Biota Environmental Sciences

West Pilbara Iron Ore Project Rail Corridor Fauna and Fauna Assemblages Survey

Prepared for API Management

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1.0 Introduction

1.1 Project Background

API Management (API) proposes to develop the West Pilbara Iron Ore Project (WPIOP). The spatial scope of this project is considerable, encompassing several mine deposits and three options for rail corridors. The project is located primarily in the vicinity of Red Hill in the western Pilbara, with the primary rail corridor extending from this locality to Anketell Point, east of Karratha (Figure 1.1).

API referred the WPIOP to the Western Australian Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986*. The EPA determined that the proposal would be formally assessed at the level of Public Environmental Review (PER). The project was also referred to the Federal Department of the Environment, Water, Heritage and the Arts (DEWHA) under the *Environment Protection and Biodiversity (EPBC) Conservation Act 1999*. DEWHA determined that the project would also be treated as a Controlled Action for the purposes of this latter act. Biota Environmental Sciences (Biota) was commissioned to complete fauna surveys of areas to be impacted by the proposed WPIOP development, including the rail corridors from the mine areas to the port

Three options are under consideration for the rail corridor required to connect the mine areas to the coast. These comprise a rail transport corridor from the ore body areas to port facilities to be developed at either:

- Anketell Point, to the east of Karratha (Figure 1.1);
- Cape Preston, to the south west of Karratha; or
- Onslow, to the west of Red Hill.

In addition to the terrestrial fauna surveys documented here, API has undertaken various land access and engineering investigations for these rail corridors and the prospective port sites. This work has identified Anketell Point as the preferred port site for the project, with the Anketell Point corridor consequently the primary rail option for the project.

1.2 Study Area

This report addresses the terrestrial fauna of the Anketell Point rail corridor. Separate reports have been previously produced addressing the fauna of the Cape Preston (Biota 2009a) and Onslow (Biota 2009b) rail corridor options. The terrestrial fauna of the project mine and infrastructure areas are also not considered in the current report, having been addressed separately by Biota (2009c).

The study area comprised a survey corridor approximately 203 km in length and generally 200 m wide, though this varied to 400 m in some sections (Figure 1.1). The southern limit of the study area was the immediate north of the planned Cochrane and Jewel deposits rail loop, some 16 km south of where the corridor crosses the Robe River (Figure 1.1). The initial southern section of the rail corridor followed a generally northerly bearing for approximately 40 km until the Northwest Coastal Highway. The central and northern sections of the route then generally parallel the Highway at varying distance until reaching Anketell Point (Figure 1.1).

API also identified several potential materials sourcing areas in the northern section of the Anketell Point rail corridor (Figure 1.1). These also formed part of the current study area. The total survey area covered an extent of approximately 30,295 ha.

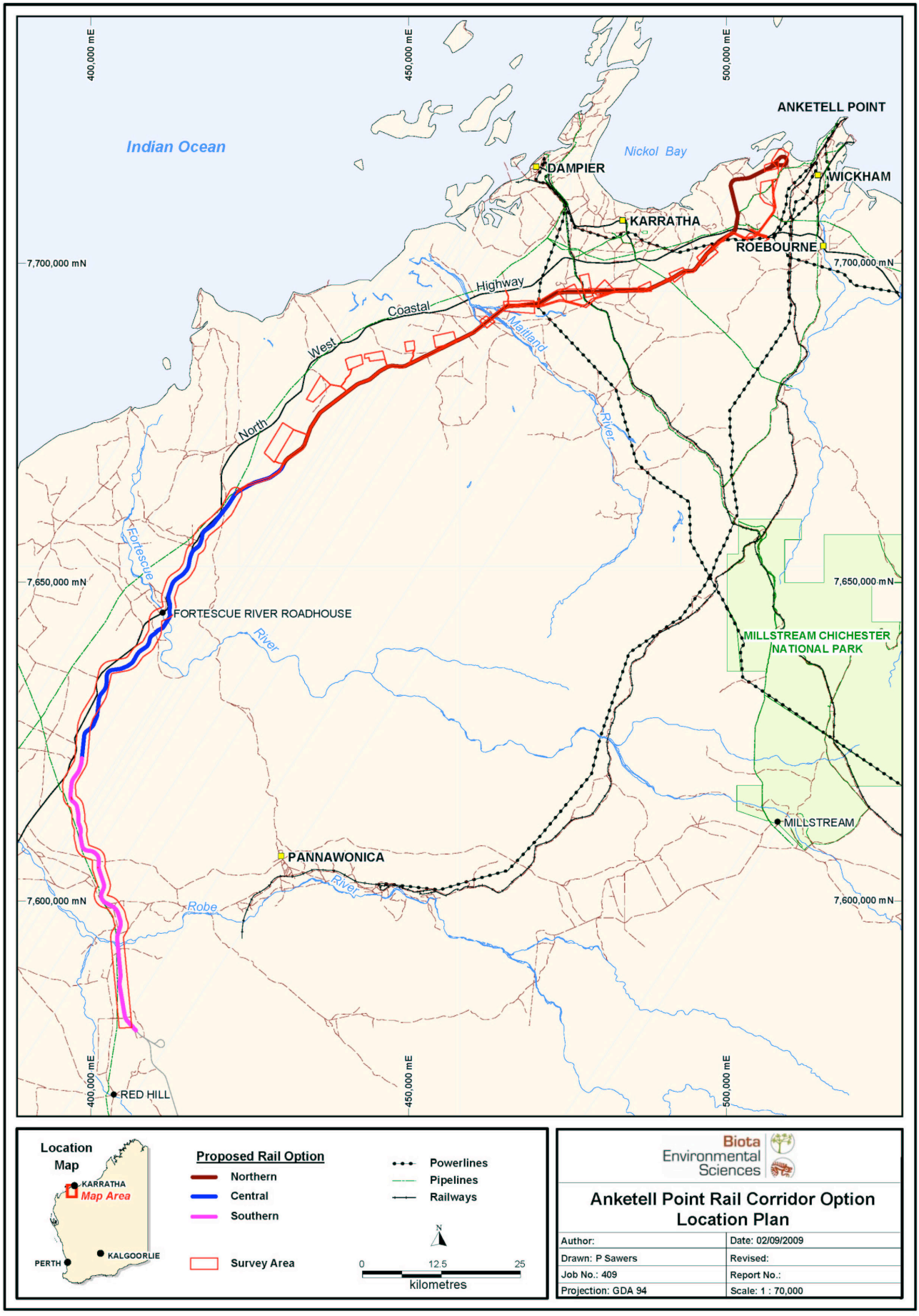

Figure 1.1: **Locality map for the Anketell Point rail corridor, showing the extent of the study area for this report.**

1.3 Study Objectives and Scope

The survey documented in this report was planned and implemented in accordance with:

- EPA Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002);
- EPA Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2003); and
- EPA Guidance Statement No. 20 "Sampling of Short-range Endemic Fauna for Environmental Impact Assessment in Western Australia" (EPA 2009).

The scope of this study was to:

- document the vertebrate and short-range endemic (SRE) invertebrate fauna assemblage within the habitats of the study area using established sampling techniques;
- identify and assess the local and regional conservation significance of the fauna habitats, species and assemblages present in the project area;
- identify fauna (particularly Schedule and Priority listed fauna as well as potential SRE taxa) of particular conservation significance; and
- provide a generic assessment of the potential impacts the proposed development on the fauna habitats and assemblages occurring in the study area.

This report describes the methodology employed for the fauna survey of the proposed WPIOP Anketell Point rail corridor. It documents the results of the surveys and discusses the potential impacts of the project on fauna habitats and assemblages. Its intended use is as a supporting document for the formal environmental assessment of the WPIOP project. Both the field surveys and this report are subject to the limitations discussed in Section 2.5.

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2.0 Methodology

2.1 Database Searches

A Level 1 fauna assessment (EPA 2003) was conducted for the Anketell Point rail corridor study area (Biota 2007a). A range of database searches were conducted for this assessment, consisting of:

- the DEC (Department of Environment and Conservation) Threatened Fauna Database;
- the Western Australian Museum FaunaBase database was also searched for records of vouchered fauna from the area (records now on DEC NatureMap); and
- the *EPBC Act 1999* Protected Matters database was searched for fauna of national environmental significance potentially occurring in the study area.

These searches were conducted using a 25 km buffer (due to the linear nature of the study area), with bounding coordinates of:

- southwest end - 21°07'14.79"S 116°15'27.25"E; and
- northeast end - 20°39'31.57"S 117°04'45.71"E.

The Biota internal database was also searched for records from the study area locality (Biota 2007a).

2.2 Survey Timing and Weather

2.2.1 Survey Timing

The survey of the rail corridor was split into three sections with differing survey timing:

- the north section of the rail corridor, from North West Coastal Highway to Anketell Point (sites AQD02E-AQD20), was surveyed from 2nd to the 9th April 2009 (Phase I of this section) (Table 2.2);
- the middle section of the corridor (sites AQAR08-AQAR19), was initially surveyed from 5th to 14th September 2007 (Phase I), with a seasonal Phase II survey of all sites completed from 18th to the 26th March 2008 (Table 2.2); and
- the south section of the corridor (sites AQA01-AQA11), was initially surveyed from 23rd to 30th May 2007 (Phase I), with two sites in this section (AQA08 and AQA09) again sampled from 20th to 24th June 2009 (Phase II) (Table 2.2).

While occurring in different timeframes, the data from the first phases of all sites have been grouped in the balance of this report as Phase I, with Phase II data reported for seasonally sampled sites.

2.2.2 Climatological Data

Field sampling in the study area was conducted under a range of weather conditions as follows.

2.2.2.1 May 2007

Minimum temperatures during the May 2007 survey ranged from 16.7°C to 24.5°C and maximum temperatures ranged from 30.8°C to 35.0°C (Table 2.1). Rainfall data were not available from Mardie Station (the closest recording station) during this survey period.

2.2.2.2 September 2007

Temperatures during the September 2007 survey work ranged from minima of 12.8°C to 15.7°C and maxima of 29.1°C to 36.6°C (Table 2.1). Again, there were no rainfall data available from Mardie Station for this period.

2.2.2.3 March 2008

Minimum temperatures during March 2008 ranged from 22.4°C to 27.0°C, with maximum temperatures from 26.8°C to 39.1°C (Table 2.1). Rainfall was recorded on the last day of survey, with 17.2 mm falling at Mardie Station.

2.2.2.4 April 2009

Temperatures during the April 2009 survey ranged from minima of 19.3°C to 29.6°C to maximum temperatures from 34.1°C to 38.7°C (Table 2.1). No rainfall was recorded during this period.

2.2.2.5 June 2009

Minimum temperatures in June 2009 ranged between 9.0°C and 17.4°C, with maximum temperatures ranging from 25.6°C to 27.4°C (Table 2.1). A total of 28 mm of rain was recorded at Cardo Camp during this survey.

Table 2.1: Daily meteorological observations recorded at Mardie Station and Karratha during the WPIOP rail corridor fauna surveys (data provided by the Bureau of Meteorology; NA = Not Available).

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
May 2007 (Mardie Station)			
23/5/07	21.5	34.4	NA
24/5/07	24.5	35.0	NA
25/5/07	19.9	33.6	NA
26/5/07	18.5	32.3	NA
27/5/07	19.5	31.8	NA
28/5/07	17.5	31.1	NA
29/5/07	16.8	30.8	NA
30/5/07	16.7	31.6	NA
Survey Averages	**19.4**	**32.6**	**NA**
September 2007 (Mardie Station)			
5/9/07	15.4	36.6	NA
6/9/07	15.4	35.2	NA
7/9/07	14.5	31.9	NA
8/9/07	15.7	31.2	NA
9/9/07	12.9	31.7	NA
10/9/07	13.8	33.0	NA
11/9/07	13.8	32.9	NA
12/9/07	15.0	31.9	NA
13/9/07	14.8	32.2	NA
14/9/07	12.8	29.1	NA
Survey Averages	**14.4**	**32.6**	**NA**
March 2008 (Mardie Station)			
18/3/08	25.7	39.1	0
19/3/08	26.4	37.9	0
20/3/08	25.6	38.0	0
21/3/08	25.9	38.0	0
22/3/08	27.0	37.6	0
23/3/08	26.9	36.2	0
24/3/08	25.3	35.5	0
25/3/08	26.8	31.9	0
26/3/08	22.4	26.8	17.2
Survey Averages	**25. 8**	**35.7**	**1.9**
April 2009 (Karratha)			
2/4/09	27.2	38.4	0
3/4/09	29.6	NA	0
4/4/09	NA	38.7	0
5/4/09	23.4	37.1	0
6/4/09	23.3	36.0	0
7/4/09	24.2	35.9	0
8/4/09	19.3	34.1	0
9/4/09	19.9	34.8	0
Survey Averages	**23.8**	**36.4**	**0**

Table 2.1: **Daily meteorological observations recorded at Mardie Station and Karratha during the WPIOP rail corridor fauna surveys** (data provided by the Bureau of Meteorology; NA = Not Available).

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
June 2009 (Mardie Station)			
20/6/09	12.7	27.4	0
21/6/09	9.0	26.4	0
22/6/09	10.9	26.4	0
23/6/09	10.3	26.2	0
24/6/09	17.4	25.6	0.6
Survey Averages	**12.1**	**26.4**	**0.12**
Overall Averages	**19.1°C**	**32.7°C**	**0.7 mm**

2.3 Study Team

The vertebrate fauna sampling for the field surveys was conducted under "Licence to Take Fauna for Scientific Purposes" No. SF005841 issued to Mr Garth Humphreys and "Licence to Take Fauna for Scientific Purposes" No. SF006833 issued to Dr Phil Runham (Appendix 1). Overall project coordination and direction was provided by Garth Humphreys (Biota).

The fauna survey team for the Phase I (April 2009) survey of the northern section of the rail corridor comprised Dr Phil Runham, Ms Erin Harris, Mr Tim Sachse (all of Biota) and Mr Greg Harold (private consultant). Mr David Keirle and Mr Sean McCulloch (both of Biota) assisted with the set-up component of this fauna survey.

The fauna survey team for the Phase I (September 2007) survey of the central section of the rail corridor comprised Mr Roy Teale, Dr Phil Runham, Ms Zoë Hamilton (all of Biota) and Mr Greg Harold (private consultant). Mr Michael Greenham and Mr Paul Sawers (both of Biota) assisted with the set-up component of this fauna survey. The fauna survey team for Phase II (March 2008) survey of the central rail corridor section comprised Dr Phil Runham, Ms Erin Harris, Mr Michael Greenham, Mr Jason Alexander and Mr Ashley Johnsen (all of Biota).

The fauna survey for the Phase I (May 2007) survey of the southern section of the rail corridor comprised Mr Roy Teale, Dr Phil Runham, Ms Erin Harris, Ms Jane Adcroft, Mr Ashley Johnsen and Mr Dan Kamien (all of Biota) and Mr Greg Harold (private consultant). Mr Garth Humphreys and Mr Luke Lovell (all of Biota) assisted with the set-up component of this fauna survey. The fauna survey team for the Phase II (June 2009) sampling of the southern section of the rail corridor comprised Dr Phil Runham, Ms Erin Harris, Mr Jason Alexander, Ms Jess Cairnes and Mr David Keirle (all of Biota), and Mr Greg Harold (private consultant).

Invertebrate specimen identifications were completed by Mr Dan Kamien and Mr Roy Teale (Biota), and Dr Mark Harvey, Dr Volker Framenau and Dr Sarah Crews (Western Australian Museum). Bat call analysis was undertaken by Dr Kyle Armstrong of Specialised Zoological. GIS analysis and maps produced for this report were completed by Mr Paul Sawers and Mr Luke Lovell (Biota).

2.4 Fauna Sampling

2.4.1 Selection and Location of Sampling Sites

The central component of this study consisted of a combination of systematic fauna sampling of representative habitats and targeted searches within habitats suitable for SRE or Threatened Fauna. The systematic sampling centred on 41 trapping grids installed in defined habitats considered to represent the range available habitats within the study area. Targeted searches were conducted in as many additional areas as practicable and encompassed the range of habitats available within the study area. Locations of systematic trapping sites are detailed in Table 2.2 and shown in Figure 2.1 to Figure 2.3.

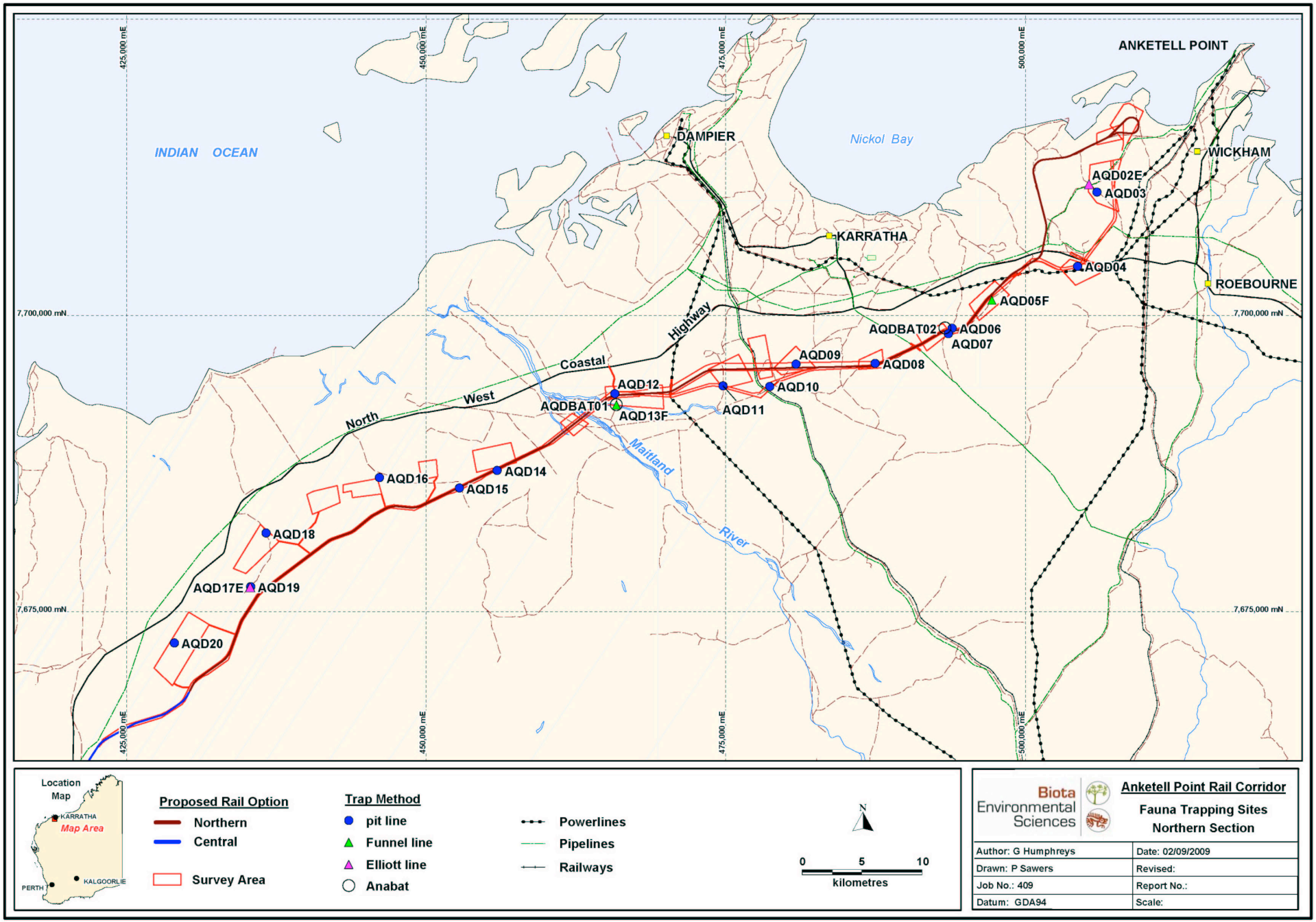

Figure 2.1: Location of systematic trapping and bat sampling sites within the northern section of the rail corridor study area.

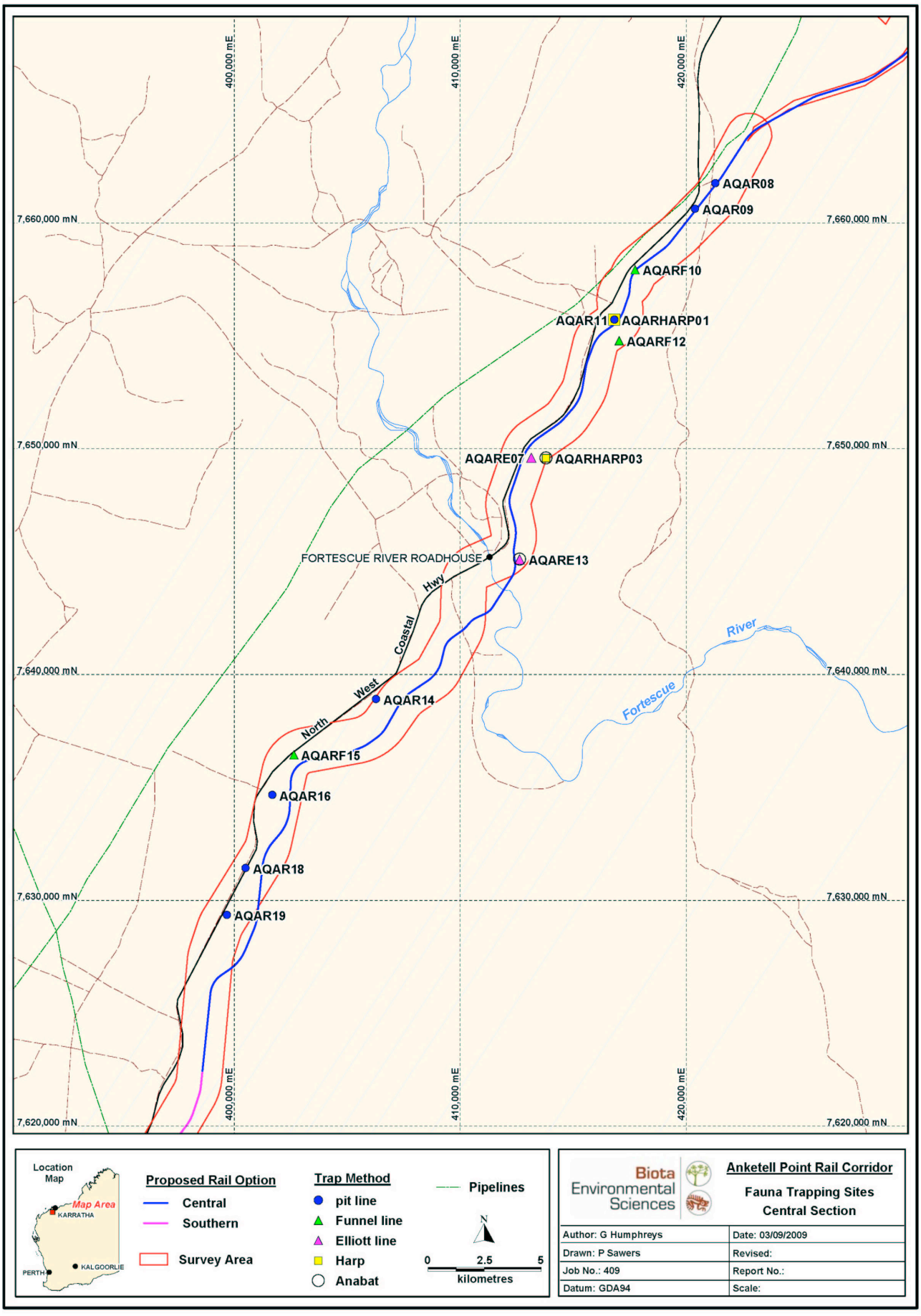

Figure 2.2: **Location of systematic trapping and bat sampling sites within the central section of the rail corridor study area.**

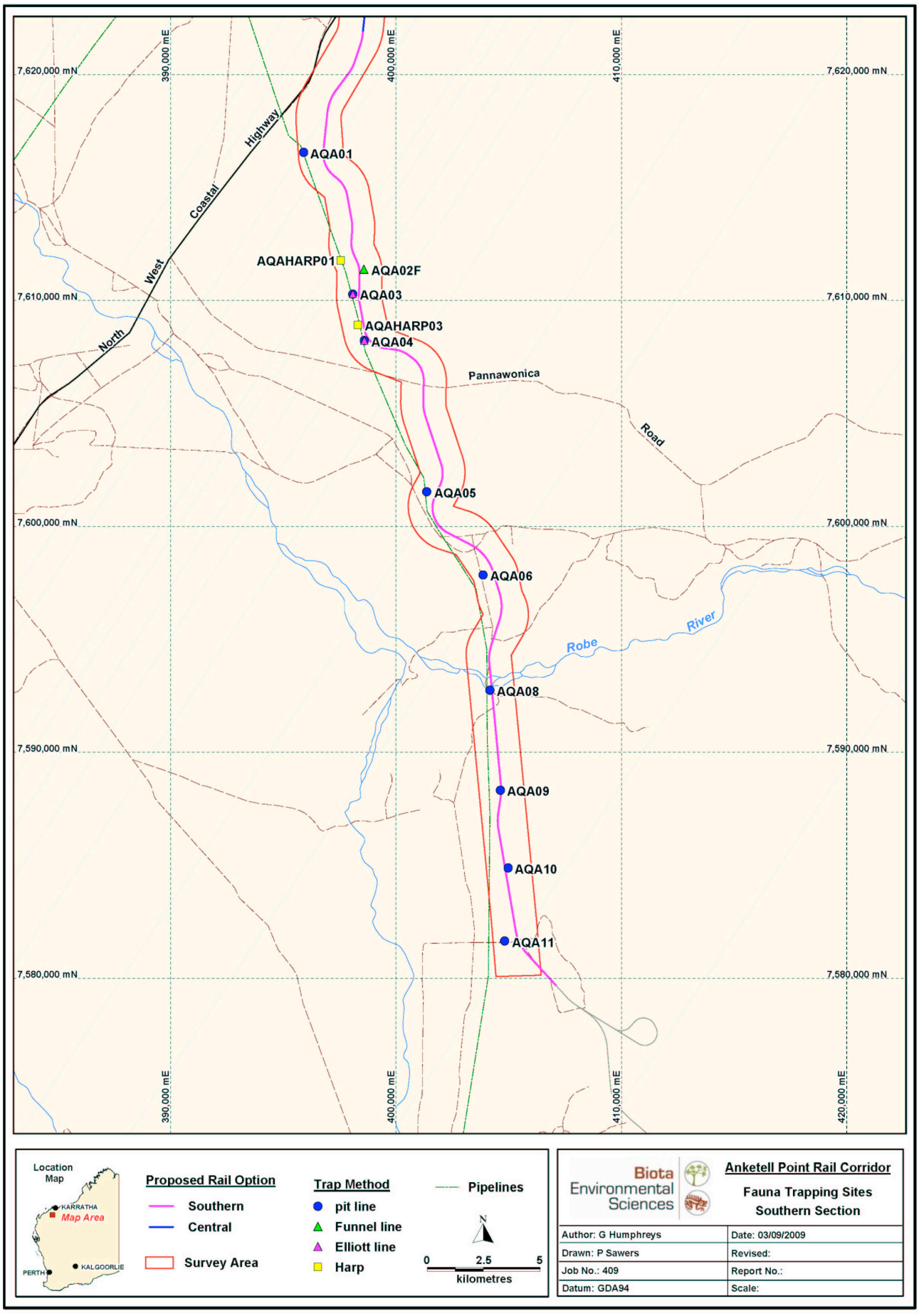

Figure 2.3: **Location of systematic trapping and bat sampling sites within the southern section of the rail corridor study area.**

The fauna habitat classification for site selection was undertaken by the lead survey zoologists on the basis of landform, soils and vegetation. This classification approach does not cover all microhabitats available to the entire assemblage of invertebrate and vertebrate fauna, as this would be difficult to resolve and logistically impracticable to sample. Rather, the classifications provide a broader scale framework within which to summarise species occurrence. The faunal assemblage within these habitats will depend to some extent on the Land System in which they occur (Section 3.4), but can also differ within each Land System (as expressed in the vegetation classification; Section 4.1). In most situations, it is the vegetation type that best approximates a meaningful habitat classification.

In addition to sampling the range of habitats present, the number of survey sites and allocation of effort within each habitat was proportional to the relative extent of each habitat within the survey area (i.e. more sites were installed in the better represented habitats in the survey area). Each sample site was located within a defined habitat and was selected such that equal weight was given to accessibility of the sites in terms of regular inspection of traps, or repeat targeted sampling of habitats where necessary. Details of habitats present along the rail corridor and at each survey site are provided in Section 4.1.

2.4.2 Site Design and Trap Effort

An indicative layout for the rail corridor fauna survey pit-trapping sites is shown in Figure 2.4, with trap effort at the systematic trapping sites detailed in Table 2.2. Pit-traps at each site were arranged in a single row of 10 traps, alternating between 20 litre buckets (350 mm diameter) and PVC tubes (150 mm diameter). Pit-traps were spaced at ~10 m intervals and connected with a single length of 30 cm tall flywire fence. This pit trap design was utilised at 31 sampling sites during this survey. Six additional sites of between 16 and 52 funnel traps, and four sites of either 25 or 50 Elliott traps were also installed as detailed at Table 2.2. The overall trap effort for the survey totalled 4,165 trap nights across 41 systematic site (Table 2.2; Figure 2.1 to Figure 2.3).

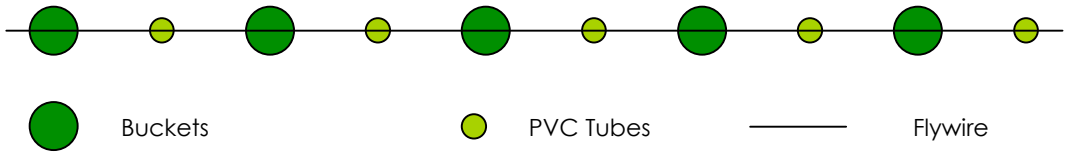

Figure 2.4: Indicative layout of pit-trapping sites (N.B. not to scale).

Table 2.2: Location of systematic sampling sites and trap effort for the WPIOP rail corridor fauna survey.

	Site	Location	Trap Type	Date Opened	Date Closed	Nights Open	No. of Traps	Trap Effort
North section	AQD02E	505321mE; 7711069mN	Elliott	4/4/09	9/4/09	5	25	125
	AQD03	505988mE; 7710408mN	Pit	4/4/09	9/4/09	5	10	50
	AQD04	504368mE; 7704147mN	Pit	4/4/09	9/4/09	5	10	50
	AQD05F	497217mE; 7701295mN	Funnel	3/4/09	9/4/09	6	16	96
	AQD06	493903mE; 7698936mN	Pit	3/4/09	9/4/09	6	10	60
	AQD07	493584mE; 7698466mN	Pit	3/4/09	9/4/09	6	10	60
	AQD08	487473mE; 7695966mN	Pit	3/4/09	9/4/09	6	10	60
	AQD09	480874mE; 7695907mN	Pit	3/4/09	9/4/09	6	10	60
	AQD10	478675mE; 7694011mN	Pit	3/4/09	9/4/09	6	10	60
	AQD11	474777mE; 7694070mN	Pit	3/4/09	9/4/09	6	10	60
	AQD12	465752mE; 7693414mN	Pit	3/4/09	8/4/09	5	10	50
	AQD13F	465882mE; 7692460mN	Funnel	2/4/09	8/4/09	6	16	96
	AQD14	455923mE; 7686938mN	Pit	2/4/09	8/4/09	6	10	60
	AQD15	452779mE; 7685457mN	Pit	2/4/09	8/4/09	6	10	60
	AQD16	446107mE; 7686330mN	Pit	2/4/09	8/4/09	6	10	60
	AQD18	436639mE; 7681656mN	Pit	2/4/09	8/4/09	6	10	60
	AQD19	435361mE; 7677132mN	Pit	2/4/09	8/4/09	6	10	60
	AQD17E	435308mE; 7677084mN	Elliott	4/4/09	8/4/09	4	25	100
	AQD20	728989mE; 7672383mN	Pit	2/4/09	8/4/09	6	10	60

Table 2.2: Location of systematic sampling sites and trap effort for the WPIOP rail corridor fauna survey.

	Site	Location	Trap Type	Date Opened	Date Closed	Nights Open	No. of Traps	Trap Effort
Central section	AQAR08	421288mE; 7661758mN	Pit	6/9/07	12/9/07	6	10	60
			Pit	20/3/08	25/3/08	5	10	50
	AQAR09	420386mE; 7660625mN	Pit	6/9/07	12/9/07	6	10	60
			Pit	20/3/08	25/3/08	5	10	50
	AQARF10	417737mE; 7657923mN	Funnel	7/9/07	13/9/07	6	16	96
			Funnel	21/3/08	26/3/08	5	16	80
	AQAR11	416820mE; 7655717mN	Pit	7/9/07	13/9/07	6	10	60
			Pit	19/3/08	25/3/08	6	10	60
	AQARF12	417032mE; 7654783mN	Funnel	7/9/07	13/9/07	6	16	96
			Funnel	20/3/08	25/3/08	5	16	80
	AQARE07	413144mE; 7649599mN	Elliott	21/3/08	25/3/08	4	50	200
	AQARE13	412625mE; 7645102mN	Elliott	20/3/08	25/3/08	5	50	250
	AQAR14	406272mE; 7638918mN	Pit	8/9/07	14/9/07	6	10	60
			Pit	19/3/08	25/3/08	6	10	60
	AQARF15	402642mE; 7636448mN	Funnel	8/9/07	14/9/07	6	16	96
			Funnel	19/3/08	25/3/08	6	20	120
	AQAR16	401679mE; 7634674mN	Pit	8/9/07	14/9/07	6	10	60
			Pit	19/3/08	25/3/08	6	10	60
	AQAR18	400494mE; 7631439mN	Pit	8/9/07	14/9/07	6	10	60
			Pit	19/3/08	25/3/08	6	10	60
	AQAR19	399674mE; 7629360mN	Pit	8/9/07	14/9/07	6	10	60
			Pit	18/3/08	25/3/08	7	10	70
South section	AQA01	395905mE; 7616561mN	Pit	23/5/07	29/5/07	6	10	60
	AQA02F	398573mE; 7611387mN	Funnel	23/5/07	29/5/07	6	20	120
	AQA03	398082mE; 7610287mN	Pit	23/5/07	29/5/07	6	10	60
			Elliott	24/5/07	29/5/07	5	25	125
	AQA04	398594mE; 7608230mN	Pit	23/5/07	29/5/07	6	10	60
			Elliott	24/5/07	29/5/07	5	25	125
	AQA05	401365mE; 7601538mN	Pit	23/5/07	29/5/07	6	10	60
	AQA06	403864mE; 7597851mN	Pit	23/5/07	30/5/07	7	10	70
	AQA08	404170mE; 7592749mN	Pit	23/5/07	30/5/07	7	10	70
			Pit	20/6/09	24/6/09	4	10	40
	AQA09	404633mE; 7588319mN	Pit	23/5/07	30/5/07	7	10	70
	AQA10	404975mE; 7584884mN	Pit	23/5/07	30/5/07	7	10	70
			Pit	20/6/09	24/6/09	4	10	40
	AQA11	404820mE; 7581645mN	Pit	24/5/07	30/5/07	6	10	60
							Total Pit Effort	**2,360**
							Total Elliott Effort	**925**
							Total Funnel Effort	**880**
							Total Trapping Effort	**4,165**

2.4.3 Avifauna Sampling

The avifauna of the project area was sampled using a combination of techniques, including:

- unbounded area censuses conducted at the systematic sampling grids (Table 2.3);
- unbounded area censuses conducted at opportunistic locations containing habitats or microhabitats likely to support previously unrecorded species; and
- opportunistic observation of birds while driving and walking around the study area.

A total of 76 avifauna censuses were completed across 41 sites during the total duration of the rail corridor survey (Table 2.3).

Table 2.3: Census times for avifauna surveys in the Anketell Point rail corridor study area (* denotes opportunistic records).

		Phase I											
	Site	**1/4/09**	**2/4/09**	**3/4/09**	**4/4/09**	**5/4/09**	**6/4/09**	**7/4/09**	**8/4/09**	**9/4/09**			**Total (min)**
North section	AQD02E					0730-0800		*					30
	AQD03						*			*			*
	AQD04					0910-0940	*	*					30
	AQD05F					1010-1040		*					30
	AQD06				*	1045-1115	*	*		*			30
	AQD07				*		*	0730-0800					30
	AQD08				*		0945-1015	0845-0930					75
	AQD09				*		0848-0922	0940-1010					60
	AQD10				*		0815-0845	1020-1050					60
	AQD11					*	0725-0755						30
	AQD12						0745-0815	*					30
	AQD13F						0700-0730	0725-0805					70
	AQD14		*	*		1240-1310	0850-0920	*					60
	AQD15	*	*	*		1150-1220	0955-1025	*	*				60
	AQD16					1100-1130	*	*					30
	AQD18					0950-1020							30
	AQD19				0900-0930			*					30
	AQD20				0745-0815		*						30

		Phase I					Phase II						
	Site	**9/9/07**	**10/9/07**	**11/9/07**	**12/9/07**	**13/9/07**	**20/3/08**	**21/3/08**	**22/3/08**	**23/3/08**	**24/3/08**	**25/3/08**	**Total (min)**
Central section	AQAR08			*					0935-1005		0745-0820		65
	AQAR09		*						0840-0915		0830-0900	*	65
	AQARF10								0750-0825		0915-0945		65
	AQAR11	*					0800-0840		0750-0820	*			70
	AQARF12	*	0740-0810	*	*				0830-0900	*	0830-0900		90
	AQARE07									*			*
	AQARE13									1125-1155	0930-1000		60
	AQAR14	*	*		*		0915-0945	*	0930-1000				60
	AQARF15	*		*			0950-1020	*	*	0825-0855			60
	AQAR16		*	*				0940-1010		0905-0935			60
	AQAR18	*	*					0900-0930		0955-1025			60
	AQAR19	*	*	0805-0835	*	*		0810-0840	1015-1045				90

Table 2.3: Census times for avifauna surveys in the Anketell Point rail corridor study area (* denotes opportunistic records).

		Phase I					Phase II				
	Site	**25/5/07**	**26/5/07**	**27/5/07**	**28/5/07**	**29/5/07**	**20/6/09**	**22/6/09**	**24/6/09**		**Total (min)**
South section	AQA01	1005-1045			0800-0840	0720-0800					120
	AQA02F	0915-0945		1145-1225							70
	AQA03	0810-0850		1055-1135	0950-1030	0840-0920					160
	AQA04	0725-0805	1130-1210		1050-1130	0940-1020					160
	AQA05	1115-1155	0715-0755		1150-1230						120
	AQA06		0815-0855	0715-0755							80
	AQA08		0915-0955	0810-0850				0910-0950			120
	AQA09		1010-1050	0910-0950							80
	AQA10	0750-0830			0710-0750	1345-1425		1030-1110	*		160
	AQA11	0900-0940			0800-0840		*				80

Avifauna were sampled using 30 or 40 minute censuses comprising a total of 43.5 hours of dedicated avifauna sampling (Table 2.3). Censuses were conducted between 0700 and 1300 and were supplemented by avifauna species opportunistically recorded in the study area.

2.4.4 Bat Sampling

Sampling for bats was carried out at eight locations along the rail corridor study area at varying periods during the survey (Table 2.4; Figure 2.1). Bats were sampled both by means of harp traps located in potential flyways over water and at cave mouths, and by the use of Anabat II ultrasonic call detectors. 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 2.4: Location of bat sampling sites within the rail corridor study area.

Site	Location	Type	Date Opened	Date Closed	No. of Nights
AQDBAT02	493903mE; 7698936mN	Anabat	7/4/09	8/4/09	1
AQDBAT01	465868mE; 7692456mN	Anabat	3/4/09	7/4/09	4
AQARHARP01	416820mE; 7655717mN	Harp	9/9/07	14/9/07	5
		Harp	22/3/08	25/3/08	3
AQARHARP02	416820mE; 7655717mN	Harp	9/9/07	14/9/07	5
AQARHARP03	413792mE; 7649583mN	Harp	22/3/08	25/3/08	3
		Anabat	22/3/08	25/3/08	3
AQAHARP01	397542mE; 7611787mN	Harp	23/5/07	30/5/07	7
AQAHARP03	398308mE; 7608924mN	Harp	23/5/07	30/5/07	7
AQARE13	412625mE; 7645102mN	Anabat	23/3/08	25/3/08	2
				Total No. of Nights:	**40**

2.4.5 Non-systematic Sampling of Vertebrate Fauna

A range of non-systematic fauna survey activities was also undertaken by the survey team during each survey phase 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;
- searching of microhabitats for reptile, frog and small mammal 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.

2.4.6 SRE Fauna Sampling

Potential SRE invertebrates were collected from systematic sampling sites in the course of removing vertebrates from traps, as well as searches being conducted in the habitats sampled at those 41 locations (Table 2.2). Additional targeted sampling for invertebrate groups supporting potential SRE taxa was conducted at a further 12 sites along the study areas, with SREs collected at 53 sites in total across the study area.

Groups targeted during SRE searches included:

- mygalomorph (trap-door) spiders;
- selenopid (crab) spiders;
- pseudoscorpions;
- millipedes; and
- terrestrial snails.

Trapdoor spiders were specifically targeted by searching for burrows and excavating them with the aim of collecting and preserving individuals in 70% ethanol. One leg was removed and placed in 100% ethanol for future molecular studies. Selenopid spiders, a family restricted to below rocks, were searched for by over-turning suitable microhabitats. Specimens were preserved via the same protocol.

Pseudoscorpions were specifically targeted by peeling back bark of trees and searching beneath rocks. The majority of individuals were preserved in 70% ethanol for morphological identification, with a sub-sample preserved in 100% ethanol for future molecular studies.

Millipedes were searched for under leaf litter and logs. Aestivating land snails were targeted by digging under spinifex hummocks and in drainage gullies.

2.5 Limitations

The following limitations should be recognised by the reader of this report:

- Not all sections of the survey area were ground-truthed or equally sampled for fauna. Parts of the study area were inaccessible by vehicle, particularly in the central part of the corridor, and 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 grids installed in habitats considered to be representative of the range of units present within the study area.
- Terrestrial invertebrate sampling was targeted at a small number of specific groups that may harbour SRE taxa only (EPA 2009).
- Due to the developing scope of the preferred rail corridor for the project, 26 of the 41 systematic sites in this study were only sampled on one survey phase (Table 2.2). Additional, seasonal sampling would therefore probably add to the total species list.

Despite the above limitations, the survey is considered to have provided an assessment of terrestrial fauna and fauna habitats suitable to support the formal assessment of the proposed WPIOP Anketell Point rail corridor.

3.0 Regional Context

3.1 Geology

Regional geological mapping completed by Thorne and Trendall (2001) covers the extent of the study area. These data indicate that the rail corridor traverses 31 geological types (Table 3.1).

Table 3.1: Geological units occurring within the study area.

Unit	Description
Qc	Colluvium – sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits
AFr	Rhyolite; metamorphosed; possibly related to quartz-feldspar porphyry (Apf)
Qhm	Marine mud and silt on supratidal to intertidal flats; includes intertidal deposits with mangroves; Holocene
Qw	Sheetwash deposits – silt, sand, and pebbles in distal outwash fans
ARr	Regal Formation: massive and pillow basalt, with local basal peridotitic komatiite; minor chert; metamorphosed
Qaa	Alluvium; sand and gravel in rivers and creeks; clay, silt, and sand in channels on floodplains
AGl	Cleaverville Formation: banded iron-formation, ferruginous chert, jaspilite, chert, siltstone, shale, and minor felsic volcaniclastic rocks; metamorphosed
Qwb	Sand, silt, and clay in distal outwash fans, with gilgai surface in areas of expansive clay
ARru	Serpentinized peridotite; locally peridotitic komatiite with olivine-spinifex texture; metamorphosed; basal unit
ARwb	Metabasalt; minor chert
ARnu	Serpentinized peridotite; locally peridotitic komatiite with olivine-spinifex texture; metamorphosed; basal unit
ARrg	Foliated and sheared metabasalt with sheared veins and sheets of microgranite and pegmatite; metamorphosed to amphibolite facies
ARw	Ruth Well Formation: metabasalt and serpentinized peridotite, and thin chert units
Agka	Karratha Granodiorite: granodiorite and tonalite; foliated with local compositional banding; metamorphosed
ARwc	Chert, grey and white banded or ferruginous, and minor quartzite; metamorphosed
ARnc	Chert
ARwu	Serpentinized peridotite; locally peridotitic komatiite with olivine-spinifex texture; metamorphosed
Qao	Alluvial sand, silt, and clay on floodplains
Qaoc	Mixed floodplain deposits with numerous small claypans
AFrb	Basaltic breccia
AFrbm	High-Mg basalt
AFh	Hardey Formation: sandstone, conglomerate, siltstone, shale, and tuff; thin basal conglomerate
Qg	Colluvium. Unconsolidated to loosely consolidated piedmont deposits; scree, talus
As	Nickol River Formation. Amphibole schist; quartz-mica schist; banded chert, jaspilite, dolomite and prase; fuchsite-bearing rocks; altered basic volcanic rocks, pillow lavas
Ae	Regal Formation. Altered basic and acid volcanic rocks with intercalated sedimentary rocks; intruded by concordant bodies of porphyry and metadolerite
Qk	Kunkar. Impure earthy limestone in sheets and incrustations
Qp	Eluvium and alluvium. Residual 'high level' clay and sandy clay plain with gilgaies; intermittent
Ql	Flood deposits. Unconsolidated fluviatile and sheet-flood deposits in levees, river terraces
Qb	Alluvium. Unconsolidated sand, gravel and pebbles; over kunkar or granite
Pfk	Kylena Volcanics. Basic, intermediate, and acid lavas, with thin intercalated pyroclastic rocks; sandstone
Agc	Undivided granitoid rock; metamorphosed

3.2 Major Physiographic Units

The Anketell Point rail corridor traverses five of the major physiographic units identified by Beard (1975) within the Fortescue Botanical District:

- Abydos Plain: Extending from Cape Preston east to Pardoo Creek, and south to the Chichester Range; including alluvial plains, low stony hills and granite outcrops; comprising largely granitic soils, with alluvial sands on the coastal portion;
- Chichester Plateau: A plateau of mainly basalts, with included siltstone, mudstone, shale, dolomite and jaspilite; forming a watershed between numerous rivers flowing north through the Abydos Plain to the coast, and the Fortescue drainage on the southern side of the range;
- Hamersley Plateau: Rounded hills and ranges, mainly of jaspilite and dolomite with some shale, siltstone and volcanics (only accounts for a very small area of the corridor at 65 ha);
- Onslow Coastal Plain: Coastal mudflats (with some sand plains and coastal dunes) on coastal deposits over Cretaceous sedimentary rocks of the Carnarvon Basin. Tidal soils with Calcareous deeps sands and some Red deeps sands, Red/brown non-cracking clays and Salt lake soils. Bare mudflats with samphire and spinifex/tussock grasslands (and some mangroves). Located in the north-west coast between Cape Preston and the Exmouth Gulf (Tille 2006); and
- Stuart Hills: Hills, ranges, stony plains and sand plains on sedimentary rocks (with some granite) of the northern Ashburton Basin and Gascoyne Complex. Stony soils and Red deep sandy duplexes with Red loamy earths and Red shallow loams and some Red sandy earths. Spinifex grasslands with *Acacia xiphophylla* and *A. inaequilatera*. Located in the northern Gascoyne from the Robe River to Nanutarra.

3.3 IBRA Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions (May and McKenzie 2003). The Anketell Point rail corridor study area lies within the Pilbara bioregion, which is divided into four subregions: Hamersley, Fortescue Plains, Chichester and Roebourne Plains, which were are described by May and McKenzie (2003) as the four major components of the Pilbara Craton. These subregions are largely equivalent to the physiographic regions of Beard (1975) (Section 3.2), although the coastal portion of Beard's Abydos Plain unit comprises the Roebourne Plains subregion, while the inland portion is included within the Chichester subregion. The Anketell Point rail corridor traverses three of the four subregions, comprising:

- Chichester (PIL1): 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;
- Hamersley (PIL3): mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine textured soils in valley floors, and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges; and
- Roebourne Plains (PIL4): quaternary alluvial and older colluvial coastal and sub-coastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera*. Uplands are dominated by *Triodia* hummock grasslands. Ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* woodlands. Samphire, *Sporobolus* and mangal occur on marine alluvial flats and river deltas.

3.4 Land Systems of the Study Area

Land Systems (Rangelands) mapping covering the study area has been prepared to a draft stage by the Western Australian Department of Agriculture (van Vreeswyk et al. 2004). Land

Systems are comprised of repeating patterns of topography, soils, and vegetation (Christian and Stewart 1953) (i.e. a series of "land units" that occur on characteristic physiographic types within the Land System). A total of 107 Land Systems occur in the Pilbara bioregion. [This information was obtained by combining the Land System mapping for the Pilbara (van Vreeswyk et al. 2004) and Ashburton (Payne et al. 1988), and intersecting this with the Pilbara bioregion (Environment Australia 2000) in ArcView 3.2.].

Land Systems mapped by the Department of Agriculture (van Vreeswyk et al. 2004) for the region including the Anketell Point rail corridor are shown in Figure 3.1 to Figure 3.3. Details of the Land System present within the study area are provided in Table 3.2, along with the proportion they represent of the mapped extent within the State.

Table 3.2: Land Systems occurring within the study area, listed from best represented to least, with proportion each area represents of the Land System's State extent.

Code	Land System Name and Description	Extent within Study Area (ha)	Extent within State (ha)	% of total within State
RGEBGD	BOOLGEEDA - Stony plains adjacent to hills	6,413	961,635	0.7%
RGEHOF	HORSEFLAT - Gilgaied clay plains supporting tussock grasslands and grassy snakewood shrublands.	4,890	328,122	1.5%
RGENNT	NANUTARRA - Low mesas and hills of sedimentary rocks supporting soft and hard spinifex grasslands.	4,025	77,384	5.2%
RGEROC	ROCKLEA - Basalt hills	3,181	2,881,200	0.1%
RGEPAR	PARABURDOO - Basalt derived stony gilgai plains and stony plains supporting snakewood and mulga shrublands with spinifex and tussock grasses	2,255	130,692	1.7%
RGERUT	RUTH - Hills and ridges of volcanic and other rocks supporting hard spinifex grasslands.	2,250	169,300	1.3%
RGENEW	NEWMAN - Rugged ironstone ridges	1,855	1,993,742	0.1%
RGEURY	URANDY – Stony plains	1,504	131,976	1.1%
RGECPN	CAPRICORN - Rugged sandstone hills and ridges; hard spinifex or stony short grass forb pasture	1,151	698,531	0.2%
RGEPED	PEEDAMULLA - Gravelly plains supporting hard spinifex grasslands and minor snakewood shrublands	879	59,201	1.5%
RGERIV	RIVER - Active flood plains and major rivers supporting grassy eucalypt woodlands	781	482,176	0.2%
RGEMAL	MALLINA - Sandy-surfaced alluvial plains supporting soft spinifex grasslands.	590	335,753	0.2%
RGESRK	SHERLOCK - Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands.	372	38,638	1.0%
RGEMAC	MACROY - Stony plains and occasional tor fields on granite supporting hard and soft spinifex grasslands.	99	1,331,614	0.0%
RGECHE	CHEERAWARRA - Sandy coastal plains and saline clay plains supporting soft and hard spinifex grasslands and minor tussock grasslands.	41	49,211	0.1%
RGELIT	LITTORAL - Bare coastal mudflats with mangroves on seaward fringes	3	210,733	0.0%

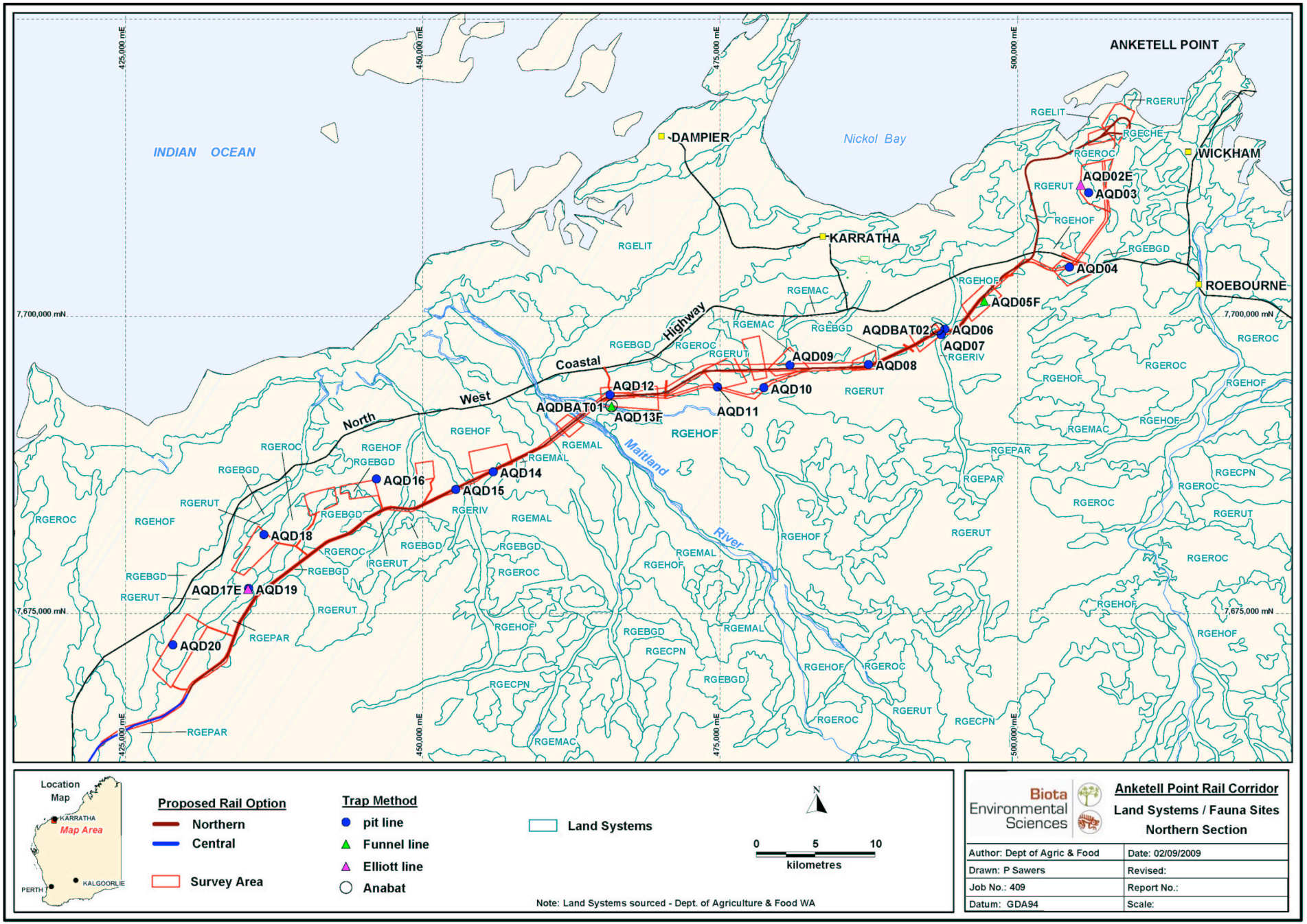

Figure 3.1: Land Systems present in the northern section of the rail corridor study area, showing survey site locations.

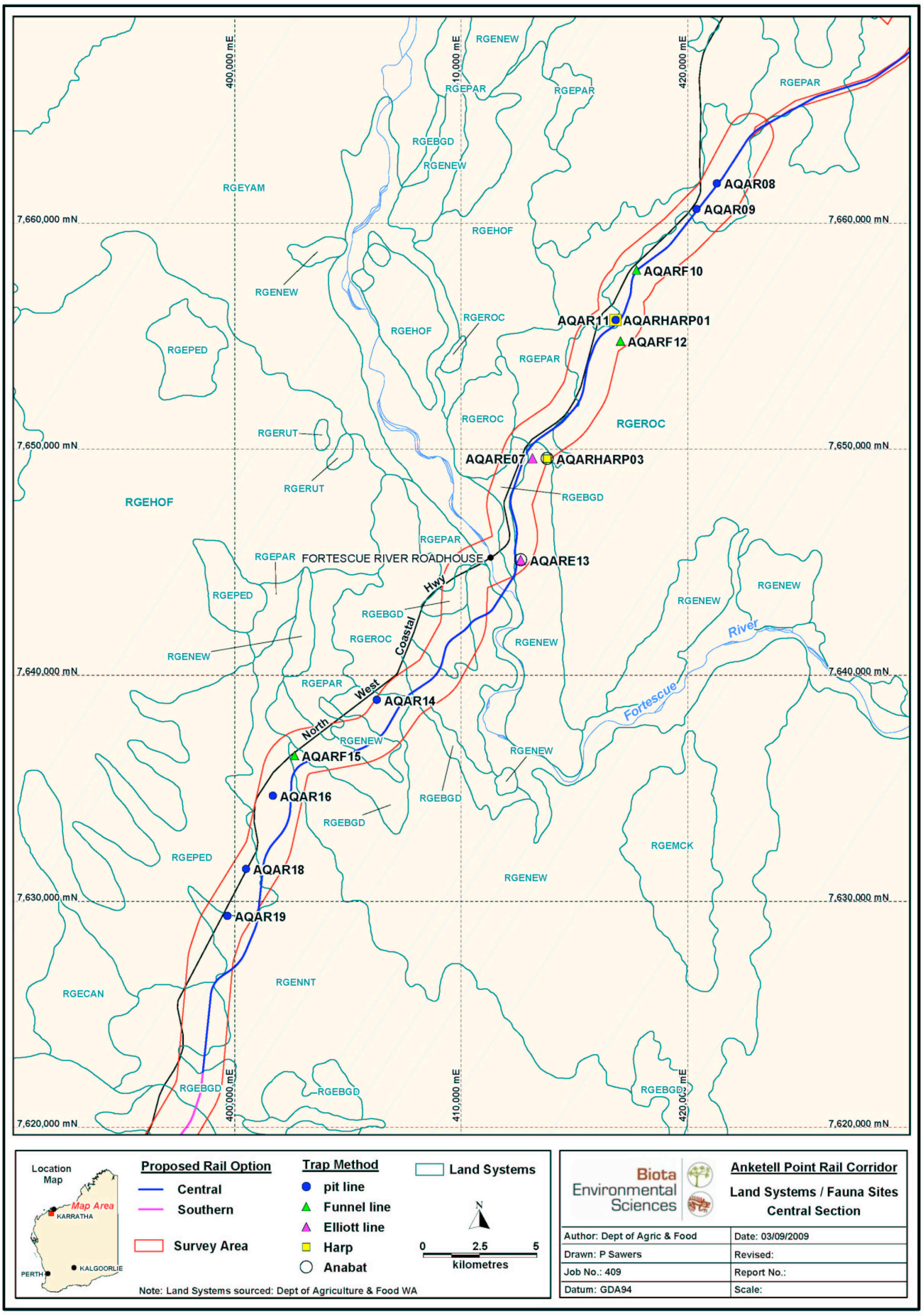

Figure 3.2: **Land Systems present in the central section of the rail corridor study area, showing survey site locations.**

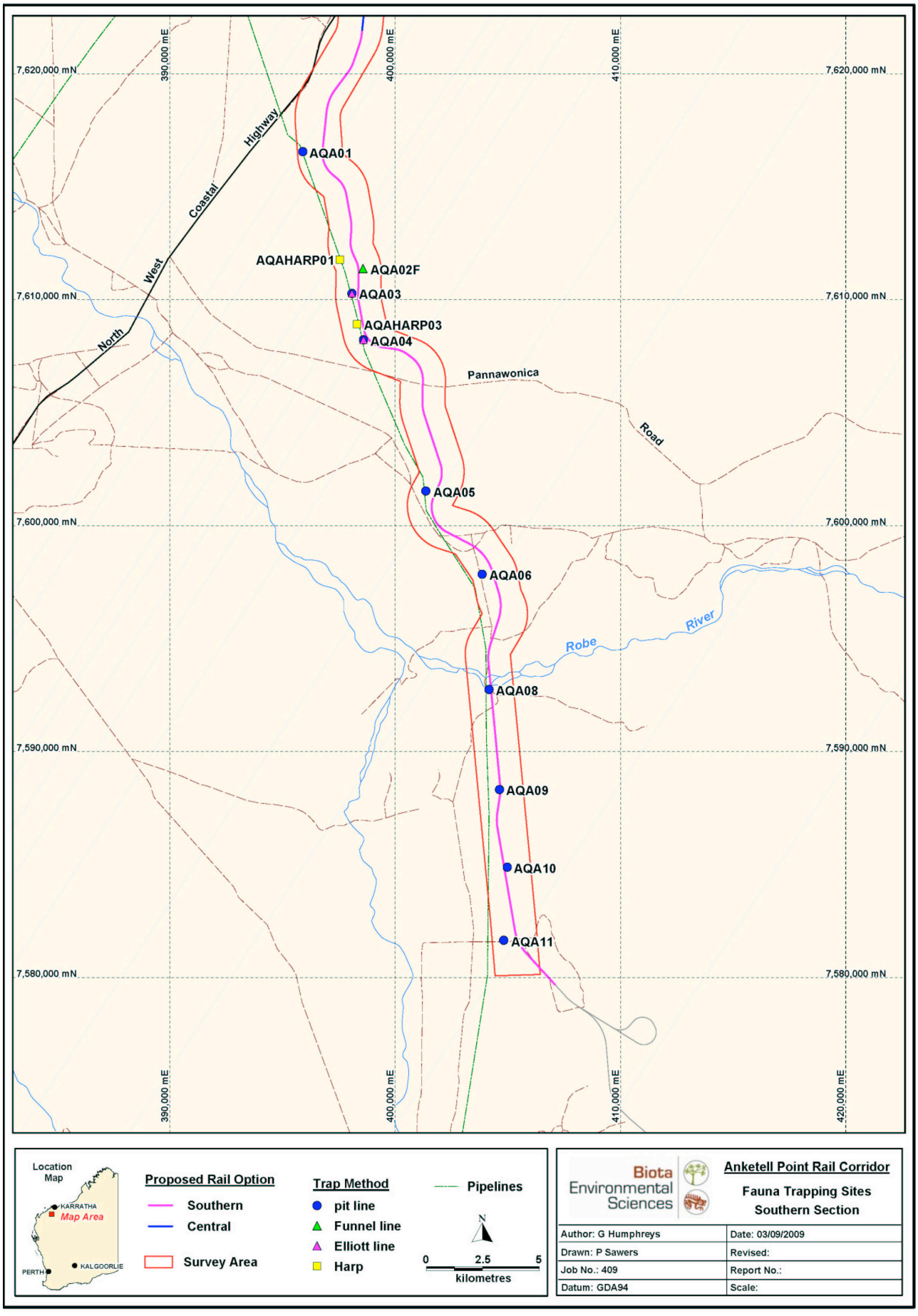

Figure 3.3: **Land Systems present in the southern section of the rail corridor study area, showing survey site locations.**

3.5 Vegetation Mapping

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The study area lies entirely within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts. Given the broad nature of Beard's mapping, these units are only broadly applicable to the vegetation occurring in the Anketell Point rail corridor.

A systematic study of the vegetation types present within the Anketell Point study area was undertaken by Western Botanical (2009) and Aecom (2009). This provides a more detailed and site-specific analysis of vegetation types in the project area (Section 4.1).

3.6 Conservation Reserves in the Locality

There are three conservation reserves in the vicinity of the study area:

- Millstream-Chichester National Park is located ~50 km east of the study area;
- Karijini National Park is located ~200 km southeast; and
- Cane River Conservation Park is located ~30 km southwest.

Due to the limited representation of the region's habitats in conservation reserves, land purchases in the Pilbara bioregion are listed as medium priority for funding under the National Reserves System Cooperative Program. Portions of various pastoral leases in the region have been nominated for exclusion for public purposes in 2015, when these leases are renewed. Many of the submissions are from the DEC, with the intention of adding these areas to the existing conservation estate in order to provide a comprehensive, adequate and representative reserve system.

In the vicinity of the current study area, sections of Yarraloola, Karratha and Mardie Stations (all of which are intersected by the rail corridor); and Peedamulla (25 km west), Mount Stuart (45 km south) and Nanutarra (70 km south-southwest) Stations are proposed for exclusion. No other proposed exclusions are located in the vicinity of the Anketell Point study area.

3.7 Previous Fauna Studies in the Region

Several previous fauna studies have been conducted within the region of the Anketell Point Rail corridor study area. These studies, in combination with database searches (see Section 2.1) were used as context for the results of this survey and as part of the Level 1 assessment (Biota 2007a). Relevant previous studies include:

- Biota (2006a). Mesa A Transport Corridor Seasonal Fauna Survey. Unpublished report prepared for Robe River Iron Associates;
- Biota (2008a). Cape Lambert Port B Development Seasonal Fauna Survey. Unpublished report prepared for Pilbara Iron Pty. Ltd.;
- Biota (2008b). Rio Tinto Iron Ore Rail Duplication Fauna Survey: Cape Lambert to Emu Siding. Unpublished report prepared for Rio Tinto Iron Ore;
- Biota (2008c). Rio Tinto Iron Ore Rail Duplication Fauna Survey: Cape Lambert Variation. Unpublished report prepared for Rio Tinto Iron Ore;
- Biota (2009c). WPIOP Mine Areas Terrestrial Fauna Survey. Unpublished report for API Management; and
- Department of Environment and Conservation (2003 - 2007). Pilbara Biological Survey Dataset.

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4.0 Results

4.1 Fauna Habitats

The relationship between the survey sites and the identified fauna habitats from the study area is shown in Table 4.1. These were determined following the methods outlined in Section 2.4.1, and supplemented and given context by the vegetation mapping prepared by Aecom (2009) and Western Botanical (2009). Representative site photographs are provided in Plate 4.1 to Plate 4.27.

Table 4.1: Relationship between habitat types in the Anketell Point rail corridor and systematic fauna survey sites (vegetation descriptions supplemented by Aecom (2009) and Western Botanical (2009)).

Landform and soils	Vegetation	Section	Sites
Rocky slope	Open *Triodia* hummock grassland	Central	AQARF10, AQARF15
		South	AQA02F
Low calcrete hills with shallow loam	Open Shrubland of *Acacia pyrifolia* and *Acacia ancistrocarpa* over *Triodia* Hummock Grasslands	North	AQD05F
Stony loam plain	*Acacia* spp. shrubland over *Triodia* hummock grassland	Central	AQAR09
		South	AQA06, AQA09, AQA10
	Open *Acacia* shrubland over dense tussock grasses	North	AQD03
	Open *Grevillea wickhamii* shrubland over tussock grasses	North	AQD04
	Scattered *Acacia* shrubs over open *Triodia* hummock grassland	North	AQD10
		Central	AQARF12
	Scattered *Acacia xiphophylla* over large *Triodia* spp. hummock grassland	Central	AQAR16
		South	AQA05
	Shrubland of *Grevillea wickhamii* and *Acacia* species over *Triodia* and Buffel hummock grassland	North	AQD02E
	Scattered *Acacia inaequilatera* over *Triodia* hummock grassland	South	AQA08
Clay loam plain	*Corymbia hamersleyana* scattered low trees over *Acacia bivenosa* and *A. pyrifolia* shrubland over *Triodia wiseana* open hummock grassland	Central	AQAR08
		South	AQA04
	Horseflats of *Eriachne* sp., *Eragrostis* sp. and *Dichanthium* sp. ephemeral grassland on red clay loam.	North	AQD15
	Open *Acacia* and *Grevillea* shrubland over mid-dense *Triodia wiseana* and *T. epactia* hummock grasses.	North	AQD11
	Open *Acacia xiphophylla* shrubland	North	AQD12
	Patchy *Acacia xiphophylla* and open *Acacia* species over *Triodia* hummock grasslands	North	AQD08
	Scattered *Acacia aneura* and *Acacia* spp. shrubland over open *Triodia* hummock grassland	Central	AQAR18, AQAR19
	Triodia hummock grassland	Central	AQAR11
Gilgai clay plain	Horseflats of *Eriachne* sp., *Eragrostis* sp. and *Dichanthium* sp. ephemeral grassland on red clay loam.	North	AQD09
	Open *Acacia pyrifolia* shrubland and scattered *Acacia* species over *Triodia* hummock grassland	North	AQD14, AQD16
	Low *Acacia xiphophylla* shrubland over tussock grasses	North	AQD18
Broad drainages with clay loam	Scattered *Corymbia hamersleyana* over open mixed *Acacia* shrubland over dense Buffel tussock grasses	North	AQD07
	Triodia sp. hummock grassland with emergent *Acacia inaequilatera*	South	AQA03
Major drainage stony alluvial bed	*Eucalyptus* and *Corymbia* species over mixed *Acacia* species over native tussock grasses	North	AQD19
		South	AQA11
Minor drainage with clay loam	*Acacia tumida* shrubland over dense *Triodia* hummock grassland	South	AQA01
	Eucalyptus and *Corymbia* species over mixed shrubs over mixed grasses	North	AQD13F
	Mid-dense to Closed Hummock Grassland of *Triodia wiseana* and Open Tussock Grassland of **Cenchrus ciliaris* and *Eragrostis* sp. on sandy clays.	North	AQD06, AQD20

Rocky slope habitats

Plate 4.1: Site AQARF10.

Plate 4.2: Site AQA02F.

Low calcrete hill habitat

Plate 4.3: Site AQD05F.

Stony loam plain habitat

Plate 4.4: Site AQAR09.

Plate 4.5: Site AQA06.

Stony loam plain habitat (continued)

Plate 4.6: Site AQA09.

Plate 4.7: Site AQD10.

Plate 4.8: Site AQARF12.

Plate 4.9: Site AQR16.

Plate 4.10: Site AQA05.

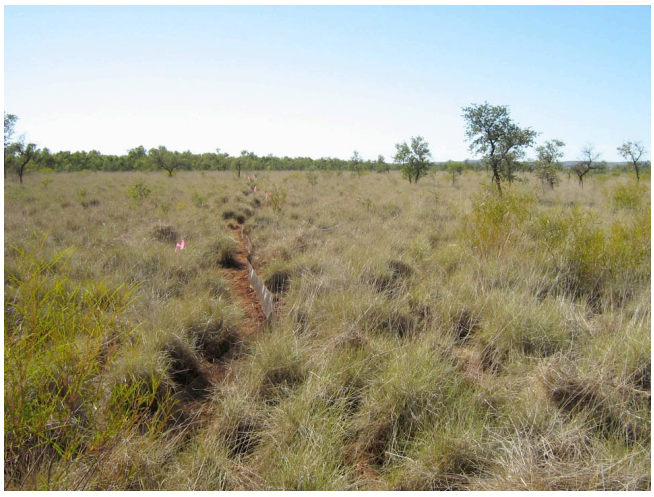

Plate 4.11: Site AQA08.

Clay loam plain habitat

Plate 4.12: Site AQAR08.

Plate 4.13: Site AQA04.

Plate 4.14: Site AQD15.

Plate 4.15: Site AQD11.

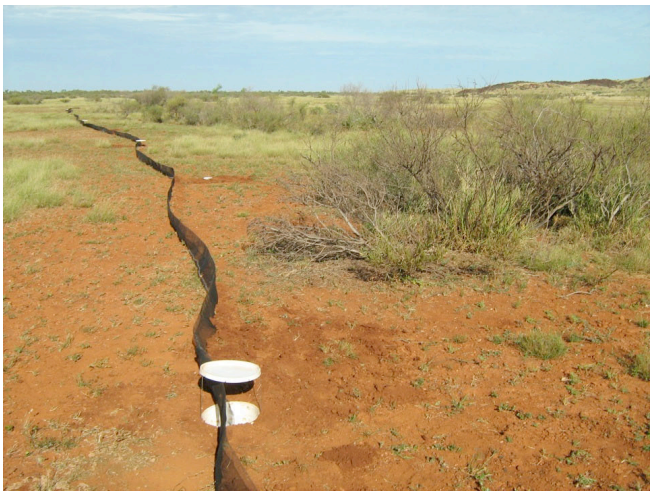

Plate 4.16: Site AQD12.

Plate 4.17: Site AQD08.

Clay loam plain habitat (continued)

Plate 4.18: Site AQAR18.

Plate 4.19: Site AQAR19.

Gilgai clay plain

Plate 4.20: Site AQD14.

Plate 4.21: Site AQD18.

Broad drainage and floodplain habitat

Plate 4.22: Site AQD07.

Plate 4.23: Site AQA03.

Major drainage habitat

Plate 4.24: Site AQD19.

Plate 4.25: Site AQA11

Minor drainage habitat

Plate 4.26: Site AQA01.

Plate 4.27: Site AQA08

4.2 Vertebrate Fauna Overview

The first phase of the Anketell Point rail corridor survey yielded a total of 157 vertebrate fauna species (Table 4.2). The second phase yielded a total of 111 vertebrate fauna species. Removing overlaps, the combined total for the study area amounted to 184 species: 87 avifauna species, 22 mammal species and 75 herpetofauna species (comprising three frogs and 72 reptiles; Table 4.2).

Table 4.2: Overview of vertebrate fauna species recorded during the surveys of the study area.

Fauna Group	Number of Species		
	Phase 1	Phase 2	Overall
Avifauna	71	53	87
Native Non-volant Mammals	11	7	13
Bats	6	4	6
Introduced Mammals	1	2	3
Amphibians	2	3	3
Reptiles	66	42	72
Total	**157**	**111**	**184**

4.3 Avifauna

4.3.1 The Assemblage

A total of 87 bird species were recorded from the Anketell Point rail corridor study area (Table 4.2). This comprised 46 non-passerine species and 41 passerine species from 38 families (Table 4.4 and Table 4.5).

The Galah *Cacatua roseicapilla* was the most abundant species recorded (604 individual records), representing 16% of the total avifauna (Table 4.5). Budgerigar *Melopsittacus undulatus* (n=173), Zebra Finch *Taeniopyia guttata* (n=371) and Painted Finch *Emblema pictum* (n=365) were also common, collectively accounting for a further 24% of the avifauna (). The most species rich family of birds was the Accipitridae (birds of prey including harriers, kites and eagles) with 10 species recorded. The Columbidae (doves and pigeons), Psittacidae (parrots) and Meliphagidae (honeyeaters) were all also well represented with six species per family (Table 4.4 and Table 4.5)

Sites and habitats where the greatest avifauna species richness was recorded during the Anketell Point rail corridor survey are summarised in Table 4.3.

Table 4.3: Sites and habitats where the greatest number of avifauna species were recorded during the survey.

Site	No. of species	Phases	Habitat	Most abundant species
AQA11	20	1	*Eucalyptus* and *Corymbia* species over mixed *Acacia* species over native tussock grasses on major drainage	Galah Singing Honeyeater Yellow-throated Miner
AQD16	20	1	Open *Acacia inaequilatera* shrubland and scattered *Acacia* species over *Triodia* hummock grassland on gilgai clay plain	Galah Little Corella Budgerigar
AQARF12	18	2	Scattered *Acacia* shrubs over open *Triodia* hummock grassland on stony loam plain	Spinifex Pigeon White-plumed Honeyeater Zebra Finch
AQA10	18	2	*Acacia* spp. shrubland over *Triodia* hummock grassland on stony loam plain	Galah Singing Honeyeater Crested Pigeon
AQAR19	16	2	Scattered *Acacia aneura* and *Acacia* spp. shrubland over open *Triodia* hummock grassland on clay loam plain	Zebra Finch
AQD12	15	1	Open *Acacia xiphophylla* shrubland on clay loam plain	Singing Bushlark Tree Martin

Sites in major drainages and *Acacia* shrublands generally yielded the greatest avifauna species richness (Table 4.3); a typical result for the region reflecting the structural diversity of the vegetation types. The differential sampling effort and range of seasonal conditions during which the censuses were conducted (Section 2.2.1) has undoubtedly affected the above comparisons, and also limits any more quantitative analysis of relative diversity.

4.3.2 Avifauna of Conservation Significance

Two bird species of conservation significance were recorded from the Anketell Point rail corridor during the field survey: the Peregrine Falcon *Falco peregrinus* (State: Schedule 4) and the Australian Bustard *Ardeotis australis* (State: Priority 4) (Section 5.2.1). Two species listed as 'Migratory' under the Federal EPBC Act 1999 were also recorded: the Fork-tailed Swift *Apus pacificus* and the Rainbow Bee-eater *Merops ornatus* (Table 4.4 and Table 4.5).

Table 4.4: Avifauna records from sites in the northern and central sections of the Anketell Point rail corridor survey area (values = Phase 1/Phase 2; - = site not sampled that phase; species of conservation significance shown in bold).

		North section																	Central section											
Family and Common Name	**Species**	**AQD02E**	**AQD03**	**AQD04**	**AQD05F**	**AQD06**	**AQD07**	**AQD08**	**AQD09**	**AQD10**	**AQD11**	**AQD12**	**AQD13F**	**AQD14**	**AQD15**	**AQD16**	**AQD18**	**AQD19**	**AQD20**	**AQAR08**	**AQAR09**	**AQARF10**	**AQAR11**	**AQARF12**	**AQARE07**	**AQARE13**	**AQAR14**	**AQARF15**	**AQAR16**	**AQAR18**	**AQAR19**
CASUARIIDAE																														
Emu	*Dromaius novaehollandiae*																													
PHASIANIDAE																														
Stubble Quail	*Coturnix pectoralis*																			0/1										
ANATIDAE																														
Pacific Black Duck	*Anas superciliosa*												2/-																	
PODICIPEDIDAE																														
Australasian Grebe	*Tachybaptus novaehollandiae*																	3/-												
PELECANIDAE																														
Australian Pelican	*Pelecanus conspicillatus*																													
ARDEIDAE																														
White-necked Heron	*Ardea pacifica*																													
White-faced Heron	*Ardea novaehollandiae*												5/-											1/0							
THRESKIORNITHIDAE																														
Straw-necked Ibis	*Threskiornis spinicollis*															3/-														
ACCIPITRIDAE																														
Black-breasted Buzzard	*Hamirostra melanosternon*					1/-																								
Black Kite	*Milvus migrans*																													
Whistling Kite	*Haliastur sphenurus*					2/-												1/-								0/1		0/1	0/2	1/0
Brahminy Kite	*Haliastur indus*																													
Brown Goshawk	*Accipiter fasciatus*												2/-						1/-											
Collared Sparrowhawk	*Accipiter cirrocephalus*														1/-			1/-												
Little Eagle	*Aquila morphnoides*									1/-																				
Wedge-tailed Eagle	*Aquila audax*							2/-	3/-	2/-								1/-	1/-		3/0		0/1				1/0	0/3			3/1
Spotted Harrier	*Circus assimilis*	2/-				1/-	1/-	1/-		1/-	1/-	1/-	1/-		3/-	1/-		1/-			0/1								0/1	
Swamp Harrier	*Circus approximans*																							0/1						
FALCONIDAE																														
Brown Falcon	*Falco berigora*							2/-		1/-							1/-			0/4				0/3			0/2			0/1	1/2
Australian Kestrel	*Falco cenchroides*				2/-		5/-	1/-	2/-	2/-	1/-	1/-			1/-		1/-	1/-	2/-				0/1	1/0	2/-					
Peregrine Falcon	***Falco peregrinus***																													
RALLIDAE																														
Eurasian Coot	*Fulica atra*																													
OTIDIDAE																														
Australian Bustard	***Ardeotis australis***																			**0/2**										
TURNICIDAE																														
Little Button-quail	*Turnix velox*	6/-	1/-	3/-		1/-			1/-	2/-	1/-	3/-			3/-	4/-			2/-				0/2	0/1						0/1
CHARADRIIDAE																														
Banded Lapwing	*Vanellus tricolor*														7/-	4/-														
Black-fronted Dotterel	*Charadrius melanops*																													
GLAREOLIDAE																														
Australian Pratincole	*Stiltia isabella*														9/-															
COLUMBIDAE																														
Common Bronzewing	*Phaps chalcoptera*																				2/0									3/0
Flock Bronzewing	***Phaps histrionica***																													
Crested Pigeon	*Ocyphaps lophotes*					4/-	1/-	3/-		1/-	2/-	2/-							1/-	0/1	4/1	-/5	0/2				0/1			
Spinifex Pigeon	*Geophaps plumifera*				2/-			1/-		1/-	1/-				1/-	8/-	3/-			0/4	3/6	-/10	27/2	35/0	8/-	2/-	0/3	0/12	0/1	0/1	2/4
Diamond Dove	*Geopelia cuneata*																					-/5	0/13		2/-	2/-					
Peaceful Dove	*Geopelia striata*	1/-			4/-	2/-	2/-	3/-					4/-											1/0							
PSITTACIDAE																														
Galah	*Cacatua roseicapilla*				7/-	21/-		16/-					3/-		6/-	226/-		159/-	6/-	0/2	0/2		0/6	10/2			0/1	12/0			
Little Corella	*Cacatua sanguinea*															50/-								2/7						

		North section																		Central section										
Family and Common Name	**Species**	**AQD02E**	**AQD03**	**AQD04**	**AQD05F**	**AQD06**	**AQD07**	**AQD08**	**AQD09**	**AQD10**	**AQD11**	**AQDI2**	**AQD13F**	**AQD14**	**AQD15**	**AQD16**	**AQD18**	**AQD19**	**AQD20**	**AQAR08**	**AQAR09**	**AQARF10**	**AQAR11**	**AQARF12**	**AQARE07**	**AQARE13**	**AQAR14**	**AQARF15**	**AQAR16**	**AQAR18**	**AQAR19**
Cockatiel	*Nymphicus hollandicus*					5/-	21/-						1/-			4/-				0/3			0/8						0/5		
Red-winged Parrot	*Aprosmictus erythropterus*																						0/1								
Australian Ringneck	*Platycercus zonarius*																							2/0							
Budgerigar	*Melopsittacus undulatus*	35/-	8/-			1/-	6/-									25/-				0/8		-/11		0/19		15/-	0/1	0/11		0/9	
CUCULIDAE																															
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*												1/-						1/-	0/1	0/1		0/1								
CENTROPODIDAE																															
Pheasant Coucal	*Centropus phasianinus*						1/-																	0/5							
APODIDAE																															
Fork-tailed Swift	***Apus pacificus***																						**0/8**	**0/1**							**0/6**
HALCYONIDAE																															
Blue-winged Kookaburra	*Dacelo leachii*					1/-	3/-						1/-					1/-					0/1	0/2							
Red-backed Kingfisher	*Todiramphus pyrrhopygia*																	2/-					0/2								
Sacred Kingfisher	*Todiramphus sanctus*												1/-						1/-												
MEROPIDAE																															
Rainbow Bee-eater	***Merops ornatus***												**2/-**											**2/0**							
MALURIDAE																															
Variegated Fairy-wren	*Malurus lamberti*											7/-					2/-			0/3	0/8			7/0							0/2
White-winged Fairy-wren	*Malurus leucopterus*			5/-													3/-			0/2	0/3										5/0
Striated Grasswren	*Amytornis striatus*																														
PARDALOTIDAE																															
Red-browed Pardalote	*Pardalotus rubricatus*																		1/-					1/0							
Striated Pardalote	*Pardalotus striatus*																														
ACANTHIZIDAE																															
Weebill	*Smicrornis brevirostris*																							1/4							
Western Gerygone	*Gerygone fusca fusca*																		1/-				0/1				0/1				
MELIPHAGIDAE																															
Brown Honeyeater	*Lichmera indistincta*												5/-				1/-		11/-		0/2	-/2	0/10	0/1			0/3		0/1	0/7	0/4
Singing Honeyeater	*Lichenostomus virescens*	2/-								2/-	5/-		3/-			1/-					0/2	-/2	0/1	0/5		1/-	0/4	0/1	1/0	0/4	4/0
Grey-headed Honeyeater	*Lichenostomus keartlandi*																								3/-	1/-					
White-plumed Honeyeater	*Lichenostomus penicillatus*					5/-							36/-					1/-	2/-				0/1	13/4	3/-						
Yellow-throated Miner	*Manorina flavigula*						7/-			1/-						1/-		2/-	1/-	0/4			0/1				0/2			0/1	2/0
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*																														
Crimson Chat	*Epthianura tricolor*															1/-															
PETROICIDAE																															
Red-capped Robin	*Petroica goodenovii*																						0/1								
Hooded Robin	*Petroica cucullata*																														
POMATOSTOMIDAE																															
Grey-crowned Babbler	*Pomatostomus temporalis*												8/-																		
PACHYCEPHALIDAE																															
Crested Bellbird	*Oreoica gutturalis*									1/-		1/-								0/1	0/1		0/1	0/1			1/5	0/1	0/1	0/1	4/3
Rufous Whistler	*Pachycephala rufiventris*												2/-											0/1		3/-	0/2				
Grey Shrike-thrush	*Colluricincla harmonica*																										0/3				
DICRURIDAE																															
Willie Wagtail	*Rhipidura leucophrys*												2/-						1/-				0/2	0/1	2/-						1/1
Magpie-lark	*Grallina cyanoleuca*											3/-	8/-			4/-		2/-	1/-	0/6	0/1		0/2	3/2					0/2		
CAMPEPHAGIDAE																															
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	3/-		2/-			2/-	1/-		1/-		3/-	4/-			1/-		1/-		0/4	0/4		0/1	5/4							3/5
White-winged Triller	*Lalage tricolor*				1/-								8/-																		
ARTAMIDAE																															
White-breasted Woodswallow	*Artamus leucorynchus*																														
Black-faced Woodswallow	*Artamus cinereus*	3/-						2/-			9/-	3/-								2/2	0/3					7/-			1/2	4/6	3/3

		North section																	Central section											
Family and Common Name	**Species**	**AQD02E**	**AQD03**	**AQD04**	**AQD05F**	**AQD06**	**AQD07**	**AQD08**	**AQD09**	**AQD10**	**AQD11**	**AQD12**	**AQD13F**	**AQD14**	**AQD15**	**AQD16**	**AQD18**	**AQD19**	**AQD20**	**AQAR08**	**AQAR09**	**AQARF10**	**AQAR11**	**AQARF12**	**AQARE07**	**AQARE13**	**AQAR14**	**AQARF15**	**AQAR16**	**AQAR18**	**AQAR19**
Little Woodswallow	*Artamus minor*																													
CRACTICIDAE																														
Pied Butcherbird	*Cracticus nigrogularis*						1/-		1/-	2/-		2/-	2/-							0/5		-/1	0/1	1/1						1/1	2/0
Australian Magpie	*Cracticus tibicen*					3/-												2/-	3/-		0/3		0/5								
CORVIDAE																														
Torresian Crow	*Corvus orru*									2/-		4/-	8/-			1/-		4/-		0/3		-/1	0/2	2/3			0/2			0/2	2/0
Little Crow	*Corvus bennetti*																														
HIRUNDINIDAE																														
Welcome Swallow	*Hirundo neoxena*						2/-																								
Tree Martin	*Hirundo nigricans*					20/-	10/-					11/-											0/6				0/1			0/40	
Fairy Martin	*Hirundo ariel*																							2/0							
SYLVIIDAE																														
Spinifex-bird	*Eremiornis carteri*															3/-					0/2				1/-			1/0	1/3	0/1	2/1
Rufous Songlark	*Cincloramphus mathewsi*																				0/4		0/13								
Brown Songlark	*Cincloramphus cruralis*														9/-	1/-	5/-														
ALAUDIDAE																														
Singing Bushlark	*Mirafra javanica horsfieldii*	16/-		2/-					18/-		8/-	12/-			3/-	2/-				2/20	0/11									
PASSERIDAE																														
Zebra Finch	*Taeniopygia guttata*	21/-		2/-		4/-		10/-			6/-	5/-	10/-			13/-	6/-		29/-	0/3	0/25	-/4	0/8	28/2			15/18		0/2	0/4	37/15
Painted Finch	*Emblema pictum*	4/-						7/-				2/-				1/-		7/-	1/-	0/9	0/40	-/45	0/52	0/16	8/-	1/-	0/26	0/48	0/20	0/33	0/43
MOTACILLIDAE																														
Australian Pipit	*Anthus australis*																			0/2							1/0				
Total individuals:		**93/-**	**9/-**	**14/-**	**16/-**	**71/-**	**62/-**	**49/-**	**25/-**	**20/-**	**34/-**	**60/-**	**119/-**	**-/-**	**43/-**	**354/-**	**22/-**	**189/-**	**66/-**	**4/89**	**12/121**	**-/86**	**27/157**	**117/86**	**29/-**	**32/-**	**18/75**	**13/77**	**3/36**	**5/116**	**75/91**
Site species richness:		**10/-**	**2/-**	**5/-**	**5/-**	**14/-**	**13/-**	**12/-**	**5/-**	**14/-**	**9/-**	**15/-**	**23/-**	**-/-**	**10/-**	**20/-**	**8/-**	**16/-**	**18/-**	**2/21**	**4/20**	**-/10**	**1/30**	**18/22**	**8/-**	**8/-**	**4/16**	**2/7**	**3/9**	**2/17**	**16/14**

Table 4.5: **Avifauna records from sites in the southern section, and totals for entire Anketell Point rail corridor survey area** (values = Phase 1/Phase 2; - = site not sampled that phase; 'Opp' = opportunistic records; species of conservation significance shown in bold).

		Southern Section										Study Area Totals			
Common Name	**Species**	**AQA01**	**AQA02F**	**AQA03**	**AQA04**	**AQA05**	**AQA06**	**AQA08**	**AQA09**	**AQA10**	**AQA11**	**P1 Total**	**P2 total**	**Opp**	**TOTAL**
CASUARIIDAE															
Emu	*Dromaius novaehollandiae*			3/-	2/-					2/0	1/-	**8**			**8**
PHASIANIDAE															
Stubble Quail	*Coturnix pectoralis*												**1**		**1**
ANATIDAE															
Pacific Black Duck	*Anas superciliosa*											**2**		**23**	**25**
PODICIPEDIDAE															
Australasian Grebe	*Tachybaptus novaehollandiae*											**3**			**3**
PELECANIDAE															
Australian Pelican	*Pelecanus conspicillatus*													**3**	**3**
ARDEIDAE															
White-necked Heron	*Ardea pacifica*													**6**	**6**
White-faced Heron	*Ardea novaehollandiae*											**6**		**3**	**9**
THRESKIORNITHIDAE															
Straw-necked Ibis	*Threskiornis spinicollis*											**28**			**28**
ACCIPITRIDAE															
Black-breasted Buzzard	*Hamirostra melanosternon*											**1**			**1**
Black Kite	*Milvus migrans*													**2**	**2**
Whistling Kite	*Haliastur sphenurus*											**4**	**4**	**2**	**10**
Brahminy Kite	*Haliastur indus*													**1**	**1**
Brown Goshawk	*Accipiter fasciatus*									0/1		**3**	**1**		**4**
Collared Sparrowhawk	*Accipiter cirrocephalus*											**2**			**2**
Little Eagle	*Aquila morphnoides*							0/1				**1**	**1**		**2**
Wedge-tailed Eagle	*Aquila audax*									1/1	2/-	**21**	**6**		**27**
Spotted Harrier	*Circus assimilis*									0/4		**14**	**6**	**2**	**22**
Swamp Harrier	*Circus approximans*												**1**		**1**
FALCONIDAE															
Brown Falcon	*Falco berigora*				1/-	2/-				1/2		**11**	**14**		**25**
Australian Kestrel	*Falco cenchroides*				1/-						1/-	**32**	**1**		**33**
Peregrine Falcon	***Falco peregrinus***													**1**	**1**

Common Name	Species	Southern Section										Study Area Totals			
		AQA01	AQA02F	AQA03	AQA04	AQA05	AQA06	AQA08	AQA09	AQA10	AQA11	P1 Total	P2 total	Opp	TOTAL
RALLIDAE															
Eurasian Coot	*Fulica atra*													1	1
OTIDIDAE															
Australian Bustard	***Ardeotis australis***												2	1	3
TURNICIDAE															
Little Button-quail	*Turnix velox*											33	4		37
CHARADRIIDAE															
Banded Lapwing	*Vanellus tricolor*											11			11
Black-fronted Dotterel	*Charadrius melanops*													9	9
GLAREOLIDAE															
Australian Pratincole	*Stiltia isabella*											9			9
COLUMBIDAE															
Common Bronzewing	*Phaps chalcoptera*										2/-	7		1	8
Flock Bronzewing	***Phaps histrionica***													2	2
Crested Pigeon	*Ocyphaps lophotes*					3/-	13/-		14/-	40/0		91	10		101
Spinifex Pigeon	*Geophaps plumifera*			40/-		2/-	15/-	4/2	2/-	17/50		174	93		267
Diamond Dove	*Geopelia cuneata*	1/-						2/0				7	18		25
Peaceful Dove	*Geopelia striata*											17		3	20
PSITTACIDAE															
Galah	*Cacatua roseicapilla*	1/-		2/-			48/-	6/4		35/0	26/-	584	17	3	604
Little Corella	*Cacatua sanguinea*											52	7	1	60
Cockatiel	*Nymphicus hollandicus*							0/15				38	31	33	102
Red-winged Parrot	*Aprosmictus erythropterus*												1		1
Australian Ringneck	*Platycercus zonarius*										2/-	4		2	6
Budgerigar	*Melopsittacus undulatus*					6/-		0/15				99	74		173
CUCULIDAE															
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*											2	3		5
CENTROPODIDAE															
Pheasant Coucal	*Centropus phasianinus*											1	5		6
APODIDAE															
Fork-tailed Swift	***Apus pacificus***												15		15
HALCYONIDAE															
Blue-winged Kookaburra	*Dacelo leachii*											6	3	3	12
Red-backed Kingfisher	*Todiramphus pyrrhopygia*							1/0				3	2		5

Common Name	Species	Southern Section										Study Area Totals			
		AQA01	AQA02F	AQA03	AQA04	AQA05	AQA06	AQA08	AQA09	AQA10	AQA11	P1 Total	P2 total	Opp	TOTAL
Sacred Kingfisher	*Todiramphus sanctus*											**2**			**2**
MEROPIDAE															
Rainbow Bee-eater	***Merops ornatus***							**12/0**			**6/-**	**22**		**17**	**39**
MALURIDAE															
Variegated Fairy-wren	*Malurus lamberti*	2/-	3/-	12/-	5/-	3/-	6/-		5/-	6/0	8/-	**66**	**13**	**9**	**88**
White-winged Fairy-wren	*Malurus leucopterus*						5/-				4/-	**27**	**5**		**32**
Striated Grasswren	*Amytornis striatus*									2/0		**2**			**2**
PARDALOTIDAE															
Red-browed Pardalote	*Pardalotus rubricatus*				2/-						1/-	**5**		**2**	**7**
Striated Pardalote	*Pardalotus striatus*													**1**	**1**
ACANTHIZIDAE															
Weebill	*Smicrornis brevirostris*											**1**	**4**	**32**	**37**
Western Gerygone	*Gerygone fusca fusca*											**1**	**2**	**2**	**5**
MELIPHAGIDAE															
Brown Honeyeater	*Lichmera indistincta*	3/-								0/1	14/-	**34**	**31**		**65**
Singing Honeyeater	*Lichenostomus virescens*	13/-	2/-	2/-	2/-	3/-	2/-	3/0	2/-	13/2	27/-	**91**	**21**	**4**	**116**
Grey-headed Honeyeater	*Lichenostomus keartlandi*	1/-								0/2		**5**	**2**		**7**
White-plumed Honeyeater	*Lichenostomus penicillatus*	10/-						5/0			17/-	**92**	**5**	**21**	**118**
Yellow-throated Miner	*Manorina flavigula*									2/0	28/-	**44**	**8**	**7**	**59**
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	1/-								0/1	1/-	**2**	**1**		**3**
Crimson Chat	*Epthianura tricolor*											**1**			**1**
PETROICIDAE															
Red-capped Robin	*Petroica goodenovii*												**1**		**1**
Hooded Robin	*Petroica cucullata*					3/-				2/0		**5**			**5**
POMATOSTOMIDAE															
Grey-crowned Babbler	*Pomatostomus temporalis*							1/0			7/-	**16**			**16**
PACHYCEPHALIDAE															
Crested Bellbird	*Oreoica gutturalis*	4/-		1/-		2/-				3/2	1/-	**18**	**17**		**35**
Rufous Whistler	*Pachycephala rufiventris*				1/-	2/-				1/0	1/-	**10**	**3**	**5**	**18**
Grey Shrike-thrush	*Colluricincla harmonica*				2/-							**2**	**3**		**5**
DICRURIDAE															
Willie Wagtail	*Rhipidura leucophrys*	1/-	2/-	2/-	8/-	2/-	3/-	2/0	1/-	5/0	4/-	**36**	**4**	**6**	**46**
Magpie-lark	*Grallina cyanoleuca*			2/-								**23**	**14**	**7**	**44**
CAMPEPHAGIDAE															

Common Name	Species	Southern Section										Study Area Totals			
		AQA01	AQA02F	AQA03	AQA04	AQA05	AQA06	AQA08	AQA09	AQA10	AQA11	P1 Total	P2 total	Opp	TOTAL
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*							0/1				**26**	**19**	**3**	**48**
White-winged Triller	*Lalage tricolor*							0/10				**9**	**10**		**19**
ARTAMIDAE															
White-breasted Woodswallow	*Artamus leucorynchus*													**12**	**12**
Black-faced Woodswallow	*Artamus cinereus*							1/6				**35**	**22**	**2**	**59**
Little Woodswallow	*Artamus minor*							14/0				**14**		**4**	**18**
CRACTICIDAE															
Pied Butcherbird	*Cracticus nigrogularis*										1/-	**13**	**9**		**22**
Australian Magpie	*Cracticus tibicen*											**8**	**8**		**16**
CORVIDAE															
Torresian Crow	*Corvus orru*			2/-	3/-	1/-	3/-			2/0		**34**	**13**	**4**	**51**
Little Crow	*Corvus bennetti*				21/-							**21**			**21**
HIRUNDINIDAE															
Welcome Swallow	*Hirundo neoxena*											**2**			**2**
Tree Martin	*Hirundo nigricans*							2/0				**43**	**47**		**90**
Fairy Martin	*Hirundo ariel*											**2**			**2**
SYLVIIDAE															
Spinifex-bird	*Eremiornis carteri*	3/-		5/-	3/-	2/-	1/-			1/0		**23**	**7**		**30**
Rufous Songlark	*Cincloramphus mathewsi*						1/-					**1**	**17**		**18**
Brown Songlark	*Cincloramphus cruralis*											**19**			**19**
ALAUDIDAE															
Singing Bushlark	*Mirafra javanica horsfieldii*											**71**	**31**		**102**
PASSERIDAE															
Zebra Finch	*Taeniopygia guttata*	4/-	10/-	22/-				0/28		1/29		**230**	**138**	**3**	**371**
Painted Finch	*Emblema pictum*									2/0		**33**	**332**		**365**
MOTACILLIDAE															
Australian Pipit	*Anthus australis*											**2**	**2**		**4**
	Total individuals:	**44/-**	**17/-**	**93/-**	**51/-**	**31/-**	**97/-**	**53/80**	**24/-**	**136/95**	**154/-**	**2,365**	**1,109**	**243**	**3,717**
	Total number of species:	**12/-**	**4/-**	**11/-**	**12/-**	**12/-**	**10/-**	**12/8**	**5/-**	**18/11**	**20/-**	**71**	**53**	**38**	**87**

4.4 Mammals

4.4.1 The Assemblage – Non-volant Mammals

A total of 22 mammal species were recorded from the Anketell Point rail corridor study area, including 16 non-volant (ground) mammal species representing six families (Table 4.2). This comprised five dasyurids (carnivorous marsupials), two macropods (kangaroos), six murids (rodents), one canid, one felid and one bovid (Table 4.6 and Table 4.7).

The Pilbara Ningaui *Ningaui timealeyi* was the most often trapped species, with 55 individuals representing 24% of the total recorded mammals (Table 4.6 and Table 4.7). The Stripe-faced Dunnart *Sminthopsis macroura* (n=50) and the Red Kangaroo *Macropus rufus* (n=32) were also common (Table 4.6 and Table 4.7). The Muridae was the best-represented family with six species, followed by the Dasyuridae (five species) (Table 4.6 and Table 4.7). Three introduced mammals, the House Mouse *Mus musculus*, Cat *Felis catus* and Cattle *Bos Taurus*, were recorded, but none were at notably high densities (Table 4.6 and Table 4.7). Species richness did not vary substantively amongst the sites and habitats sampled, and the more commonly recorded species were recorded from along the entire length of the rail corridor (Table 4.6 and Table 4.7).

4.4.2 The Assemblage – Bats

Six bat species representing four families were recorded from the study area (Table 4.6 and Table 4.7). Species identifications from echolocation call analysis were only used where identified with certainty (see Appendix 2). Representative call sequences for the five species recorded via Anabat detectors in the rail corridor are shown in Figure 4.1 to Figure 4.5 (sourced from Appendix 2).

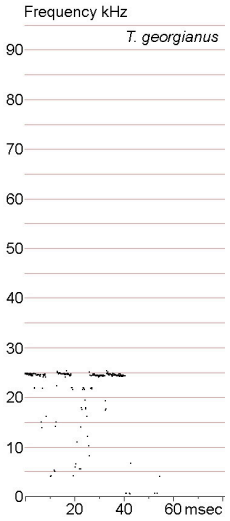

Figure 4.1: *Taphozous georgianus* call sequence.

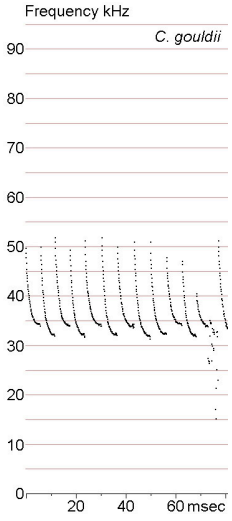

Figure 4.2: *Chalinolobus gouldii* call sequence.

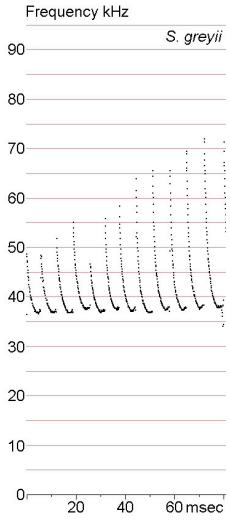

Figure 4.3: *Scotorepens greyii* call sequence.

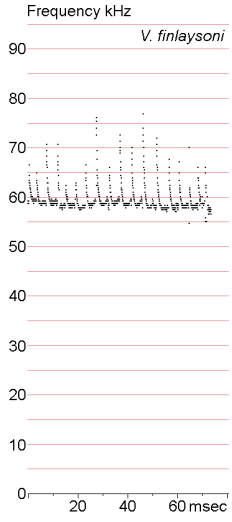

Figure 4.4: *Vespadelus finlaysoni* call sequence.

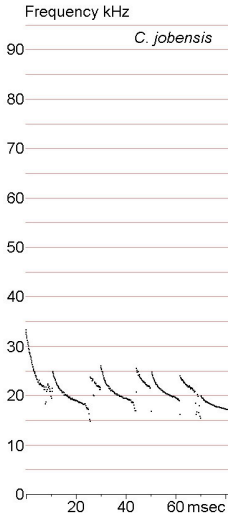

Figure 4.5: *Chaerephon jobensis* call sequence.

Table 4.6: **Mammal records from sites in the northern and central sections of the Anketell Point rail corridor survey area** (values = Phase 1/Phase 2; C = Calls; T = Trace; - = site not sampled that phase; species of conservation significance shown in bold).

		Northern section																		Central section										
Species	**Common Name**	**AQD02E**	**AQD03**	**AQD04**	**AQD06**	**AQD07**	**AQD08**	**AQD09**	**AQD10**	**AQD11**	**AQD12**	**AQD13F**	**AQD14**	**AQD15**	**AQD16**	**AQD18**	**AQD19**	**AQD17E**	**AQD20**	**AQAR08**	**AQAR09**	**AQARF10**	**AQAR11**	**AQARE07**	**AQARE13**	**AQAR14**	**AQARF15**	**AQAR16**	**AQAR18**	**AQAR19**
DASYURIDAE																														
Dasykaluta rosamondae	Little Red Kaluta								2/-						1/-											3/0		2/0		
Dasyurus hallucatus	**Northern Quoll**																													
Ningaui timealeyi	Pilbara Ningaui								2/-								1/-		3/-				1/0					2/1	1/0	2/-
Planigale sp. 't'	Planigale sp. 't'		1/-			1/-							1/-	1/-									0/1			0/1			0/1	
Sminthopsis macroura	Stripe-faced Dunnart	1/-	10/-	5/-			4/-	9/-	3/-	6/-			1/-		2/-				1/-	0/1	1/3		2/0							
MACROPODIDAE																														
Macropus robustus	Euro			1/-	1/-						1/-	1/-						1/-				0/3			1/-		0/1		
Macropus rufus	Red Kangaroo									4/-			6/-	5/-		5/-	4/-													
PTEROPODIDAE																														
Pteropus scapulatus	Little Red Flying-fox																							1/-						
EMBALLONURIDAE																														
Taphozous georgianus	Common Sheathtail-bat																													
VESPERTILIONIDAE																														
Chalinolobus gouldii	Gould's Wattled Bat																													
Scotorepens greyii	Little Broad-nosed Bat																													
Vespadelus finlaysoni	Finlayson's Cave Bat											1/-																		
MOLOSSIDAE																														
Chaerephon jobensis	Northern Freetail-bat																													
MURIDAE																														
Mus musculus	House Mouse			1/-						2/-											1/0									
Notomys alexis	Spinifex Hopping-mouse																													
Pseudomys chapmani	**Western Pebble-mound Mouse**																					**0/3T**								
Pseudomys desertor	Desert Mouse				2/-														3/-											
Pseudomys hermannsburgensis	Sandy Inland Mouse		2/-		3/-				1/-										1/-		2/0								0/1	1/-
Zyzomys argurus	Common Rock-rat																								3/-					
CANIDAE																														
Canis lupus dingo	Dingo						1/-																							
FELIDAE																														
Felis catus	Cat																						0/1							
BOVIDAE																														
Bos taurus	European Cattle																			0/5			0/1							
	Total individuals:	**1/-**	**13/-**	**7/-**	**6/-**	**1/-**	**5/-**	**9/-**	**8/-**	**12/-**	**1/-**	**2/-**	**8/-**	**6/-**	**3/-**	**5/-**	**5/-**	**1/-**	**8/-**	**0/6**	**4/3**	**0/3**	**3/3**	**1/-**	**4/-**	**3/1**	**0/1**	**4/1**	**1/2**	**3/-**
	Species richness:	**1/-**	**3/-**	**3/-**	**3/-**	**1/-**	**2/-**	**1/-**	**4/-**	**3/-**	**1/-**	**2/-**	**3/-**	**2/-**	**2/-**	**1/-**	**2/-**	**1/-**	**4/-**	**0/2**	**3/1**	**0/2**	**2/3**	**1/-**	**2/-**	**1/1**	**0/1**	**2/1**	**1/2**	**2/-**

Table 4.7: Mammal records from sites in the southern section, from bat sampling sites in all sections of the corridor, and totals for entire Anketell Point rail corridor survey area (values = Phase 1/Phase 2; C = Calls; T = Trace; - = site not sampled that phase; Opp=opportunistic records; species of conservation significance shown in bold).

		Southern Section									North	Central		South		Study Area Totals			
Family and Species	**Common Name**	**AQA01**	**AQA03**	**AQA04**	**AQA05**	**AQA06**	**AQA08**	**AQA09**	**AQA10**	**AQA11**	**AQDBAT01**	**AQARHARP01**	**AQARHARP03**	**AQAHARP01**	**AQAHARP03**	**P1 Total**	**P2 Total**	**Opp**	**TOTAL**
DASYURIDAE																			
Dasykaluta rosamondae	Little Red Kaluta								3/0							11			11
Dasyurus hallucatus	**Northern Quoll**																	**1**	**1**
Ningaui timealeyi	Pilbara Ningaui	1/-	5/-	8/-	12/-	4/-		4/-	2/5	1/-						49	6		55
Planigale sp. 't'	Planigale sp. 't'			1/-	2/-											7	3		10
Sminthopsis macroura	Stripe-faced Dunnart						0/1									45	5		50
MACROPODIDAE																			
Macropus robustus	Euro								1/0							7	4		11
Macropus rufus	Red Kangaroo					1/-	2/0		4/0	1/-						32			32
PTEROPODIDAE																			
Pteropus scapulatus	Little Red Flying-fox															1			1
EMBALLONURIDAE																			
Taphozous georgianus	Common Sheathtail-bat										C		0/C		1/-	1+C	C		1+2C
VESPERTILIONIDAE																			
Chalinolobus gouldii	Gould's Wattled Bat										C		0/C			C	C		2C
Scotorepens greyii	Little Broad-nosed Bat										C		0/C			C	C		2C
Vespadelus finlaysoni	Finlayson's Cave Bat										C	0/1	0/C	1/-	1/-	3+C	1+C		4+2C
MOLOSSIDAE																			
Chaerephon jobensis	Northern Freetail-bat										C					C			C
MURIDAE																			
Mus musculus	House Mouse															4			4
Notomys alexis	Spinifex Hopping-mouse			3/-												3			3
Pseudomys chapmani	**Western Pebble-mound Mouse**																**3T**		**3T**
Pseudomys desertor	Desert Mouse						0/5		0/1							5	6		11
Pseudomys hermannsburgensis	Sandy Inland Mouse	1/-		3/-		1/-			1/5	1/-						17	6		23
Zyzomys argurus	Common Rock-rat															3			3
CANIDAE																			
Canis lupus dingo	Dingo			1/-												2			2
FELIDAE																			
Felis catus	Cat								0/1								2		2
BOVIDAE																			
Bos taurus	European Cattle																6		6
	Total individuals:	**2/-**	**5/-**	**16/-**	**14/-**	**6/-**	**2/6**	**4/-**	**11/12**	**3/-**	**5C/-**	**0/1**	**0/4C**	**1/-**	**2/-**	**190+5C**	**39+3T+4C**	**1**	**230+3T+9C**
	Species richness:	**2/-**	**1/-**	**5/-**	**2/-**	**3/-**	**1/2**	**1/-**	**5/4**	**3/-**	**5/-**	**0/1**	**0/4**	**1/-**	**2/-**	**18**	**13**	**1**	**22**

Most bat species identified by call sequences were also confirmed with specimen captures, with the exception of the Northern Free-tail Bat *Chaerephon jobensis* (Figure 4.5; Table 4.6 and Table 4.7). The Little Red Flying-fox *Pteropus scapulatus* was recorded only from a single individual collected in a harp trap at site AQARE07, close to the Fortescue River in the central section of the corridor (Table 4.6 and Table 4.7; Figure 2.1).

4.4.3 Mammals of Conservation Significance

Two mammal species of conservation significance were recorded from the Anketell Point rail corridor during the field survey: the Northern Quoll *Dasyurus hallucatus* (State: Schedule 1; Federal: Endangered) and the Western Pebble-mound Mouse *Pseudomys chapmani* (State: Priority 4) (Table 4.6 and Table 4.7; Section 5.2.1).

4.5 Herpetofauna

4.5.1 The Assemblage

A total of 75 species of herpetofauna (72 reptiles and three frogs) were recorded from the Anketell Point rail corridor study area (Table 4.10). The skink *Ctenotus pantherinus* was the most abundant species recorded, with 90 individuals from 24 sites (representing 7% of the total herpetofauna; Table 4.10). Other herpetofauna that were common in the study area included the skink *Menetia greyii* (n=71), the geckos *Diplodactylus conspicillatus* and *Heretonotia binoei* (n=68 and 67 respectively), and the frog *Cyclorana maini* (n=68) (accounting for a further 22% of the records; Table 4.10). By far the most species rich family was the Scincidae (skinks) with 28 species recorded (39% of the species recorded; Table 4.10).

Sites and habitats where the greatest herpetofauna species richness was recorded during the Anketell Point rail corridor survey are summarised in Table 4.8.

Table 4.8: Sites and habitats where the greatest number of herpetofauna species were recorded during the survey.

Site	No. of species	Phases	Habitat	Most abundant species
AQD06	24	1	*Triodia* hummock grassland on minor clay loam drainage	*Ctenotus serventyi* *Lerista bipes* *Ctenophorus isolepis*
AQD08	22	1	Patchy *Acacia xiphophylla* and open *Acacia* species over *Triodia* hummock grasslands on clay loam plain	*Ctenophorus caudicinctus* *Heteronotia binoei* *Ctenotus pantherinus*
AQD07	20	1	Scattered *Corymbia hamersleyana* over open mixed *Acacia* shrubland over dense Buffel tussock grasses on broad drainages	*Ctenophorus isolepis*
AQD20	16	1	*Triodia* hummock grassland on minor clay loam drainage	*Ctenotus helenae* *Lialis burtonis*
AQD14	14	1	Open *Acacia inaequilatera* shrubland and scattered *Acacia* species over *Triodia* hummock grassland on gilgai clay plain	*Ctenotus pantherinus* *Menetia greyii*
AQD03	13	1	Open *Acacia* shrubland over dense tussock grasses on stony loam plain	*Menetia greyii* *Lerista muelleri*

Sites with *Triodia* hummock grasslands on loamy plains and drainages generally yielded the greatest herpetofauna species richness (Table 4.8). However, seasonal conditions are likely to be the most important factor contributing to the results above. All of the sites exhibiting high species richness were in the northern section of the corridor, which was only surveyed once during April 2009 in warm conditions following a major rainfall event (Section 2.2.2.4). These conditions were optimal for herpetofauna sampling, as illustrated by the fact that the six northern sites exceeded the species tally for all sites in the southern part of the rail corridor despite being sampled twice.

4.5.2 Herpetofauna of Elevated Conservation Significance

A single herpetofauna species of elevated conservation significance, *Notoscincus butleri* (State: Priority 4), was recorded during the rail corridor survey (Table 4.9, Table 4.10 and Section 5.2.1).

Table 4.9: Herpetofauna records from sites in the northern and central sections of the Anketell Point rail corridor survey area (values = Phase 1/Phase 2; T = Trace; - = no records; species of conservation significance in bold).

	North Section																	Central Section											
Family and Species	**AQD03**	**AQD04**	**AQD05F**	**AQD06**	**AQD07**	**AQD08**	**AQD09**	**AQD10**	**AQD11**	**AQD12**	**AQD13F**	**AQD14**	**AQD15**	**AQD16**	**AQD18**	**AQD19**	**AQD20**	**AQAR08**	**AQAR09**	**AQARF10**	**AQAR11**	**AQARF12**	**AQARE07**	**AQARE13**	**AQAR14**	**AQARF15**	**AQAR16**	**AQAR18**	**AQAR19**
MYOBATRACHIDAE																													
Uperoleia russelli																													
HYLIDAE																													
Cyclorana maini																1/-		0/1	0/7		0/18		1/-		0/8			0/9	0/17
Litoria rubella											3/-					1/-					0/1								
AGAMIDAE																													
Ctenophorus caudicinctus						5/-		4/-	2/-						1/-		3/-	0/7	0/6		0/6				0/3		0/4	0/1	0/1
Ctenophorus isolepis				14/-	6/-	2/-		1/-		1/-							2/-	0/1	0/3									0/1	0/2
Ctenophorus nuchalis		1/-					1/-						3/-		1/-														
Amphibolurus longirostris						1/-					1/-					6/-						0/1	1/-					1/0	
Pogona minor	4/-	2/-		9/-		4/-		2/-	1/-				1/-	2/-	1/-				0/1									0/5	0/10
Tympanocryptis cephala	5/-	2/-					3/-			3/-		4/-	33/-	10/-	3/-														
GEKKONIDAE																													
Lucasium stenodactylum		3/-		1/-		4/-												0/1	0/1		0/1	0/1				0/1			
Diplodactylus conspicillatus				5/-		4/-		5/-									5/-	0/3	4/7						2/1		1/1	0/8	3/9
Diplodactylus mitchelli							2/-																						
Diplodactylus savagei						1/-						1/-			1/-		1/-				1/0								
Gehyra pilbara																													
Gehyra punctata																	6/-			1/0					2/7				
Gehyra variegata											2/-	2/-			7/-	1/-			1/1			1/1			0/1				
Heteronotia binoei	1/-			3/-	1/-	10/-				1/-		4/-		3/-	1/-	1/-	6/-		0/3		2/0	3/2			0/1	0/1	0/3		0/3
Nephrurus wheeleri																						0/2							
Oedura marmorata																													
Rhynchoedura ornata																		0/1											
Strophurus elderi																													
PYGOPODIDAE																													
Delma nasuta						1/-		1/-	1/-	1/-															0/3				
Delma pax				4/-	2/-	2/-		3/-	1/-		1/-			1/-		1/-	1/-												
Delma tincta								1/-				2/-		1/-													0/1		
Lialis burtonis				1/-	1/-			1/-	1/-			2/-		3/-			7/-		0/1			0/1						1/0	
Pygopus nigriceps				2/-		1/-																							
SCINCIDAE																													
Carlia munda	2/-			1/-	3/-				1/-		3/-						5/-				0/1	0/3					0/2	1/1	1/2
Cryptoblepharus plagiocephalus												2/-																	
Ctenotus aff. *helenae*								1/-																					
Ctenotus duricola				2/-		2/-	11/-	3/-								1/-	3/-	1/2	2/4	1/0									
Ctenotus grandis				3/-													3/-											0/1	0/5	0/2
Ctenotus hanloni																			0/3										
Ctenotus helenae		3/-		2/-	3/-	1/-		3/-					1/-				9/-	0/2							0/1	0/1	0/1		0/3
Ctenotus pantherinus	1/-	5/-		3/-	3/-	15/-	2/-	10/-	2/-			8/-	1/-	1/-	4/-		3/-	0/3	0/3		0/6				0/3	0/2	0/4	0/1	0/4
Ctenotus robustus	2/-	1/-					4/-		2/-			4/-	1/-	3/-	4/-														
Ctenotus rubicundus																										1/0			
Ctenotus saxatilis				1/-	1/-	4/-			1/-						1/-	3/-				1/0	0/1	1/2	1/-		0/5	0/9	0/3		0/3
Ctenotus schomburgkii	2/-	7/-								2/-																			
Ctenotus serventyi				25/-	2/-																								
Ctenotus uber uber										1/-																			
Cyclodomorphus melanops													1/-						0/1							0/1	0/1	0/1	
Egernia depressa																	1/-									0/1			
Egernia formosa																							1/-						
Glaphyromorphus isolepis					2/-						1/-					1/-						0/2							
Lerista bipes				19/-																									
Lerista clara																												2/0	
Lerista muelleri	5/-	2/-			2/-	1/-			1/-	1/-		1/-		4/-	7/-	2/-		1/0	0/2		1/0						0/1	0/1	

Family and Species	North Section																	Central Section											
	AQD03	AQD04	AQD05F	AQD06	AQD07	AQD08	AQD09	AQD10	AQD11	AQD12	AQD13F	AQD14	AQD15	AQD16	AQD18	AQD19	AQD20	AQAR08	AQAR09	AQARF10	AQAR11	AQARF12	AQARE07	AQARE13	AQAR14	AQARF15	AQAR16	AQAR18	AQAR19
Menetia greyii	5/-			4/-	3/-	2/-		2/-	4/-			10/-	1/-	7/-	4/-		5/-	2/0	1/0		0/2				0/3	0/1	1/2	2/1	3/0
Menetia surda																	1/-				0/2						0/2		
Morethia ruficauda exquisita																	1/-					4/2			0/1	1/0			
Notoscincus butleri								**1/-**						**1/-**			**2/-**	**3/3**	**3/2**						**1/1**		**0/2**	**3/1**	
Notoscincus ornatus																			0/2								0/4	0/4	0/4
Proablepharus reginae			1/-																										
Tiliqua multifasciata				3/-																									
VARANIDAE																													
Varanus acanthurus			4/-			1/-				1/-						1/-						0/6						0/1	0/1
Varanus brevicauda	1/-			2/-				4/-				2/-		1/-	2/-		7/-	0/1	0/1										0/1
Varanus bushi				1/-	1/-					1/-																			
Varanus eremius				1/-	1/-																							1/0	
Varanus giganteus																													
Varanus panoptes	1/-					1/-					1/-										0/1					0/1			
Varanus pilbarensis																								2/-					
Varanus tristis																2/-													
TYPHLOPIDAE																													
Ramphotyphlops ammodytes	2/-	2/-		2/-	4/-	1/-						1/-		1/-	2/-	2/-		0/2	1/1		1/0							2/3	4/2
Ramphotyphlops grypus	3/-			8/-	3/-										1/-			0/1	2/0						0/1			0/5	2/1
Ramphotyphlops hamatus																					0/1								
Ramphotyphlops pilbarensis																												2/3	0/1
BOIDAE																													
Antaresia perthensis			1/-			1/-																				1/1			
Antaresia stimsoni														1/-												0/1			0/1
ELAPIDAE																													
Acanthophis wellsi																													
Brachyurophis approximans				1/-													1/-												
Demansia psammophis			1/-							1/-	1/-											0/1			1/0	0/1			
Demansia rufescens			1/-																										
Furina ornata																					1/0								
Pseudonaja modesta																					0/1								
Suta punctata						2/-		1/-		1/-		1/-			2/-			0/1	0/1										
Total individuals:	**34/-**	**28/-**	**8/-**	**117/-**	**38/-**	**66/-**	**23/-**	**43/-**	**17/-**	**14/-**	**13/-**	**44/-**	**42/-**	**39/-**	**42/-**	**23/-**	**72/-**	**7/29**	**14/50**	**3/0**	**6/41**	**9/24**	**4/-**	**2/-**	**4/32**	**5/28**	**2/32**	**15/51**	**13/67**
Species richness:	**13/-**	**10/-**	**5/-**	**24/-**	**16/-**	**22/-**	**6/-**	**16/-**	**11/-**	**11/-**	**8/-**	**14/-**	**8/-**	**14/-**	**16/-**	**13/-**	**20/-**	**4/14**	**7/19**	**3/0**	**5/12**	**4/12**	**4/-**	**1/-**	**3/13**	**4/13**	**2/15**	**9/17**	**5/18**

Table 4.10: Herpetofauna records from sites in the southern section, and totals for entire Anketell Point rail corridor survey area (values = Phase 1/Phase 2; T = Trace; - = site not sampled that phase; Opp = opportunistic records; species of conservation significance in bold).

	Southern Section										Study Area Totals			
Family and Species	**AQA01**	**AQA02F**	**AQA03**	**AQA04**	**AQA05**	**AQA06**	**AQA08**	**AQA09**	**AQA10**	**AQA11**	**P1 Total**	**P2 Total**	**Opp**	**TOTAL**
MYOBATRACHIDAE														
Uperoleia russelli							0/33					**33**		**33**
HYLIDAE														
Cyclorana maini							0/5				**2**	**65**	**1**	**68**
Litoria rubella											**5**	**1**		**6**
AGAMIDAE														
Ctenophorus caudicinctus	1/-				2/-						**18**	**28**		**46**
Ctenophorus isolepis	1/-		3/-	3/-			2/0		1/4		**36**	**11**		**47**
Ctenophorus nuchalis											**6**			**6**
Amphibolurus longirostris											**10**	**1**		**11**
Pogona minor				1/-							**27**	**16**		**43**
Tympanocryptis cephala											**63**			**63**
GEKKONIDAE														
Lucasium stenodactylum									0/1		**8**	**6**		**14**
Diplodactylus conspicillatus	3/-		2/-		1/-		1/0	1/-	2/0		**39**	**29**		**68**
Diplodactylus mitchelli											**2**			**2**
Diplodactylus savagei											**5**			**5**
Gehyra pilbara													**2**	**2**
Gehyra punctata											**9**	**7**		**16**
Gehyra variegata											**14**	**3**		**17**
Heteronotia binoei	9/-			2/-	1/-	1/-		2/-	1/0		**53**	**13**	**1**	**67**
Nephrurus wheeleri												**2**		**2**
Oedura marmorata											**T**			**T**
Rhynchoedura ornata												**1**		**1**
Strophurus elderi				1/-							**1**			**1**
PYGOPODIDAE														
Delma nasuta			1/-		1/-			1/-			**7**	**3**		**10**
Delma pax	1/-		1/-								**18**			**18**
Delma tincta											**4**	**1**		**5**
Lialis burtonis						2/-		1/-			**20**	**2**	**1**	**23**
Pygopus nigriceps											**3**			**3**
SCINCIDAE														
Carlia munda									0/1		**17**	**10**		**27**

Family and Species	Southern Section										Study Area Totals			
	AQA01	AQA02F	AQA03	AQA04	AQA05	AQA06	AQA08	AQA09	AQA10	AQA11	P1 Total	P2 Total	Opp	TOTAL
Cryptoblepharus plagiocephalus											**2**			**2**
Ctenotus aff. *helenae*											**1**			**1**
Ctenotus duricola	2/-										**28**	**6**		**34**
Ctenotus grandis				2/-	1/-	1/-			0/1		**10**	**6**		**16**
Ctenotus hanloni												**3**		**3**
Ctenotus helenae											**22**	**8**		**30**
Ctenotus pantherinus	1/-		2/-			1/-			0/1	0/1	**63**	**27**		**90**
Ctenotus robustus											**21**			**21**
Ctenotus rubicundus		5/-									**6**			**6**
Ctenotus saxatilis		1/-		1/-							**16**	**23**		**39**
Ctenotus schomburgkii											**11**			**11**
Ctenotus serventyi											**27**			**27**
Ctenotus uber uber											**1**			**1**
Cyclodomorphus melanops											**1**	**4**		**5**
Egernia depressa											**1**	**1**		**2**
Egernia formosa											**1**			**1**
Glaphyromorphus isolepis				1/-							**5**	**2**		**7**
Lerista bipes											**19**			**19**
Lerista clara											**2**			**2**
Lerista muelleri											**28**	**4**		**32**
Menetia greyii				2/-	1/-	2/-					**62**	**9**		**71**
Menetia surda								1/-			**2**	**4**		**6**
Morethia ruficauda exquisita		1/-									**7**	**3**	**2**	**12**
Notoscincus butleri			**1/-**								**15**	**9**		**24**
Notoscincus ornatus									0/1			**15**		**15**
Proablepharus reginae											**1**			**1**
Tiliqua multifasciata											**3**			**3**
VARANIDAE														
Varanus acanthurus		1/-									**8**	**8**		**16**
Varanus brevicauda											**19**	**3**		**22**
Varanus bushi											**3**			**3**
Varanus eremius	1/-						1/0			0/1	**6**			**6**
Varanus giganteus				1/-							**1**			**1**
Varanus panoptes											**3**	**2**		**5**
Varanus pilbarensis											**2**			**2**
Varanus tristis											**2**			**2**
TYPHLOPIDAE														

Family and Species	Southern Section										Study Area Totals			
	AQA01	AQA02F	AQA03	AQA04	AQA05	AQA06	AQA08	AQA09	AQA10	AQA11	P1 Total	P2 Total	Opp	TOTAL
Ramphotyphlops ammodytes			1/-								**26**	**8**		**34**
Ramphotyphlops grypus										0/2	**24**	**8**		**32**
Ramphotyphlops hamatus												**1**		**1**
Ramphotyphlops pilbarensis											**2**	**3**		**5**
BOIDAE														
Antaresia perthensis		2/-									**5**	**1**		**6**
Antaresia stimsoni											**1**	**2**		**3**
ELAPIDAE														
Acanthophis wellsi					1/-			1/-	1/0		**3**			**3**
Brachyurophis approximans											**2**			**2**
Demansia psammophis											**4**	**2**		**6**
Demansia rufescens		1/-									**2**			**2**
Furina ornata											**1**			**1**
Pseudonaja modesta				1/-							**1**	**1**		**2**
Suta punctata											**7**	**2**		**9**
Total individuals:	**19/-**	**11/-**	**14/-**	**15/-**	**8/-**	**7/-**	**4/38**	**7/-**	**5/9**	**0/4**	**845+T**	**397**	**7**	**1,248+T**
Species richness:	**8/-**	**6/-**	**8/-**	**10/-**	**7/-**	**5/-**	**3/2**	**6/-**	**4/6**	**0/3**	**68**	**45**	**5**	**75**

4.6 Potential Short Range Endemic Invertebrates

Taxonomic groups of invertebrates with naturally small distributions are described as SRE taxa and are characterised by poor dispersal capabilities, confinement to disjunct habitats and low fecundity (Harvey 2002, Ponder and Colgan 2002, EPA 2009). 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. While not all species will be restricted at small scale, taxa belonging to these groups have the potential to be SREs.

4.6.1 Diplopoda (Millipedes)

In general, this group is poorly studied taxonomically (Harvey 2002) and poorly collected (Harvey 2002, Hoffman 2003). Potential millipede taxa within the Pilbara bioregion include the Polydesmida, the Spirobolida, the Polyxenida (pin-cushion millipedes) and the Polyzoniida (sucking millipedes)(source Biota Internal Database).

According to Harvey (2002), the polydesmid millipedes are considered likely to harbour species that have narrow ranges. Within this family it is the genus *Antechiropus* that has undergone the largest radiation and displays some of the smallest documented distributions (Dr Mark Harvey, WA Museum, pers. comm. 2004).

4.6.2 Mygalomorph (Trapdoor) Spiders

Whilst this group is regularly collected in the Pilbara bioregion (source: Biota Internal Database), much of the taxonomy has only been resolved to the level of genus. This group is known to support a number of taxa with very limited distributions, and several species are included in Schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2008* (although none of these occur in the Pilbara bioregion).

Two species of Mygalomorph spider were recorded from the rail corridor study area: *Synothele* sp. (family Barychelidae; Plate 4.28) and *Aname* sp. (family Nemesiidae; Plate 4.29) (Table 4.11). Specimens were collected during dedicated SRE searches via the excavation of burrows or captured via pit trapping.

Plate 4.28: *Synothele* sp.

Plate 4.29: *Aname* sp

Table 4.11: Mygalomorph spiders recorded within the Anketell Point Rail Corridor study area.

Site	Taxa	Latitude	Longitude	Number
AQA11	*Synothele* sp.	-21.867	116.084	1
AQA11	*Synothele* sp.	-21.867	116.084	1
AQAR19	*Aname* sp.	-21.435	116.032	1
AQA opportunistic	*Aname* sp.	-21.764	116.071	1
AQA opportunistic	*Aname* sp.	-22.164	116.254	1
AQA opportunistic	*Aname* sp.	-22.164	116.254	1
AQARF02	*Aname* sp.	-20.915	116.234	1
AQAR02	*Aname* sp.	-20.915	116.234	1
AQAR02	*Aname* sp.	-20.915	116.234	1
AQAR02	*Aname* sp.	-20.915	116.234	1
AQAR02	*Aname* sp.	-20.915	116.234	1
AQAR03	*Aname* sp.	-20.948	116.245	1
AQAR09	*Aname* sp.	-21.154	116.233	1
AQAR09	*Aname* sp.	-21.154	116.233	1
AQAR14	*Aname* sp.	-21.349	116.096	1
AQAR16	*Aname* sp.	-21.388	116.051	1
AQAR16	*Aname* sp.	-21.388	116.051	1
AQAR16	*Aname* sp.	-21.388	116.051	1
AQAR16	*Aname* sp.	-21.388	116.051	1
AQAR16	*Aname* sp.	-21.388	116.051	1
AQAR18	*Aname* sp.	-21.417	116.040	1
AQAR18	*Aname* sp.	-21.417	116.040	1
AQAR19	*Aname* sp.	-21.435	116.032	1
AQA opportunistic	*Aname* sp.	-21.764	116.071	1
AQA opportunistic	*Aname* sp.	-22.005	116.138	1
AQAR09	*Aname* sp.	-22.154	117.233	1
AQAR09	*Aname* sp.	-22.154	117.233	1
AQAR18	*Aname* sp.	-22.417	117.040	1
AQD18	*Aname* sp.	-20.963	116.391	1
AQD18	*Aname* sp.	-20.963	116.391	1
AQD18	*Aname* sp.	-20.963	116.391	1
AQD18	*Aname* sp.	-20.963	116.391	1
APISRE01	*Aname* sp.	-21.935	116.130	1
AQD20	*Aname* sp.	-21.044	116.318	1
APISRE01	*Aname* sp.	-21.934	116.130	1
AQD06	*Aname* sp.	-20.809	116.941	1
AQD06	*Aname* sp.	-20.809	116.941	1
AQD04	*Aname* sp.	-20.762	117.042	1
AQD04	*Aname* sp.	-20.762	117.042	1

4.6.3 Pseudoscorpions

Potential pseudoscorpion families occurring within the Pilbara bioregion include Olipiidae, Garypidae, Garypinidae, Sternophridae, Chernetidae, Chthoniidae, Syarinidae and Feaellidae (Biota 2006a, 2006b, 2007a, 2007b).

Two pseudoscorpion species were recorded from the Mine Areas study area: *Solinus* sp. (family Garypinidae; Plate 4.30) and Synsphyronus sp. (family Garypidae; Plate 4.31) (Table 4.12). All specimens were collected from underneath bark of *Corymbia* sp. trees.

Table 4.12: Pseudoscorpions recorded within the Anketell Point Rail Corridor study area.

Site	Taxa	Latitude	Longitude	Number
AQAR opportunistic	*Solinus* sp	-22.154	116.250	15
AQAR08	*Synsphyronus* sp.	-21.144	116.242	1

Plate 4.30: ***Solinus* sp.**

Plate 4.31: ***Synsphyronus* sp.**

4.6.4 Land Snails

In his review of the conservation status of Australia's non-marine molluscs, Ponder (1997) identified over 900 described terrestrial land snails from 23 families, with the most speciose families being the Camaenidae (408 taxa), Helicarionidae (60 taxa), Pupillidae (41 taxa), Bulimulidae (31 taxa), Punctidae (23 taxa) and Pupinidae (19 taxa). There are 230 described taxa In Western Australia, with 201 of these restricted to this State (Ponder 1997). Within the Pilbara bioregion, the most conspicuous elements of this fauna are the *Rhagada* and *Quistrachia* species (Camaenidae), though several *Bothriembryon* species (Bulimulidae) are also known.

Genus *Rhagada*

The geographic range of the genus *Rhagada* extends from the northern Kimberley to the Carnarvon area. With 29 species currently described, the Western Australian endemic *Rhagada* is the second most diverse genus of the family Camaenidae (Solem 1997), which includes more than half the terrestrial snails of Australia (Ponder 1997). A number of *Rhagada* species inhabit the coast of the Pilbara region and the islands of the Dampier Archipelago. On the mainland, there is a series of eight coastal species between Shark Bay and Cape Leveque. These form a set of non-overlapping geographic replacements (Solem 1997).

Genetic diversification may be expected to be greater amongst land snails than for more vagile insects and vertebrates, however few genetic studies have been completed to investigate this (see Johnson et al. 2004). There is certainly extensive variation in shell morphology for *Rhagada* species from the Dampier Archipelago (including the Burrup Peninsula), with seven species described (Solem 1997) and several additional species awaiting description (Dr Peter Kendrick, DEC Karratha, pers. comm. 2004; Ms Shirley Slack-Smith, WA Museum, pers. comm. 2004). Many of these taxa have very narrow distributions, with some confined to single outcrops (Dr Peter Kendrick, pers. comm. 2004). Shell morphology of mainland *Rhagada* species within the Pilbara bioregion tends to be more conservative by comparison and species tend to have larger non-overlapping distributions (e.g. spanning a linear distance in excess of 200 km) (Solem 1997; see also Johnson et al. 2004).

Based on morphological characters, three species of the genus *Rhagada* were collected from the Anketell Point Rail Corridor study area (Table 4.13): *Rhagada* sp. "*Du Boulay*", *Rhagada* sp. "P*annawonica*", and *Rhagada convicta*. A fourth species (*Rhagada* sp. "*Cape Preston*") was collected in the vicinity of the study area at *Cape Preston* near the coast. Typically, ina southerly direction from Cape Preston snail records comprised *Rhagada* sp. "*Du Boulay*", *Rhagada* sp. "*Pannawonica*" with *Rhagada convicta* occurring furthest south in the vicinity of the mine areas.

Table 4.13: *Rhagada* snail species recorded within and in the vicinity of the Anketell Point Rail Corridor study area.

Site	Species	Latitude	Longitude	Number of Live Individuals
AQARSN24	sp. *"Cape Preston"*	-20.889°	116.224°	2
AQARSN24	sp. *"Cape Preston"*	-20.889°	116.224°	3
AQARSN26	sp. *"Cape Preston"*	-20.891°	116.226°	4
AQARSN02	sp. *"Cape Preston"*	-20.894°	116.227°	4
AQARSN28	sp. *"Cape Preston"*	-20.897°	116.229°	3
AQD20	sp. *"Du Boulay"*	-21.050°	116.320°	8
AQD 19	sp. *"Du Boulay"*	-21.010°	116.380°	8
AQD20	sp. *"Du Boulay"*	-21.050°	116.320°	1
AQD19	sp. *"Du Boulay"*	-21.010°	116.380°	1
AQARSN36	sp. *"Du Boulay"*	-21.196°	116.192°	1
AQARSN36	sp. *"Du Boulay"*	-21.196°	116.192°	5
AQAR11	sp. *"Du Boulay"*	-21.198°	116.199°	1
AQARF12	sp. *"Du Boulay"*	-21.207°	116.201°	11
AQARSN44	sp. *"Du Boulay"*	-21.627°	117.126°	20
AQAR11	sp. *"Du Boulay"*	-21.198°	116.199°	1
AQARSN18	sp. *"Pannawonica"*	-21.387°	116.051°	3
AQASN09	sp. *"Pannawonica"*	-21.571°	116.002°	5
AQARSN46	sp. *"Pannawonica"*	-21.591°	117.070°	10
AQARSN48	sp. *"Pannawonica"*	-21.708°	116.766°	7
AQASN01	sp. *"Pannawonica"*	-22.406°	116.021°	10
RTSN05	sp. *convicta*	-21.009°	116.113°	1
AQASN03	sp. *convicta*	-21.901°	116.102°	1
AQA15F	sp. *convicta*	-22.011°	116.137°	1
AQASN04	sp. *convicta*	-22.038°	116.080°	9
AQA18	sp. *convicta*	-22.041°	116.162°	17
AQASN05	sp. *convicta*	-22.047°	116.152°	2
AQASN01	sp. *convicta*	-22.406°	116.021°	8
AQMSN01	sp. *convicta*	-22.406°	116.268°	5

Genus *Quistrachia*

Quistrachia species occupy similar areas of the Pilbara to *Rhagada* (O'Neill 2008 and Solem 1997). However, in the Pilbara *Quistrachia* species typically inhabit rocky outcrops as many species seal to rocks during aestivation.

Snails of the genus Quistrachia were not recorded within the rail corridor study area. However, the proposed rail corridor intersects the distributions of three known *Quistrachia* species (O'Neill 2008). That is, *Quistachia herberti*, *Quistrachia* sp. *X* and *Quistrachia* sp. *W*. These species have potential to occur within the rail corridor rocky outcrop habitat.

4.6.5 Aquatic Molluscs (Freshwater)

Two species of freshwater molluscs were recently collected from an ephemeral pool on the Robe River (Biota 2006a). The two species, *Thiara balonnensis* and *Lymnea tomentosa*, are from the families Thiarididae and Lymnaeidae respectively. The taxonomy is not resolved and there is some conjecture as to whether these species actually represent species complexes (Ms. Shirley Slack-Smith, WA Museum, pers. comm. 2005). As currently understood, these species have broad distributions. Though not recorded from the rail corridor study area during the current survey, it is likely that these species may periodically occur in the major creeks of the corridor, particularly the Maitland River.

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5.0 Conservation Significance

5.1 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 *EPBC Act 1999*.

5.1.1 *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).

5.1.2 *Wildlife Conservation Act 1950-1979*

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 2008* 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 by DEC 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.

5.2 Fauna Species of Conservation Significance

5.2.1 Threatened Fauna Species Confirmed from the Study Area

Eight species of elevated conservation significance were recorded from the Anketell Point rail corridor study area during the field surveys:

- Northern Quoll *Dasyurus hallucatus* (State: Schedule 1, Federal: Endangered);
- Peregrine Falcon *Falco peregrinus* (State: Schedule 4);
- Australian Bustard *Ardeotis australis* (State: Priority 4);
- Flock Bronzewing *Phaps histrionica* (State: Priority 4);
- Western Pebble-Mound Mouse *Pseudomys chapmani* (State: Priority 4);
- *Notoscincus butleri* (State: Priority 4);
- Fork-tailed Swift *Apus pacificus* (Federal: Migratory); and
- Rainbow Bee-eater *Merops ornatus* (Federal: Migratory).

More detailed accounts of the fauna species of conservation significance recorded during the survey follow.

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 juvenile male quolls fail to survive to adulthood, reduced breeding the following year could potentially lead to the local population becoming extinct (Braithwaite and Griffiths 1994, Oakwood 2000). Any factor that results in significant increases in mortality rates of female and juvenile quolls could therefore result in local extinction of quoll populations.

Likelihood of Occurrence: Confirmed from the study area. A single Northern Quoll specimen was recorded from the central section of the rail corridor as a road kill on the Fortescue River bridge (Section 4.4) and other individuals are likely to occur in this locality. This species has also been recorded in several locations (Wickham, Roebourne, Maitland and Mardie) in the vicinity of the

study area (Biota 2007a). Suitable habitat also occurs in association with the Robe River (Biota 2006a), Maitland River and other larger drainages, particularly where these adjoining rocky hills in the corridor. It is therefore possible that this species also occurs at these other selected localities within the study corridor.

Potential Impacts: Suitable habitat, and known and likely populations, of *D. hallucatus* occur in defined sections of the rail corridor. These are primarily associated with rocky habitats adjacent to the major regional drainage systems crossed by the corridor. In these locations, the rail route crosses the habitat extents in a perpendicular fashion, meaning habitat loss would be localised and proportional effects on populations of Northern Quolls would also be minimal. Potential changes to fire regimes from track grinding activities (Section 6.3) would also likely result in little additional pressure on these populations, as the area is already subject to periodic fires and the rocky habitats favoured by *D. hallucatus* act as refugia during these events (Biota 2009d). Therefore, while the species may occur in selected portions of the rail corridor, the proposed Anketell Point Rail option is unlikely to affect the conservation status of this species.

Peregrine Falcon *Falco peregrinus macropus* (State: Schedule 4)
Distribution: The Peregrine Falcon has an almost cosmopolitan distribution, but is absent from most deserts and the Nullarbor Plain (Johnstone and Storr 1998).

Ecology: The Peregrine Falcon, like other birds of prey, is a relatively long-lived species, with low reproductive rates and low population density. These factors, combined with the fact that they are a top order predator and limited by their prey, make them particularly vulnerable to human impact. This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country (Pizzey and Knight 1997).

Likelihood of Occurrence: Confirmed from the study area. A single Peregrine Falcon was recorded opportunistically during the survey in the northern section of the rail corridor close to the Northwest Coastal Highway approaching Anketell Point (Table 4.4). Other individuals would be likely to occur on a transitory and periodic basis in the area.

Potential Impacts: Peregrine Falcons prefer cliff faces as nest sites. As there were no cliffs observed along the survey area, no potential nest sites for this species would be affected. The construction of the rail would result in no discernible change to extensive foraging habitats in the region, no impacts on this species would be expected.

Australian Bustard *Ardeotis australis* (State: Schedule 4)
Distribution: The Australian Bustard occurs over much of Western Australia, with the exception of the more heavily wooded southern portions of the State.

Ecology: This species prefers open or lightly wooded grassland, including *Triodia* sp. sandplains, and is considered scarce to common depending on season and habitat (Johnstone and Storr 1998).

Likelihood of Occurrence: Confirmed from the study area. Two Bustards were recorded from site AQAR08 in the central portion of the corridor, plus another individual was opportunistically sighted in the northern section of the study area (Table 4.4).

Potential Impacts: Due to the linear but narrow nature of the proposed development, and the mobile nature of Bustards, the potential impacts on this species are likely to be minimal. The conservation status of this species would not be altered by the proposed development.

Flock Bronzewing *Phaps histrionica* (State: Priority 4)
Distribution: This species occurs on coastal riverine plains of north-west WA, south to Carnarvon. Also in the Kimberley and arid and semiarid north-eastern interior of Australia (Johnstone and Storr 1998).

Ecology: *P. histrionica* 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 last Atlas Project, undertaken between 1998 and 2002 (Barrett et al. 2003).

Likelihood of occurrence: Confirmed from the study area. Two individuals opportunistically recorded in the northern section of the corridor near site AQD18 (Table 4.4).

Potential Impacts: Given its mobile and transitory occurrence, the conservation status of this species is unlikely to be altered by the proposed rail development.

Western Pebble-mound Mouse *Pseudomys chapmani* (State: Priority 4)
Distribution: The Western Pebble-mound Mouse is confined to the central and eastern Pilbara including Karijini National Park (Menkhorst and Knight 2001).

Ecology: The species is found on stony hillsides with hummock grasslands (Menkhorst and Knight 2001) and is common to very common in suitable habitat within the Hamersley and Chichester subregions of the Pilbara bioregion. The Western Pebble-mound Mouse is well known for its behaviour of constructing extensive mounds of small stones covering areas from 0.5 to 9.0 square meters (Strahan 2004). Mounds are most common on spurs and gentle slopes where suitably sized stones are present.

Likelihood of Occurrence: Three mounds constructed by *P. chapmani* were recorded from stony habitat in the central section of the corridor at site AQARE07 (Section 4.4.1).

Potential Impacts: Given the broad distribution of this species, and its low density in the study area, the conservation status of *P. chapmani* would not be altered by the proposed rail development.

5.2.2 Other Threatened Fauna Species that May Occur in the Study Area

Based on known fauna distributions and habitat preferences, an additional two Schedule and nine Priority species may potentially occur within the survey area (Table 5.1; Biota 2007a).

Table 5.1: Other Threatened Fauna species that database searches indicate could potentially occur within the study area (Biota 2007a).

Species	Status	
	State	Federal
Pilbara Orange Leaf-nosed Bat *Rhinonicteris aurantius*	Schedule 1	Vulnerable
Pilbara Olive Python *Liasis olivaceus barroni*	Schedule 1	Vulnerable
Lerista quadrivincula	Priority 1	-
Ramphotyphlops ganei	Priority 1	-
Spectacled Hare-wallaby *Lagorchestes conspicillatus leichardti*	Priority 3	-
Mulgara *Dasycercus blythi*	Priority 4	-
Grey Falcon *Falco hypoleucos*	Priority 4	-
Bush Stone-Curlew *Burhinus grallarius*	Priority 4	-
Star Finch *Neochmia ruficauda subclarescens*	Priority 4	-
Short-tailed Mouse *Leggadina lakedownensis*	Priority 4	-
Ghost Bat *Macroderma gigas*	Priority 4	-

Detailed accounts of the above species are provided in Biota (2007a). Of the taxa listed in Table 5.1, those considered most likely to occur in the Anketell Point rail corridor comprise:

- Pilbara Orange Leaf-nosed Bat *Rhinonicteris aurantius* – confirmed from the WPIOP mine area to the immediate south of the rail corridor study area (Biota 2007a) and from the Robe River locality (Biota 2006a, 2006b), though no roost sites of significance appear to occur in the rail corridor.
- Pilbara Olive Python *Liasis olivaceus barroni* – known from previous DEC records at the Maitland and Fortescue Rivers where suitable habitat occurs, and also recorded at the WPIOP mine area to the immediate south.
- *Lerista quadrivincula* – this poorly known species is only known from a single specimen collected from the Maitland River locality close to the study area corridor (Biota 2007a), and it may be present.
- Bush Stone-Curlew *Burhinus grallarius* –suitable habitat occurs in several parts of the rail corridor and the species is likely to be present on occasion.

- Star Finch *Neochmia ruficauda subclarescens* – suitable habitat occurs at the Robe, Fortescue and Maitland River crossing points, and confirmed from the Robe River locality by Biota (2006a).
- Short-tailed Mouse *Leggadina lakedownensis* – suitable habitat occurs in the northern section of the rail corridor
- Ghost Bat *Macroderma gigas* – confirmed from both the Robe River locality (Biota 2006a) and from the WPIOP WPIOP mine area to the immediate south of the rail corridor study area (Biota 2009c).

5.2.3 Migratory Species

Database searches also indicated that 16 species listed as 'Migratory' under the *EPBC Act 1999* could occur in the area (Biota 2007a), two of which were recorded as noted in Section 5.2.1. The majority of these are marine species and of no relevance to a terrestrial rail corridor and are therefore given no further consideration here. The two migratory species confirmed from the project area are discussed below.

Fork-tailed Swift *Apus pacificus*
Distribution: The distribution of the Fork-tailed Swift is temporally and spatially extremely patchy, but the species visits most parts of the State (Johnstone and Storr 1998).

Ecology: With its irruptive nature, this species may on occasion be present over most open habitats. It is present in Western Australia from September to May, and is noted as often occurring prior to or after cyclone activity (Johnstone and Storr 1998).

Likelihood of occurrence: Confirmed from the study area. Fifteen individuals of this species were recorded from three sites in the central rail corridor.

Potential Impacts: Given its highly transitory nature, and the small number of individuals recorded, no significant impacts would be expected on this taxon as a result of the construction of the rail corridor.

Rainbow Bee-eater *Merops ornatus*
Distribution: Occurs through the majority of the western third of Western Australia where free water is relatively readily available. May occur in many areas as either a casual or transitory species.

Ecology: This species forages aerially for insects and nests in burrows in the ground (Higgins 1999). It occurs in lightly wooded habitats that provide suitable (sandy) soil for nesting and a tall stratum of vegetation for perching.

Likelihood of occurrence: Confirmed from the study area. This species was recorded 39 times during the survey and is likely to be a routine visitor to the study corridor.

Potential Impacts: Given the mobility and habitat preferences of the species, and the relatively small extent of habitat affected, there is unlikely to be any significant impacts on the Rainbow Bee-eater's conservation status.

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6.0 Discussion and Conclusions

6.1 Summary of Findings

The survey of the Anketell Point rail corridor has documented 184 vertebrate fauna species: 87 avifauna species, 22 mammal species and 75 herpetofauna species (comprising three frogs and 72 reptiles) (Section 4.0). The habitats sampled were representative of the Land Systems and vegetation types present in the region (Section 4.1), with major drainages and *Triodia* shrublands on loam plains generally yielding the greatest diversity of ground fauna (Section 4.5.1). Habitats otherwise of significance within the study area occur at the crossing points of the Robe, Fortescue and Maitland Rivers. These major regional drainages support riverine woodlands, semi-permanent pools and often adjoining rocky landforms, making them suitable for the Schedule listed species the Northern Quoll *Dasyurus hallucatus* and the Pilbara Olive Python *Liasis olivaceus barroni.*

Eight species of elevated conservation significance were recorded from the Anketell Point rail corridor study area:

- Northern Quoll *Dasyurus hallucatus* (State: Schedule 1, Federal: Endangered);
- Peregrine Falcon *Falco peregrinus* (State: Schedule 4);
- Australian Bustard *Ardeotis australis* (State: Priority 4);
- Flock Bronzewing *Phaps histrionica* (State: Priority 4);
- Western Pebble-Mound Mouse *Pseudomys chapmani* (State: Priority 4);
- *Notoscincus butleri* (State: Priority 4);
- Fork-tailed Swift *Apus pacificus* (Federal: Migratory); and
- Rainbow Bee-eater *Merops ornatus* (Federal: Migratory).

There are two other Schedule species and five Priority species that were not recorded during the surveys but are considered likely to occur in the study corridor (Section 5.2.2).

6.2 Comparisons with other Surveys in the Locality

Although conducted under different seasonal conditions, including additional habitats, and with differential sampling effort, comparisons with other similar studies done in the locality can provide useful contextual information for the current study (Table 6.1).

Table 6.1: Comparison of the results of the Anketell Point rail corridor fauna survey with other similar fauna studies in the locality.

	No. of Species				
Survey	**Herpetofauna**	**Avifauna**	**Mammals**	**Total**	**Formally Listed Species**
Anketell Point Rail Corridor (this study)	75	87	20	**184**	*Dasyurus hallucatus* *Falco peregrinus* *Ardeotis australis* *Phaps histrionica* *Pseudomys chapmani* *Notoscincus butleri* *Merops ornatus* *Apus pacficifus*
Mesa A Transport Corridor (Biota 2006a)	67	93	21	**181**	*Dasyurus hallucatus* *Macroderma gigas* *Ardeotis australis* *Burhinus grallarius* *Pseudomys chapmani* *Notoscincus butleri* *Merops ornatus*

Table 6.1: Comparison of the results of the Anketell Point rail corridor fauna survey with other similar fauna studies in the locality.

	No. of Species				
Survey	**Herpetofauna**	**Avifauna**	**Mammals**	**Total**	**Formally Listed Species**
Bungaroo Trial Pit (Biota 2006b)	51	81	16	**147**	*Dasyurus hallucatus* *Pseudomys chapmani* *Ardeotis australis* *Burhinus grallarius* *Notoscincus butleri* *Tringa glareola*
Cape Lambert Port B Development (Biota 2008a)	40	63	17	**120**	*Mormopterus loriae cobourgiana* *Numenius madagascariensis* *Neochmia ruficauda subclarescens*

The Threatened and migratory species recorded by other surveys in the locality represent a similar listing of species to those recorded from the Anketell Point rail corridor (Table 6.1). The species richness recorded from the Anketell Point study area is actually the greatest of these studies, partly reflecting the range of habitats traversed by the corridor, but also the optimal seasonal timing for some phases (Table 6.1). These comparisons support the view that the current study documented an adequate proportion of the terrestrial fauna suitable for the formal environmental assessment process (Section 2.5).

6.3 Potential Impacts

Potential impacts to terrestrial fauna arising from the construction and operation of the proposed Anketell Point railway would include the following:

- **Direct fauna habitat disturbance**

The primary impact that is likely to arise from the proposed railway would be the clearing of fauna habitat necessary to construct the rail corridor including the rail formation, adjacent access tracks, borrow pits, stockpiles and associated facilities. Some fauna habitats along the alignment have been identified as supporting significant species, particularly the crossing points of the major riverine systems (Section 6.1). The rail alignment and any related ground disturbing activities should aim to minimise or ideally avoid any impacts on these habitats.

- **Indirect fauna habitat modification**

A number of indirect modifications may also occur to fauna habitat in the corridor as a result of the construction and operation of the railway. These include changes to surface hydrology, increased erosion and weed introduction or spread. The new railway has the potential to alter surface hydrology in the minor and major drainage systems that cross the corridor. Backwater effects or reduction in downstream flows could result in changes to both upstream and downstream vegetation, with flow on effects on fauna habitat and riverine habitat dependent fauna species. Changes to surface flows could also result in increased scour and erosion, with similar consequences for riverine fauna habitats, and engineering design of drainage treatments and crossing structures should take account of these factors. The spread or introduction of weeds is a potential risk associated with the construction of any linear infrastructure corridor and this can also have implications for fauna species. Changes to the floristic and structural nature of vegetation and fauna habitat can result in the habitat resource value of areas being diminished for native fauna. Mesic environments such as major creeklines are particularly susceptible to weed invasion and any consequent changes to fauna habitat. Weed and topsoil hygiene protocols will therefore be required for railway earthworks.

- **Direct loss of individual fauna**

It is inevitable that there will be some localised loss of fauna due to direct mortality arising from construction of the new railway, including that which may occur during the clearing of habitat. Ongoing impacts may also arise from more frequent vehicle movements, train movements and machinery operation along the corridor once the rail and associated access tracks are

constructed. It is unlikely that the loss of individuals associated with such direct mortalities would be significant enough to affect the overall conservation status of any of the species recorded from the corridor.

- **Restriction of Fauna Movement**

The construction of the railway formation will result in a barrier to the movement of some fauna species and potential subdivision of populations situated along the rail alignment. The extent to which this would affect the various fauna occurring along the corridor is dependent on the range, dispersal and effective population size of the various species involved. Populations of species associated with riverine habitats are perhaps less likely to be potentially affected by this, given the bridges and culverts to be constructed at all significant drainage system crossings. The proposed rail would not present any barrier to gene flow amongst avifauna and bats.

- **Modifications to Fire Regimes**

The frequency of fires in the proposed rail corridor is already likely to be higher than in the surrounding locality. Track grinding and maintenance activities have the potential to increase fire frequency in adjacent areas and have apparently contributed to fires in the locality. The presence of additional personnel and equipment in the area during construction of the rail may also result in unplanned fires in the corridor.

The consequences of this potential for increased fire frequency would depend on the affected fauna habitats and the fauna species present. Open vegetation types such as tussock grasslands and snakewood shrublands tend not to carry fires. However, *Triodia* hummock grassland habitats tend to dominate much of the proposed corridor and these are highly flammable. A number of fauna species and communities identified from the corridor require mature spinifex as a component of their habitat and therefore, local populations in the immediate locality could be affected over time if fire frequencies increase. Suitable management practices should be put in place to address this during both construction and maintenance of the rail.

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7.0 References

Abbott, I. and Burbidge, A. A. (1995). The occurrence of mammal species on the islands of Australia: a summary of existing knowledge. *CALM Science* 1: 259-324.

Allen, G.R., Midgley, S.H. and Allen, M. (2002). Field guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth, Western Australia.

Armstrong, K.N. (2001). The roost habitat and distribution of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia. *Wildlife Research*. 28:95-104.

Armstrong, K.N. and W.J. Wilmer (2004). *The importance of determining genetic population structure for the management of Ghost Bats, Macroderma gigas, in the Pilbara region of Western Australia*. Oral presentation at the 11th Australasian Bat Society Conference Toowoomba, Queensland, 12-14 April 2004.

Biota Environmental Sciences (2001). Managing threatened bats during the Klondyke Queen drilling program, Marble Bar. Unpublished report by Biota Environmental Sciences Pty Ltd for Cardinal Minerals Ltd and Lynas Corporation.

Biota Environmental Sciences (2003). Mesa J Extension Vegetation, Flora and Fauna Assessment. Unpublished report for Pilbara Iron Pty. Ltd.

Biota Environmental Sciences (2006a). Fauna habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo. Unpublished report for Pilbara Iron Pty. Ltd.

Biota Environmental Sciences (2006b). Bungaroo Creek Trial Pits and Transport Corridor to Mesa J near Pannawonica: Fauna Habitats and Fauna Assemblages Survey. Unpublished report for Pilbara Iron Pty. Ltd.

Biota Environmental Sciences (2007a). West Pilbara Iron Ore Project Level 1 Fauna Assessment. Unpublished report for Pilbara Iron Pty. Ltd.

Biota Environmental Sciences (2007b). Mesa K Targeted Fauna Survey. Unpublished report for Pilbara Iron Pty. Ltd.

Biota Environmental Sciences (2008a). Cape Lambert Port B Development Seasonal Fauna Survey. Unpublished report prepared for Pilbara Iron Pty. Ltd.

Biota Environmental Sciences (2008b). Rio Tinto Iron Ore Rail Duplication Fauna Survey: Cape Lambert to Emu Siding. Unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (2008c). Rio Tinto Iron Ore Rail Duplication Fauna Survey: Cape Lambert Variation. Unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (2009a). West Pilbara Iron Ore Project Mine Cape Preston Rail Corridor Fauna Survey. Unpublished report for API Management Limited, Perth

Biota Environmental Sciences (2009b). West Pilbara Iron Ore Project Onslow Rail Corridor Fauna Survey. Unpublished report for API Management Limited, Perth

Biota Environmental Sciences (2009c). West Pilbara Iron Ore Project Mine Areas Seasonal Fauna Survey. Unpublished report for API Management Limited, Perth

Biota Environmental Sciences (2009d). Hope Downs IV Northern Quoll Position Paper. Unpublished report for Rio Tinto Iron Ore and Hamersley HMS, Perth.

Braithwaite R.W. and Griffiths A. (1994) Demographic variation and range contraction in the Northern Quoll Dasyurus hallucatus (Marsupialia: Dasyuridae). *Wildlife Research* 21: 203-217.

Burbidge A. A. and McKenzie, N. L. Eds. (1978). The Islands of the North-west Kimberley. *Wildlife Research Bulletin of Western Australia*. No 7.

Christian, C.S. and G.A. Stewart (1953). General Report on Survey of Katherine-Darwin Region, 1946. CSIRO Land Research Series No. 1.

Churchill, S.K. (1991). Distribution, abundance and roost selection of the orange horseshoe bat, Rhinonicteris aurantius, a tropical cave dweller. *Wildlife Research* 18: 343-353.

Churchill, S.K. (1998). *Australian Bats*. Reed New Holland: Sydney.

Dickman C.R. and Braithwaite (1992) Post-mating mortality of males in the Dasyurid Marsupials Dasyurus and Parantechinus. *Journal of Mammalogy*. 73(1): 143-147.

Environment Australia (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and development of Version 5.1, Summary Report. Environment Australia, November 2000.

Environmental Protection Authority (2002). Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection. http://www.epa.wa.gov.au/docs/1033_ps3.pdf

Environmental Protection Authority (2004). EPA Guidance for the Assessment of Environmental Factors No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. http://www.epa.wa.gov.au/docs/1850_GS56.pdf

Environmental Protection Authority (2009). EPA Guidance for the Assessment of Environmental Factors No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia. http://www.epa.wa.gov.au/docs/2953_GS20SRE250509.pdf

Harvey, M.S. (2002). Short-range endemism among Australian fauna: some examples from non-marine environments. *Invertebrate Systematics*, 16: 555-570.

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

Hoffman (2003). A new genus and species of trigoniuline milliped from Western Australia (Spirobolida: Pachybolidae: Trigoniulinae). Records of the Western Australian Museum 22: 17-22.

Johnstone R.E. and G.M. Storr (1998). *Handbook of Western Australian Birds. Volume I – Nonpasserines (Emu to Dollarbird)*. Western Australian Museum, Perth WA.

Johnson, M.S., Hamilton, Z.R., Murphy, C.E., MacLeay, C.A., Roberts, B. and Kendrick, P.G. (2004). Evolutionary genetics of island and mainland species of Rhagada (Gastropoda: Pulmonata) in the Pilbara Region, Western Australia. *Australian Journal of Zoology* 52: 341-355

Kendrick, P. (2001). Pilbara 3 (PIL3- Hamersley Subregion). In: *A biodiversity Audit of Western Australia's 53 Bogeographical Subregions*. Department of Conservation and Land Management, WA.

Marchant, S. and P.J. Higgins (Eds) (1993). *Handbook of Australian, New Zealand and Antarctic Birds: Volume two, raptors to lapwings*. Oxford University Press, Melbourne.

Maxwell, S., A.A. Burbidge and K. Morris (1996). *The 1996 Action Plan for Australian marsupials and monotremes*. Wildlife Australia, Canberra.

Menkhorst P. and F. Knight (2001). *A Field Guide to the Mammals of Australia*. Oxford University Press.

O'Neill, C. (2008). *The relationship between morphology and genetics in Quistrachia (Gastropoda: Pulmonata) from the Pilbara, Western Australia.* Honours thesis University of Western Australia.

Oakwood M. (1997). The Ecology of the Northern Quoll, Dasyurus hallucatus. PhD thesis, Australian National University.

Oakwood M. (2000). Reproduction and demography of the northern quoll, Dasyurus hallucatus, in the lowland savanna of northern Australia. *Australian Journal of Zoology* 48:519–539.

Oakwood, M. (2008). Monitoring extinction of the northern quoll. Report to the Australian Academy of Science.

Payne, A.L, Mitchell, A.A, and Holman, W.F. (1988). An inventory and condition survey of rangelands in the Ashburton River catchment. Western Australian Department of Agriculture Technical Bulletin No. 62, 1988.

Pearson, D. (2003). Giant Pythons of the Pilbara. *Landscope*, 19(1).

Pizzey, G. and F. Knight (1997). *Field Guide to the Birds of Australia*. Angus & Robertson: Sydney.

Ponder (1997). Conservation status, threats and habitat requirements of Australian terrestrial and freshwater Mollusca. *Memoirs of the Museum of Victoria*, 56: 421-430.

Ponder, W.F. and D.J. Colgan (2002). What makes a narrow-range taxon? Insights from Australian fresh-water snails. Invertebrate Systematics 16: 571–582.

Storr, G.M., Smith, L.A. and R.E. Johnstone (1999). Lizards of Western Australia I: Skinks. Western Australian Museum, Perth.

Solem (1997). Camaenid land snails from Western and Central Australia (Mollusca: Pulmonata: Camaenidae). VII Taxa from Dampierland through the Nullarbor. *Records of the Western Australian Museum*, Supplement No 50: 1461-1906.

Thorne, A.M. and A.F. Trendall (2001). Geology of the Fortescue Group, Pilbara Craton, Western Australia. *Geological Survey of Western Australia Bulletin 144*. Department of Minerals and Energy, Perth 2001.

Van Dyck, S. and Strahan, R. (2008). The Mammals of Australia (third edition). Queensland Museum, Brisbane.

van Vreeswyk, A.M.E., A.L. Payne, K.A. Leighton and P. Hennig (2004). An inventory and condition survey of the Pilbara region, Western Australia. *Department of Agriculture Technical Bulletin No*. 92, December 2004.

Western Botanical (2009). West Pilbara Iron Ore Project Flora and Vegetation Survey. Unpublished report for API Management, Perth.

Wilson, S. and Swan, G. (2008). *A Complete Guide to Reptiles of Australia, Second Edition*. New Holland Publishers.

Wilson, S. K, and D. G. Knowles. 1988. *Australia's reptiles: a photographic reference to the terrestrial reptiles of Australia*. Collins, Sydney, New South Wales.

Woolley, P.A. (2005). The species of Dasycercus Peters, 1875 (Marsupialia: Dasyuridae). *Memoirs of Museum Victoria* 62: 213-221.

Appendix 1

Regulation 17 Licence to Take Protected Fauna

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

Correspondence: **Locked Bag 30**
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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 TO) ARE ATTACHED.

PURPOSE	CAPTURE AND RELEASE FAUNA SURVEY OF WEST PILBARA IRON ORE PROJECT MINE AND RAIL FROM CAPE PRESTON TO APPROX 30KM SOUTH OF REDHILL STATION.
AUTHORISED PERSONS	MR ROY TEALE, MR GREG HAROLD, MR PHIL RUNHAM, MS ZOE HAMILTON, MR M GREENHAM, MR A JOHNSON, MR D KAMIEN, MS E HARRIS, MS J ADCOFT, MR L LOVELL, MR P SAWERS. JASON ALEXANDER

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PAGE 2
NO. SF005841

DATE OF ISSUE 23/04/2007
VALID FROM 01/05/2007
DATE OF EXPIRY 30/04/2008

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PAGE NO. 2
SF006833
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MR DAN KAMIEN
MR MICHAEL GREENHAM
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VALID FROM 01/04/2009
DATE OF EXPIRY 30/04/2009

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PAGE 1
NO. SF006833
PERSON NO. 69992

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WILDLIFE CONSERVATION ACT 1950
REGULATION 17

LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

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DIRECTOR GENERAL

CONDITIONS

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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.**********

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

PURPOSE CAPTURE AND RELEASE FAUNA SURVEY USING UP TO 300 DRY PIT TRAPS; 100 ELLIOT TRAPS AND TWO HARP TRAPS FOR IMPACT ASSESSMENT AT WEST PILBARA IRON ORE PROJECT - ANKETELL POINT RAIL CORRIDOR

WILDLIFE CONSERVATION REGULATIONS 1970

Regulation 17:- Licence to Take Fauna for Scientific Purposes

FURTHER CONDITIONS (OF LICENCE NUMBER SF 6833)

1. The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.

2. Except in the case of approved lethal traps, the licensee shall ensure that measures are 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 deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and 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.

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

4. Any form of colour marking of birds or bats shall only be undertaken in accordance with the requirements of the Australian Bird and Bat Banding Scheme.

5. Any inadvertently captured specimen 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.

6. Within one month of the expiration of this licence, the holder shall submit an electronic return detailing the locality, site, geocode, date and number of each species captured, sighted or vouchered during the currency of the licence, into the Department of Environment and Conservation Fauna Survey Database (DECFSD). A copy of any paper, report or thesis resulting from the research shall on completion be lodged with the Director General. If a renewal of this licence is required, the licensee shall submit a written progress report for activities undertaken during this licence period prior to the expiry of this licence.

7. Not more than ten specimens of any one protected species shall be taken and removed 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. 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.

9. 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.

Appendix 2

Bat Call Analysis

Specialised Zoological

Bat call identification from Cape Preston and the NW Coastal Highway

Type:	Bat Call Analysis
Prepared for:	Biota Environmental Sciences
Date:	18 August 2009
Job No.:	SZ123
Prepared by:	Specialised Zoological Kyle Armstrong and Yuki Konishi ABN 92 265 437 422 0404 423 264 kyle.armstrong@graduate.uwa.edu.au kyle.n.armstrong@gmail.com

SZ123: *Bat call identification from Cape Preston and the NW Coastal Highway*

SUMMARY

Bat identifications from Anabat echolocation call recordings are provided from Cape Preston and gorge habitats nearby adjacent to the NW Coastal Highway, Western Australia. Seven species were identified as being present (Table 1). The western little free-tailed bat *Mormopterus loriae cobourgiana* is listed under Priority 1 of the Department of Environment and Conservation's Priority Fauna List.

The calls of the yellow-bellied sheath-tailed bat *Saccolaimus flaviventris* can sometimes be confused with those of the northern free-tailed bat *Chaerephon jobensis*, and these species could not be separated here. The calls of long-eared bats *Nyctophilus* are typically difficult to identify to species, and those recorded may be attributed to the northern long-eared bat *N. arnhemensis* on the basis of the mangal habitat, but the lesser long-eared bat *N. geoffroyi* is also a possibility. The common sheath-tailed bat *Taphozous georgianus* was separated from Hill's sheath-tailed bat *T. hilli* on the basis of their distributions (Churchill 2008).

Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). A summary of pulse parameters is provided in Table 2, and representative call sequences are illustrated in Figure 1. Further data is available should verification be required.

METHODS

Signals as recorded with an Anabat II detector connected to a CF-ZCAIM unit were supplied as downloaded sequences, which were examined in AnalookW 3.7a software. Three call variables were measured on good quality search phase pulses in representative call sequences: pulse duration (milliseconds), maximum frequency (kHz) and characteristic frequency (equivalent to minimum frequency; kHz). Species were identified based on information in McKenzie and Muir (2000) and Milne (2002). Nomenclature follows Armstrong and Reardon (2006). Species designations of Churchill (2008) are not followed until formal publication of the relevant taxonomic study.

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.

Churchill, S.K. (2008). *Australian bats*. 2nd ed. Allen and Unwin, Crows Nest, NSW.

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.

Milne, D.J. (2002). *Key to the bat calls of the Top End of the Northern Territory*. Parks and Wildlife Commission of the Northern Territory, Technical Report No. 71.

TABLE 1. Species identifications, with the degree of confidence indicated by a code. Date correlates with site; see Table 2 for full species names.

	C. gouldii	*C. jabensis / S. flaviventris*	*M. loriae*	*N. arnhemensis*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Date							
Serial 682							
21/03/2009	—	—	H	NC	—	—	—
22/03/2009	—	—	H	NC	—	—	—
23/03/2009	—	—	—	—	—	—	—
24/03/2009	—	—	—	—	—	—	—
Serial 683							
22/03/2009	H	NC	—	—	H	H	H
23/03/2009	H	—	—	—	H	H	H
24/03/2009	H	—	—	—	H	H	H

Definition of confidence level codes:

H High. Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or submission of a specimen/tissue to a museum.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the Summary section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

TABLE 2. Summary of variables from representative call sequences.

Species	s,p[1]	Duration (msec)[2]	Max Frequency (kHz)[2]	Char frequency (kHz)[2]
Gould's wattled bat *Chalinolobus gouldii*	3,30	5.6 ± 1.1 3.6 – 7.7	49.5 ± 6.8 39.0 – 70.8	32.9 ± 1.0 31.5 – 34.9
Northern free-tailed bat *Chaerephon jobensis* / Yellow-bellied sheath-tailed bat *Saccolaimus flaviventris*	2,2	6.4 ± 4.5 3.2 – 9.6	21.9 ± 2.5 20.2 – 23.7	20.3 ± 2.0 18.8 – 21.7
Western little free-tailed bat *Mormopterus loriae cobourgiana*	2,22	7.6 ± 1.6 4.4 – 10.5	33.1 ± 1.2 31.9 – 36.7	31.6 ± 0.5 30.4 – 32.8
Northern long-eared bat *Nyctophilus arnhemensis*	4,30	2.7 ± 0.9 1.2 – 4.3	63.4 ± 8.9 52.3 – 82.5	48.5 ± 1.3 45.5 – 50.6
Little broad-nosed bat *Scotorepens greyii*	3,51	5.5 ± 1.1 4.1 – 7.8	62.1 ± 11.6 44.7 – 89.9	37.3 ± 0.8 35.7 – 39.6
Common sheath-tailed bat *Taphozous georgianus*	3,28	9.6 ± 2.1 4.3 – 14.2	26.9 ± 1.1 25.1 – 29.2	25.1 ± 0.6 24.3 – 26.4
Finlayson's cave bat *Vespadelus finlaysoni*	5,61	5.1 ± 0.7 3.6 – 7.0	74.7 ± 10.1 61.1 – 100.0	58.3 ± 1.4 55.2 – 62.0

[1] s,p: number of sequences measured, combined total number of pulses measured;

[2] Mean ± SD; range.

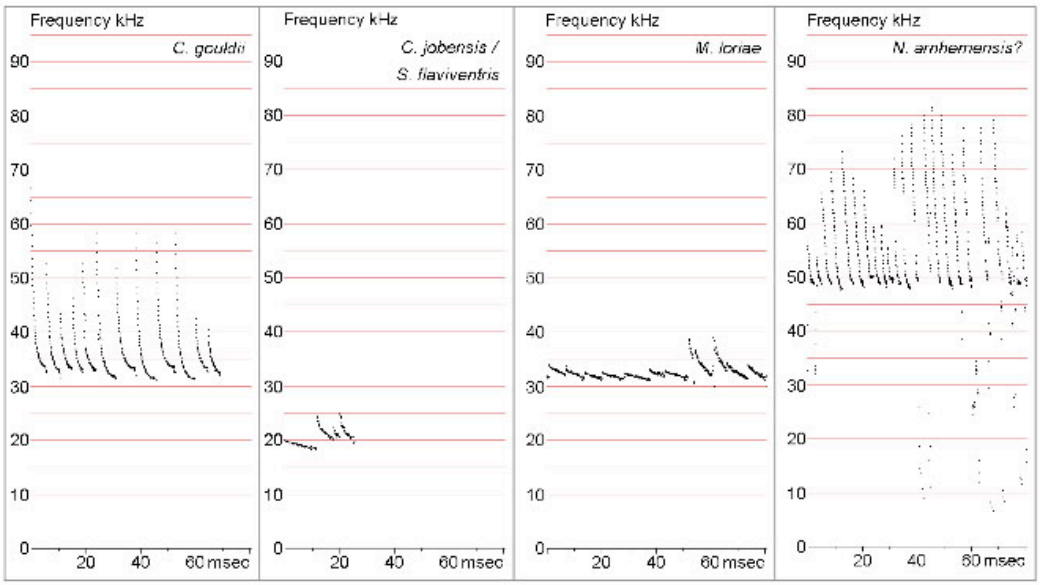

FIGURE 1A. Representative call sequences of the species identified (time is compressed between pulses).

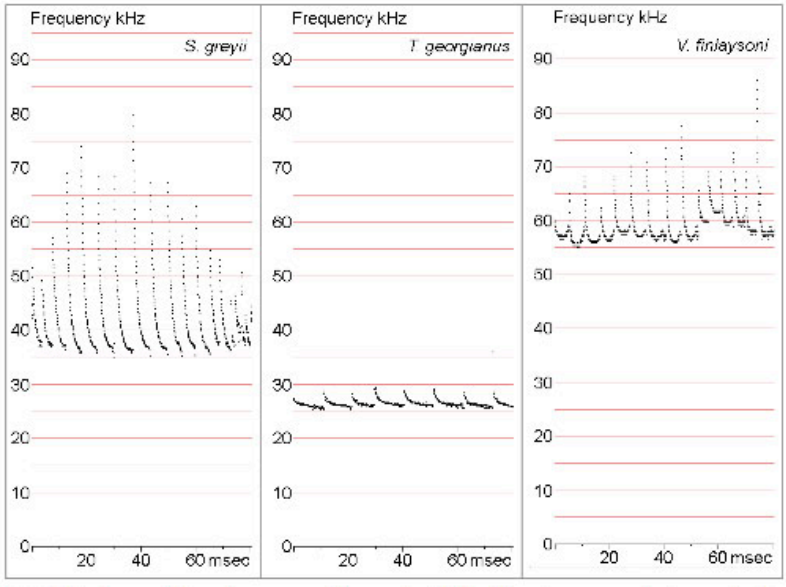

FIGURE 1B. Representative call sequences of the species identified (time is compressed between pulses).

Specialised Zoological

Bat call identification

from Anketell Point, WA

Type:	Bat Call Analysis
Prepared for:	Biota Environmental Sciences
Date:	9 July 2009
Job No.:	SZ120
Prepared by:	Specialised Zoological Kyle Armstrong and Yuki Konishi ABN 92 265 437 422 0404 423 264 kyle.armstrong@graduate.uwa.edu.au kyle.n.armstrong@gmail.com

SUMMARY

Bat identifications from Anabat echolocation call recordings are provided from Anketell Point, near Karratha, Western Australia. At least five species were identified as being present, with the possibility of one other that could not be distinguished reliably based on acoustic recordings (Table 1).

Diagnostic calls of Gould's wattled bat *Chalinolobus gouldii* were present, but some call types can be difficult to distinguish from those of the western little free-tailed bat *Mormopterus loriae cobourgiana*, especially if call quality is low. Thus, the latter species may have also been present.

Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). A summary of pulse parameters is provided in Table 2, and representative call sequences are illustrated in Figure 1. Further data is available should verification be required.

METHODS

Signals as recorded with Anabat SD1 detectors were supplied as downloaded sequences, which were examined in AnalookW 3.7a software. Three call variables were measured on good quality search phase pulses in representative call sequences: pulse duration (milliseconds), maximum frequency (kHz) and characteristic frequency (equivalent to minimum frequency; kHz). Species were identified based on information in McKenzie and Muir (2000). Nomenclature follows Armstrong and Reardon (2006). Species designations of Churchill (2008) are not followed until formal publication of the relevant taxonomic study.

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TABLE 1. Species identifications, with the degree of confidence indicated by a code. Date correlates with site; see Table 2 for full species names.

	C. gouldii	*C. gouldii / M. l. cobourgiana*	*C. jobensis*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Date						
Serial 3726						
4/04/2009	H	NC	H	H	H	H
5/04/2009	H	—	—	H	—	—
6/04/2009	H	—	—	H	—	—
7/04/2009	—	NC	—	H	—	—
8/04/2009	—	—	—	—	—	—

Definition of confidence level codes:

H High. Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or submission of a specimen/tissue to a museum.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the Summary section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

TABLE 2. Summary of variables from representative call sequences.

Species	s,p[1]	Duration (msec)[2]	Max Frequency (kHz)[2]	Char frequency (kHz)[2]
Gould's wattled bat *Chalinolobus gouldii*	1,10	6.1 ± 0.3 5.6 – 6.6	50.4 ± 1.3 47.9 – 52.0	33.2 ± 1.0 32.0 – 34.5
Gould's wattled bat *Chalinolobus gouldii* / Western little free-tailed bat *Mormopterus loriae cobourgiana*	1,4	9.4 ± 0.3 9.0 – 9.8	32.7 ± 0.5 32.3 – 33.3	31.1 ± 0.4 30.8 – 31.6
Northern free-tailed bat *Chaerephon jobensis*	2,21	11.6 ± 3.8 4.5 – 16.5	24.5 ± 3.7 19.8 – 33.3	19.5 ± 1.9 16.8 – 22.9
Little broad-nosed bat *Scotorepens greyii*	2,16	6.4 ± 0.4 5.8 – 7.1	54.1 ± 12.6 40.6 – 73.4	37.0 ± 0.8 35.9 – 38.5
Common sheath-tailed bat *Taphozous georgianus*	1,1	4.9	24.8	24.4
Finlayson's cave bat *Vespadelus finlaysoni*	3,20	4.2 ± 1.5 2.8 – 9.9	71.0 ± 6.7 60.6 – 82.5	58.2 ± 1.1 55.9 – 60.2

[1] s,p: number of sequences measured, combined total number of pulses measured;

[2] Mean ± SD; range.

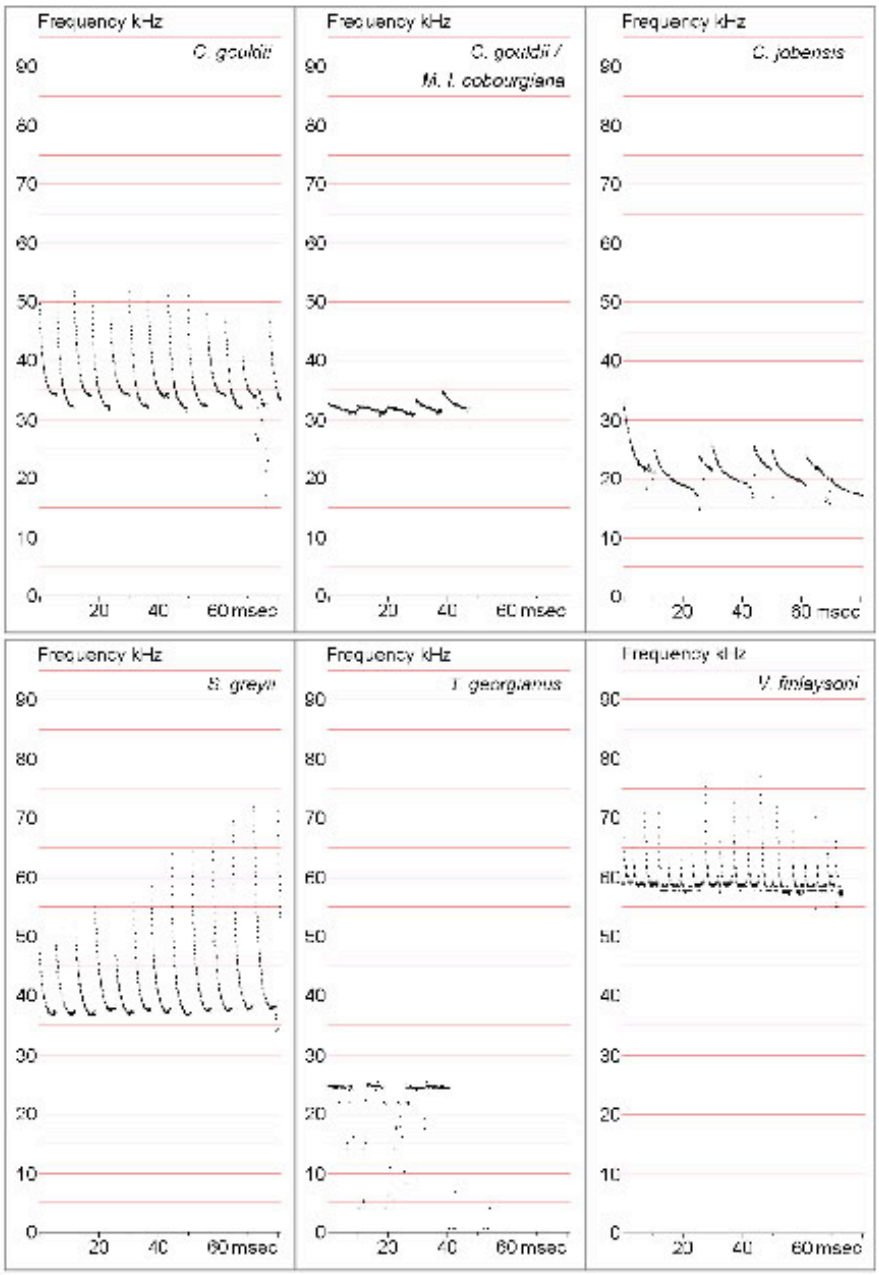

FIGURE 1. Representative call sequences of the species identified (time is compressed between pulses).