API
WEST PILBARA
IRON ORE PROJECT

West Pilbara Iron Ore Project Stage 1 Mine & Rail

Threatened Fauna Offset Strategy

EPBC 2009/4706 Approval Decision
10 May 2013

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Inside cover image: Permanent pool, West Hamersley Range

Executive Summary

API Management Pty (API) is managing the development of the West Pilbara Iron Ore Project (WPIOP) on behalf of Australian Premium Iron Joint Venture (APIJV) participants Aquila Resources Limited and American Metals and Coal International Inc. The first stage of the project is based on the mining of eight channel iron deposits accessed through joint ventures between API and Cullen Resources Ltd (Mount Stuart Iron Ore Joint Venture) and Red Hill Iron Ltd (Red Hill Iron Ore Joint Venture), in addition to an area under the APIJV. The deposits are located on the western fringe of the Hamersley Range south of Pannawonica, and are to be linked by construction of a 285 km railway to a deepwater port to be developed at Anketell Point, 25 km east of Karratha (Figure 1). Mining and export of iron ore from Stage 1 is planned at the rate of 30 million tonnes per annum. The projected life of the project is 15 years post construction.

The mine and rail components of the project were granted conditional approval under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 27 November 2011 (EPBC 2009/4706). Embedded in the proposal developed by API was the principle of capturing opportunities presented by the implementation of the project to achieve positive environmental and conservation outcomes. API proposed several initiatives during environmental offset discussions with the Department of Sustainability, Environment, Water, Population and Communities which were subsequently formalised in the conditions of approval by that Department.

Condition 6 of the approval requires the development of a Threatened Fauna Offset Strategy comprising two key elements. Condition 6a requires funding support for the Western Australian Department of Environment and Conservation *Pilbara Living Country* initiative, initially targeting the development of fire management strategies sympathetic to the biodiversity of the West Hamersley region. Condition 6b requires the development of a Threatened Fauna Conservation Plan describing measures to enhance the conservation of EPBC Act listed threatened species in an area to be designated.

This document is the Threatened Fauna Offset Strategy and Threatened Fauna Conservation Plan prepared in fulfillment of Condition 6.

API commitment to the Pilbara Living Country initiative is re-stated and the Threatened Fauna Conservation Plan details the nomination of a 6,126 hectare (ha) Conservation Focus Area in the Hamersley Range adjacent to the WPIOP Stage 1 mine area. The plan describes proposed actions by API to progressively investigate and document the environmental values of the Conservation Focus Area and the processes required to develop and implement appropriate management actions to protect and enhance these values once threatening processes and associated risk, have been identified.

Studies of the Conservation Focus Area completed by API to date have demonstrated the presence of three key species of National Environmental Significance: the Northern Quoll (*Dasyurus hallucatus*); Pilbara Leaf-nosed Bat *(Rhinonicteris aurantius*); and Pilbara Olive Python *(Liasis olivaceus barroni*). A significant roost of the Pilbara Leaf-nosed Bat has been confirmed in the area.

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The mine and rail elements of the project were granted conditional approval under sections 130(1) and 133 of the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) on the 27 November 2011 (EPBC 2009/4706). The wording of Condition 6 under this approval was amended on 17 September 2012 to facilitate the implementation of the condition.

Condition 6 of the EPBC Act approval requires the development of a Threatened Fauna Offset Strategy with two key obligations: (1) funding support for the Western Australian Department of Environment and Conservation (DEC) *Pilbara Living Country* initiative including a commitment to fund on ground, landscape based fire management practices (Condition 6a); and (2) development of a Threatened Fauna Conservation Plan to maintain and enhance the biodiversity values of a nominated area that hosts EPBC Act listed species (Condition 6b).

This document is the Threatened Fauna Offset Strategy prepared by API. It details the commitment to the Pilbara Living Country initiative and outlines the objectives, environmental values assessment, management actions and key milestones of a Threatened Fauna Conservation Plan to be applied by API to a 'Conservation Focus Area' identified in the west Hamersley Range.

2 Threatened Fauna Offset Strategy

The Threatened Fauna Offset Strategy comprises two elements:

- The commitment of API to fund a component of the *Pilbara Living Country* initiative managed by the Western Australian Department of Environment and Conservation (DEC). The initial objectives of this initiative include the development and implementation of appropriate fire management strategies that are sympathetic to the maintenance of the biodiversity of the West Hamersley region.
- A Threatened Fauna Conservation Plan proposed to be applied to a designated area to protect and enhance the environmental values of that area, with a particular emphasis on local fauna species of National Environmental Significance.

The strategy has been prepared in accord with commitments made by API as part of the WPIOP Stage 1 proposal and to fulfill the requirements of Condition 6 of the Project EPBC Act approval. Condition 6 of the EPBC approval is detailed in Appendix 1.

API notes that in complying with obligations under the EPBC Act approval decision (2009/4706) that the implementation of the Threatened Fauna Offset Strategy will also comply with Western Australian legislation, in particular, the *Wildlife Conservation Act 1950* and other legislative requirements as applicable.

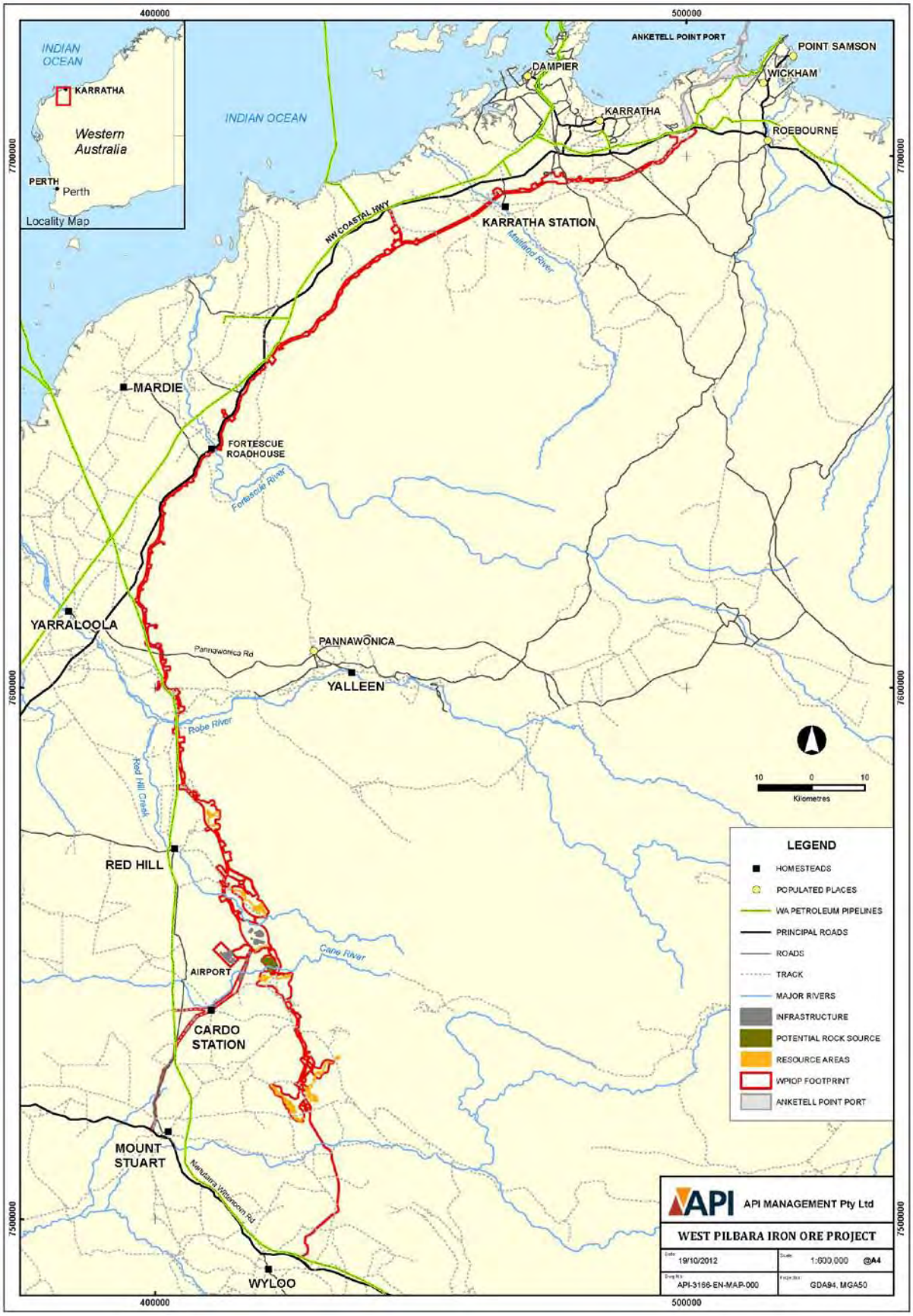

Figure 1: Location of the West Pilbara Iron Ore Project Stage 1

3 Pilbara Living Country

API reiterates its commitment to supporting the *Pilbara Living Country* initiative as developed and managed by DEC.

API will contribute $1 million to a trust fund to be established by DEC for Pilbara Living Country programmes. Funding will be provided in five annual installments of $200,000 (GST exclusive), with the first installment paid within three months of the commencement of construction of the WPIOP Stage 1.

The key components of the *Pilbara Living Country* initiative of the Hamersley sub-region (DEC, 2011) are:

- Complete floristic surveys and compile 1:100,000 vegetation maps of the Hamersley sub-region; and
- Complete a bioregional Wildfire Threat Analysis.

The funding provides for DEC employment of two full time equivalent (FTE) botanical staff (at the Scientist and Technical Officer levels) to undertake two years of surveys, six months for specimen identification with additional GIS support, and a six month period to undertake a Wildfire Threat Analysis.

A Memorandum of Understanding formalising the arrangement between API and DEC will be finalised prior to the commencement of construction.

4 Threatened Fauna Conservation Plan

4.1 OBJECTIVES

The Threatened Fauna Conservation Plan (TFCP) describes the activities proposed to protect and enhance the environmental values of a specified area, with a particular emphasis on local fauna species of National Environmental Significance. API has designated a suitable area referred to as a Conservation Focus Area (CFA).

The key objectives of the plan are:

- Document the environmental values, threatening processes and any trends in key values within the CFA through baseline and long-term environmental investigations and monitoring;
- Develop and implement actions to protect and enhance the determined environmental values;
- Monitor and record the effectiveness of protection and biodiversity enhancement actions; and
- Communicate progress in the implementation of the plan.

The documentation of environmental values would constitute a comprehensive reference for informed conservation estate planning and any formal gazettal of the area by the State as conservation reserve.

4.2 CONSERVATION FOCUS AREA

The designated CFA is a 6,126 hectare (ha) area located in the Hamersley Range adjacent to the WPIOP Stage 1 mine area (Figure 2).

The area is unallocated Crown Land (UCL), and similar to the majority of the Hamersley Range, is the subject of tenure granted under the *Mining Act 1978* (Mining Act) that provides for mineral exploration and exploitation. API manages the mineral titles that fall on the CFA and retains the rights to iron ore within the tenements. The rights to explore for other minerals on these tenements are held by other entities. The boundaries of the CFA are nominal and have been initially guided by the proposed WPIOP development to the west, Mining Act leases held by a third party to the south, and to the north by a potential transport corridor for iron ore haulage.

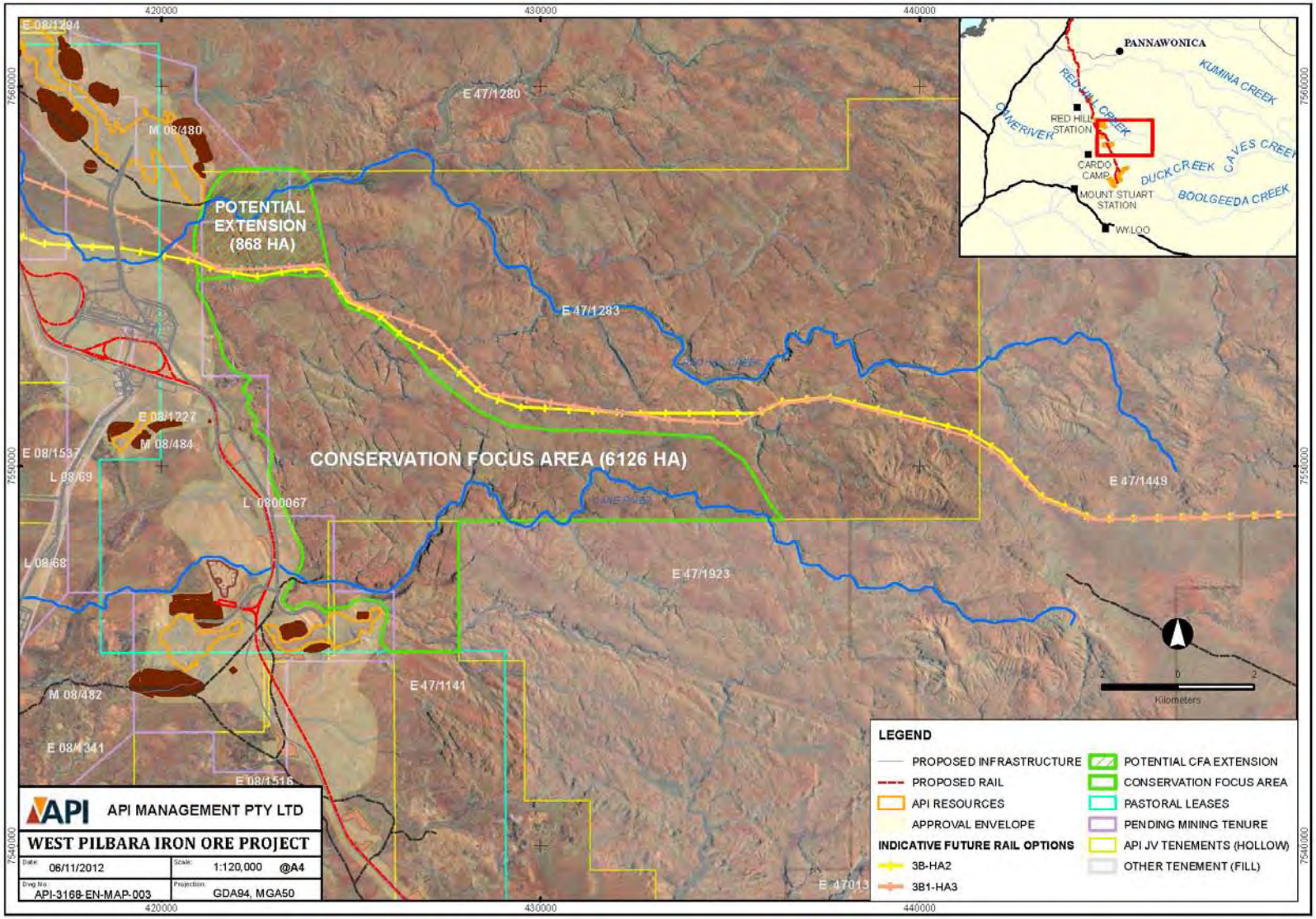

Figure 2: Location of the nominated Conservation Focus Area

An area of 868 ha adjoining the northern extent of the CFA is proposed as a 'potential CFA extension' on the basis of environmental values recorded to date (see Figure 2). This area has not been automatically included in the CFA due to the possibility of the above-mentioned future transport corridor crossing the area, and the possible requirement in this event, to have to substitute the nominated CFA with another area in accordance with clause (b)(vi) of Condition 6. API will apply the management and monitoring actions of this TFCP equally to the potential CFA extension area. The summary information of the attributes of the proposed CFA described to date and reported in this TFCP includes data from the proposed extension area. Subject to the completion of baseline studies, the environmental values of the extension area may warrant the inclusion of the area in the CFA, notwithstanding that at some point a transport corridor may be constructed across a small section of the land. That is, while there is some linear ground disturbance associated with the transport corridor, the conservation benefit of including the extension area within the CFA may outweigh the environmental impact of the transport corridor. This approach could be applied to vary other parts of the CFA boundary, if not constrained by Condition 6(b)(iv). The concept of a multiple use management framework for conservation estate is discussed in Section 5.

The CFA covers part of the upper catchment of the Cane River and approximately 18 km of the river length. The Cane River Conservation Park lies approximately 40 km to the west of the western boundary of the CFA (see Figure 3).

The location of the CFA in relation to conservation estates in the region is presented in Figure 3. The CFA falls in an area of the Hamersley Range not represented in any conservation estate. Beyond the Cane River Conservation Park the nearest reserves are Barlee Range Nature Reserve, approximately 96 km southwest and the Millstream-Chichester National Park, approximately 99 km northeast (Figure 3).

The CFA is within the area of the proposed West Hamersley Range Conservation Park as recommended by DEC in 2002 (see Figure 3). DEC proposed the creation of this reserve to ensure the protection of restricted flora species and communities of summit habitats within the Hamersley Range that were different from those communities of summits in the central and eastern range area (DEC, 2002).

The proposed CFA and extension area relative to the Pilbara Interim Biogeographic Regionalisation for Australia (IBRA Version 7) and the Hamersley sub-region (PIL03), the Hamersley Range itself and the percentage area of the proposed West Hamersley Range Conservation Park is indicated in Table 1, the proposed CFA and extension area being 1.8% of the proposed West Hamersley Range Conservation Park.

Historical ground disturbance in the CFA is limited to a few vehicle tracks mostly around the periphery of the area. The generally rugged terrain is not conducive to vehicle access. Cattle have utilised some of the drainage valleys and main riparian areas for grazing.

Table 1: Percentage Area of the CFA in relation to the Pilbara region and Hamersley sub-region of the Interim Biogeographic Regionalisation for Australia.

Area Description	Hectares	Percentage of PIL03 Hamersley Sub Region	Percentage of Pilbara IBRA Region	Percentage of Hamersley Range	Percentage of West Hamersley Range Conservation Park
Pilbara IBRA Version 7	17,830,076	N/A	100.0	N/A	N/A
PIL03, Hamersley Sub Region (IBRA Version 7)	5,632,613	100	31.6	N/A	N/A
Hamersley Range Area	4,402,000	78.2	24.7	100	N/A
Proposed West Hamersley Range Conservation Park	383,037	6.80	2.15	8.7	100.0
Proposed Conservation Focus Area (6,126 ha)	6,126	0.11	0.03	0.14	1.60
Conservation Focus Area Extension Area (6,126 + 868 ha)	6,994	0.12	0.04	0.16	1.83

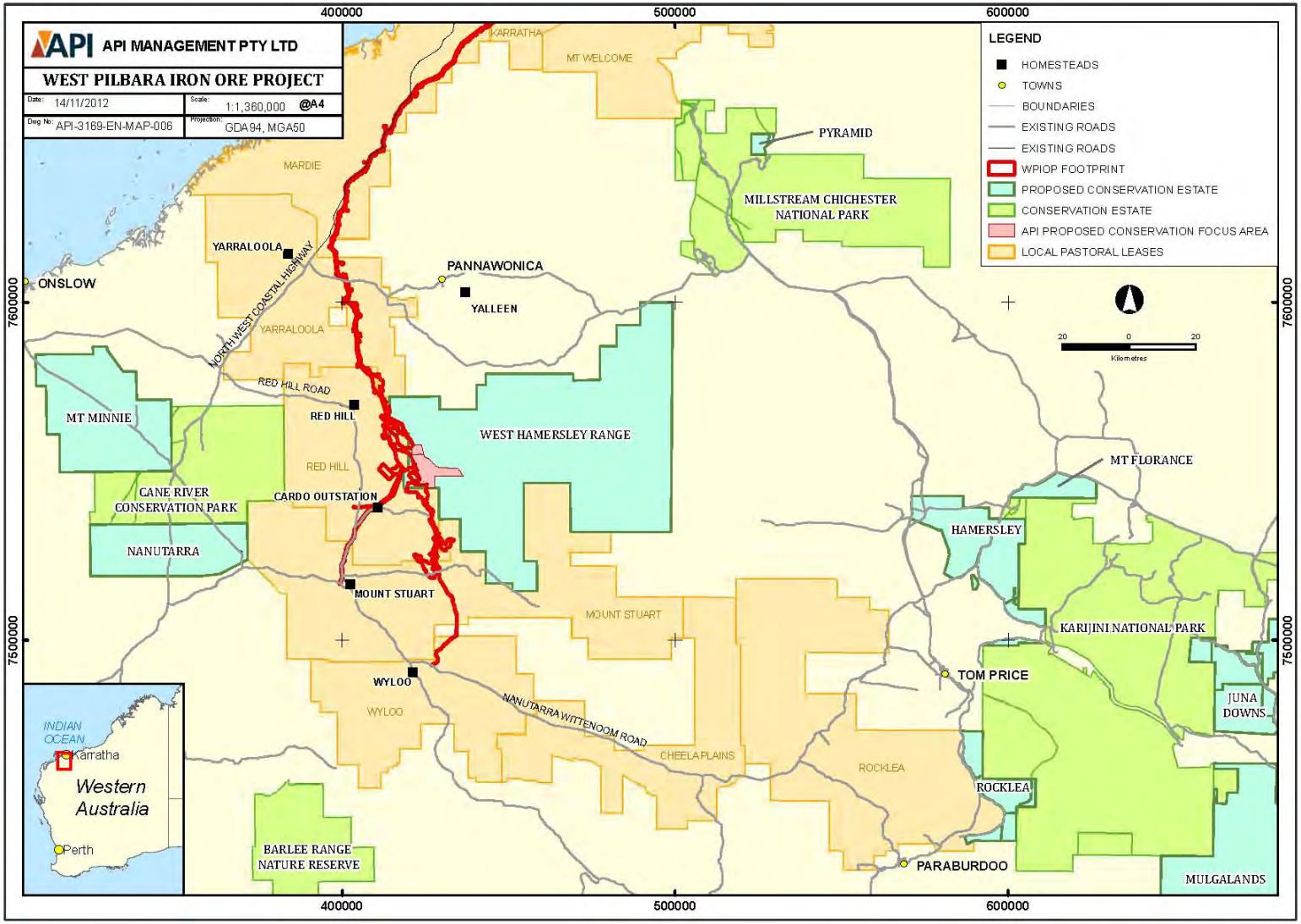

Figure 3: Location of the Conservation Focus Area in relation to existing and proposed conservation estate.

4.3 HABITAT VALUE OF THE CFA

The CFA hosts a range of habitat types. Eight major habitat types have been delineated to date including deeply incised gorges, stony hills and plateaus, incised major drainage, broad major drainage, incised minor drainage, broad minor drainage, mesa and outcrops, and plains (Rapallo 2012a).

The area is dissected by numerous gorges and drainage systems containing a number of ephemeral and potentially permanent pools. Three potentially permanent pools and twenty six ephemeral pools have been recorded in the area of the CFA that has been surveyed to date. Numerous caves have been recorded within the surveyed area.

The incised, rocky topography is recognised as favourable habitat for the Northern Quoll with the cliff lined drainage systems providing extensive denning habitat for the species. The cavernous nature of some rocky features, particularly in proximity to water, provides potential roost sites for Pilbara Leaf-nose Bat. Rocky terrain in proximity to water is also a preferred habitat of the Pilbara Olive Python.

4.4 FAUNA VALUES OF THE CFA

API has completed several preliminary fauna investigations, compliant with the Western Australian *Wildlife Conservation Act 1950*, across the western-most portion of the CFA in 2011 and 2012. The investigations have involved ecologists traversing the area, with a focus on the drainage lines, undertaking habitat assessments and inspecting and describing caves and other relevant features. Motion detection cameras (MDC) and echolocation detectors (SM2BAT+) were deployed, contributing to the observed fauna assemblages.

Extant populations of Northern Quoll, Pilbara Leaf-nosed Bat, and Pilbara Olive Python have been confirmed in the CFA (species profiles are included as Appendix 2). Other conservation significant species recorded within the CFA include the Rainbow Bee-eater (S3, migratory), Peregrine Falcon (S4), Ghost Bat (P4), Australian Bustard (P4), Bush Stone-curlew (P4) and the Fortescue Grunter (P4) (see Figure 4). Table 2 lists the conservation significant fauna recorded in the CFA. The surveys to date have identified 14 mammals (of which 9 are bat species), 29 reptiles, 2 amphibians and 43 bird species occurring within the CFA (full species lists are included in Appendix 3).

Approximately 36 individual Northern Quolls were recorded in the CFA. Northern Quolls are considered to occur across the majority of the drainage systems, with densities influenced by geology, weathering history and hence presence of rocky terrain.

A confirmed Pilbara Leaf-nosed Bat roost within the CFA is estimated, based on interrogation of thermal and infra-red video footage, to contain a population of approximately 10,000 individuals. This is significantly larger than previously recorded roosts in the Pilbara region, for which estimated populations have not exceeded 350.

Less records and/or evidence of the Pilbara Olive Python were obtained which is attributed in part to the cryptic nature of the species. Nevertheless the detection rate from the traversed areas (derived from observed animals, sloughed skins and urates), and extent of suitable habitat, suggests a Pilbara Olive Python population is present in the CFA.

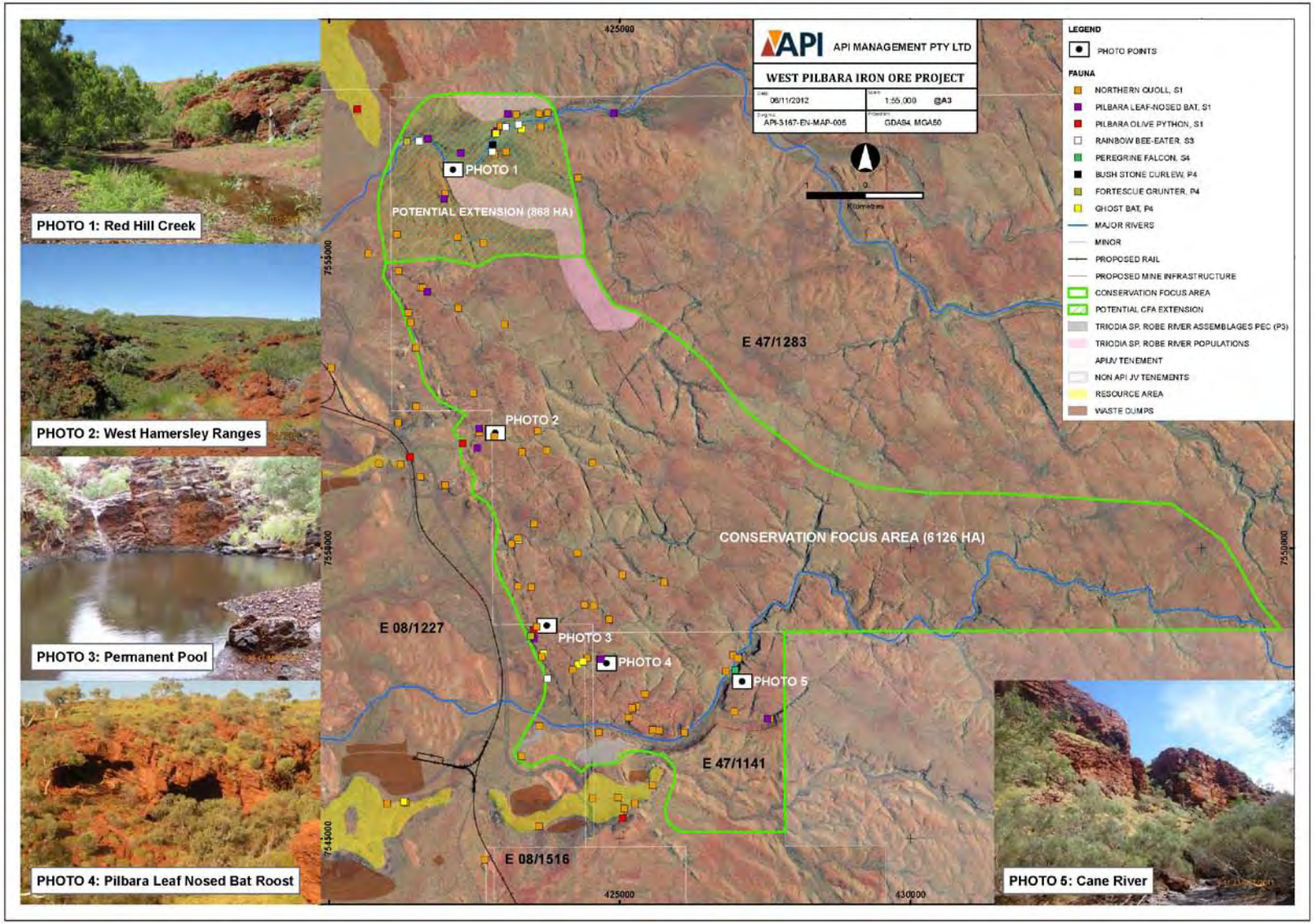

Figure 4: Fauna Values of the CFA

Table 2: Fauna of conservation significance recorded in the CFA

Species	State (status)	Commonwealth (status)	Recorded type
Northern Quoll (*Dasyurus hallucatus*)	Schedule 1[+]	Endangered	Observed and recorded via motion detection cameras and secondary observations (scats and tracks)
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*)	Schedule 1[+]	Vulnerable	Observed and recorded via echolocation recorders
Pilbara Olive Python (*Liasis olivaceus barroni*)	Schedule 1[+]	Vulnerable	Observed and recorded via slothed skins and urates.
Rainbow Bee-eater (*Merops ornatus*)	Schedule 3[+]	Migratory	Visual Observation
Peregrine Falcon (*Falco peregrinus*)	Schedule 4[+]	Not Listed	Visual Observation
Australian Bustard (*Ardeotis australis*)	Priority 4*	Not Listed	Visual Observation
Ghost Bat (*Macroderma gigas*)	Priority 4*	Not Listed	Visual Observation
Bush Stone-Curlew (*Burhinus grallarius*)	Priority 4*	Not Listed	Visual Observation
Fortescue Grunter (*Leiopotherapon aheneus*)	Priority 4*	Not Listed	Visual Observation

* Listed on DEC Threatened and Priority Fauna list as a species of conservation significance (6 November 2012). [+] Listed under the Wildlife Conservation (Specially Protected Fauna) Notice 2012 (2), Government Gazette 6 November 2012, *Wildlife Conservation Act 1950*.

4.5 INDIGENOUS CULTURAL HERITAGE VALUES OF THE CFA

The proposed CFA is situated within the Kuruma Marthudunera native title claim area. Preliminary surveys of parts of the CFA have been undertaken by API in consultation with the Kuruma Marthudunera people. Parts of the CFA are noted to have archaeological, ethnographic and historical significance, particularly a site called 'Sarah's Cave'.

'Sarah's Cave' is a place and a living story for the Kuruma Marthudunera people. Sarah was a Kuruma woman who occupied and subsisted on the land in this area from around 1930 to 1950 having little contact with family or the broader community (Brehaut and Vitenbergs, 2001). Sarah's story is known by her direct Kuruma Marthudunera descendants and the physical evidence of her daily life remains visible in the rock shelters, waterholes, river systems and surrounding areas. These specific locations are highly significant to the Kuruma Marthudunera people who support the proposed CFA as a means of affording protection to these areas. API will continue to engage with the Kuruma Marthudunera people to plan further surveys and develop appropriate management actions.

4.6 INVESTIGATION AND MONITORING ENVIRONMENTAL VALUES

4.6.1 Summary of surveys completed to 2012.

API has obtained data from the CFA through: (1) dedicated reconnaissance assessments of the CFA; and (2) surveys undertaken as part of the baseline monitoring programme for WPIOP Stage 1. This section summarises the data obtained from related surveys and Section 4.6.5 describes the results of the reconnaissance survey undertaken to inform the dedicated preliminary assessment (see also Figure 5).

The WPIOP baseline surveys that have yielded data relevant to the CFA are detailed in Table 3.

Northern Quoll Targeted Surveys completed in 2011 recorded Northern Quolls via foraging surveys, motion detection cameras (MDC), and cage trapping in the western portion of the CFA (Figure 5). This programme was continued at a selection of these sites in 2012.

Approximately 36 individual Northern Quolls were identified within the CFA. This data suggests the existence of a Northern Quoll population in the CFA. Additional surveying and monitoring is proposed to determine the population size and extent of occupancy of Northern Quoll within the CFA (Section 4.6.5).

Pilbara Olive Pythons, and evidence of, have been recorded opportunistically and during fauna surveys undertaken within the CFA, including sightings at two permanent pools near the western boundary of the CFA. It is proposed to extend the monitoring in the CFA utilising microchips to enhance assessments of the Pilbara Olive Python population (Section 4.6.5). This will be undertaken in consultation with DEC's Nature Protection Branch.

A Pilbara Leaf-nosed Bat roost was discovered in the CFA during the 2011 Northern Quoll targeted survey (Rapallo 2012b). Subsequent monitoring using an acoustic detector (Song Meter SM2BAT+ 384 kHz detector) recorded high bat activity levels and in conjunction with visual observations suggested the presence of a large colony (Astron 2012). The colony, one of only a few known in the Hamersley Range and occurring in a natural cave, is considered to be highly significant for the Pilbara Leaf-nosed Bat in the Pilbara region (Astron 2012).

In March 2012, API commissioned an infra-red and thermal imaging assessment to assist in quantifying the size of the Pilbara Leaf-nosed Bat colony. A manual count was undertaken from the recorded footage by slowing the frame rate so that individual bats could be tracked entering and leaving the cave. Analysis of the first hour of full darkness concluded, that an average 1,000 bats left the cave every ten minutes and 50 returned every ten minutes (Biologic Environmental Pty Ltd [Biologic] 2012). This provided a preliminary estimate of the colony size of 10,000 – 12,000 (Biologic 2012). Further investigations are planned to improve the confidence of colony size estimate.

Table 3: WPIOP Fauna Surveys with Sites in the CFA

Survey Description	Timing	Methodology	CFA Component	
			Effort	Species of NES Results
Targeted Surveys for the Northern Quoll 2011 (Rapallo 2012b).	Four phases of survey June, July, August and November 2011.	Habitat assessments, Foraging surveys, MDCs, and Baited cage traps.	24 MDC sites, 3 sites - 60 cage traps, deployed for a total of 300 trap nights.	13 Northern Quoll individuals were identified from MDC analyses. 8 Northern Quoll individuals were captured during the trapping. Pilbara Leaf-nosed Bat roost identified. Pilbara Olive Python sighted.
Activity Assessment for Bats of Conservation Significance 2011 (Astron 2012).	Three phases of survey March, July and October 2011.	Habitat and cave assessments SM2BAT+ recordings	7 cave assessments 5 SM2BAT+ monitoring sites	Pilbara Leaf-nosed Bat roost was confirmed Pilbara Leaf-nosed Bat activity recorded at all 5 SM2BAT+ sites.
Pilbara Olive Python Reconnaissance Survey 2011 (Rapallo 2011).	August 2011.	Habitat assessments, and Foraging surveys.	6 habitat assessments.	Evidence of Python recent use found.
Trapping Survey for the Northern Quoll 2012 (Rapallo 2012c).	July 2012.	Baited cage traps	2 sites - 40 cage traps deployed for a total of 200 trap nights.	15 individual Northern Quolls were captured.
Pilbara Leaf-nosed Bat monitoring 2012 (Biologic 2012).	March 2012.	SM2BAT+ recordings Infra-red and thermal imagery	5 SM2BAT+ monitoring sites. Imagery undertaken at 1 site.	Pilbara Leaf-nosed Bat activity recorded at 4 SM2BAT+ sites. Population estimate of 10,000 to 12,000 individuals at the roost.
MDC and SM2 Annual Monitoring (API).	MDC footage collected every two months and SM2BAT+ recordings collected every three months.	MDC footage collection and SM2BAT+ recordings	4 MDC monitoring sites 5 SM2BAT+ monitoring sites.	Full data analysis pending. All four MDC sites have recorded the presence of Northern Quoll.

MDC – motion detector camera
SM2BAT+ - acoustic detectors deployed

Note all surveys were undertaken in conformance to the Western Australian *Wildlife Conservation Act 1950* and *Wildlife Conservation Regulations 1970,* other relevant legislation, and regulatory position and guidance documents relevant to terrestrial fauna surveys.

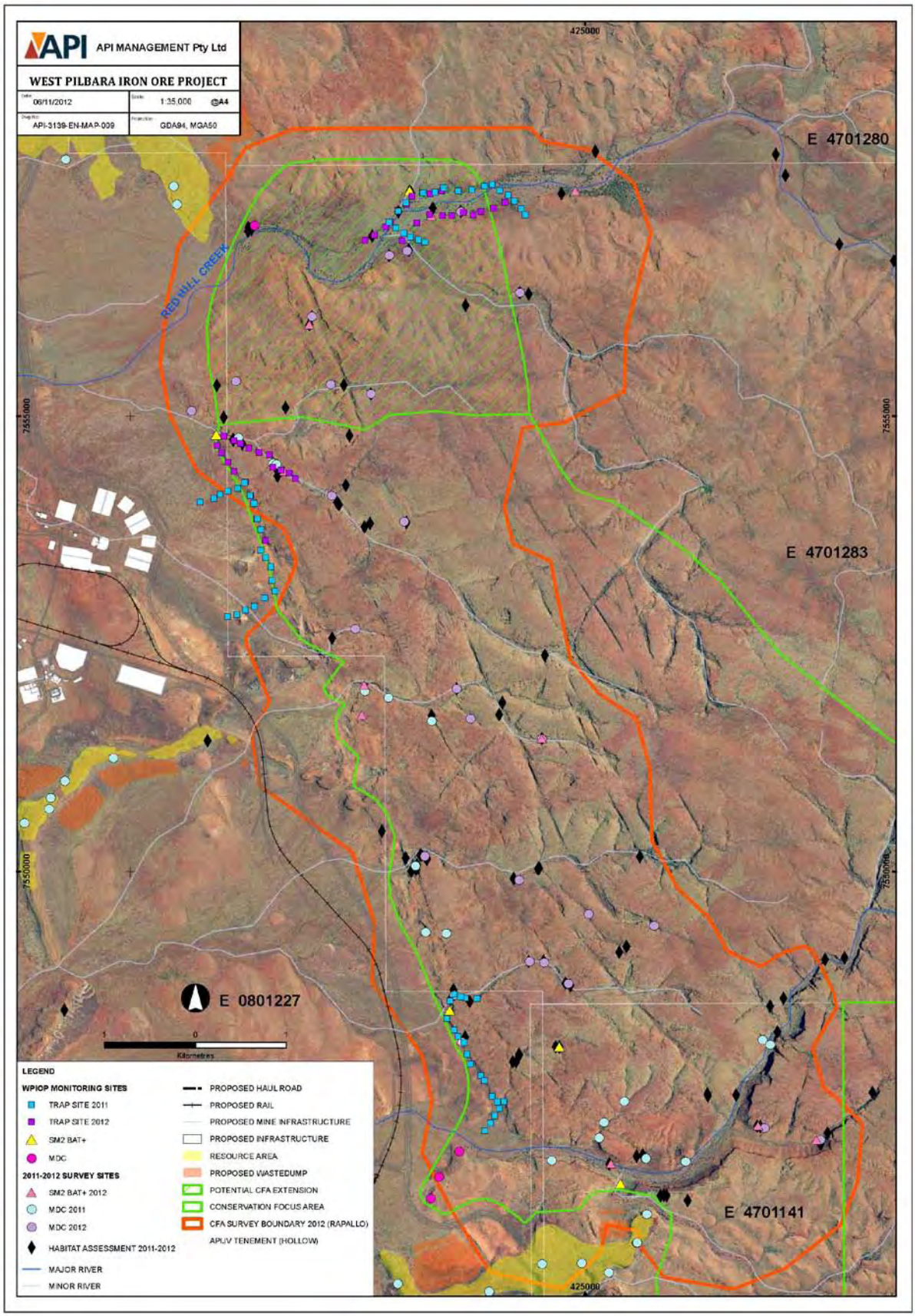

Figure 5 WPIOP Fauna Monitoring and Survey Sites within the CFA

4.6.2 Objectives of Proposed CFA Investigation and Monitoring Programme

Key objectives of the investigation and monitoring programme are:

(i) describe and document environmental values;

(ii) measure and detect changes in key environmental values of the CFA;

(iii) measure the distribution and/or activity levels of conservation species; and

(iv) measure the effectiveness of prescribed management action(s).

4.6.3 Investigations and Monitoring Approach

The proposed investigations, surveys and monitoring methods will be compatible with other regional scale monitoring undertaken in the Pilbara. Four phases have been developed to achieve the key objectives. These phases are:

- Phase 1 – Identification of Environmental Values;
- Phase 2 – Monitoring Implementation and continued Baseline Data Collection;
- Phase 3 – Development of Management Actions: and
- Phase 4 – Monitoring the Effectiveness of Implemented Management Actions.

The proposed timeline for implementation of the monitoring programme are presented in Table 4. Phase 1 and 2 are discussed in detail in section 4.6.5 below. The development of prescriptive management actions (Phase 3) is presented in section 4.7. Phase 4 of the monitoring programme will be developed following the finalisation of the Phase 3 – Developing of Management Actions.

Table 4: Proposed Implementation of the CFA Monitoring Programme[β]

Key Task	Year 1*	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10 to 15
Phase 1 - Identification of environmental values										
Fauna survey(s)										
Flora survey(s)										
Phase 2 - Monitoring implementation and baseline data collection										
Development of detailed monitoring programme										
Statistical review of monitoring programmes										
Fauna										
Establishment of monitoring sites										
Collection of baseline monitoring data										
Flora										
Establishment of monitoring sites										
Collection of baseline monitoring data										
Phase 3 - Development of prescriptive management actions										
Development of management actions										
Phase 4 - Monitor effectiveness of implemented management actions										
Fauna monitoring										
Flora monitoring										
Reporting and Review										
Annual Reporting										
Monitoring programme review										

*From the commencement of action
Schedule subject to change pending the outcomes of surveying and monitoring
[β]Programme implementation to commence after the first wet season following the commencement of the action (construction).
Surveys will comply with the Western Australian *Wildlife Conservation Act 1950* and *Wildlife Conservation Regulations 1970*.

4.6.4 Framework and Procedures

Detailed monitoring frameworks and procedures will be developed prior to implementation of the Phase 2 monitoring programme, based on data from Phase 1 surveys. The frameworks will detail:

- The objective(s) of the monitoring programme;
- Identify monitoring design and criteria;
- The development of a set of standard operating procedures (SOPs) for undertaking the monitoring;
- Data management, analysis and reporting requirements; and
- The schedule of internal and external review periods.

To ensure the quality and accuracy of the data to be collected, the SOPs will include detailed instructions on how each aspect of the monitoring programme is to be undertaken.

4.6.5 Fauna Investigations and Monitoring Programmes

Phase 1 - Identification of Fauna Values

A dedicated reconnaissance fauna survey was undertaken across part of the CFA in May 2012. The survey documented general fauna assemblages as well as fauna of conservation significance. The survey included habitat assessments, cave assessment, foraging surveys, spotlighting surveys, bird surveys, MDC and echolocation recording (Song meter SM2BAT+). The survey recorded the presence of the Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python and Rainbow Bee-eaters. Table 5 presents a summary of the findings of the survey. The complete report, with full species lists, is included as Appendix 3.

Table 5: Summary of findings of the 2012 Reconnaissance Survey of the CFA (Rapallo 2012c).

Methodology	Description	Effort	Key Findings
Habitat assessments	Habitats were described and key features and range recorded.	31 habitat assessments	8 habitat types identified; hill/plateau, gorge, mesa/outcrop, major drainage (incised and open) and minor drainage (incised and open) and plain. 23 ephemeral pools identified.
Cave assessments	Caves characteristics were recorded including depth, height, shape, complexity, connectivity with other formations, position in strata, evidence of use.	37 cave assessments	Sightings of Ghost Bats (P4*) from 5 caves, Common Sheath-tailed Bat from 24 caves and Finlayson's Cave Bat from 4 caves.

Methodology	Description	Effort	Key Findings
Foraging surveys	Active foraging included flipping rocks, lifting bark, lifting logs and sifting litter, in targeted habitats.	14 foraging surveys	Northern Quoll, Pilbara Olive Python and Rainbow Bee-eater were recorded. Peregrine Falcon (S4+), Ghost Bat (P4*) and Australian Bustard (P4*) were recorded. Also recorded were 2 mammals, 35 birds, 1 amphibian, and 20 reptile species.
Targeted spotlighting for Pilbara Olive Pythons	Spotlight surveys conducted over 2 to 3 hours from dusk in targeted habitats.	3 surveys	1 Northern Quoll was sighted Also sighted were 2 mammals, 2 birds, 1 amphibian, and 9 reptile species.
Bird surveys	20 minute timed bird surveys.	8 surveys	Rainbow Bee-eater sighted. 26 other bird species recorded.
Motion detecting camera (MDC)	Scoutguard 550 MDC deployed for a minimum 3 nights.	24 MDC sites	21 Northern Quoll individuals identified. Also recorded: 2 mammals; 4 birds; and 2 reptile species.
Echolocation Recording	Song meter SM2BAT+ passive ultrasonic bat recorders deployed for 3 to 6 nights.	7 SM2BAT+ sites	Pilbara Leaf-nosed Bat recorded from 6 sites. Ghost Bat (P4*) recorded from one site. 7 other species of bat recorded.

+ Fauna listed by the *Wildlife Conservation Act 1950.*

* Listed on DEC Threatened and Priority Fauna list as a species of conservation significance (6 November 2012).

API proposes to complete the reconnaissance fauna survey of the CFA in the first two years of implementing the TFCP, utilising the same methodologies as described in Table 5.

Phase 2 – Fauna Monitoring Implementation and Baseline Data Collection

The fauna monitoring programme for the CFA will include monitoring of the Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, native fauna and feral animals from a suite of permanent sites, based on data collected during the Phase 1 surveys. The programme will be structured to ensure statistical rigour. The baseline monitoring will be undertaken for a minimum of three years to obtain population, community and habitat data to inform the development of prescriptive management actions and be capable of supporting subsequent analyses of the effectiveness of management actions. Access to large portions of the CFA is limited to helicopter and by foot, and consequently cost, and the health and safety of monitoring teams are significant considerations in the scoping and timing of monitoring programmes. An outline of the proposed monitoring is presented in Table 6 and further described in the sections below. All programmes will comply with legal requirements under the Western Australian *Wildlife Conservation Act 1950* and will include appropriate liaison with DEC Nature Protection Branch in any activities involving the 'handling' or 'taking' of any fauna including protected fauna.

Table 6: Proposed fauna monitoring in the CFA

Target Species	Methodology*	Key Outcomes	Timing for the first 3 years of monitoring
Northern Quoll	Baited MDC	Population size (numbers of individuals), Area/extent of occupancy, Movement (range, dispersal, migration), Behavior (interactions between Northern Quolls), Breeding information.	MDC to be recording continuously. Data to be collected quarterly.
Pilbara Leaf-nosed Bat	Song meter SM2BAT+ recorders.	Species present, Activity levels, Foraging areas.	SM2BAT+ recorders to be deployed quarterly for a minimum of 4 nights.
Pilbara Olive Pythons	Extension of the WPIOP micro-chipping monitoring programme.	Morphological data on individuals, Population size (number of individuals), Area/extent of occupancy, Movement (range, dispersal, migration).	Encounter based.
	Targeted spotlighting.	Species presence, Population size (number of individuals), Area/extent of occupancy.	Post large rainfall event.
Feral Animals	Targeted spotlighting.	Species presence, Population size (number of individuals), Area/extent of occupancy.	Twice a year.
	Scat and dietary analysis.	Dietary information.	Encounter based.
Other Vertebrate Assemblages (birds, reptiles, short range endemics)	Foraging surveys in each habitat type.	Presence/absence of each species, Inventory of reptiles present, Collection of potential short range endemic specimens,	Surveys to be undertaken twice a year.
	Transect bird surveys, in each habitat type. Timed counts will be undertaken at designated locations along the transect.	Inventory of birds present, Population size (numbers of individuals), Changes in species diversity.	Surveys to be undertaken quarterly.
Habitat observations	Record and describe climate and other events that result in alterations in habitat.	Occurrence and extent of fire, River and creek flow events, Presence of water in ephemeral pools, Rainfall or drought events, Rock fall or cave collapse, Grazing.	Quarterly in conjunction with surveys above. Event driven.

*Subject to adaptive management, details subject to Phase 1 outcomes and ongoing review.

Northern Quoll

Permanent motion detecting camera (MDC) monitoring sites, targeting the Northern Quoll will be established progressively within the CFA, from the second year of the programme. Sites will be established in habitats considered highly suitable for Northern Quoll denning and foraging, including gorges and complex caves, crevices and boulder systems. While targeting suitable habitats for the proposed sites is preferable, access to some of these areas will be a limiting factor during the site selection. The number of proposed sites will be finalised upon completion of the Phase 1 surveys.

The MDC sites will initially be baited with a fish based cat food. All sites will be checked four times a year. During this time the data will be retrieved, bait stations refreshed, power supplies checked and replenished and functionality of each MDC camera tested. Still images of the Northern Quolls will be extracted from the video footage and analysed for unique spot patterns by visual assessment and WildID software (Bolger et al, 2011).

Pilbara Leaf-nosed Bat

Pilbara Leaf-nosed Bat populations will be monitored by Song Meter SM2BAT+ echolocation recordings, from the second year of the monitoring programme. The SM2BAT+ units will be located in foraging habitats including pools, riparian and cliff face areas and potential roosting sites. The final number of SM2BAT+ sites will be determined after the completion of Phase 1 surveys.

The SM2BAT+ units will be deployed at each site for a minimum of four nights. Alternative power supplies will be investigated to extend the duration of recording nights. All site recordings will be analysed for species identification, activity levels and timing of activity.

Pilbara Olive Python

Pilbara Olive Pythons populations will be monitored by micro-chipping tracking of individuals and targeted post rain spotlighting surveys. The Pilbara Olive Python occurs in low population densities, has a cryptic nature and is inherently difficulty to trap. Thus the proposed micro-chipping and spotlighting surveys are encounter and event driven, rather than utilising a traditional monitoring approach, structured by repeat sampling at a given location and time. It is anticipated that by micro-chipping as many individuals as possible, API will be able to build a data base that could ultimately assist in developing a future Population Viability Analysis (PVA).

As individuals are opportunistically encountered, while undertaking the other aspects of the fauna monitoring programme, they are to be scanned with a micro-chip reader to identify the individual. If the Pilbara Olive Python does not have an existing micro-chip identification, the individual is to be injected with an 11 mm passive integrated transponder (PIT) micro-chip by authorised (competent/experienced) personnel. Individual features including body length, reproductive condition, weight, identifying features and micro-chip identification number (if the individual is a recapture) are to be recorded. A tissue sample will be collected from the individual for genetic analysis. Tissue samples attained may assist in determining and genetic variation between Pilbara populations.

Pilbara Olive Pythons are most active during the warmer, wetter months of the year particularly in areas were ephemeral pools have been recharged by seasonal rainfall events. To increase the opportunity to encounter and micro-chip the Pilbara Olive Python population within the CFA, post rain targeted spotlighting surveys are proposed. Pending access to the CFA, spotlighting will be undertaken for 3 to 4 hours commencing at dusk, for 3 nights following the rain event. The spotlighting surveys are to be undertaken in areas known to support Pilbara Olive Pythons such as gorges containing ephemeral pools and in habitats where Pilbara Olive Pythons are expected to occur such as minor gorges, cave systems, rivers and creeks, and hilltops where sub adults have been observed foraging. In addition, autumn surveys will be conducted in an effort to capture individuals prior to the breeding season.

All secondary evidence, urates and skins, of Pilbara Olive Pythons are to be documented. Any new individuals encountered during the spotlighting surveys are to be micro-chipped and documented, as described above.

Feral Animals

Some presence of feral animals including cats, potentially foxes, cattle, dingoes, and others within the CFA is assumed. Information regarding the size of the feral population, landscape utilisation and impacts on conservation significant fauna of the CFA has been identified as a knowledge gap.

A collection of complementary monitoring techniques, for feral animal observation and monitoring, including spotlighting, scat and dietary analysis are proposed to gather data to inform the development of appropriate prescriptive management actions. Implementation of set monitoring sites is to commence from the second year of the monitoring programme. Records of feral animals encountered during the undertaking of other aspects of the fauna monitoring programme, including spotlighting surveys and use of MDCs will also be documented.

Spotlighting surveys are proposed to be undertaken within accessible areas, to identify the presence of feral animals within the CFA. Spotlighting will be undertaken for 3 to 4 hours commencing at dusk, twice a year. The spotlighting surveys are to be undertaken in habitats where feral animals are expected to occur. These habitats include creek and rivers systems and the associated riparian fringes and gorges containing ephemeral pools.

Scat analysis is proposed to identify the occurrence of feral animals, specifically cats and foxes, and their diet. Scat specimens will be collected and stored for later analysis. The location and habitat details of each record are to be documented.

Other Vertebrate Assemblages

Foraging and bird surveys are proposed to be undertaken within the CFA, to document the assemblages of reptiles and birds. Foraging surveys, targeting reptiles are to be undertaken twice a year preferably one sampling event during the wet season (January to April) and one in the dry (June to September). The foraging surveys are to include flipping rocks, lifting bark and logs and sifting litter. During the surveys any evidence of fauna of conservation significance and other general fauna, including tracks, scats, burrows and remains are to be recorded.

Bird surveys are to be undertaken quarterly within the CFA. The permanent transects of approximately 1 kilometre are to be walked early each morning during the survey event. Birds recorded are to be identified to species level using direct observations and where possible calls. At designated locations along the transect, approximately every 100 metres and within a 50 metre radius, timed bird surveys of 10 minutes are to be undertaken. At these locations, species and number of birds observed are to be recorded.

Habitat Observations

Recording of events that can result in an alteration of the condition of a habitat, can provide valuable information, when interpreting fauna data. When undertaking any of the aspects of the monitoring programme, occurrences of and extent of fires, cave collapses, areas of senescing vegetation, pooling of water, creek or river flows, insect infestations, and large flowering events are to be documented. Local rainfall and climate data for a year preceding the survey and during the undertaking of the survey are to be collected.

4.6.6 Flora Investigations and Monitoring

Phase 1 – Identification of Flora Values

Surveys to document the flora values of the CFA are proposed commencing in the first year of the TFCP implementation. The proposed surveys will be structured to collect data on vegetation communities, conservation significant species and communities and introduced species. Surveys will be phased and based on spatial constraints and seasonality. A Western Australian Priority Ecological Community (PEC) has been identified in the CFA (see Figure 4, southern area) *Triodia* sp. Robe River (MET 12.369) assemblages of mesas of the West Pilbara. This was identified as part of the impact assessment process at the State level leading to the Ministerial Statement 881 (MS881). Management of this community is conditioned by the State as part of MS881.

Phase 2 – Flora Monitoring Implementation and Baseline Data Collection

Flora monitoring will focus on introduced species within the CFA. Transects will be established to monitor introduced species occurrence, distribution and abundance, in areas identified as low, medium, and high risk and in any communities of conservation significance identified during the Phase 1 flora surveys. Each transect is to be approximately 100 metres long, with a total 20 metre wide monitoring corridor, established either side of a centerline. Data to be collected includes: list of species present; cover for each species; and photographs of the transect.

4.6.7 Indigenous cultural heritage

Discussions between API and the Kuruma Marthudunera People have commenced on proposed management activities in the CFA. In consultation with the Traditional Owners, archaeological and anthropological surveys will be conducted.

4.7 MANAGEMENT ACTIONS

An adaptive approach is proposed to the development of management actions to protect and enhance, if appropriate, the biodiversity value of the CFA, underpinned by a sound understanding of the values and threatening processes to be gained through an initial period of survey and monitoring.

The CFA is remote and given the generally incised topography and rocky substrate, has not been subject to material human access in modern times, save for some pastoral related activities on the western edge and opportunistic grazing by cattle along the Cane River and Red Hill Creek.

Consequently, the preliminary assessment of the CFA is that ground disturbance is limited, there is a small weed burden along river channels probably facilitated by cattle movement and grazing and a limited presence of feral predators. The historical fire regime is not well defined, and given the topography and habitat diversity is unlikely to have uniformly affected the whole of the CFA.

The CFA is unallocated Crown Land. By virtue of the exploration licence(s) granted under the Mining Act API holds rights to mineral exploration for iron ore. The rights to explore for other minerals on the tenements is held by other entities, and API does not control access to the land or the nature of any exploration activities undertaken on that land. Similarly, API does not have control of any non – resource related land use in the CFA. There are currently no known third party proposals to access or use the CFA for any purpose. Any proposal will be subject to normal government regulatory processes.

Initial management of the CFA, to be applied in years 1 to 5 of the TFCP, will aim to maintain the existing status of the area with the establishment of an adjacent mining operation. Key management actions are centred on restricting access to all personnel within the control of API, and managing activities in the operational area to minimise the risk of impact on the CFA (such as weed infestation, fire etc).

Following the characterisation of the CFA and establishment of baseline data in the first 5 years, direct management actions will be developed for implementation within the CFA aimed at diminishing or eradicating identified threats. These direct actions may include weed and feral animal control, and management of fire regimes, developed and conducted in consultation with DEC and traditional owners. Continuation of targeted monitoring will enable the effectiveness of the direct management actions to be evaluated.

Table 7 summarises the proposed initial management actions.

Table 7: Management actions, preliminary and prescriptive, and KPIs.

Threat	Potential impact	Preliminary Management Actions	Key Performance Indicator
Human activity	Uncontrolled human activity may result in the degradation of habitat, change of species behavior and injury or death of fauna.	Access to CFA for people under API control will be restricted. Area permit required for any personnel entry into or through the CFA to be approved by the Site Manager. Signs will be installed demarcating the area as 'Authorised Access Only'. No firearms or pets will be permitted in mining operations. (exclusion may apply to firearms for qualified feral animal control personnel). Training on fauna identification and reporting of conservation-significant fauna species will be included in the environmental induction and environmental awareness sessions (toolbox training presentations).	CFA will be clearly marked and sign posted. No unauthorised access to the CFA. Training of all API personnel and contractors successfully completed. All personnel and contractors aware of their environmental responsibility. No records of unauthorised firearms. No records of pets in areas under API control.
Vehicle activity	Vehicle strike may result in injury or death of individuals.	Access under API control will limit movements to authorised personnel only. Speed limits will be implemented on all API roads bordering and tracks within the CFA. No unauthorised off-track driving.	No unauthorised access to the CFA. No records of speeding or off-track driving. No records of injury or death of fauna.
Introduced plants (weeds)	Weed species may out-compete native species and modify natural ecosystems. Several species known to the region are highly invasive and may colonise the CFA.	Application of hygiene procedures to minimise risk of weed introduction and dispersal.	Completion of weed surveys and weed risk assessment. No records or control of declared plants within the CFA. Successful control of invasive weeds, if required. Identified high weed risk zones marked and sign posted.
Introduced fauna	Introduced fauna pose a threat to the native species populations both directly through predation competition resources and habitat degradation.	Exclusion of stock achieved through agreement with pastoralist and implementation of WPIOP Stage 1.	Reduction in pastoral stock entering the CFA.

Threat	Potential impact	Preliminary Management Actions	Key Performance Indicator
Altered fire regime	Unnatural fire regime may impact ecosystem integrity.	Hot work permit system in place for API operations. No fires to be lit in or around the CFA unless part of a DEC approved management programme. The potential impact from fires originating in the neighbouring WPIOP Stage 1 area will be controlled as per normal fire emergency practices. Firefighting equipment will be part of the construction and operations of the WPIOP.	No man made fires impacting on the CFA. An appropriately equipped emergency response team available to prevent fires entering the CFA from neighbouring WPIOP Stage 1 area.

5 Long Term Protection of CFA Conservation Values.

The control and use of Crown land for the protection of conservation values is primarily achieved in Western Australia through reservation of the subject land. The *Land Administration Act 1997* (LAA) is the principal State legislation for the creation and management of reserve lands. The Minister for Regional Development and Lands (Minister) administers the LAA, assisted by the Department of Regional Development and Lands (DRDL).

The most secure and enduring form of land tenure that may be created in Western Australia for the protection of conservation values is a Class A Reserve. The Minister may create Class A reserves 'by Ministerial Order' under Sections 41 and 42 of the LAA and once created, such a reserve may only be amended or cancelled with the approval of State Parliament. Class A reservation is used to protect areas of the highest conservation or community value.

The Minister may create conservation reserves under Section 41 of the LAA that are not subsequently classified Class A (under Section 42 LAA), and consequently not afforded the same level of security. The Minister may amend 'non Class A' reserves without recourse to Parliament.

Conservation reserves are normally vested in the Conservation Commission of Western Australia and managed through the provisions of the *Conservation and Land Management Act 1984* (section 5(1)(h)).

The processes to create a conservation reserve are normally implemented by DRDL. A request to create conservation estate may be made by the community, a corporation, Local Government or Government Agency. The creation of conservation reserves is a matter of Government policy and DRDL will consider the request in the context of policy and other documented principles.

In considering the reservation of land, the DRDL will consult across Government. Departments will generally respond to reservation proposals in accord with their respective charter and not ordinarily be completely aligned. While generally in favour of the protection of the environmental assets and biodiversity values of the State, DEC will carefully consider the budgetary implications of managing additional lands. In the case of the API proposed CFA, concern over longer term funding for management activities is particularly relevant after the cessation of API support and closure of API mining operations.

The majority of the Hamersley Range including the CFA is subject to tenure granted under the Mining Act which both entitles and obliges the tenement holder, subject to approvals, to explore for and exploit mineral resources. Mining Act tenure is administered by the Department of Mines and Petroleum (DMP). The DMP regulates the resource sector, promotes responsible resource development and argues for the maintenance of land access for mineral exploration. A proposal to create conservation estate that limits or prevents exploration activity is unlikely to be received favourably by the DMP.

Any proposed change of land tenure that may affect (impair) claimed or determined native title rights and interests must comply with the future act provisions of the *Native Title Act 1993* in order to be validly done. As the CFA lies wholly within the boundaries of the Kuruma Marthudunera People's registered native title claim, this requirement is activated. The creation of conservation estate, and more particularly its vesting in a management body, could result in the extinguishment of native title rights and interests, depending upon the future act process applied to validate it. Compensation may also be payable for any effects on native title rights. API understands that the support of the Kuruma Marthudunera People for formalising the CFA would be dependent upon there being a minimal effect on native title and formalisation of their involvement through a joint management arrangement.

The CFA could be recognised without extinguishing native title by use of an Indigenous Land Use Agreement, which could also incorporate terms enshrining joint management. This would likely secure the support of the Kuruma Marthudunera People and limit any compensation that may be payable under the *Native Title Act 1993*. However, it would be necessary for the Western Australian Government to drive such an agreement-making process as:

- An agreement of this scope would have implications for the resolution of the entire Kuruma Marthudunera native title claim, which is a matter for the Western Australian Government; and
- API is not able to unilaterally agree to arrangements that would bind the Western Australian Government to jointly manage the CFA with the Kuruma Marthudunera People.

Notwithstanding the complexity of the future act process, which is beyond API's power to resolve, API has already developed initiatives to involve Kuruma Marthudunera People in conservation-related activities throughout the CFA, including direct participation in fauna studies and baseline monitoring exercises. API will continue to engage with the Kuruma Marthudunera People to promote consideration of formalising the CFA as conservation estate.

The CFA is within a larger area recommended by DEC for reservation as the West Hamersley Range Conservation Park in 2002. In part acknowledgement of the extensive Mining Act tenure and prospectivity for iron ore, the area was proposed as a conservation park with a 'multiple-use' land management framework. A 'multiple-use' framework, which would require detailed definition, could provide the greatest likelihood of support from stakeholders for the creation of conservation estate. Such a 'multiple-use' framework may include areas set aside from mining based on confirmed and documented conservation and/or heritage values. Other areas may be deemed suitable only for infrastructure such as road, rail, and utility corridors - as opposed to extractive mining - based on environmental and heritage values. While on face value any ground disturbance would appear contrary to a conservation objective, the presence of long term economic infrastructure in lower value areas can provide the financial means for the protection and management of high value areas, without significant overall environmental impact.

API has proposed a process for the investigation, documentation and enhancement of environmental values of the CFA. The programme will provide a data set and context to present the strongest possible case for Government consideration of a proposal that the CFA be reserved for conservation. Implementation of the proposal, in accord with policy (including effects on Native Title rights or extinguishment), is a matter for Government.

By virtue of a commercial agreement and granted mining tenement (Exploration Licences E08/1283-I, E08/1227-I, E47/1141-I, E47/1280-I, and Miscellaneous Licence L08/67) API has the right to explore for iron ore across the CFA. API does not have exclusive rights to access the CFA and cannot regulate third party access or activities such as to explore for other minerals. API's influence is limited to broad communication of objectives, environmental programmes and environmental values of the CFA, to be considered by Government agencies in regulating, investigation and land management activities.

In keeping with a multi-use objective, and as discussed above, it is conceivable that 'low impact' activities or certain infrastructure development within the CFA may not compromise the conservation objectives of the CFA.

In the event the CFA is subject to land use approved by government that following analysis is likely to result in unacceptable, large scale, or irreversible impacts to the documented key environmental values, API will submit a revised TFCP. The revised TFCP will propose an alternative conservation area to which the objectives, programmes, and procedures of the TFCP will be applied.

API has identified a suite of environmental values within the CFA to date. Any proposal for an alternative conservation area will need to consider the values that may be foregone in the existing area (for example API considers there would need to be a compelling argument to abandon a focus on the significant PLNB roost as a consequence of nominating an alternate conservation area).

If further investigations and studies related to the expansion of the West Pilbara Iron Ore Project indicate a need to revise the current proposed CFA boundary approval of the Minister for Sustainability, Environment, Water, Population and Communities, then API will submit a revised Threatened Fauna Conservation Plan describing the proposed changes.

The following is a list of key milestones anticipated for the long term protection of CFA biodiversity values:

Milestone	Submission to	Timing *
Report of collated environmental data including appraisal of environmental values to DEC and SEWPaC	SEWPaC	30 June, Year 5.
Submission of Paper • as to the merits and risks of altering land tenure status as a means of affording improved conservation outcomes; • examination of the feasibility of incorporating the CFA in any Pilbara wide conservation programmes or initiatives in accord with multi-use government policy (such as the emerging Strategic Pilbara Conservation Initiative as promoted by the Western Australian Environmental Protection Authority).	DEC	30 June, Year 5
Follow up actions: • Identify follow up actions as may arise from correspondence and dialogue with DEC; • Provide plan of action to address the matters arising and /or close out and report on these.	DEC SEWPaC	30 September, Year 5

* Baseline year (Year 0) = year of substantial commencement of the action.

6 Key Milestones, performance indicators and timeframes

Milestone	Performance indicator	Timeframe
Characterisation of CFA values and threatening processes		
Reconnaissance Survey of CFA.	Confirm presence of three focus NES species.	Completed May-July 2011.
Preliminary surveys.	Undertake preliminary Level 1 terrestrial fauna survey. Determine the viability of NES populations.	Completed May 2012.
Reconnaissance / baseline surveys (to complete description of environmental values of CFA).	Annual survey completed. Data analysed and reported.	Year 1 – 5.
Establishment of baseline monitoring sites.	Establish monitoring sites Monitoring frequency and methodologies are defined. Measure/demonstrate positive response to actions implemented to enhance the biodiversity values for EPBC Act listed threatened species in the area.	From Year 2 monitored annually.
Implement annual monitoring of baseline monitoring sites.	Monitoring completed. Data analysed and reported.	Commencing from Year 2 - 5 Year.
First initial compilation of results from biological surveys and initial monitoring programme.	Confirmation of the core environmental values for the CFA in areas surveyed.	By end of Year 5 post the commencement of the action.
Presentation of results from biological surveys and initial monitoring programme to key stakeholders including SEWPaC and DEC.	In dialog with regulators, consolidate an appropriate CFA boundary that supports viable populations of EPBC Act listed threatened fauna species.	By end of Year 5 post the commencement of the action.
Coordinated multi WA Government departmental meeting through DRDL including appropriate Government and Non Government Organisation representatives regarding the proposed reservation of the CFA.	Meeting undertaken and determination of support and/or key concerns of the represented stakeholders obtained. Action plan proposed.	Year 5 post the commencement of the action.
API facilitated development of a key strategy through DRDL to map the required processes and mandatory consultative actions to promote the conversion of UCL into a reserve for biodiversity conservation based on the proposed boundary of the CFA.	Strategy developed that outlines the key actions, timelines, and performance indicators to enable DRDL to progress to the eventual conversion of UCL to a reserve for biodiversity conservation.	Year 5 post the commencement of the action.

Milestone	Performance indicator	Timeframe
Management Actions (indirect)		
Exclude API construction and operations personnel.	No events of unauthorised access by API project related personnel.	Commencement of the action and for life of project.
Manage operational activities to minimise risks to CFA in accord with operational management plans.	No pets. No firearms. Project fauna management plans implemented. Weed hygiene procedures implemented.	Commencement of action and for life of project.
Management Actions (direct)		
Progressively implement agreed annual management actions following review of ongoing investigative studies developed on review of an accumulating data set.	To be defined and collaboratively introduced as a result of consultation with DEC and SEWPaC during reviews of annual reporting outcomes.	Year 2 – 5
Specific management actions and KPI's defined on the basis of survey data and knowledge of threatening processes. Potentially include, for example: Feral predator control programme; Management of fire regime; and Weed eradication programme;	To be defined.	Year 5.
Specific monitoring to be developed to measure effectiveness of direct management actions.	To be defined.	Year 5.
Implementation of direct management actions.	To be defined.	Year 5 – Year 15 (life of project).
Implementation of monitoring actions.	To be defined.	Year 5 – Year 15 (life of project).
Annual review and analysis of the effectiveness of implemented management actions.	To be undertaken progressively as management actions are defined and implemented.	Year 2 to Year 15 (life of project).
Reporting		
Annual performance and compliance report.	Report published on corporate website.	Annually from commencement of action by 30 June each year.

7 References

Astron Environmental Services (Astron) (2012). West Pilbara Iron Ore Project Activity Assessment for Bats of Conservation Significance, February 2012. Prepared for API Management Pty Ltd, Report Reference: 12021-11SRV4Rev0_120227.

Biologic Environmental Pty Ltd (Biologic) (2012). Pilbara Leaf-nosed Bat Monitoring 2012.

Bolger. D.T., Vance, B., Morrison, T.A., and Farid, H. (2011). Wild-ID User Guide: Pattern Extraction and Matching Software for Computer--Assisted Photographic Mark-- Recapture Analysis Version 1.0, January 2011, Environmental Studies Program, Dartmouth College, Hanover, N.H. 03755.

Brehaut, L. and Vitenbergs, A. (eds) 2001. *The Guruma Story: told by Guruma Elders led by Peter Stevens*. Alice Springs: Jukurrpa Books.

Department of Conservation and Land Management (DEC) (2002). Botanical Survey of Hamersley Range Uplands, National Reserve System Project N709. May 2002. Department of Conservation and Land Management, Government of Western Australia, Perth, Western Australia.

Department of Environment and Conservation (DEC) (2011). Draft Pilbara Living Country: Landscape scale Management for Biodiversity in the Hamersley and Fortescue subregions of the Pilbara; Draft Project Objectives, Activities/Outcomes/Output, Resourcing and Indicative Budget, April 2011.

Department of Environment and Conservation (2012). Priority Ecological Communities for Western Australia Version 17, Species and Communities Branch, 13 April 2012.

Department of Environment and Conservation (2012b). Wildlife Conservation (Specially Protected Fauna) Notice 2012 (2), *Wildlife Conservation Act 1950*, Government Gazette p5295 as of 6 November 2012.

Rapallo (2011). Pilbara Olive Python Reconnaissance Survey of the West Pilbara Iron Ore Project, August 2011. Unpublished report for API Management Pty Ltd, 7 October 2011.

Rapallo (2012a). Biological Assessment of the Conservation Focus Area for API Management Pty Ltd, October 2012. October 2012.

Rapallo (2012b). 2011 Targeted Surveys for Populations of the Northern Quoll (*Dasyurus hallucatus*) on the West Pilbara Iron Ore Project. Draft report for API Management Pty Ltd.

Rapallo (2012c). Trapping Survey for the Northern Quoll (*Dasyurus hallucatus*) 2012. Draft report for API Management Pty Ltd

Department of Sustainability, Environment, Water, Population and Communities (2012). Variation to Conditions attached to approval decision West Pilbara Iron Ore Mine & Rail Project, WA (EPBC 2009/4706), Annexure A., signed by the Delegate to the Minister for Sustainability, Environment, Water, Population and Communities, 17 September 2012.

Appendix 1 Condition 6 EPBC 2009/4706

Condition 6. Threatened Fauna Offset Strategy

(Exert from West Pilbara Iron Ore Mine & Rail, WA [EPBC 2009/4706] as amended 17 September 2012; Annexure A)

The person taking the action must prepare a Threatened Fauna Offset Strategy, for approval by the Minister, to ensure the better protection and long term conservation of EPBC Act listed threatened fauna species in the Pilbara region of Western Australia."

The Threatened Fauna Offset Strategy must be submitted within twelve months of the date of this approval decision, and must be developed **in consultation with** the WA DEC prior to submission to the Minister. The Threatened Fauna Offset Strategy must contain, but is not limited to:

- A commitment to funding of not less than $200 000 (GST exclusive) per annum for a period of 5 years to be provided to the WA DEC to support the Pilbara Living Country initiative. The first payment must be made within three months of the commencement of construction;

  The Threatened Fauna Offset Strategy must include commitments to fund on- ground, landscape based, fire management practices.

- A Threatened Fauna Conservation Plan for an area to be identified. The plan must include measures to document the environmental values, develop and implement actions to enhance the environmental values and measure and record the effectiveness of those actions for the enhancement of biodiversity values for EPBC Act listed threatened species within the specified area.

  The location of the area subject to the Threatened Fauna Conservation Plan must not be subject to alternative land-uses which are not compatible with the long-term protection and management of the site for conservation, such as land-uses that require the clearing of native vegetation or lead to the degradation of native vegetation;

  The Threatened Fauna Conservation Plan must include:

- Information demonstrating that the conservation area will contribute to the protected area network in the Pilbara region;
- Evidence indicating that the size of the conservation area supports viable populations of EPBC listed threatened species through empirical scientific evidence.
- Details of ongoing management actions that will minimise the impact of threatening processes within the conservation area;
- Objectives and targets for the conservation, protection, management, enhancement and monitoring EPBC Act listed threatened fauna species.
- A description of the process that needs to be undertaken to protect the conservation area in perpetuity;
- Undertakings to ensure that in the event that an approved conservation area is subsequently subject to alternative land-uses, other than the conservation of biodiversity, the person taking the action must submit a revised Threatened Fauna Conservation Plan with an alternative conservation area to the Minister for approval; and
- Key milestones, performance indicators, corrective actions and timeframes for the completion of the actions.

The Threatened Fauna Offset Strategy must be published on the company's website within 10 business days of approval by the Minister and implemented for the duration of the life of the action. If revisions are made to the Threatened Fauna Offset Strategy, then the revised Threatened Fauna Offset Strategy must be approved by the Minister and published on the company's website within one month of approval.

An annual compliance report against the Threatened Fauna Offset Strategy the must be published on the company's website on an annual basis until the action has been completed.

Appendix 2 NES Species Profiles

Northern Quoll *Dasyurus hallucatus*

Conservation status

The Northern Quoll *Dasyurus hallucatus* is currently listed as:

- Endangered under the EPBC Act; and
- Rare or Likely to become Extinct (Schedule 1) under the WC Act.

Description

The Northern Quoll is a carnivorous marsupial from the genus Dasyurus. It is a sexually dimorphic species with male weights ranging between 340 - 1120 grams and females ranging between 202 - 690 grams (Begg 1981; Van Dyck and Strahan 2008). Its colour varies from brown to reddish brown with white spots located on its rump, back and head (Plate 1).

Plate 1. Female Northern Quoll *(Dasyurus hallucatus)* photographed at Trinity Bore (WPIOP Stage 1)

Regional distribution

Historically, the species was distributed across the northern regions of Australia, from the Pilbara in the west to north of Brisbane in the east (Braithwaite and Griffiths 1994; Oakwood 2000; Pollock 1999; Van Dyck and Strahan 2008). Today its distribution has contracted severely to several small disjunct mainland populations and offshore islands (Van Dyck and Strahan 2008; Woinarski et al. 2008).

Information on populations in the Pilbara is lacking with most of the data on distribution, abundance and ecology of Northern Quolls generated from localised fauna studies that accompany mineral development (SEWPaC 2009) (Figure 1).

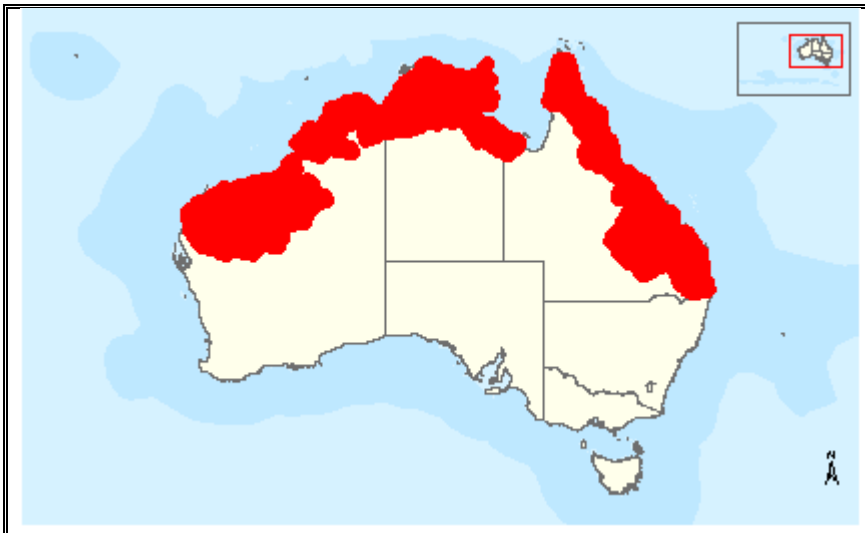

Figure 1. Indicative distribution map of the present distribution of the Northern Quoll (Source: SEWPaC).

Local distribution

Although the Northern Quoll can utilise a wide variety of habitats previous studies suggest that the species utilises the rocky outcrops, gullies and hills of the Pilbara as core habitat. Steep, rocky terrain (sometimes in proximity to riverine woodlands), occurs in the extensive Hamersley Ranges. Rocky terrain in proximity to riverine woodlands contains suitable habitat for the Northern Quoll.

Preliminary analysis indicates that differing geology/landform types support varying Northern Quoll population densities. Mesa formations support high density Northern Quoll populations, West Hamersley Ironstone formations support medium to low density populations and other rocky outcrops (including dolomite ridges) support low density populations (Rapallo, 2012b).

Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*

Conservation status

The Pilbara Leaf-nose Bat *Rhinonicteris aurantia* is currently listed as:

- Vulnerable under the EPBC Act; and
- Rare or Likely to become Extinct (Schedule 1) under the WC Act.

The limited availability of suitable caves or mine adits (entrance to an underground mine) for roosting is the basis of the conservation status for the Pilbara Leaf-nose Bat.

Description

The Pilbara Leaf-nose Bat is a small (9g) insectivorous bat with orange fur and a complex nose leaf (Armstrong, 2001; 2002) (Plate 1).

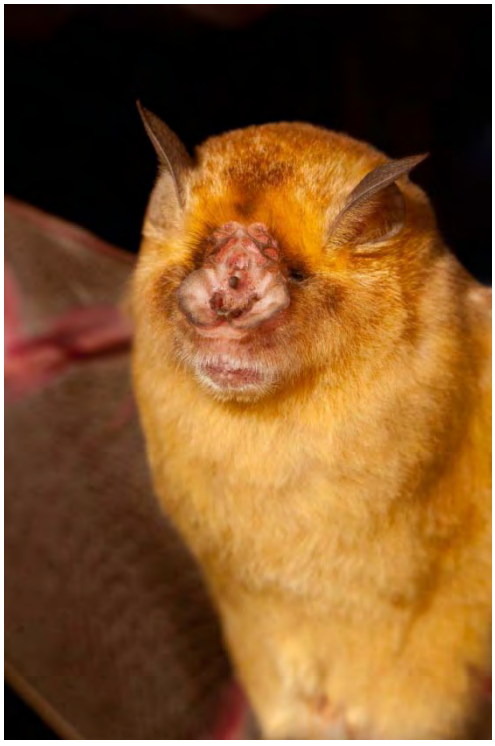

Plate 1. Pilbara Leaf-nose Bat (Source: API)

Regional distribution

The Pilbara Leaf-nose Bat is a geographically isolated form of the orange leaf-nosed bat (Gray, 1845). The Pilbara Leaf-nose Bat is known only from the Pilbara and Gascoyne regions of Western Australia. The Pilbara population is isolated from the main tropical population of the orange leaf-nosed bat to the north and east by 400 km of uninhabitable arid zone (Figure 1). The Western Australian Department of Environment and Conservation (DEC) Pilbara microbat survey found that the Pilbara Leaf-nose Bat is more common than previously thought, albeit occurring in reasonably low numbers (McKenzie and Bullen, 2009).

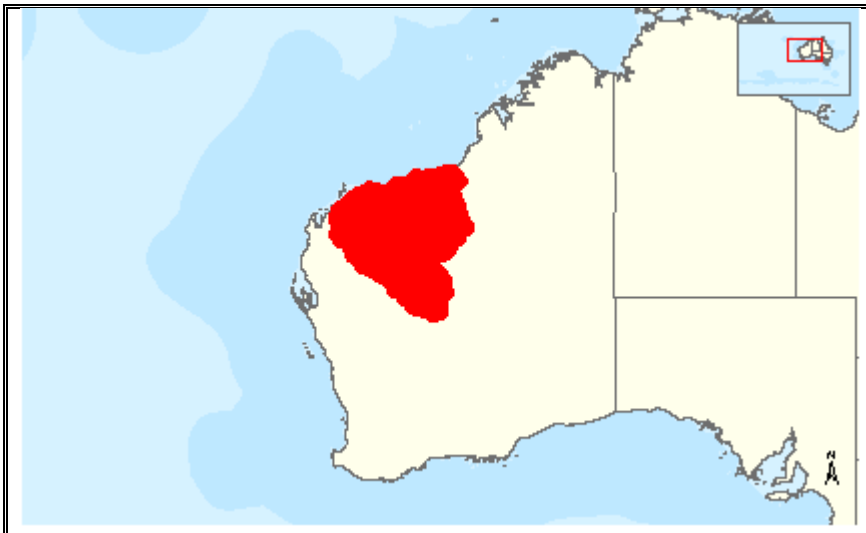

Figure 1. Indicative distribution map of the present distribution of the Pilbara Leaf nosed bat (Source: SEWPaC)

Local distribution

The few known roosts (< 10) of the Pilbara Leaf-nose Bat are concentrated in disused mines and gorge systems in the Hamersley Range, Barlee Range Nature Reserve and in the eastern Pilbara (SEWPAC, 2010).

Baseline fauna surveys of the WPIOP Stage 1 mine area recorded Pilbara Leaf-nosed Bats at resource areas close to the CFA (Trinity Bore and Upper Cane) and at three locations along Red Hill Creek. A Pilbara Leaf-nose Bat roost as well as other recordings have also been reported in the West Hamersley Range, within the CFA (Rapallo 2012b).

The CFA contains steep-sided gullies, gorges with permanent water, caves and geology (Brockman formation) that contains at least one known roost the potential to host other cave structures capable of supporting Pilbara Leaf-nose Bat populations.

Pilbara Olive Python *Liasis olivaceus barroni*

Conservation status

The Pilbara Olive Python *Liasis olivaceus barroni* is currently listed as:

- Vulnerable under the EPBC Act; and
- Rare or Likely to become Extinct (Schedule 1) under the WC Act.

Description

The Pilbara Olive Python is a sub species of the widely distributed Olive Python. It is one of the larger pythons (Boidae family) in Australia, and the largest in the Pilbara bioregion, reaching an average length of 2.5 m, and a maximum length of 4 m (Cogger 2000). The Pilbara sub species has dull olive-brown, pale fawn or rich brown colouring dorsally, and is white or cream ventrally. In sunlight the dorsal scales appear to have a strong blue iridescence (Plate 3). Pilbara Olive Pythons have an exceptionally fine-scaled appearance owing to the high number of mid-body scale rows (61-72 scale rows in Olive Python compared to 17 scale rows in Mulga Snake *Pseudechis australis*).

Like many large pythons that prey on mammals, this species possesses prominent labial pits on the tip of the snout and on the lower lips which are used to detect heat signatures of target species (Storr et al. 2002; Shine and Slip 1990, SEWPaC 2011a).

Plate 1. Pilbara Olive Python photographed at Red Hill Creek, WA (Source: API)

Regional distribution

The sub species is confined to ranges within the Pilbara bioregion of north-western Western Australia, including the Hamersley Ranges, and islands of the Dampier Archipelago (SEWPaC 2011b). It is found in an area bounded to within 50 kilometres south-southeast of Port Hedland, to approximately 55 kilometres north-east of Marble Bar, as far south as Newman and Mt Augustus (and possibly as far south as Yinnietharra), bounded on the north-west by the Barlee Range and Ashburton River (near Nanutarra Roadhouse) and to the east by the North West Coastal Highway (SEWPaC 2011a) (Figure 1). Its distribution is separated from the other Olive Python populations by the Great Sandy Desert.

Pilbara Olive Python prefers rocky areas such as gorges, caves, rock crevices and shelter beneath

rocks and hollow logs. In the warmer months they move widely and are often found in the grassy areas in close proximity to water bodies. In the cooler winter months the python predominately hide in caves and rock crevices away from water sources (Swan, 2007).

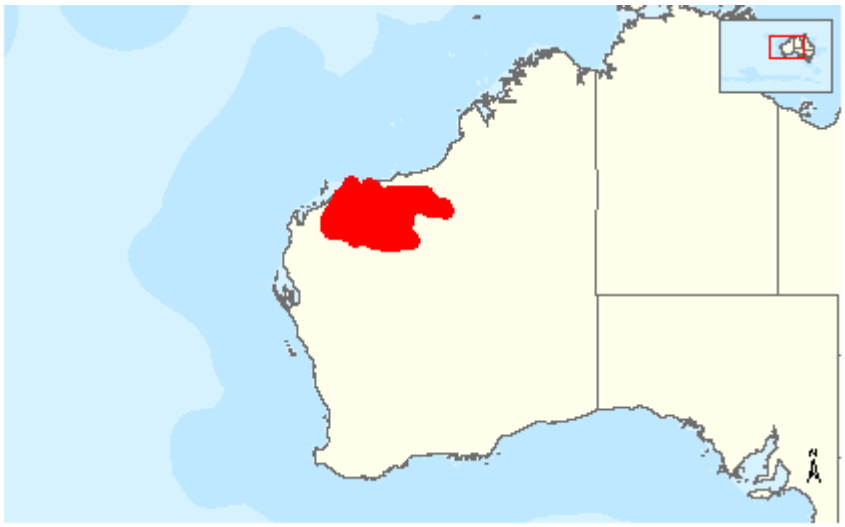

Figure 1. Indicative distribution map of the present distribution of the Pilbara olive python (Source: SEWPaC)

Local distribution

The preferred habitat - steep, rocky terrain (sometimes in proximity to riverine woodlands) - occurs along the length of the WPIOP Stage 1 mine area palaeochannels and also in the extensive Hamersley Ranges, including in the CFA (Rapallo 2011).

The Pilbara Olive Python has been recorded at various sites directly (individuals) and indirectly (presence of bones, urates and sloughed skins) within the mine area and the CFA, usually at sites associated with permanent water in gorges, rock crevices and caves.

Rainbow Bee-eater *Merops ornatus*

Conservation status

The Rainbow Bee-eater *Merops ornatus* is currently listed as:

- Migratory under the EPBC Act; and
- Migratory birds protected under an international agreement (Schedule 3) under the WC Act.

Description

A striking, colourful bird, the Rainbow Bee-eater is medium sized, with a long slim curved bill and a long tail with distinctive tail-streamers. It has a golden crown and a red eye set in a wide black stripe from the base of the bill to the ears, which is edged with a thin blue line. The throat is orange-yellow, with a broad black band separating it from a green breast.

Rainbow Bee-eaters eat insects, mainly catching bees and wasps, as well as dragonflies, beetles, butterflies and moths (BirdLife Australia 2012). They catch flying insects on the wing and carry them back to a perch to beat them against it before swallowing them. Bees and wasps are rubbed against the perch to remove the stings and venom glands.

Plate 1. Rainbow bee-eater *(Merops ornatus)* (Source: API)

Regional distribution

The Rainbow Bee-eater is found throughout mainland Australia, as well as eastern Indonesia, New Guinea and, rarely, the Solomon Islands (BirdLife Australia 2012) (Figure 1). In Australia it is widespread, except in desert areas, and breeds throughout most of its range, although southern birds move north to breed.

The total population size of the Rainbow Bee-eater in Australia has not been estimated. However, the population size is assumed to be reasonably large based on reporting rates for the species (SEWPaC 2012).

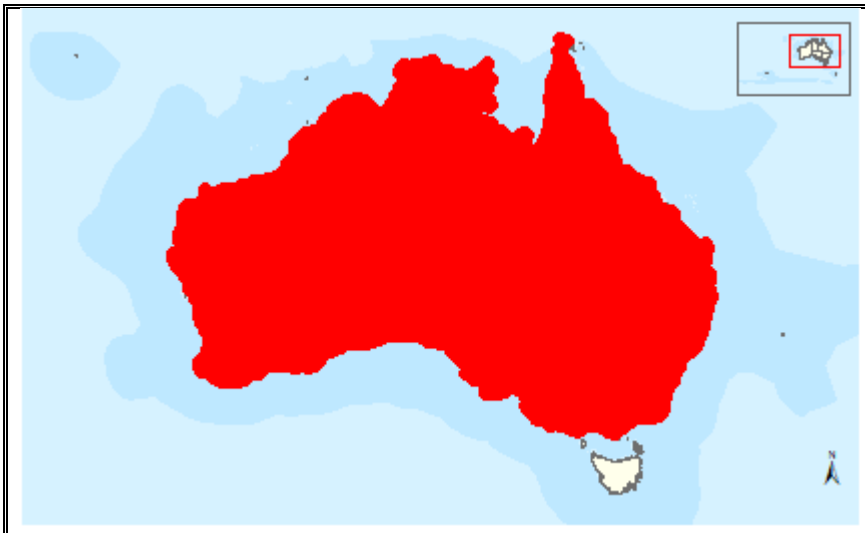

Figure 1. Indicative distribution map of the present distribution of the Rainbow bee-eater (Source: SEWPaC).

Local distribution

The Rainbow Bee-eater is most often found in open forests, woodlands and shrublands, and cleared areas, usually near water (BirdLife Australia 2012). It will be found on farmland with remnant vegetation and in orchards and vineyards. It will use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels

The Rainbow bee-eater has been recorded from a wide variety of habitats across the WPIOP, including plains, riparian and within the Hamersley Ranges. The presence of permanent pools and many persistent ephemeral pools in the area also contribute to the suitability of the habitats for the Rainbow bee-eater. It is unknown if the Rainbow bee-eater population is permanently established in the area of the WPIOP or if the species migrates to the area for breeding.

References

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

Armstrong, K.N. (2002). Morphometric divergence among populations of *Rhinonicteris aurantius* (Chiroptera: Hipposideridae) in northern Australia. *Australian Journal of Zoology*. 50:649- 669.

Begg, R. J. 1981. The small mammals of Little Nourlangie Rock, N. T. III. Ecology of *Dasyurus hallucatus*, the Northern Quoll (Marsupialia: Dasyuridae). *Australian Wildlife Research* 8:73-85.

BirdLife Australia (2012), Merops ornatus, Rainbow Bee-eater Profile in BirdLife Australia database. Available from http://www.birdlife.org.au/. Accessed October 2012.

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

Cogger, H.G. (2000) Reptiles and Amphibians of Australia, Sixth ed. Reed, Chatswood, NSW

McKenzie, N.L. and Bullen, R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. Records of the Western Australian Museum Supplement 78: 123–155.

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. 2002. Spatial and social organisation of a carnivorous marsupial *Dasyurus hallucatus* (Marsupialia: Dasyuridae). *Journal Zoology London* 257:237-248.

Pollock, A.B. (1999) Notes on status, distribution and diet of northern quoll Dasyurus hallucatus in the Mackay-Bowen area, mideastern Queensland. Australian Zoologist, 31, 388–395.

Shine, R. & D. Slip (1990). Biological aspects of the adaptive radiation of Australasian pythons (Serpentes: Boidae). Herpetologica. 46(3):283-290.

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

SEWPaC. 2009. Draft Workshop Outcomes - Northern Quoll Workshop. Perth 21 - 22nd April 2009.

SEWPaC (2010). *Rhinonicteris aurantia* (Pilbara form) in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed October 2011.

SEWPaC (2011a) *Survey guidelines for Australia's threatened reptiles: Guidelines for detecting reptiles listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*. Department of Sustainability, Environment, Water, Population and Communities, Commonwealth of Australia.

SEWPaC (2011b) Biodiversity: Species Profile and Threats Database: *Liasis olivaceus barroni* - Olive Python (Pilbara subspecies). http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66699#information_sheets_loop accessed 25/08/2011. Department of Sustainability, Environment, Water, Population and Communities, Commonwealth of Australia.

SEWPaC (2012). *Merops orrnatus* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed October 2012.

Swan, M 2007, *Keeping and Breeding Australian Pythons*, Mike Swan Herp Books, Lilydale.

Van Dyck, S, and R Strahan, eds. 2008. *The Mammals of Australia*. 3rd ed. Sydney: Reed New Holland. Original edition, 1983.

Woinarski, J.C.Z., M. Oakwood, J. Winter, S. Burnett, D. Milne, P. Foster, H. Myles, and B. Holmes. 2008. Surviving the toads: patterns of persistence of the northern quoll *Dasyurus hallucatus* in Queensland. Report submitted to the Natural Heritage Trust Strategic Reserve Program, as a component of project 2005/162: Monitoring & Management of Cane Toad Impact in the Northern Territory.

Appendix 3 Biological Assessment of the CFA

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BIOLOGICAL ASSESSMENT

OF THE

CONSERVATION FOCUS AREA

FOR

API MANAGEMENT PTY LTD

OCTOBER 2012

Revision	Date	Prepared by	Reviewed By	Approved by
Draft A	8 Oct 2012	Cara McGary Chris Cooper	Chris Jackson Kimberley Flowerdew (API) Carolyn Ringrose (API)	
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Appendix VI: SM2 Sites Data

1. EXECUTIVE SUMMARY

To fulfil conditions of approval developed by the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), API Management Pty Ltd (API) has demarked a 6,635 ha area of land to be managed as a Conservation Focus Area (CFA).

API engaged Rapallo to undertake a reconnaissance fauna survey across the CFA (the CFA fauna survey), commencing in May 2012. The primary focus of these investigations was to determine the fauna values of the CFA. Targeted searches for conservation significant fauna; the Northern Quoll *Dasyurus hallucatus*, the Pilbara Olive Python *Liasis olivaceus barroni* and the Pilbara Leaf-nosed *Rhinonicteris auratia* were also undertaken.

The aims of the survey were to :

- review and analyse data collected from within the CFA during previous fauna surveys;
- identify key habitat features for populations of species of national environmental significance in the CFA;
- characterise and map fauna habitats of the CFA;
- catalogue, map and characterise caves capable of supporting bat species in the proposed conservation zone;
- collect baseline data on abundance, distribution and habitat preference of the Northern Quoll, Pilbara Olive Python and the Pilbara Leaf-nosed Bat; and
- collect baseline data on all fauna encountered in the CFA.

A review of previous studies undertaken across the WPIOP Stage 1 indicated that extant populations of the Northern Quoll, Pilbara Olive Python and the Pilbara Leaf-nosed Bat were likely to be present within the CFA. Rapallo also utilised previous habitat characterisation data from the WPIOP Stage 1 to develop a system of characterising habitats within the CFA as being of high, medium and low value for species of National Environmental Significance.

Eight habitat types were identified during habitat assessment undertaken by Rapallo. These habitats are broadly consistent with the general habitats of the Hamersley Ranges.

The Northern Quoll, Pilbara Olive Python and the Pilbara Leaf-nosed Bat were all recorded during the surveys of the CFA. Several records of the Rainbow Bee-eater *Merops ornatus,* listed as migratory under the *Environmental Protection and Biodiversity Conservation Act 1999*, were made along major riparian habitats.

In addition the Peregrine Falcon *Falco peregrinus*, listed as Schedule 4 – specially protected fauna, and two species listed by the DEC as Priority 4 – taxa in need of monitoring, the Ghost Bat *Macroderma gigas* and the Australian Bustard *Ardeotis australis* were recorded.

Thrity-seven caves were characterised and/or catalogued during the CFA fauna survey. During assessments, Common Sheath-tail Bat *Taphozous georgianus* were recorded in 24 of the caves, Ghost bats were recorded in five of the caves and Finlayson's Cave Bat *Vespadelus finlaysoni* were recorded in four of the caves.

Twenty-four motion detecting cameras (MDCs) were deployed during the CFA fauna survey. Sixty-six percent of MDCs deployed detected the presence of Northern Quolls. Twenty-one Northern Quolls were identified by unique spot patterns.

Ten SM2+ echolocation recording units were placed across the CFA. Nine bat species were recorded on the SM2+. Pilbara Leaf-nosed Bats were detected at six sites and Ghost Bats were possibly detected at two sites (though the species is difficult to identify from echolocation calls alone).

In addition to the species of conservation significance recorded during the surveys, forty bird species, twenty-eight reptile species, two amphibian species and eleven mammal species were observed during all survey activities.

Survey data collected to date suggests that the CFA hosts extensive areas of highly suitable and highly connective habitat for all three species of national environmental significance. Rapallo concludes that the current data suggest that the CFA supports viable populations of each of the three species.

2. INTRODUCTION

2.1. PROJECT BACKGROUND

API proposes to develop the West Pilbara Iron Ore Project Stage 1 (WPIOP area), which is a 30 million tonnes per annum pisolite iron ore operation based on a number of resources located on the western fringe of the Hamersley Ranges, between 30 and 85 km south of Pannawonica, in the Pilbara region of Western Australia (Figure 1).

API has referred the project to the Western Australian Environmental Protection Authority (EPA) and the Federal Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC) both of which have granted approval.

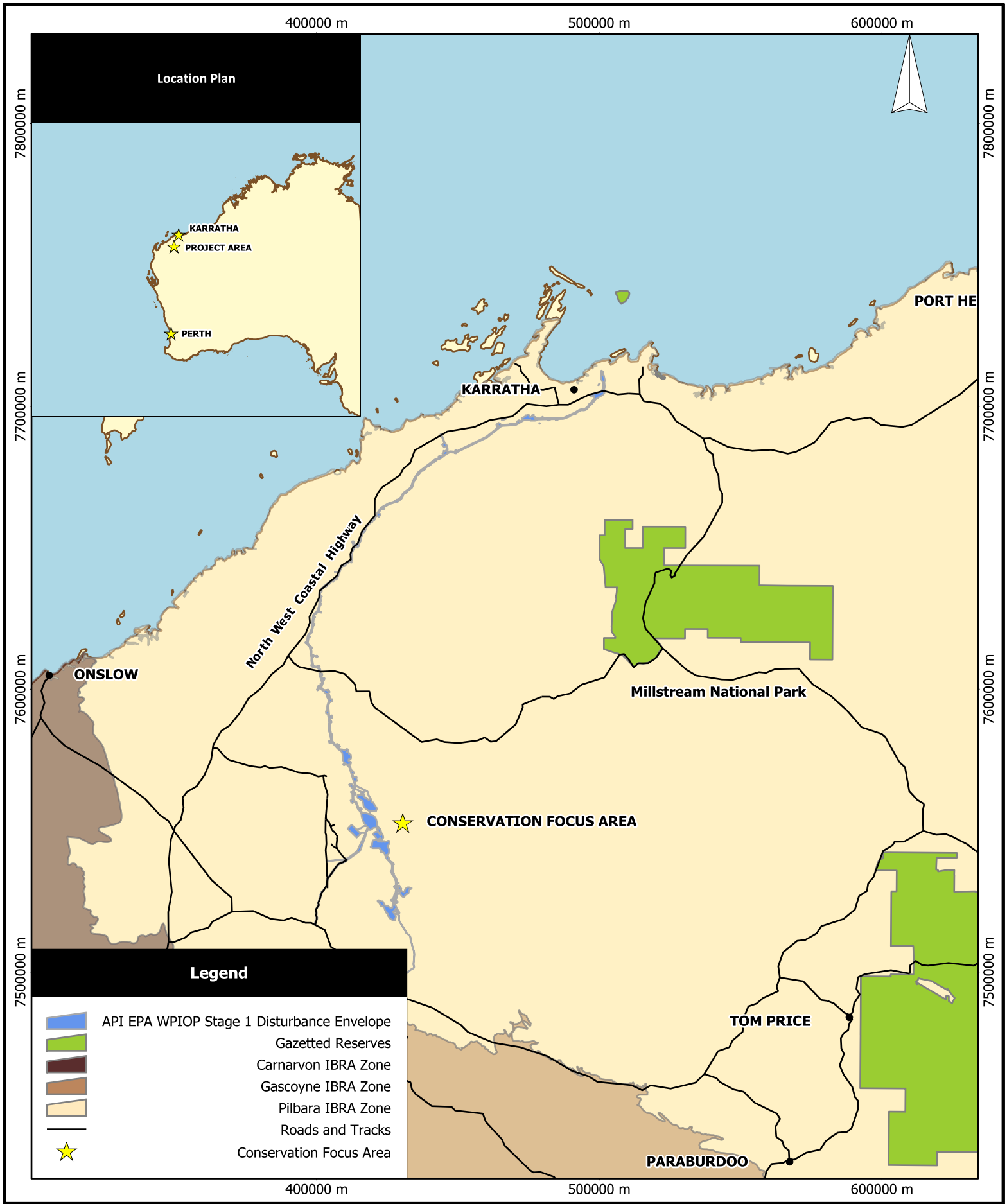
SEWPaC granted approval with 15 conditions (EPBC 2009/4706). Condition 6 of EPBC 2009/4706 requires API to develop a Threatened Fauna Offset Strategy (TFOS) to 'ensure the better protection and long term conservation of *Environmental Protection and Biodiversity Conversation Act 1999* (EPBC Act) listed threatened fauna species in the Pilbara region of Western Australia'. A key element of the TFOS is to identify an area of land that can be managed as a conservation reserve. To this end, API has demarked a 6,635 ha area of land to be managed as a Conservation Focus Area (CFA) (Figure 2). Condition 6 further states that the TFOS must include measures to document the environmental values for *Environmental Protection and Biodiversity Act 199* (EPBC Act) listed threatened species within the specified area.

2.2. SCOPE AND OBJECTIVES

API engaged Rapallo to undertake a baseline investigation across the CFA in May, 2012 (the CFA fauna survey). The primary focus of the survey were three species of National Environmental Significance; the Northern Quoll *Dasyurus hallucatus*, the Pilbara Olive Python *Liasis olivaceus barroni* and the Pilbara Leaf-nosed *Rhinonicteris auratia*.

The key aim of the survey across the CFA was to document the environmental values for EPBC Act listed threatened species. To achieve the key aim, the following survey aims were developed:

- Review and analyse data collected from within the CFA during previous fauna surveys;
- identify key habitat features for populations of species of national environmental significance in the CFA;
- characterise and map fauna habitats of the CFA;
- catalogue, map and characterise caves capable of supporting bat species in the proposed conservation zone;
- collect baseline data on abundance, distribution and habitat preference of the Northern Quoll, Pilbara Olive Python and the Pilbara Leaf-nosed Bat; and
- collect baseline data on all fauna encountered in the CFA.



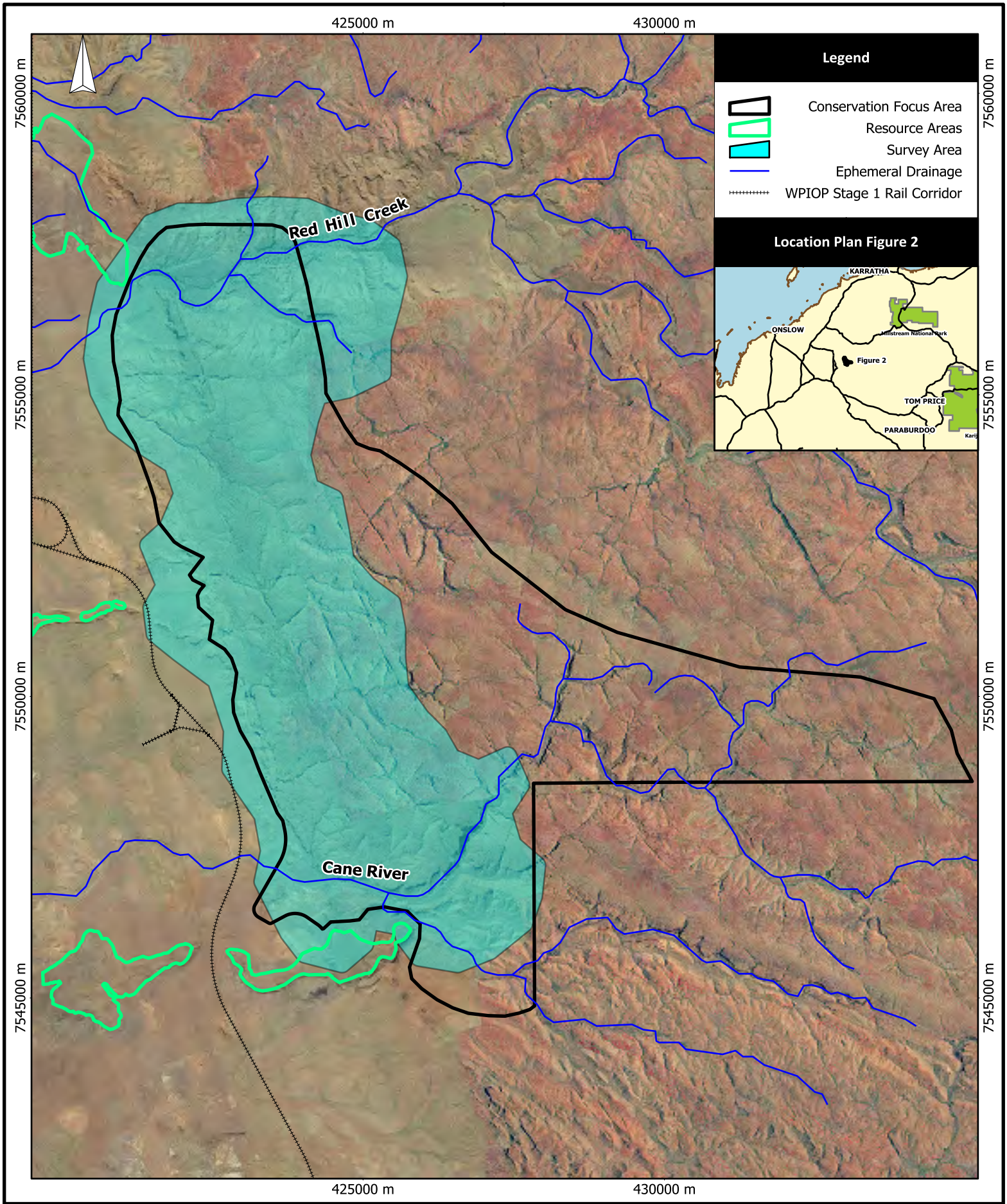
Rapallo

Project: Conservation Focus Area Fauna Survey
Scale: 1 : 1,700,000
Datum: MGA94 (50)

0 100 km

Location Plan

Figure 1



Rapallo

Project: Conservation Focus Area Fauna Survey
Scale: 1 : 80,000
Datum: MGA94 (50)

0 5 km

Survey Area

Figure 2

2.3. LEGISLATION AND SURVEY GUIDANCE

2.3.1. ENVIRONMENTAL PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

Native flora, fauna and ecological communities are protected at a federal level under the EPBC Act. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined as matters of national environmental significance. Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance need to be referred to the Australian Government Minister for SEWPaC for assessment and approval.

The EPBC Act protects Australia's native species and ecological communities by providing for identification and listing of threatened species and ecological communities. The conservation status of native species and communities is assessed by the Commonwealth Threatened Species Scientific Committee criteria outlined in the EPBC Act and the *Environment Protection and Biodiversity Conservation Regulations 2000*.

The following categories of threatened fauna are recognised under the EPBC Act: Extinct (EX), Extinct in the Wild (EXW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Conservation Dependent (CD) (Appendix I).

Ecological communities are unique and naturally occurring groups of plants and animals. Their presence can be determined by factors such as soil type, position in the landscape, climate and water availability. The following categories of Threatened Ecological Communities are recognised under the EPBC Act: Critically Endangered (CR), Endangered (EN), and Vulnerable (VU).

2.3.2. WILDLIFE CONSERVATION ACT 1950

All native fauna are protected under the *Wildlife Conservation Act 1950* (WCA) and cannot be collected, kept or culled without the appropriate permits.

The Western Australian WCA provides for taxa (species, subspecies and varieties) of native flora and fauna to be specially protected because they are under identifiable threat of extinction, are rare, or otherwise in need of special protection (Appendix I). The WCA uses a set of Schedules to classify the level of protection given to fauna species. Those species listed in the Japan-Australia Migratory Birds Agreement (JAMBA) are protected under Schedule 3 of the WCA.

2.3.3. DEC PRIORITY LISTINGS

In Western Australia, the DEC has produced a supplementary list of Priority fauna. These are species that are not considered Threatened under the WCA, but for which the Department of Environment and Conservation (DEC) feels there is cause for concern. Thus these species are recognised as having

conservation significance. A summary of the Priority Codes developed by the DEC, and their definitions, are provided in Appendix I.

3. EXISTING ENVIRONMENT

3.1. BIOGEOGRAPHY

The CFA lies within the Hamersley (PIL3) sub-region of the Pilbara IBRA region (SEWPAC 2012a). The Hamersley sub-region is characterised as a mountainous area of proterozoic sedimentary ranges and plateaux dissected by gorges. The vegetation comprises 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 (Kendrick 2002).

3.1.1. LAND SYSTEMS

The conservation focus area ` contains six land systems as described by Van Vreeswyk *et al*.(2004) (Table 1).

Table 1: Land systems of the CFA

Land System	Description	Total area in the Pilbara (km^2)	Total area in the CFA (km^2)
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.	7,748	0.026
Capricorn	Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands.	5,296	1.15
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	14,580	119.68
Robe	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands.	865	1.75
Rocklea	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands.	22,993	2.87
Urandy	Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands.	1,311	0.21

3.1.2. SOILS AND LANDFORMS

The CFA within the Fortescue Province of the Western region of the soil landscape zone of western Australia (Tille 2006). The province is characterised by rocky hills and stony plains with rugged hills, ridges, dissected plateaux and mountains. Long stony footslopes and plains are often associated with hills of the region.

The CFA lies on the boundary of the Fortescue Valley zone and the Hamersley Plateaux zone of the Fortescue Province.

The Fortescue Valley zone is described as alluvial plains, hardpan wash plains and sandplains (with stony plains, floodplains and some salt lakes) on alluvial deposits over sedimentary rocks of the Hamersley Basin. The soils are comprised of red deep sands, red loamy earths and red/brown non-cracking clays with some red shallow loams and hard cracking clays. The vegetation is mostly Mulga shrublands and spinifex grasslands (with some tussock grasslands and halophytic shrublands) (Tille 2006). The plains that fringe the western face of the CFA match the properties of the Fortescue Valley zone soils, despite the fact the CFA does not sit within the Fortescue River valley.

The Hamersley Plateaux zone is described as hills and dissected plateaux (with some stony plains and hardpan wash plains) on sedimentary and volcanic rocks of the Hamersley Basin (Opthalmia Fold Belt). The soils are stony soils with red shallow loams and some red/brown non-cracking clays and red loamy earths. Vegetation is mostly spinifex grasslands with snappy gum and kanji (and some Mulga shrublands). It is located in the Pilbara between Pannawonica, Newman and Paraburdoo (Tille 2006).

3.1.3. GEOLOGY

The CFA lies across the south western extent of the Hamersley Range (Tille 2006). The Hamersley Range formed on the late Archaean-Palaeoproterozoic metamorphosed banded iron formations, shales, dolerite, carbonate, chert and rhyolite. The rocks that belong to the Hamersley Group make up part of the Ophthalmia Fold Belt (Tille 2006).

The geology of the CFA is mapped to 1:250,000 on the Wyloo map sheet (Williams *et al.,* 1963). The following geological units occur in the CFA:

- **Hb** – Brockman Iron Formation: banded iron formation, chert and shale intruded by dolerite sills.
- **Hj** – Weeli Wolli Formation: banded iron-formation and some shale. Intruded by dolerite sills.
- **Ho** – Boolgeeda Iron Formation: fine-grained, finely laminated, dark grey-brown to black, flaggy iron-formation. Minor chert.
- **Qc** – Quaternary colluvium – superficial, unconsolidated sand and gravel.
- **Tc** – Colluvium partly consolidated valley-fill deposits.
- **Tp** - Robe Pisolite: pisolitic limonite deposits with fossil wood fragments. Occurs along old river channels.
- **Wb** – Cheela Springs Basalt: vesicular and amygdaloidal basalt with minor tuff, tuffaceous mudstone and chert.
- **Wq** - Beasley River Quartzite: conglomerate, fine to coarse arenite (some silicified), mudstone and dolomite.

3.1.4. HYDROLOGY

Two major and 12 minor ephemeral drainage lines have catchments within the CFA. Red Hill Creek lies across the northern boundary of the CFA and Cane River lies along the southern boundary.

The CFA is dissected by a series of un-named creeks, streams and gorges, the majority of which flow out onto the plains to the west of the CFA and connect with the two major ephemeral systems, Red Hill Creek and Cane River. These steep sided gorges host several semi-permanent waterholes, which hold water during the dry season.

The Cane River is the main ephemeral drainage system of the region. The river flows westward and reaches the coast approximately 30 kilometres north of Onslow. Within the CFA it is defined by steep sided channels.

Red Hill creek is a major ephemeral system that eventually flows into the Robe River. The CFA encompasses sections of the creek that have well defined channels. The creek is dry for the majority of the year but has extensive underground expression (WRM, 2009). As it flows west across the plains, the channel is less clearly defined.

3.2. REGIONAL VEGETATION

The CFA is located in the Hamersley Plateau and Stuart Hills units of the Fortescue Botanical District (Beard 1975), which forms part of the Eremaen Province.

The majority of the CFA falls within the Hamersley Plateau unit which consists of four main sub-units, the ranges, the valley plains, the basalt hills and minor communities. Tree steppe vegetation of *Eucalyptus leucophloia* and *Triodia wiseana* generally dominate the jaspilite and dolomite ranges. *Eucalyptus gamophylla* may also be present. At the summits of the mountains the trees include *Eucalyptus kingsmillii, E. gamophylla* and *E. leucophloia*. The few large shrubs that are present include *Senna* spp., *Dodonaea viscosa* and *Grevillea wickhamii*. There is also characteristically a rich flora of small shrubs and forbs including *Acacia* spp. and *Ptilotus* spp. The cliffs of the gorges often support a local and endemic flora including *Ficus platypoda, Astrotricha hamptonii* and *Brachychiton gregorii*.

The Stuart Hills unit is described as very poor stony country and is generally mapped as sparse shrub steppe. The understory is characterised by a cover of *Triodia basedowii* and *T. wiseana*, with sparse *Acacia* shrubs less than two metres in height. Other dominant species include *Senna* spp. and *Ptilotus* spp. On more loamy soils there are patches of *Triodia pungens* and on clays there are patches of *Acacia xiphophylla* with either *Triodia basedowii* or *T. pungens*. The mesas of the unit are generally iron-capped and support a sparse cover of *Triodia wiseana* with scattered *Ficus platypoda* and *Corchorus walcottii* (Beard 1975).

Major rivers of the Stuart Hills unit are lined with *Eucalyptus camaldulensis* and *Acacia citrinoviridis*. On wide river flats the scrub consists of *Acacia xiphophylla, Acacia victoriae* with *A. pyrifolia, A. pachycarpa, Hakea suberea, Eucalyptus* sp. and locally *Triodia pungens* (Beard 1975).

Table 2: Beard (1975) vegetation areas of the conservation area

Beard (1975) vegetation type	Description	Total area in WA (km^2)*	Area within CFA (km^2)
Hamersley Plateau 82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana.*	2,920,910	63.9
Stuart Hills 103	Hummock grasslands, shrub steppe; snakewood over soft spinifex and *Triodia wiseana*.	646,291	2.4

*Note: areas of vegetation types are taken from (Shepherd *et al.,* 2001). This document is now over ten years old, and significant vegetation clearing has taken place in the Pilbara region in the time since its publication. Area values given should be considered optimistic estimates rather than actual areas.

3.3. CLIMATE

The Pilbara region of Western Australia experiences an arid tropical climate with most rain falling during the hot summers between January and March (Beard 1990). Rainfall occurs in sporadic heavy rainfall events that occur during or immediately following cyclones. Cyclones develop off the north-west coast and often cross the coastline between Karratha and Port Hedland and move inland towards Newman.

The nearest active Bureau of Meteorology (BoM) weather station is situated at Onslow, a coastal town approximately 140 km to the west. Another station is active at Paraburdoo (Station Number 007185), approximately 175 km south east of the project area. The station at Paraburdoo is likely to be more indicative of conditions experienced on the CFA. The Onslow station is more likely to be impacted by coastal climatic influences.

Data recorded at Paraburdoo shows a mean annual rainfall of 313.9 mm. Mean monthly rainfall is highest in February with 78.3 mm and lowest in September with 3.5 mm. The hottest month is January with a mean maximum temperature of 41.1°C and a mean minimum temperature of 26.0°C (BOM 2012).

The 2012 CFA fauna survey followed a wet season with patchy rainfall, above average in some areas and below average in other areas.

4. SPECIES OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

4.1. NORTHERN QUOLL

4.1.1. DISTRIBUTION AND CONSERVATION STATUS

The Northern Quoll *Dasyurus hallucatus* is listed under the EPBC Act as Endangered. Within the state of Western Australia the Northern Quoll is also listed as a Schedule 1 species under the WCA.

Historically, the Northern Quoll was distributed across the northern regions of Australia, from the Pilbara in the west to north of Brisbane in the east (Braithwaite and Griffiths 1994; Oakwood 2000; Pollock 1999; Van Dyke and Strahan 2008). Today its distribution has contracted severely to several small disjunct mainland populations and offshore islands (Van Dyke and Strahan 2008; Woinarski *et al*. 2008). Historic population strongholds in the Kimberley and western Northern Territory are showing signs of decline (Woinarski *et al*. 2008) and face future pressures from the invasion of Cane Toads *Bufo marinus*.

Information on populations in the Pilbara is growing in conjunction with growing mineral development in the region. Data collated from recent surveys suggest that the species is more abundant in suitable habitats that are found within 200 kilometres from the coast (Cook, pers com 2012).

4.1.2. BIOLOGY, ECOLOGY AND BEHAVIOUR

The Northern Quoll is a carnivorous marsupial from the genus *Dasyurus*. It is a sexually dimorphic species with male weights ranging between 340 - 1120 grams and females ranging between 202 - 690 grams (Begg 1981; Van Dyke and Strahan 2008). Its colour varies from brown to reddish brown with white spots located on its rump, back and head. The tail is generally a darker brown at the base and the feet have striated pads (Menkhorst and Knight 2011; Van Dyke and Strahan 2008).

The Northern Quoll is generally a nocturnal predator, although it will occasionally forage and bask during daylight hours (Begg 1981; Braithwaite and Griffiths 1994; Oakwood 2002). Diets vary across its distribution and can include reptiles, amphibians, small mammals, invertebrates, fruits and carrion. Diets have been reported to vary seasonally (Begg 1981; Oakwood 2002; Pollock 1999; Van Dyke and Strahan 2008).

The species can use a wide variety of habitats and populations have been recorded on savannah, boulder fields, rocky gorges, rocky hills, woodlands and riparian zones (Oakwood 2000; Oakwood 2002; Schmitt *et al*., 1989; Van Dyke and Strahan 2008; Woinarski *et al.,* 2001; Woinarski *et al*., 2008).

Habitat preferences for the species in the Pilbara are not well documented. Unlike populations in Northern Australia the species does not seem to be utilising major drainage ways. Instead, data indicates the majority of the Pilbara population uses rocky outcrops, gorges and ranges as denning

habitat (Rapallo 2010, 2011a, 2011b, 2012a). Not all rocky habitats are populated by the species. Large areas of the Hamersley Ranges appear not to support the species (Rapallo 2011b, 2012a, Ninox 2011). The species is still extant within Millstream National Park but recent data suggests that the species currently does not inhabit Karijini National Park and Cane River Conservation Park.

Northern Quoll population size and densities vary between habitats and sexes. The rocky riparian zones in Kakadu National Park support females at a density of one Quoll per 35 hectare and males at a Quoll per 100 hectares (Oakwood 2002). Territories in these habitats will rarely overlap within each sex, although male territories will overlap several female territories (Oakwood 2002). Territorial patterns vary on rocky escarpments and overlap within the sexes is more common (Van Dyke and Strahan 2008). Beyond breeding, interaction between individuals is rare in all habitats.

The Northern Quoll breeds once a year. Breeding usually occurs in June or July although dates as late as August to September have been noted (Van Dyke and Strahan 2008, Rapallo 2010). Breeding is synchronous, with all mating usually occurring within an intense two week period. During the breeding season, males will range over large distances surveying for the onset of oestrous amongst females (Braithwaite and Griffiths 1994; Oakwood 2000; Oakwood 2002; Schmitt *et al*., 1989). The physical stress experienced during this intense breeding season results in physiological decline amongst males and is the likely cause of the total male-die off experienced in most studied populations of Northern Quoll. The breeding biology of the species in the Pilbara is not well studied though recent data suggest that some Northern Quoll populations in the Pilbara may not experience total male die-off (Rapallo, 2010a).

All young will disperse from the den after weaning (Oakwood 2000). Drainage lines have been reported as being important habitats in aiding dispersion, although dispersion is not confined to such habitats.

4.2. PILBARA OLIVE PYTHON

4.2.1. DISTRIBUTION AND CONSERVATION STATUS

The Pilbara Olive Python *Liasis olivaceus barroni* is listed as Vulnerable under the EPBC Act and is listed as Schedule 1 - Rare or likely to become extinct by the WCA. The Pilbara Olive Python is confined to ranges within the Pilbara bioregion of north-western Western Australia, including the Hamersley Range, and islands of the Dampier Archipelago (SEWPaC 2012). It is found in an area bounded to within 50 kilometres south-south-east of Port Hedland, to approximately 55 kilometres north-east of Marble Bar, as far south as Newman and Mt Augustus (and possibly as far south as Yinnietharra), bounded on the north-west by the Barlee Range and Ashburton River (near Nanutarra Roadhouse) and to the east by the North West Coastal Highway (SEWPaC 2012b).

4.2.2. BIOLOGY, ECOLOGY AND BEHAVIOUR

The Pilbara Olive Python is one of the larger pythons (Boidae family) in Australia, and the largest in the Pilbara bioregion, reaching an average of 2.5m, and a maximum of 4m in total length (Cogger 2000, Shine and Slip 1990). It has dull olive-brown, pale fawn or rich brown colouring dorsally, white or cream ventrally. In sunlight the dorsal scales appear to have a strong blue iridescence. Pilbara Olive Pythons have an exceptionally fine-scaled appearance owing to the high number of mid-body scale rows (61-72 scale rows compared to 17 scale rows in Mulga Snake *Pseudechis australis).* Like many large pythons that prey on mammals, this species possesses prominent labial pits on the tip of the snout and on the lower lips (Storr *et al.* 2002; SEWPaC 2012b).

The Pilbara Olive Python is primarily nocturnal, using permanent waterholes, rocky crevices or the cover of vegetation to ambush its prey of mammals and birds.

Males actively search for breeding females in June to August, covering distances of up to 4km (Pearson 2003). After laying a clutch of large eggs females incubate their eggs by wrapping their body around the egg cluster, insulating them from temperature fluctuations (Greer 1997). The female snake is able to raise her body temperature to warm the eggs by "shivering" (Shine, 1991; Greer 1997). The eggs hatch approximately 80 days later (Shine, 1991). Hatchlings are independent and disperse from the incubation site (Shine, 1991). Hatchling snakes are large (approx 700mm) and can feed on small mammals, lizards and small birds (Ian Harris pers. comm. 2011).

Pilbara Olive Pythons are known from a variety of habitats including rocky outcrops, gorges, springs and major drainages particularly where those habitats have water present (Rapallo 2011c). Rapallo has also reported Pilbara Olive Pythons in minor riparian areas (Rapallo 2012b), in *Eucalyptus camaldulensis* and Melaleuca woodlands associated with broad ephemeral riverbeds (Rapallo 2011d), near livestock watering facilities and in a small cave on a mesa over 5 kilometres from a known water source (Rapallo 2011c).

4.3. PILBARA LEAF-NOSED BAT

4.3.1. DISTRIBUTION AND CONSERVATION STATUS

The Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* is listed under the EPBC Act as Vulnerable. Within the state of Western Australia the Pilbara Leaf-nosed Bat is listed as a Schedule 1 species under the WCA. The Pilbara Leaf-nosed Bat has been recorded at several locations within the CFA and the neighbouring WPIOP Stage 1 area.

The Pilbara Leaf-nosed Bat is an isolated 'form' (Armstrong 2006) of the Orange Leaf-nosed Bat, an Australian endemic species distributed across the top end of the Northern Territory and the Kimberley (Kulzer *et al.* 1970). The Pilbara 'form' as recognized under the EPBC Act is comprised of relictual populations in the Pilbara region. They are considered to be the only remaining representatives of a

diverse group that was present in the Miocene, and the species itself is thought to be ancient following the discovery of three – five million year old fossil material in the Riversleigh World Heritage Area (Archer *et al.* 1991).

The Pilbara population is known from relatively few diurnal roosts in six defunct gold and copper mines in the eastern Pilbara and the silcretes of Barlee Range Nature Reserve (Biologic 2012). However, other occurrences have been recorded across the Pilbara (McKenzie and Bullen 2009).

4.3.2. BIOLOGY, ECOLOGY AND BEHAVIOUR

The Pilbara Leaf-nosed Bat is limited by roost availability in the Pilbara because of its particularly restricted temperature and humidity requirements. The species is unable to enter torpor (daily hibernation) to conserve heat (suffering exhaustion and hypothermia when exposed to cool roost temperatures) (Kulzer *et al*. 1970). It has one of the highest rates of pulmocutaneous water loss recorded for a mammal when exposed to low humidity (Baudinette *et al.* 2000). Consequently, during the dry season, the species is restricted to relatively deep subterranean roosts that provide a stable, warm and humid environment (Churchill *et al.* 1988, Armstrong, 2001, Churchill, 2008). Most identified roosts also have permanent water bodies within the cave system. If such water is absent, roosts are located in an area where permanent water occurs close to the site. Suitable roosts are uncommon in the landscape although some underground mine workings in the Pilbara provide additional habitat (Armstrong, 2007).

5. SURVEY METHODS

5.1. DESKTOP ASSESSMENT – PREVIOUS SURVEYS

Prior to undertaking the survey, Rapallo analysed previous surveys undertaken across the WPIOP Stage 1 for data that was collected within the boundaries of the CFA. Sections 5.1.1 to 5.1.3 describe fauna surveys that have collected data within the boundaries of the CFA. These data were used to refine the CFA Fauna Survey methodologies and to focus survey efforts for species of National Environmental Significance.

5.1.1. HABITAT CHARACTERISATION SURVEYS (2010 – 2011)

Several habitat characterisation and mapping surveys have been undertaken across the WPIOP Stage 1 (Astron, 2011a, Astron, 2011b, Rapallo, 2011a and Rapallo, 2011b) though only very minor areas of the CFA were covered during these surveys.

Astron 2011a mapped the habitats of the WPIOP Stage 1 by merging vegetation association mapping data with a series of landform and geological characteristics that were considered valuable to species of conservation significance.

Rapallo refined the model produced by Astron by ground-truthing habitats on foot and adding additional landform and geological characteristics to the model. This exercise was undertaken for Northern Quolls (Rapallo, 2011a) and Pilbara Olive Pythons (Rapallo, 2011b). Astron refined the habitat value model for Pilbara Leaf-nosed Bats by utilising echolocation recording devices (Astron, 2011b).

The primary focus of these surveys was to identify and demarcate habitats that were considered highly suitable for species of National Environmental Significance. Habitats were classified as high, medium and low for each species of National Environmental Significance. Table 3 summarises the attributes that were used to define habitat value.

5.1.2. NORTHERN QUOLL RECONNAISSANCE SURVEY

A Northern Quoll Reconnaissance Survey was undertaken in June 2011. The key aims of this survey were:

1. ground truth existing Northern Quoll habitat mapping;
2. collect landform, geological and vegetation data that could be used to develop the existing habitat model;
3. confirm the presence or absence of extant Northern Quoll population(s) on the project area;
4. gather baseline data on population size and density; and,

5. gather baseline data on landform and habitat preference of Northern Quoll populations on the project area.

During the survey, 20 motion detecting cameras (MDCs) were deployed in habitats considered suitable for the Northern Quoll. They were set facing a station baited with sardine based cat food. The MDCs were deployed for between 19 and 22 days.

In addition to the MDCs, foraging surveys for secondary signs of Northern Quoll presence were also completed. Foraging surveys focused on caves, cliff faces, breakaways and other features where Northern Quoll scats and tracks were likely to be found.

5.1.3. NORTHERN QUOLL TRAPPING SURVEYS (2011 AND 2012)

Two seasons of targeted trapping for the Northern Quoll have been undertaken within the western border of the CFA.

In 2011, three sites were deployed, each consisting of 20 cage traps. Ten cage traps were placed approximately 100 metres apart along habitats that were characterised as potentially suitable for denning. Running perpendicular from this line of traps, beginning at either end, were a further 5 traps spread 100 meters apart.

In 2012, two trap sites were deployed, each consisting of 20 cage traps. Each site was comprised of two lines of ten traps, running along each bank of the Red Hill Creek bed. GPS locations and habitat descriptions were recorded for each cage trap location.

Data on morphology, sexual condition, health and capture history was collated and analysed during each survey.

A tissue sample was collected from each captured Northern Quoll after which they were injected with an 11 mm Trovan PIT microchip for re-identification purposes.

The population size for each survey area was estimated using the Chapman extension of the Petersen-Lincoln Method (Southwood and Henderson, 2000). This formula was used to calculate an estimated population from each sample night. The average of these values was used as the estimated population size plus or minus the Petersen-Lincoln variation (Southwood and Henderson, 2000).

Table 3: Habitat Characterisation Criteria

Species	Habitat Value	Habitat Characteristics	Photo Example of Habitat
Northern Quoll	High	**Species use:** habitats are considered suitable for denning and foraging **Habitat features:** caves, crevices, honeycombing, boulder fields **Common landform types:** gorges, steep gullies, cliff faces, outcrops **Common geology:** pisolites, mudstone, dolomites **Species evidence:** large numbers of scats and scats, high MDC detection rate **Other comments:** The presence of fig trees will enhance the suitability for the species. Records of the species utilising a habitat will usually result in high classification.	
	Medium	**Species use:** occasional foraging and potential dispersal **Habitat features:** linear habitat features, occasional boulders, overhangs and small isolated rocky outcrops **Common landform types:** BIF outcrops, gorges and cliff faces**;** plateaus and plains adjacent to denning habitats; drainage channels linking denning habitats; small isolated outcrops **Common geology:** dolomites, banded ironstone **Species evidence:** occasional scat, infrequent MDC detection rates **Other comments:** habitats may occasionally host denning quolls but are most often utilised for foraging and dispersal.	

Species	Habitat Value	Habitat Characteristics	Photo Example of Habitat
	Low	**Species use:** rarely used, occasional dispersal **Habitat features:** **Common landform types:** open plains, minor ephemeral drainage on open plains, rolling stony hills with no breakaways or outcropping **Common geology/soil:** no rocky outcrops, habitats characterised by stony, loam or sand plains **Species evidence:** no evidence of species utilising habitat **Other comments:** habitats have few (if any) features that could be utilised by the species.	
Pilbara Olive Python	High	**Species use:** habitats are considered suitable for shelter and foraging **Habitat features:** caves, crevices, cliff faces, semi-permanent waterholes **Common landform types:** gorges, steep gullies, cliff faces, major ephemeral drainage systems **Common geology:** no detectable preference. Records exist from pisolite, banded ironstone and riparian **Species evidence:** large numbers of urates, several direct observations **Other comments:** Records of the species utilising a habitat will usually result in high classification.	

Species	Habitat Value	Habitat Characteristics	Photo Example of Habitat
	Medium	**Species use:** habitats are considered suitable for occasional shelter and for dispersal **Habitat features:** linear habitat features, overhangs and small isolated rocky outcrops **Common landform types:** minor ephemeral drainage systems, plateaus and plains adjacent to high value habitats **Common geology:** no detectable preference **Species evidence:** rarely any evidence **Other comments:** species may occasionally be recorded in medium value habitats but usually moving between areas of high value habitats	
	Low	**Species use:** very rare dispersal **Habitat features:** rolling stony hills, stony plains, alluvial plains **Common landform types:** open plains, minor ephemeral drainage systems on open plains, small breakaways **Common geology:** ironstone and BIF pebbles and rocks, alluvial sands and loams **Species evidence:** no evidence of species utilising habitat **Other comments:**	

Species	Habitat Value	Habitat Characteristics	Photo Example of Habitat
Pilbara Leaf-nosed Bat	High	**Species use:** colony roost site and key foraging features **Habitat features:** caves, semi-permanent waterholes **Common landform types:** gorges, steep gullies, cliff faces **Common geology:** no detectable preference. Records exist from pisolite, banded ironstone and riparian habitats **Species evidence:** frequent SM2+ echolocation records, confirmed roost, caves with high temperature and humidity which could be used as seasonal roost **Other comments:** habitats difficult to classify due to cryptic nature of the species. Caves may be suitable for the species at certain time of the year but this can't be confirmed through simple habitat assessment exercises.	
	Medium	**Species use:** occasional foraging pathways, dispersal routes between roosts **Habitat features:** caves, drainage channels **Common landform types:** gorges, steep gullies, cliff faces (north facing) **Common geology:** no detectable preference **Species evidence:** infrequent, single SM2+ echolocation records **Other comments:** habitats include ephemeral watercourses with shrubs and thin tree cover; complex vegetation structure	

Species	Habitat Value	Habitat Characteristics	Photo Example of Habitat
	Low	**Species use:** rare fly-overs **Habitat features:** small breakaways and outcrops that have limited caves and crevices **Common landform types:** open plains, small rocky outcrops **Common geology:** dolomite and BIF **Species evidence:** no evidence of species utilising habitat **Other comments:**	

5.1.4. SOURCES OF INFORMATION

The following literature sources have been used to determine nomenclature, taxonomy and fauna distribution patterns used in this report:

- **Mammals:** Van Dyke and Strahan (2008), Menkhorst and Knight (2011);
- **Bats:** Churchill (2008);
- **Reptiles:** Cogger (2000); Storr *et al*.,(2002); Storr *et al*.,(1999); Wilson and Swan (2008);
- **Amphibians:** Tyler *et al.*, (2000);
- **Birds:** Christidis and Boles (2008); Barrett (2003); Johnstone and Storr (1998); Benshemesh (2000) ; Marchant and Higgins (1993); Garnett and Crowley (2000); Higgins (1999).

Nomenclature for herpetofauna and mammals follows that of the Western Australian Museum Reptile and Frog Checklist and Mammal Checklist (WAM 2012) except where indicated otherwise. Nomenclature for birds follow Christidis and Boles (2008), except where indicated otherwise

5.2. CFA FAUNA SURVEY

5.2.1. SURVEY PERSONNEL

Table 4 lists the personnel used to complete this project.

Table 4: Survey personnel

Name	Position	Field Survey	Reporting
Chris Jackson	Senior Ecologist	▼	▼
Cara McGary	Ecologist	▼	▼
Henry Cook	Ecologist		▼
David Nelson	Field Ecologist	▼	
Chris Cooper	Graduate Ecologist	▼	▼

5.2.2. HABITAT CHARACTERISATION

Habitats were assessed by ground truthing areas of interest identified on aerial photographs and from GIS land system mapping. In each area, data points were marked wherever habitats noticeably change.

Based on data collated from previous habitat assessment projects on the WPIOP Stage 1 (see section 5.1.1), the following data was recorded during each assessment:

- date, time, GPS location;
- dominant plant species;
- dominant geology and landform features;
- presence of water;
- connectivity;
- suitability for species of conservation significance; and,
- photographs.

This data was used to rank each habitats value to the species of National Environmental Significance. Rankings followed those listed in Table 3 (see section 5.1.1). Habitat characterisation points are shown in Figure 3.

5.2.3. CAVE CHARACTERISATION

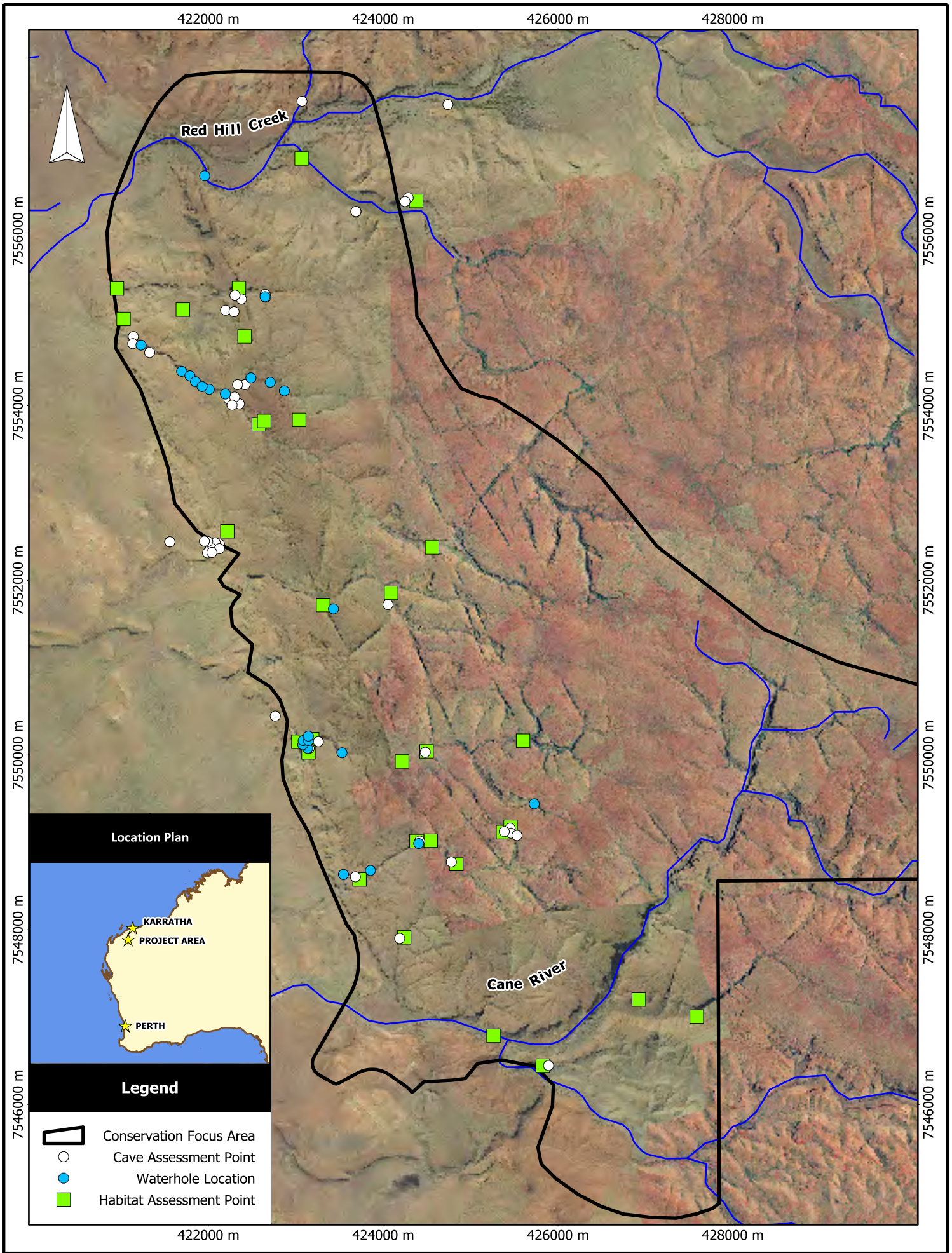
Cave characterisations were completed during the CFA Fauna Survey. Caves which were characterised during the survey are shown in Figure 3.

Caves in the CFA were catalogued and characterised by searching along rocky breakaways, gorges and boarder riparian systems. Caves were characterised by the following features:

- size estimate (i.e. large, medium, small, crevice, pothole etc.);
- complexity (cavernous, pillars, side tunnels, bell holes etc.);
- connectivity (to other cave systems, distance to other cave systems);
- additional features (evidence of animal activity, additional entrances etc.);
- position within strata, geology and landform type.; and

For each cave, the following additional data were also collected:

- date, time, gps location;
- cave type (as characterised by the variables listed above);
- suitability for species of conservation significance; and,
- fauna present (including secondary evidence).



Rapallo

Scale - 1 :55,000
Datum - MGA94 (50)

0 2 km

Conservation Focus Area
Fauna Survey

Habitat Assessment Points,
Waterhole Locations, Cave Caracterisation Points

Figure 3

5.2.4. MOTION DETECTING CAMERA SURVEYS

Scoutguard 550 motion detecting cameras (MDCs) were deployed across the western parts of the CFA in habitats with potential to support Northern Quolls (foraging and denning habitat). Twenty-four MDCs were deployed during survey.

Each camera was securely fastened at each location upon a small camera tripod and focused onto a bait station. The bait used consisted of tinned cat food with high sardine content. Each camera was programmed to record for 30 seconds at 1 minute intervals with detection sensitivity set to high. Data recorded of non-target species has been included in the overall species list for the survey.

At each MDC site, habitats were assessed following the same procedure described in section 5.1.1.

The number of unique Northern Quolls recorded on each MDC was determined by using a combination of visual assessment and the software package WILD ID V1.0.

Prior to the analysis on the WILD ID software, images were briefly assessed the data to determine how many files were recording the same individual. This was undertaken for the footage from each camera.

Once repetitious files (videos of the same Northern Quoll revisiting the bait station) were removed from the analysis, a photo still from video files showing full left or right side body images of the Northern Quolls was captured using Microsoft Movie Maker. The contrast on each captured still was adjusted to ensure the definition between spots was clearer. Each edited photo file was then uploaded onto WILD ID and compared to all other files collected during the survey.

After the completion of the WILD ID analysis the results were visually assessed to ensure there were no false positives (files that had been identified as similar but which were not the same animal) and false negatives (files which were suspected of being from the same animal but which were identified as different).

5.2.5. ACTIVE FORAGING SURVEYS

Active foraging was used to collect baseline data on fauna assemblages of the CFA, with a special focus on habitat features that might support species of conservation significance. Active foraging included flipping rocks, lifting bark, lifting logs and sifting litter. Particular focus was placed on habitats where secondary signs of species of conservation significance (tracks, scats, burrows etc) were likely to be recorded. Active track logs were recorded for each search.

All fauna identified during each foraging survey were recorded, including bird species identified by call. Species lists were compiled for each specific habitat type. If the foraging survey crossed into a new habitat, a new species list was started.

Invertebrate fauna that belong to groups prone to short range endemism (SRE) were vouchered for future identification.

GPS locations were recorded for species of conservation significance encountered during each search. The following generic data was collected for each record:

- date and time;
- GPS location;
- habitat description;
- habitat features that could increase the suitability of the habitat for conservation significant species (i.e. fig trees, caves, crevices etc.); and
- photograph (of evidence and habitat type).

5.2.6. BIRD SURVEYS

Systematic 20 minute 2 hectare bird surveys, following Birdlife Australia guidelines (Barrett *et al.,* 2008), were completed during the CFA Fauna Survey. Surveys were undertaken between sunrise and 7am on four mornings.

The systematic surveys were designed so that they sampled only one habitat. As such, isolated habitats such as gorges could not be surveyed systematically during the survey.

5.2.7. SPOTLIGHTING SURVEYS

Spotlight surveys were undertaken during the CFA Fauna Survey in habitats that were likely to support Pilbara Olive Pythons. This included riparian habitats and gorges, especially those containing water pools. Spotlight surveys were undertaken over two to three hours, commencing at dusk, and were undertaken by a team of at least four ecologists.

Fauna, including potential SREs, identified during the searches were recorded. If a species of conservation significance was observed, time, GPS location and a brief habitat description were recorded.

5.2.8. ECHOLOCATION SURVEYS

Echolocation surveys were conducted using Songbird SM2BAT+ ultrasonic recorders. Prior to deployment, Rapallo stratified the habitats of the CFA. Ten SM2BAT+ devices were placed in specific habitats in the CFA, with each habitat sampled for three to six nights. Three devices failed to record data during the survey. Echolocation survey locations included areas with caves, water or mature woodlands with hollow bearing trees. Echolocation recordings were analyzed by Specialized Zoological.

6. RESULTS

6.1. DESKTOP ASSESSMENT

6.1.1. NORTHERN QUOLL RECONNAISSANCE SURVEY

62% of the MDCs deployed, detected the presence of Northern Quolls. Thirteen unique Northern Quolls were identified by unique spot patterns (Table 5). In addition to the cameras, five Northern Quoll scats were recorded during the survey.

MDC data suggests that Northern Quoll populations within the CFA show trends in habitat preference towards landforms and geology types. Specifically, Northern Quoll detection rates increased when cameras were placed on rocky strata hosted within remnant pisolite, conglomerates or mudstone.

Table 5: Conservation focus area MDC survey results summary

Landform	Number of cameras deployed	Number of Cameras with Northern Quoll Records	Success (%)	Number of Quolls
Gorge	7	5	71%	5
Major Drainage	8	6	75%	6
Minor Drainage	5	1	20%	1
Outcrop/Mesa	1	1	100%	1
Total	**21**	**13**	**62%**	**13**

The skeletal remains of a Pilbara Olive Python were found in a cave. In addition, several large urates, likely belonging to a Pilbara Olive Python, were recorded during the survey. A major Pilbara Leaf-nosed Bat roost was discovered in the south of the CFA.

Two bird species of conservation significance were recorded during the survey; the Peregrine Falcon *Falco peregrinus* and the Rainbow Bee-eater *Merops ornatus*.

Forty-two vertebrate fauna species were recorded during the survey (including data from the MDCs) including seven mammals, seventeen Reptiles, two amphibians and twenty-six bird species.

6.1.2. NORTHERN QUOLL TRAPPING SURVEYS

Eight individual Northern Quolls were trapped during the 2011 trapping survey, from 14 captures. During the 2012 trapping survey, 15 individuals were recorded from 27 captures. Males (n_{2011} = 7; n_{2012} = 10) were trapped more often than females (n_{2011} = 1, n_{2012} = 5) suggesting a male skewed sex bias existed in the populations of the CFA. No second year males were recorded during either survey. Only one of the females captured in 2012 was identified as a second year female.

Table 6: Morphometric and behavioural data from the CFA trapping surveys in 2011 and 2012

Year	Sex	Average Weight (g)*	Average Foot Length (cm)*	Average Skull Width (cm)*	Average Testis (cm)*
2011	Male	908.5	4.72	7.20	2.10
2011	Female	420	3.96	6.9	N/A
2012	Male	750.3	4.39	6.89	2.33
2012	Female	406.6	4.02	6.00	N/A

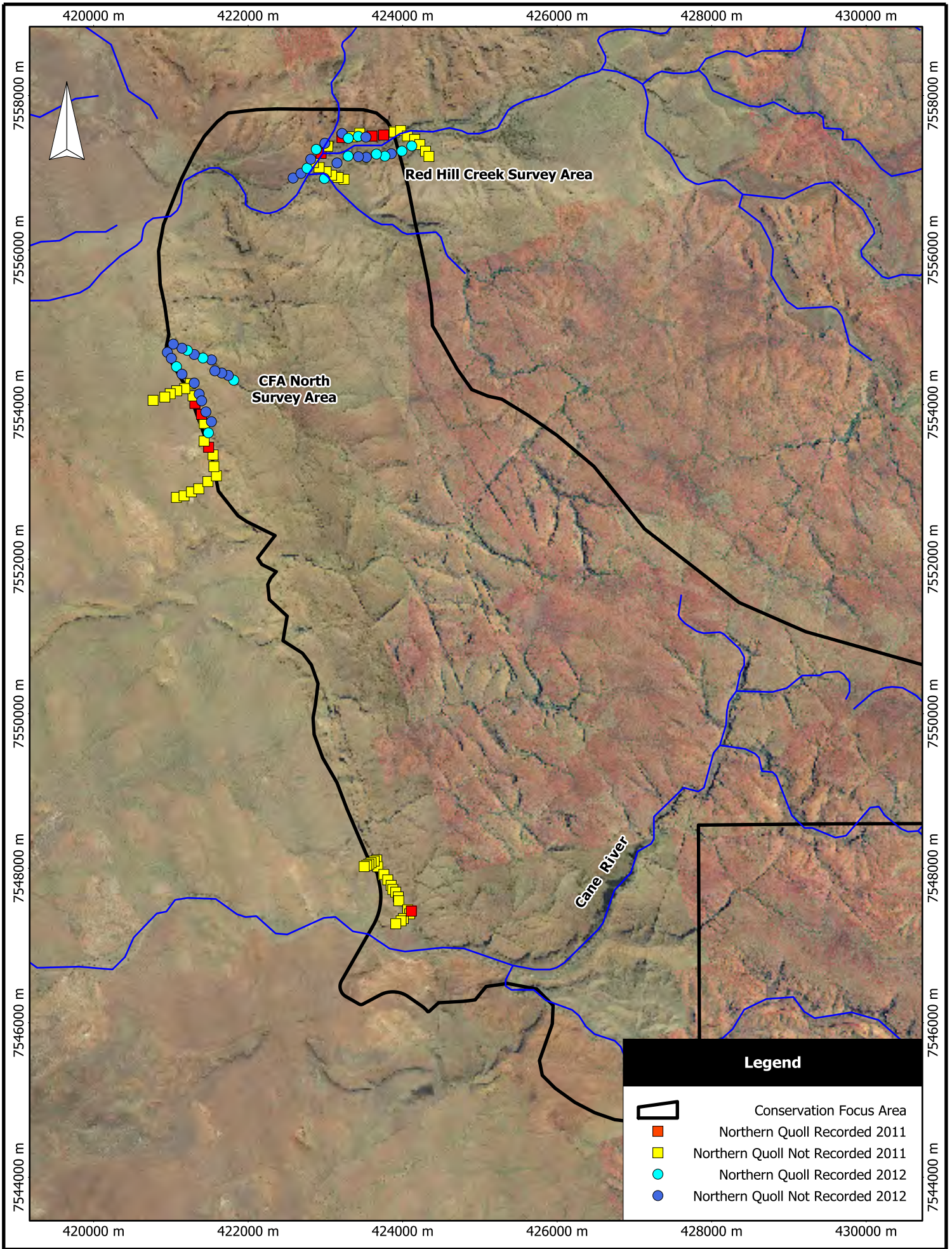
*averages sampled from males $n_{2011} = 7$; $n_{2012} = 10$, females $n_{2011} = 1$, $n_{2012} = 5$

One non-target species was trapped during the survey – the Common Rock Rat *Zyzomys argurus*. Two individuals were captured along Red Hill Creek.

The estimated populations for each survey site are presented in Table 7 with the survey areas shown on Figure 4. High levels of variance are likely due to the relatively low number of Northern Quolls trapped and the variability in capture rate from day to day.

Table 7: Population estimates for each survey area

Survey Area	Number of Quolls captured	Population Estimate (variance)
CFA 2011	8	14.5 (± 13.9)
North CFA 2012	6	13.75 (± 12.25)
Red Hill Creek 2012	9	15.46 (± 14.31)



Rapallo

Scale - 1 :60,000
Datum - MGA94 (50)
0 2 km

Conservation Focus Area
Fauna Survey

Cage Trap Locations
and Success

Figure 4

6.2. CFA FAUNA SURVEY

The results of the CFA fauna survey are presented in sections 6.2.1 to 6.2.6.

Evidence of four species listed under the EPBC Act was recorded during the survey. These were the Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python and the Rainbow Bee-eater.

An additional two species of conservation significance were recorded during the survey. These were the Peregrine Falcon, listed under the WCA as Schedule 4 – other specially protected fauna, and the Ghost Bat, listed as Priority 4 – taxa in need of monitoring by the DEC.

6.2.1. HABITAT CHARACTERISATION

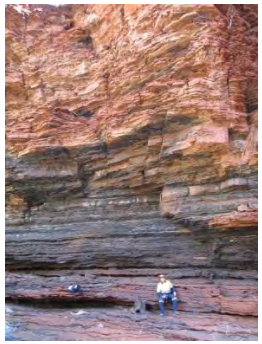
The characteristics outlined in Table 3 were used to determine if habitats were of high, medium or low suitability. A total of eight habitats were identified and characterised during the survey. The results of the assessment are presented in Table 8 and mapped in Figure 5. Raw data from each habitat assessment are included in Appendix II.

6.2.2. CAVE CHARACTERISATION

Thirty-seven caves were recorded and assessed during the survey. These are mapped in Figure 3. Raw data on these caves are presented in Appendix III.

During assessments, Common Sheath-tailed Bat *Taphozous georgianus* were recorded in 24 of the caves assessed. Ghost bats *Macroderma gigas* were recorded in five of the caves and Finlayson's Cave Bat *Vespadelus finlaysoni* were recorded in four of the caves.

Table 8: Habitat assessment of the CFA

Habitat	Description	Habitat Suitability			Habitat Example
		NQ*	POP+	PLNB#	
Gorge	**Landform types:** gorge **Habitat features:** caves, crevices, boulders, waterholes **Geology:** BIF, mudstone/conglomerates **Connectivity:** High **Evidence:** Northern Quoll scats and MDC records, Pilbara Olive Python records, Pilbara Leaf-nosed Bat SM2+ records **Comments:** Steep-sided, deeply incised gorge with walls generally higher than the width of the gorge floor with major or minor ephemeral drainage. Two microhabitats: one defined by numerous large boulders and dense vegetation (boulder gorges); the second defined by fine slabby BIF^ with thin scree and open vegetation (BIF gorges) **Vegetation Description:** Vegetation is often *Eucalyptus leucophloia* and *Terminalia* with occ. *Ficus* over *Acacia, Senna,* and *Astrotricha hamptonii* over hummock and tussock grasses.	High (boulder gorge) to Medium (BIF gorge)	High	High	
Hill / Plateau	**Landform types:** plateau, stony hill **Habitat features:** slabby breakaways and gentle drainage **Geology:** BIF **Connectivity:** High **Evidence:** two Northern Quoll scats on bordering cliffs and MDC records	High to Medium	Low	Medium	

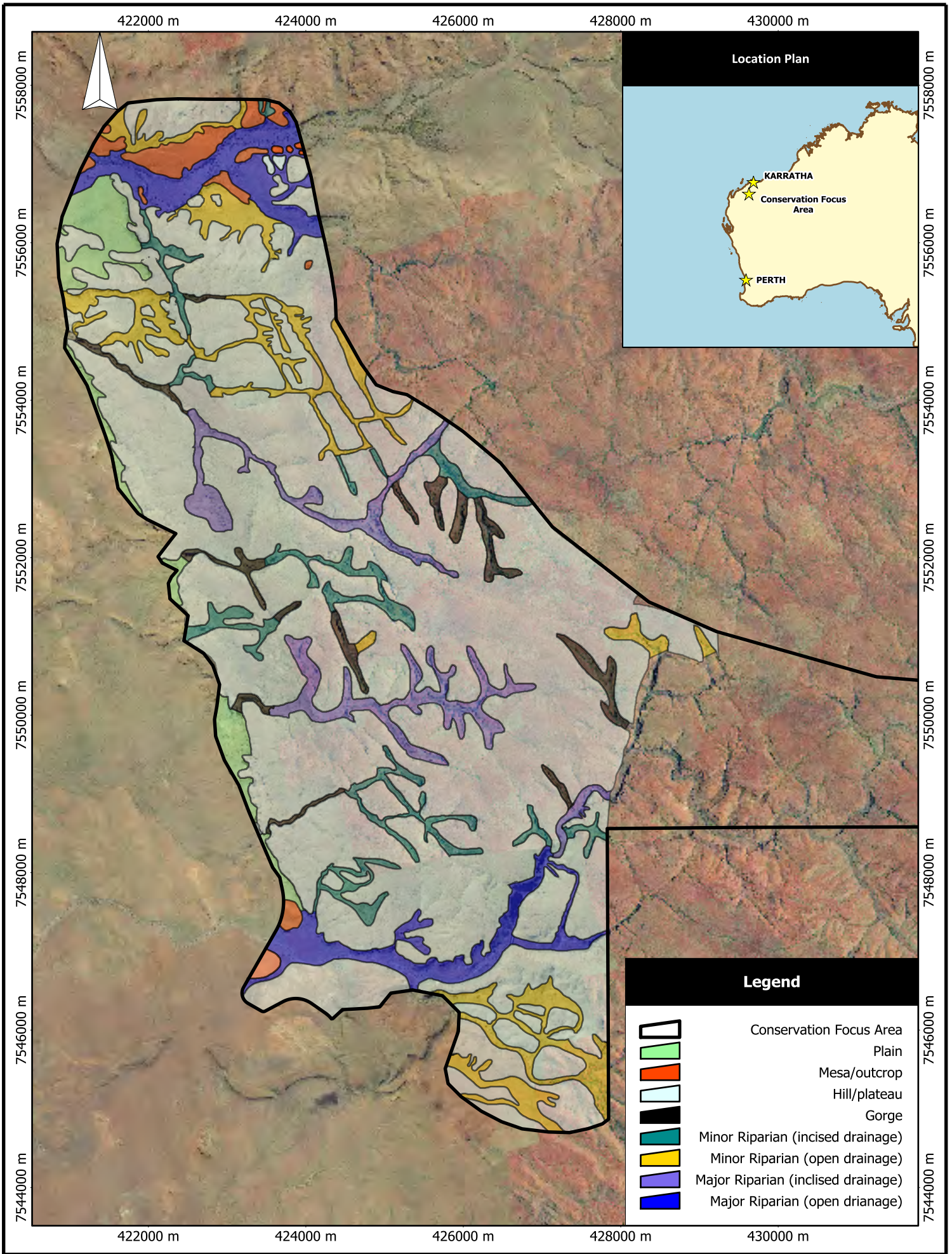
Habitat	Description	Habitat Suitability			Habitat Example
		NQ*	POP+	PLNB#	
	Comments: hilltop a representation of non-eroded Hamersley Plateau with occasional breakaways. Plateaus with steep cliffs are more suitable for the Northern Quoll but the plateau itself is less value **Vegetation Description:** sparse *Eucalyptus leucophloia* over *Senna sp., Acacia spp.*, *Grevillea wickhamii* and *Hakea sp*. over hummock grass.				
Mesa/outcrop	**Landform types:** mesa, outcrop **Habitat features:** extensive caves, cliff faces, crevices, boulders **Geology:** pisolite, dolomite **Connectivity:** Low but usually adjacent to other highly connective habitats **Evidence:** Northern Quoll scats and MDC records, SM2+ echolocation records of Pilbara Leaf-nosed Bats **Comments:** most common along Red Hill Creek and Cane River. Mesa formations of Red Hill Creek often small and highly eroded **Vegetation Description: s**parse *Eucalyptus leucophloia, Ficus* sp, *Brachychiton* over *Senna sp., Acacia spp.*, *Grevillea wickhamii* and *Hakea sp*. over hummock grass.	High	High	High	

Habitat	Description	Habitat Suitability			Habitat Example
		NQ*	POP+	PLNB#	
Major Riparian (incised drainage)	**Landform types:** drainage **Habitat features:** small caves, cliff faces, crevices, boulders **Geology:** BIF, mudstone/conglomerate **Connectivity:** high **Evidence:** Northern Quoll MDC records **Comments:** broad areas with steep to moderately steep sides that are lower than the width across the drainage (i.e. similar to a gorge but not so deep). **Vegetation Description:** vegetation is *Eucalyptus camaldulensis* or *E. leucophloia* and *Corymbia hamersleyana* with occasional *Melaleuca sp.* over *Solanum, Stemodia sp.* and *Rhynchosia sp.* over hummock and tussock grass.	High	High	Medium	
Major Riparian (open drainage)	**Landform types:** drainage **Habitat features:** caves, cliff faces **Geology:** BIF, mudstone/conglomerate **Connectivity:** high **Evidence:** Northern Quoll MDC record **Comments:** Broad riparian area associated with a major drainage line (i.e. Cane River and Red Hill Creek). River bed much wider then adjacent cliffs (if cliffs are present) **Vegetation Description:** *Eucalyptus camaldulensis over Acacia spp.,* Malvaceae, *Dodonaea sp., Grevillea wickhamii* and *Senna sp.* over mixed herbs, tussock grass with some patches of *Cyperus*	Medium	High	Medium to Low	

Habitat	Description	Habitat Suitability			Habitat Example
		NQ*	POP+	PLNB#	
Minor Riparian (incised drainage)	**Landform types:** drainage **Habitat features:** cliff faces, waterholes **Geology:** BIF **Connectivity:** medium **Evidence:** Northern Quoll scats, 1 Pilbara Olive Python record, SM2+ echolocation records of Pilbara Leaf-nosed Bat **Comments:** narrow incised gully with minor drainage, usually with a stony or slabby drainage bed, flows into major drainage. **Vegetation Description:** *Eucalyptus leucophloia and Corymbia hamersleyana* over *Acacia bivenosa, Acacia inaequilatera, Gossypium robinsonii, Senna sp., Grevillea wickhamii,* and *Petalostylis sp.* over *Triodia wiseana, Cymbopogan sp.,* with occasional *Ficus sp.* and *Brachychiton* over *Trichodesma zeylanicum, and Stemodia grossa* in moist areas	High	High	High	
Minor Riparian (open drainage)	**Landform types:** drainage (usually first drainage system flowing from hilltop) **Habitat features:** breakaways, scree slopes **Geology:** BIF **Connectivity:** Medium **Evidence:** none **Comments:** poorly defined riparian areas with stony creek bed.	Medium	Low	Low	

Habitat	Description	Habitat Suitability			Habitat Example
		NQ*	POP+	PLNB#	
	Vegetation Description: *Eucalyptus leucophloia* and *Acacia spp., Senna sp., Hakea sp., Dodonaea sp., Grevillea wickhamii,* and Malvaceae over *Triodia wiseana*.				
Plains	**Landform types:** plains **Habitat features:** stony, loam or sandy flats **Geology:** NA **Connectivity:** High **Evidence:** none **Comments:** alluvial or stony plains adjacent to the cliff face of the Hamersley scarp or adjacent to Red Hill Creek and Cane River. **Vegetation Description:** hummock and tussock grasslands of *Triodia wiseana* and *T. pungens* with *Acacia bivienosa*, *Hakea* sp. *Grevillea* sp.	Low	Low	Low	

*NQ – Northern Quoll
+ POP – Pilbara Olive Python
# PLNB – Pilbara Leaf-nosed Bat
^ BIF- Banded Iron Formation



Rapallo

Scale - 1 : 80,000
Datum - MGA94 (50)
0 2 km

Conservation Focus Area
Fauna Survey

Habitat Associations

Figure 5

6.2.3. MOTION DETECTING CAMERA SURVEYS

Fourteen of the MDCs deployed detected the presence of Northern Quolls. Twenty-one unique Northern Quolls were identified by unique spot patterns. Full site descriptions from each MDC location set in 2012 are presented in Appendix IV.

Table 9: Conservation focus area MDC survey results summary

Habitat	Number of cameras deployed	Number of Cameras with Northern Quoll Records	Success (%)	Number of Quolls
Gorge (BIF)	5	1	20%	2
Gorge (boulder)	7	6	86%	8
Hill	3	3	100%	5
River	2	1	50%	1
Outcrop/Mesa	4	3	75%	5
Total	**21**	**14**	**66%**	**21**

6.2.4. ACTIVE FORAGING SURVEYS AND BIRD SURVEYS

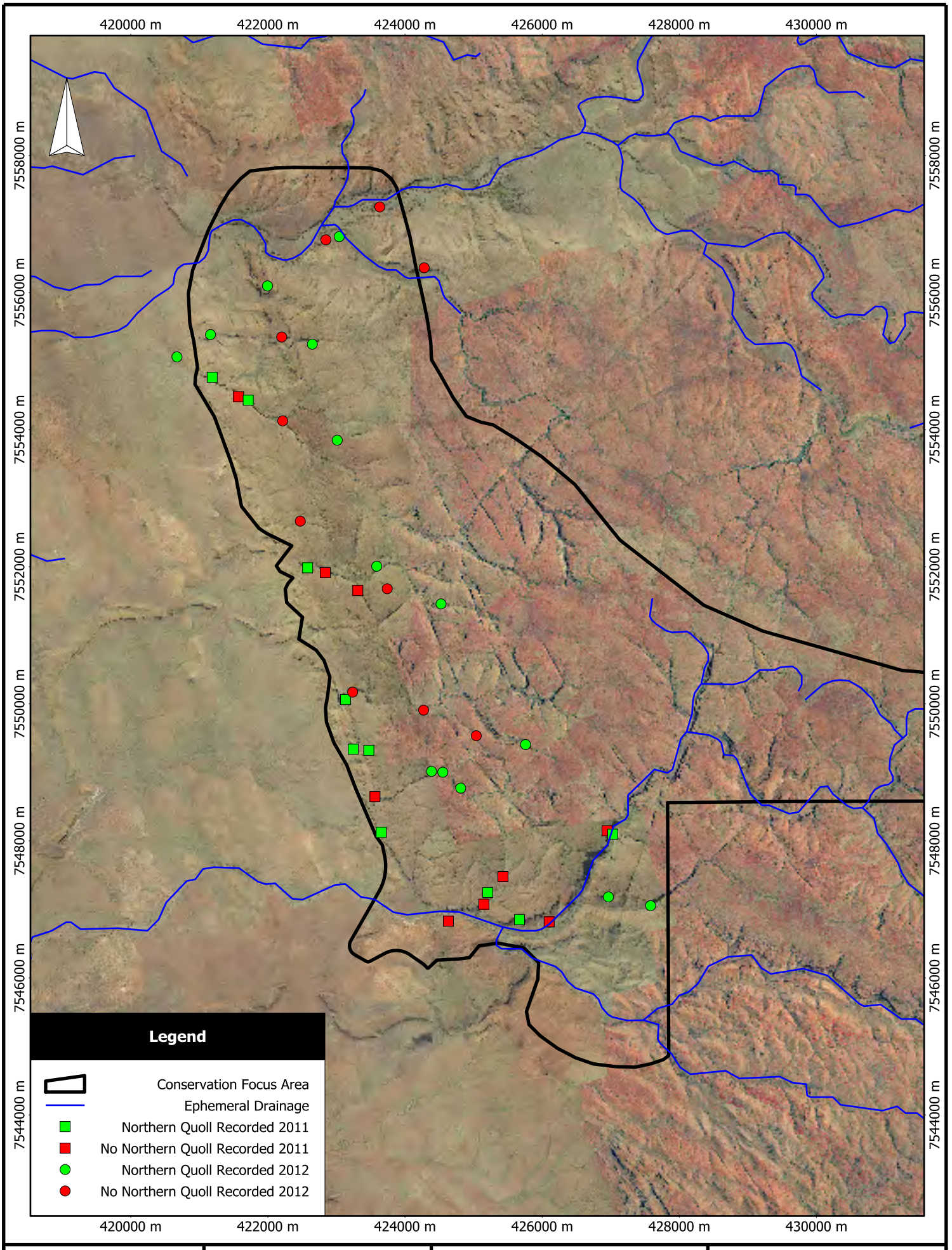
All species encountered during diurnal surveys (2011 and 2012) are listed in Table 10, including data collected data during two-hectare, twenty minute bird surveys.

Twenty-two reptile species, two amphibian species and eight mammal species were observed during active foraging surveys. Forty-three bird species were recorded via a combination of opportunistic records and two hectare, twenty minute bird surveys.

Four species of National Environmental Significance were recorded during the active foraging surveys, the Pilbara Olive Python, Northern Quoll, Pilbara Leaf-nosed Bat, and the Rainbow Bee-eater

In addition the Peregrine Falcon, listed as Schedule 4 – specially protected fauna, was recorded both in 2011 and 2012. Two species listed by the DEC as Priority 4 – taxa in need of monitoring were recorded, the Ghost Bat and the Australian Bustard.

Land mollusc specimens, including three live specimens were recorded at five sites and vouchered for future identification.



Rapallo

Scale - 1 :70,000
Datum - MGA94 (50)
0 2 km

Conservation Focus Area
Fauna Survey

Motion Detecting Camera
Locations and Success

Figure 6

Table 10: Vertebrate fauna records from diurnal foraging surveys

Scientific Name	Common Name	Habitat type							
		Plain	Mesa	Gorge	Major Riparian (incised drainage)	Major Riparian (open drainage)	Minor Riparian (incised drainage)	Minor Riparian (open drainage)	Hilltop
Birds									
Ardeotis australis	Australian Bustard					1			
Tachybaptus novaehollandiae	Australasian Grebe			1					
Platycercus zonarius	Australian Ringneck					4	3		
Certhionyx niger	Black Honeyeater			1	1				
Melithreptus gularis	Black-chinned Honeyeater				4		2		
Coracina novaehollandiae	Black-faced Cuckoo-shrike			1		4			1
Elseyornis melanops	Black-fronted Dotterel					1	1		
Ninox novaeseelandiae	Boobook Owl			1					
Falco berigora	Brown Falcon				2				1
Accipiter fasciatus	Brown Goshawk			1					
Lichmera indistincta	Brown Honeyeater				2	1	1	3	1
Melopsittacus undulatus	Budgerigar				13		2	20	1
Nymphicus hollandicus	Cockatiel			1				11	
Accipiter cirrocephalus	Collared Sparrowhawk					1			
Phaps chalcoptera	Common Bronzewing			3	1		1		
Geopelia cuneata	Diamond Dove			1		2			4
Cracticus torquatus	Grey Butcherbird				1			1	
Colluricincla harmonica	Grey Shrike Thrush			3	1				
Pomatostomus temporalis	Grey-crowned Babbler					11			
Lichenostomus plumulus	Grey-headed Honeyeater			2	2		3	2	1
Artamus minor	Little Woodswallow		3					5	
Grallina cyanoleuca	Magpie-lark				1				
Falco cenchroides	Nankeen Kestrel				1	1			
Emblema pictum	Painted Finch		2	3	11		11	2	
Cuculus pallidus	Pallid Cuckoo							1	
Falco peregrinus	Peregrine Falcon					2			1
Cracticus nigrogularis	Pied Butcherbird		2	1		1		1	

Scientific Name	Common Name	Habitat type							
		Plain	Mesa	Gorge	Major Riparian (incised drainage)	Major Riparian (open drainage)	Minor Riparian (incised drainage)	Minor Riparian (open drainage)	Hilltop
Merops ornatus	Rainbow Bee-eater						8		
Todiramphus pyrrhopygius	Red-backed Kingfisher							1	
Pardalotus rubricatus	Red-browed Pardalote			1	1	1		1	
Lichenostomus virescens	Singing Honeyeater			4	8		2	2	
Eremiornis carteri	Spinifex-bird							1	
Geophaps plumifera	Spinifex Pigeon				6		1		3
Acanthagenys rufogularis	Spiny-cheeked Honeyeater							1	
Eurostopodus argus	Spotted Nightjar				1				
Corvus orru	Torresian Crow			2	6	1		1	1
Malurus lamberti	Variegated Fairy-wren			1			1		
Smicrornis brevirostris	Weebill		1	3	2	1	3	1	
Ptilonorhynchus maculatus	Western Bowerbird		1	2	1		1		1
Lichenostomus penicillatus	White-plumed Honeyeater				1				2
Rhipidura leucophrys	Willie Wagtail		1	1	2	1	3	1	
Manorina flavigula	Yellow-throated Miner					1		1	
Taeniopygia guttata	Zebra Finch			2	1		1		1
Reptiles									
Gehyra punctata			1						1
Oedura marmorata			1						
Nephurus wheeleri									1
Cryptoblepharus ustulatus			1	2					
Ctenotus rubicundus								2	
Ctenotus saxatilis	Rock Ctenotus								1
Cyclodomorphus melanops								2	
Egernia formosa				1					
Morethia ruficauda			3	3					4
Amphibolurus longirostris				1		2	5		
Ctenophorus caudicinctus	Ring-tailed Dragon		9		1				23
Ctenophorus isolepis				2					3
Pogona minor	Dwarf Bearded Dragon				1		1		

Scientific Name	Common Name	Habitat type							
		Plain	Mesa	Gorge	Major Riparian (incised drainage)	Major Riparian (open drainage)	Minor Riparian (incised drainage)	Minor Riparian (open drainage)	Hilltop
Varanus acanthurus	Spiny-tailed Monitor		1	3		1			1
Varanus giganteus	Perentie		2						3
Varanus panoptes	Yellow-spotted Monitor					5	2	2	
Varanus pilbara	Pilbara Rock Monitor		2	2					5
Varanus tristis	Black-headed Monitor				1				
Aspidites melanocephalus	Black-headed Python								1
Liasis olivaceus barroni	Pilbara Olive Python		urates		1 in pool	2 (one deceased)			
Demansia psammophis				1					
Pseudechis australis	Mulga Snake				1				
Frogs									
Litoria rubella	Dessert Tree Frog					4			
Pseudophryne douglasi	Douglas's Toadlet			11					
Mammals									
Canis lupus	Dingo		scat						2
Tachyglossus aculeatus	Echidna		scat						scat
Macropus robustus	Euro		scat		1			2	11
Petrogale rothschildi	Rothchild's Rock-wallaby		2						1
Macroderma gigas	Ghost Bat		11 + 7 middens						
Dasyurus hallucatus	Northern Quoll		6 scats	3 scats					1+ 8 scats
Taphozous georgianus	Common Sheath-tail Bat		~160						
Vespadelus finlaysoni	Finlayson's Cave Bat		9						
	Indicates species of conservation significance								

6.2.5. SPOTLIGHTING SURVEYS

Fifteen species were recorded during the surveys, including one direct observation of a Northern Quoll and eight scats attributed to the species (Figure 7). These data are presented in Table 11.

Table 11: Vertebrate fauna records from spotlighting surveys

Scientific Name	Common Name	Spotlight Transect (shown on Figure 7)		
		Red Hill Creek	Gorge	Stockyard Pool
Dasyurus hallucatus	Northern Quoll	1 scat	1 + 7 scats	
Taphozous georgianus	Common Sheath tail-bat	1	10	
Macropus robustus	Euro	1		
Eurostopodus argus	Spotted Nightjar		1	
Podargus strigoides	Tawny Frogmouth	2		
Diplodactylus savagei	Southern Pilbara Beak-faced Gecko			1
Gehyra pilbara				1
Gehyra punctata		17	15	7
Gehyra variegata		11		
Heteronotia binoei	Bynoe's Gecko		1	1
Heteronotia spelea	Desert Cave Gecko		2	
Lucasium stenodactylum		1		
Oedura marmorata	Marbled Velvet Gecko	7	7	
Suta fasciata	Rosen's Snake	1		
Litoria rubella	Little Red Tree Frog	2		

6.2.6. ECHOLOCATION SURVEYS

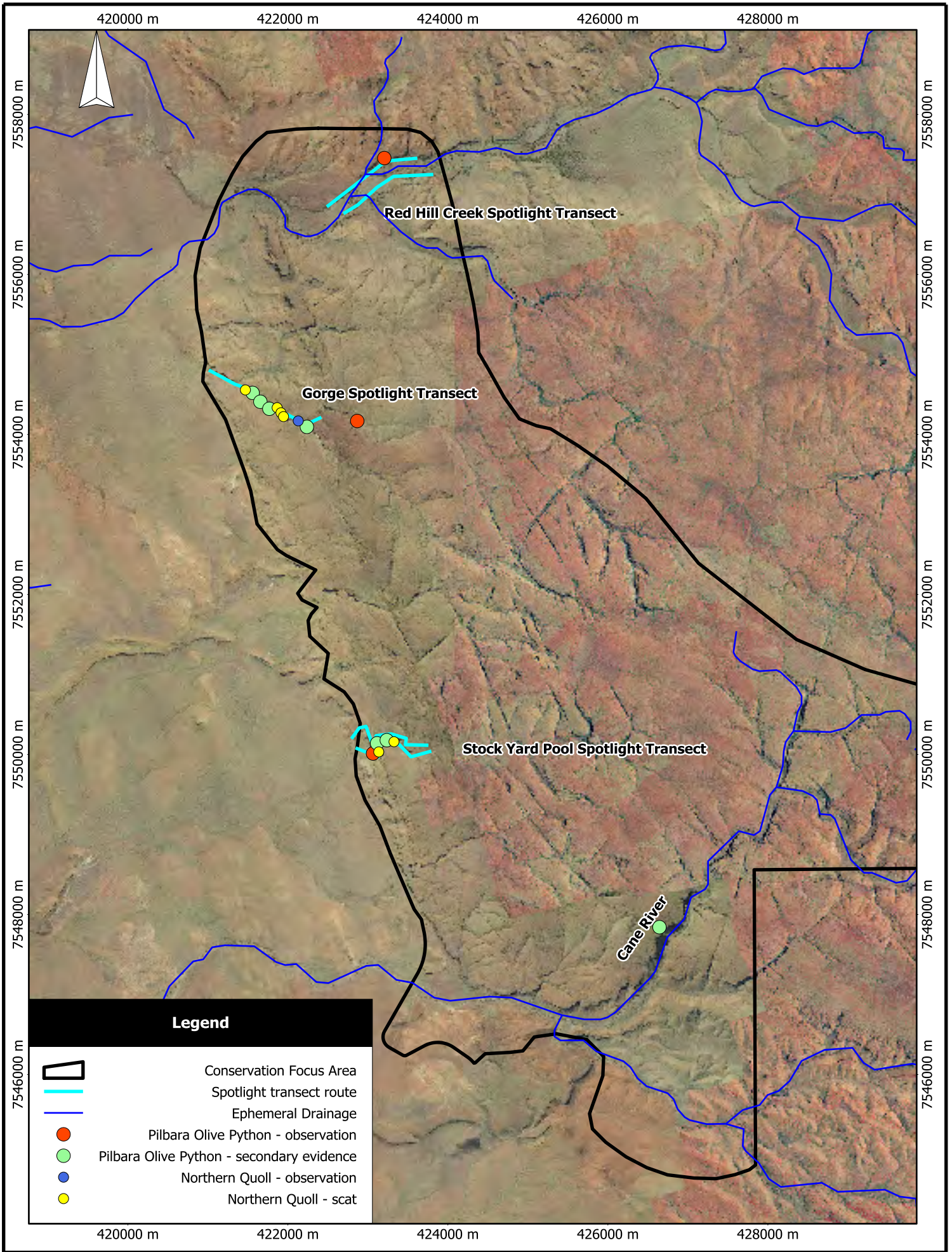
Nine bat species were recorded on SM2+ devices (Appendix V). Six devices recorded Pilbara Leaf-nosed Bats and two devices detected possible Ghost Bat echolocations. The habitat type, recording dates and conservation significant species recorded are provided in Table 12 and in Appendix V. SM2BAT+ locations are displayed in Figure 8.

Table 12: Echolocation survey results

SM2BAT+ Site	Habitat Type	Number of Record Nights	Pilbara Leaf-nosed Bat Record-nights	Ghost Bat Record-nights	Record Rate #
PCSM201	Outcrop	5	5	0	100%
PCSM202	Hilltop	0	-	-	-
PSSM201	Major Riparian	0	-	-	-
PSSM202	Mesa/outcrop	0	-	-	-
PSSM203	Minor Riparian (incised drainage)	4	3	0	75%
Python Pool	Gorge/ Waterhole	2	2	0	100%
SM2N01	Mesa/outcrop	6	4	0	67%
SM2N02	Mesa/outcrop	5	0	5*	100%*
SM2N03	Major Riparian (open drainage)	5	2	1+1*	40%; 40%*
SM2N04	Gorge	2	2	0	100%

*Needs confirmation – Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls (Specialised Zoological 2012 Appendix 5).

number of nights recorded/number of nights active



Rapallo

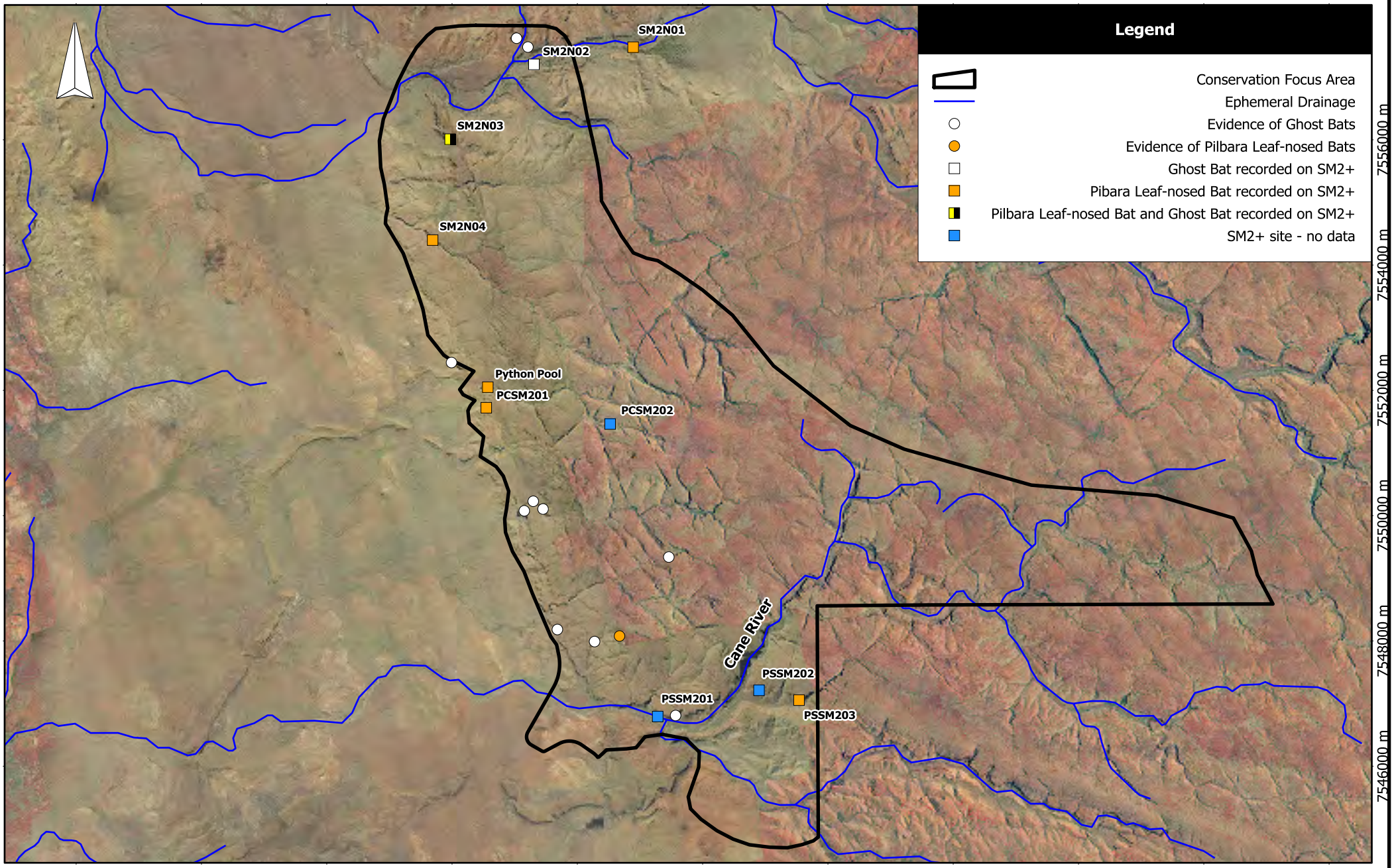
Scale - 1 :60,000
Datum - MGA94 (50)

0 2 km

Conservation Focus Area
Fauna Survey

Spotlight Transects and Pilbara Olive Python Evidence

Figure 7



Rapallo

Scale - 1 : 80,000
Datum - MGA94 (50)
0 4 km

Conservation Focus Area
Fauna Survey

Bat Species of Conservation Significance and SM2+ Records

Figure 8

7. DISCUSSION AND RECOMMENDATIONS

7.1. HABITATS

7.1.1. HABITATS OF THE CFA

The habitats recorded in the CFA during the survey are broadly consistent with the general habitat patterns of the Hamersley Ranges (Tillie 2006, Beard 1990, Kendrick 2002).

The tussock grasslands of the Hamersley Plateau (characterised as Hill and Plateau in Table 8) account for the greatest area within the CFA. They are homogeneous in vegetation structure, geology and soil and are very similar to other areas found along the Hamersley Plateau (Beard 1990, Kendrick 2002). The habitats are often fringed by cliffs which can be used by for denning by Northern Quolls. Other species of conservation significance could also potentially utilise such habitats including the Pilbara Pebble-mound Mouse. The habitat is highly connective throughout the CFA.

Riparian habitats form in areas of the plateau that have been eroded. The riparian habitats characterised in the CFA can be divided into three associations; major riparian, minor riparian and gorges. Both major and minor riparian habitats can be broken down further depending on the size and gradient of the cliff faces surrounding them. The cliff faces are either deeply incised, forming a closed system, or gently sloping, forming an open system. The relationship between the drainage and the cliff faces influences the habitats suitability to several species of conservation significance. Drainage habitat that are fringed by steeper cliffs that contain caves and crevices are more likely to support populations of the Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat.

The drainage features of the CFA are highly suitable for all three species of national environmental significance. The cliff faces that border each of these systems host crevices and cave systems of varying complexity (depending on the geology). The riparian flats of these systems are often lined with boulders that have eroded from the strata of the high cliff faces.

While riparian habitats are localised in area, they are also highly connective. For example, a Northern Quoll situated in the far east of the CFA could disperse along drainage systems to the north of the CFA without leaving the boundaries of the area. All riparian systems were ephemeral and not flowing during the survey. However, freshwater pools were present along some systems (see section 7.1.3)

To the north of the CFA, the Plateau becomes more weathered as it approaches Red Hill Creek. This area hosts small mesas and weathered outcrops. Several outcrops are comprised of remnant pisolites which host complex cave and crevice systems. While the area and relief are low (when compared to the cliff faces of the plateau to the south), they are considered highly suitable for the three species of national environmental significance. Several outcrops are remanent patches of banded ironstone and jaspilite. The weathering of these outcrops results on broader, more open cave systems. These outcrops are considered less suitable for the three species of national environmental significance.

7.1.2. CAVES

In arid ecosystems, caves are used by a large number of species for shelter and foraging (Strong and Goodbar, 2005). Emerging data from the Pilbara suggests rocky strata that host complex cave systems often support a wide range of species of conservation significance (EPA 2004). Each of the three species of National Environmental Significance targeted by surveying utilise cave systems for shelter and for foraging.

The cliff faces outcrops of the CFA host a large number of cave systems. Only a small percentage of the caves present within the borders of the CFA have been investigated and characterised during the surveys to date.

No peer reviewed data has been collected on the abundance of cave formations capable of supporting bat roosts along the Hamersley Ranges. Anecdotally, the number of caves detected in the CFA that supports roosting bats exceeds other areas surveyed by Rapallo in the Pilbara (Rapallo 2010a, 2011d, 2011e, 2011f, 2012b).

Evidence of the Northern Quoll and the Pilbara Olive Python was detected in caves of the CFA. Additionally, a major roost cave for the Pilbara Leaf-nosed Bat was also recorded. Currently, population estimates for this cave exceed all other roosts in the Pilbara (Astron 2011b, Biologic 2012, SEWPAC 2011). Several caves of the project supported small roosts of the Ghost Bat *Macroderma gigas* which is listed by the DEC as Priority 4 – Taxa in need of monitoring.

The value of the CFA for the three species of national environmental significance is increased by the abundance of caves hosted by the landforms of the CFA.

7.1.3. WATERHOLES

Semi-permanent waterholes are considered to be of high importance to for the Pilbara Olive Python and the Pilbara Leaf-nosed Bat (SEWPaC 2011b, 2012b).

While it is possible for Pilbara Olive Pythons to forage far away from water during good seasons (I. Harris pers com 2011), waterholes become very important during dry periods when prey species abundance drops. During such periods, waterholes become activity points for animals that require free water to survive. Waterholes are also used by Pilbara Olive Pythons to slough.

Pilbara Leaf-nosed Bats have high sub-cutaneous water loss rates (Baudinette *et al.*, 2000). The species survives by roosting in humid caves to reduce water loss and by foraging in areas where free standing water is easily accessible.

The steep sided gorge systems of the CFA support a large number of waterholes that can persist through extended dry periods. One gorge system to the north of the CFA hosted in excess of 11 waterholes along its length several of which were deep and large in surface area. A Pilbara Olive Python was recorded sloughing in a small pool at the end of this gorge system.

A second, deceased, Pilbara Olive Python was recorded adjacent to a major pool in the southern portion of the CFA.

The abundance and size of waterholes within the CFA increases the value of the habitats within the CFA. They also increase the ability of the CFA to support long term viable populations of the Pilbara Olive Python and Pilbara Leaf-nosed Bats.

7.2. SPECIES OF NATIONAL ENVIRONMENTAL SIGNIFICANCE – NORTHERN QUOLL

7.2.1. POPULATION ASSESSMENT

Cage trap, MDC and scat data collected to date suggests that habitats within the CFA host viable populations of Northern Quoll. The majority of the Northern Quoll records come from cliff faces that border the plateaus, riparian systems and mesas. Preliminary trends in the data suggest that certain riparian systems support larger populations than others.

Population estimates for the CFA increased slightly between 2011 and 2012. This can be accounted for by the increased sampling rate on habitats deemed to be suitable for denning. Cage trap data confirms that some habitats of the CFA supported extant populations over a 12 month period.

Cage trap data from Red Hill Creek also confirms that Northern Quolls regularly move between the rocky cliff faces that border the river bed. In some areas, the distance between the river banks exceeds 500 meters. It is also highly likely that Northern Quolls forage along the river beds. Males were more mobile than females, data that conforms to trends observed in the Oakwood (2000) who observed that males were more mobile and defended larger territories then females.

The population shows traits similar to those reported in peer reviewed literature. No second year males were detected in 2012 and only 1 second year female was detected. This suggests that the population experienced total male die off after the 2011 breeding season. It also suggests that few females survived beyond raising their litters. These trends have previously been reported in studies on populations in Northern Australia (Oakwood 2004).

The weight ranges recorded during the survey fall towards the upper end of those previously published (Van Dyke and Strahan, 2008).

7.2.2. SUITABLE HABITATS WITHIN THE CFA

Baseline data collected during the surveys suggests the CFA hosts several habitat types that are considered to be suitable for Northern Quoll denning and foraging.

Boulder gorges and areas of major and minor riparian habitats that were fringed by pisolite, mudstone and ironstone are considered highly suitable for the species. This is indicated by increased detection rates on the MDCs, scat surveys and cage trap surveys.

The highly suitable habitats identified during the survey have more complex cave systems, crevices and boulders, which can all be used for shelter. They are more productive with higher levels of plant diversity.

BIF gorges, some of the minor riparian habitat types and cliff faces are all considered highly to moderately suitable for the species. Detection rates within these habitats were much lower. However,

repeat detections over several nights suggest that some of these areas are being utilised for denning. These habitats offer few complex cave systems and while there is crevicing, it is often shallow, providing limited protection. These habitats would be used for dispersal and potentially for foraging and in association with gorge and riparian systems, create a network of connective Northern Quoll habitat that spreads across most areas of the CFA.

7.2.3. ASSESSMENT OF CFA VALUE

The CFA contains a variety of highly connective habitats that are considered suitable for denning and foraging. Baseline data collected to date suggests that the CFA hosts extensive and viable populations of the Northern Quoll.

7.3. SPECIES OF NATIONAL ENVIRONMENTAL SIGNIFICANCE – PILBARA OLIVE PYTHON

7.3.1. POPULATION ASSESSMENT

The Pilbara Olive Python is a cryptic species and population size is difficult to calculate. Anecdotal observations from traditional owners suggest that the species is often sighted at two semi-permanent waterholes along the western face of the CFA.

The two sightings of extant animals made by Rapallo during the survey occurred at sights over five kilometres from the anecdotal observation sites. The animal observed during surveys in 2012 was smaller than the animal observed in 2011, indicating it was a different animal.

Secondary evidence, including two skeletons and several urates, were recorded at a number of caves along several gorge systems in the CFA. Combined, these records suggest that Pilbara Olive Pythons are using the majority of the riparian systems found within the CFA.

7.3.2. SUITABLE HABITAT S WITHIN THE CFA

All records of the Pilbara Olive Python within the CFA, both sightings and secondary evidence, have been detected within riparian systems. The majority of those records were located in gorge systems. This pattern matches the reported habitat preference for the species (Cogger, 2000).

The gorge systems of the CFA are extensive and highly connective. They are lined by cliff faces that host caves and crevices which the species may use for both foraging and shelter. Many of the gorges also host waterholes that persist during extended dry periods.

The gorge systems also regularly contained piles of debris from flash flooding events. Pilbara Olive Pythons are often recorded using debris piles for shelter and hunting (I. Harris, *pers com* 2011).

7.3.3. ASSESSMENT OF CFA VALUE

The CFA encompasses several areas of habitat that host caves, crevices, waterholes and debris. These habitats are considered highly valuable for the Pilbara Olive Python. Baseline data collected to date suggests that the CFA is capable of supporting viable populations of the Pilbara Olive Python. The

extensive area and high connectivity of riparian habitats found within the boundaries of the CFA is considered to be of conservation value to the species.

7.4. SPECIES OF NATIONAL ENVIRONMENTAL SIGNIFICANCE – PILBARA LEAF-NOSED BAT

7.4.1. POPULATION ASSESSMENT

A major Pilbara Leaf-nosed Bat Roost was recorded within the CFA during the Northern Quoll Reconnaissance Survey in 2011. Further investigations by Biologic (2012) suggest that the roost hosts a population of between 10,000 and 12,000 bats. Prior to the discovery of this roost, large roosts in the Pilbara were considered to be caves that supported between 100 and 200 Pilbara Leaf-nosed Bats.

Caves that support the temperature and humidity levels required by the species are uncommon. Rapallo identified several caves within the CFA that had elevated temperature and humidity levels. No Pilbara Leaf-nosed Bats were recorded utilising these caves. It is possible that the roost cave identified by Rapallo supports the majority of the bats that are found in the CFA. Other caves may provide suitable roosting habitat during suitable seasons.

7.4.2. SUITABLE HABITAT S WITHIN THE CFA

Data collected by Rapallo during the CFA survey suggest that Pilbara Leaf-nosed Bats are utilising the riparian systems of the CFA for foraging. This includes the river beds and the cliff faces that border the river beds. Records from SM2+ devices were made across the breadth of/and deeper within the CFA.

Waterholes are considered to be of high value for the Pilbara Leaf-nosed Bat. High detection rates were recorded around waterholes with direct observations of Pilbara Leaf-nosed Bats flying around two pools.

Visual records of the species were also made in a minor riparian system with deeply incised banks. The bats were observed flying laps along the system, presumably foraging for prey. The vegetation structure in this habitat was relatively open. Based on visual records and SM2+ data, Rapallo concludes major riparian and deeply incised minor riparian habitats of the CFA are of high value to the species.

No records of the species were made on SM2+ devices that were located on plateaus. However this result may have been impacted by the fact that two SM2+ devices that were deployed on plateaus failed during the survey. The plateau habitats of the CFA offered few features that are consistent with being suitable for the Pilbara Leaf-nosed Bat.

7.4.3. ASSESSMENT OF CFA VALUE

The CFA hosts a roost that is considered to be important for the conservation of the species in the Pilbara. It also hosts a large number of waterholes, which are highly important to the species survival in the local area.

The CFA encompasses highly valuable habitats and is considered to be able to support long term viable populations of the species.

7.5. OTHER VERTEBRATE FAUNA

7.5.1. BIRDS

Bird abundance and diversity within the CFA was low. The assemblage that was recorded was strongly characteristic of habitats found along the Hamersley Range (Barret *et al.,* 2003).

The low abundance can be explained by several factors including the limited flowering during all surveys. Flowering attracts a variety of bird species not limited to honey-eaters and their allies. Another explanation is that the CFA is dominated by large areas of habitat that are not expected to host robust avifauna populations. The tussock grassland plateaus have very limited vegetation diversity and complexity. Such habitats will usually only support arid adapted generalists (Johnstone and Storr 1998, 2004).

Granivorous species were the most abundant during the survey periods. This is likely the result of the large areas of tussock grassland which supply both food and shelter. Despite there being large waterholes within the CFA, very few wetland bird species were recorded.

The highest diversity and abundance was recorded along major open riparian habitats of the CFA. These habitats supported more complex vegetation structures that were likely to offer more abundant food and shelter resources to bird species.

Large areas of suitable habitat exist for each of the three bird species of conservation significance recorded.

The Rainbow Bee-eater was recorded utilising the major riparian habitats of Red Hill Creek. This species is likely to be abundant throughout Red Hill Creek and the Cane River.

A Peregrine Falcon nest was recorded along the Cane River in the south of CFA. While this species is slowly becoming more abundant in Australia, nesting sites are still uncommon. The cliff faces of the Cane River represent ideal nesting habitat for the species (Johnstone and Storr, 1998). The habitats of the CFA represent excellent foraging habitat for the species.

The Australian Bustard was recorded utilising the extensive major riparian habitats of the CFA. The species is likely to be locally abundant along these riparian systems where it will feed on locusts and other large insects.

7.5.2. REPTILES

The recorded reptile assemblage was robust for surveys that were undertaken on foot; twenty-nine species were recorded during all survey activities. Based on the habitats present, this represents a large proportion of the expected reptile assemblage (Biota 2009, Naturemap 2012).

Both gorge and cliff face habitats supported the highest reptile diversity within the CFA. These habitats offer both shelter and sunning structures for reptiles.

The reptile assemblage recorded during the survey is broadly matches other assemblages recorded in the region (Naturemap 2012).

7.5.3. AMPHIBIANS

The habitats of the CFA are not characteristics of those that support high amphibian abundance and diversity. The two species recorded during the survey, *Litoria rubella* and *Pseudophryne douglasi* are the most likely species to be able to utilises the water holes and ephemeral streams found along the rocky gorges and minor ephemeral drainage systems. There is also the possibility that *Uperolia saxatilis* could be present within the borders of the CFA.

The frog assemblage recorded during the survey does not contain any unexpected records for the region.

7.5.4. MAMMALS

Baseline data collated from MDCs, cage traps and visual observation suggests that the mammal assemblage of the CFA broadly matches that of other sites along the Hamersley Ranges. Most mammal species in the Pilbara are cryptic and are rarely recorded during surveys that do not involve trapping.

Microchiropterans (bats) dominated the mammal fauna assemblage, a trend that matched the high abundance of cave dwelling bats observed during the surveys of the CFA. Nine species were recorded across the site.

The Ghost Bat *Macroderma gigas* was recorded eleven times within the CFA. Anecdotally, this suggests that the population within the Hamersley Range is large. The Ghost Bat is listed as Priority 4 – Taxa in need of monitoring by the DEC.

The CFA is likely to host a selection of additional rodent and dasyurid species. The majority of these species are only likely to be caught during pit and Elliot trap surveys.

8. CONCLUSION

The CFA hosts large areas of habitat that are considered suitable for the Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat. The surveys undertaken to date have confirmed the presence of extant populations of these species within the boundaries of the CFA.

The habitats within the CFA are also suitable for species of conservation significance not listed under the EPBC Act including the Peregrine Falcon, Australian Bustard and the Ghost Bat. Future surveys are likely confirm the CFA hosts viable populations of these species.

9. REFERENCES

Archer, M., Hand, S. & Godthelp, H. (1991) The Story of Animals in Ancient Rainforests of Inland Australia. Reed Books, Balgowlah, N.S.W.

Armstrong, K.N. (2006a) Resolving the correct nomenclature of the orange leaf-nosed bat *Rhinonicteris aurantia* (Gray, 1845) (Hipposideridae). *Australian Mammalogy* 28: 125–130.

Astron (2011a) West Pilbara Iron Ore Project Habitat Assessment for Terrestrial Fauna of National Environmental Significance. Draft unpublished report prepared by Astron Environmental Services for API Management Pty Ltd

Astron (2011b) West Pilbara Iron Ore Project Pilbara Leaf-nosed Bat Habitat Assessment. Draft unpublished report prepared by Astron Environmental Services for API Management Pty Ltd

Barrett, G. (2003) *The New Atlas of Australian Birds.* Royal Australasian Ornithologists Union, Hawthorn East, Vic.

Baudinette, R.V., Churchill, S.K., Christian, K.A., Nelson, J.E. & Hudson, P.J. (2000) Energy, waterbalance and the roost microenvironment in three Australian cave-dwelling bats (Microchiroptera). *Journal of Comparative Physiology*, 170, 439–446.

Beard, J.S. (1975) *Pilbara, 1:1 000 000 Vegetation Series : Explanatory Notes to Sheet 5 : the Vegetation of the Pilbara Area*. University of Western Australia Press, Nedlands, W.A.

Beard, J.S. (1990) Plant Life of Western Australia. Kangaroo Press, Kenthurst, N.S.W.

Begg, R.J. (1981) The small mammals of Little Nourlangie Rock, NT III. Ecology of Dasyurus hallucatus, the northern quoll (Marsupialia: Dasyuridae). Wildlife Research, 8, 73–85.

Benshemesh, J. (2000) *National Recovery Plan for Malleefowl*. Department of Environment and Heritage, Adelaide.

Biologic (2012) Pilbara Leaf-nosed Bat Monitoring Programme. Unpublished report for API West Pilbara Iron Ore Project, July 2012.

Biota (2009) West Pilbara Iron Ore Project Seasonal Surveys. Unpublished report for API West Pilbara Iron Ore Project, November 2009.

Birdlife Australia. (2012) Birdata. URL http://www.birdata.com.au/homecontent.do [accessed 14 June 2012]

Braithwaite, R.W. & Griffiths, A.D. (1994) Demographic variation and range contraction in the northern quoll, Dasyurus hallucatus (Marsupialia: Dasyuridae). Wildlife Research, 21, 203–217.

Bureau of Meteorology. (2012) Bureau of Meteorology - Climate data online. URL http://www.bom.gov.au/ [accessed 14 June 2012]

Christidis, L. & Boles, W. (2008) *Systematics and Taxonomy of Australian Birds*. CSIRO Publishing, Collingwood, Vic.

Churchill, S. (2008) *Australian Bats*. Allen & Unwin, Crows National Environmental Significancet, N.S.W.

Cogger, H.G. (2000) Reptiles and Amphibians of Australia, Sixth ed. Reed, Chatswood, NSW.

Environmental Protection Authority. (2004) *Guidance for the Assessment of Environmental Factors. No. 56. Terrestrial Fauna Survey for Environmental Impact Assessment in Western Australia.* Environmental Protection Authority, Government of Western Australia.

Garnett, S. & Crowley, G.M. (2000) *The Action Plan for Australian Birds 2000*. Environment Australia, Canberra :

Government of Western Australia. (2005) *Environmental Protection (Environmentally Sensitive Areas) Notice 2005.* Western Australian Government Gazette: State Law Publisher. No. 55. 08-Apr-2005. URL http://www.slp.wa.gov.au/gazette

Greer, A. (1997) Biology and Evolution of Australian Snakes. Chipping Norton, Surrey

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

Johnstone, R.E. & Storr, G.M. (1998) *Handbook of Western Australian Birds*. Western Australian Museum, Perth, W.A.

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

Kendrick, P. (2002) Pilbara 3 (PIL3 - Hamersley subregion). *A Biodiversity Audit of Western Australia's 53 Biogeographic subregions in 2002.* (eds M. Cowan, G. Graham & N. McKenzie), Department of Conservation and Land Management.

Kulzer, E., Nelson, J.E., McKean, J.L. and Möhres, F.P. (1970). Untersuchungen über die Temperaturregulation australischer Fledermäuse (Microchiroptera). Zeitschrift fuer Vergleichende Physiologie 69: 426–438.

Marchant, S. & Higgins, P.J. (eds). (1993) *Handbook of Australian, New Zealand & Antarctic Birds. Volume 2. Raptors to Lapwings.* Oxford University Press, Melbourne.

McKenzie, N.L. and Bullen, R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. Records of the Western Australian Museum Supplement 78: 123–155.

Menkhorst, P. & Knight, F. (2011) A Field Guide to the Mammals of Australia, Third ed. Oxford University Press.

Naturemap (2012) URL http://naturemap.dec.wa.gov.au/ [accessed 14 June 2012]

Ninox Wildlife Consulting (2011) A Targeted Survye of Northern Quoll (*Dasyurus hallucatus*), Turee Syncline. Unpublished report published for Rio Tinto, September 2011.

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. (2002) Spatial and social organization of a carnivorous marsupial Dasyurus hallucatus (Marsupialia: Dasyuridae). Journal of Zoology, 257, 237–248.

Oakwood, M. (2004) Death after sex. *Biologist* 51(1) 5 – 8.

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

Pollock, A.B. (1999) Notes on status, distribution and diet of northern quoll Dasyurus hallucatus in the Mackay-Bowen area, mideastern Queensland. Australian Zoologist, 31, 388–395.

Rapallo Environmental. (2010) Targeted Survey of the Poondano Project Area for Populations of the Northern Quoll. Unpublished report for Process Minerals International.

Rapallo Environmental. (2011a) Targeted Survey of the API West Pilbara Iron Ore Project for Populations of the Northern Quoll (*Dasyurus hallucatus*). Unpublished report for Australian Premium Iron Ore Joint Venture.

Rapallo Environmental (2011b) Pilbara Olive Python habitat assessment of the WPIOP Stage 1. Unpublished report for API Pty Ltd.

Rapallo Environmental (2011c) Management Plan for Matters of National Environmental Significance: Pilbara Olive Python - *Liasis olivaceous barroni*, June 2011. Unpublished draft report for API Pty Ltd.

Rapallo Environmental (2011d) Terrestrial Fauna Survey of the Caliwinjina Project Area. Unpublished memorandum for Rio Tinto Iron Ore.

Rapallo Environmental (2011e) Short-range Endemic Fauna survey of the Mellenium Gold Project Areas, Unpublished report for Mellenium Resources Pty Ltd.

Rapallo Environmental (2011f) Short-range Endemic Fauna Survey of the Wheelara Hill Extension, Unpublished report for BHP Pty Ltd.

Rapallo Environmental. (2012a) 2011 Targeted Survey for Populations of the Northern Quoll (*Dasyurus hallucatus*) on the API West Pilbara Iron Ore Project. Unpublished report for Australian Premium Iron Ore Joint Venture.

Rapallo Environmental. (2012b) Level 2 Fauna Survey and Targeted Northern Quoll Survey of the Lamb Creek Project Area. Unpublished report for Process Minerals International.

Schmitt, L.H., Bradley, A.J., Kemper, C.M., Kitchener, D.J., Humphreys, W.F. & How, R.A. (1989) Ecology and physiology of the northern quoll, Dasyurus hallucatus (Marsupialia, Dasyuridae), at Mitchell

SEWPaC. (2011a) *Environment Protection and Biodiversity Conservation Act 1999 Referral GuideliNational Environmental Significance for the Endangered Northern Quoll, Dasyurus Hallucatus.* Department of Sustainability, Environment, Water, Population and Communities, Canberra, A.C.T.

SEWPaC (2011b) Pilbara Leaf-nosed Bat SPRAT Profile URL http:// www.environment.gov.au/epbc/public/publicspecies.html [accessed 02 Dec 2011]

SEWPaC (2012a) Interim Biogeographic Regionalisation for Australia (IBRA), Version 6.1 (Sub-regions). URL www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra [accessed 3 July 2012]

SEWPaC. (2012b) Liasis olivaceus barroni - Olive Python (Pilbara subspecies). Species Profiles and Threats Database (SPRAT). URL http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66699 Department of Sustainability, Environment, Water, Population and Communities, Canberra, A.C.T.

Shepherd, D., Beeston, G. & Hopkins, A. (2001) *Native Vegetation in Western Australia: Extent, Type, and Status*. Department of Agriculture, South Perth, Western Australia.

Shine, R. (1991) Australian Snakes: A Natural History. Reed New Holland, Sydney.

Shine, R. & D. Slip (1990). Biological aspects of the adaptive radiation of Australasian pythons (Serpentes: Boidae). Herpetologica. 46(3):283-290.

Southwood, T.R.E. & Henderson, P.A. (2007) Ecological Methods, Third ed. Blackwell Publishing.

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

Storr, G.M., Johnstone, R.E. & Smith, L.A. (1999) Lizards of Western Australia I. Skinks, Second ed. University of Western Australia Press with Western Australian Museum, Nedlands, W.A.

Strong, T.R., and Goodbar, J.R. (2005) Vertebrate species use of caves in the Chihuuahuan Desert. Proceedings of the 14th International Congress of Speleology. Hellenic Speleological Society. O-73

Tille, P.J. (Peter J. (2006) Soil-landscapes of Western Australia's Rangelands and Arid Interior. Resource Science and Land Management Branches of the Dept. of Agriculture, South Perth, W.A.

Tyler, M.J., Johnstone, R.E. & Smith, L.A. (2000) *Frogs of Western Australia / by M.J. Tyler, L.A. Smith, R.E. Johnstone*. Western Australian Museum, Perth [W.A.]

Van Dyke, S. & Strahan, R. (2008) The Mammals of Australia. New Holland Publishers, Sydney.

Van Vreeswyk, A.M.E., Payne, A.L., Leighton, K.A. & Hennig, P. (2004) Inventory and Condition Survey of the Pilbara Region, Western Australia. Department of Agriculture and Food, Western Australia, Perth, W.A.

Western Australian Museum. (2012) Checklist of the Terrestrial Vertebrate Fauna of Western Australia. URL http://museum.wa.gov.au/research/departments/terrestrial-zoology/checklist-terrestrial-vertebrate-fauna-western-australia [accessed 21 June 2012]

Wetland Research and Management (2009) API Aquila: Baseline Aquatic Ecosystem Surveys. Unpublished report prepared for Australian Premium Iron, August 2009.

Williams, I.R., Ryan, G.R. & Halligan, R. (1963) Yarraloola 1:250,000 Geology Map sheet (SF 50-6).

Wilson, S. & Swan, G. (2008) *A Complete Guide to Reptiles of Australia*. New Holland Publishers, Chatswood, N.S.W.

Woinarski, J.C.Z., Milne, D.J. & Wanganeen, G. (2001) Changes in mammal populations in relatively intact landscapes of Kakadu National Park, Northern Territory, Australia. Austral Ecology, 26, 360–370.

Woinarski, J.C.Z., Oakwood, M., Winter, J., Burnett, S., Milne, D., Foster, P., Myles, H. & Holmes, B. (2008) Surviving the toads: patterns of persistence of the northern quoll Dasyurus hallucatus in Queensland. Department of Natural Resources, Environment and the Arts, Darwin.

Appendices

Appendix I: State and Federal Conservation Codes

APPENDIX 1-A

Conservation Listings under the Environment Protection and Conservation Act 1999 (EPBC Act)

Threatened fauna and flora may be listed in any one of the following categories as defined in Section 179 of the EPBC Act. Section 179 Categories of threatened species

Extinct

(1) A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.

Extinct in the Wild

(2) A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time:

(a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or

(b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.

Critically Endangered

(3) A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.

Endangered

(4) A native species is eligible to be included in the endangered category at a particular time if, at that time:

(a) it is not critically endangered; and

(b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.

Vulnerable

(5) A native species is eligible to be included in the vulnerable category at a particular time if, at that time:

(a) it is not critically endangered or endangered; and

(b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.

Conservation Dependent

(6) A native species is eligible to be included in the conservation dependent category at a particular time if, at that time:

(a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or

(b) the following subparagraphs are satisfied:

(i) the species is a species of fish;

(ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised;

(iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory;

(iv) cessation of the plan of management would adversely affect the conservation status of the species.

(7) In subsection (6): fish includes all species of bony fish, sharks, rays, crustaceans, molluscs and other marine organisms, but does not include marine mammals or marine reptiles.

Species listed as 'conservation dependent' and 'extinct' are not matters of national environmental significance and therefore do not trigger the EPBC Act.

APPENDIX 1-B

Categories and definitions of Threatened Flora species under the *Wildlife Conservation Act (1950)* of Western Australia, taken directly from the DEC WA Herbarium website.

Under the *Wildlife Conservation Act(1950)* the Minister for the Environment may declare species of flora to be protected if they are considered to be in danger of extinction, rare or otherwise in need of special protection. Schedules 1 and 2 deal with those that are threatened and those that are presumed extinct, respectively.

T: Threatened Flora (Declared Rare Flora - Extant)

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*).

Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN (2011) Red List criteria :

- **Critically Endangered** (CR): considered to be facing an extremely high risk of extinction in the wild
- **Endangered** (EN): considered to be facing a very high risk of extinction in the wild
- **Vulnerable** (VU): considered to be facing a high risk of extinction in the wild.

X: Presumed Extinct Flora (Declared Rare Flora - Extinct)

Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the *Wildlife Conservation Act 1950*).

Species that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora List under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation Dependent species are placed in Priority 5.

Priority One - Poorly Known Taxa

Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.

Priority Two - Poorly Known Taxa

Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.

Priority Three - Poorly Known Taxa

Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.

Priority Four – Rare, Near Threatened and other species in need of monitoring

a. **Rare**. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.
b. **Near Threatened**. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
c. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Priority Five – Conservation Dependent species

Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

APPENDIX 1-C

Definitions and criteria for presumed totally destroyed, critically endangered, endangered and vulnerable ecological communities, taken from DEC (2010).

THREATENED ECOLOGICAL COMMUNITIES

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Presumed Totally Destroyed (PD)

An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

Critically Endangered (CR)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

Endangered (EN)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

Vulnerable (VU)

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

PRIORITY ECOLOGICAL COMMUNITIES

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the **Priority Ecological Community** List under priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) Communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;

(iii) Communities made up of large, and/or widespread occurrences that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Appendix II: Habitat Characterisation Data

ID	Date	Easting	Northing	Survey type	Habitat type	Upperstorey	Upperstorey1	Mid-storey1	Understorey 1	Soil	Litter Thickness	Litter Cover	Disturbance	Vertebrate Fauna			Species of Cons Sig Suitability				Photo Numbers	Comments
														Mammals	Birds	Reptiles	NQ	POP	PLNB	GB		
H1	23/05/2012	426898	7547206.2	Habitat Assessment	Riparian	brachychiton 10m+ E. camaldulensis 10m+	Brachychiton gregori, Eucalyptus camaldulensis	Senna sp.	?Cyperus sp.	loam. Red/brown.	0 - 2	50%	grazing	Taphozous georgianus		Cryptoblepharus ustulatus.	High	High	Low	Medium	3399-3404	large cave with vertical crevasse extending upwards at back of cave. Long unburnt.
H2	23/05/2012	423695.7	7548595.1	Habitat Assessment	Riparian	E. leucophloia.	Eucalyptus leucophloia	Acacia sp., Senna sp., Ficus sp. sp.	Triodia wiseana, Cymbopogon sp.	rocky loam. Red/brown.	0-2	Patchy	grazing	Taphozous georgianus Northern Quoll and Ghost Bat scats collected.	Magpielark		High	High	Medium	Medium	3387-3392	
H3	23/05/2012	420956.5	7555327.5	Habitat Assessment	Riparian	occasional corymbia and E. leucophloia	Corymbia sp., Eucalyptus leucophloia	Acacia spp., Senna glutinosa, Gossypium robinsonii, Acacia sp.	Triodia wiseana, Triodia epactia/pungens and mixed tussock grasses.	stony loam. red brown	0-2	minimal	grazing	Euro (scat), Northern Quoll (scat)			High	High	Low	Low	3410-3415	
H4	23/05/2012	422412.9	7554777.8	Habitat Assessment	Mesa /Stoney Hill	Occasional E. leucophloia	Eucalyptus leucophloia	acacia, hakea	Triodia wiseana, Triodia sp. Robe River	brown loam.	0-2	<5%		Euro (scat), Northern Quoll (scat)		Black-headed Python, Ctenophorus caudisinctus	High	Medium	Low	Low	3416-3421	not used as MDC site due to faulty camera.
H5	23/05/2012	422952	755726	Habitat Assessment	Gorge	E. leucophloia, rough barked tree.	Eucalyptus leucophloia,Terminalia canescens			stony	0-2		none		Willie Wagtail, Brown Honeyeater, Grey Shrike-thrush, Grey Butcherbird		High	Medium	Low	Medium		Possible NQ scat recovered.
H6	23/05/2012	424362.2	7549017.7	Habitat Assessment	Riparian	Sparse E. leucophloia, Acacia.	Sparse Eucalyptus leucophloia, Acacia sp.	Acacia sp., Ficus sp. sp., Astrotricha hamptonii	Trioida wiseana, Ptilotus sp. and mixed tussock grasses.	Stony	0-2		none	Euro	Brown Falcon, Singing Honeyeater, Weebill,	Cryptoblepharus ustulatus.	Medium	High	High	Medium	0620-0624 (jaxons camera)	
H7	23/05/2012	424827.9	7548755.8	Habitat Assessment	Minor Riparian (open drainage)	E. leucophloia and Terminalia (rough barked tree)	Eucalyptus leucophloia, Terminalia canescens	Malvaceae, Dodonaea sp., Acacia sp., Grevillea wickhamii	Triodia sp., Ptilotus polystachyus, Stemodia grossa.	stony	none				Spiny-cheeked Honeyeater, Brown Honeyeater, Weebill.	Ctenotus rubicundis	Medium	Low	Medium	Medium		
H8	23/05/2012	424274.5	7547939.2	Habitat Assessment	Major Riparian (open drainage)	E. camaldulensis to 20m	Eucalyptus camaldulensis	Acacia spp., Hibiscus sp., Senna sp.	Cyperus sp. and mixed herbs.	stony. Red/brown.	5-Oct	40%	grazing	Cattle	Diamond Dove, Black-faced Cuckoo-shrike, Honeyeater sp.		Low	Low	Low	Low	3393-3398	
H9	24/05/2012	422349.4	7555343.9	Habitat Assessment	Minor Riparian (open drainage)	E. camaldulensis, C. hamersleyana.	Eucalyptus camaldulensis, Corymbia hamersleyana.	Acacia sp., Senna sp.	Triodia wiseana, Cymbopogon sp. and mixed herbs.	stony loam. Red brown.	0-2	patchy	long unburnt		Pied Butcherbird, Willie Wagtail, Little Woodswallow, Brown Honeyeater		Low	Low	Medium	Medium	0655-0659	creek drainage witb large eucs surrounded by gorges and shet hills.
H10	24/05/2012	425468.2	7549177.8	Habitat Assessment	Cave	brachychiton, E. camaldulensis.	Brachychiton gregorii, Eucalyptus camaldulensis.	Corymbia, acacias.	Aristida sp.	stony loam. Brown.	0-2	Patchy	long unburnt	Taphozous georgianus (multiple), Northern Quoll	Boobook Owl, Pied Butcherbird		High	High	Medium	Medium	0649-0654	good habitat with extensive caves and nearby waterholes.
H11	24/05/2012	422201.8	7555351.8	Habitat Assessment	Mesa (BIF)	no upper story	no upper-storey	Ficus sp. sp., Senna sp., Astrotricha hamptonii.	Triodia wiseana, Cymbopogon sp.	stony loam with rock. Brown.				Macropod (scats)	Brown Honeyeater, Little woodswallow, Willie Wagtail.	Ctenophorus caudisinctus	High	High	Medium	Medium	0660-0664	
H12	24/05/2012	424085.8	7551855.4	Habitat Assessment	Major Riparian (incised drainage)	Melaleuca sp. E. leucophloia	Melaleuca sp., Eucalyptus leucophloia	Melaleuca sp.	Stemodia sp., Rhynchosia sp., Solanum sp., Themeda triandra, Triodia wiseana.	stony. Red/brown.	2-5	40%	none		Singing Honeyeater, Common Bronzewing, Painted Finch, Spotted Nightjar, Black-chinned Honeyeater, Torresian Crow.	Ctenophorus caudisinctus	High	High	Low	Low	3477-3484	
H13	24/05/2012	423312.5	7551717.5	Habitat Assessment	Minor Riparian (incised drainage)	Corymbia hamersleyana, E. leucophloia.	Corymbia hamersleyana, Eucalyptus leucophloia.	Acacia bivenosa, Acacia inaequilatera, Acacia spp., Malvaceae, Senna sp.	Triodia wiseana, Cymbopogon sp.	stony. Red/brown.	2-5	patchy	none		Weebill		Medium	Medium	Medium	Medium	3436-3447	
H14	24/05/2012	425351.8	7549090.5	Habitat Assessment	MajorRiparian (incised drainage)	Occasional E. leucophloia, Corymbia hamersleyana.	Eucvalyptus leucophloia, Corymbia hamersleyana.	Acacia inaequilatera, Acacia sp, Gossypium robinsonii, Solanum sp., Stemodia sp.	Triodia wiseana, Triodia sp. Robe River, Cymbopogon sp.	stony. Red/brown	2-5	patchy			Torresian Crow, Singing Honeyeater, Weebill, Grey-headed Honeyeater.		High	High	Medium	Medium	3457-3472 (includes photos of unknown	
H15	24/05/2012	424566	7552350.1	Habitat Assessment	Minor Riparian (incised drainage)	Ficus sp. brachypoda, sparse E. leucophloia	Ficus sp. brachypoda, sparse Eucalyptus leucophloia	Acacia inequilatera, Acacia spp., Petalostylus sp., Grevillea wickhamii.	Triodia wiseana	rocky. Red/brown	0-2	patchy			Western Bowerbird, Willie Wagtail.		Medium	Medium	Medium	Medium	3452-3456	
H16	24/05/2012	425599.2	7550138.2	Habitat Assessment	Cave	occasional E. leucophloia	Eucalyptus leucophloia	smaller Eucs with occasional iron plant	Triodia wiseana, Triodia sp. Robe River, Cymbopogon sp.	red brown		patchy and sparse			Torresian Crow, Painted Finch.	Ctenophorus caudisinctus	High	Medium	Medium	Medium	3473-3476	
H17	24/05/2012	423023.5	7550152.8	Habitat Assessment	Stony Plains / Hilltop	Occasional E. leucophloia	Eucalyptus leucophloia	Senna sp., Acacia sp., Grevillea wickhamii, Acacia inaequilatera, Hakea sp.	Triodia wiseana, Triodia sp. Robe River	stony. Red/brown.	0-2	<5%		Pilbara Pebble-mound Mouse.	Black-faced Cuckoo-shrike, Western Bowerbird,	Morethia ruficauda, Ctenotus saxatilis	Low	Low	Low	Low	3427-3435	
H18	24/05/2012	421028.6	7554992.6	Habitat Assessment	Stony Plains / Hilltop	E. leucophloia	Eucalyptus leucophloia	Senna sp., Petalostylis labicheoides.	Triodia wiseana	stony loam. Red/brown.	0-2	patchy	long unburnt	Euro (2)	Pied Butcherbird.	Ctenotus rubicundis	Low	Low	Low	Low	0639-0643 Camera 1	regular style SHET habitat
H19	24/05/2012	421707	7555099.4	Habitat Assessment	Minor Riparian	Corymbia hamersleyana, E. leucophloia.	Corymbia hamersleyana, Eucalyptus leucophloia.	Senna sp., Acacia spp.	Triodia wiseana	stony loam. Red/brown.	0-2	<5%	no recent fire		Painted Finch, Red-backed Kingfisher, Brown Honeyeater, Spinifexbird		Low	Low	Low	Low	0644-0648	stony drainage surrounded by SHET hills

ID	Date	Easting	Northing	Survey type	Habitat type	Upperstorey	Upperstorey1	Mid-storey1	Understorey 1	Soil	Litter Thickness	Litter Cover	Disturbance	Vertebrate Fauna			Species of Cons Sig Suitability				Photo Numbers	Comments
														Mammals	Birds	Reptiles	NQ	POP	PLNB	GB		
H20	25/05/2012	423146	7550013	Habitat Assessment	Cave (conglomerate, mudstone)	E. leucophloia, rough barked tree, occasional Ficus sp. brachypoda	Eucalyptus leucophloia, Terminalia canescens, occasional Ficus sp. brachypoda	Astrotricha hamptonii, Senna sp., Acacia spp.	Triodia wiseana, Triodia sp. Robe River	stony/rock, red/brown	5-Oct	Patchy		Taphozous georgianus, Northern Quoll (sighting and scat)	Brown Goshawk, Spinifex Pigeon, Common Bronzewing	Pilbara Olive Python, Amphibolurus longirostris	High	High	Medium	Medium	0719-0723	
H21	25/05/2012	422575.2	7553785.9	Habitat Assessment	Open Riparian (minor drainage)	occasional corymbia and E. leucophloia	Occasional Corymbia sp. and Eucalytpus leucophloia	Acacia inaequilatera, Acacia spp., Malvaceae.	Triodia wiseana, Triodia sp. Robe River, tussock grasses, Stemodia grossa.	stony. Red/brown.	0-2	patchy			Yellow-throated Miner, Grey Butcherbird, Red-browed Pardalote, Painted Finch.	Pogona minor	Low	Medium	Low	Low	0685-0689	
H22	25/05/2012	427572.5	7547007	Habitat Assessment	Cave (conglomerate, mudstone)	E. camaldulensis, rough barked soft leaf thing..	Eucalyptus camaldulensis, Terminalia cansecens	Acacia sp., Senna sp., Petalostylis sp., Eremophila sp., Astrotricha hamptonii	Triodia epactia/pungens	Stony	2-5	patchy			Willie Wagtail, Variegated Fairy-wren, Grey-headed Honeyeater, Weebill, Black-faced Cuckoo-shrike, Grey-shrike Thrush.		High	Medium	Low	Low	3501-3507	
H23	25/05/2012	425282.6	7546792.9	Habitat Assessment	Major Riparian (open drainage)	E. camaldulensis (in river) Meleleuca on river edges.	Eucalytpus camaldulensis (in river) Melaleuca spp. on river edges.	Hakea sp., Acacia spp.	Trachymene oleracea, Triodia wiseana, Cyperaceae, Stemodia grossa.	stony, brown/grey	0-5	patchy	minor grazing, long unburnt		Yellow-throated Miner, Weebill, Pied Butcherbird, Brown Honeyeater, Red-browed Pardalote, Nankeen kestrel, Torresian Crow, Willie Wagtail, Australian Ringneck, Grey-crowned Babbler, Diamond Dove.		High	Low	Low	Low	3490-3494	
H24	25/05/2012	422639.9	7553821.9	Habitat Assessment	Stony Plains / Hilltop	Corymbia hamersleyana, E. leucophloia.	Corymbia hamersleyana, E. leucophloia.	Acacia inaequilatera, Senna sp. , Grevillea wickhamii, Hakea sp., Acacia sp..	Triodia wiseana	stony. Red/brown.	0-2	minimal	possibly burnt within last 5 years	Euro	Budgerigar, Grey-headed Honeyeater, Brown Falcon, Zebra Finch, Painted Finch.		Low	Low	Low	Low	0690-0694	shet continues up gorge and into little valleywith slabby compacted outcroppings. These have some depressions and a couple of deep flutes but are pretty marginal.
H25	25/05/2012	423194.2	7550176.9	Habitat Assessment	Gorge (BIF with Pisolite cap)	Occasional Ficus sp. and E. leucophloia. Rough barked mystery tree.	Eucalyptus leucophloia, Terminalia canescens, Ficus sp. sp.	Astrotricha hamptonii, Senna sp., Acacia spp.	Triodia wiseana, Triodia sp. Robe River, Trichodesma zeylanicum.	stony/rock. Red/brown	0-2	patchy	long unburnt		Western Bowerbird, Torresian Crow, Painted Finch, Budgerigar, Common Bronzewing, Grey-shrike Thrush, Cockatiels, Black Honeyeater, Grey-	Egernia formosa	High	Low	Medium	Medium	0671-0675 (camera 1)	several deep horizontal and diagonal fissures/crevices with good for heps and possible denning sites. Few true 'caves'
H26	26/05/2012	423065.9	7556829.1	Habitat Assessment	Minor Riparian	E. camaldulensis. Acacias, Terminalia sp.	Eucalyptus camaldulensis. Acacia sp., Terminalia canescens	Hakea sp., Acacia spp., Senna sp. Trichodesma zeylanicum, Grevillea wickhamii.	Triodia wiseana, Solanum sp., Stemodia grossa.	loamy/stone/sand. Red brown.	0-5	patchy	grazing, erosion, long unburnt,		Weebill, Pallid Cuckoo, Torresian Crow.		Low	Low	Low	Low	3548-3552	at edge of red hill tributory and red hill creek.
H27	26/05/2012	423039.9	7553909.7	Habitat Assessment	Cave (conglomerate, mudstone)	E. camaldulensis	Eucalyptus camaldulensis	Mixed acacias, Malvacea, Trichodesma, Senna.	Trioida wiseana, Aristida sp.	Stony, Dark brown.		<5%	native grazing.	Euro (scat), Mammal tooth (macropod), large scat (canine).	Nankeen kestrel, Willie Wagtail		Low	Medium	Low	Medium		large quantities of quoll scats of numerous sizes in and around cave entrance. Possible den location.
H28	26/05/2012	424409.5	7556321	Habitat Assessment	Cave (conglomerate, mudstone)	E. leucophloia, occasional Ficus sp..	Eucalyptus leucophloia, Ficus sp. sp.	Astrotricha hamptonii, Acacia sp.	Triodia wiseana and tussock grasses.	rock. Red/brown.	0-2	patchy	none	Northern Quoll (scat)	Willie Wagtail		High	Medium	Low	Low	1263524-3528	
H29	26/05/2012	423312.5	7551717.5	Habitat Assessment	Gorge	Rough barked tree, E. camaldulensis, three species of Ficus sp..	Terminalia canescens, Eucalyptus camaldulensis, three species of Ficus sp..	Acacia spp.	Triodia wiseana, Triodia sp. Robe River, Trichodesma zeylanicum.	Stony/rock	5-Oct	patchy			Painted Finch, Zebra Finch, Diamond Dove, Grey-shrike Thrush, Willie Wagtail, Brown Falcon, Australasian Grebe,	Cryptoblepharus ustullatus, Egernia formosa, Ctenophorus isolepis	Medium	High	Low	Low		bird waterhole in sun, BEES!
H30	26/05/2012	424216.7	7549919.9	Habitat Assessment	Minor Riparian (incised drainage)	occasional E. leucophloia, rough barked tree and Ficus sp.	occasional Eucalyptus leucophloia, rough barked tree and Ficus sp. sp.	Senna sp., Stemodia grossa, Malvaceae, Acacia spp.	Triodia wiseana, Trichodesma zeylancium, Stemodia grossa.	stony, brown/grey	0-2	patchy			Grey-headed Honeyeater, Zebra Finch, Painted Finch, Willie Wagtail, Common Bronzewing, Brown Honeyeater, Spinifex Pigeon, Budgerigar	Ctenophorus caudisinctus	Medium	High	Medium	Medium	736-741 (camera 1)	Heritage cave - partial wall at back left chamber. Waterhole close by.
H31	26/05/2012	424522.3	7550036.4	Habitat Assessment	Minor Riparian (incised drainage)	E. leucophloia	E. leucophloia	Grevillea wickhamii, Senna sp., Acacia sp.	Triodia wiseana	stony					Willie Wagtail, Grey-headed Honeyeater, Weebill	Menetia greyi	High	High	Low	Low	0742-0746	very odd loaction for quoll scat.
H32	27/05/2012	425861.3	7546445.5	Habitat Assessment	Cave (conglomerate, mudstone)	Terminalia, brachychiton, Ficus sp. and E. camaldulensis	Terminalia canescens, Brachychiton gregorii, Ficus sp. sp. and Eucalyptus	Malvaceae, Senna sp.	Mixed tussock grasses.						Western Bowerbird, Grey-headed Honeyeater, Brown Honeyeater, Zebra Finch, Painted Finch, Black Honeyeater.	Ctenophorus caudisinctus, Gehyra punctata	Medium	Medium	Low	Medium	3553-3559 (habitat) 3560-3566 (Heritage)	broad open cave with several gringstones, axe chip stone, shell.
H33	27/05/2012	422216.6	7552561.5	Habitat Assessment	Minor Riparian	E. leucophloia	Eucalyptus leucophloia	Gossypium robinsonii, Senna sp., Acacia sp., Grevillea wickhamii	Triodia wiseana, Cymbopogon sp.	Stony, brown stones.	0-5	50% patchy	long unburnt		Grey-headed Honeyeater, Rainbow Bee-eater.		Medium	Low	Low	Low	0750-0754	minor drainage in SHET hills, flows into gorge system.

Source	Type_site	Site_ID	Easting	Northing	Location
Rapallo	Waterhole	WH1	422647.7	7555247	Red Hill Creek Catchment
Rapallo	Waterhole	WH2	421232.2	7554696	Red Hill Creek Catchment
Rapallo	Waterhole	WH3	423312.5	7551718	Cane River Catchment
Rapallo	Waterhole	WH4	425728	7549442	Cane River Catchment
Rapallo	Waterhole	WH5	421957	7556631	Red Hill Creek Catchment
Rapallo	Waterhole	WH6	421988	7554192	Red Hill Creek Catchment
Rapallo	Waterhole	WH7	422868.9	7554169	Red Hill Creek Catchment
Rapallo	Waterhole	WH8	421693.5	7554393	Red Hill Creek Catchment
Rapallo	Waterhole	WH9	422194.3	7554133	Red Hill Creek Catchment
Rapallo	Waterhole	WH10	423103.8	7550070	Cane River Catchment
Rapallo	Waterhole	WH11	423098.9	7550128	Cane River Catchment
Rapallo	Waterhole	WH12	423098.9	7550135	Cane River Catchment
Rapallo	Waterhole	WH13	423106.2	7550150	Cane River Catchment
Rapallo	Waterhole	WH14	423123.3	7550179	Cane River Catchment
Rapallo	Waterhole	WH15	423528.3	7550026	Cane River Catchment
Rapallo	Waterhole	WH16	423545.1	7548632	Cane River Catchment
Rapallo	Waterhole	WH17	423853.6	7548679	Cane River Catchment
Rapallo	Waterhole	WH18	424406	7548987	Cane River Catchment
Rapallo	Waterhole	WH19	421825.7	7554305	Red Hill Creek Catchment
Rapallo	Waterhole	WH20	421879.6	7554244	Red Hill Creek Catchment
Rapallo	Waterhole	WH21	421938.2	7554223	Red Hill Creek Catchment
Rapallo	Waterhole	WH22	422706.7	7554267	Red Hill Creek Catchment
Rapallo	Waterhole	WH23	422486.5	7554319	Red Hill Creek Catchment

Date Installed	Landform
Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley
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Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley
Conservation Focus Area Survey 2012	Gorge/Valley

Appendix III: Cave Characterisation Data

API Conservation Focus Area – Cave Characterisation					
Surveyor	CM CC			**Site name**	CAVEN01
Location	Project Area North	**Zone**	50K	424740.62 mE	7557446 mN
Habitat type	Cave	**Habitat description**	North facing cave on creekline. Large cave with vertical crevasse extending upwards at back of cave		
Disturbances		**Litter thickness**	0 - 2 cm	**Litter Cover**	0.5

Vegetation composition	
Upper storey:	*Brachychiton gregori*, *Eucalyptus camaldulensis*
Mid-storey:	*Senna* sp.
Lower-storey:	*Cyperus* sp.
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded
Taphozous georgianus

API Conservation Focus Area – Cave Characterisation					
Surveyor	CM DN	**Date**	25/5/2012	**Site name**	CAVEN5/6
Location	Project Area North	**Zone**	50K	422294.7 mE	7554031.7 mN
Habitat type	Cave	**Habitat description**	Deep cave which tapers down to two narrow flutes at 10 and 15m long respectively. NQ and echidna scat found in each. A second cave opening 2X2m (CAVEN6) was located next to this-goes back quite deep but was empty.		
Disturbances		**Litter thickness**	5 - 10 cm	**Litter Cover**	Minimal but pockets in dry wash.

Vegetation composition	
Upper storey:	*Terminalia canescens*, *Eucalyptus leucophloia*, *Ficus* sp. sp.
Mid-storey:	*Astrotricha hamptonii*, mixed *Acacia* sp.
Lower-storey:	*Triodia wiseana*, *Triodia* sp. Robe River, *Cymbopogon* sp.
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded

Echidna (scat), *Taphozous georgianus* (2) Cave 5, *Taphozous georgianus* (6) Cave 6

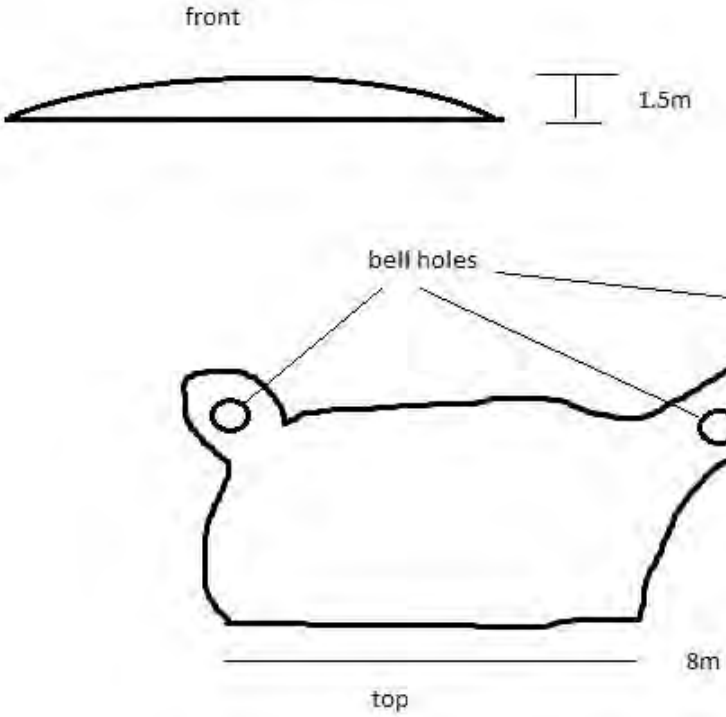
API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ CM	**Date**	27/5/2012	**Site name**	PNCA1
Location	Project Area North	**Zone**	50K		
Habitat type	Cave	**Habitat description**	simple cave with chimney and bell holes containing guano stains indicating regular/permanent use.		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	
Mid-storey:	
Lower-storey:	
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded

Taphozous georgianus (9)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	26/5/2012	**Site name**	PCC2
Location	Project Area Central	**Zone**	50K	423152.97 mE	7550076.54 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	Upper strata cave embedded within mudstone remnant. entrance about 8m, height 1-1.5m High humidity and High temperature.		
Disturbances		**Litter thickness**		**Litter Cover**	



Vegetation composition	
Upper storey:	
Mid-storey:	
Lower-storey:	
Temperature and Humidity	Increased temp and humidty at bell holes

Fauna Species Recorded
Ghost Bat (middens) *Taphozous georgianus*

API Conservation Focus Area – Cave Characterisation					
Surveyor	CM CC	**Date**	23/5/2012	**Site name**	MDCN03
Location	Project Area North	**Zone**	50K	421993.8mE	7556097.29 mN
Habitat type	Cave (BIF)	**Habitat description**	East facing cave at slabby mesa base. Mouth 3 meters wide, cave approx 6 meters deep, no chambers or bell holes		
Disturbances		**Litter thickness**	0-2 cm	**Litter Cover**	<5%

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp., *Hakea* sp.
Lower-storey:	*Triodia wiseana, Triodia* sp. Robe River
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded
Euro (scat), Northern Quoll (scat)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CM CJ	**Date**	24/5/2012	**Site name**	PCCAVE1
Location	Project Area Central	**Zone**	50K	424055.12 mE	7551722.80 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	Shallow wide cave in upper strata. Slabby silt stone/slate ~ 10m deep, no noticeable change in temp or humidity		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	
Mid-storey:	
Lower-storey:	
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded

Taphozous georgianus (3)

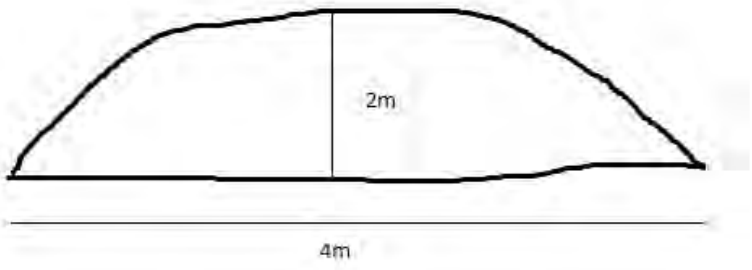
API Conservation Focus Area – Cave Characterisation					
Surveyor	CM DN	**Date**	25/5/2012	**Site name**	CaveN04
Location	Project Area North	**Zone**	50K	422270.65 mE	7554059.84 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	Contorted slab and pisolite cave. Passageway ~ 10m back from entrance approx 2m X 2m passage.		
Disturbances		**Litter thickness**		**Litter Cover**	

Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded

Taphozous georgianus

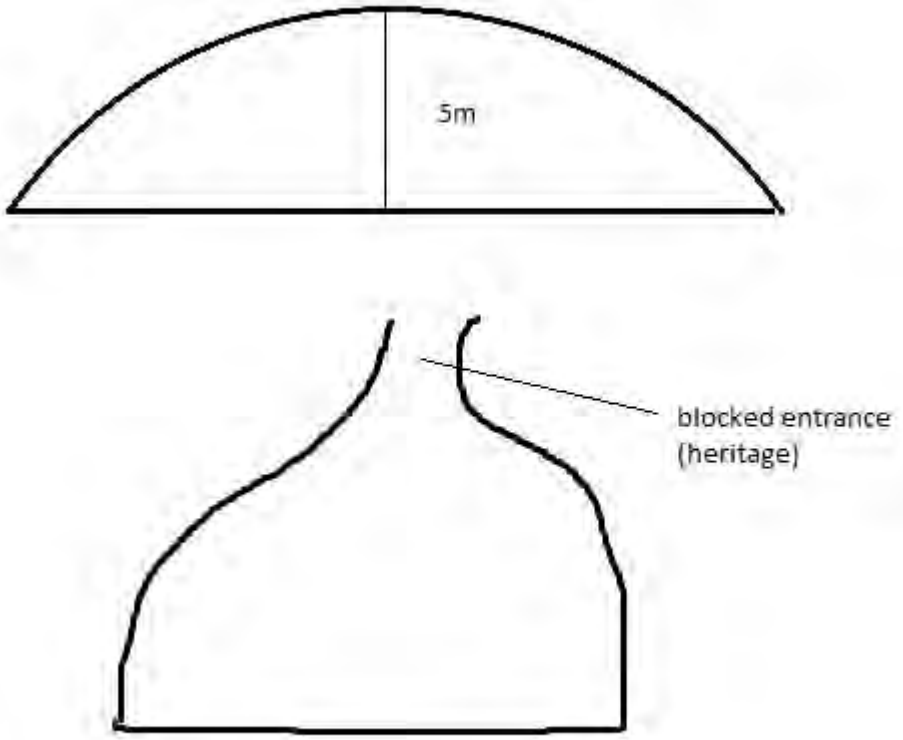
API Conservation Focus Area – Cave Characterisation					
Surveyor	CM DN	**Date**	25/5/2012	**Site name**	CAVEN09
Location	Project Area North	**Zone**	50K	421132.82 mE	7554743.48 mN
Habitat type	Cave (conglomerate, mudstone)	**Habitat description**	Cave in metamorph BIF. Cave entrance 4 metres wide, and 2 meters high. Very deep, approx 15 metres.		
Disturbances		**Litter thickness**		**Litter Cover**	



Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Terminalia canescens*, occasional *Ficus brachypoda*
Mid-storey:	*Astrotricha hamptonii*, *Senna* sp., *Acacia* spp.
Lower-storey:	*Triodia wiseana, Triodia* sp. robe river
Temperature and Humidity	Increased temp and humidty in rear chamber

Fauna Species Recorded
Taphozous georgianus (20)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	26/5/2012	**Site name**	PCC7
Location	Project Area Central	**Zone**	50K	422764.6mE	7550445.9 mN
Habitat type	Cave	**Habitat description**	Large cave with gentle upwards slope to a rear chamber that has been anthropogenically blocked.		
Disturbances		**Litter thickness**		**Litter Cover**	

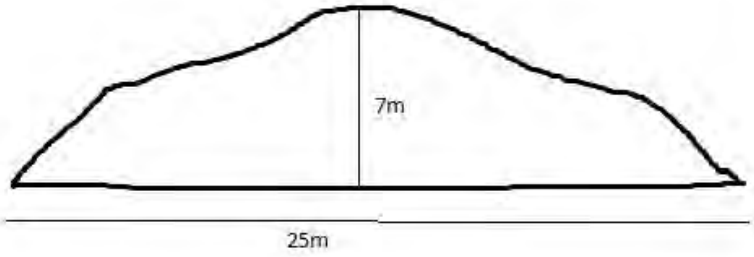


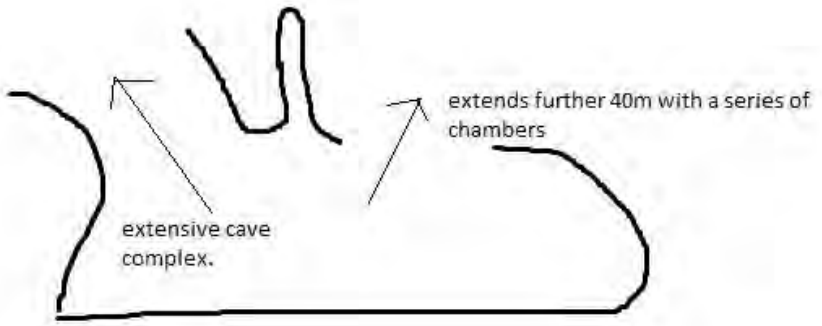
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded

Taphozous georgianus (>40)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	26/5/2012	**Site name**	PCC3
Location	Project Area Central	**Zone**	50K	423257.58 mE	7550153.33 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	Extensive cave complex extending deep within strata. Chambers extend over 40 meters with several side chambers and bell holes. Chambers with high temperatures and high humidity.		
Disturbances		**Litter thickness**		**Litter Cover**	



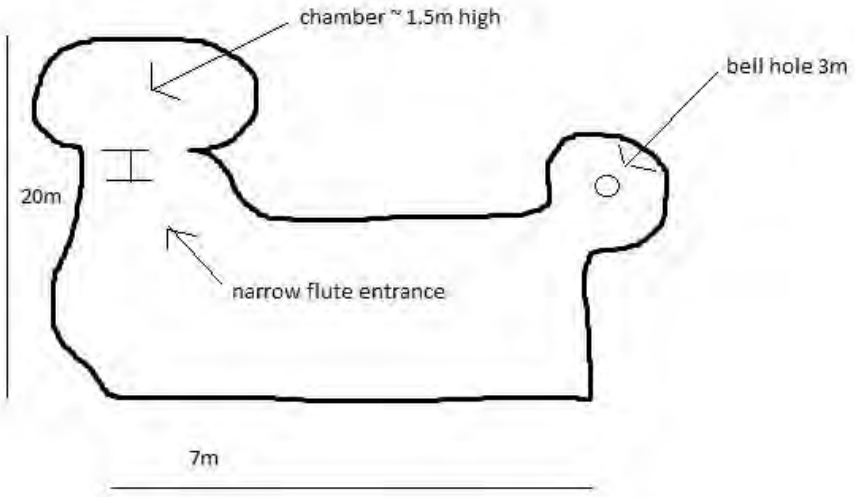


Vegetation composition	
Upper storey:	
Mid-storey:	
Lower-storey:	
Temperature and Humidity	Very high temperature and humidity in deeper chambers

Fauna Species Recorded

Taphozous georgianus , *Vespadelus finlaysoni*, Ghost Bat (3 individuals, several middens); Potetnial Pilbara Olive Python (Urates)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	26/5/2012	**Site name**	PCQS5
Location	Project Area Central	**Zone**	50K	423087.84 mE	7550005.92 mN
Habitat type	Cave (conglomerate, mudstone)	**Habitat description**	Blocky mudstone. Large open cave, seven metres wide and extending 20 metres deep. Beel holes with increased temperature and humidity.		
Disturbances		**Litter thickness**		**Litter Cover**	



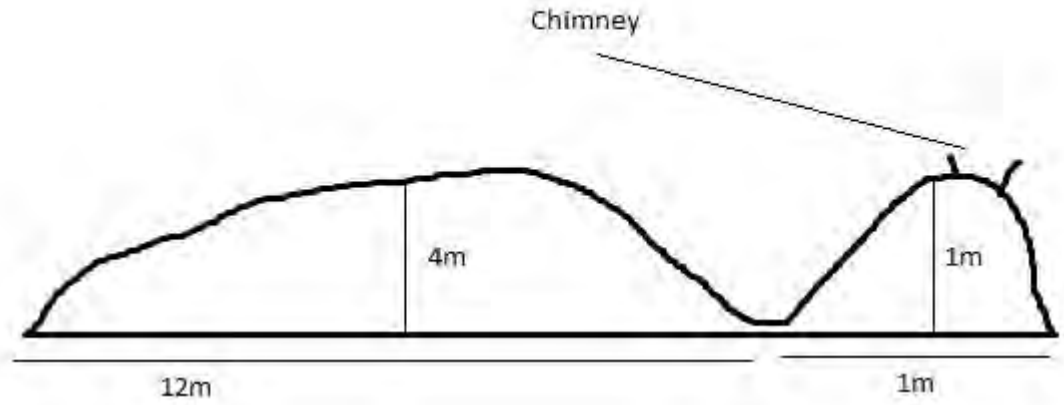
Vegetation composition	
Upper storey:	*Terminalia canescens*
Mid-storey:	*Acacia* sp.
Lower-storey:	*Triodia* sp. Robe river
Temperature and Humidity	Increased temperature and humidity in bell holes

Fauna Species Recorded

Taphozous georgianus (5), Northern Quoll (scat)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CM CC	**Date**	26/5/2012	**Site name**	CAVEN10
Location	Project Area North	**Zone**	50K	423686.94 mE	7556222.50 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	Deep cave with long chimney and two flutes. Depth of main chamber ~ 10m, thin layered meta BIF.		
Disturbances		**Litter thickness**		**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:		*Eucalyptus leucophloia*			
Mid-storey:					
Lower-storey:		*Triodia wiseana*			
Temperature and Humidity		No noticable increased temp or humidty			
Fauna Species Recorded					
Taphozous georgianus (heavy scats)					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CM CC	**Date**	26/5/2012	**Site name**	CAVEN9
Location	Project Area North	**Zone**	50K	421131.46 mE	7554747.67 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	Cave above stoney hills and wide dry creek bed in conglomerate cliffs. Heritage evidence . Small cave with rocks piled in entrance. Inner chamber approx 5 X 5m. Did not investigate further - HERITAGE		
Disturbances		**Litter thickness**	0-2 cm	**Litter Cover**	patchy

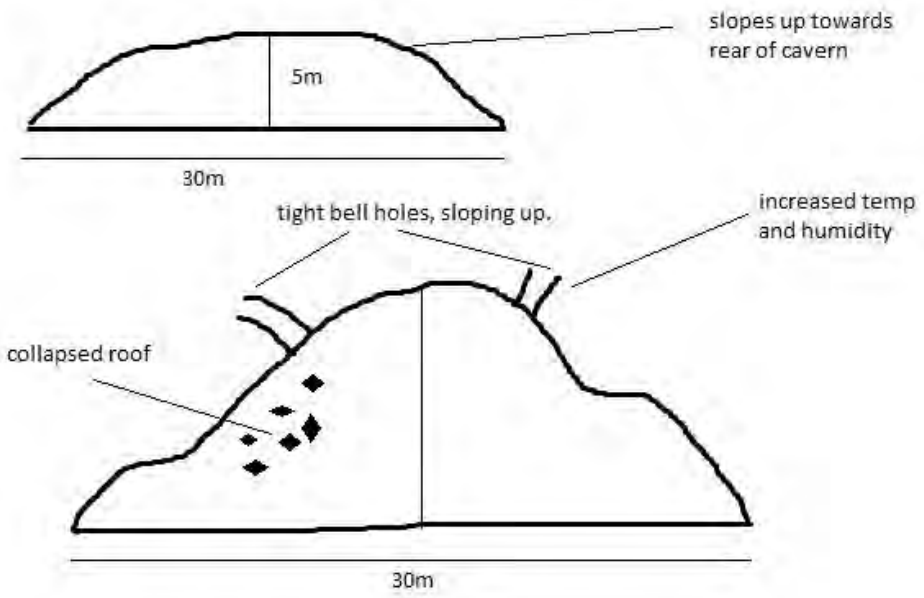


Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Ficus* sp. sp.
Mid-storey:	*Astrotricha hamptonii*, *Senna* sp., *Acacia* spp.
Lower-storey:	*Triodia wiseana* and tussock grasses.
Temperature and Humidity	Noticable increased temp and humidty

Fauna Species Recorded

Taphozous georgianus (4, abundant scats) *Vespadelus finlaysoni*

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ CM	**Date**	27/5/2012	**Site name**	PSC6
Location	Project Area South	**Zone**	50K	424188.51 mE	7547900.51 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	Open bouldery cave with a long stretch of overhang. Not too layered, more mudstone conglomerate.		
Disturbances		**Litter thickness**		**Litter Cover**	



Temperature and Humidity	Increased temp and humidty

Fauna Species Recorded

Taphozous georgianus (>20), *Vespadelus finlaysoni* (>5)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ CM	**Date**	27/5/2012	**Site name**	PNCGB
Location	Project Area North	**Zone**	50K		
Habitat type	Cave (pisolite)	**Habitat description**	Large extensive cave with obvious bat use. Small opening chamber that turns to the left and opens. Large rear chamber with two large cavers.		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	
Mid-storey:	
Lower-storey:	
Temperature and Humidity	High in rear chamber

Fauna Species Recorded

Tahpozous georgianus (10), *Vespadelus finlaysoni* (2), Ghost Bat (2 individuals, 2 middens)

API Conservation Focus Area – Cave Characterisation					
Surveyor	CCDN	**Date**	24/5/2012	**Site name**	MDCN04
Location	Project area North	**Zone**	50K	422647.6	7555247
Habitat type	Cave (BIF)	**Habitat description**	Wide open cave at end of gorge system, entrance 4 meters wide, cave up to 3 metres high		
Disturbances		**Litter thickness**		**Litter Cover**	Patchy

Vegetation composition	
Upper storey:	*E. camaulsulensis*
Mid-storey:	Malvaceae, *Acacia* sp., *Grevillea wickhamii*
Lower-storey:	*Triodia* sp., *Ptilotus polystachyus,*
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded

Taphozous georgianus, Northern Quoll, Boobook Owl, Pied Butcher Bird

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	24/5/2012	**Site name**	PCMDC03
Location	Project area Central	**Zone**	50K	423586.87	7552007.35
Habitat type	Cave (pisolite)	**Habitat description**	Shallow simple cave located within the upper strata. No more then 1.5 meters high, 3 meters deep. Bat scat present		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp. *Senna* sp. *Astrotricha hamptonii*
Lower-storey:	*Triodia wiseana*
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded

API Conservation Focus Area – Cave Characterisation					
Surveyor	CC CM	**Date**	23/5/2012	**Site name**	SM2N02
Location	Project area North	**Zone**	50K	423326.99E	7557285.99N
Habitat type	Cave (pisolite)	**Habitat description**	Cave narrows to the rear, cleft continues into rock face Not explored further in.		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	*Ficus* sp., *Brachychiton gregori*
Mid-storey:	*Acacia* sp., *Gossypium* sp., *Eremophila* sp.
Lower-storey:	*Triodia wiseana* and mixed herbaceous.
Temperature and Humidity	No noticable increased temp or humidty

Fauna Species Recorded
Taphozous georgianus

API Conservation Focus Area – Cave Characterisation					
Surveyor	CC CM	**Date**	23/5/2012	**Site name**	SM2N03
Location	Project area south	**Zone**	50K		
Habitat type	Cave	**Habitat description**	10m deep X 2.5m high tapering towards rear. 3 Moderately deep horizontal shafts.		
Disturbances		**Litter thickness**		**Litter Cover**	

Site Photo:

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp., *Hakea* sp.
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river
Temperature and Humidity	Temperature increases as the cave goes deeper

Fauna Species Recorded

Taphozous georgianus

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	23/5/2012	**Site name**	PSC2
Location	Project area south	**Zone**	50K	424416.26	7549013.58
Habitat type	Cave (BIF)	**Habitat description**	Small cave in crumbly pisolite, Chambers deeper in but not explored, 2 meter wide entrance.		
Disturbances		**Litter thickness**	None	**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:	*E. leucophloia*				
Mid-storey:	*Acacia, Ficus*				
Lower-storey:	*Triodia wiseana, Ptilotus*				
Temperature and Humidity	Increaseing temp and humidity as you progress further into cave				
Fauna Species Recorded					
Singing Honeyater, Brown Falcon, Euro, *C. ustalatus*					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	23/5/2012	**Site name**	PSC3
Location	Project area south	**Zone**	50K	424779.93	7548776.33
Habitat type	Cave (BIF)	**Habitat description**	Broad open cave up to 5 meters deep, two bell holes, large boulders on cave floor. Bat scat on cave floor		
Disturbances		**Litter thickness**	None	**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:	*E. leucophloia and Terminalia*				
Mid-storey:	*Malvacea, Dodonaea, Acacia, Grevillea wickhamii*				
Lower-storey:					
Temperature and Humidity	No noticable increased temp or humidty				
Fauna Species Recorded					
Taphozous georgianus , Egernia formosa, Brown Honeyeater, Weebill					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	23/5/2012	**Site name**	PSC4
Location	Project area south	**Zone**	50K	424779.93	7548776.33
Habitat type	Cave (BIF)	**Habitat description**	Open simple cave within BIF. Bat scat on floor. Roof up to 10 metres high, tapering off towards the rear		
Disturbances		**Litter thickness**	None	**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:					
Mid-storey:					
Lower-storey:					
Temperature and Humidity		No noticable increased temp or humidty			
Fauna Species Recorded					
Taphozous georgianus , Collard Sparrowhawk					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ CC TM	**Date**	23/5/2012	**Site name**	PSMDC04
Location	Project area south	**Zone**	50K	426889.15E	7547206.46N
Habitat type	Cave (pisolite)	**Habitat description**	one major offshoot into deep horizontal cave (anthropogenically blocked), appears to extend approx. 35m from cave mouth to rear of cavern. Two minor offshoots of main cave contain several small chimneys and bells.		
Disturbances		**Litter thickness**	None	**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:	*E. leucophloia*				
Mid-storey:	Mixed Acacias and senna				
Lower-storey:	*Triodia wiseana*				
Temperature and Humidity	Temp and humidity high				
Fauna Species Recorded					
Taphozous georgianus					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	23/5/2012	**Site name**	BC3
Location	Project area south	**Zone**	50K	424062 mE	7548846 mN
Habitat type	Cave (pisolite)	**Habitat description**	Series of caves with tight entrances leading to caverns.		
Disturbances		**Litter thickness**		**Litter Cover**	
Site Photo: No photo available					
Temperature and Humidity		Caves warmer and humid.			
Fauna Species Recorded					
Tahpozous georgianus (5)					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CM DN	**Date**	25/5/2012	**Site name**	CAVEN7
Location	Project Area North	**Zone**	50K	422370.5 mE	7554246.20 mN
Habitat type	Cave (conglomerate, mudstone)	**Habitat description**	Open dry creek bed transitioning to gorge. Cave with 2 entrances each 2m tall X 10m wide. One cave chamber ~15m deep in metamorphed BIF. Cave contains ~ 10 chimneys, the ends of 3 cannot be seen.		
Disturbances		**Litter thickness**	0 - 2 cm	**Litter Cover**	patchy
Site Photo: No photo available					
Vegetation composition					
Upper storey:	*Eucalyptus camaldulensis*. *Acacia* sp., *Terminalia canescens*				
Mid-storey:	*Hakea* sp. *Acacia* sp. *Senna* sp. *Trichodesma* sp. *Grevillea wickhamii*				
Lower-storey:	*Triodia wiseana*				
Temperature and Humidity	Increased temp and humidty				
Fauna Species Recorded					
Taphozous georgianus (6) Ghost Bat (middens)					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ CC TN	**Date**	25/5/2012	**Site name**	PSC5
Location	Project Area South	**Zone**	50K	425891.66mE	7546445.25mN
Habitat type	Cave (BIF)	**Habitat description**	ESE facing cave in slabby rock escarpment. Cave entrance 2m wide, .5m High and 10m deep		
Disturbances		**Litter thickness**		**Litter Cover**	
Vegetation composition					
Upper storey:					
Mid-storey:					
Lower-storey:					
Temperature and Humidity		No noticable increased temp or humidty			
Fauna Species Recorded					
Tahpozous georgianus					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	26/5/2012	**Site name**	PCC6
Location	Project Area Central	**Zone**	50K	424481.04mE	7550031.20 mN
Habitat type	Cave (BIF)	**Habitat description**	Crevice cave at junction of 3 gorges. Slabby with high temp and humidity.		
Disturbances		**Litter thickness**		**Litter Cover**	
Site Photo:					
Vegetation composition					
Upper storey:					
Mid-storey:					
Lower-storey:					
Temperature and Humidity	Increased temp and humidty				
Fauna Species Recorded					
Taphozous georgianus (15)					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	23/5/2012	**Site name**	BC4
Location	Project area south	**Zone**	50K	424099 mE	7548846 mN
Habitat type	Cave (pisolite)	**Habitat description**	Extremely large system with many sub-chambers - large back cavern with bat guano.		
Disturbances		**Litter thickness**		**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:					
Mid-storey:					
Lower-storey:					
Temperature and Humidity	Increased temp and humidty				
Fauna Species Recorded					
Taphozous georgianus					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ CM	**Date**	27/5/2012	**Site name**	HERITAGE
Location	Project area south	**Zone**	50K	425861.1	7546445.4
Habitat type	Cave (pisolite)	**Habitat description**	Broad open cave with roof up to ten meters. Evidence of Heritage and bats		
Disturbances		**Litter thickness**		**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:	*Terminalia, E. camaldulensis*				
Mid-storey:	*Acacia, Ficus*				
Lower-storey:					
Temperature and Humidity	No noticable increased temp or humidty				
Fauna Species Recorded					
Western Bowerbird, Grey-headed Honey Eater, Brown Honeyeater, Zebra Finch, Painted Finch Black Honeyeater, *Taphozous georgianus*					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CC CM	**Date**	23/5/2012	**Site name**	SM2N04
Location	North	**Zone**	50K		
Habitat type	Cave (BIF)	**Habitat description**	Caves above major waterhole. Several deep horizontal and diagonal fissures/crevices with good potential for heaps and possible denning sites..		
Disturbances		**Litter thickness**		**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:	*Eucalyptus leucophloia*, *Terminalia canescens*, *Ficus* sp.				
Mid-storey:	*Astrotricha hamptonii*, *Senna* sp., *Acacia* spp.				
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river, *Trichodesma zeylanicum*.				
Temperature and Humidity	No noticable increased temp or humidty				
Fauna Species Recorded					
Western Bowerbird, Torresian Crow, Painted Finch, Budgerigar, Common Bronzewing, Grey-shrike Thrush, Cockatiels, Black Honeyeater, Grey-headed Hoenyeater, Red-browed Pardalote, Zebra Finch, Spinifex Pigeon, *Egernia formosa*					

API Conservation Focus Area – Cave Characterisation					
Surveyor	CJ DN	**Date**	23/5/2012	**Site name**	PNQS1
Location	Project Area North	**Zone**	50K	422952 mE	755726 mN
Habitat type	Cave (pisolite)	**Habitat description**	Pisolite overhang with gorge, bouldery. Not steep sided.		
Disturbances		**Litter thickness**	0-2 cm	**Litter Cover**	
Site Photo: No photo available					
Vegetation composition					
Upper storey:	*Eucalyptus leucophloia*,*Terminalia canescens*				
Mid-storey:					
Lower-storey:					
Temperature and Humidity	No noticable increased temp or humidty				
Fauna Species Recorded					
Willie Wagtail, Brown Honeyeater, Grey Shrike-thrush, Grey Butcherbird					

Appendix IV: Motion Detecting Camera Site Data

API Conservation Focus Area – MDC					
Surveyor	CM CC			**Site name**	MDCN01
Location	Project Area North	**Zone**	50K	423631.09 mE	7557249.83 mN
Habitat type	Cave	**Habitat description**	Large overhange		
Disturbances	Grazing	**Litter thickness**	0-2 cm	**Litter Cover**	Patchy

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp., *Senna* sp., *Ficus* sp. sp.
Lower-storey:	*Triodia wiseana*, *Cymbopogon* sp.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Scat	No	No	Scat
Potential	High	High	High	High

Short Range Endemic Potential	medium , *Ficus* sp. present near overhangs

Fauna Species Recorded
Taphozous georgianus. Northern Quoll (scats) and Ghost Bat (scats)

API Conservation Focus Area – MDC					
Surveyor	CM CC			**Site name**	MDCN02
Location	Project Area North	**Zone**	50K	422845.15 mE	7556770.66 mN
Habitat type	Cave (pisolite)	**Habitat description**	Small cave with deep opening, couldn't see back in pisolite		
Disturbances	grazing	**Litter thickness**	0-2 cm	**Litter Cover**	minimal

Vegetation composition	
Upper storey:	*Corymbia* sp., *Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp., *Senna glutinosa*, *Gossypium robinsonii*, *Acacia* sp.
Lower-storey:	*Triodia wiseana*, *Triodia epactia*/*pungens* and mixed tussock grasses.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Scat	No	No	No
Potential	High	High	Medium	Medium

Short Range Endemic Potential	Medium

Fauna Species Recorded
Euro (scat), Northern Quoll (scat)

API Conservation Focus Area – MDC					
Surveyor	CC CM			**Site name**	MDCN03
Location	Project Area North	**Zone**	50K	421993 mE	7556097 mN
Habitat type	Minor Riparian (open drainage)	**Habitat description**	Open drainage, BIF Hills		
Disturbances		**Litter thickness**	0 – 2cm	**Litter Cover**	Patchy

Vegetation composition	
Upper storey:	*E. leucophloia*
Mid-storey:	*Acacia* sp.,
Lower-storey:	*Triodia* sp., *Ptilotus polystachyus*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	Low	Low

Short Range Endemic Potential	Low

API Conservation Focus Area – MDC					
Surveyor	CC CM			**Site name**	MDCN04
Location	Project Area South	**Zone**	50K	422647 mE	7559097 mN
Habitat type	Minor Riparian (incised drainage)	**Habitat description**	Minor incised drainage, bouldery		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	*E. camaulsulensis*
Mid-storey:	Malvaceae, *Acacia* sp., *Grevillea wickhamii*
Lower-storey:	*Triodia* sp., *Ptilotus polystachyus,*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	High	High

Short Range Endemic Potential	High

API Conservation Focus Area – MDC					
Surveyor	CC DN			**Site name**	MDCN05
Location	Project Area North	**Zone**	50K	422201.84 mE	7555351.78 mN
Habitat type	Mesa (BIF)	**Habitat description**	South facing overhang on slabby mesa		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	no upper-storey
Mid-storey:	*Senna* sp., *Astrotricha hamptonii*.
Lower-storey:	*Triodia wiseana*, *Cymbopogon* sp.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	Low	Low	Low	Low

Short Range Endemic Potential	Low

API Conservation Focus Area – MDC					
Surveyor	CC DN			**Site name**	MDCN06
Location	Project Area North	**Zone**	50K	421163 mE	755388 mN
Habitat type	Mesa	**Habitat description**	Remnant pisolitic mesa - cave		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp.
Lower-storey:	*Triodia wiseana*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	Medium	Medium	Medium

Short Range Endemic Potential	

API Conservation Focus Area – MDC					
Surveyor	CC CM			**Site name**	MDCN07
Location	Project Area North	**Zone**	50K	423040.01 mE	7556816.88 mN
Habitat type	Cave (conglomerate , mudstone)	**Habitat description**	East facing mudstone/conglomerate overhang with a small cave extending rearwards.		
Disturbances	grazing	**Litter thickness**		**Litter Cover**	<5%

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* Sp., *Malvacea* sp. *Trichodesma* sp., *Senna* sp.
Lower-storey:	*Trioida wiseana*, *Aristida* sp.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	Medium	Medium

Short Range Endemic Potential	Low

Fauna Species Recorded
Euro (scat), Mammal tooth (macropod), large scat (canine).

API Conservation Focus Area – MDC					
Surveyor	CM CC			**Site name**	MDCN08
Location	Project Area North	**Zone**	50K	424279.64 mE	7556361.86 mN
Habitat type	Cave (conglomerate, mudstone)	**Habitat description**	Conglomerate cliffs over stoney hills.		
Disturbances	none	**Litter thickness**	0-2 cm	**Litter Cover**	patchy

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Ficus* sp. sp.
Mid-storey:	*Astrotricha hamptonii*, *Acacia* sp.
Lower-storey:	*Triodia wiseana* and tussock grasses.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Scat	No	No	No
Potential	High	Medium	Medium	Medium

Short Range Endemic Potential	Medium to high

Fauna Species Recorded
Northern Quoll (scat)

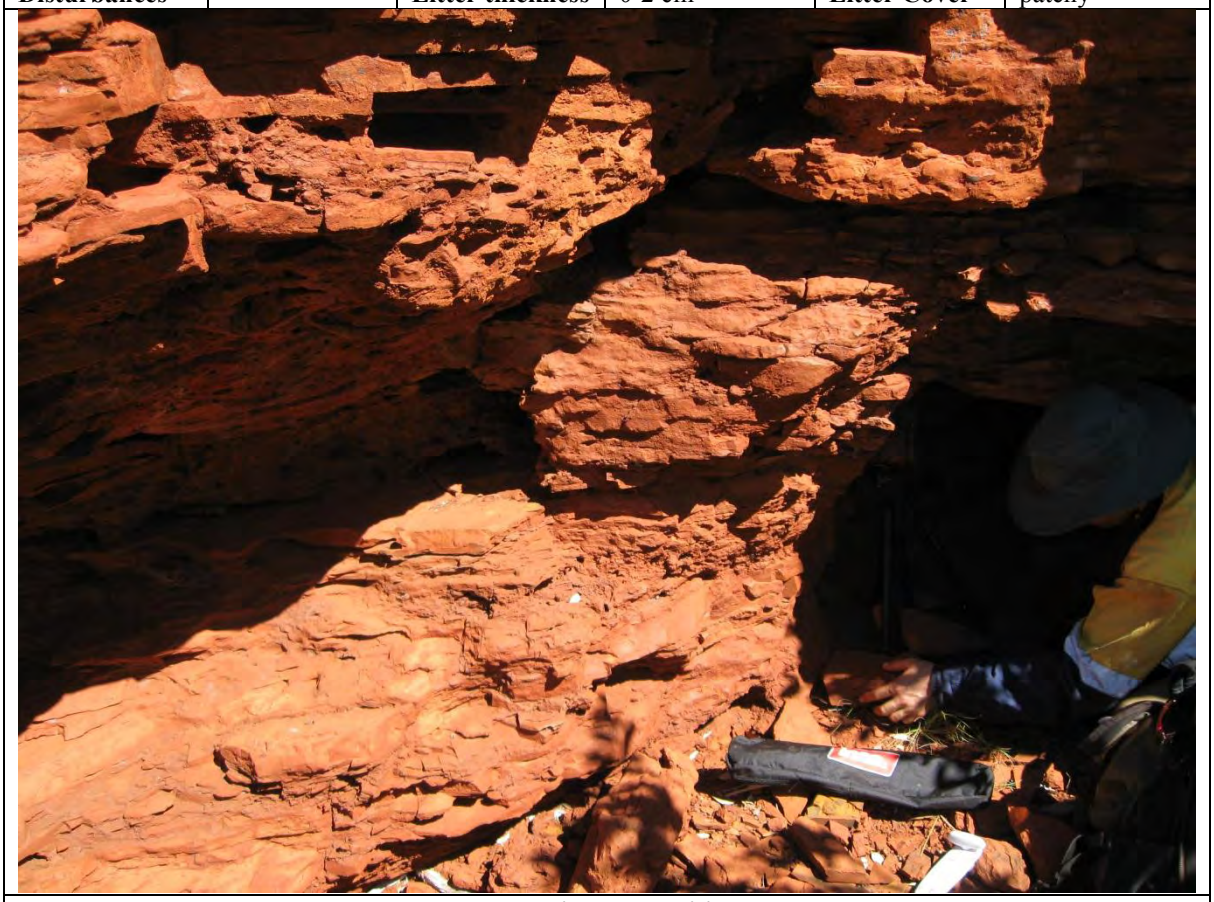
API Conservation Focus Area – MDC					
Surveyor	CC DN			**Site name**	MDCN09
Location	Project Area North	**Zone**	50K	420673 mE	755062 mN
Habitat type	Mesa	**Habitat description**	Cave		
Disturbances		**Litter thickness**		**Litter Cover**	None

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia,*
Mid-storey:	Malvaceae, *Dodonaea* sp., *Acacia* sp.,
Lower-storey:	*Triodia* sp., *Ptilotus polystachyus, Stemodia grossa*.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	Low	Medium

Short Range Endemic Potential	Medium

API Conservation Focus Area – MDC					
Surveyor	CM CJ			**Site name**	PCMDC01
Location	Project Area Central	**Zone**	50K	423740.07 mE	7551678.66 mN
Habitat type	Minor Riparian (incised drainage)	**Habitat description**	Small gorge/incised drainage system		
Disturbances		**Litter thickness**	0-2 cm	**Litter Cover**	patchy



Vegetation composition	
Upper storey:	*Ficus brachypoda*, *Eucalyptus leucophloia*
Mid-storey:	*Acacia inequilatera*, *Acacia* sp., *Petalostylus* sp., *Grevillea wickhamii*.
Lower-storey:	*Triodia wiseana*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	Medium	Low	Low	Low

Short Range Endemic Potential	Low

API Conservation Focus Area – MDC					
Surveyor	CM CJ			**Site name**	PCMDC02
Location	Project Area Central	**Zone**	50K	424523.45 mE	7551462.49 mN
Habitat type	Cave	**Habitat description**	Small overhang/shallow cave in top strata of cliff		
Disturbances		**Litter thickness**		**Litter Cover**	patchy and sparse

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Astrotricha hamptonii*
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river, *Cymbopogon* sp.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	Medium	Medium	Medium

Short Range Endemic Potential	Medium

API Conservation Focus Area – MDC					
Surveyor	CM CJ			**Site name**	PCMDC03
Location	Project Area Central	**Zone**	50K	423586.87 mE	7552007.34 mN
Habitat type	Cave (BIF)	**Habitat description**	Cave/overhang in BIF cliffside		
Disturbances	minimal litter	**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp. *Senna* sp. *Astrotricha hamptonii*
Lower-storey:	*Triodia wiseana*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	Medium	Medium

Short Range Endemic Potential	Low

API Conservation Focus Area – MDC					
Surveyor	CJ DN			**Site name**	PCMDC4
Location	Project Area Central	**Zone**	50K	423200.75 mE	7550176.74 mN
Habitat type	Cave (conglomerate, mudstone)	**Habitat description**	Upper strata cave, complex crumbly, bouldery.		
Disturbances		**Litter thickness**	cm	**Litter Cover**	

Vegetation composition	
Upper storey:	
Mid-storey:	*Acacia* sp., *Senna* sp.
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	High	High	High	High

Short Range Endemic Potential	Low

Fauna Species Recorded

Taphozous georgianus (2)

API Conservation Focus Area – MDC					
Surveyor	CJ DN			**Site name**	PCMDC5
Location	Project Area Central	**Zone**	50K	424270.55 mE	7549908.46 mN
Habitat type	Minor Riparian (incised drainage)	**Habitat description**	Undulating hills with pisolitic, mudstone and slabby incised banks.		
Disturbances		**Litter thickness**	0-2 cm	**Litter Cover**	patchy

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Terminalia canescens* and *Ficus* sp.
Mid-storey:	*Senna* sp., *Stemodia grossa*, Malvaceae, *Acacia* sp.
Lower-storey:	*Triodia wiseana*, *Trichodesma zeylancium*, *Stemodia grossa*.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	High	High	Medium	Medium

Short Range Endemic Potential	Medium

API Conservation Focus Area – MDC					
Surveyor	CC DN			**Site name**	PCMDC6
Location	Project Area Central	**Zone**	50K	422472.3 mE	7552665 mN
Habitat type	Minor Riparian (open drainage)	**Habitat description**	Gentle drainage with hummock grassland		
Disturbances		**Litter thickness**	None	**Litter Cover**	None

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp.
Lower-storey:	*Triodia wiseana*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	Low	Low	Low	Low

Short Range Endemic Potential	Low

API Conservation Focus Area – MDC					
Surveyor	DN CM			**Site name**	PCMDC7
Location	Project Area South	**Zone**	50K	423011.3 mE	7553846 mN
Habitat type	MinorRiparian (incised drainage)	**Habitat description**	BIF lined minor drianage		
Disturbances		**Litter thickness**	0 – 2 cm	**Litter Cover**	Patchy

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	Malvaceae, *Dodonaea* sp., *Acacia* sp., *Grevillea wickhamii*
Lower-storey:	*Triodia wiseana*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	Medium	Low	Low

Short Range Endemic Potential	Low

API Conservation Focus Area – MDC					
Surveyor	CM DN			**Site name**	PCMDC08
Location	Project Area Cantral	**Zone**	50K	422215.6 mE	7554128 mN
Habitat type	Major Riparian (Incised drainage)	**Habitat description**	Incised drainage with Acacia and *Terminalia canescens*		
Disturbances		**Litter thickness**	5 – 10 cm	**Litter Cover**	Patchy

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia, Terminalia canesce*ns
Mid-storey:	Malvaceae, *Dodonaea* sp., *Acacia* sp., *Grevillea wickhamii*
Lower-storey:	*Triodia* sp., *Ptilotus polystachyus, Stemodia grossa*.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	High	High	High	High

Short Range Endemic Potential	High

API Conservation Focus Area – MDC					
Surveyor	CJ DN			**Site name**	PSMDC2
Location	Project Area South	**Zone**	50K	424386 mE	7549908 mN
Habitat type	Gorge	**Habitat description**	Rocky gorge, slightly open.		
Disturbances	none	**Litter thickness**	0-2 cm	**Litter Cover**	

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Acacia* sp.
Mid-storey:	*Acacia* sp., *Ficus* sp. sp., *Astrotricha hamptonii*
Lower-storey:	*Trioida wiseana*, *Ptilotus* sp. and mixed tussock grasses.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	Low	Medium

Short Range Endemic Potential	High

API Conservation Focus Area – MDC					
Surveyor	CJ DN			**Site name**	PSMDC3
Location	Project Area South	**Zone**	50K	424812 mE	7548770 mN
Habitat type	Minor Riparian (open drainage)	**Habitat description**	Open drainage		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Terminalia canescens*
Mid-storey:	Malvaceae, *Dodonaea* sp., *Acacia* sp., *Grevillea wickhamii*
Lower-storey:	*Triodia* sp., *Ptilotus polystachyus*, *Stemodia grossa*.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	Medium	Low	Low

Short Range Endemic Potential	Low

API Conservation Focus Area – MDC					
Surveyor	CC CJ TN			**Site name**	PSMDC04
Location	Project Area South	**Zone**	50K	426889.15 mE	7547206.46 mN
Habitat type	Cave (pisolite)	**Habitat description**	South West facing overhang with small continuing cave		
Disturbances	long unburnt	**Litter thickness**	0-2 cm	**Litter Cover**	<5%

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp., *Senna* sp.
Lower-storey:	*Triodia wiseana*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	Medium	Medium

Short Range Endemic Potential	Medium

Fauna Species Recorded
Taphozous georgianus

API Conservation Focus Area – MDC					
Surveyor	CJ CC TN			**Site name**	PSMDC05
Location	Project Area South	**Zone**	50K	427572.48 mE	7547006.95 mN
Habitat type	Cave (conglomerate, mudstone)	**Habitat description**	Steep sided gorge with bouldery drainage, conglomerate/mudstone top cap eroded with slabby slate beneath		
Disturbances		**Litter thickness**	2-5 cm	**Litter Cover**	patchy

Vegetation composition	
Upper storey:	*Eucalyptus camaldulensis*
Mid-storey:	*Acacia* sp., *Senna* sp., *Petalostylis* sp., *Eremophila* sp., *Astrotricha hamptonii*
Lower-storey:	*Triodia epactia/pungens*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	High	High	High

Short Range Endemic Potential	Medium

API Conservation Focus Area – MDC					
Surveyor	CJ DN			**Site name**	PSMDC6
Location	Project Area South	**Zone**	50K	427581 mE	7547054 mN
Habitat type	Major Riparian (open drainage)	**Habitat description**	Overhsng nect to open drainage with Acacia and *Terminalia canescens*		
Disturbances		**Litter thickness**		**Litter Cover**	

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia, Terminalia canesce*ns
Mid-storey:	Malvaceae, *Dodonaea* sp., *Acacia* sp., *Grevillea wickhamii*
Lower-storey:	*Triodia* sp., *Ptilotus polystachyus, Stemodia grossa*.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	Yes	No
Potential	High	High	High	High

Short Range Endemic Potential	Medium

API Conservation Focus Area – MDC					
Surveyor	CJ DN			**Site name**	PSMDC07
Location	Project Area South	**Zone**	50K	425039 mE	7549534 mN
Habitat type	Minor Riparian (open drainage)	**Habitat description**	Overhang in BIF outcrop/breakaway		
Disturbances		**Litter thickness**	0 – 2cm	**Litter Cover**	Patchy
NO PHOTO AVILABLE					
Vegetation composition					
Upper storey:		*Eucalyptus leucophloia*			
Mid-storey:		Malvaceae, *Acaci a* sp.			
Lower-storey:		*Triodia wiseana*., *Ptilotus* sp.			
Conservation significant Fauna					
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**	
Recorded	No	No	No	No	
Potential	Medium	Medium	Low	Low	
Short Range Endemic Potential	Low				

API Conservation Focus Area – MDC					
Surveyor	CJ DN			**Site name**	PSMDC8
Location	Project Area South	**Zone**	50K	425757.7 mE	7549405 mN
Habitat type	Minor Riparian (incised drainage)	**Habitat description**	Bouldery incised drainage		
Disturbances		**Litter thickness**	5 – 10cm	**Litter Cover**	Ptchy

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Terminalia canescens*
Mid-storey:	Malvaceae, *Acacia* sp., *Grevillea wickhamii*
Lower-storey:	*Triodia wiseana*., *Ptilotus polystachyus*, *Stemodia grossa*, *Rhyncosia*, *Indogophora*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Yes	No	No	No
Potential	High	Medium	Low	Low

Short Range Endemic Potential	Medium

Source	Method	Type_site	Target_Species	Site_ID	Easting	Northing	Location	Date Installed	Date Closed	Quoll Detected
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE01	423652.9	7548123	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE03	425427.4	7547479	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE04	425205.1	7547247	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE05	425149.6	7547076	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE06	424632.1	7546828	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE07	423132.3	7550063	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE08	423474.8	7549322	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE09	423471.4	7549321	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE10	423245.2	7549337	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE11	423561.4	7548645	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE12	426946.5	7548150	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE13	427028.7	7548096	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE14	426101.6	7546818	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZONE15	425669	7546851	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZ01b	421188	7554763	Red Hill Creek Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZ02b	421571.2	7554483	Red Hill Creek Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZ03b	421605.9	7554478	Red Hill Creek Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZ04b	422579.3	7551985	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZ05b	422838	7551915	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	CZ06b	423311.2	7551652	Cane River Catchment	June Reconnaissance Survey 2011	Septmeber_2011	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN01	423631.1	7557250	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN02	422845.2	7556771	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN03	421993.9	7556097	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN04	422647.7	7555247	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN05	422201.8	7555352	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN06	421163.3	7555388	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN07	423040	7556817	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN08	424279.6	7556362	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	MDCN09	420673.7	7555062	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC1	423740.1	7551679	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC3	423586.9	7552007	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC4	423236	7550170	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PSMDC5	426966.4	7547182	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PSMDC6	427581	7547054	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PSMDC2	424386.2	7549014	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PSMDC3	424812.2	7548770	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PSMDC4	424550.5	7549002	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC2	424524.3	7551458	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC5	424270.6	7549908	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PSMDC7	425039	7549534	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PSMDC8	425757.7	7549405	Cane River Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC8	422215.6	7554128	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	NO
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC7	423011.3	7553846	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	YES
Rapallo	Motion Detecting Camera Site	Single Survey Period	Northern Quoll	PCMDC6	422472.3	7552665	Red Hill Creek Catchment	May Conservation Focus Area Survey 2012	May_2012	NO

Appendix V: Echolocation Survey Report from Specialised Zoological

Bat call identification from the API Conservation area, western Pilbara, WA

Type:	Acoustic analysis
Prepared for:	Rapallo Pty Ltd
Date:	17 September 2012
Job No.:	SZ279
Prepared by:	Kyle Armstrong and Yuki Konishi Specialised Zoological ABN 92 265 437 422 Tel 0404 423 264 kyle.n.armstrong@gmail.com http://www.szool.com.au

SUMMARY

Bat identifications from full spectrum acoustic recordings are provided from the API Conservation area, in the Pilbara region of Western Australia. Nine species of bat were identified as being present (Tables 1 and 2). Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). Representative call sequence portions are illustrated in Figure 1. Further data are available should verification be required.

COMMENTS ON IDENTIFICATIONS

Species were recognised and identified unambiguously from pulse characteristic frequency (frequency at the end or flattest portion of the pulse) and pulse shape. In addition, some species with similar pulse characteristic frequencies could be differentiated on the basis of their harmonic patterns. The northern free-tailed bat *Chaerephon jobensis* and yellow-bellied sheath-tailed bat *Saccolaimus flaviventris* could not be distinguished if no harmonics were present. The echolocation calls of the ghost bat *Macroderma gigas* are very similar to a short duration multi-harmonic broadband call type of the common sheath-tailed bat *Taphozous georgianus*, and the identification of *M. gigas* was therefore made conservatively.

METHODS

Analysis was conducted on full spectrum WAV format files, as supplied to Specialised Zoological, which had been recorded at a sampling rate of 384 kHz with a Wildlife Acoustics Song Meter SM2BAT bat detector. Each WAV file was opened and inspected in Cool Edit 2000 software, with relevant measurements made on the computer screen using the mouse. Identifications were made with reference to information in McKenzie and Muir (2000) and McKenzie and Bullen (2009), and nomenclature follows Armstrong and Reardon (2006).

REFERENCES

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

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

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.

McKenzie, N.L. and Bullen, R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum* Supplement 78: 123–155.

TABLE 1. Species identified in the present survey from all sites combined.

MEGADERMATIDAE	
Ghost bat	*Macroderma gigas*
HIPPOSIDERIDAE	
Pilbara leaf-nosed bat	*Rhinonicteris aurantia*
EMBALLONURIDAE	
Yellow-bellied sheath-tailed bat	*Saccolaimus flaviventris*
Common sheath-tailed bat	*Taphozous georgianus*
VESPERTILIONIDAE	
Gould's wattled bat	*Chalinolobus gouldii*
Little broad-nosed bat	*Scotorepens greyii*
Finlayson's cave bat	*Vespadelus finlaysoni*
MOLOSSIDAE	
Northern free-tailed bat	*Chaerephon jobensis*
White-striped free-tailed bat	*Tadarida australis*

TABLE 2. Species identifications, with the degree of confidence indicated by a code. Refer to Table 1 for full species names.

Site	Date	*C. gouldii*	*C. jobensis*	*M. gigas*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. australis*	*T. georgianus*	*V. finlaysoni*
PCSM2_01	24/5/2012	—	—	—	◆	—	—	—	◆	◆
	26/5/2012	◆	◆	—	◆	—	◆	◆	◆	◆
	27/5/2012	◆	◆	—	◆	NC	◆	◆	◆	◆
	28/5/2012	◆	◆	—	◆	NC	◆	◆	◆	◆
	25/5/2012	◆	◆	—	◆	NC	—	◆	◆	◆
PSSM2_02	No data	—	—	—	—	—	—	—	—	—
PSSM2_03	25/5/2012	◆	◆	—	◆	—	—	—	◆	◆
	26/5/2012	◆	◆	—	◆	—	—	—	◆	◆
	27/5/2012	◆	◆	—	◆	—	—	—	◆	◆
	28/5/2012	◆	◆	—	—	—	◆	◆	◆	◆
Python Pool	26/5/2012	◆	◆	—	◆	—	—	◆	◆	◆
	27/5/2012	◆	—	—	◆	—	◆	—	◆	◆
SM2N01	23/5/2012	◆	◆	—	◆	—	◆	—	◆	◆
	24/5/2012	◆	◆	—	—	◆	◆	—	◆	◆
	25/5/2012	◆	◆	—	◆	—	◆	◆	◆	◆
	26/5/2012	◆	◆	—	◆	—	—	—	◆	◆
	27/5/2012	◆	—	—	◆	—	—	—	◆	◆
	28/5/2012	—	◆	—	—	—	—	—	◆	—
SM2N02	23/5/2012	—	—	NC	—	—	—	—	◆	◆
	24/5/2012	◆	—	NC	—	—	—	—	◆	◆
	25/5/2012	—	—	NC	—	—	—	—	◆	—
	26/5/2012	—	—	NC	—	—	—	—	◆	◆
	27/5/2012	—	—	NC	—	—	—	—	◆	◆
SM2N03	23/5/2012	—	—	NC	—	—	—	—	◆	◆
	24/5/2012	◆	—	—	—	—	—	—	◆	◆
	25/5/2012	◆	—	—	—	—	—	—	◆	◆
	26/5/2012	—	—	—	◆	—	—	—	◆	◆
	27/5/2012	—	—	◆	◆	—	—	—	◆	◆
SM2N04	25/5/2012	◆	◆	—	◆	—	◆	—	◆	◆
	26/5/2012	◆	—	—	◆	—	◆	—	◆	◆

Definition of confidence level codes:

— Not detected.

◆ Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in the identification would be facilitated by capture and supported by morphological measurements or a DNA sequence.

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 *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

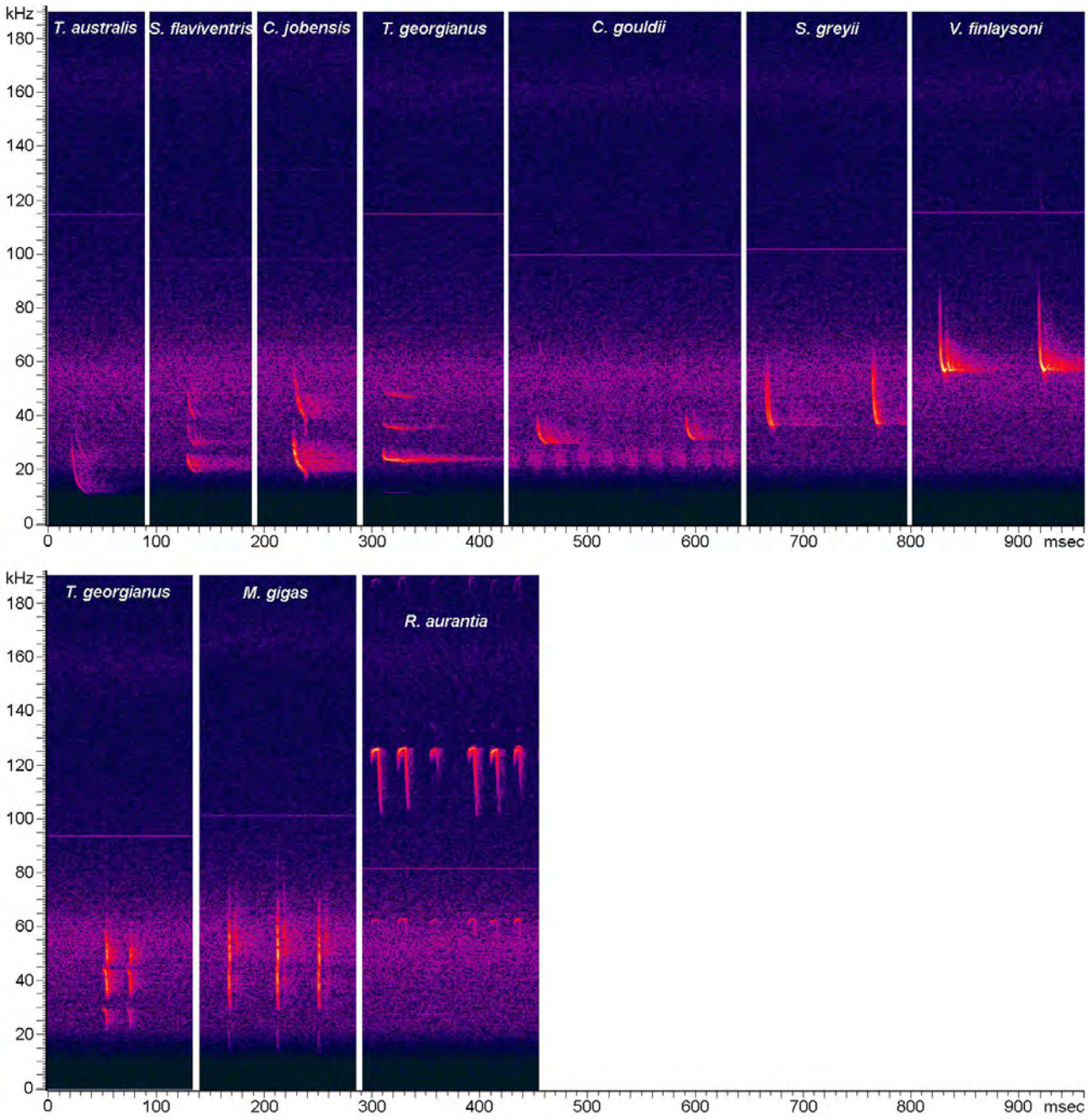


FIGURE 1. Representative call sequence portions of the species identified. Refer to Table 1 for full species names.

Appendix VI: SM2 Sites Data

API Conservation Focus Area – SM2					
Surveyor	CM CC	**Date**	23/5/2012	**Site name**	SM2N02
Location	Project Area North	**Zone**	50K	423326.98 mE	7557285.99 mN
Habitat type	Cave in Mesa and outcrop	**Habitat description**	North facing cliff face		
Disturbances	Grazing	**Litter thickness**	0-2 to 5-10 cm	**Litter Cover**	Patchy

Vegetation composition	
Upper storey:	*Ficus* sp., *Brachychiton gregori*
Mid-storey:	*Acacia* sp., *Gossypium* sp., *Eremophila* sp.
Lower-storey:	*Triodia wiseana* and mixed herbaceous.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	Yes	No	No	No

Short Range Endemic Potential	high in *Ficus* sp. litter

Fauna Species Recorded

Visual record: *Taphozous georgianus, Gehyra punctata*
SM2 record: *Chalinolobus gouldii, Macroderma gigas* (needs confirmation), *Taphozous georgianus, Vespadelus finlaysoni*

API Conservation Focus Area – SM2					
Surveyor	CM CJ	**Date**	24/5/2012	**Site name**	PCSM202
Location	Project Area Central	**Zone**	50K	424523.45 mE	7551462.49 mN
Habitat type	Cave in cliff face of hill	**Habitat description**	Small overhang/shallow cave in top strata of cliff		
Disturbances		**Litter thickness**		**Litter Cover**	patchy and sparse

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Astrotricha hamptonii*
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river, *Cymbopogon* sp.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	Yes	No	No	No

Short Range Endemic Potential	medium

Fauna Species Recorded

Visual Records: Torresian Crow, Painted Finch.
SM2 record: Malfunction, no data

API Conservation Focus Area – SM2					
Surveyor	CM CC	**Date**	23/5/2012	**Site name**	SM2N03
Location	Project Area North	**Zone**	50K	421969.97 mE	7556009.83 mN
Habitat type	Cave (BIF), Major Riparian	**Habitat description**	South facing cave at slabby hill base		
Disturbances		**Litter thickness**	0-2 cm	**Litter Cover**	<5%

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp., *Hakea* sp.
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	Yes	No
Potential	Yes	Yes	Yes	Yes

Short Range Endemic Potential	medium

Fauna Species Recorded

Visual record: *Taphozous georgianus*, Euro (scat),
SM2 record: *Chalinolobus gouldii, Macroderma gigas , Rhinonicteris aurantia, Taphozous georgianus, Vespadelus finlaysoni*

API Conservation Focus Area – SM2					
Surveyor	CJ, CC, TN	**Date**	25/5/2012	**Site name**	PSSM203
Location	Project Area South	**Zone**	50K	427572.48 mE	7547006.95 mN
Habitat type	Minor Riparian	**Habitat description**	Steep sided bouldery drainage, conglomerate/mudstone top cap eroded with slabby slate beneath		
Disturbances		**Litter thickness**	2-5 cm	**Litter Cover**	Patchy

Vegetation composition	
Upper storey:	*Eucalyptus camaldulensis, Terminalia cansecens*
Mid-storey:	*Acacia* sp., *Senna* sp., *Petalostylis* sp., *Eremophila* sp., *Astrotricha hamptonii*
Lower-storey:	*Triodia epactia/pungens*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	Yes	No
Potential	Yes	Yes	Yes	No

Short Range Endemic Potential	medium

Fauna Species Recorded

Visual record: Willie Wagtail, Variegated Fairy-wren, Grey-headed Honeyeater, Weebill, Black-faced Cuckoo-shrike, Grey-shrike Thrush

SM2 record: *Chalinolobus gouldii, Chaerephon jobensis, Rhinonicteris aurantia, Scotorepens greyii, Tadarida australis, Taphozous georgianus, Vespadelus finlaysoni*

API Conservation Focus Area – SM2					
Surveyor	CC CJ TN	**Date**	25/5/2012	**Site name**	PSSM202
Location	Project Area South	**Zone**	50K	426889.15 mE	7547206.46 mN
Habitat type	Cave (pisolite)	**Habitat description**	South West facing overhang with small continuing cave		
Disturbances	long unburnt	**Litter thickness**	0-2 cm	**Litter Cover**	<5%

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Acacia* sp., *Senna* sp.
Lower-storey:	*Triodia wiseana*

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	Yes	Yes	No	Yes

Short Range Endemic Potential	low

Fauna Species Recorded

Visual record: *Taphozous georgianus*
SM2 record: Malfunction, no data

API Conservation Focus Area – SM2					
Surveyor	CM DN	**Date**	25/5/2012	**Site name**	SM2N04
Location	Project Area North	**Zone**	50K	421690.21 mE	7554398.79 mN
Habitat type	Gorge (BIF with Pisolite cap)	**Habitat description**	Narrow gorge, slabby in lower portion with pisolite towards the cap, waterhole 20m X 8m		
Disturbances	long unburnt	**Litter thickness**	0-2 cm	**Litter Cover**	patchy

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*, *Terminalia canescens*, *Ficus* sp.
Mid-storey:	*Astrotricha hamptonii*, *Senna* sp., *Acacia* spp.
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river, *Trichodesma zeylanicum*.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	Scat	No	Yes	No
Potential	Yes	Yes	Yes	Yes

Short Range Endemic Potential	medium to high

Fauna Species Recorded

Visual record: Western Bowerbird, Torresian Crow, Painted Finch, Budgerigar, Common Bronzewing, Grey-shrike Thrush, Cockatiels, Black Honeyeater, Grey-headed Hoenyeater, Red-browed Pardalote, Zebra Finch, Spinifex Pigeon, *Egernia formosa*

SM2 record: *Chalinolobus gouldii, Chaerephon jobensis, Rhinonicteris aurantia, Scotorepens greyii, Taphozous georgianus, Vespadelus finlaysoni*

API Conservation Focus Area – SM2					
Surveyor	CC CJ TN	**Date**	25/5/2012	**Site name**	PSSM201
Location	Project Area South	**Zone**	50K	425282.58 mE	7546792.94 mN
Habitat type	Major Riparian (open drainage)	**Habitat description**	Cane River bed		
Disturbances	minor grazing, long unburnt	**Litter thickness**	0-5 cm	**Litter Cover**	patchy

Vegetation composition	
Upper storey:	*Eucalytpus camaldulensis* (in river) *Melaleuca* sp. on river edges.
Mid-storey:	*Hakea* sp., *Acacia* sp.
Lower-storey:	*Trachymene oleracea*, *Triodia wiseana*, Cyperaceae, *Stemodia grossa*.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	No	No
Potential	Yes	Yes	No	No

Short Range Endemic Potential	high

Fauna Species Recorded

Visual Record: Yellow-throated Miner, Weebill, Pied Butcherbird, Brown Honeyeater, Red-browed Pardalote, Nankeen kestrel, Torresian Crow, Willie Wagtail, Australian Ringneck, Grey-crowned Babbler, Diamond Dove.
SM2 record: Malfunction, no data

API Conservation Focus Area – SM2					
Surveyor	CM CC	**Date**	23/5/2012	**Site name**	SM2N01
Location	Project Area North	**Zone**	50K	423981.79 mE	7557537.12 mN
Habitat type	Major Riparian (open drainage)	**Habitat description**	Riparian area- major drainage (currently dry) with stony BIF pebble substrate.		
Disturbances	grazing	**Litter thickness**	41187 cm	**Litter Cover**	0.4

Vegetation composition	
Upper storey:	*Eucalyptus camaldulensis*
Mid-storey:	*Acacia* spp., *Gossypium* sp., *Senna* sp.
Lower-storey:	*Cyperus* sp. and mixed herbs.

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	Yes	No
Potential	No	No	Yes	No

Short Range Endemic Potential	medium

Fauna Species Recorded

Visual record: European Cattle, Diamond Dove, Black-faced Cuckoo-shrike, Honeyeater sp.
SM2 record: *Chalinolobus gouldii, Chaerephon jobensis, Rhinonicteris aurantia, Saccolaimus flaviventris, Scotorepens greyii, Tadarida australis, Taphozous georgianus, Vespadelus finlaysoni*

API Conservation Focus Area – SM2					
Surveyor	CM CJ	**Date**	24/5/2012	**Site name**	PCSM201
Location	Project Area Central	**Zone**	50K	422546.34 mE	7551722.29 mN
Habitat type	Hilltop	**Habitat description**	Hummock grassland with stoney hill top.		
Disturbances		**Litter thickness**	0-2 cm	**Litter Cover**	<5%

Vegetation composition	
Upper storey:	*Eucalyptus leucophloia*
Mid-storey:	*Senna* sp., *Acacia* sp., *Grevillea wickhamii*, *Acacia inaequilatera*, *Hakea* sp.
Lower-storey:	*Triodia wiseana*, *Triodia* sp. robe river

Conservation significant Fauna				
	Northern Quoll:	**Pilbara Olive Python**	**Pilbara Leaf-nosed Bat**	**Ghost Bat**
Recorded	No	No	Yes	No
Potential	No	No	Yes	No

Short Range Endemic Potential	low

Fauna Species Recorded

Visual record: Pilbara Pebble-mound Mouse, Black-faced Cuckoo-shrike, Western Bowerbird, *Morethia ruficauda*, *Ctenotus saxatilis*

SM2 record: *Chalinolobus gouldii*, *Chaerephon jobensis*, *Rhinonicteris aurantia*, *Saccolaimus flaviventris* (needs confirmation), *Scotorepens greyii*, *Tadarida australis*, *Taphozous georgianus*, *Vespadelus finlaysoni*

Method	Site_ID	Easting	Northing	Location	Access Notes	Date Installed	Date Closed	Reason for Closing	Landform	Photo Taken of Site	Other Notes
SM2 Echolocation Recording	PCSM201	422546.3	7551722	Cane River Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	Hilltop	Yes	
SM2 Echolocation Recording	PCSM202	424523.4	7551462	Cane River Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	Hill/Cave	Yes	
SM2 Echolocation Recording	PSSM201	425282.6	7546793	Cane River Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	River	Yes	PLNB calls recorded on SM2+
SM2 Echolocation Recording	PSSM202	426900.1	7547212	Cane River Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	Hill/Cave	Yes	PLNB calls recorded on SM2+
SM2 Echolocation Recording	PSSM203	427538.4	7547054	Cane River Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	Gorge	Yes	PLNB calls recorded on SM2+
SM2 Echolocation Recording	Python Pool	422570.6	7552051	Cane River Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	Gorge/Waterhole	Yes	PLNB calls recorded on SM2+
SM2 Echolocation Recording	SM2N01	424890.7	7557479	Red Hill Creek Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	River	Yes	PLNB calls recorded on SM2+
SM2 Echolocation Recording	SM2N02	423307.1	7557204	Red Hill Creek Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	River/Mesa	Yes	Possible Ghost Bat calls
SM2 Echolocation Recording	SM2N03	421970	7556010	Red Hill Creek Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	Hill/Cave	Yes	
SM2 Echolocation Recording	SM2N04	421690.2	7554399	Red Hill Creek Catchment	Walked	Conservation Focus Area Survey 2012	May_2012	Survey End	Gorge	Yes	

Disclaimer

This document has been prepared based on assumptions as reported throughout and upon information and data supplied by others.

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