Biota Environmental Sciences

Cape Lambert Port B Development Seasonal Fauna Survey

Prepared for Pilbara Iron Pty Ltd

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1.0 Summary

1.1 Background

Pilbara Iron Pty. Ltd. proposes to increase throughput capacity of the Cape Lambert Operation through the construction of its Cape Lambert Port B Development. The proposed development lies adjacent to the existing Cape Lambert Operation and is mostly focused in the area to the west of the existing railway.

Biota Environmental Sciences (Biota) was commissioned to complete a two phase, seasonal fauna survey within the area encompassing the proposed Cape Lambert Port B Development.

The scope of the study was to:

- document the vertebrate and short range endemic (SRE) invertebrate fauna assemblage within the defined study area using established sampling techniques;
- identify and assess the local and regional conservation significance of the fauna assemblage and habitats present in the study area;
- identify fauna (particularly Schedule and Priority listed fauna as well as potential SRE taxa) of particular conservation significance; and
- discuss the likely impacts of the project on fauna and their habitats with particular reference to species having elevated conservation significance.

1.2 Methods

The survey was conducted over two phases. The Phase I survey was conducted over a 13-day period between October 1st and 12th, 2007. The Phase II survey was completed between March 5th and 12th, 2008. An additional targeted survey for the restricted skink *Lerista nevinae* was conducted in late December 2007.

The principal component of this study consisted of systematic fauna sampling centred on 11 trapping grids, which were established in environments considered to represent the range of habitats available within the study area.

Each survey site was installed within a defined habitat and was selected such that equal weight was given to accessibility of the sites in terms of regular inspection of pit-fall traps. Systematic censusing of terrestrial fauna assemblages, including mammals and herpetofauna, consisted of a single trapping line at each of the 11 sites. Ten of these sites consisted of 10 pit-fall traps, comprising alternating 20L buckets and PVC tubes (150 mm diameter, 600 mm deep) spaced at 10 m intervals, connected by a 90 m long by 30 cm high flywire drift fence. An additional site consisted of 10 pairs of funnel traps also spaced at 10 m intervals, connected by a 90 m long by 30 cm high flywire drift fence.

During each survey phase, 20 avifauna censuses were completed across the 10 pit-trapping sites during the survey period. Avifauna was sampled during 30 to 40-minute censuses at established trapping grids. Censuses were conducted between 6:30 am and 11:00 am, and were supplemented by recording all avifauna species observed opportunistically while driving within the study area.

Bats were sampled using both direct capture via harp nets and through echolocation call recordings. During this study, harp traps were installed in mangrove habitat, specifically within flyways between trees. Bat echolocation calls were recorded using an Anabat II bat detector, which detects and records ultrasonic echolocation calls emitted during bat flight.

Specific invertebrate groups were sampled using both systematic and non-systematic collections during the survey. Invertebrate groups targeted during the survey, primarily those considered to support SRE taxa, included:

- Mygalomorphae (Trapdoor Spiders);
- Diplopoda (Millipedes);
- Pulmonata (Land Snails); and
- Pseudoscorpionida (Pseudoscorpions).

1.3 Results

1.3.1 Fauna Habitats

Six broad habitats were defined within the Cape Lambert Port B Development study area:

- Wirewood (*Acacia coriacea*) open shrublands over Soft Spinifex (*Triodia epactia*) hummock grasslands and/or mixed tussock grasslands on primary and secondary sand dunes;
- Soft Spinifex (*Triodia epactia*) hummock grasslands and/or Buffel Grass (**Cenchrus ciliaris*) tussock grasslands on loamy coastal plains;
- Marine Couch (*Sporobolus virginicus*) tussock grassland on saline clay plains;
- Shrubby Samphire (*Halosarcia halocnemoides*) low shrublands in low-lying saline drainage areas;
- Mixed hummock grasslands on rocky hills and outcrops; and
- Mangal on tidal mudflats.

1.3.2 Fauna Assemblage

The Phase I and II surveys recorded a total of 40 herpetofauna species, 63 bird species and 17 species of mammal, giving a total of 120 vertebrate fauna species.

The herpetofauna comprised one hylid frog (family Hylidae), one myobatrachid frog (Myobatrachidae), six geckos (Gekkonidae), three legless lizards (Pygopodidae), 14 skinks (Scincidae), six dragons (Agamidae), three monitors (Varanidae), one blind snake (Typhlopidae) and five front-fanged snakes (Elapidae).

The total of 63 species of birds included 40 non-passerine and 23 passerine species from 28 families.

The non-volant mammals comprised five dasyurids (carnivorous marsupials), two macropods (kangaroos and wallabies), three murids (murid rodents), one bovid (the goat), and one canid (the Fox). Five bat species were also recorded, comprising two vespertilionids (evening bats), one molossid (freetail bats), and two emballonurids (sheathtail bats).

1.3.3 Fauna of Conservation Significance

Three species of Priority fauna were recorded within or adjacent to the Cape Lambert Port B Development study area during the Phase I and II surveys:

- **Little Northern Freetail Bat (*Mormopterus loriae cobourgiana*) Priority 1**: echolocation calls recorded over mangrove habitat (outside the proposed impact area) during both survey phases.
- **Eastern Curlew (*Numenius madagascariensis*) Priority 4**: recorded during Phase II on three occasions on tidal mudflats (outside the proposed impact area).

- **Star Finch (*Neochmia ruficauda subclarescens*) Priority 4**: recorded on a single occasion at site CLP09 during Phase I.

Based on known fauna distributions and habitat preferences, a total of 12 Schedule or Priority may potentially occur within the study area (Table 1.1).

Table 1.1: Schedule and Priority fauna listed at State and Federal levels recorded or potentially occurring in the Cape Lambert Port B Development study area.

Species Name	Common Name	Status	
		State	Federal
Dasyurus hallucatus	Northern Quoll	Schedule 1	Endangered
Liasis olivaceus barroni	Pilbara Olive Python	Schedule 1	Vulnerable
^*Chelonia mydas*	Green Turtle	Schedule 1	Vulnerable Marine Migratory
^*Eretmochelys imbricata*	Hawksbill Turtle	Schedule 1	Vulnerable Marine Migratory
^*Natator depressus*	Flatback Turtle	Schedule 1	Vulnerable Marine Migratory
Falco peregrinus	Peregrine Falcon	Schedule 4	–
**Mormopterus loriae cobourgiana*	Little Northern Freetail Bat	Priority 1	–
**Numenius madagascariensis*	Eastern Curlew	Priority 4	Migratory
**Neochmia ruficauda subclarescens*	Star Finch	Priority 4	–
Ardeotis australis	Australian Bustard	Priority 4	–
Burhinus grallarius	Bush Stone-curlew	Priority 4	–
Phaps histrionica	Flock Bronzewing	Priority 4	–

* denotes species recorded during the current Cape Lambert Port B Development seasonal fauna survey.
^ denotes species recorded during the Cape Lambert Port B Development marine turtle survey (Biota 2008b).

No Schedule listed fauna, or fauna species listed under the EPBC Act 1999, were recorded during the survey. Known distributions suggested that two Schedule fauna species might occur within the proposed development area (Northern Quoll and Pilbara Olive Python). However, core habitats where these species typically occur were not recorded in the development area (see section 6.3). The relatively small nature of the development indicates a low risk of significant impact to these Schedule species in the even that they do occur. Marine Turtles are known to nest on adjacent Bell's Beach and the significance of this is discussed in the 'Cape Lambert Port B Development Marine Turtle Survey' report (Biota 2008b).

Three potential SRE invertebrate species, specifically Mygalomorph spiders of the family Nemesiidae and Idiopidae, were recorded from the Cape Lambert Port B Development study area. While the conservation significance of these species is not currently known, the specimens have been lodged with the Western Australian Museum and are currently the subject of a phylogeographic study examining the broader distribution of the putative taxa.

A risk-based assessment was adopted using defined habitat units as a surrogate for inferring the distributional boundaries of the mygalomorph spiders. Based on the broad distribution of the habitat types and vegetation units in which the mygalomorph spiders were found to occur at Cape Lambert, it is concluded that the recorded Mygalomorph taxa have a high potential to be widely distributed beyond the confines of the study area.

Though not formally listed as threatened, the fossorial skink *Lerista nevinae* is currently only known from the general vicinity of Cape Lambert, having been recorded from the pale coastal sands between 20°37'00"S, 117°10'59"E and 20°39'12"S, 117°06'21"E. This is equivalent to roughly 15 km of the coastline in the locality, and includes parts of the Cape Lambert Port B Development. This species is considered likely to extend further west to at least 20°38'50"S, 117°05'39"E. Further

targeted surveys for *Lerista nevinae* are scheduled for the winter months of 2008. During this field work, other areas of dune habitat will be targeted along the Pilbara coast so as to further clarify the distribution of this species.

The survey also recorded specimens of a *Diporiphora* that could not be confidently assigned to *Diporiphora winneckei* on the basis of morphological features. These have been assigned the temporary nomenclature *Diporiphora* aff. *winneckei*.

1.4 Potential Impacts

The principal direct impacts arising from the proposed development are associated with the clearing of fauna habitat. A number of indirect modifications may also occur to fauna habitat as a result of construction and operation of the Cape Lambert Port B Development. These include changes to noise levels, light spill, weed introduction or spread, and feral animal spread.

1.4.1 Direct Loss of Habitat

Based on this study, it appears that habitat potentially supporting two terrestrial Schedule 1 taxa will be cleared for the proposed development. However, based on on-ground examination of habitats within the study area, the Northern Quoll (*Dasyurus hallucatus*) and Pilbara Olive Python (*Liasis olivaceus barroni*) are unlikely to occur more than sporadically within the Cape Lambert Port B Development study area, and as a result these species are considered unlikely to be affected by the development.

1.4.2 Direct Loss of Individual Fauna

It is inevitable that there will be some localised loss of fauna due to direct mortality arising from construction activities, including that which may occur during the clearing of habitat. Additional short-term impacts may also arise from more frequent vehicle movements and machinery operation. For vertebrate and invertebrate taxa, it is unlikely that the loss of individuals associated with direct mortalities would be significant enough to affect the overall conservation status of any of the species recorded from the study area. The exception to this may be the fossorial skink *Lerista nevinae*, which appears to be restricted to coastal sands in the immediate locality. In relation to both habitat loss and direct loss of fauna, it is noted that cumulative effects of a variety of disturbances (eg. road construction and maintenance, wildfires, increased road usage, and feral animals) in the region may impact negatively on some species.

1.4.3 Noise

Noise from construction activities including blasting and haulage may impact on fauna, however there were no particularly sensitive habitats or communities within the study area that may be at particular risk (e.g. there were no recorded significant bat roosts or breeding populations of birds).

1.4.4 Light Spill

Light spill presents a key threatening processes to marine turtles. The implications of light spill in regards to adult marine turtles and hatchlings utilising beaches at Cape Lambert are discussed in the 'Cape Lambert Port B Development Marine Turtle Assess' report (Biota 2008b).

1.4.5 Weed Spread

Ground disturbance associated with construction provides an opportunity for the introduction and spread of weeds. The consequences of weed introduction on the biodiversity of fauna are not well documented, however precautions should be taken to prevent the further introduction or spread of weeds.

2.0 Introduction

2.1 Project Background

The existing Cape Lambert Operation is located within the Shire of Roebourne, 10 km north of Wickham on the Pilbara coast of Western Australia.

Pilbara Iron Pty. Ltd. proposes to increase throughput capacity at the existing Cape Lambert Operation through the construction of its Cape Lambert Port B Development. The proposed development lies adjacent to the existing Cape Lambert Operation and is focused in the area to the west of the existing railway.

The primary study area comprises approximately 605 ha. The location of Cape Lambert is shown in Figure 2.1 and the Cape Lambert Port B Development conceptual layout is shown in Figure 2.2.

2.2 Study Objectives and Scope

Biota Environmental Sciences (Biota) was commissioned to complete a two phase, seasonal fauna survey within the area encompassing the proposed Cape Lambert Port B Development. The survey was planned and implemented in accordance with the Environmental Protection Authority (EPA) Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004).

The scope of the study was to:

- document the vertebrate and short range endemic (SRE) invertebrate fauna assemblage within the defined study area using established sampling techniques;
- identify and assess the local and regional conservation significance of the fauna assemblage and habitats present in the study area;
- identify fauna (particularly Schedule and Priority listed fauna as well as potential SRE taxa) of particular conservation significance; and
- discuss the likely impacts of the project on fauna and their habitats with particular reference to species having elevated conservation significance.

2.3 Purpose of this Report

This report describes the methodology employed for the fauna survey of the Cape Lambert Port B Development study area. It documents the results of the survey and discusses the potential impacts of the development on fauna habitats and assemblages at generic level. Its intended use is as a supporting document for the environmental assessment of the Cape Lambert Port B Development. Both the survey and report are subject to specific limitations that are discussed in detail in Section 3.6.

2.4 Previous Fauna Surveys

A number of biological surveys have previously been conducted in the general vicinity of the Cape Lambert Port B Development, including the two principal comparative references used for this study:

- Cape Lambert SRE Survey for Cape Lambert Iron Ore Pty Ltd (Biota 2007); and
- Dampier Salt Solar Saltfield Expansion Fauna Survey (Biota 2006).

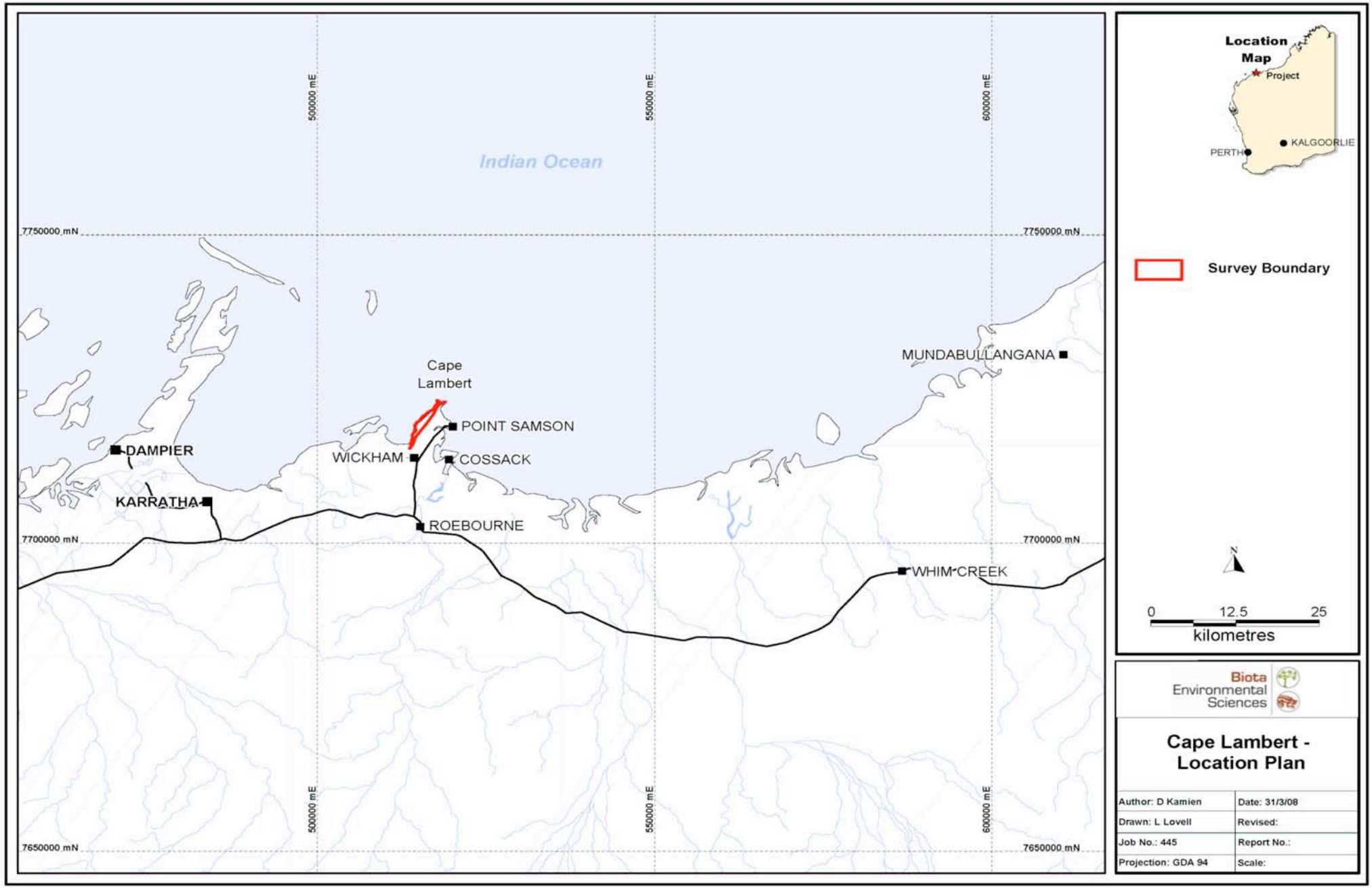

Figure 2.1: Location of the Cape Lambert Port B Development study area.

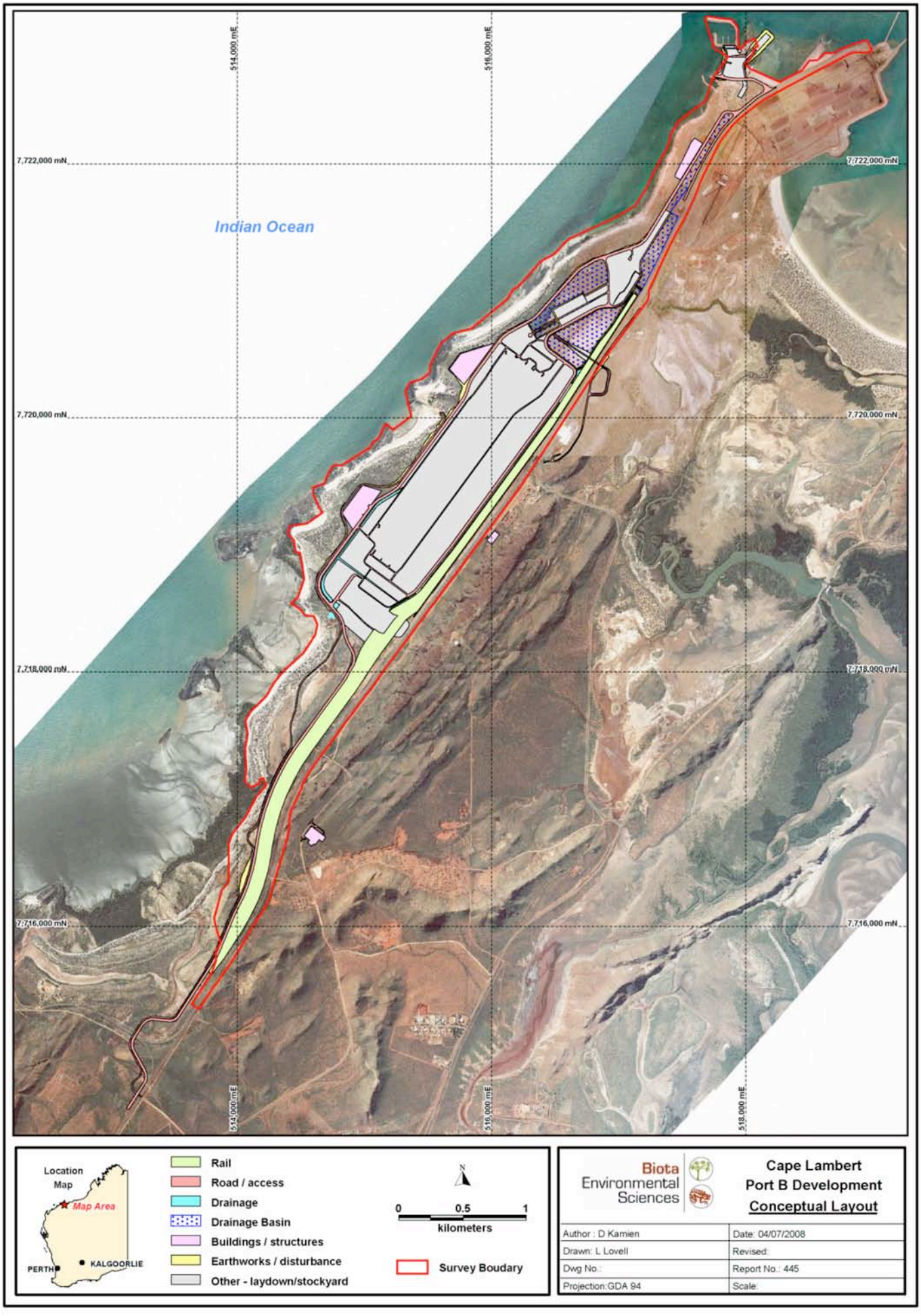

Figure 2.2: Cape Lambert Port B Development conceptual layout.

2.5 Existing Environment

2.5.1 Geology

The Cape Lambert Port B Development study area encompasses five major geological types (Figure 2.3):

- AFr: (Mount Roe Basalt) massive, vesicular, and glomeroporphyritic basalt.
- Qhms: Coastal sand in beach deposits and dunes; chiefly marine sand reworked by wind, but includes some reworked alluvium near deltas; shelly sand contains *Anadara granosa*.
- Qs: Eolian sand - red-yellow, wind-blown sand; local ridges.
- Qhm: Marine mud and silt on supratidal to intertidal flats; includes intertidal deposits with mangroves.
- Qc: Colluvium - sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits (Thorne and Trendall 2001).

2.5.2 Major Physiographic Units

Beard (1975) recognised that each ecological region has its own characteristic features of climate, landforms, geology and soils and that often vegetation is an expression of that particular environment. The Cape Lambert Port B Development study area lies entirely within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The Cape Lambert Port B Development study area is within the Abydos Plain physiographic unit extending from Cape Preston east to Pardoo Creek, and south to the Chichester Range. This physiographic unit includes alluvial plains, low stony hills and granite outcrops, comprising largely granitic soils, with alluvial sands on the coastal portion.

2.5.3 Land Systems

Land System (Rangelands) mapping covering the study area has been prepared by Agriculture Western Australia (van Vreeswyk et al. 2004). These are broad units that each consist of a series of "land units" that occur on characteristic physiographic types within the Land System.

Four land systems occur in the study area: Littoral, Rocklea, Ruth and Uaroo (Figure 2.4 and Table 2.1). The Littoral land system is mapped mainly along the coastal and northern sections of the study area. The Ruth land system dominates the central portion of the study area, while the Rocklea land system is mapped along the central eastern border. A very small area of the Uaroo land system is mapped at the southernmost tip of the study area.

Table 2.1: Land systems (rangelands) affected by the proposed development and their wider representation in the Chichester subregion (source: van Vreeswyk et al. 2004).

Land System	Description	Extent in Chichester subregion (ha)	Extent within survey area (ha)	% of total in Chichester subregion
Littoral	Tidal mudflats; mangroves and samphire; little pastoral value.	3,304	224.2	6.8 %
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex).	2,129,000	86.5	0.004 %
Ruth	Hills and ridges of volcanic and other rocks supporting hard spinifex (and occasionally soft spinifex) grasslands.	137,600	282.3	0.2 %
Uaroo	Broad sandy plains supporting shrubby hard and soft spinifex grasslands.	490,000	0.47	0.0 %
		Total area	**593.47 ha**	**7.004%**

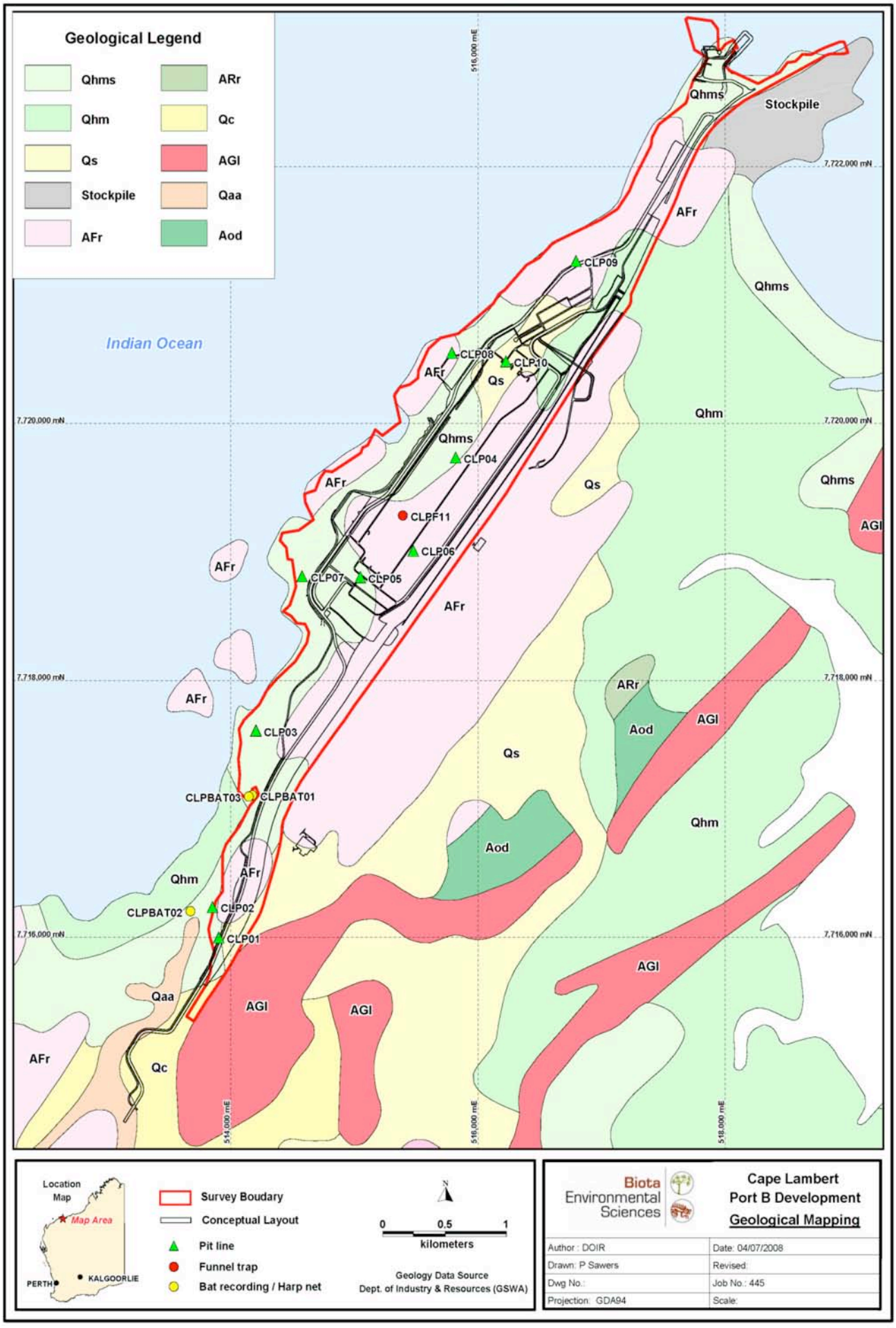

Figure 2.3: Geological mapping within the Cape Lambert Port B Development study area.

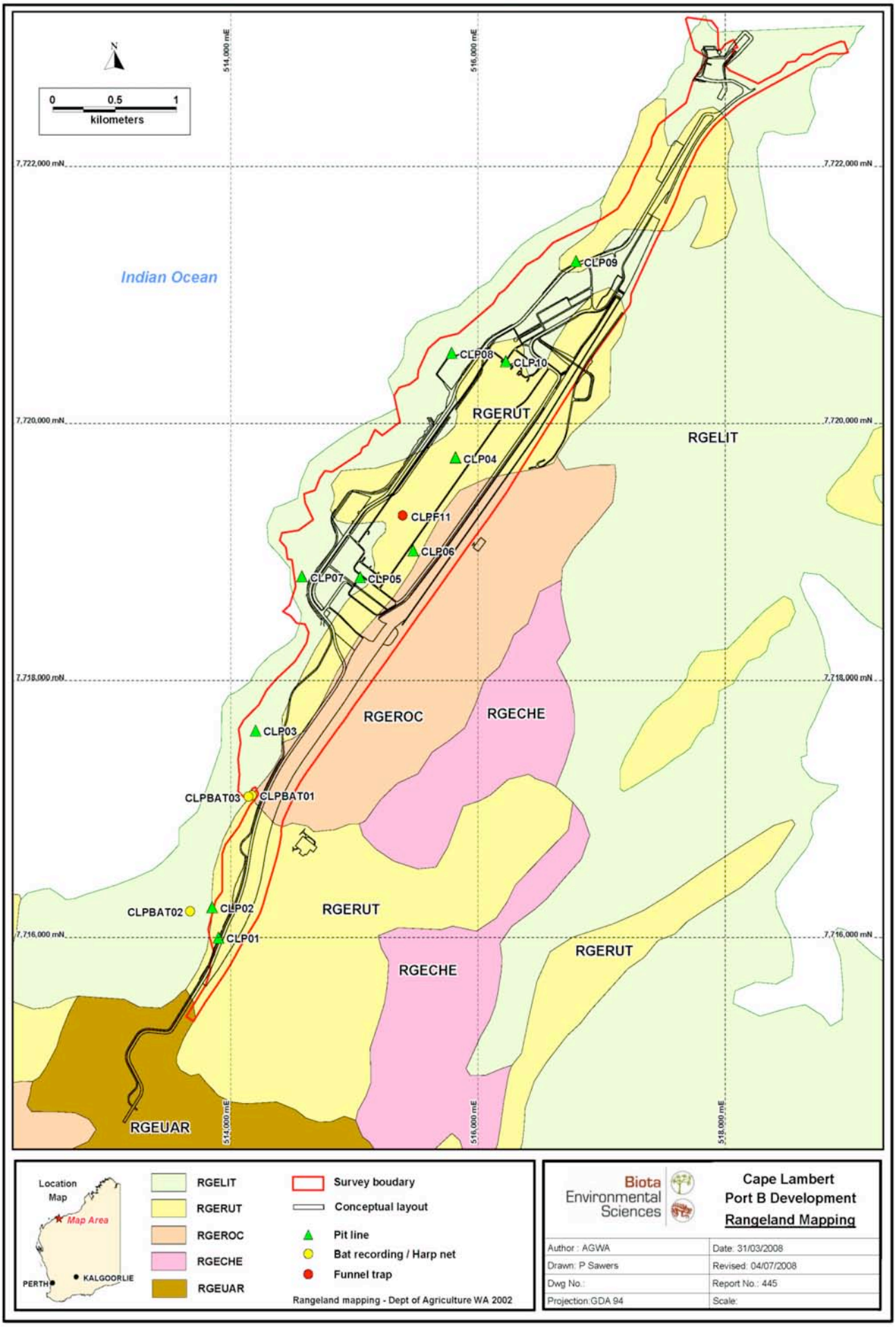

Figure 2.4: **Rangeland mapping (land systems) within the Cape Lambert Port B Development study area** (source: van Vreeswyk et al. 2004).

2.5.4 IBRA Bioregions

The proposed Cape Lambert Port B Development area is located within the Pilbara bioregion (PIL) as defined in the most recent update of the Interim Bioregionalisation of Australia (IBRA) (Environment Australia 2000).

The Pilbara bioregion has four major components:

1. Hamersley: Mountainous area of Proterozoic sedimentary ranges and plateaux with Mulga low woodland over bunch grasses on fine textured soils and Snappy Gum over *Triodia brizoides* on skeletal sandy soils of the ranges.
2. Fortescue Plains: Alluvial plains and river frontages. Salt marsh, mulga-bunch grass, and short grass communities on alluvial plains. River Gum woodlands fringe the drainage lines. This is the northern limit of Mulga (*Acacia aneura*).
3. Chichester: Archaean granite and basalt plains supporting shrub steppe characterised by *Acacia pyrifolia* over *Triodia pungens* hummock grasses. Snappy Gum tree steppes occur on ranges.
4. Roebourne: Quaternary alluvial plains with a grass savanna of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia translucens* over *Triodia pungens*. Samphire, *Sporobolus* and mangal occur on marine alluvial flats. Arid tropical with summer rain. (Environment Australia 2000).

Kendrick and McKenzie (2001) place the study area in the PIL1 (Chichester) biological subregion within the Pilbara bioregion. The PIL1 subregion covers 9,044,560 ha and is described as:

> "The Chichester subregion (PIL1) comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is semi-desert-tropical and receives 300mm of rainfall annually. Drainage occurs to the north via numerous rivers (eg. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock)".

2.5.5 Vegetation Mapping

The Cape Lambert Port B Development study area is located in an area which has previously been mapped by Shepherd et al. (2001) as 'vegetation type 144'. Shepherd's mapping is a refinement of Beard's (1975) original mapping. This vegetation is described as; '*Triodia wiseana* (hard spinifex) open hummock grasslands, grass steppe. Abydos Plain – Chichester – Oakover Valley.' The vegetation is described in more detail as; '*Eucalyptus leucophloia* isolated trees over *Acacia* species isolated shrubs over *Triodia wiseana* or *T. brizoides* open hummock grassland'.

In addition, Biota (2008a) has conducted current and detailed vegetation mapping of the Cape Lambert Port B Development study area.

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3.0 Survey Methodology

3.1 Database Searches

A search of the DEC Threatened Fauna Database was conducted for the Cape Lambert Port B Development study area (Appendix 1). The FaunaBase database of the Western Australian Museum was also searched for records of vouchered fauna from the area (Appendix 2). In addition, the Federal *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters database was searched for fauna of environmental significance within the study area (Appendix 3). The bounding coordinates delineating the search area for these databases were:

- 20.334°S, 116.67°E; and
- 21.066°S, 117.64°N.

These coordinates encompassed a search area 50 km east and west, and 40 km north and south of the Cape Lambert Port B Development study area.

3.2 Survey Timing and Weather

The survey was conducted over two phases. The Phase I survey (including trap installation) was conducted over a 13-day period between October 1st and October 12th, 2007. Minimum temperatures during the survey ranged from 15.3°C to 23.1°C and maximum temperatures ranged from 31.1°C to 40.6°C (Table 3.1). Nil rainfall was recorded in Roebourne during the survey. A total of 33.8 mm of rain fell in Roebourne in the six months prior to the survey, compared to an expected rainfall of 107.5 mm for this period (based on long term averages), indicating that the Phase I survey was conducted following a relatively dry period (Figure 3.1 and Figure 3.2).

The Phase II survey was completed between March 5th and March 12th, 2008. Minimum temperatures during the survey ranged from 19.2°C to 28.7°C (Table 3.2). A total of 24 mm of rainfall was recorded in Roebourne during the survey, all of which was recorded in a single night. A total of 124.8 mm of rain fell in Roebourne in the six months prior to the Phase II survey, compared to an average rainfall of 139.7 mm for this period (based on long term averages), indicating that the Phase II survey was conducted following a period of close to average rainfall (Figure 3.1 and Figure 3.2).

Table 3.1: **Daily meteorological observations at Roebourne during the Phase I survey conducted in October 2007** (data provided by the Western Australian Bureau of Meteorology).

Date	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10	11/10	12/10	Mean/ total
Maximum Temperature (°C)	39.1	36.9	38.2	39.5	40.6	40.5	38.8	36.5	33.5	33.7	36.4	31.1	37.1
Minimum Temperature (°C)	16.7	16.4	16.1	19.6	17.6	21.3	23.1	21.4	20.2	19.5	16.5	15.3	18.6
Rainfall (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.2: **Daily meteorological observations at Roebourne during the Phase II survey conducted in March 2008** (data provided by the Western Australian Bureau of Meteorology).

Date	5/03	6/03	7/03	8/03	9/03	10/03	11/03	12/03	Mean/total
Maximum Temperature (°C)	35.0	37.9	40.7	41.2	36.6	38.4	41.0	41.5	39.0
Minimum Temperature (°C)	26.4	25.8	27.1	28.7	19.2	25.1	23.8	23.4	24.9
Rainfall (mm)	0.0	0.0	0.0	0.0	24.0	0.0	0.0	0.0	24.0

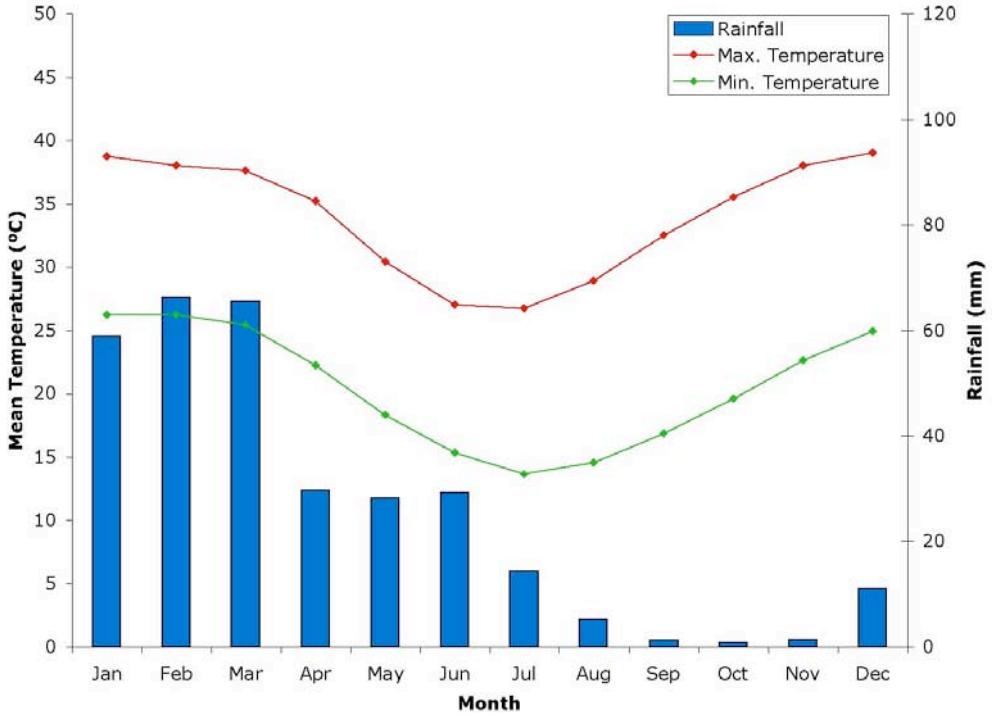

Figure 3.1: **Climatological summary for Roebourne using data from 1901 to 2000** (data provided by the Western Australian Bureau of Meteorology).

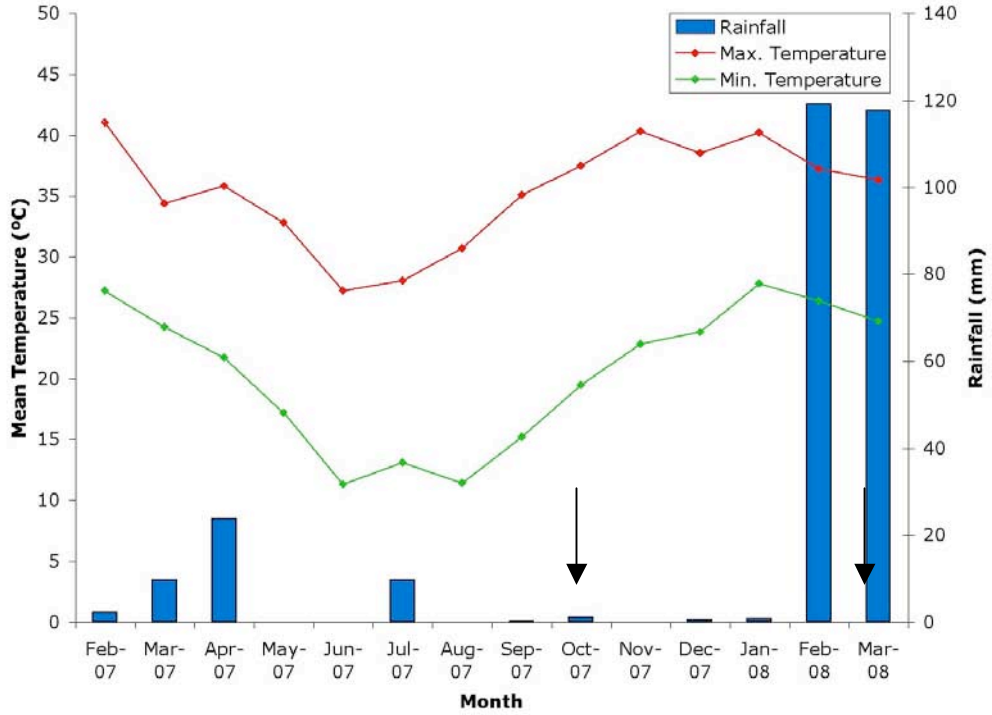

Figure 3.2: **Climatological summary for Roebourne for period 2007/2008** (data provided by the Western Australian Bureau of Meteorology; arrows indicate timing of surveys).

3.3 Fauna Survey Team

Vertebrate fauna sampling for this survey took place under "Licence to Take Fauna for Scientific Purposes" No. SF006036 issued under DEC Regulation 17 to Dan Kamien. The permit also authorised Mr. Mike Greenham, Mr. Greg Harold, Mr Roy Teale and Mr Tim Sachse (Appendix 4).

During Phase I, the fauna team comprised Mr. Dan Kamien and Mr Tim Sachse (both of Biota), and Mr Greg Harold and Mr Mike Greenham (both private contractors). The Phase II fauna team comprised Mr. Dan Kamien, Ms Erin Harris (Biota) and Mr Greg Harold.

Analyses of bat recordings were completed by Dr. Kyle Armstrong (Specialised Zoological). Invertebrate identifications were undertaken by Mr. Dan Kamien, and Dr Mark Harvey (WA Museum). Mr Brad Maryan (WA Museum) assisted with confirmation of herpetofauna identifications.

3.4 Fauna Sampling

3.4.1 Selection and Location of Sampling Sites

The principal component of this study consisted of systematic fauna sampling centred on 11 trapping grids, which were located in environments considered to represent the range of habitats available within the defined study area.

Each survey site was installed within a defined habitat and was selected such that equal weight was given to accessibility of the sites in terms of regular inspection of pit-fall traps. Locations of trapping sites are shown on Figure 2.3 and Figure 2.4, whilst representative photos are presented in Plate 3.1 to Plate 3.11.

3.4.2 Trapping Effort and Design

Trapping effort at each location is shown in Table 3.3 and Table 3.4. Systematic censusing of terrestrial fauna assemblages, including mammals and herpetofauna, consisted of a single trapping line at each of the 11 sites (Plate 3.1 to Plate 3.11). Ten of these sites consisted of 10 pit-fall traps, comprising alternating 20L buckets and PVC tubes (150 mm diameter, 600 mm deep) spaced at 10 m intervals, connected by a 90 m long by 30 cm high flywire drift fence. An additional site consisted of 10 pairs of funnel traps also spaced at 10 m intervals, connected by a 90 m long by 30 cm high flywire drift fence. Funnel traps are used when the substrate is too hard for pit-trap installation.

Table 3.3: Phase I trapping grid locations and effort within the Cape Lambert Port B Development study area.

Site	Easting	Northing	Trap Type	Number of Traps	Date Opened	Date Closed	Nights open	Trap Effort
CLP01	513902	7715999	Pit-trap	10	4/10/07	10/10/07	6	60
CLP02	513851	7716236	Pit-trap	10	4/10/07	10/10/07	6	60
CLP03	514202	7717610	Pit-trap	10	4/10/07	10/10/07	6	60
CLP04	515818	7719736	Pit-trap	10	4/10/07	10/10/07	6	60
CLP05	515047	7718804	Pit-trap	10	4/10/07	10/10/07	6	60
CLP06	515476	7719011	Pit-trap	10	4/10/07	10/10/07	6	60
CLP07	514576	7718811	Pit-trap	10	4/10/07	10/10/07	6	60
CLP08	515787	7720550	Pit-trap	10	4/10/07	10/10/07	6	60
CLP09	516792	7721264	Pit-trap	10	5/10/07	11/10/07	6	60
CLP10	516225	7720484	Pit-trap	10	5/10/07	11/10/07	6	60
CLP11F	515391	7719284	Funnel	20	5/10/07	11/10/07	6	120
						Total	**Pits** **Funnels**	**600** **120**

Table 3.4: Phase II trapping grid locations and effort within the Cape Lambert Port B Development study area.

Site	Easting	Northing	Trap Type	Number of Traps	Date Opened	Date Closed	Nights open	Trap Effort
CLP01	513902	7715999	Pit-trap	10	05/03/08	11/03/08	6	60
CLP02	513851	7716236	Pit-trap	10	05/03/08	11/03/08	6	60
CLP03	514202	7717610	Pit-trap	10	05/03/08	11/03/08	6	60
CLP04	515818	7719736	Pit-trap	10	06/03/08	12/03/08	6	60
CLP05	515047	7718804	Pit-trap	10	05/03/08	11/03/08	6	60
CLP06	515476	7719011	Pit-trap	10	06/03/08	12/03/08	6	60
CLP07	514576	7718811	Pit-trap	10	05/03/08	11/03/08	6	60
CLP08	515787	7720550	Pit-trap	10	06/03/08	12/03/08	6	60
CLP09	516792	7721264	Pit-trap	10	06/03/08	12/03/08	6	60
CLP10	516225	7720484	Pit-trap	10	06/03/08	12/03/08	6	60
CLP11F	515391	7719284	Funnel	20	06/03/08	12/03/08	6	120
						Total	**Pits** **Funnels**	**600** **120**

Plate 3.1: Site CLP01.

Plate 3.2: Site CLP02.

Plate 3.3: Site CLP03.

Plate 3.4: Site CLP04.

Plate 3.5: Site CLP05.

Plate 3.6: Site CLP06.

Plate 3.7: Site CLP07.

Plate 3.8: Site CLP08.

Plate 3.9: Site CLP09.

Plate 3.10: Site CLP10.

Plate 3.11: Site CLP11F.

3.4.3 Avifauna Sampling

Sampling of avifauna during both survey phases was carried out using a combination of techniques including:

- unbounded area searches conducted at all of the pit-fall sampling grids;
- unbounded area searches conducted opportunistically at locations containing habitats or microhabitats likely to support previously unrecorded species; and
- opportunistic observations of birds recorded while driving within the study area.

During each survey phase, 20 avifauna censuses were completed across the 10 pit-trapping sites during the survey period (Table 3.5 and Table 3.6). Avifauna was sampled using 30 to 40-minute censuses at established trapping grids. Censuses were conducted between 6:30 am and 11:00 am, and were supplemented by recording avifauna species observed opportunistically while driving within the study area. During Phase I, a total of over 11 person hours was dedicated to avifauna censusing, while 10 hours was dedicated to avifauna censusing during Phase II.

Table 3.5: Time and date of systematic avifauna censuses undertaken at each fauna site during Phase I.

Site	6/10/07	7/10/07	8/10/7	9/10/07	10/10/07	Total (min)
CLP01	-	8:17-8:47	-	7:52-8:22	-	60
CLP02	7:02-7:42	8:47-9:17	-	-	-	70
CLP03	8:10-8:50	-	-	7:10-7:40	-	70
CLP04	-	-	6:42-7:12	-	6:40-7:20	70
CLP05	-	-	-	6:35-7:05	7:19-7:49	60
CLP06	9:10-9:50	-	-	-	6:49-7:19	70
CLP07	9:55-10:35	-	-	-	7:30-8:10	80
CLP08	-	-	7:29-7:59	-	8:30-9:00	60
CLP09	-	6:40-7:15	8:23-9:03	-	-	75
CLP10	-	7:21-8:01	-	-	7:58-8:28	70
					Total	**685**

Table 3.6: Time and date of systematic avifauna censuses undertaken at each fauna site during Phase II.

Site	7/3/08	8/3/08	9/03/08	10/3/08	Total (min)
CLP01	7:34-8:04	-	7:30-8:00	-	60
CLP02	-	7:30-8:00	8:20-8:50	-	60
CLP03	8:30-9:00	-	9:40-10:10	-	60
CLP04	-	-	7:30-8:00	7:40-8:10	60
CLP05	10:00-10:30	-	-	8:35-9:05	60
CLP06	-	10:00-10:30	8:25-8:55	-	60
CLP07	9:15-9:45	-	9:45-10:15	-	60
CLP08	9:20-9:50	7:42-8:12	-	-	60
CLP09	7:40-9:10	9:00-9:30	-	-	60
CLP10	8:40-9:10	8:25-8:55	-	-	60
				Total	**600**

3.4.4 Bats

Bats were sampled using both direct capture via harp traps and echolocation call recordings. During this study, harp traps were installed in mangrove habitat, specifically within flyways between trees (Table 3.7, Plate 3.12 to Plate 3.14).

Bat echolocation calls were recorded using an Anabat II bat detector, which detects and records ultrasonic echolocation calls emitted during bat flight. The calls were stored on a compact flash card after being processed by an Anabat CF ZCAIM. Calls were visualised on Analook 3.3f software. Only sequences containing good quality search phase calls were considered for identification.

Table 3.7: Locations and effort of Harp Traps and Anabat units used during the Cape Lambert survey.

Site	Phase	Location	Sampling Method	Opened	Closed	Trap Effort (days)
CLPBAT01	Phase I	514172mE; 7717107mN	Harp Trap Anabat	6/10/07 6/10/07	10/10/07 9/10/07	4 3
CLPBAT02	Phase I Phase II	513672mE; 7716204mN	Anabat Anabat	6/10/07 7/03/08	9/10/07 9/03/08	3 2
CLPBAT03	Phase II	514144mE; 7717097mN	Harp Trap Anabat	7/03/08 9/03/08	11/03/08 11/03/08	4 2
				Total	**Harp Trap** **Anabat**	**8** **10**

Plate 3.12: Site CLPBAT01.

Plate 3.13: Site CLPBAT02.

Plate 3.14: Site CLPBAT03.

3.4.5 Invertebrate Fauna Sampling

Specific invertebrate groups were sampled using both systematic and non-systematic collections during the survey. Invertebrate groups targeted during the survey, primarily those considered to support SRE taxa, included:

- Mygalomorphae (Trapdoor Spiders);
- Diplopoda (Millipedes);
- Pulmonata (Land Snails); and
- Pseudoscorpionida (Pseudoscorpions).

Trapdoor spiders and scorpions were specifically targeted by searching for and excavating burrows. Individuals were preserved in 70% ethanol, with one or two legs removed and placed in 100% ethanol or liquid nitrogen for future molecular studies.

3.4.6 Non-systematic Sampling

A range of non-systematic fauna survey activities were undertaken by the survey team to supplement the trapping and investigate additional habitats identified during the course of the survey. These included:

- habitat specific searches for Schedule and Priority listed fauna species;
- opportunistic sightings and records;
- identification of road kills and other animal remains; and
- recording and identification of secondary signs (where possible) including tracks, scats and diggings.

3.5 Targeted Trapping for *Lerista nevinae*

Between 13/12/2007 and 19/12/2007, pitfall traps were established at four locations between Cape Lambert and the Karratha townsite in an attempt to locate additional specimens of the fossorial skink *Lerista nevinae,* which had previously been recorded in the Cape Lambert area (Figure 3.3). Six pit traps were established at each site along a 30 m section of flywire fence (Table 3.8). Trapping grids were opened for between five and six consecutive nights.

Table 3.8: Location of *Lerista nevinae* targeted trapping sites (GDA94).

Trapping Site	Easting	Northing
LN01	511024mE	7716214mN
LN02	500347mE	7715787mN
LN03	499479mE	7715449mN
LN04	490022mE	7707976mN

3.6 Study Limitations

Not all sections of the study area were ground-truthed or equally sampled for fauna. Parts of the Cape Lambert Port B Development area were inaccessible by vehicle and as a result regular checking of fauna traps in these areas would not have been possible. However, systematic fauna sampling, the primary component of the study, was completed on the basis of trapping grid installation in habitats considered to be representative of the range of units present within the development area.

Terrestrial invertebrate sampling was targeted at a small number of specific groups and collection of other taxa was largely opportunistic. This report provides an assessment of faunal conservation values and discusses generic impacts, but management is not addressed as this will be considered in the PER for the project.

3.7 Data Analysis

Sampling adequacy may be assessed by plotting species accumulation curves or rarefaction curves and examining the trend in the resultant curve over time. EstimateS v7.5 (Colwell 2005) was used to calculate species accumulation curves (rarefaction curves) based on 100 random sampling events of individuals recorded at each sampling site across both surveys (Phase I and Phase II). This produced a randomised or smoothed curve that generated the expected number of species with collections of decreasing sample sizes (Gotelli and Colwell 2001).

It should be noted that rarefaction alone cannot be used to extrapolate predicted species richness for hypothetical future biological sampling. In order to estimate asymptotic richness (ie. extrapolation of species richness), asymptotic estimators were utilised (Gotelli and Colwell 2001).

During this study, the average of four estimators was used to extrapolate species richness within the Cape Lambert Port B Development study area. These include:

- ACE Mean - Abundance-based coverage estimator of species richness;
- ICE Mean - Incidence-based coverage estimator of species richness;
- Chao 2 Mean - Chao 2 richness estimator; and
- Jack 2 Mean - Second-order jackknife richness estimator (Colwell 2005).

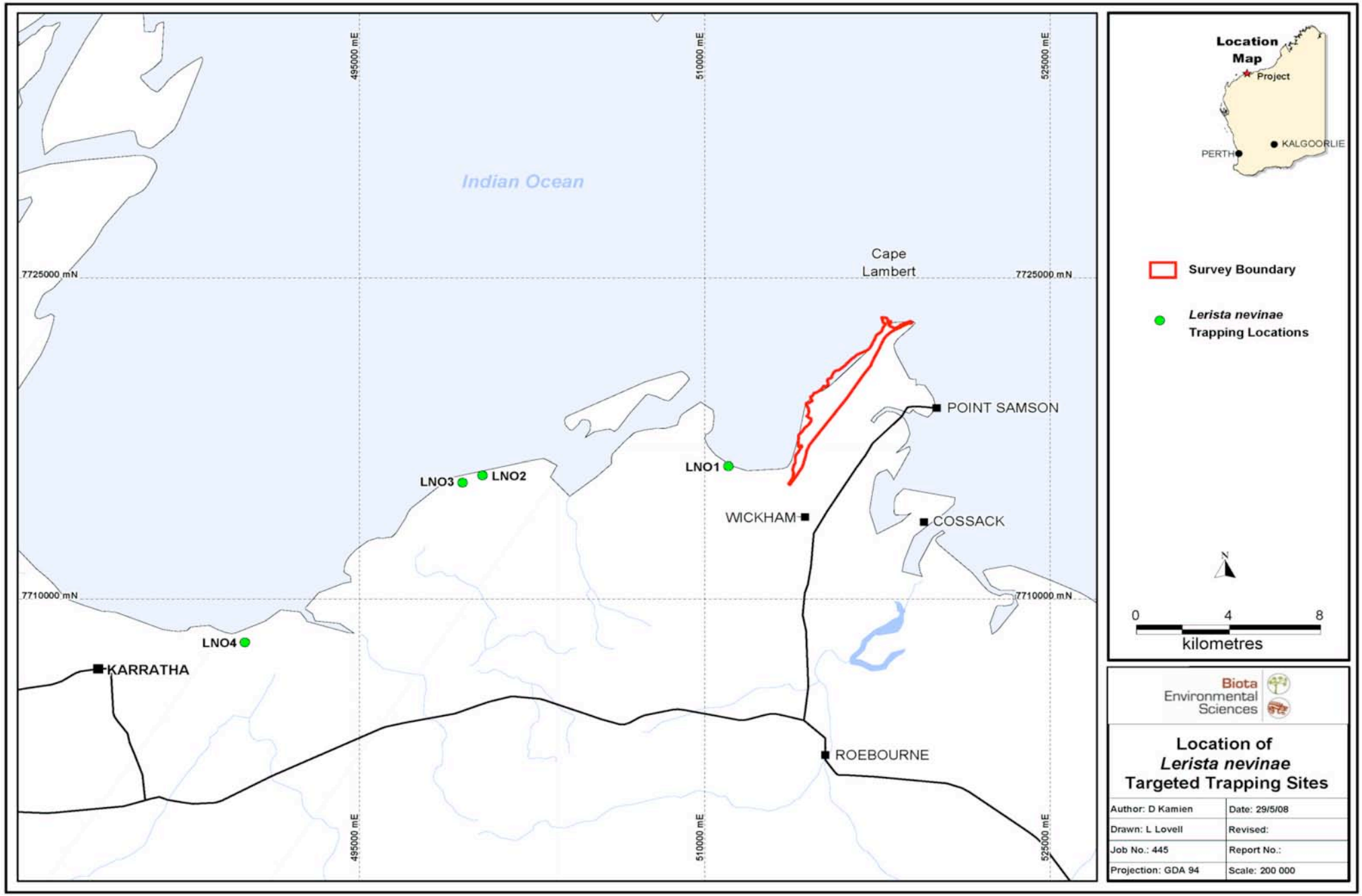

Figure 3.3: Location of *Lerista nevinae* targeted trapping sites.

4.0 Results

4.1 Vegetation Types and Habitat Classification

The study area comprised a range of habitat units, distinguished on the basis of differences in substrate, vegetation and landform (Table 4.1, Plate 3.1 to Plate 3.11).

Table 4.1: Fauna habitats within the Cape Lambert Port B Development study area and characteristics of each trapping grid.

Site	Habitat	Vegetation Description	Soils Description
Wirewood (*Acacia coriacea*) open shrublands over Soft Spinifex (*Triodia epactia*) hummock grasslands and/or mixed tussock grasslands on sand dunes			
CLP03	Primary Dune	Wirewood over Beach Spinifex (*Spinifex longifolius*) and Buffel Grass (**Cenchrus ciliaris*)	Coastal Sand
CLP07	Primary Dune	Wirewood over Beach Spinifex, Buffel Grass and Kapok Bush (**Aerva javanica*)	Coastal Sand
CLP08	Primary Dune	Wirewood over Beach Spinifex and Buffel Grass	Coastal Sand
CLP02	Secondary Dune	Wirewood over sparse *Tephrosia* sp., Soft Spinifex and Buffel Grass	Coastal Sand
CLP04	Secondary Dune	Wirewood over Buffel Grass	Coastal Sand
CLP09	Secondary Dune	Wirewood over Soft Spinifex and Buffel Grass	Red Sand
Soft Spinifex (*Triodia epactia*) hummock grasslands and/or Buffel Grass (Cenchrus ciliaris*) tussock grasslands on loamy coastal plains**			
CLP06	Flat Coastal Plain	Dense Soft Spinifex hummock grassland	Loam over Clay
CLP10	Flat Coastal Plain	Buffel Grass tussock grassland	Stony Loam
Marine Couch (*Sporobolus virginicus*) tussock grassland on saline clay plains			
CLP01	Saline Interzone	Marine Couch (*Sporobolus virginicus*) tussock grassland	Clay
Shrubby Samphire (*Halosarcia halocnemoides*) low shrublands in low-lying saline drainage areas			
CLP05	Low Lying Saline Drainage	Shrubby Samphire (*Halosarcia halocnemoides*) low shrubland	Loamy Clay
Mixed hummock grasslands on rocky hills and outcrops			
CLP11F	Rocky Hill and Outcrop	Limestone Spinifex (*Triodia wiseana*) / Soft Spinifex hummock grassland	Rock and Clay
Mangal on tidal mudflat			
-	Tidal Mudflat	Mixed Mangrove tall shrublands on tidal mudflats	Saline mud

* denotes introduced non-native species

4.2 Vertebrate Fauna Overview

The Phase I and II surveys of the Cape Lambert Port B Development study area recorded a combined total of 120 vertebrate species representing 45 families. Table 4.2 provides a summary of the number of species recorded from each major vertebrate group during both surveys.

Table 4.2: Number of species recorded during the Phase I and II surveys of the Cape Lambert Port B Development study area.

Fauna Group	Phase I	Phase II	Total
Amphibians	0	2	2
Reptiles	30	31	38
Avifauna	43	51	63
Native Volant Mammals (Bats)	4	4	5
Native Non-Volant Mammals	8	5	9
Introduced Mammals	3	0	3
Total	**88**	**93**	**120**

4.3 Herpetofauna

4.3.1 The Assemblage

The Phase I and II surveys yielded a combined total of 40 herpetofauna species from the study area (Table 4.3). The tally comprised one hylid frog (family Hylidae), one myobatrachid frog (Myobatrachidae), six geckos (Gekkonidae), three legless lizards (Pygopodidae), 14 skinks (Scincidae), six dragons (Agamidae), three monitors (Varanidae), one blind snake (Typhlopidae) and five front-fanged snakes (Elapidae).

The Desert Spadefoot Toad (*Notaden nichollsi*) was the most abundant species encountered during the survey with 1921 records, representing 74% of all herpetofauna recorded during both survey phases. It should be noted that *Notaden nichollsi* was recorded solely from dune habitat during Phase II. Additionally, *Lerista bipes* was relatively common, representing 11.8% of the herpetofauna individuals recorded.

Sites CLP03 and CLP09 exhibited the highest herpetofauna diversity within the study area, both comprising 18 species (45% of all herpetofauna species recorded in the study area). In general, both primary and secondary dune habitats exhibited high herpetofauna diversity (Table 4.3). The most diverse herpetofauna family was the Scincidae, with 14 species (35% of all herpetofauna species recorded).

4.3.2 Phase Comparison

The herpetofauna species composition varied significantly between the Phase I and II surveys, with only 21 recorded species in common (52%). Thirty species of herpetofauna were recorded during Phase I, compared to 31 species during Phase II. Ten additional species were recorded during Phase II that were not recorded during Phase I. Similarly nine species were recorded during Phase I that were not recorded during Phase II (Table 4.3).

4.3.3 Rarefaction Curve

Following two sampling phases, the herpetofauna rarefaction curve appears to be approaching an asymptote, indicating a reduced rate at which additional new species are likely to be recorded with continued trapping effort (Figure 4.1).

Non-parametric estimators predict total herpetofauna species richness within the Cape Lambert Port B Development study area could range from 43 to 48 taxa (mean Smax estimate of 45.7 $\pm$ 1.13 species; Table 4.4).

Table 4.3: Herpetofauna records from Cape Lambert survey sites during Phases I and II.

Family *Species*	CLP01		CLP02		CLP03		CLP04		CLP05		CLP06		CLP07		CLP08		CLP09		CLP10		CLPF11		Total	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Hylidae																								
Cyclorana maini	–	3	–	4	–	–	–	14	–	–	–	44	–	–	–	–	–	4	–	28	–	–	**0**	**97**
Myobatrachidae																								
Notaden nichollsi	–	–	–	209	–	147	–	681	–	–	–	–	–	88	–	459	–	188	–	149	–	–	**0**	**1921**
Gekkonidae																								
Lucasium stenodactylum	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	–	**0**	**5**
Gehyra punctata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	**1**	**3**
Heteronotia binoei	–	–	–	–	1	–	–	–	–	–	2	–	–	1	–	1	–	–	–	–	–	–	**3**	**2**
Strophurus ciliaris	–	–	1	–	4	2	3	–	–	–	1	–	1	–	4	1	1	1	–	–	–	–	**15**	**4**
Strophurus jeanae	–	–	–	3	–	3	–	1	–	–	–	–	–	2	–	6	–	7	–	–	–	–	**0**	**22**
Gehyra variegata	–	–	–	–	2		1	–	–	–	–	–	–	–	1	–	–	–	–	–	3	–	**7**	**0**
Pygopodidae																								
Delma pax	4	2	–	–	–	3	–	1	–	–	–	2	2	1	1	3	1	–	–	5	–	–	**8**	**17**
Delma tincta	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Lialis burtonis	1	–	–	1	1	–	–	–	–	–	–	–	–	2	–	–	–	3	–	2	–	–	**2**	**8**
Scincidae																								
Carlia munda	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	**0**	**2**
Ctenotus grandis	–	1	–	–	–	–	–	–	–	–	3	2	–	–	–	–	–	–	–	–	–	–	**3**	**3**
Ctenotus pantherinus	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	**2**	**0**
Ctenotus saxatilis	2	–	–	–	1	–	1	–	–	–	1	–	2	–	–	3	2	–	–	–	–	5	**9**	**8**
Ctenotus serventyi	–	1	–	2	–	1	–	–	–	–	–	–	–	1	–	1	–	–	1	–	–	1	**1**	**7**
Cyclodomorphus melanops	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	**1**	**1**
Egernia depressa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	**0**	**2**
Eremiascincus fasciolatus	–	–	–	–	–	–	5	4	–	–	–	–	–	–	3	1	2	–	–	–	–	–	**10**	**5**
Lerista bipes	–	–	33	8	39	10	23	5	–	–	–	–	39	13	18	11	59	18	24	8	–	–	**235**	**73**
Lerista nevinae	–	–	5	2	3	1	4	–	–	–	–	–	3	2	3	–	2	–	–	–	–	–	**20**	**5**
Lerista verhmens	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	**0**	**1**
Menetia greyii	1	2	–	1	–	1	3	–	–	–	1	–	5	3	–	–	–	–	1	1	–	–	**11**	**8**
Morethia ruficauda exquisita	–	–	–	–	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	**1**	**2**
Tiliqua multifasciata	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Agamidae																								
Ctenophorus caudicinctus	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	2	–	2	–	1	**1**	**5**
Ctenophorus isolepis	1	–	–	–	2	3	–	2	–	–	–	–	–	–	3	4	2	3	–	1	–	1	**8**	**14**

Family ***Species***	**CLP01**		**CLP02**		**CLP03**		**CLP04**		**CLP05**		**CLP06**		**CLP07**		**CLP08**		**CLP09**		**CLP10**		**CLPF11**		**Total**	
Diporiphora aff. *winneckei*	–	–	–	1	–	–	1	2	–	–	–	–	2	1	1	1	–	1	–	–	–	1	**4**	**7**
Lophognathus gilberti gilberti	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**2**
Lophognathus longirostris	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**0**	**2**
Pogona minor	–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**2**
Varanidae																								
Varanus acanthurus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	4	1	**5**	**2**
Varanus eremius	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	**3**	**0**
Varanus giganteus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	**1**	**0**
Typhlopidae																								
Ramphotyphlops grypus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	**0**	**1**
Elapidae																								
Furina ornata	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	**1**	**1**
Pseudonaja nuchalis	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	**1**	**2**
Brachyurophis approximans	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Demansia rufescens	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	–	**7**	**0**
Vermicella snelli	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Number of Individuals	**11**	**9**	**42**	**235**	**54**	**176**	**42**	**710**	**1**	**0**	**11**	**53**	**54**	**114**	**34**	**492**	**74**	**229**	**27**	**199**	**15**	**17**	**365**	**2234**
Number of Species	**7**	**5**	**6**	**12**	**9**	**13**	**9**	**8**	**1**	**0**	**8**	**6**	**7**	**10**	**8**	**12**	**11**	**10**	**4**	**11**	**5**	**10**	**30**	**31**
Total Number of Species	**9**		**16**		**18**		**14**		**1**		**12**		**12**		**14**		**18**		**13**		**13**		**40**	

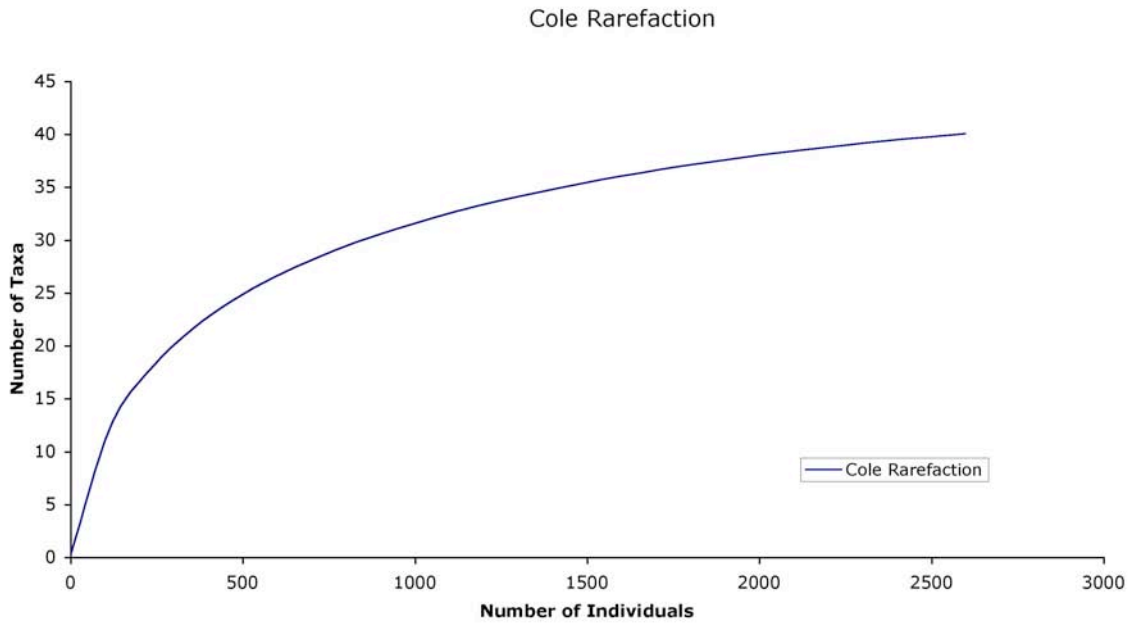

Figure 4.1: **A sample-based rarefaction curve for herpetofauna collected over two sampling phases at the Cape Lambert Port B Development study area** (generated using EstimateS v7.5; Colwell 2005).

Table 4.4: **Observed and estimated herpetofauna species richness at Cape Lambert based on four non-parametric estimators** (calculated using EstimateS; Colwell 2005).

Actual Observed (Phases I and II)	40

Species Richness Estimator	**Estimated S_{max}**
Ace Mean	44.7
Ice Mean	47.0
Chao 2 Mean	43.1
Jackknife 2 Mean	48.1

4.3.4 *Lerista nevinae*

In respect of *Lerista nevinae*, 25 individuals were recorded from grids established within the study area (Table 4.3). In addition, a solitary individual was recorded from the additional pit line (LN01) established at 20°39'12"S, 117°6'21"E (Figure 4.2). The further searches for this species undertaken in the dunes at Cleaverville Beach and east of the Karratha townsite, using pit traps supplemented with some hand foraging (raking of debris), failed to detect any specimens. Figure 4.2 depicts the known distribution of this species. The conservation significance of *Lerista nevinae* is discussed in Section 6.3.5.

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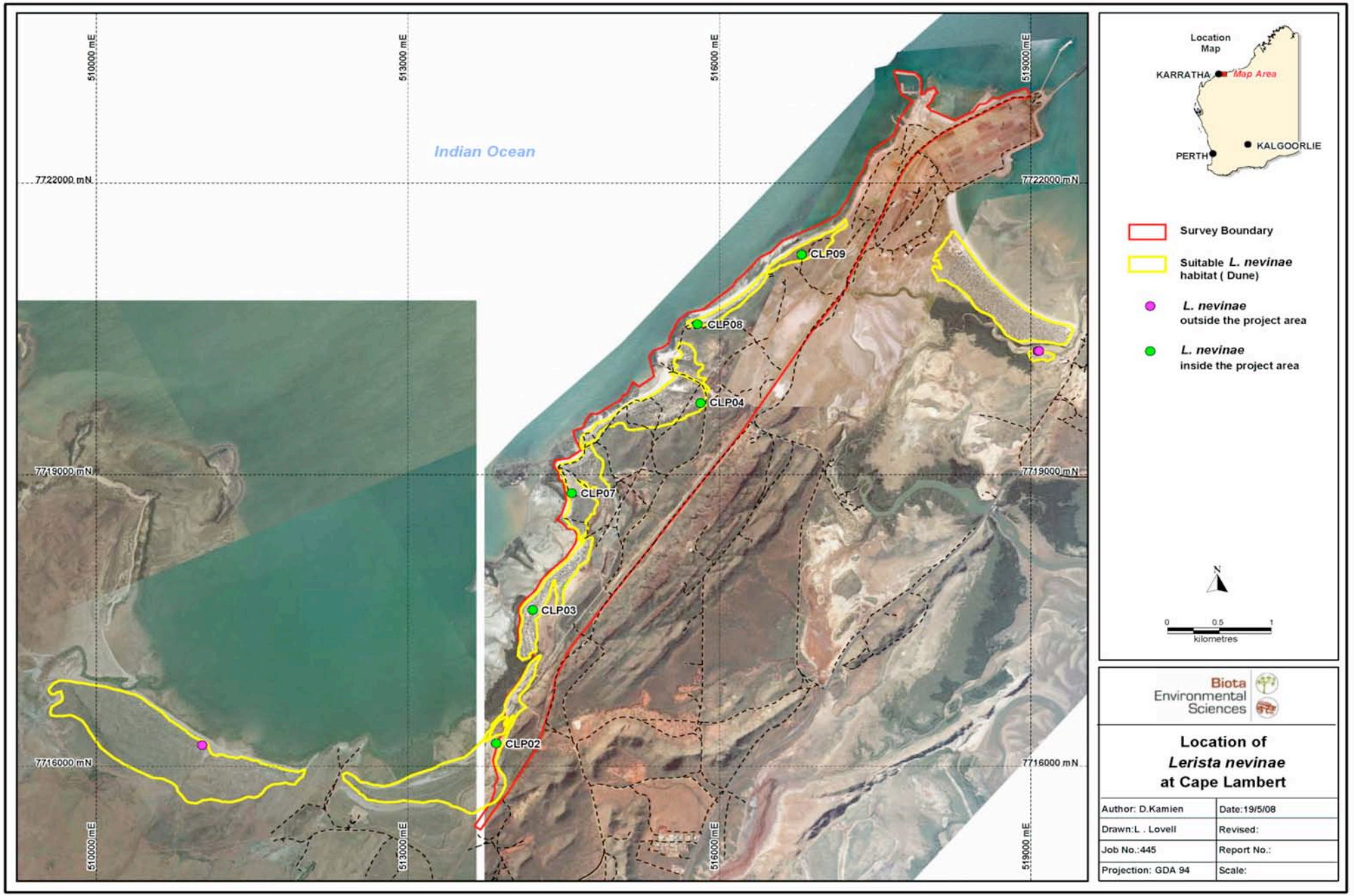

Figure 4.2: Location of *Lerista nevinae* at Cape Lambert.

4.4 Avifauna

4.4.1 The Assemblage

Sixty-three bird species were recorded during the Phase I and II surveys combined. The total species tally comprised 40 non-passerine species and 23 passerine species from 28 families (Table 4.5).

The most abundant species recorded was the Zebra Finch (787 records), representing 49% of all recorded avifauna during both surveys combined. The most speciose family of birds was the Scolopacidae (waders). Nine species of waders were recorded, predominantly via opportunistic sightings on the tidal mud flats. Site CLP02 (secondary dune) exhibited the highest avifauna diversity within the study area with 30 species (48% of the bird species recorded in the study area during both phases). Site CLP07 (primary dune) also displayed a high species richness, with 29 species recorded (46% of the total records).

4.4.2 Phase Comparison

The avifauna species composition varied significantly between the Phase I and II surveys. Only 30 (48%) of the total recorded species were observed during both phases, with the number of recorded species also varying between phases (Table 4.5). This indicates a marked change in avifauna species composition between surveys. Recorded avifauna abundance varied only slightly between Phases I and II, with 872 individuals recorded during Phase I and 719 birds observed during Phase II.

4.4.3 Rarefaction Curve

Similar to the herpetofauna (Section 4.3), the avifauna rarefaction curve for Phases I and II combined also appears to be approaching an asymptote, indicating a reduced rate at which additional new species are likely to be recorded with continued trapping effort (Figure 4.3).

Non-parametric estimators predict total avifauna species richness within the Cape Lambert Port B Development study area could range from 73 to 102 species (mean Smax estimate of 91.3 $\pm$ 6.3 species; Table 4.6).

Table 4.5: Avifauna records from Cape Lambert survey sites during Phases I and II.

Family *Species*	Common Name	CLP01		CLP02		CLP03		CLP04		CLP05		CLP06		CLP07		CLP08		CLP09		CLP10		Tidal Flat	Total	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P2	P1	P2
Phasianidae																								
Coturnix ypsilophora australis	Brown Quail	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**4**
Ardeidae																								
Ardea alba modesta	Great Egret	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	**0**	**2**
Ardea garzetta	Little Egret	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**	**1**
Scolopacidae																								
Limosa lapponica	Bar-tailed Godwit	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	**0**	**2**
Numenius arquata	Eurasian Curlew	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Numenius minutus	Little Curlew	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	**0**	**1**
Numenius madagascariensis	Eastern Curlew	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	**0**	**3**
Numenius phaeopus	Whimbrel	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**	**0**
Tringa nebularia	Common Greenshank	–	–	5	1	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**6**	**2**
Tringa brevipes	Grey-tailed Tattler	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	12	**2**	**12**
Arenaria interpres interpres	Ruddy Turnstone	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	**0**	**2**
Calidris ruficollis	Red-necked Stint	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	**0**	**13**
Haematopodidae																								
Haematopus longirostris	Pied Oystercatcher	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	**0**	**2**
Haematopus fuliginosus	Sooty Oystercatcher	–	–	–	–	–	–	–	–	–	–	–	–	–	4	1	–	–	–	–	–	–	**1**	**4**
Recurvirostridae																								
Himantopus himantopus leucocephalus	Black-winged Stilt	–	–	–	3	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	**0**	**5**
Charadriidae																								
Charadrius ruficapillus	Red-capped Plover	–	–	4	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	**4**	**6**
Charadrius leschenaultii leschenaultii	Greater Sand Plover	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	**0**	**8**
Laridae																								
Larus novaehollandiae	Silver Gull	–	–	6	–	6	–	–	–	–	2	–	–	1	1	3	–	2	–	–	–	11	**18**	**14**
Sterna caspia	Caspian Tern	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Sterna bengalensis	Lesser Crested Tern	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	**5**	**0**
Sterna bergii	Crested Tern	–	–	–	–	–	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	**0**	**39**
Accipitridae																								
Pandion haliaetus	Osprey	–	–	–	1	1	–	1	–	–	1	–	–	–	1	1	–	1	–	1	–	–	**5**	**3**
Elanus caeruleus	Black-shouldered Kite	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**1**	**1**
Haliaeetus leucogaster	White-bellied Sea-Eagle	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Haliastur indus	Brahminy Kite	2	–	1	1	–	–	–	–	2	–	–	–	4	1	–	–	–	–	–	2	–	**9**	**4**

Family *Species*	Common Name	CLP01		CLP02		CLP03		CLP04		CLP05		CLP06		CLP07		CLP08		CLP09		CLP10		Tidal Flat	Total	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P2	P1	P2
Falconidae																								
Falco berigora berigora	Brown Falcon	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**0**	**1**
Falco cenchroides	Australian Kestrel	–	–	–	–	–	–	–	1	–	1	2	–	1	–	1	1	1	–	–	–	–	**5**	**3**
Columbidae																								
Ocyphaps lophotes	Crested Pigeon	–	–	–	1	–	1	2	–	–	–	–	–	–	1	–	–	–	–	1	–	–	**3**	**3**
Geophaps plumifera	Spinifex Pigeon	–	7	–	–	–	–	2	–	4	4	3	1	–	–	3	–	2	–	2	–	–	**16**	**12**
Geopelia striata	Peaceful Dove	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**	**0**
Geopelia humeralis	Bar-shouldered Dove	–	–	–	1	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**2**	**1**
Psittacidae																								
Cacatua roseicapilla	Galah	2	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	2	–	–	**4**	**6**
Cacatua sanguinea	Little Corella	–	–	12	7	7	–	–	–	–	7	–	12	–	21	–	–	37	1	–	2	–	**56**	**50**
Melopsittacus undulatus	Budgerigar	–	–	–	70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**70**
Cuculidae																								
Chrysococcyx basalis	Horsfield's Bronze Cuckoo	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**1**
Centropodidae																								
Centropus phasianinus melanurus	Pheasant Coucal	–	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**3**
Halcyonidae																								
Todiramphus pyrrhopygia	Red-backed Kingfisher	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	**0**	**3**
Todiramphus sanctus	Sacred Kingfisher	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	**3**	**2**
Todiramphus chloris	Collared Kingfisher	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**	**0**
Meropidae																								
Merops ornatus	Rainbow Bee-eater	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Maluridae																								
Malurus lamberti	Variegated Fairy-wren	–	3	–	1	–	5	–	8	–	4	–	–	–	1	5	10	8	7	2	2	–	**15**	**41**
Malurus leucopterus	White-winged Fairy-wren	–	1	–	2	–	2	8	32	–	–	–	12	–	4	–	–	–	5	–	–	–	**8**	**58**
Acanthizidae																								
Smicrornis brevirostris	Weebill	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**	**0**
Gerygone tenebrosa	Dusky Gerygone	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**	**0**
Meliphagidae																								
Lichmera indistincta	Brown Honeyeater	–	3	–	–	–	1	–	1	–	–	–	2	1	–	–	1	–	4	–	–	–	**1**	**12**
Lichenostomus virescens	Singing Honeyeater	3	–	1	2	1	1	9	5	1	–	1	–	9	4	6	2	3	2	2	1	–	**36**	**17**
Manorina flavigula	Yellow-throated Miner	–	–	–	–	–	–	–	–	–	–	–	–	4	2	–	–	–	–	–	–	–	**4**	**2**
Pachycephalidae																								
Oreoica gutturalis	Crested Bellbird	–	–	–	–	–	1	–	2	–	–	–	–	–	1	–	–	–	–	–	–	–	**0**	**4**
Dicruridae																								
Rhipidura phasiana	Mangrove Grey Fantail	–	–	1	2	–	2	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**2**	**4**
Rhipidura leucophrys	Willie Wagtail	–	–	3	7	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	**3**	**8**
Grallina cyanoleuca	Magpie-lark	1	4	–	–	1	–	–	3	–	1	–	–	2	1	–	–	–	–	–	–	–	**4**	**9**
Campephagidae																								
Coracina novaehollandiae	Black-faced Cuckoo-shrike	–	4	2	2	2	–	–	5	3	–	2	5	–	4	2	–	1	–	3	–	1	**15**	**21**

Family *Species*	Common Name	CLP01		CLP02		CLP03		CLP04		CLP05		CLP06		CLP07		CLP08		CLP09		CLP10		Tidal Flat	Total	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P2	P1	P2
Lalage tricolor	White-winged Triller	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**1**	**0**
Artamidae																								
Artamus leucorynchus	White-breasted Woodswallow	–	–	3	–	1	3	–	–	–	3	–	–	–	9	1	–	–	1	–	–	–	**5**	**16**
Artamus cinereus	Black-faced Woodswallow	–	–	–	3	–	–	8	–	3	–	–	–	–	1	–	–	–	–	–	–	–	**11**	**4**
Cracticidae																								
Cracticus nigrogularis	Pied Butcherbird	3	2	–	1	2	2	2	2	–	–	1	–	–	1	1	3	1	–	–	3	–	**10**	**14**
Corvidae																								
Corvus orru cecilae	Torresian Crow	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**1**
Zosteropidae																								
Zosterops luteus	Yellow White-eye	–	–	–	1	5	–	–	–	–	–	–	–	5	2	–	–	–	–	–	–	4	**10**	**7**
Alaudidae																								
Mirafra javanica horsfieldii	Singing Bushlark	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	**0**	**3**
Passeridae																								
Taeniopygia guttata	Zebra Finch	1	8	37	21	33	25	100	19	–	28	1	10	29	37	53	–	154	–	184	47	–	**592**	**195**
Emblema pictum	Painted Finch	–	–	–	–	–	4	–	–	–	8	–	–	–	–	–	–	–	–	–	–	–	**0**	**12**
Neochmia ruficauda	Star Finch	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	**1**	**0**
Motacillidae																								
Anthus australis	Australian Pipit	–	–	–	–	–	3	–	–	–	3	–	–	–	–	–	–	–	–	1	2	–	**1**	**8**
	Number of Individuals	**12**	**35**	**86**	**138**	**60**	**72**	**134**	**80**	**13**	**74**	**10**	**42**	**64**	**100**	**84**	**17**	**211**	**20**	**198**	**59**	**82**	**872**	**719**
	Number of Species	**6**	**10**	**17**	**23**	**11**	**14**	**10**	**12**	**5**	**15**	**6**	**6**	**16**	**20**	**14**	**5**	**11**	**6**	**9**	**7**	**15**	**43**	**51**
	Total number of Species	**13**		**30**		**21**		**18**		**19**		**9**		**29**		**15**		**14**		**12**		**15**	**63**	

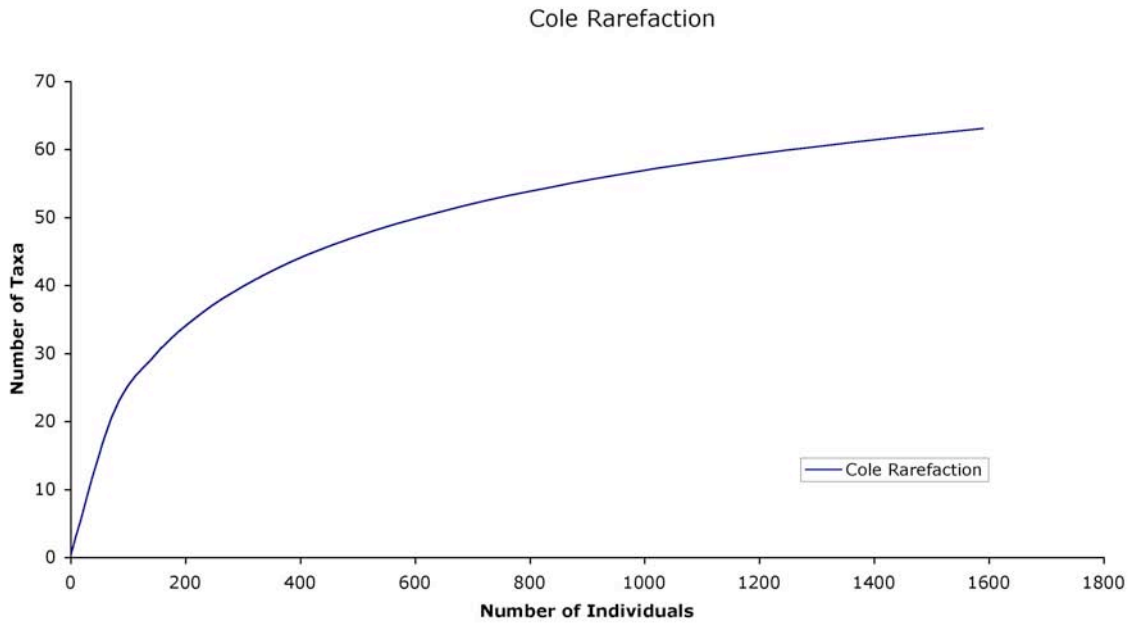

Figure 4.3: **A sample based rarefaction curve for avifauna collected over two sampling phases at the Cape Lambert Port B Development study area** (generated using EstimateS v7.5; Colwell 2005).

Table 4.6: **Observed and estimated avifauna species richness at Cape Lambert based on four non-parametric estimators** (calculated using EstimateS; Colwell 2005).

Actual Observed (Phases I and II)	63

Species Richness Estimator	**Estimated S_{max}**
Ace Mean	73.2
Ice Mean	96.4
Chao 2 Mean	93.7
Jackknife 2 Mean	102

4.5 Mammals

4.5.1 The Assemblage

A total of 17 mammal species (14 native and three introduced) were recorded within the study area during Phases I and II (Table 4.7). Twelve non-volant mammal species were recorded during the survey, comprising five dasyurids (carnivorous marsupials), two macropods (kangaroos and wallabies), three murids (murid rodents), one bovid (the goat) and one canid (the fox).

The most commonly recorded mammal species was *Pseudomys hermannsburgensis* (Sandy Inland Mouse), with 39 records representing almost 30% of the non-volant mammal records during the survey. It should be noted that the majority of *P. hermannsburgensis* were recorded during Phase I. *Macropus robustus* (Euro) was also abundant during the survey (Table 4.7). Between one and five non-volant mammal species were recorded from each trapping grid.

Harp trapping during Phase II resulted in the capture of a single species (*Nyctophilus geoffroyi*, the Lesser Long-eared Bat) in mangrove habitat at site CLPBAT03. Based on examination of recorded call sequences, five bat species were found to occur within the study area. These include two Vespertilionids (evening bats), one Molossid (freetail bats), and two Emballonurids (sheathtail bats) (Table 4.7 and Appendix 5).

4.5.2 Phase Comparison

The mammalian species composition varied significantly between the Phase I and II surveys. Only seven (41%) of the total recorded species were observed during both phases, with the number of recorded species also varying between phases (Table 4.7). As similarly noted with the avifauna (Section 4.4.2), this indicates a clear change in mammalian species composition between surveys.

4.5.3 Rarefaction Curve

Based on data from Phases I and II, the rarefaction curve for non-volant mammals appears to be close to asymptotic, indicating that few additional species are likely to be recorded with continued trapping effort (Figure 4.4).

However, non-parametric estimators predict total non-volant mammalian species richness within the Cape Lambert Port B Development study area could range from 14 to 20 species (mean Smax estimate of 17.5 $\pm$ 1.31 species; Table 4.8).

Table 4.7: Mammal records from Cape Lambert survey sites during Phases I and II.

Family Species	Common Name	CLP01		CLP02		CLP03		CLP04		CLP05		CLP06		CLP07		CLP08		CLP09		CLP10		CLPF11		CLPBAT01		CLPBAT02		CLPBAT03		Total	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Dasyuridae																															
Dasykaluta rosamondae	Little Red Kaluta	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**1**
Planigale ingrami	Long-tailed Planigale	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**4**
Ningaui timealeyi	Pilbara Ningaui	–	–	–	–	–	–	–	–	–	–	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**7**	**0**
Sminthopsis macroura	Stripe-faced Dunnart	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	**2**	**0**
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**	**0**
Macropodidae																															
Macropus robustus	Euro	–	–	–	–	–	–	2	1	–	1	–	1	–	–	5	1	1	5	–	2	2	–	–	–	–	–	–	–	**10**	**11**
Macropus rufus	Red Kangaroo	–	–	–	–	–	1	–	2	–	–	–	–	–	1	2	7	3	–	–	3	–	–	–	–	–	–	–	–	**5**	**14**
Muridae																												–	–	–	–
**Mus musculus*	House Mouse	1	–	–	–	–	–	3	–	3	–	–	–	4	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**12**	**0**
Pseudomys desertor	Desert Mouse	1	–	1	–	2	–	1	–	–	–	2	–	2	–	7	–	2	–	–	–	–	–	–	–	–	–	–	–	**18**	**0**
Pseudomys hermannsburgensis	Sandy Inland Mouse	3	–	6	–	2	–	6	–	–	–	2	–	8	1	4	–	5	–	1	1	–	–	–	–	–	–	–	–	**37**	**2**
Vespertilionidae																															
Nyctophilus geoffroyi	Lesser Long-eared Bat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,E	**0**	**2**
Vespadelus finlaysoni	Inland Cave Bat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	E	–	–	E	–	–	**1**	**1**
Molossidae																															
Mormopterus loriae cobourgiana	Little Northern Freetail Bat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	E	–	–	E	–	E	**1**	**2**
Emballonuridae																															
Taphozous georgianus	Common Sheathtail bat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	E	–	–	E	–	E	**1**	**2**
Saccolaimus flaviventris	Yellow-bellied Sheathtail bat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	E	–	–	–	–	–	**1**	**0**
Bovidae																															
**Capra hircus*	Goat	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
Canidae																															
**Vulpes vulpes*	Red Fox	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0**
	Number of Individuals	**7**	**0**	**8**	**0**	**5**	**1**	**12**	**3**	**3**	**2**	**11**	**5**	**15**	**2**	**19**	**8**	**13**	**5**	**1**	**6**	**2**	**0**	**4**	**0**	**0**	**3**	**0**	**5**	**100**	**42**
	Number of Species	**5**	**0**	**3**	**0**	**3**	**1**	**4**	**2**	**1**	**2**	**3**	**2**	**4**	**2**	**5**	**2**	**5**	**1**	**1**	**3**	**1**	**0**	**4**	**0**	**0**	**3**	**0**	**3**	**15**	**9**
	Total number of Species	**5**		**3**		**4**		**5**		**3**		**4**		**5**		**5**		**5**		**3**		**1**		**4**		**3**		**3**		**17**	

* denotes non- native introduced species
E denotes bat echolocation recording

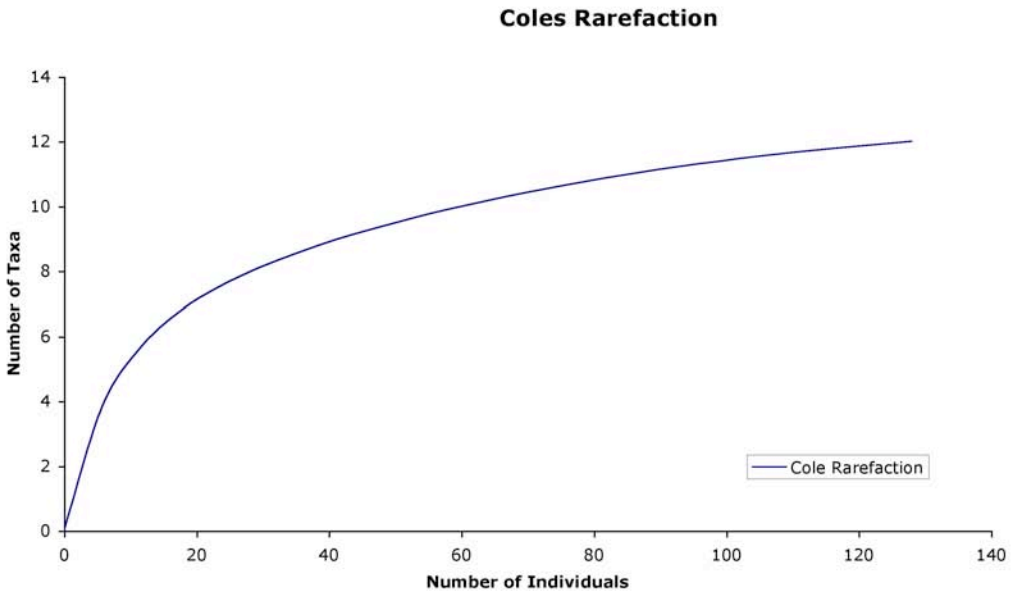

Figure 4.4: **A sample based rarefaction curve for non-volant mammals collected over two sampling phases at the Cape Lambert Port B Development study area** (generated using EstimateS v7.5; Colwell 2005).

Table 4.8: **Observed and estimated non-volant mammalian species richness at Cape Lambert based on four non-parametric estimators** (calculated using EstimateS; Colwell 2005).

Actual Observed (Phases I and II)	12

Species Richness Estimator	**Estimated S_{max}**
Ace Mean	13.7
Ice Mean	18.5
Chao 2 Mean	18.2
Jackknife 2 Mean	19.6

4.6 Invertebrates

Taxonomic groups of invertebrates with naturally small distributions are described as SRE taxa and are in part characterised by poor dispersal capabilities, confinement to disjunct habitats and low fecundity (Harvey 2002, Ponder and Colgan 2002). Given the importance of short-range endemism to the conservation of biodiversity, the assessment of such invertebrate taxa is a potentially important component of impact assessment. Examples of taxonomic groups that show high levels of short-range endemism in this respect include mygalomorph spiders, millipedes, pseudoscorpions and freshwater and terrestrial molluscs.

4.6.1 Mygalomorph spiders

Three potentially SRE invertebrate species, specifically Mygalomorph spiders of the families Nemesiidae and Idiopidae, were recorded from the Cape Lambert Port B Development study area (Table 4.9, Plate 4.1 to Plate 4.4, Figure 4.5 and Figure 4.6). Mr Dan Kamien (Biota) identified spider families, with morpho-species determined based on spider morphology (examination of key characteristics) in combination with burrow characteristics.

Table 4.9: Mygalomorph spiders recorded at the Cape Lambert Port B Development study area during Phase I and II.

Family Species	CLP01		CLP02		CLP03		CLP04		CLP05		CLP06		CLP07		CLP08		CLP09		CLP10		CLPF11		Opp		Total	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P1	P2													
Nemesiidae																										
Aname sp. A	–	–	1	4	–	–	–	–	–	–	–	1	1	1	–	–	–	–	–	3	–	–	8	–	**10**	**9**
Aname sp. B	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	–	**2**	**1**
Idiopidae																										
sp A	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**0**	**1**

Plate 4.1: *Aname* sp. A female.

Plate 4.2: *Aname* sp. A male.

Plate 4.3: *Aname* sp. B.

Plate 4.4: Idiopidae sp. A.

4.6.2 Land Snails

Dead *Rhagada convicta* land snails were observed at sites CLP01 and CLP02, however live snails were not recorded during either survey phase. *Rhagada convicta* has an extensive coastal distribution, including additional records from Cape Lambert outside the study area (Biota 2007). *Rhagada convicta* does not qualify as a short-range endemic species.

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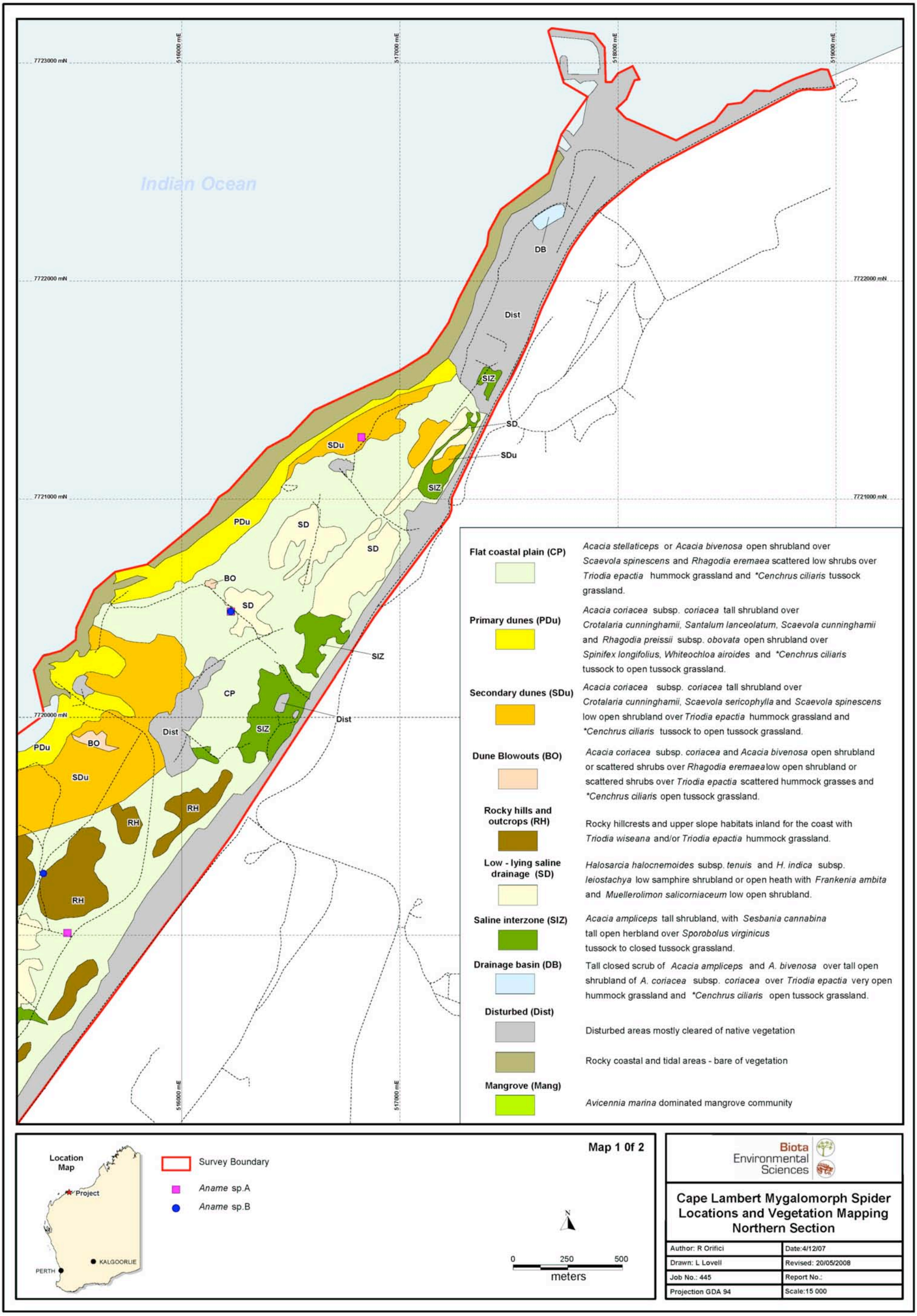

Figure 4.5: Cape Lambert Mygalomorph spider locations and vegetation mapping – northern section.

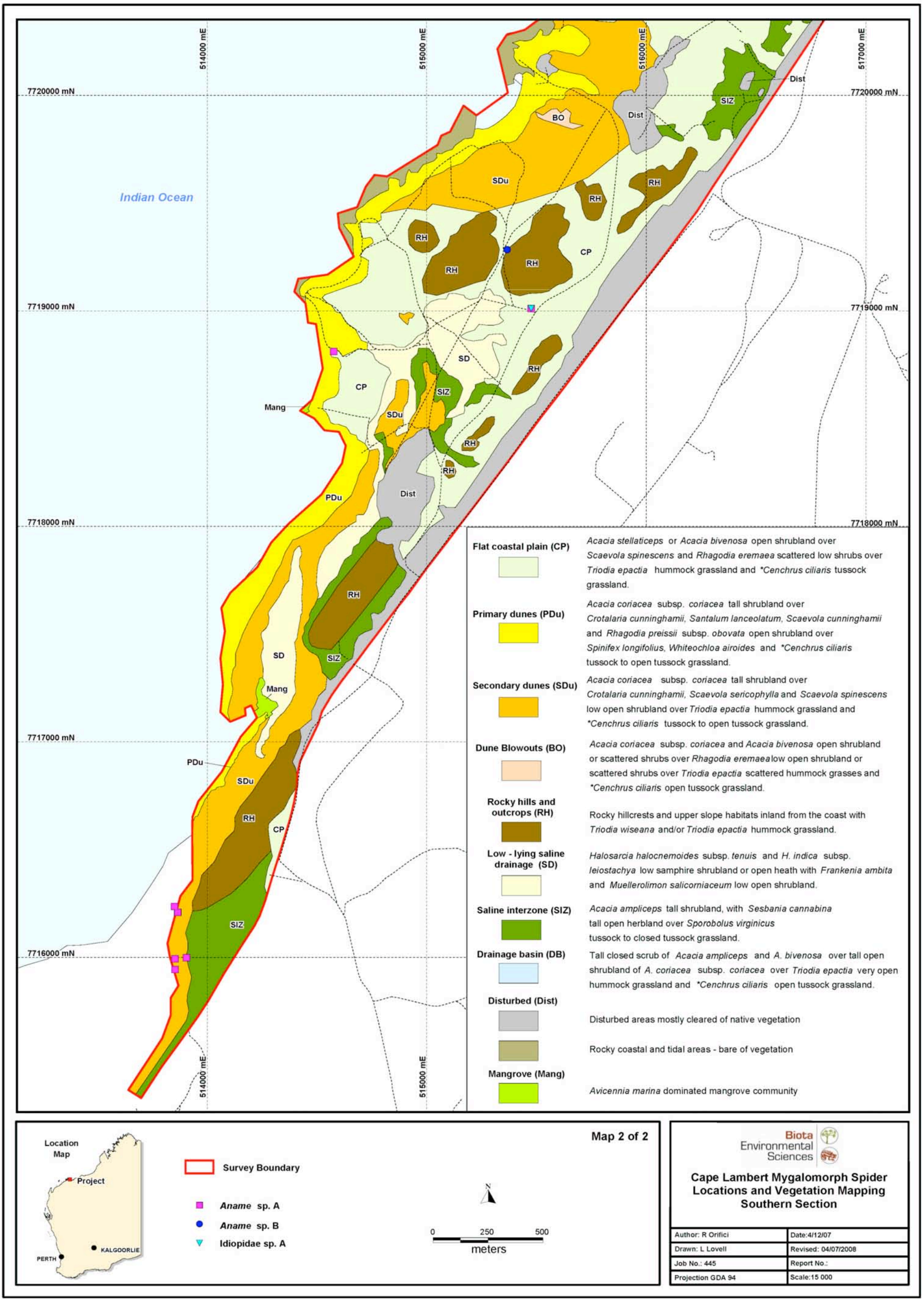

Figure 4.6: Cape Lambert Mygalomorph spider Locations and vegetation mapping – southern section..

5.0 Discussion

The marked disparity of herpetofauna, avifauna and mammal species composition between the Phase I and II surveys may be largely explained by seasonal climatic variation (Driscoll et al. 2000). Phase I was conducted in spring and following a drier than average period, hence food and water resources may have been scarce; in contrast, Phase II was conducted at the end of summer, following a period of average rainfall for this time of year (see Section 3.2). Certain species may be favoured or repelled by different climatic conditions.

5.1 Herpetofauna

The number of herpetofauna species recorded during Phases I and II (n=40) comprises 51% of the total number of terrestrial species recorded by the WA Museum for the locality (n=79, Appendix 2). This ostensibly indicates that the study area supports a depauperate subset of herpetofauna typically found in this region. However, it should be noted that the WA Museum FaunaBase search was conducted within a 50 km buffer of the study area (2,500 km^2), and this broader area includes habitat types not present within the Cape Lambert Port B Development study area. Several of the species on the WA Museum list would not be expected to occur in the Cape Lambert Port B Development study area based on habitat preferences and known distributions.

Based on species richness estimates (Colwell 2005), the total number of herpetofauna species recorded represents between 83% and 92% (mean = 87.5%) of the total predicted assemblage within the Cape Lambert Port B Development study area. It should be noted that these figures are not definitive, as different sampling outcomes can affect the estimator's expressions (Colwell and Coddington 1994, Thompson and Withers 2003). Nevertheless, it is likely that only a small number of additional species would be recorded within the Cape Lambert Port B Development study area as a result of further survey work.

Primary and secondary dune habitats yielded the greatest species richness (12 to 18 species) within the study area. This may be attributed to the fact that sites in dune habitats (CLP02, CLP03, CLP04, CLP07, CLP08 and CLP09) contain a relatively diverse flora assemblage (for the area) with diverse microhabitats, thereby offering a variety of niches for reptiles to inhabit. The flora assemblage in some of the other habitats sampled was extremely depauperate and the resultant herpetofauna diversity reflected this (ie. the saline interzone of CLP01, samphire shrubland of CLP05, and spinifex monoculture of CLP06). Site CLP10 was the exception where, relative to other sites, a high number of herpetofauna species was recorded in a floristically depauperate Buffel Grass tussock grassland. Site CLP10 was surrounded by dune habitat, and it is possible that many of the species recorded here were itinerant individuals originating from dune habitat.

It is likely that the more common and easily collected species in the area have already been documented. The estimated 3 to 8 species that remain uncollected are likely to be at naturally low density or less easily collectible with the methods utilised in this study. As a result, the law of diminishing returns suggests that considerable additional sampling effort would be required to add a small number of extra species to survey records.

Alternatively, it is possible that longer-term (multiple year) cyclical shifts in species assemblage occur at Cape Lambert (Cowan and How 2004). If this is the case then future surveys are likely to detect additional species that reflect assemblage changes.

5.2 Avifauna

The majority of avifauna species were recorded from dune habit in the southern section of the study area at sites in close proximity to mangroves (CLP02 and CLP07). The ecotone, or

transition between these two adjacent ecosystems creates an edge effect most likely resulting in the occurrence of a greater than usual diversity of species (ie. avifauna adapted to the dune and/or mangrove environments were recorded at these sites). Moreover, dune sites typically contained tall *Acacia* shrubs that offered a degree of vertical stratification, thereby providing additional habitat niches. It is likely that this contributed to the relatively high observed avifauna diversity, compared to other habitats in the study area that comprised mostly low-lying vegetation.

Based on species richness estimates (Colwell 2005), the total number of avifauna species recorded represent between 62% and 86% (mean = 69%) of the total predicted assemblage. Again, it should be noted that these figures are not definitive as different sampling outcomes can affect the estimator's expressions (Colwell and Coddington 1994, Thompson and Withers 2003).

The estimated 10 to 39 species that remain unrecorded are likely to be at naturally low density, cryptic species, migratory or occur during specific seasonal/climatic conditions. As a result, it is likely that considerable additional sampling effort would be required to add a small number of extra species to the survey records.

5.3 Mammals

Thirty mammalian species are currently vouchered with the WA Museum for the locality (Appendix 2). Seventeen mammal species were recorded from the Cape Lambert Port B Development study area during Phases I and II combined. Eight of these were not among the list of species recorded by the WA Museum, indicating that the Museum records are not a complete inventory for the area.

As discussed in Section 5.1, the WA Museum FaunaBase search was conducted within a 50 km buffer of the study area, and this area includes habitat types not present within the Cape Lambert Port B Development study area. Several of the species recorded by the WA Museum would not be expected to occur within the study area based on their preferred habitat and distribution:

- the Dugong is a marine mammal;
- *Rattus tunneyi* is considered extinct through the Pilbara mainland areas;
- the two *Pseudantechinus* species, *Petrogale rothschildi* and *Zyzomys argurus* are all virtually restricted to rocky habitats such as gorges, which are absent from the study area; and
- *Leggadina lakedownensis* is largely restricted to areas of cracking clay, a habitat which is absent from the study area.

A number of the other species recorded by the WA Museum but not recorded during the current survey work may occur in the Cape Lambert locality, but would be unlikely to occur in the study area except on a sporadic basis, due to a lack of core (preferred) habitat. This includes species such as:

- the Black Rat (*Rattus rattus*), which is most likely to be encountered around townsites;
- the two Flying Foxes (*Pteropus* species), which are most commonly seen around coastal settlements, or in areas of tall trees near permanent water;
- the Northern Quoll (*Dasyurus hallucatus*), which is most commonly recorded in rocky habitats, particularly near permanent water; and
- the Western Pebble-mound Mouse (*Pseudomys chapmani*), which is most common on hill crests and hillslopes with a stony scree substrate.

Thus while the number of species recorded within the Cape Lambert Port B Development study area during Phases I and II comprises only 45% of the total number of mammalian species recorded from the broader locality (n=38 species), this proportion is probably closer to 63% when

only those species likely to occur in the area are included (n=27 species). This is supported by the species richness estimates (Colwell 2005), which indicate that the total number of non-volant mammalian species recorded from Phases I and II represent between 61% and 88% (mean = 69%) of the total predicted assemblage.

Several of the mammal species within the potential assemblage occur naturally at low densities and/or are less easily collectible and observable with the methods utilised in this study. This includes species such as:

- the Echidna (*Tachyglossus aculeatus*), which is rarely seen and typically recorded from diggings or scats;
- *Notomys alexis* and *Pseudomys delicatulus*, which are relatively uncommon; and
- the various other bat species; the harp nets and Anabat recorders utilised in the current study were positioned along flyways in order to maximise the chances of recording individuals, however any of the bat species listed may occur sporadically over the remainder of the study area.

It is therefore probable that additional mammalian species would be recorded within the Cape Lambert Port B Development study area with further survey effort, but this would probably necessitate considerable additional trapping effort and possibly the use of different techniques.

5.4 Invertebrates

Three potential SRE invertebrate taxa (Mygalomorph spiders) were recorded within the Cape Lambert Port B Development study area. While the conservation significance of these species is not currently known, the specimens have been lodged with the Western Australian Museum and are currently the subject of a phylogeographic study examining the broader distribution of putative taxa.

Ideally it would be beneficial to directly determine the broader distribution of the Mygalomorph spiders recorded within the Cape Lambert Port B Development study area (ie. whether these species occur further afield). Although targeted searches outside the Cape Lambert Port B Development study area may result in confirmation of certain species being more widely distributed (eg. *Aname* sp. A in dune habitat), targeting species represented by only a few specimens is unlikely to yield results (e.g. Idiopidae sp. A is represented by a single record within the Cape Lambert Port B Development study area).

In short, determining the conservation significance of potential SRE taxa is made difficult where:

- taxa are represented by one or few specimens;
- contextual information from the Western Australian Museum is unavailable; and
- additional targeted surveys are unlikely to yield results.

In regards to the mygalomorph spiders recorded during the Phase I and Phase II surveys, it is practical to adopt a risk-based assessment using defined habitat units as a surrogate for inferring distributional boundaries. Figure 4.5 and Figure 4.6 show that *Aname* sp. A was recorded predominantly from dune habitat, while *Aname* sp. B and Idiopidae sp. A were recorded from flat coastal plain. Both of these habitat types and associated vegetation units (Figure 4.5 and Figure 4.6) are widespread and well represented south-west of the study area towards Karratha and north-east towards Port Hedland. Based on the extensive distribution of the habitat types and vegetation units in which mygalomorph spiders were found to occur at Cape Lambert, it is not unreasonable to conclude that the recorded Mygalomorph species are also more widely distributed beyond the bounds of the Cape Lambert Port B Development survey area.

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6.0 Conservation Significance

6.1 Threatened Fauna Statutory Framework

Native fauna species that are rare, threatened with extinction, or have high conservation value are specially protected by law under the Western Australian *Wildlife Conservation Act 1950-1979*. In addition, many of these species are listed under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*).

6.1.1 Federal *EPBC Act 1999*

Fauna species of national conservation significance are listed under the *EPBC Act 1999*, and may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent' (consistent with IUCN categories: http://www.iucn.org/themes/ssc/redlist2006/categories.htm

Migratory wader species are also protected under the *EPBC Act 1999*. The national List of Migratory Species consists of those species listed under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

6.1.2 Western Australian *Wildlife Conservation Act 1950-1979*

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 2006* recognises four distinct schedules of taxa:

Schedule 1 - taxa are fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;

Schedule 2 - taxa are fauna which are presumed to be extinct and are declared to be fauna in need of special protection;

Schedule 3 - taxa are 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; and

Schedule 4 - taxa are fauna that are in need of special protection, otherwise than for the reasons mentioned in paragraphs (1), (2) and (3).

In addition to the above, fauna are also classified under five different Priority codes:

Priority One **Taxa with few, poorly known populations on threatened lands.**
Taxa which are known from a few specimens or sight records from one or 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 fauna.

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

Priority Four **Taxa in need of monitoring.**
Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.

Priority Five **Taxa in need of monitoring.**
Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

6.2 Fauna Habitat and Assemblage Conservation Value

No threatened ecological communities (TECs) were recorded from within the boundaries of the Cape Lambert Port B Development survey area. No TECs would be expected in the study area, as none have been designated for the Chichester subregion of the Pilbara bioregion.

A number of community types in the Pilbara have been listed as Priority Ecological Communities by the DEC (see Kendrick and McKenzie 2001), however none of these occur or would be expected within the boundaries of the Cape Lambert Port B Development area.

6.3 Schedule and Priority Fauna

Three species of Priority fauna were recorded within or adjacent to the Cape Lambert Port B Development study area during the Phase I and II surveys:

- **Little Northern Freetail Bat (*Mormopterus loriae cobourgiana*) Priority 1**: echolocation calls recorded over mangrove habitat (outside the proposed impact area) during both survey phases.
- **Eastern Curlew (*Numenius madagascariensis*) Priority 4**: recorded during Phase II on three occasions on tidal mudflats (outside the proposed impact area).
- **Star Finch (*Neochmia ruficauda subclarescens*) Priority 4**: recorded on a single occasion at site CLP09 during Phase I.

Based on known fauna distributions and habitat preferences, a total of 12 Schedule or Priority species may potentially occur within the study area (Table 6.1; Appendices 1, 2 and 3).

Table 6.1: Schedule and Priority fauna listed at State and Federal levels recorded or potentially occurring in the Cape Lambert Port B Development study area.

Species Name	Common Name	Status	
		State	Federal
Dasyurus hallucatus	Northern Quoll	Schedule 1	Endangered
Liasis olivaceus barroni	Pilbara Olive Python	Schedule 1	Vulnerable
^*Chelonia mydas*	Green Turtle	Schedule 1	Vulnerable Marine Migratory
^*Eretmochelys imbricata*	Hawksbill Turtle	Schedule 1	Vulnerable Marine Migratory
^*Natator depressus*	Flatback Turtle	Schedule 1	Vulnerable Marine Migratory
Falco peregrinus	Peregrine Falcon	Schedule 4	–
**Mormopterus loriae cobourgiana*	Little Northern Freetail Bat	Priority 1	–
**Numenius madagascariensis*	Eastern Curlew	Priority 4	Migratory
**Neochmia ruficauda subclarescens*	Star Finch	Priority 4	–
Ardeotis australis	Australian Bustard	Priority 4	–
Burhinus grallarius	Bush Stone-curlew	Priority 4	–
Phaps histrionica	Flock Bronzewing	Priority 4	_

* denotes species recorded during the current Cape Lambert Port B Development survey.
^ denotes species recorded during the Cape Lambert Port B Development marine turtle survey (Biota 2008b).

Accounts of the ecology, status, likelihood of occurrence, and potential impacts on these threatened species follow.

6.3.1 Schedule One Species

Northern Quoll (*Dasyurus hallucatus*)
State: Schedule 1 'Endangered'; Federal: Endangered

Distribution: The Northern Quoll was originally recorded across Northern Australia from the Northwest Cape, Western Australia to south-east Queensland but has declined in recent years. Its distribution is now restricted to six main areas: the north and western top end of the Northern Territory, north of Cape York, the Atherton-Cairns area, the Carnarvon Range-Bowen area of Queensland (Menkhorst and Knight 2001), and the northwest Kimberley and Pilbara regions of Western Australia (Braithwaite and Griffiths 1994). It also occurs on numerous islands off the Australian coast (Abbott and Burbidge 1995, Burbidge and McKenzie 1978).

Ecology: The Northern Quoll, *Dasyurus hallucatus*, is classed as a medium-sized marsupial, with adult weight ranging from 300 g up to 1,200 g. It is considered a partially arboreal and aggressive carnivore, preying on a varied diet of small invertebrates and vertebrates, including lizards, birds, snakes, small mammals and frogs (Oakwood 1997).

The Northern Quoll is a short-lived mammal with both sexes maturing at 11 months. Females reproduce only once each year, and all males die shortly after reproducing (Dickman and Braithwaite 1992, Oakwood 2000). The discrete male cohorts that arise within populations make quolls vulnerable to extinction. If no juvenile male quolls survive to adulthood, there will be no males for females to mate with the following year, and the local population will rapidly go extinct (Braithwaite and Griffiths 1994, Oakwood 2000). Therefore, any factor that results in significant increases in mortality rates of female and juvenile quolls could cause local extinction of quoll populations.

Likelihood of Occurrence: Although the Northern Quoll may potentially occur within the study area at times, it is unlikely due to a lack of core habitat. This species is most abundant in open,

rocky habitat and is also commonly found in gorges and near creek lines, where breeding is successful (Strahan 2004). Major creek lines are absent from the study area, as are gorges and significant rocky habitat, resulting in sub-optimal habitat for this species.

Potential Impacts: The proposed Cape Lambert Port B Development is unlikely to affect the conservation status of the Northern Quoll.

Pilbara Olive Python (*Liasis olivaceus barroni*)
State: Schedule 1 'Vulnerable'; Federal: Vulnerable

Distribution: Regarded as a Pilbara endemic, this subspecies has a known distribution that coincides roughly with the Pilbara bioregion (Environment Australia 2000).

Ecology: The Pilbara Olive Python occurs in rocky areas within the Pilbara, showing a preference for rocky habitats near water, particularly rock pools.

Likelihood of Occurrence: Given this species preference for gorges and escarpments, particularly near permanent water, it is unlikely to occur within the Cape Lambert Port B Development study area due to a lack of suitable habitat.

Potential Impacts: The proposed Cape Lambert Port B Development is unlikely to affect the conservation status of the Pilbara Olive Python.

Green Turtle (*Chelonia mydas*)
State: Schedule 1 'Vulnerable'; Federal: Vulnerable

Distribution: Green Turtles are abundant along the tropical coasts of Australia. Four major breeding units are recognised in Australia, and include the southern Great Barrier Reef (GBR), northern GBR, Wellesley Island in the Gulf of Carpentaria and the North West Shelf in WA (Limpus 1995).

In WA, major nesting occurs on Lacepede Island, Monte Bello Island, Barrow Island, the islands of the Dampier Archipelago, Browse Island and the North West Cape (Prince 1994a). The population of Western Australian stocks have been estimated at 20,000 (Environment Australia 1998).

Ecology: Green Turtles make long reproductive migrations between foraging grounds and nesting beaches (Limpus et al. 1992). Although carnivorous when young (Cogger 2000), Green Turtles are primarily herbivorous, with a major diet of seagrass and algae (Cogger 2000). They also feed on a variety of other items including mangrove (Limpus and Limpus 2000), fish egg cases (Forbes 1996), jellyfish (Limpus et al. 1994) and sponges (Whiting 2000).

The timing of the breeding season depends on the location of the rookeries. It is estimated to take approximately 30 years for individuals to grow from recruitment size to maturity (Limpus and Walter 1980).

Likelihood of Occurrence: Green Turtles have been recorded at beaches adjacent to the Cape Lambert Port B Development study area (Biota 2008b).

Potential Impacts: Threatening processes to marine turtles arising from developments adjacent to rookeries have been well documented (Pendoley and Wilshaw 1996, Environment Australia 2003), though the subsequent impacts are less well understood, primarily because of the longevity of the species involved and the "invisible" recruitment period.

Key threatening processes or activities include: light spill, noise, vibration and increased beach activity from an increased human presence (larger workforce). Key threatening processes and the implications of the Cape Lambert Port B Development are discussed in the 'Cape Lambert Port B Development Marine Turtle Survey' report (Biota 2008b).

Hawksbill Turtle (*Eretmochelys imbricata*)
State: Schedule 1 'Vulnerable'; Federal: Vulnerable

Distribution: Hawksbill Turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. In Australia there are two nesting populations (Great Barrier Reef/Arnhem Land and North West Shelf) that are genetically distinct from each other and from populations in other countries, indicating little interbreeding between populations (Broderick et al. 1995).

Major nesting in Australia occurs at Varanus Island and Rosemary Island in WA (Prince 1993, 1994a). Australia may support the largest breeding populations of Hawksbill Turtles in the world, following serious declines in stocks in other countries. Current estimates of the number of nesting female turtles annually are 1000-2000 in Western Australia (Limpus 1995).

Ecology: Adult Hawksbill Turtles exhibit benthic foraging on coral and rocky reef habitat in tropical and subtropical waters (Limpus 1992). Limited studies have shown that this species migrates up to 2400 km between foraging areas to nesting beaches (Miller et al. 1998). No migration records are known for the Indian Ocean.

Juvenile and adult Hawksbill Turtles have been described as sponge specialists (Meylan 1988) but other evidence suggests they are omnivorous, feeding on a variety of animals and plants including sponges, hydroids, cephalopods, gastropods, cnidarians, seagrass and algae (Whiting 2000). In Australia they eat both sponges and algae in high proportions (Whiting 2000).

In Western Australia nesting occurs all year round, with a peak between October to January (Limpus 1995). Females lay between 1 and 6 clutches per season, each with an average of 122 eggs. Growth is slow and variable over the life of the individual (Chaloupka and Limpus 1997), with the estimated age to maturity greater than 31 years (Limpus 1992).

Likelihood of Occurrence: Hawksbill Turtles have been recorded at beaches adjacent to the Cape Lambert Port B Development study area (Biota 2008b).

Potential Impacts: As per the Green Turtle (above).

Flatback Turtle (*Natator depressus*)
State: Schedule 1 'Vulnerable'; Federal: Vulnerable

Distribution: This species is found only in the tropical waters of northern Australia and New Guinea (Zangerl et al. 1988), with nesting confined to Australia. On the North West Shelf, the major rookeries are at Barrow Island and Cape Thouin on the mainland (Prince 1994a).

Ecology: Post-hatchlings and juveniles do not have the wide dispersal phase in the oceanic environment like other sea turtles (Walker and Parmenter 1990). Adults inhabit soft bottom habitat over the continental shelf of northern Australia, extending to New Guinea (Zangerl et al. 1988). Capture locations from trawlers indicate that Flatbacks feed in turbid, shallow inshore waters north of latitude 25°S in depths from less than 10 m to over 40 m (Robins 1995).

This species makes long reproductive migrations similar to other species of marine turtles, although these movements are restricted to the continental shelf (Limpus et al. 1983). Little is known about the diet of this species, however juveniles are known to eat gastropod molluscs, squid and siphonophores (Zangerl et al. 1988).

In northern Australia, most nesting occurs between June and August (Guinea 1994). In the Pilbara region of Western Australia peak nesting occurs in the summer months, while in the Kimberley nesting occurs in the middle of the year (Prince 1994b).

Likelihood of Occurrence: Flatback Turtles have been recorded at beaches adjacent to the Cape Lambert Port B Development study area (Biota 2008b).

Potential Impacts: As per the Green Turtle (above).

6.3.2 Schedule Four Species

Peregrine Falcon (*Falco peregrinus*)
State: Schedule 4

Distribution: The Peregrine Falcon has an almost cosmopolitan distribution. The only subspecies in Australia (*Falco peregrinus macropus*) is widespread throughout Australia and Tasmania (Marchant and Higgins 1993). The Australian population has been estimated at 3,000 to 5,000 pairs (Cade 1982).

Ecology: This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country. The availability of prey is apparently more important than habitat in determining its distribution. Home ranges are probably defended year round and are variable in size, though not typically less than 480 ha (Marchant and Higgins 1993). This species typically nests on cliffs (81% of nests Australia-wide) but also on stick nests (11%) and in tree hollows (8%). Breeding typically occurs from August to November (Johnstone and Storr 1998). Food is almost exclusively birds such as pigeons, parrots and passerines, which are captured in flight (Johnstone and Storr 1998). Mammals such as possums and rabbits have been recorded as rare prey items (Marchant and Higgins 1993).

Likelihood of Occurrence: Peregrine Falcons have large home ranges (Marchant and Higgins 1993), and this species probably occurs periodically in the Cape Lambert study area and immediate surrounds.

Potential Impacts: There is potential for the proposed development to result in loss of nesting and foraging habitat. However, the Cape Lambert Port B Development study area does not represent core habitat for this specs (ie. coastal cliffs, rivers, ranges, and wooded watercourses; Johnstone and Storr 1998). As a result, the Cape Lambert Port B Development is unlikely to affect the conservation status of this species.

6.3.3 Priority Species

Little Northern Freetail-bat (*Mormopterus loriae cobourgiana*)
State: Priority 1

Distribution: Endemic to Australia, this species' distribution encompasses the Western Australian coastal areas from Derby to the Exmouth Gulf (Churchill 1998).

Ecology: This species is a mangrove specialist, restricted to mangrove forest and adjacent areas (Churchill 1998). It has been found roosting in small crevices in dead upper branches of the mangrove *Avicennia marina*. Individuals emerge early in the evening in groups of up to 100 individuals above the mangrove canopy, before dispersing to forage alone or in pairs. *M. loriae* prey on insects above and beside the forest canopy. They give birth to single young, which are born in the wet season (summer) (Churchill 1998).

Likelihood of Occurrence: This species was recorded during the current survey at Cape Lambert (Table 4.7).

Potential Impacts: Impacts through habitat loss are considered low as roosting occurs within mangrove habitat, which is outside the current proposed impact area. The proposed development is therefore unlikely to affect the conservation status of this species.

Eastern Curlew (*Numenius madagascariensis*)
State: Priority 4; Federal: Migratory

Distribution: The Eastern Curlew occurs throughout coastal Western Australia, south to Bunbury (Johnstone and Storr 1998).

Ecology: This species occurs mainly on tidal mudflats, and also on sandy beaches and rarely near coastal lakes, including saltfield ponds (Johnstone and Storr 1998). The Eastern Curlew breeds in northern Asia and is a summer migrant to Australia. It is moderately common in the Pilbara.

Likelihood of Occurrence: This species was recorded on three occasions during Phase II within the Cape Lambert Port B Development study area, always on tidal mudflats adjacent to mangroves.

Potential Impacts: The Cape Lambert Port B Development is unlikely to result in significant habitat loss for this species, as mangrove and intertidal habitats will not be affected. Moreover, significant aggregations of this wader species were not observed during any of the surveys. The proposed development is therefore unlikely to affect the conservation status of this species.

Star Finch (*Neochmia ruficauda subclarescens*)
State: Priority 4

Distribution: This species is endemic to Australia, where it is found from the Pilbara to south-eastern Australia. It remains most common in the tropics. Its population has not been estimated but the species is typically patchy and highly variable in abundance.

Ecology: The Star Finch is most commonly recorded in reedbeds and adjacent vegetation communities along permanent waterways in the Pilbara. It is considered to be resident in most of its range but, as with all finches, the species can wander widely. Its ecology in the Pilbara is not well known but it has been observed feeding on the seed of sedges (*Cyperus* spp.) and Buffel Grass (*Cenchrus ciliaris*) (Dr Mike Craig, pers. obs.). In other parts of its range, it feeds mainly on seeds, but insects are a common part of its diet during the breeding season. It typically nests in March and April, as seeds are maturing after summer cyclones, and its domed nest is usually built in reeds up to several metres from the ground. The clutch is between three and six and the young usually fledge after about 16 days. In captivity, Star Finches may produce as many as three broods per year. The main threat to the species is considered to be overgrazing by stock along waterways, which destroys the riparian vegetation on which they depend (Garnett and Crowley 2000).

Likelihood of Occurrence: This species was recorded within the Cape Lambert Port B Development area during Phase I at site CLP09.

Potential Impacts: The Cape Lambert Port B Development may result in the loss of some habitat for the Star Finch, but given its widespread distribution and mobile nature, the development is unlikely to affect the conservation status of this species.

Australian Bustard (*Ardeotis australis*)
State: Priority 4

Distribution: The Australian Bustard occurs over much of Western Australia, with the exception of the more heavily wooded southern portions of the State (Johnstone and Storr 1998).

Ecology: This species prefers open or lightly wooded grassland including *Triodia* sandplains (Johnstone and Storr 1998) and is considered scarce to common depending on season and habitat. It has an omnivorous diet and occurs in a relatively broad range of habitats, but appears to have some preference for grasshoppers and is often attracted to recently burnt areas (Marchant and Higgins 1993). The Bustard is typically nomadic and has a large home

range (Marchant and Higgins 1993). This species breeds from March to September and the eggs are laid on bare, preferably stony, ground (Johnstone and Storr 1998), which makes the eggs and young vulnerable to predation by foxes and cats.

Likelihood of Occurrence: Although not recorded during the survey, this species would probably occur within the Cape Lambert Port B Development study area.

Potential Impacts: The main impact from the proposed Cape Lambert Port B Development on the Australian Bustard would comprise small-scale habitat loss associated with additional infrastructure and potentially altered fire regimes. This would not affect the overall conservation status of this species.

Bush Stone-curlew (*Burhinus grallarius*)
State: Priority 4

Distribution: The Bush Stone-curlew is widespread throughout much of Australia. The species remains common in tropical Australia but has declined alarmingly in temperate regions (Marchant and Higgins 1993). Populations appear secure in the Pilbara (Ron Johnstone, WA Museum, pers. comm. 2003).

Ecology: The nocturnal Bush Stone-curlew inhabits sparsely grassed, lightly timbered forest or woodland. In southern Australia, they persist most often where there is a well-structured litter layer and fallen timber debris. This species breeds from July to January. The eggs are either laid directly on the ground or in a small scrape (Johnstone and Storr 1998). The Bush Stone-curlew feeds primarily on invertebrates, particularly beetles, but also eats small lizards, frogs, snakes, vegetation and seeds (Marchant and Higgins 1993).

Likelihood of Occurrence: Although not recorded during the Cape Lambert Port B Development fauna survey, the Bush Stone-curlew may potentially occur within the study area.

Potential Impacts: Foxes are considered to be the primary cause for the decline of the Bush Stone-curlew, hence their relative abundance in the tropics, however habitat clearance has also been identified as a threatening process (Garnett and Crowley 2000). It is considered that the proposed Cape Lambert Port B Development is unlikely to affect the conservation status of this species.

Flock Bronzewing (*Phaps histrionica*)
State: Priority 4

Distribution: This species inhabits coastal riverine plains of north-west WA, south to Carnarvon, and also occurs in the Kimberley and in the arid and semi-arid north-eastern interior of Australia (Johnstone and Storr 1998).

Ecology: The Flock Bronzewing is typically found on treeless or sparsely wooded grassy plains and is probably nomadic (Marchant and Higgins 1993, Johnstone and Storr 1998). It has declined greatly in the last century due to the degradation of its habitat by livestock and there were no records of this species in the Pilbara during the most recent Birds Australia Bird Atlas Project (Barrett et al. 2003).

Likelihood of Occurrence: This species has the potential to occur within the study area, but given its rarity in the Pilbara, this is unlikely. However, it should be noted that populations fluctuate dramatically throughout space and time and the Flock Bronzewing is known as a 'boom-bust' species. They can be locally abundant following good seasons but then vanish and may not reappear in the area for decades.

Potential Impacts: It is unlikely the proposed Cape Lambert Port B Development will affect the conservation status of this species.

6.3.4 Marine and Migratory Listed Avifauna

Eight bird species listed as either migratory and/or marine under the *EPBC Act 1999*, were recorded within the Cape Lambert Port B Development study area during the Phase I and II surveys (

Table 6.2 and Table 4.5). A total of 18 listed migratory and/or marine birds may potentially occur within the study area (

Table 6.2). It should be noted that the migratory waders were observed in small numbers and often individually (ie. no significant colonies were observed). In addition, the majority of migratory and marine avifauna were recorded on either the tidal mudflats or in the southern section of the study area, outside the confines of the proposed development area.

Table 6.2: Migratory and Marine fauna listed under the *EPBC Act 1999* that were recorded or potentially occur in the Cape Lambert Port B Development study area.

Species Name	Common Name	Status
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory, Marine
Hirundo rustica	Barn Swallow	Migratory, Marine
**Merops ornatus*	Rainbow Bee-eater	Migratory, Marine
**Ardea alba*	Great Egret	Migratory, Marine
Ardea ibis	Cattle Egret	Migratory, Marine
**Arenaria interpres*	Ruddy Turnstone	Migratory, Marine
Charadrius veredus	Oriental Plover	Migratory, Marine
Glareola maldivarum	Oriental Pratincole	Migratory, Marine
**Numenius minutus*	Little Curlew	Migratory, Marine
**Numenius phaeopus*	Whimbrel	Migratory, Marine
**Tringa nebularia*	Common Greenshank	Migratory, Marine
Apus pacificus	Fork-tailed Swift	Migratory, Marine
Puffinus pacificus	Wedge-tailed Shearwater	Migratory, Marine
**Sterna caspia*	Caspian Tern	Migratory, Marine
**Pandion haliaetus*	Osprey	Marine
Sterna bergii	Crested Tern	Marine
Sterna fuscata	Sooty Tern	Marine
Sterna nereis	Fairy Tern	Marine

• denotes species recorded during the current Cape Lambert Port B Development surveys.

6.3.5 Other Species of Interest

Lerista nevinae

The skink, *Lerista nevinae* (Plate 6.1) was recorded on 25 occasions from six trapping sites, all within dune habitat (sites CLP02, CLP03, CLP04, CLP07, CLP08 and CLP09; see Table 4.3). This species was formally part of the *Lerista muelleri* species complex, which has recently undergone taxonomic revision (Smith and Adams 2007). Although *L. nevinae* is not currently assigned a conservation listing under either the *EPBC Act 1999* or the *Wildlife Conservation Act 1950-1979*, it should be noted that to date records of *L. nevinae* are known solely from the general vicinity of Cape Lambert; that is, all current records are from the pale coastal sands between 20°37'00"S, 117°10'59"E and 20°39'12"S, 117° 06'21"E, equivalent to roughly 15 km of the coastline (including parts of the study area). This species is considered likely to extend further west to at least 20°38'50"S, 117°05'39"E.

In total, four specimens have been recorded outside the Cape Lambert Port B Development study area: there was one record in 2002 from approximately 3.5 km north-west of Wickham (20°39'12"S, 117°06'21"E), and there was another record from the same locality in December 2007; there were also two records in 1998 from approximately 8 km north-east of Wickham (20°37'00"S, 117°10'59"E).

Further targeted surveys for *Lerista nevinae* are scheduled for the winter months of 2008. During this field work, other areas of dune habitat will be targeted along the Pilbara coast so as to further clarify the distribution of this species. *Lerista nevinae* occurs within primary and

secondary dune habitat at Cape Lambert, and similar to other *Lerista* species, is likely to be restricted to sand dunes.

Plate 6.1: ***Lerista nevinae*.**

Diporiphora* aff. *winneckei

The dragon, *Diporiphora* aff. *winneckei* (Plate 6.2), was recorded on 11 occasions from six trapping sites, predominantly from dune habitat (sites CLP02, CLP04, CLP07, CLP08, CLP09 and CLP11F). This species displays characteristics that are not in accordance with WA Museum records of *D. winneckei* (specifically the presence of a strong gular fold). Detailed examination of the lodged specimens from the current study area is pending.

Plate 6.2: ***Diporiphora* aff. *winneckei*.**

6.4 Conservation Significance Summary

The survey of the Cape Lambert Port B project area yielded a combined total of 120 vertebrate species, comprising 63 avifauna species, 17 mammals and 40 herpetofauna species: two frogs and 38 reptiles. This tally appears in keeping with other similar surveys completed in the region and does not appear to indicate a particularly diverse assemblage. The species recorded were also representative of the taxa commonly recorded in this part of the bioregion. This is consistent with the available habitat data, which indicates that no restricted or uncommon geological units or land systems occur in the study corridor (see Section 2.1).

No Schedule listed fauna, or fauna species listed under the *EPBC Act 1999*, were recorded during the survey. Known distributions suggested that two Schedule fauna species might occur within the proposed development area (Northern Quoll and Pilbara Olive Python). However, core habitats where these species typically occur were not recorded in the development area. The relatively small nature of the development indicates a low risk of significant impact to these Schedule species in the even that they do occur. Marine Turtles are known to nest on adjacent

Bell's Beach and the significance of this is discussed in the 'Cape Lambert Port B Development Marine Turtle Survey' report (Biota 2008b).

Three Priority fauna species, the Little Northern Freetail Bat, the Eastern Curlew and the Western Star Finch were recorded during the survey. In all cases, little or none of the local habitat suitable for these taxa would be cleared for the development.

7.0 Potential Impacts

The principal direct impacts arising from the proposed development are associated with the clearing of fauna habitat. A number of indirect modifications may also occur to fauna habitat as a result of construction and operation of the Cape Lambert Port B Development. These include changes to noise levels, light spill, weed introduction or spread, and feral animal spread.

7.1 Direct Loss of Habitat

Based on the review of species in Section 6.3, it appears that habitat potentially supporting two terrestrial Schedule 1 taxa will be cleared for the proposed development. However, based on on-ground examination of habitats within the study area, the Northern Quoll (*Dasyurus hallucatus*) and Pilbara Olive Python (*Liasis olivaceus barroni)* are unlikely to occur more than sporadically within the Cape Lambert Port B Development study area, and as a result these species are considered unlikely to be affected by the development.

7.2 Direct Loss of Individual Fauna

It is inevitable that there will be some localised loss of fauna due to direct mortality arising from construction activities, including that which may occur during the clearing of habitat. Additional short-term impacts may also arise from more frequent vehicle movements and machinery operation. For vertebrate and invertebrate taxa, it is unlikely that the loss of individuals associated with direct mortalities would be significant enough to affect the overall conservation status of any of the species recorded from the study area. The exception to this may be *Lerista nevinae* (see Section 6.3.5).

In relation to both habitat loss and direct loss of fauna, it is noted that cumulative effects of a variety of disturbances (eg. road construction and maintenance, wildfires, increased road usage, and feral animals) in the region may impact negatively on some species.

7.3 Noise

Noise from construction activities including blasting and haulage may impact on fauna, however there were no particularly sensitive habitats or communities within the study area that may be at particular risk (eg. there were no recorded significant bat roosts or breeding populations of birds).

7.4 Light Spill

Light spill presents a key threatening processes to marine turtles. The implications of light spill in regards to adult marine turtles and hatchlings utilising beaches at Cape Lambert are discussed in the 'Cape Lambert Port B Development Marine Turtle Survey' report (Biota 2008b).

7.5 Weed Spread

Ground disturbance associated with construction provides an opportunity for the introduction and spread of weeds. The consequences of weed introduction on the biodiversity of fauna are not well documented, however precautions should be taken to prevent the further introduction or spread of weeds.

7.6 Feral Animal Spread

Ground disturbance and construction of roads or tracks also offer opportunities for the spread of feral animals, which use these disturbances as pathways for travel. Feral animals may be predators or competitors of native fauna, and their spread should be kept to a minimum.

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Appendix 1

DEC Threatened Fauna Database Search

Threatened and Priority Fauna Database

20.333 °S 116.672 °E / 21.065 °S 117.642 °E Cape Lambert Port expansion study area

*	Date	Certainty	Seen	Location Name	Method
Schedule 1 - Fauna that is rare or is likely to become extinct					
Dasyurus hallucatus				**Northern Quoll**	*19 records*
This carnivorous marsupial occurs across much of northern Australia with a disjunct population in the Pilbara. Occurs in a wide range of habitats but most suitable habitat appear to be rocky areas.					
		1		BULGARRA	
		1		DAMPIER ARCHIPELAGO	
		1		DAMPIER ARCHIPELAGO	
		1		ROEBOURNE	
	1900	1		DAMPIER ARCHIPELAGO	
	1900	1		ROEBOURNE	
	1967	1		POINT SAMSON	
	1970	1		DAMPIER ARCHIPELAGO	
	1975	1		WICKHAM	
	1980	1		DAMPIER ARCHIPELAGO	
	1980	1		DAMPIER ARCHIPELAGO	
	1980	1		DAMPIER ARCHIPELAGO	
	1980	1		DAMPIER ARCHIPELAGO	
	1980	1		DAMPIER ARCHIPELAGO	
	1980	1		DAMPIER ARCHIPELAGO	
	1980	1		DAMPIER ARCHIPELAGO	
	1986	1		DAMPIER ARCHIPELAGO	
	1986	1		DAMPIER ARCHIPELAGO	
	1986	1		DAMPIER ARCHIPELAGO	
Lagostrophus fasciatus fasciatus				**Banded Hare-wallaby, Mernine**	*1 records*
This small macropod occurs in low shrubland and extant populations occur on Bernier and Dorre islands in Shark Bay. An attempted reintroduction to Peron Peninsula showed that the species is highly vulnerable to predation from cats as well as foxes.					
		2		Cossack	Day sighting
Megaptera novaeangliae				**Humpback Whale**	*2 records*
	1996	1	1	Point Samson	Dead
	1999	1	1	Burrup Peninsula	
Liasis olivaceus barroni				**Pilbara Olive Python**	*4 records*
	1993	3	1	Dolphin Island Nature Reserve	Day sighting
	2001	1	9	Burrup Rifle Range	
	2004	1	1	Burrup	Hair/skin
	2005	1	1	Dampier	Day sighting
Schedule 4 - Other specially protected fauna					
Dugong dugon				**Dugong**	*3 records*

Monday, 7 April 2008

Department of Environment and Conservation

Threatened and Priority Fauna Database

20.333 °S 116.672 °E / 21.065 °S 117.642 °E Cape Lambert Port expansion study area

*	Date	Certainty	Seen	Location Name	Method
	2000	1	1	Point Samson	Dead
	2004	1	4	Antonymyre	Day sighting
	2006	1	2	Dampier	Day sighting

Falco peregrinus **Peregrine Falcon** *1 records*

This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.

2006	1	1	Burrup	Day sighting

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

Mormopterus loriae cobourgiana **Little North-western Mastiff Bat** *2 records*

This species occurs along the northwest coast and is known to roost in mangroves.

2001	2		Cowrie Cove	Heard
2006	1	1	Burrup	Caught or trapped

Lerista quadrivincula *1 records*

This is skink known from only one locality on the Maitland River south east of Karratha Homestead.

1990	1	1	Mt Welcome	Caught or trapped

Priority Four: Taxa in need of monitoring

Macroderma gigas **Ghost Bat** *1 records*

This species is Australia's only carnivorous bat and has a patchy distribution across northern Australia. It shelters in caves, mine shafts and deep rock fissures and is sensitive to disturbance.

2006	1	1	Burrup	Caught or trapped

Pseudomys chapmani **Western Pebble-mound Mouse, Ngadji** *3 records*

This species is well-known for the characteristic pebble-mounds which it constructs over underground burrow systems. These mounds are most common on spurs and lower slopes of rocky hills.

1979	2	0	Karratha	Definite signs
1983	2	0	Burrup Peninsula	Definite signs
1994	2	0	Mt Anketel	

Sousa chinensis **Indo-Pacific Humpback Dolphin** *1 records*

2000	1	1	Dampier	Dead

Ardeotis australis **Australian Bustard** *1 records*

This species is uncommon and may occur in open or lightly wooded grasslands.

2007	1	2	Mount Anketell	Day sighting

Burhinus grallarius **Bush Stonecurlew** *1 records*

A well camouflaged, ground nesting bird which prefers to 'freeze' rather than fly when disturbed. It inhabits lightly timbered open woodlands.

2006	1	1	Burrup	Day sighting

Numenius madagascariensis **Eastern Curlew** *2 records*

This species is a migratory visitor and has been observed on reef flats and sandy beaches along the West Australian coast and in coastal estuaries.

Monday, 7 April 2008

Department of Environment and Conservation

Threatened and Priority Fauna Database

20.333 °S 116.672 °E / 21.065 °S 117.642 °E Cape Lambert Port expansion study area

*	*Date*	*Certainty*	*Seen*	*Location Name*	*Method*
	1966	1		Nichol Bay	Day sighting
	2002	1	2	Nichol Bay	

Phaps histrionica **Flock Bronzewing** *2 records*

This species is gregarious and occurs in treeless or sparsely wooded grassy plains within reach of open water.

	1968	1	300	Nickol River	Day sighting
	1985	1	50	Warambie	Day sighting

* Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Monday, 7 April 2008

Department of Environment and Conservation

Appendix 2

Western Australian Museum FaunaBase Database Search

Amphibia collected between -20.334, 116.67 and -21.066, 117.64

Hylidae
Cyclorana maini
Cyclorana australis
Litoria rubella

Myobatrachidae
Notaden nichollsi
Uperoleia russelli

Reptiles collected between -20.334, 116.67 and -21.066, 117.64

Agamidae
Ctenophorus caudicinctus
Ctenophorus caudicinctus caudicinctus
Ctenophorus isolepis
Ctenophorus isolepis isolepis
Ctenophorus nuchalis
Ctenophorus reticulatus
Lophognathus gilberti gilberti
Lophognathus longirostris
Pogona minor
Pogona minor minor
Tympanocryptis cephala

Boidae
Antaresia perthensis
Antaresia stimsoni stimsoni
Aspidites melanocephalus

Cheloniidae
Chelonia mydas
Eretmochelys imbricata bissa
Natator depressus

Colubridae
Fordonia leucobalia

Elapidae
Acalyptophis peronii
Acanthophis wellsi
Aipysurus apraefrontalis
Aipysurus laevis
Brachyurophis approximans
Demansia psammophis cupreiceps
Demansia rufescens
Furina ornata
Hydrelaps darwiniensis
Pseudechis australis
Pseudonaja modesta
Pseudonaja nuchalis
Suta fasciata
Suta punctata

Gekkonidae
Crenadactylus ocellatus
Crenadactylus ocellatus horni
Diplodactylus conspicillatus
Diplodactylus mitchelli
Diplodactylus savagei
Diplodactylus stenodactylus
Gehyra pilbara
Gehyra punctata
Gehyra purpurascens
Gehyra variegata
Heteronotia binoei
Nephrurus levis pilbarensis
Oedura marmorata
Rhynchoedura ornata
Strophurus ciliaris aberrans
Strophurus elderi

Pygopodidae
Delma pax
Delma tincta
Lialis burtonis
Pygopus nigriceps

Scincidae
Carlia munda
Carlia triacantha
Cryptoblepharus carnabyi
Cryptoblepharus plagiocephalus
Ctenotus duricola
Ctenotus grandis titan
Ctenotus helenae
Ctenotus pantherinus ocellifer
Ctenotus rubicundus
Ctenotus saxatilis
Ctenotus serventyi
Cyclodomorphus melanops
Cyclodomorphus melanops melanops
Egernia depressa
Egernia pilbarensis
Glaphyromorphus isolepis
Lerista bipes
Lerista muelleri
Lerista quadrivincula
Menetia greyii
Menetia surda surda
Morethia ruficauda exquisita
Notoscincus butleri
Notoscincus ornatus ornatus
Tiliqua multifasciata

Typhlopidae
Ramphotyphlops ammodytes
Ramphotyphlops australis
Ramphotyphlops braminus
Ramphotyphlops grypus

Varanidae
Varanus acanthurus
Varanus brevicauda
Varanus eremius
Varanus panoptes rubidus
Varanus pilbarensis
Varanus tristis tristis

Birds collected between -20.334, 116.67 and -21.066, 117.64

Acanthizidae
Gerygone tenebrosa

Accipitridae
Circus assimilis
Haliastur indus girrenera
Pandion haliaetus cristatus

Alaudidae
Mirafra javanica horsfieldii

Anatidae
Anas gracilis
Anas rhynchotis rhynchotis
Chenonetta jubata

Ardeidae
Ardea sacra sacra

Artamidae
Artamus cinereus

Campephagidae
Coracina novaehollandiae subpallida

Charadriidae
Charadrius ruficapillus

Columbidae
Geopelia humeralis
Geophaps plumifera

Cracticidae
Cracticus tibicen

Cuculidae
Cuculus pallidus
Cuculus saturatus optatus

Dicruridae
Rhipidura fuliginosa preissi
Rhipidura leucophrys leucophrys

Falconidae
Falco berigora berigora

Halcyonidae
Todiramphus chloris pilbara
Todiramphus sanctus sanctus

Laridae
Anous stolidus pileatus
Sterna albifrons

Maluridae
Stipiturus ruficeps ruficeps

Meliphagidae
Epthianura tricolor
Lichenostomus penicillatus
Lichenostomus virescens
Lichmera indistincta indistincta
Melithreptus gularis laetior

Meropidae
Merops ornatus

Motacillidae
Anthus australis australis

Muscicapidae
Ficedula cyanomelana cyanomelana

Pachycephalidae
Pachycephala lanioides
Pachycephala melanura melanura

Passeridae
Emblema pictum
Neochmia ruficauda
Neochmia ruficauda clarescens

Petroicidae
Eopsaltria pulverulenta

Phasianidae
Coturnix ypsilophora cervina

Pittidae
Pitta moluccensis

Podargidae
Podargus strigoides
Podargus strigoides brachypterus

Pomatostomidae
Pomatostomus superciliosus

Psittacidae
Cacatua sanguinea westralensis

Rallidae
Gallirallus philippensis mellori

Scolopacidae
Tringa glareola

Strigidae
Ninox novaeseelandiae boobook

Sylviidae
Acrocephalus australis
Acrocephalus australis gouldi
Cincloramphus cruralis

Zosteropidae
Zosterops luteus balstoni

Mammals collected between -20.334, 116.67 and -21.066, 117.64

Canidae
Vulpes vulpes

Dasyuridae
Dasykaluta rosamondae
Dasyurus hallucatus
Ningaui timealeyi
Planigale sp
Pseudantechinus roryi
Pseudantechinus woolleyae
Sminthopsis macroura

Dugongidae
Dugong dugon

Macropodidae
Macropus robustus erubescens
Petrogale rothschildi

Molossidae
Chaerephon jobensis
Mormopterus beccarii

Muridae
Leggadina lakedownensis
Mus musculus
Notomys alexis
Pseudomys chapmani
Pseudomys delicatulus
Pseudomys hermannsburgensis
Rattus rattus
Rattus tunneyi
Zyzomys argurus

Pteropodidae
Pteropus alecto
Pteropus scapulatus

Tachyglossidae
Tachyglossus aculeatus

Vespertilionidae
Chalinolobus gouldii
Nyctophilus bifax daedalus
Scotorepens greyii
Vespadelus finlaysoni
Vespadelus regulus

Appendix 3

EPBC Act 1999 Protected Matters Database Search

Matters of National Environmental Significance		
Threatened Species	**Status**	**Type of Presence**
Birds		
Macronectes giganteus Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Mammals		
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Species or species habitat may occur within area
Chelonia mydas Green Turtle	Vulnerable	Breeding likely to occur within area
Dermochelys coriacea Leatherback Turtle	Vulnerable	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle	Vulnerable	Breeding likely to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Vulnerable	Breeding known to occur within area

Migratory Species	**Status**	**Type of Presence**
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Breeding known to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur with area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Migratory	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Numenius phaeopus Whimbrel	Migratory	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Species or species habitat likely to occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Migratory	Breeding known to occur within area
Sterna caspia Caspian Tern	Migratory	Breeding known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Migratory	Species or species habitat may occur within area
Chelonia mydas Green Turtle	Migratory	Breeding likely to occur within area
Dermochelys coriacea Leatherback Turtle	Migratory	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle	Migratory	Breeding likely to occur within area
Natator depressus Flatback Turtle	Migratory	Breeding known to occur within area

Other Matters Protected by the EPBC Act		
Listed Marine Species		
Birds		
Apus pacificus Fork-tailed Swift	Listed – overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed – overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed – overfly marine area	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Listed	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed – overfly marine area	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Listed – overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Breeding known to occur within area
Hirundo rustica Barn Swallow	Listed – overfly marine area	Species or species habitat may occur within area
Larus novaehollandiae Silver Gull	Listed	Breeding known to occur within area
Macronectes giganteus Southern giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed – overfly marine area	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed – overfly marine area	Species or species habitat may occur within area
Numenius phaeopus Whimbrel	Listed	Species or species habitat likely to occur within area
Pandion haliaetus Osprey	Listed	Breeding known to occur within area
Puffinus pacificus Wedge-tailed Shearwater	Listed	Breeding known to occur within area
Sterna bergii Crested Tern	Listed	Breeding known to occur within area
Sterna caspia Caspian Tern	Listed	Breeding known to occur within area
Sterna fuscata Sooty Tern	Listed	Breeding known to occur within area
Sterna nereis Fairy Tern	Listed	Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed – overfly marine area	Species or species habitat likely to occur within area

Appendix 4

DEC Regulation 17 permit

JOB 445

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

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Bentley Delivery Centre WA 6983

PAGE 2
NO. SF006036

DATE OF ISSUE 11/09/2007
DATE OF EXPIRY 30/09/2008
VALID FROM 01/10/2007

LICENSING OFFICER

LICENSEE: MR D KAMIEN (DAN)
ADDRESS BIOTA ENVIRONMENTAL SCIENCES
P.O. BOX 155
LEEDERVILLE
W.A. 6903

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

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Correspondence: Locked Bag 30
Bentley Delivery Centre WA 6983

PAGE 1
NO. SF006036

RECEIPT NO. AMOUNT
$0.00

WILDLIFE CONSERVATION ACT 1950
REGULATION 17
LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

THE UNDERMENTIONED PERSON MAY TAKE FAUNA FOR RESEARCH OR OTHER SCIENTIFIC PURPOSES AND WHERE AUTHORISED, KEEP IT IN CAPTIVITY, SUBJECT TO THE FOLLOWING AND ATTACHED CONDITIONS, WHICH MAY BE ADDED TO, SUSPENDED OR OTHERWISE VARIED AS CONSIDERED FIT.

DIRECTOR GENERAL

CONDITIONS

1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.

2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.

3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.

4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.

5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTORGENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.

6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.

7 **********ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE COMMONWEALTH DEPT OF THE ENVIRONMENT AND WATER RESOURCES, PHONE 02 6274 1900. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.**********

8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.

9 FURTHER CONDITIONS (NUMBERED 1 TO 10) ARE ATTACHED.

PURPOSE	CAPTURE AND RELEASE FAUNA SURVEY FOR CAPE LAMBERT PORT ENVIRONMENTAL IMPACT ASSESSMENT. (20KMS NORTH OF ROEBOURNE).
AUTHORISED PERSONS	MR MIKE GREENHAM, MR ROY TEALE, MR GREG HAROLD, MR TIM SACHSE, MR TODD WILLIAMSON.

WILDLIFE CONSERVATION ACT 1950
WILDLIFE CONSERVATION REGULATIONS

Regulation 17:- Licence to Take Fauna for Scientific Purposes

FURTHER CONDITIONS (OF LICENCE NUMBER SF 6036)

1. The licensee shall ensure that all due care is taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be inspected at regular intervals throughout each day of their use. At the conclusion of research all markers etc and signs erected by the licensee and all traps shall be removed, all pitfalls shall be refilled or capped and the study area returned to the condition it was in prior to the research/capture program. During any break in research, cage traps should be removed and pitfalls either removed, capped or filled with sand.

2. No collecting is to be undertaken in areas where it would impinge on pre-existing scientific research programs.

3. Any form of colour marking of birds or bats to be coordinated by the Australian Bird and Bat Banding Schemes.

4. Any inadvertently captured specimens of fauna which is declared as likely to become extinct, rare or otherwise in need of special protection is to be released immediately at the point of capture. Where such a specimen is injured or deceased, the licensee shall contact Department of Environment and Conservation licensing staff at Kensington (08 9423 2434) for advice on disposal. Records are to be kept of any fauna so captured and details included in the report required under further condition 6 below.

5. Prior to any renewal of this research licence the licensee shall submit a summary report outlining work conducted under this licence and work proposed for the next research period.

6. Within one month of the expiration of this licence (or at such other time or times as the Director General may determine) the holder shall furnish to the Director General [ATTENTION: WILDLIFE CLERK] a return setting out in full detail the number of each species of fauna taken during the currency of the licence, the localities where the species was/were taken and the method of handling of such fauna and disposal of specimens. A copy of any paper or report resulting from this research should be lodged in due course with the Director General. In the case of consultants, a list of the fauna handled, the localities involved and a copy of the interpretive data prepared should be lodged.

7. As a general rule not more than ten specimens of any one protected species shall be permanently taken from any location less than 20km apart. Where exceptional circumstances make it necessary to take large series in order to obtain adequate statistical data the collector will proceed with circumspection and justify their actions to the Director General in advance.

8. No fauna, whether dead or alive, may be taken out of Western Australia without the necessary export permit issued under the *Wildlife Conservation Act 1950*. It should be noted that the permit will not be issued unless the State to which the fauna is going has approved that fauna entering that State. In addition to the requirements of the Australian States, the Commonwealth controls exports overseas through Commonwealth legislation administered by the Australian Nature Conservation Agency.

9. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected which represents a significant extension of geographic range shall be donated on request to the Western Australian Museum.

10. To prevent any unnecessary collecting in this state, all specimens and material collected under the authority of this license shall, on request, be loaned to the Western Australian Museum. Also, the unused portion or portions of any specimen collected under the authority of this license shall be offered for donation to the Western Australian Museum or made available to other scientific workers if so required.

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Appendix 5

Bat Call Identification

Specialised Zoological

Bat call identification

from Cape Lambert, WA

Type:	Bat Call Analysis
Prepared for:	Biota Environmental Sciences
Date:	4 April 2008
Job No.	SZ036
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Bat call identification from Cape Lambert, WA

SUMMARY

Bat identifications from Anabat echolocation call recordings are provided from Cape Lambert, Western Australia. Five species were identified with a medium to high level of confidence (Tables 1 and 2). The calls of the yellow-bellied sheath-tailed bat *Saccolaimus flaviventris* can sometimes be confused with the northern free-tailed bat *Chaerephon jobensis*, but no unambiguous calls of the latter were apparent. Calls attributed to the unidentified long-eared bat *Nyctophilus* sp. were of poor quality, and could have derived from one of three species: the pallid long-eared bat *Nyctophilus bifax daedalus,* lesser long-eared bat *N. geoffroyi* or the northern long-eared bat *N. arnhemensis.* The western little free-tailed bat *Mormopterus loriae cobourgiana* was particularly common at every site. Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). A summary of pulse parameters is provided in Table 3, and representative call sequences are illustrated in Figure 1. Further data are available if verification is required.

METHODS

Signals recorded with an Anabat II – CF-ZCAIM unit were downloaded and supplied as Anabat sequence files. Sequences were examined in AnalookW 3.3f software. Species were identified based on information in McKenzie and Muir (2000), and my own unpublished reference material. Representative call sequences were imported into the software Analyze (Jolly 1997) where three call variables were measured on good quality search phase pulses: pulse duration (milliseconds), maximum frequency (kHz) and end frequency (equivalent to characteristic frequency; kHz). Nomenclature follows Armstrong and Reardon (2006).

REFERENCES

ABS (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australasian Bat Society Newsletter* 27: 6–9. [ISSN 1448-5877]

Armstrong, K. and Reardon, T. (2006). Standardising common names of bats in Australia. *The Australasian Bat Society Newsletter* 26: 37–42.

Jolly, S. (1997). Analysis of Anabat files. *The Australasian Bat Society Newsletter* 9: 25–27.

McKenzie, N.L. and Muir, W.P. (2000). Bats of the southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum* Supplement 61: 465–477.

TABLE 1. Site by species matrix of identifications, with the degree of confidence indicated by a code. Date and Anabat serial number correlates with site. See Table 2 for confidence level codes; and Table 3 for full species names.

Site	*M. loriae*	*Nyctophilus* sp.	*S. flaviventris*	*T. georgianus*	*V. finlaysoni*
serial 682					
6/10/2007	H	—	M	H	H
7/10/2007	H	—	M	H	H
serial 682					
7/03/2008	H	—	—	H	M
8/03/2008	H	—	—	M	H
9/03/2008	H	L	—	H	—
10/03/2008	H	M	—	H	H

TABLE 2. Key to the confidence level of identifications in Table 1. The identification of each species is made based on one or more sequences at each site.

Code	Confidence level
R	Highest. Capture of the species was made at the site, and the identification is supported by measurements, a *Reference* call recording, and/or submission of a specimen/tissue to a museum.
H	High. Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material.
M	Medium. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated elsewhere in this report. If this is a species of conservation significance, further survey work might be required to confirm the record.
L	Low. The identification is made very tentatively. Normally such call sequences would be ignored, but in this case they have been given a tentative identification because it was felt that the record might be of general interest. Species of conservation significance will not be assigned to this category.

TABLE 3. Summary of variables from representative call sequences. (Mean ± SD; range; s,p: number of sequences measured, combined total number of pulses measured).

Species	s,p	Duration (ms)	Max Frequency (kHz)	End frequency (kHz)
Western little free-tailed bat *Mormopterus loriae cobourgiana*	4,71	9.8 ± 1.9 5.2 – 16.5	35.4 ± 3.2 30.7 – 47.3	31.7 ± 1.5 29.6 – 35.0
Unidentified long-eared bat *Nyctophilus* sp.	4,21	3.9 ± 1.5 1.3 – 6.1	60.9 ± 4.3 55.2 – 69.0	45.7 ± 1.6 43.1 – 48.5
Yellow-bellied sheath-tailed bat *Saccolaimus flaviventris*	3,19	14.6 ± 2.4 10.9 – 18.1	17.7 ± 1.2 15.6 – 19.7	15.7 ± 0.6 14.7 – 16.6
Common sheath-tailed bat *Taphozous georgianus*	3,21	11.3 ± 2.0 8.4 – 17.0	25.3 ± 0.7 24.2 – 26.9	24.2 ± 0.3 23.6 – 24.7
Finlayson's cave bat *Vespadelus finlaysoni*	2,31	5.5 ± 1.4 3.0 – 10.0	68.1 ± 7.0 59.7 – 80.8	54.8 ± 1.1 52.6 – 57.0

Bat call identification from Cape Lambert, WA

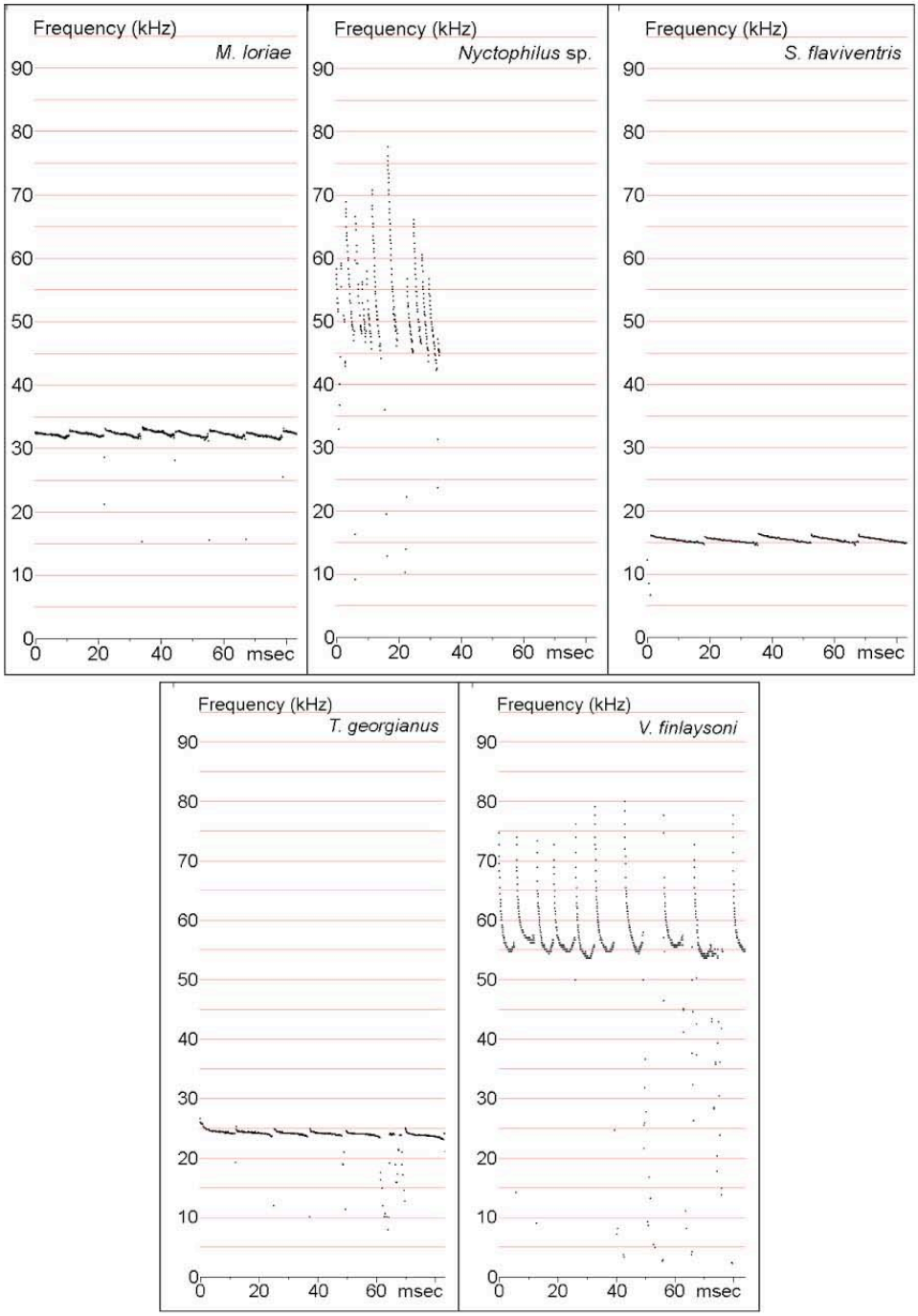

FIGURE 1. Representative call sequences of the five species identified (time is compressed between pulses).