation curve modelling predicted that 34.4 species would be present if 5,000 individuals were recorded (Chart 2). Confirmation of sufficient sampling effort was demonstrated with 99% of the predicted trappable vertebrate species recorded from the region.

CHART 2: SPECIES ACCUMULATION CURVE FOR TRAPPABLE SPECIES CAPTURED FROM ALL SITES



Across all surveys and habitats a total 31 trappable species of vertebrate fauna (mammals, amphibians and reptiles) and 1,469 individuals were trapped within the project area. Species accumulation curve modelling predicted that 32.9 species would be present if 3,000 individuals were recorded (Chart 3). Chao 2 estimates predicted a total of 31.13 vertebrate species from all survey areas (Table 16). The data suggests that sufficient trapping effort has been conducted as 31 of a predicted 32.9 species were recorded within the project area.

CHART3: SPECIES ACCUMULATION CURVE FOR TRAPPABLE SPECIES CAPTURED WITHIN THE PROJECT AREA

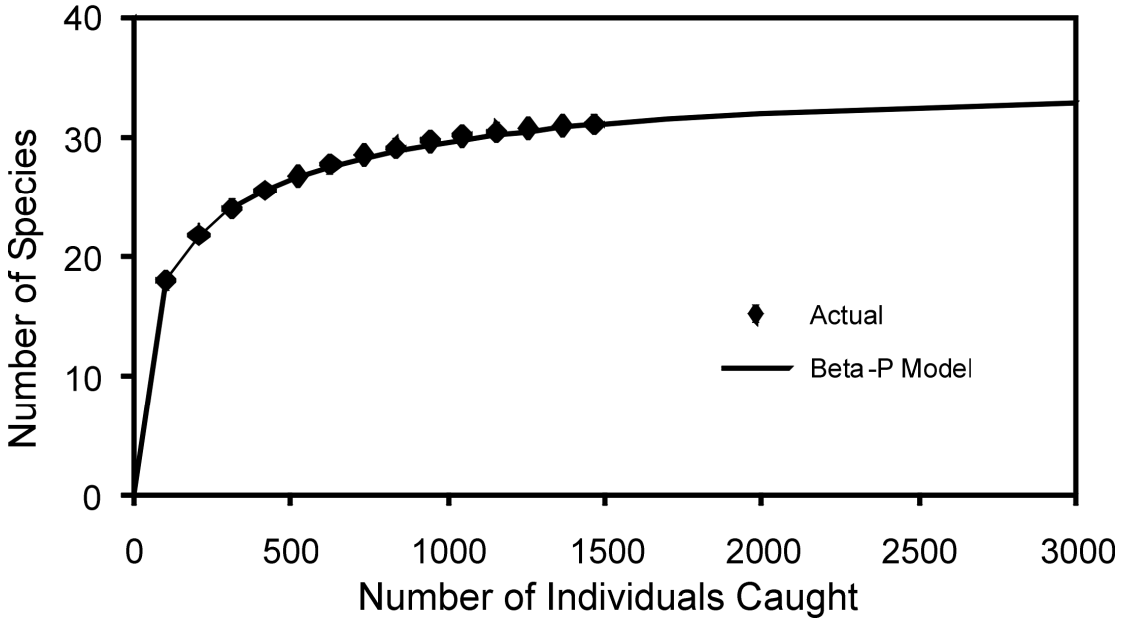
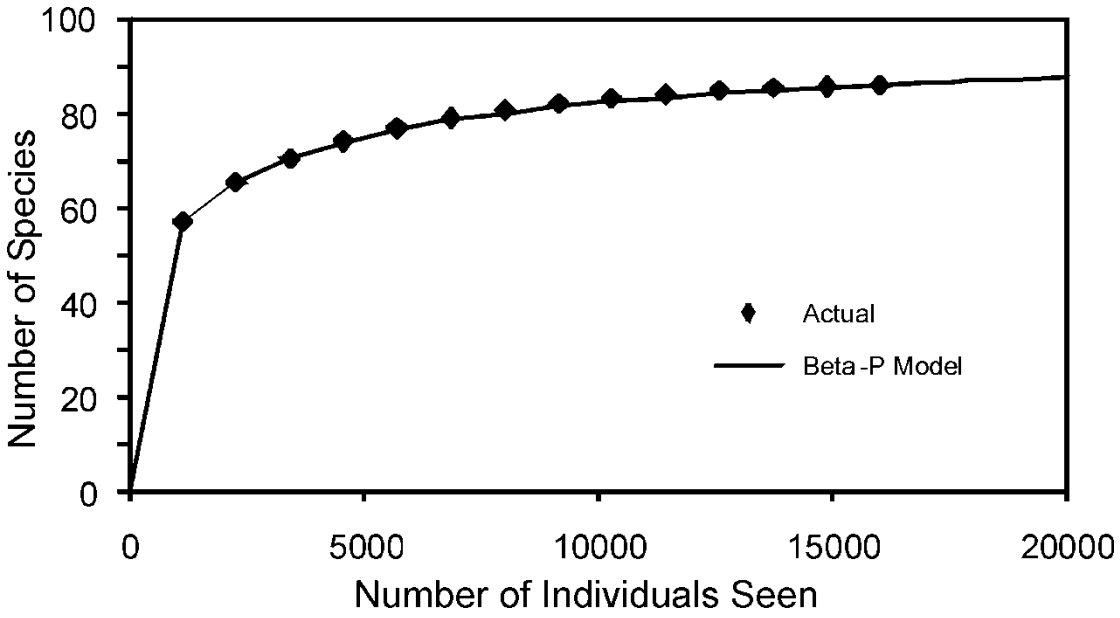


TABLE 16: CHAO 2 ESTIMATES AND 95% CONFIDENCE INTERVALS FOR VERTBRATE TRAPPING SITES

Trap Sites	Chao 2 Mean	Chao 2 95% CI
All sites	34.00	34.00 - 34.10
Project Area	31.13	31.01 - 34.08
JSW	28.39	27.14 - 41.15
HS	31.00	31.00 - 31.21
WM	32.88	28.92 - 53.85

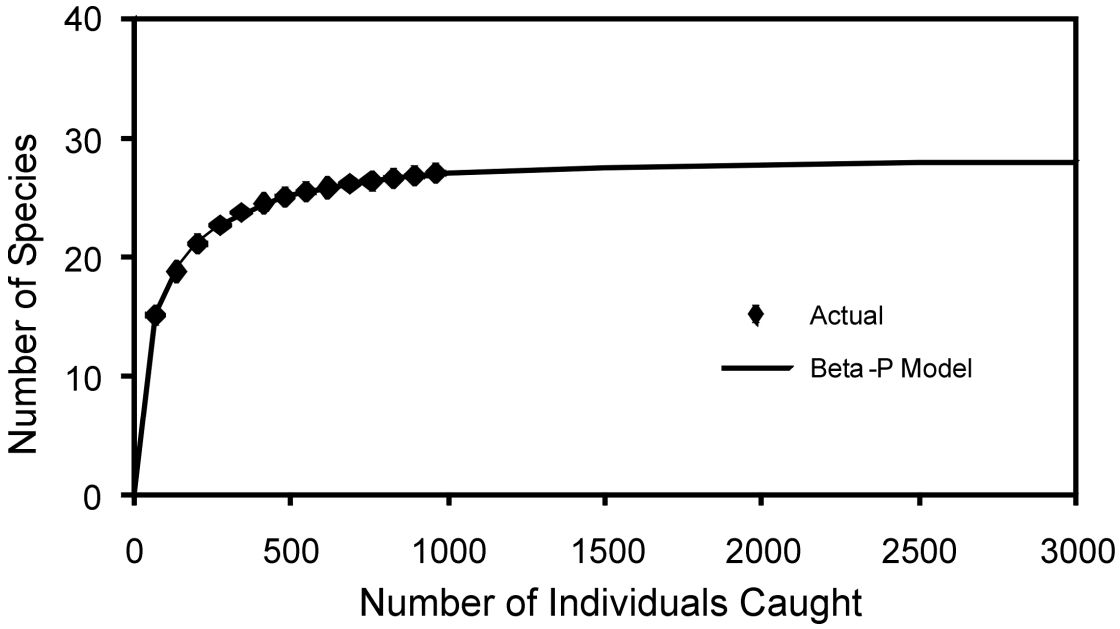
Species accumulation curve modelling predicted that 87.9 species of birds would be present if 20,000 individuals were recorded. Surveys recorded a total of 86 bird species and 16,030 individuals from the Albany region (Chart 4). Seventy eight bird species were observed in the project area (10,409) compared to 67 bird species from Yakamia and Emu Point (5,621 individuals). The data confirmed that the majority of the avifauna species likely to be present in the region were recorded as 98% of the predicted species richness was observed suggesting a sufficient sampling effort for birds.

CHART 4: SPECIES ACCUMULATION CURVE FOR BIRDS OBSERVED WITHIN THE PROJECT AREA



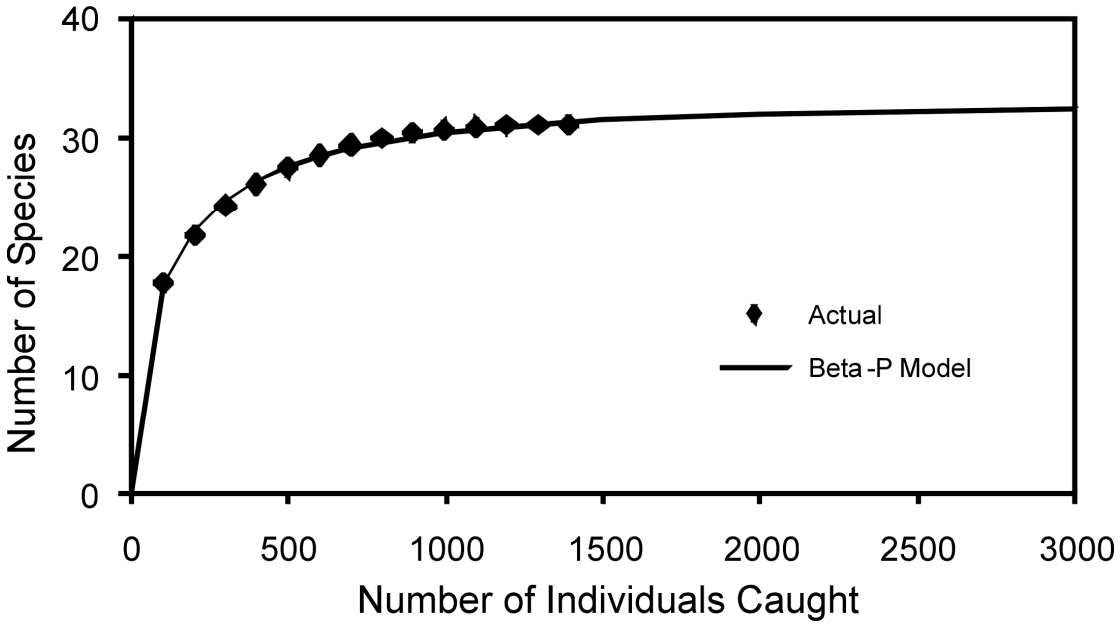
In the Jarrah/Sheoak Woodland habitat, 27 trappable vertebrate species of the predicted 28 species likely to occur (96%) were recorded (Chart 5). The 27 vertebrate species trapped also lies within 95% confidence intervals of the expected number of vertebrate species to be found in the Jarrah/Sheoak Woodland habitat based on Chao 2 estimates (Table 16). This suggests a sufficient trapping effort was conducted in the Jarrah/Sheoak Woodland habitat.

CHART 5: SPECIES ACCUMULATION CURVE FOR TRAPPABLE SPECIES OBSERVED IN THE JARRAH/SHEOAK WOODLAND HABITAT



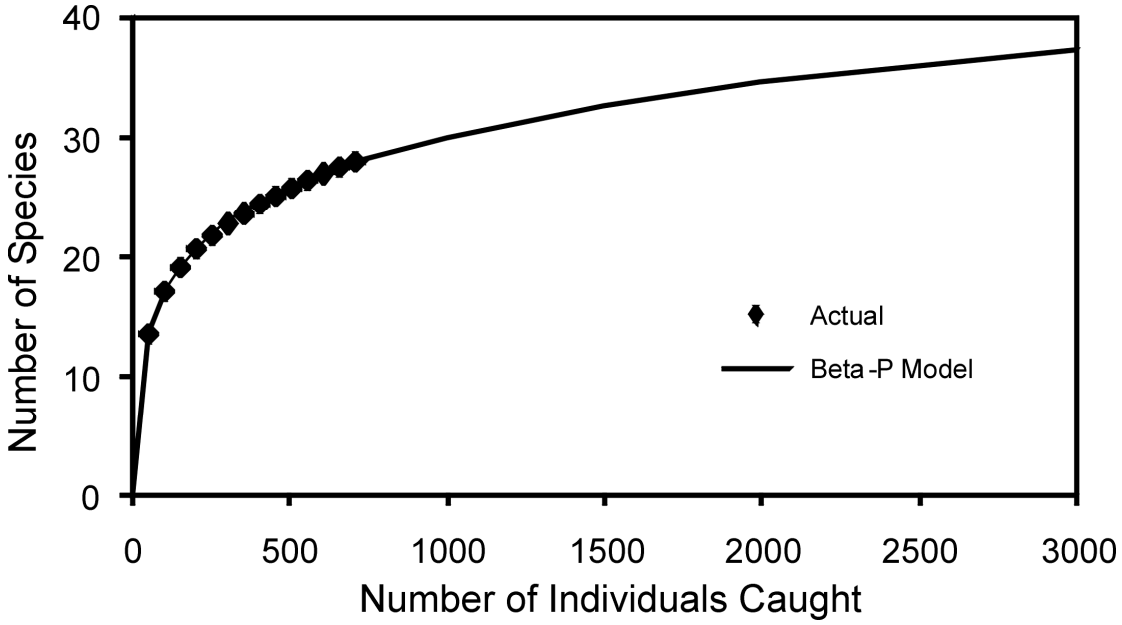
Trapping surveys recorded 31 vertebrate species in the Heath/Shrubland habitat. In comparison, 32.4 trappable vertebrate species were predicted to occur in this fauna habitat resulting in 96% of expected captures (Chart 6). The recorded captures also lie within 95% confidence intervals of the expected number of vertebrate species to be found in the Heath/Shrubland habitat based on Chao 2 estimates (Table 16). Therefore, a sufficient trapping effort was conducted in the Heath/Shrubland Woodland habitat.

CHART 6: SPECIES ACCUMULATION CURVE FOR TRAPPABLE SPECIES OBSERVED IN THE HEATH SHRUBLAND HABITAT



In the Wetland Mosaic habitat 28 trappable vertebrate species of the predicted 37 species likely to occur (75%) were recorded (Chart 7). The 28 vertebrate species trapped also lies within 95% confidence intervals of the expected number of vertebrate species to be found in the Wetland Mosaic habitat based on Chao 2 estimates (Table 16). This suggests a sufficient trapping effort was conducted in the Wetland Mosaic habitat.

CHART 7: SPECIES ACCUMULATION CURVE FOR TRAPPABLE SPECIES OBSERVED IN THE WETLAND MOSAIC HABITAT



4.4.3 Diversity, Similarity and Evenness

Fisher's Alpha and Shannon-Weiner's diversity indices were similar among the Heath Shrubland habitats, although, values were marginally higher in the project area (Table 17). Moderate diversity indices were observed in the project area from Jarrah/Sheoak Woodland habitat but values ranged from to low to high at a regional level. The Wetland Mosaic habitat also showed moderate diversity scores between all sites.

Low evenness scores (Table 17) reflect the varying abundance in the trapped fauna data within each habitat type. A number of species were abundant at all sites (e.g. *Hemiergis peronii* and *Rattus fuscipes*) and fewer species were abundant in one or two habitat types (e.g. *Tarsipes rostratus* and *Glaphyromorphus gracilipes*).

TABLE 17: DIVERSITY INDICES FOR VERTEBRATE FAUNA CAPTURES PER TRAPPING SITE

Site	Habitat Type	Fisher's Alpha	Shannon-Wiener Index (H)	Simpson Index (D)	Smith and Wilson Evenness (B)
BH 10	HS	6.47	2.20	5.74	0.40
BH 13	HS	5.43	2.03	4.80	0.39
BH 3	HS	5.40	2.14	5.46	0.50
EP 1	HS	4.92	2.37	9.76	0.40
EP 2	HS	4.17	2.16	6.49	0.40
EP 3	HS	4.25	2.00	5.23	0.41
EP 4	HS	4.39	1.97	4.97	0.37
EP 5	HS	5.30	2.37	8.50	0.52
BH 1	JSW	5.39	2.10	5.76	0.52
BH 14	JSW	3.68	1.75	3.87	0.37
BH 2	JSW	5.35	1.56	2.56	0.41
BH 6	JSW	5.72	2.30	7.38	0.52
BH 7	JSW	5.26	2.25	8.82	0.57
Yk 1	JSW	2.70	1.56	3.22	0.38
Yk 10	JSW	7.45	2.39	7.51	0.55
Yk 11	JSW	5.15	2.03	5.78	0.43
Yk 12	JSW	8.62	2.53	12.12	0.57
Yk 2	JSW	5.03	2.11	5.34	0.49
Yk 3	JSW	3.79	1.98	7.24	0.67
Yk 4	JSW	4.52	1.95	5.69	0.57
Yk 5	JSW	4.64	2.31	9.29	0.48
Yk 6	JSW	5.03	2.18	6.80	0.45
Yk 7	JSW	5.05	1.78	3.41	0.40
Yk 8	JSW	3.80	2.00	6.42	0.48
Yk 9	JSW	3.78	2.17	6.92	0.54
BH 11	WM	5.47	2.17	5.71	0.42
BH 12	WM	5.37	2.00	4.56	0.38
BH 4	WM	4.45	1.86	3.62	0.43
BH 5	WM	4.06	1.88	3.92	0.37
BH 8	WM	5.97	2.08	5.23	0.48
BH 9	WM	6.22	2.37	7.92	0.52

Overall, 199 of 469 site comparisons (42%) had a Morisito-Horn similarity indice greater then 0.8 (Table 18). When all sites are compared to each other from the project area, 55 of 91 comparisons (60%) show a Morisito-Horn similarity indice greater then 0.8. Higher Morisito-Horn similarity indices were shown between the project area and Emu Point, 92 of 161 sites (57%) than comparisons to Yakamia (121 of 259 sites (47%).

TABLE 18: MORISITA-HORN SIMILARITY INDICES FOR VERTEBRATE FAUNA CAPTURES PER TRAPPING SITE

Morisita-Horn Index (CmH)	BH 1	BH 10	BH 11	BH 12	BH 13	BH 14	BH 2	BH 3	BH 4	BH 5	BH 6	BH 7	BH 8	BH 9	EP 1	EP 2	EP 3	EP 4	EP 5	Yk 1	Yk 10	Yk 11	Yk 12	Yk 2	Yk 3	Yk 4	Yk 5	Yk 6	Yk 7	Yk 8
BH 10	**.94**																													
BH 11	**.89**	**.91**																												
BH 12	**.94**	**.97**	**.91**																											
BH 13	**.93**	**.96**	**.90**	**.97**																										
BH 14	**.95**	**.95**	**.89**	**.97**	**.97**																									
BH 2	**.88**	**.84**	**.83**	**.90**	**.89**	**.95**																								
BH 3	**.91**	**.91**	**.89**	**.92**	**.96**	**.92**	**.87**																							
BH 4	**.89**	**.87**	**.90**	**.91**	**.92**	**.92**	**.95**	**.93**																						
BH 5	.34	.43	.24	.42	.44	.38	.18	.38	.19																					
BH 6	**.91**	**.91**	**.84**	**.90**	**.92**	**.88**	.77	**.92**	**.85**	.51																				
BH 7	.65	.64	.56	.58	.57	.61	.43	.57	.44	.43	.68																			
BH 8	**.89**	**.90**	**.98**	**.89**	**.90**	**.89**	**.84**	**.91**	**.91**	.23	**.85**	.59																		
BH 9	.73	**.83**	.77	.75	.71	.67	.52	.66	.61	.41	.71	.57	.76																	
EP 1	.62	.62	.51	.60	.65	.58	.47	.74	.56	.51	.73	.58	.54	.55																
EP 2	**.83**	**.82**	.79	**.84**	**.88**	**.81**	.75	**.93**	**.82**	.37	**.84**	.52	**.80**	.64	**.84**															
EP 3	**.85**	**.84**	**.82**	**.89**	**.91**	**.86**	**.82**	**.95**	**.88**	.42	**.87**	.46	**.82**	.62	.78	**.96**														
EP 4	**.83**	**.81**	**.82**	**.85**	**.88**	**.83**	**.82**	**.94**	**.89**	.29	**.82**	.42	**.84**	.64	.77	**.97**	**.97**													
EP 5	**.80**	**.80**	.76	**.82**	**.85**	.79	.69	**.89**	.75	.45	**.85**	.59	.76	.62	**.89**	**.96**	**.93**	**.90**												
Yk 1	**.91**	**.89**	**.86**	**.93**	**.89**	**.96**	**.95**	**.84**	**.90**	.18	.78	.57	**.85**	.63	.47	.73	.78	.77	.69											
Yk 10	**.95**	**.86**	**.84**	**.85**	**.83**	**.86**	.79	**.81**	**.81**	.21	**.83**	.65	**.82**	.69	.56	.76	.75	.74	.74	**.86**										
Yk 11	**.88**	**.87**	**.85**	**.85**	**.84**	**.88**	.79	**.83**	**.81**	.21	.78	.73	**.85**	.68	.57	.76	.73	.75	.74	**.90**	**.87**									
Yk 12	.56	.49	.52	.47	.48	.46	.38	.54	.45	.23	.59	.67	.54	.46	.57	.61	.52	.52	.61	.43	.64	.60								
Yk 2	**.93**	**.92**	**.89**	**.93**	**.92**	**.94**	**.88**	**.88**	**.89**	.26	**.87**	.61	**.89**	.68	.59	**.80**	**.84**	**.81**	**.81**	**.93**	**.89**	**.89**	.55							
Yk 3	.76	.77	.77	.76	.72	.75	.66	.69	.68	.21	.70	.61	.75	.66	.56	.65	.67	.64	.71	.79	.76	**.84**	.50	**.89**						
Yk 4	.75	.71	.65	.72	.68	.76	.65	.67	.61	.28	.68	**.80**	.62	.47	.59	.65	.64	.60	.71	.79	.76	**.85**	.63	**.81**	**.81**					
Yk 5	.69	.74	.63	.70	.63	.65	.47	.58	.48	.48	.69	.79	.60	.72	.62	.59	.59	.51	.69	.63	.70	.72	.64	.75	**.83**	**.83**				
Yk 6	.79	**.80**	.75	**.81**	**.82**	.79	.70	**.80**	.72	.42	**.80**	.53	.74	.60	.72	**.80**	**.84**	.76	**.88**	.73	.74	.70	.52	**.90**	**.86**	.73	.78			
Yk 7	**.91**	**.89**	**.85**	**.94**	**.94**	**.98**	**.97**	**.90**	**.93**	.31	**.86**	.54	**.85**	.55	.54	.79	**.86**	**.82**	.77	**.95**	**.82**	**.83**	.43	**.93**	.72	.75	.59	.78		
Yk 8	.31	.25	.35	.24	.26	.22	.14	.33	.20	.29	.32	.55	.37	.33	.43	.46	.35	.35	.44	.18	.34	.42	**.81**	.27	.32	.44	.47	.32	.18	
Yk 9	**.90**	**.90**	**.83**	**.86**	**.81**	**.84**	.73	.76	.77	.30	**.82**	.66	**.81**	**.83**	.50	.68	.68	.67	.66	**.83**	**.93**	**.86**	.63	**.87**	.78	.71	.77	.69	.76	.34

Fauna Habitat Types
JSW
HS
WM
Bold numbers indicate values greater than 0.8

The trappable vertebrate fauna assemblage between all three habitat types was very similar at a regional level (Table 19). Morisita-Horn similarity indices of greater than 0.9 were found suggesting habitats within the project area had very similar faunal assemblages to other habitats within the region.

TABLE 19: MORISITA-HORN SIMILARITY INDICES FOR REGIONAL VERTEBRATE CAPTURES AMONG FAUNA HABITATS

Morisita-Horn Index (C_{mH})	JSW	HS
HS	0.91	
WM	0.93	0.92

5 DISCUSSION

5.1 Adequacy of the Fauna Assessments

Based on Coffey Environments interpretation of information contained in the EPA's *Terrestrial Biological Surveys as an Element of Biodiversity Protection Position Statement No. 3* (EPA, 2002), and *Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56* (EPA, 2004) multiple surveys should be conducted in the appropriate seasons where proposed developments are likely to have impacts that are assessed as being either 'moderate' or 'high' in the bioregion. Two surveys were conducted within the project area, one in late spring/early summer and one in late summer/early autumn, and based on a review of other surveys recently approved by the EPA as being adequate (see Thompson, 2007), the survey effort and comprehensiveness of this survey exceeds that which have generally been approved by the EPA.

The data collected during the surveys for the project area indicated that there were differences in the species caught between the two seasons. Generally, more amphibian species and individuals were recorded in the December survey, with two species recorded during December that were not recorded in March. Alternatively, more species of reptile were recorded during the March survey, with some species recorded during this survey that were not recorded in December, however, there was one reptile species that was recorded during the December survey only. More individuals of some reptile species were recorded in higher numbers during March; however, some reptile species were recorded in higher abundance during December. There was very little difference in the number of individuals or species of mammal caught between the two surveys. This variation in captures demonstrates that two seasons of trapping were required to gain an appreciation of the vertebrate assemblage in the project area.

Coffey Environments is confident that sufficient survey effort was undertaken to record most bird species likely to occur in the area as 86 of a predicted 87.9 species were recorded during the surveys. Coffey Environments is also confident that sufficient survey effort was conducted to record approximately 96% of the trappable vertebrate species likely to occur in the Jarrah/Sheoak Woodland habitat, 96% of the trappable vertebrate species likely to occur in the Heath Shrubland habitat and over 75% of the trappable vertebrate species likely to occur in the Wetland Mosaic habitat.

No other comprehensive vertebrate fauna surveys have been conducted in the greater Albany area to provide comparison of the trapping effort conducted during the Bayonet Head survey. Trapping surveys on a regional scale, such as those by Christensen *et al.*, (1985) and How *et al.*, (1987), provided the most comprehensive information on fauna to date, however, the trapping effort in these surveys was relatively low. *ecologia* (2007) recently undertook Level 2 fauna assessments for the proposed Southdown Magnetite deposit and employed 6251 trap nights over three survey periods in three broad habitat types for the mine site of 1095ha. As a comparison, for the three habitats within the project area at Bayonet Head, 29,512 trap nights were employed for an area of 191ha (Table 1 and 13).

The variety of trap types used in the fauna assessment provides confidence that sampling identified the faunal assemblage present in the project area. Table 15 shows that wire cage traps caught the lowest number of individuals and species, when compared with other trap types. Funnel traps were effective in trapping faster moving skinks and small snakes but not effective in catching small mammals, whereas small mammals were mostly caught in Elliott traps, buckets and pipes. Amphibians were mostly caught in buckets and pipes. These results are similar to findings reported by Thompson *et al*. (2005; 2007b).

5.2 Intra-Habitat Comparisons

5.2.1 Project Area

Similar fauna species and numbers were recorded between sites within each fauna habitat type. The Honey possum was trapped at every Jarrah/Sheoak Woodland site other than BH1 and no Elapidae species were recorded from sites BH7 and BH14. No Myobatrachidae or Gekkonidae fauna species were recorded from site BH3 within the Heath Shrubland habitat and few differences were observed between sites in the Wetland Mosaic habitat. Species accumulation curve modelling revealed 31 of the 32.9 predicted species were recorded from the project area. Moderate diversity indices were revealed from all fauna habitats in the project area. Most sites in the Jarrah/Sheoak Woodland habitat showed similar Fishers Alpha indices (5.26 – 5.72) except BH14 (3.68). Similarly, two sites in the Heath Shrubland habitat had moderate Fishers Alpha indices (5.40 – 5.43), while site BH10 was higher in comparison (6.47). The greatest range of diversity estimates between vertebrate trapping sites was shown amongst the Wetland Mosaic habitat (Fishers Alpha indices: 4.06 – 6.22). All sites within the project area showed very even trapped vertebrate assemblages with values ranging from 0.37 – 0.57 across all fauna habitats using Smith and Wilson's B measure.

Similarity indices based on Morisita-Horn calculations demonstrated 50% of sites with high similarity (greater than 0.8) in the Jarrah/Sheoak Woodland habitat. Only 40% of Wetland Mosaic habitat sites showed high similarity. In comparison, all sites in the Heath Shrubland habitat were highly similar.

In addition to those species trapped, a further six native species were opportunistically recorded from habitats in the project area. These included the Western Grey Kangaroo and five species of bat. Christensen *et al*., (1985) suggested that the southern, low open woodlands of the south-west region tend to contain less medium-sized native mammals, but were rich in small mammals. However, the trapping program did not indicate high small mammal species richness within the project area. Three introduced species, the cat, fox and European rabbit were also recorded opportunistically and may be a key factor in explaining the reduced species richness from southern, low open woodlands of the south-west region.

Spotlighting surveys showed low numbers of WRPs throughout the project area. Two exceptions were the central and eastern sections of the project area – both Jarrah/Sheoak Woodland habitat – where most WRPs were observed. These two areas are rated high quality habitat because they include remnant old-growth Jarrah/Sheoak Woodland habitat and support higher numbers of conservation significant fauna species. Furthermore, the majority of trees with suitable hollows for WRPs, Black Cockatoos and the Masked Owl in the project area are found within these two areas.

One additional habitat patch of high priority is the western section of Heath Shrubland habitat in the project area. This section contains mature stands of Banksia and Black Cockatoos were observed feeding in this area during both the December 2006 and March 2007 surveys. The Heath Shrubland habitat also provides a link to fauna habitat adjacent to the project area dissected only by Lower King Road.

Excellent habitat connectivity currently exists in the central and south west sections of the project area (Lots 1000, 1001, 476 and Part Lot 1) (Figure 2). Few tracks or roads dissect these areas and fauna are likely to disperse freely among all habitat types. Similarly, a small section flanking Oyster Bay on the eastern part of the project area provides unrestricted links to north and south of the coastal Jarrah/Sheoak woodland habitat (Figure 2). In comparison, the northern and eastern sections of the

project area (Lots 37, 38, 39, 2 and part of 286) are characterised by isolated pockets of Jarrah/Sheoak Woodland, Heath Shrubland and Wetland Mosaic surrounded by Cleared/Pasture (Figure 2).

Maintenance of these three key habitat patches could be achieved through a habitat corridor. Beginning from the Black Cockatoo feeding habitat in the west (Heath Shrubland habitat), the habitat corridor would continue east through Jarrah/Sheoak Woodland habitat and change course north through the key central section of the project area to the Wetland Mosaic habitat and finally go east again to the important eastern part of the project area and Oyster bay. The habitat corridor should be a minimum of 50 metres in width, and wider where possible, to buffer native fauna against feral predators and weed invasions and will provide a strategic link to all three fauna habitats in the project area and adjacent habitats. If a habitat corridor is insufficient to link these key fauna habitat patches, a larger section of habitat adjacent to these areas (provided they are planned for development) should be retained so fauna have a potential refuge. These fallback habitat patches are essential and should be a minimum of 100 metres in width (Figure 4). Furthermore, tress with hollows must be kept due to their importance to conservation significant fauna and the time required for tree hollow formation (minimum of 130 years). Linkage from west to east may be maintained through strict planting of appropriate native trees and shrubs along road reserves between habitat refuges.

5.2.2 Regional Comparison

Most species captured within each fauna habitat from the project area were also recorded regionally and in similar numbers. Two exceptions in the Jarrah/Sheoak Woodland habitat were the Honey Possum where none were recorded regionally but 12 individuals trapped in the project area and *Varanus rosenbergi* where no individuals were recorded from the project area but four were recorded at Yakamia. In the Heath Shrubland habitat, one frog species dominated the amphibian assemblage (*H. eyrie*) and 26 individuals of Grey-bellied Dunnart were captured regionally compared to a diverse amphibian assemblage and no Grey-bellied Dunnarts in the project area. Species accumulation curve modelling showed 34 of the predicted 34.4 species were recorded from the project area and region sites. A greater range of diversity estimates (Fisher's Alpha indices) for the regional Jarrah/Sheoak Woodland habitat sites were calculated (2.70 – 8.62) compared to the project area sites (3.68 – 5.72) which is likely due to the high number of regional sites surveyed. In comparison, lower diversity estimates were found regionally (Fisher's Alpha indices; 4.17 – 5.30) than those of the Heath Shrubland habitat sites in the project area (5.40 – 6.47). Historically, Shannon Weiner and Simpsons Index diversity indices were often calculated for fauna assessments and were performed here for comparison to other reports. However, all historical reports found from the greater Albany region did not contain any diversity estimates and therefore, no direct comparisons could be made. Fisher's Alpha diversity indices were used here because it is the most appropriate and accurate diversity estimate with the vertebrate trapping scheme used. Similar trapped vertebrate assemblages between the project area and regionally within both the Jarrah/Sheoak Woodland and Heath Shrubland habitat sites were found with evenness values ranging from 0.39 – 0.67 using Smith and Wilson's B measure.

Similarity indices based on Morisita-Horn calculations showed 48% of sites between the project and regional areas with high similarity (greater than 0.8). A comparable percentage of similarity indices (47%) were found between the two areas in the Jarrah/Sheoak Woodland habitat. However, higher similarity indices in the Heath Shrubland habitat between the project area and regional sites were calculated with 57% of sites having a similarity value greater than 0.8.

In addition to those species trapped, a further six native species were opportunistically recorded from habitats at Bayonet Head. These included the Western Grey Kangaroo and five species of bat.

Christensen *et al*. (1985) suggested that the southern, low open woodlands of the south-west region tend to contain less medium-sized native mammals, but were rich in small mammals. However, the trapping program did not indicate high small mammal species richness within the project area. A key factor for the reduced small mammal species richness may be the three introduced species opportunistically recorded: the cat, fox and European rabbit.

Three conservation significant mammal species were recorded regionally. The Western False Pipistrelle was tentatively identified from the echolocation surveys within the Jarrah/Sheoak Woodland habitat in the project area. This species was also recorded during the Southdown mine site survey (*ecologia*, 2007). Quenda were recorded from both the Jarrah/Sheoak Woodland and Heath Shrubland habitats but in very low densities. The close proximity to residential land and observations of feral cats and foxes is likely to impact on the Quenda populations and densities. Higher numbers of WRPs were recorded from the Jarrah/Sheoak Woodland habitat at Emu Point compared to project area and Yakamia. The higher density of WRPs recorded at Emu Point was possibly due to the dominance of Peppermint trees, which are a significant food resource for the species. Predatory species such as foxes and cats may also play a role in their low numbers.

5.2.3 Birds

Eighty six bird species were recorded from the sites surveyed in the Albany region, with 78 of these species being recorded within the project area. Most bird species recorded within the project area were also recorded from Yakamia and Emu Point. Species accumulation curve modelling revealed 86 of the predicted 87.9 species were recorded from the project area and region sites suggesting sufficient surveys were conducted. Bird species of conservation significance recorded in the project area included either Black Cockatoos (Carnaby's, Baudin's and Forest Red-tails). The bird assemblage recorded within the project area was more diverse than the bird assemblage recorded at Emu Point and Yakamia (Table 10). The bird assemblage recorded within the project area at Bayonet Head was reasonably similar to that of Yakamia but Emu Point was most dissimilar with less than half the bird species observed (38) (Table 10). This is likely due to the small available habitat at Emu Point compared to Yakamia and Bayonet Head. Many of the bird species can be maintained in the project area provided sufficient habitat is retained. Specifically, if areas of the Wetland Mosaic habitat and the old-growth Jarrah/Sheoak Woodland habitat in the western, central and eastern sections of the project area are preserved, much of the key factors important to the bird assemblage will be kept.

5.2.4 Short Range Endemic Invertebrate Fauna

The species identifications and comments provided by WAM indicate that the invertebrate species recorded during the survey and discussed in Section 4.8 are typical of many environments in the Albany region (unpub. data for the Western Australian Museum). Most, if not all, of the species collected are found throughout relatively large regions of south-west Australia. The snail species identified from Bayonet Head are introduced from Europe and not considered to be native to Australia. The conservation significance of some of the specimens collected is unknown due to the uncertainties with the taxonomy of a number of the groups. However, no specimens are thought to represent significant SRE species (Dr M. Harvey, pers. comm.).

5.3 Inter-Habitat Comparisons

5.3.1 Project Area

Similar numbers of species and individuals were captured between all three fauna habitat types (Jarrah/Sheoak Woodland, Heath Shrubland and Wetland Mosaic habitat) in the project area. Vertebrate fauna trappable species ranged from 21 (405 individuals) in the Jarrah/Sheoak Woodland habitat to 27 (710 individuals) in the Wetland Mosaic habitat in the project area. Furthermore, most species captured were recorded from two or more fauna habitat types. Conservation significant species were recorded from all three fauna habitat types. Western Ringtail Possums were recorded from Jarrah/Sheoak Woodland and Wetland Mosaic habitats and are likely to make use of both habitat types for food requirements and dispersal. Quenda were captured from both Jarrah/Sheoak Woodland and Heath Shrubland habitat and utilise the two fauna habitats for food requirements and nesting. Although fauna habitat was not generally recorded for birds, Black Cockatoos were observed feeding in Heath Shrubland habitat due to the concentration of *Banksia* species and may make use of hollows in the Jarrah/Sheoak Woodland habitat for breeding and rearing young.

5.3.2 Regional

Regional comparisons from sites at Yakamia and Emu Point to the project area showed similar fauna assemblages. Species accumulation curve modelling revealed 96% of the predicted vertebrate trappable species were recorded from all surveys combined in the Jarrah/Sheoak Woodland and Heath Shrubland habitat. In contrast, 28 of the predicted 37 species were recorded from the surveys conducted in the Wetland Mosaic habitat (75%). Despite a lower number of species captured from the Wetland Mosaic habitat, the 28 species still lies within the 95% confidence intervals of the expected number of vertebrate species based on Chao 2 estimates and sufficient surveys were carried out in all fauna habitats. Similarity indices based on Morisita-Horn calculations show all fauna habitats are very similar with values ranging from 0.91 – 0.93 indicating none of the fauna habitats is likely to be unique in the greater Albany region. However, fauna habitat on the western area of Oyster harbour is highly fragmented. The project area, Emu Point and Yakamia are part of the few remaining moderate sized fauna habitats remaining in this area and further fragmentation will cause additional loss in numbers and habitat of several species, particularly conservation significant species but the loss is unlikely to be significant. Ideally, habitat corridors or refuge habitat patches should be created (see 5.2.1) in order to maintain some fauna habitat and allow dispersal of individuals from one fauna habitat to another within the project area and between the project area and other neighbouring habitats.

5.4 Biodiversity Value

The EPA *Position Statement No. 3* indicates an ecological assessment of a site must consider its biodiversity value at the genetic, species and ecosystem levels, and its ecological functional value at the ecosystem level (EPA, 2002).

From a vertebrate fauna perspective, approximately half of the vegetation on the project area could be described as excellent or very good quality. All species recorded within the project area were also recorded from other sites surveyed regionally. At a local scale, the trappable fauna assemblage within the Jarrah/Sheoak Woodland and Heath Shrubland habitats of the project area were very similar to the same habitats surveyed regionally. The Heath Shrubland habitat within the project area was slightly more diverse than that outside the project area, whereas the Jarrah/Sheoak Woodland habitat within the project area was slightly less diverse than that outside the project area. The trappable fauna

assemblage of the Wetland Mosaic habitat within the project area was unable to be compared regionally as no replicate trapping data were available. The species recorded in the project area are mostly wide-ranging species that occur in a range of habitats across the region and many were recorded from other habitats surveyed in the Albany region such as Emu Point, Yakamia and Southdown.

5.4.1 Conservation Significant Species

Carnaby's and/or Baudin's Black Cockatoo, Forest Red-tailed Black Cockatoo, Western Ringtail Possum, Quenda and Western False Pipistrelle were recorded within the project area and are important considerations for planning design. Other species of conservation significance that may occur in the project area, but were not recorded include the Southern Brush-tailed Phascogale, Carpet Python, and Masked Owl.

Black Cockatoos were recorded feeding on *Banksia* and *Eucalyptus* species in the Jarrah/Sheoak Woodland habitat of the project area. More than 40 trees containing tree hollows that are potentially suitable for nesting Black Cockatoos were recorded in the project area. The Western Ringtail Possum was recorded in very low densities within the Jarrah/Sheoak Woodland and Wetland Mosaic habitats in the project area. Three Quenda (two in the Heath Shrubland and one in the Jarrah/Sheoak Woodland) were recorded within the project area and is likely to occur throughout the project area at low densities. The Western False Pipistrelle was tentatively recorded within the project area and is likely to utilise the Jarrah/Sheoak Woodland habitat for roosting and feeding.

Although not listed as conservation significant species, a resident pair of Ospreys was located within the project area. Local naturalists indicate the birds have bred successfully multiple times in the past. The tree containing the Osprey collapsed between December 2006 and March 2007, however, a new nest has been built north of the previous location. The nest is shown in Figure 2.

5.4.2 Fauna Habitat

Fauna habitat remaining in the project area is generally in excellent to very good condition and supports a diverse assemblage of generally wide-ranging species that occur within Eucalyptus sp. habitats across the region. The project area is bordered by residential/rural development to the north and south but links Oyster Harbour and other areas of remnant vegetation in an east-west direction. The low forests and woodlands of Jarrah, Albany Blackbutt and Sheoak to the west, north and east of Albany have been extensively cleared for agriculture. This Jarrah Forest subregion is rated as a high priority for reservation by McKenzie *et al*. (2003). Given the proximity to residential and rural development, a surprisingly low number of introduced fauna species were recorded within the project area. The Jarrah/Sheoak Woodland and Heath Shrubland habitats are considered to have a high ecological value as they are in a very good to excellent condition and support a diverse but typical fauna assemblage of the region with few introduced fauna, and in addition they provide habitat for a number of conservation significant fauna. The Wetland Mosaic habitat is also important as it provides habitat for the Western Ringtail Possum and Quenda.

It is not possible to assess the biodiversity value at a genetic level based on the information available. However, the project area does not contain isolated fauna habitat. Eastern sections of the project area are linked to Emu Point in the south and northern habitats along Oyster Harbour and western sections are separated to fauna habitat outside the project area by Lower King Road. Therefore, the project area is unlikely to be genetically isolated.

5.4.3 Commonwealth *EPBC Act 1999* Referral

The project area contains a number of species listed as significant under the Commonwealth *EPBC Act 1999*. The clearing of vegetation will result in the loss of feeding habitat for the two species of Black Cockatoo listed under the *EPBC Act 1999*. There will also be loss of WRP habitat and individuals during the development. However, due to the low density of WRPs and moderate area of Black Cockatoo feeding area adjacent to the project area, the clearing is considered to be not significant under the *EPBC Act 1999*.

5.5 Risk Assessment

Fauna surveys to support Environmental Impact Assessments (EIAs) are part of the environmental risk assessment undertaken to consider what potential impacts a development might have on fauna biodiversity on a particular area and region. Potential impacts to fauna from the proposed development identified in the risk assessment include:

Direct Impacts

- Habitat loss and fragmentation through clearing of native vegetation; and
- Loss of fauna during the clearing and construction process.

Indirect Impacts

- Increased risk of fire;
- Degradation of fauna habitat due to invasion and spread of weeds and dieback; and
- Increase in feral and domestic fauna in the area resulting in increased predation pressure.

5.5.1 Direct Impacts

The proposed development will result in the clearing of native vegetation and consequential loss and alteration of fauna habitat. Besides the initial mortality of fauna during clearing there will also be an ongoing indirect impact, largely consisting of the loss and degradation of habitat resources including feeding areas and shelter sites.

Any removal of the vegetation from the project area will require all species that utilise the area to find alternative suitable habitats. Some species and individuals will remain in the remnant vegetation, however many will seek new areas during the clearing and development stages (or alternatively could perish) and some that move away may return to the area once the development and construction work has ceased.

The clearing of vegetation in the project area may impact on species of conservation significance, including the loss of habitat for the Western Ringtail Possum, Western False Pipistrelle and Quenda and the loss of feeding habitat for the three species of Black Cockatoo.

In order to minimise impacts, habitat clearance could be conducted during winter to avoid the breeding season for many vertebrate species, particularly conservation significant species such as WRPs. A baiting program for feral vermin will minimise short-term impacts on remaining fauna. Additionally, retaining a habitat corridor or patches of habitat refuge will further reduce the effects of development.

5.5.2 Indirect Impacts

Increased human activity is often associated with a change in fire regimes, leading to degradation of natural ecosystems. Fire has been identified as one of the threatening processes in the Southern Jarrah Forest subregion and a number of small mammal and bird species rely on long unburnt vegetation. Provided that fire prevention strategies are implemented, fires are unlikely to be a significant threat to native fauna species in the vicinity of the project area.

Introduced plant species successfully and rapidly invade areas of cleared native vegetation or otherwise disturbed by humans. Introduced plant species may replace native species that provide shelter or foraging areas for native fauna. Major changes to the structure of vegetation will alter the fauna habitat and consequently may influence fauna species composition. Preparing and implementing a weed management plan will largely reduce their threat to native fauna species. Dieback caused by the pathogen *Phytophthora cinnamomi* is a serious threat to the native vegetation in the south-west. Dieback has been recorded within the project area (pers. comm. Jeremy Spencer, Coffey Environments) and an appropriate management plan to prevent the spread of dieback during construction needs to be prepared and implemented.

An increase in human activity is also often associated with an increase in the abundance of introduced species, such as the cat, fox and dog. Control measures for cats and dogs should be implemented. Tables 20-22 provide a summary of the risk assessment associated with this project.

Any risk assessment is a product of the likelihood of an event or impact occurring and the consequences of that event or impact. Likelihood and consequences are categorised and described below. The assessed risk level (likelihood x consequences) is then calculated as the overall risk for the development. This is followed by an assessment of the acceptability of the risk associated with each of the events or impacts. Disturbances and vegetation clearing have an impact on the fauna at multiple scales – site, local, landscape and regional. Each of these is considered in the risk assessment. This assessment should be considered in the context of the summary in Table 20.

TABLE 20: FAUNA IMPACT RISK ASSESSMENT DESCRIPTORS

Likelihood		
Level	Description	Criteria
A	Rare	The environmental event may rarely occur or conservation significant species may rarely be present in most circumstances.
B	Unlikely	The environmental event is unlikely to occur or conservation significant species are unlikely to be present in most circumstances.
C	Moderate	The environmental event could occur or conservation significant species could be present at sometime in most circumstances.
D	Likely	The environmental event should occur or conservation significant species should be present in most circumstances.
E	Almost certain	The environmental event will occur or conservation significant species will be present in most circumstances.
Consequences		
Level	Description	Criteria
1	Insignificant	No loss of conservation significant fauna or regional biodiversity and an insignificant impact on non-conservation significant fauna.
2	Minor	No loss of conservation significant fauna or the localised loss of individuals and species in a regional context.
3	Moderate	Loss of one conservation species individual or a moderate loss of non-conservation significant fauna in a regional context.
4	Major	Significant loss of conservation significant fauna as defined in the DEH (2006) publication or a loss of non-conservation significant fauna at landscape scale.
5	Catastrophic	Loss of a population of conservation significant at a local scale or loss of non-conservation significant fauna at regional scale.
Acceptability of Risk		
Level of risk	Management Action Required	
Acceptable	No action required.	
Moderate	Avoid if possible, routine management with internal audit and review of monitoring results annually.	
High	Externally approved management plan to reduce risks, monitor major risks annually with external audit and review of management plan outcomes annually. Will require a referral to the Commonwealth under the *EPBC Act 1999*.	
Extreme	Unacceptable, project should be redesigned or not proceed.	

TABLE 21: LEVEL OF ACCEPTABLE RISK

		Likelihood				
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)
Consequences	Insignificant (1)	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
	Minor (2)	Acceptable	Acceptable	Acceptable	Moderate	Moderate
	Moderate (3)	Acceptable	Moderate	Moderate	High	High
	Major (4)	Moderate	Moderate	High	High	Extreme
	Catastrophic (5)	Moderate	High	High	Extreme	Extreme

TABLE 22: RISK ASSESSMENT ON THE IMPACT OF CLEARING AT THE BAYONET HEAD PROJECT AREA, ALBANY

		Before Management				With Management		
Factor	**Potential Impact**	**Inherent Risk**			**Risk Controls**	**Residual Risk**		
		Likelihood	**Consequence**	**Significance**		**Likelihood**	**Consequence**	**Significance**
Fauna survey data inadequate	Unknown loss of fauna, fauna of conservation significance, fauna assemblages, or an incomplete fauna assessment	B	2	Acceptable				
Fauna assessment inadequate	Unknown impact on fauna assemblage and conservation significant species	B	2	Acceptable				
Inadequate regional data for contextual purposes	Incomplete analysis of data and appreciation of the impact on biodiversity values in a regional context	C	2	Acceptable				
Removal of habitat – site scale	Almost complete loss of terrestrial fauna in cleared areas, severe impact on local communities	E	1	Acceptable				
Significant reduction of habitats – local scale	Loss of fauna habitat and some impact on local fauna and fauna assemblage	D	3	High	Provide suitable sized habitat corridors and minimise clearing where possible	C	2	Acceptable
Significant reduction of habitats – landscape scale	Minimal impact on fauna and fauna assemblage	C	3	Moderate	Provide suitable sized habitat corridors and minimise clearing where possible	B	2	Acceptable

		Before Management				With Management			
Factor	**Potential Impact**	**Inherent Risk**			**Risk Controls**	**Residual Risk**			
		Likelihood	**Consequence**	**Significance**		**Likelihood**	**Consequence**	**Significance**	
Significant reduction of habitats – regional scale	Minimal impact on fauna and fauna assemblage	B	3	Moderate	Provide suitable sized habitat corridors and minimise clearing where possible	B	2	Acceptable	
Introduced predators	Loss of fauna and a change in the fauna assemblages	C	4	High	A Fauna Management Plan with effective measures to control feral animals. Public awareness program communicating impacts of feral animals on native fauna	C	2	Acceptable	
Road fauna deaths	Death of fauna	E	2	Moderate	Speed limits and public awareness programs	E	1	Acceptable	
Death, loss or impact on conservation significant fauna	Death or loss of Quenda	D	2	Moderate	*In Situ* management under an effective Fauna Management Plan with specific actions/strategies addressing management of Quenda	B	1	Acceptable	
	Death or loss of Southern Brush-tailed Phascogale	A	1	Acceptable					
	Death or loss of Chuditch	A	1	Acceptable					
	Death or loss of Carpet Python	B	3	Moderate	Minimise habitat clearing and habitat fragmentation, clear degraded habitats before high quality. Provide habitat corridors	B	1	Acceptable	
	Death or loss of Western Ringtail Possum	E	3	High	Minimise habitat clearing and habitat fragmentation, clear degraded habitats before high quality. Develop habitat corridors,	C	2	Acceptable	**2**

		Before Management				With Management		
Factor	**Potential Impact**	**Inherent Risk**			**Risk Controls**	**Residual Risk**		
		Likelihood	**Consequence**	**Significance**		**Likelihood**	**Consequence**	**Significance**
					particularly with Peppermints, and *in situ* Western Ringtail Possum management under an effective Fauna Management Plan with specific management actions/strategies addressing management of Western Ringtail Possum			
	Western False Pipistrelle	A	4	Moderate	Minimise clearing of habitat containing large Marri and Jarrah trees, minimise habitat fragmentation, clear degraded habitats before high quality habitats. Provide habitat corridors	A	3	Acceptable
	Loss of foraging habitat for Black Cockatoos	D	4	High	Minimise clearing of habitat containing Proteaceous species and large Marri and Jarrah trees, minimise habitat fragmentation, clear degraded habitats before high quality habitats, staged clearing, use of suitable foraging species when rehabilitating in development	C	3	Moderate
	Masked Owl	B	4	Moderate	Minimise clearing of habitat containing large Marri and Jarrah trees, minimise habitat fragmentation, clear degraded habitats before high quality	B	2	Acceptable

		Before Management				With Management		
Factor	**Potential Impact**	**Inherent Risk**			**Risk Controls**	**Residual Risk**		
		Likelihood	**Consequence**	**Significance**		**Likelihood**	**Consequence**	**Significance**
					habitats			
Migratory avian species	Loss of significant habitat	C	4	High	Retention of Wetland Mosaic and creating substantial buffer area. Retention of substantial coastal buffer area	C	2	Acceptable
Increased human activity	Increase in feral and domestic fauna. Increased predation pressure on native fauna.	C	4	High	A Fauna Management Plan with effective measures to control feral animals. Public awareness program communicating impacts of feral animals on native fauna	C	2	Acceptable
	Spread of weeds	D	4	High	Weed management plan required to monitor and control the spread of weeds	C	2	Acceptable
	Spread of dieback	D	4	High	Dieback management plan required. Public awareness program on consequences of dieback and fence off areas with dieback.	C	3	Moderate
	Degradation of fauna habitats and populations	D	4	High	Minimise habitat clearing and habitat fragmentation, clear degraded habitats before high quality. Develop habitat corridors.	C	2	Acceptable

6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Lots 1000, 1001 (Lower King Road; formerly Lot 760 Lower King Road), Lot 476 (Sibbald Road), Lots 2, 3, 286 (Alison Parade), Lots 37, 38, 39 (Elizabeth Street) and Part Lot 1 (Yatana Road) ('Project Area') is proposed for residential development. Level 1 and Level 2 vertebrate fauna assessments were undertaken by Coffey Environments in December 2006, March 2007 and March 2009 in accordance with the EPA *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002) and Coffey Environments interpretation of *Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, Guidance Statement No. 56* (EPA, 2004).

The project area contains three broad fauna habitat types; Jarrah/Sheoak Woodland, Heath Shrubland and Wetland Mosaic. One hundred and twenty eight species of vertebrate fauna were recorded within the project area during December 2006, March 2007 and March 2009. This includes 7 amphibian species, 21 reptile species, 86 bird species and 14 mammal species (including four introduced species). Most species recorded within the project area were also recorded from regional sites. At a local scale, the trappable fauna assemblage within the Jarrah/Sheoak Woodland and Heath Shrubland habitats of the project area were very similar to the same habitats surveyed elsewhere regionally. The Heath Shrubland habitat within the project area was slightly more diverse than that outside the project area, while little diversity differences within the Jarrah/Sheoak Woodland habitat inside and outside the project area were recorded. The species recorded in the project area occurred in a range of habitats across the region and were recorded from other habitats surveyed in the Albany region at Emu Point and Yakamia.

The presence of Carnaby's and/or Baudin's Black Cockatoo, Forest Red-tailed Black Cockatoo, Western Ringtail Possum, Western False Pipistrelle, Quenda and Osprey in the project area is an important consideration for the proposed development. The Carpet Python, Southern Brush-tailed Phascogale and Masked Owl may also be present within the project area.

The Western Ringtail Possum was recorded in the Jarrah/Sheoak Woodland and Wetland Mosaic habitats of the project area in very low densities when compared with other sites in the Albany region, particularly Emu Point. However, in the project area two important habitat patches (Figure 2; east portion of Lot 286 and Lot 42) contain the majority of WRPs. These two patches are considered important in maintaining the WRP population and minimising the impact upon the species within the project area.

More than 40 trees containing suitable nesting hollows for Black Cockatoos or Masked Owls were recorded in the project area and should be retained within the development design. Black Cockatoos were recorded feeding on *Banksia* and *Eucalyptus* species within the Jarrah/Sheoak Woodland habitat of the project area. These hollows are also likely to provide habitat for WRPs and are regarded as significant for several conservation significant species.

Three Quenda were recorded in the project area, within the Jarrah/Sheoak Woodland and Heath Shrubland habitats and Quenda is considered likely to occur at low densities throughout the project area. The Western False Pipistrelle was tentatively identified from bat echolocation surveys within the Jarrah/Sheoak Woodland habitat and is likely to utilise this habitat for roosting and feeding purposes.

The vegetation in the project area is generally in very good to excellent condition and supports a diverse assemblage of generally wide-ranging species. The project area is bordered by residential/rural

development to the north and south but links Oyster Harbour and other areas of remnant vegetation in an east-west direction. Given the proximity to residential and rural development, a surprisingly low number of introduced fauna species were recorded within the project area. The low forests and woodlands of Jarrah, Albany Blackbutt and Sheoak to the west, north and east of Albany have been extensively cleared for agriculture. This ecosystem is rated as a high priority for reservation by McKenzie *et al*. (2003). All three habitats, Jarrah/Sheoak Woodland, Heath Shrubland and Wetland Mosaic, are considered to have a high ecological value and in addition they provide habitat for a number of conservation significant fauna.

The risk assessment indicated with appropriate management the risk associated with clearing the land is acceptable to moderate. Development of the project area will impact upon fauna and fauna assemblages through loss of habitat, the fragmentation of existing habitat and through increased levels of human activity in the area. Proposed clearing of habitat will result in a loss of the sedentary species and will force mobile species to move to adjacent areas. Increased human presence resulting from higher density housing may lead to increased numbers of domestic and feral fauna, an increase in wildfires and an increase in the spread of weeds and dieback.

Clearing of existing vegetation will result in the loss of potential feeding habitat for the Black Cockatoo species. The feeding and dispersal behaviour of Black Cockatoo species in the greater Albany region is currently unknown and although the project area contains sections of suitable feeding habitats, large areas of forest habitat are located west of Albany. Clearing of existing habitat will also result in the loss of WRP individuals and habitat. The low density of WRPs within the project area suggests habitat and individual losses will not be a significant impact on the species.

Due to the low density of WRPs and moderate area of Black Cockatoo feeding area adjacent to the project area, the clearing is considered to be not significant under the *EPBC Act 1999*.

6.2 Management Recommendations

Coffey Environments recommends that:

- Areas of the Jarrah/Sheoak Woodland (central area and eastern section of project area), Heath Shrubland (western area of project area) and Wetland Mosaic (southern portion of lake and northern section containing weir) habitats should be retained in the project area to provide habitat on site for conservation significant fauna. The areas of habitat retained should ideally be large enough to be viable in the long term and in the form of linkage corridors to connect all fauna habitats and allow free movement;
- The 42 trees identified as containing possible breeding hollows for Black Cockatoos, Masked Owls or Western Ringtail Possums, and the 20 trees containing dreys should be retained;
- As part of the development, a Fauna Management Plan should be prepared that details management and mitigation strategies for all vertebrate fauna affected by the development;

The Fauna Management Plan should include details on:

  - The clearing protocol that should be used as part of the clearing operations;
  - The areas that should be retained as corridors and public open space (POS);
  - Rehabilitation strategies for retained areas and POS;
  - Public consultation and education; and
  - Feral animal control

6.2.1 Secondary Impacts Associated with Increased Human Activity

Coffey Environments recommends that:

- Control measures for cats and dogs should be implemented. Dogs should be kept on a leash at all times outside the owners' property boundary and registered with the council. Ideally, cats should be prohibited from the proposed development and if this is not possible, they should be registered with the local council and curfews could be established for cats as a condition of all land sales.;
- A public education program for new residents should be implemented describing the importance of remnant vegetation in the conservation of native fauna and the threat that domestic animals present to native fauna. This may be in the form of education pamphlets and interpretive signage in public areas;
- A Fire Management Plan should be prepared and implemented to protect remnant vegetation in and adjacent to the project area;
- A Weed Management Plan should be prepared and implemented to protect remnant vegetation in and adjacent to the project area; and
- A Dieback Management Plan should be prepared and implemented to protect susceptible remnant vegetation in and adjacent to the project area.

7 REFERENCES

Abbott, I. (1999) The avifauna of the forests of south-west Western Australia: changes in species composition, distribution, and abundance following anthropogenic disturbance, *CALMScience Suppl 5, 1-176.*

ATA Environmental (2000) Lot 5779 Down Road, Albany Flora Survey and Fauna Assessment, Unpublished report for Southern Districts Estates Agency.

ATA Environmental (2005) Environmental Appraisal Part Lot 760 Lower King Road, Bayonet Head, Albany. Unpublished report for Heath Development Company and Lanstart JV.

ATA Environmental (2006) Environmental Assessment Bayonet Head Outline Development Plan, Unpublished report for Heath Development Company and Landstart JV.

Beard, J.S. (1979) The Vegetation of the Albany and Mt Barker Areas. Vegmap Publications, Perth.

Bureau of Meteorology (2007) Climatic Averages for Australian Sites, Publicly available data prepared by the Bureau of Meteorology, Commonwealth of Australia, http://www.bom.gov.au/climate/averages/tables/ca_wa_names.shtml

Chapman, A. and Newbey, K.R. (1995) A vertebrate fauna survey and some notes on the vegetation of the Ravensthorpe Range, Western Australia, *CALMScience 1(4), 465-508.*

Christensen, P., Annels, A., Liddelow, G and Skinner, P. (1985) Vertebrate Fauna in the Southern Forests of Western Australia A Survey, Forests Department of Western Australia Bulletin 94.

Christides, L. and Boles, W.E. (2008) Systematics and Taxonomy of Australian Birds, CSIRO, Canberra.

Coffey Environments (2008) *Bayonet Head Outline Development Plan Wetlands Assessment*.

Prepared for Heath Development Company and CAMABB Pty Ltd. Unpublished report. Ref: EP2008/061, V1.

Connell, S. and ATA Environmental (2001) City of Albany: Vegetation Survey of the Albany Hinterland, ATA Environmental Scientists and Dr Steven Connell.

(ecologia) *ecologia* Environment (2007) Albany Iron Ore Project Public Environmental Review, Report to Grange Resources Limited.

(EPA) Environmental Protection Authority (2002) Terrestrial Biological Surveys as an Element of Biodiversity Protection: Position Statement No. 3, Environment Protection Authority, Perth.

(EPA) Environmental Protection Authority (2004) Guidance for the Assessment of Environmental Factors. Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56, Environmental Protection Authority, Perth.

Friend, G. R., Smith, G. T., Mitchell, D. S., & Dickman, C. R. (1989) Influence of pitfall and drift fence design on capture rates of small vertebrates in semi-arid habitats of Western Australia, *Australian Wildlife Research, 16, 1-10.*

Fullard, J.H., Koehler, C., Surlykke, A. and McKenzie, N.L. (1991) Echolocation ecology and flight morphology of insectivorous bats (Chiroptera) in south-western Australia, *Australian Journal of Zoology 39: 427–438.*

Government of Western Australia (2000) Bush Forever: Volume 2: A Directory of Bush Forever Sites, Western Australian Planning Commission, Perth.

Greenslade, P. J. M. (1973) Sampling ants with pitfall traps: Digging-in effects, *Insectes Socianx, 20, 343-353.*

Gozzard, J. R. (1989) *Albany Part Sheets 2427 I, 2428 II, 2527 IV and 2528 III, Environmental Geology Series,* geological Survey of Western Australia.

Hayek, L.C. and Buzas, M.A. (1997) Surveying natural populations. New York: Columbia University Press.

Hearn, R., Williams, K., Comer, S. and Beecham, B. (2002) Jarrah Forest 2 (JF – Southern Jarrah Forest subregion) within McKenzie, N.L., May, J.E. and McKenna, S., (2003). Bioregional Summary of the 2002 Biodiversity Audit for Western Australia, Department of Conservation and Land Management, Perth.

Higgins, P.J. (ed) (1999) Handbook of Australian, New Zealand and Antarctic Birds, Volume 4: Parrots to Dollarbird, Oxford University Press, Melbourne.

How, R.A., Dell, J. and Humphreys, W.F. (1987) The Ground Vertebrate Fauna of Coastal Areas between Busselton and Albany, Western Australia, *Recordings of the Western Australian Museum 13(4), 553-574.*

Johnstone, R. (2001) Checklist of the birds of Western Australia, *Records of the Western Australian Museum, Supplement No. 63, 75-90.*

Johnstone, R.E. and Storr, G.M. (1998) Western Australian Birds: Volume I – Non-Passerines (Emu to Dollarbird), W.A. Museum, Perth.

Johnstone, R.E. and Kirby, T. (1999) Food of the Forest Ref-tailed Black Cockatoo *Calyptorhynchus banksii naso* in south-west Western Australia, *Western Australian Naturalist 22, 167-177.*

Johnstone, R.E. and Storr, G.M. (2004) Western Australian Birds: Volume II –Passerines (Blue-winged Pitta to Goldfinch), W.A. Museum, Perth.

Johnstone, R., Kirby, T., Stone, P. and Minton, C. (2003) White-tailed Black Cockatoos: Identification, Challenges and Changes in Distribution and Status and Links with a Community Program – Cockatoo Care. **IN: C. Gole (ed)** Conserving Carnaby's Black Cockatoo Future Directions. Proceedings from a Conservation Symposium, pp 32-35.

Magurran A. E. (2004) Measuring Biological Diversity. Blackwell, Oxford.

Mawson, P.R. and Johnstone, R.A. (1997) Conservation Status of Parrots and Cockatoos in Western Australia, *Eclectus 2, 4-9.*

McKenzie, N.L. and Bullen, R.D. (2003) Identifying Little Sandy Desert bat species from their Echolocation calls, *Australian Mammalogy 25: 73–80.*

Newbey, K.R. and Chapman, A. (1995) A Biological Survey of the Fitzgerald Area, Western Australia, *CALMScience Supplement 3, 1-258.*

Orr, K., Danks, A. and Gillen, K. (1995) Two Peoples Bay Nature Reserve Management Plan, Department of Conservation and Land Management, Perth.

Saunders, D.A. (1974a) Subspeciation in the White-tailed Black Cockatoo, *Calyptorhynchus baudinii*, in Western Australia, *Australian Wildlife Research 1, 55-69.*

Saunders, D.A. (1974b) The Occurrence of the White-tailed Black Cockatoo, *Calyptorhynchus baudinii*, in *Pinus* plantations in Western Australia, *Australian Wildlife Research 1, 45-54.*

Saunders, D.A. (1979) Distribution and Taxonomy of the White-tailed and Yellow-tailed Black Cockatoo *Calyptorhynchus* spp., *Emu 19, 215-227.*

Saunders, D.A. (1980) Food and Movements of the Short-billed Form of the White-tailed Black Cockatoo, *Australian Wildlife Research 7, 257-269.*

Saunders, D.A., Rowley, I. and Smith, G.T. (1985) The Effects of Clearing for Agriculture on the Distribution of Cockatoos in the Southwest of Western Australia. **IN: A. Keast, H.F. Recher, H. Ford and D. Saunders (eds)** Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management. Surrey Beatty and Sons, Chipping Norton, pp 309-321.

Sedgwick, E.H. (1949) Bird Movements in the Wheatbelt of Western Australia, *Western Australian Naturalist 2, 25-33.*

Sedgwick, E.H. (1964) Birds of the Stirling Ranges, *Emu 64, 7-19*.

Sherrod, P.H. (2001) Nonlinear Regression Analysis Program, Brentwood, Tennessee.

Smith, V.W. (1990) The Terrestrial Vertebrate Fauna of the Torndirrup National Park, *Western Australian Naturalist 18, 82-91.*

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1983) Lizards of Western Australia II. Dragons and Monitors, W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1990) Lizards of Western Australia. III. Geckoes and Pygopodids, W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1999) Lizards of Western Australia. I. Skinks, 2nd edition, W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (2002) Snakes of Western Australia, W.A. Museum, Perth.

Strahan, R., (ed.). (2000) The Australian Museum Complete Book of Australian Mammals, 2nd edition, Angus and Robertson, Sydney.

Saunders, D.A., Smith, G.T., Ingram, J.A. and Forrester, R.I. (2003) Changes in a remnant of salmon gum *Eucalyptus salmonophloia* and York gum, *E. loxophleba* woodland, 1978 to 1997. Implications for woodland conservation in the wheat-sheep regions of Australia, *Biological Conservation 110, 245-256.*

Taylor-Burrell Planning and Design (2001) Bayonet Head Outline Development Plan. A report prepared for the City of Albany.

Thompson, G.G. (2007) Terrestrial Vertebrate Fauna Surveys for the preparation of Environmental Impact Assessments: How can we do it Better? A Western Australian Example. *Environmental Impact Assessment Review, 27, 41-61.*

Thompson, G.G., and Thompson, S.A. (2007a) Using species accumulation curves to estimate trapping effort in fauna surveys and species richness, *Austral Ecology, 32, 564-569.*

Thompson, G.G., and Thompson, S.A. (2007b) Usefulness of funnel traps in catching small reptiles and mammals, with comments on the effectiveness of the alternatives? *Wildlife Research, 34, 491-497.*

Thompson, G.G., and Thompson, S.A. (2008) Vertebrate by-catch in invertebrate wet pitfall traps. *Journal of the Royal Society of Western Australia.* 91, 237-241.

Thompson, G.G., Thompson, S.A., Withers, P.C. and Pianka, E.R. (2003b) Diversity and Abundance of Pit-trapped Reptiles of Arid and Mesic Habitats in Australia: Biodiversity for Environmental Impact Assessments, *Pacific Conservation Biology, 9: 120-135.*

Thompson, S.A., Thompson, G.G., and Withers, P.C. (2005) Influence of Pit-trap Type on the Interpretation of Fauna Diversity, *Wildlife Research 32, 131-173.*

Thompson, G.G., Thompson, S.A., Withers, P.C. and Fraser, J. (2007) Determining adequate trapping effort and species richness using species accumulation curves for environmental impact assessments, *Austral Ecology, 32, 570-580.*

Tyler, M.J., Smith, L.A. and Johnstone, R.E. (2000) Frogs of Western Australia, 2nd edition, W.A. Museum, Perth.

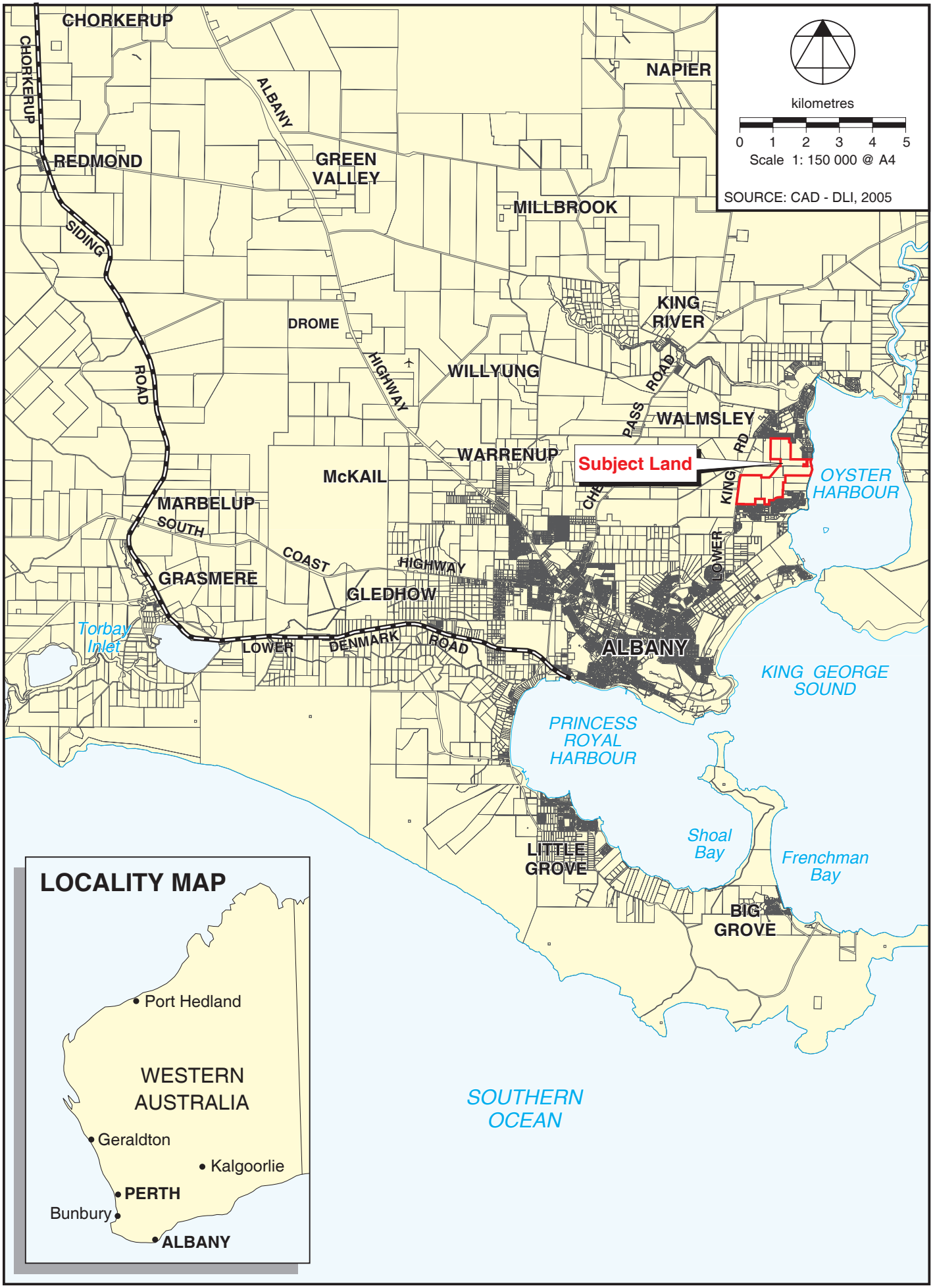
8 DISCLAIMER

This document is published in accordance with and subject to an agreement between Coffey Environments **("Coffey")** and the client for whom it has been prepared Heath Development Company, Mr K. Slee and CAMABB Pty Ltd **("Client")** and is restricted to those issues that have been raised by the client in its engagement of Coffey and prepared using the standard of skill and care ordinarily exercised by Environmental Scientists in the preparation of such Documents.

Any person or organisation that relies on or uses the document for purposes or reasons other than those agreed by Coffey and the Client without first obtaining the prior written consent of Coffey, does so entirely at their own risk and Coffey denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this Document for any purpose other than that agreed with the Client.

Figures

Bayonet Head Fauna Assessment



PRINTED: Thu 21 May 09 CHECKED: PM 20-05-09 DRAWN: CR 20-05-09 DATUM: MGA zn50 ENVI/ALBA/00547AB/Fauna Assessment/EP2009-035F01.dgn

coffey environments
SPECIALISTS IN LIVING AND WORKING PLACES

BAYONET HEAD
FAUNA ASSESSMENT

REGIONAL LOCATION

FIGURE 1

PRINTED: Thu 11 Jun 09 CHECKED: PM 11-06-09 DRAWN: CR 11-06-09 DATUM: MGA zn50 ENVI/ALBA/00547AB/Fauna Assessment/EP2009-035F02.dgn

metres

0 100 200 300 400

SCALE 1 : 7 500

LEGEND

- Study Area Boundary
- Cadastral Boundary
- Fauna Habitat Boundary
- Western Ringtail Possum Location
- Drey Location
- Osprey Location
- Possibly Suitable Possum Hollow
- Possibly Suitable Black-Cockatoo Hollow
- Quenda Caught at Trapping Location
- Trapping Site Location
- Areas of High Faunal Values particularly for Conservation Significant Species

FAUNA HABITAT TYPES

JSW
Jarrah (*Eucalyptus marginata*) and Sheoak (*Allocasuarina fraseriana*) woodland over shrubland of species such as *Agonis theiformis*, *Astartea fascicularis*, *A. humilis*, *Melaleuca thymoides* and *Xanthorrhoea brunonis* over a mixed sedgeland with occasional shelterbelt of *E. globulas* and *A. flexuosa*.

HS
Heath containing species such as *A. theiformis*, *Leucopogon glabellus*, *Lepidosperma gladiatum*, *Melaleuca thymoides*, *Melaleuca bracteosa*, *Pericalymma ellipticum var. ellipticum* and *Beaufortia decussata* with occasional Albany Blackbutt (*Eucalytpus staeri*).

WM
Wetland mosaic of Peppermint (*Agonis flexuosa*) and *Callistachys lanceolata* woodland over *Pteridium esculentum*.

CP
Cleared/Pasture with occasional tree/shrub

AERIAL PHOTOGRAPH SOURCE: DLI, 2005.

coffey environments
SPECIALISTS IN LIVING AND WORKING PLACES

BAYONET HEAD
FAUNA ASSESSMENT

FAUNA HABITAT TYPES AND TRAP SITE LOCATIONS

FIGURE 2

PRINTED: Thu 11 Jun 09
CHECKED: PM 11-06-09
DRAWN: CR 11-06-09
DATUM: MGA zn50
ENVI/ALBA/00547AB/Fauna Assessment/EP2009-035F03.dgn

metres
0 100 200 300 400
SCALE 1 : 7 500

LEGEND

- Study Area Boundary
- Cadastral Boundary
- Fauna Habitat Boundary
- Western Ringtail Possum Location
- Drey Location
- Osprey Location
- Possibly Suitable Possum Hollow
- Possibly Suitable Black-Cockatoo Hollow
- Quenda Caught at Trapping Location
- Trapping Site Location

FAUNA HABITAT QUALITY

- 1 High Quality Fauna Habitat
- 2 Very Good Fauna Habitat
- 3 Good Fauna Habitat
- 4 Disturbed Fauna Habitat
- 5 Highly Degraded Fauna Habitat

Excluded (Under Approved Subdivision)
Area Excluded from SEA
Excluded (Under Approved Subdivision)
9000 (FMR 284)
KING ROAD
LOWER KING ROAD
HOOPER RD
JASON RD
GREEN ISLAND
CRESCENT
ALLWOOD PARADE
SIBBALD ROAD
WARLOCK ROAD
ALISON PDE
BH1 BH2 BH3 BH4 BH5 BH6 BH7 BH8 BH9 BH10 BH11 BH12 BH13 BH14
P1

AERIAL PHOTOGRAPH SOURCE: DLI, 2005.

coffey environments
SPECIALISTS IN LIVING AND WORKING PLACES

BAYONET HEAD
FAUNA ASSESSMENT
FAUNA HABITAT QUALITY
FIGURE 3

Appendix A
Definitions of the classification system for significant fauna listed in DEC's Threatened and Priority Species Database

Bayonet Head Fauna Assessment

APPENDIX B: DEFINITIONS OF SPECIES LISTED UNDER THE WA *WILDLIFE CONSERVATION ACT 1950*

Schedule 1 (Sc1) – Fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection.

Schedule 2 (Sc 2) – Fauna which are presumed to be extinct and are declared to be fauna in need of special protection.

Schedule 3 (Sc 3) – 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 which are declared to be fauna in need of special protection.

Schedule 4 (Sc 4) – Fauna that are in need of special protection, otherwise than for the reasons mentioned in Schedule 1, 2 or 3.

In addition to the above classification, the DEC also classifies fauna under five different priority codes:

Priority 1 (P1) – *Taxa with few, poorly known populations on threatened lands*. Taxa which are known from few specimens or sight records from one of a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened species.

Priority 2 (P2) – *Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not 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. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority 3 (P3) – *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 4 (P4) *and 5* (P5) – *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. Taxa which are declining significantly but are not yet threatened.