



Main Roads Western Australia

Neerabup Road Extension

Level 2 Fauna Survey

March 2014

Executive summary

The Mitchell Freeway (the Freeway) provides a major transport route between the northern suburbs of Perth and the city centre. The Freeway currently terminates at Burns Beach Road. Main Roads Western Australia (Main Roads) is currently planning to extend the Freeway and the associated road network in the Neerabup area. Main Roads commissioned GHD Pty Ltd (GHD) to undertake a Level 2 fauna study for the proposed Neerabup Road Extension. This fauna survey is a requirement of Environmental Protection Authority (EPA) Amendment No. 992/33. This report presents the findings of the Level 2 fauna survey undertaken by GHD in November and December 2013.

The Study Area for this survey was located at the proposed Neerabup Road extension site which runs in an east-west alignment between the existing train line and Wanneroo road in the Neerabup National Park (as shown in Figure 1, Appendix A).

The Methods employed in this survey were consistent with EPA Guidance Statement No. 56, Terrestrial Fauna and Vegetation Surveys for Environmental Impact Assessment in Western Australia (WA) and EPA and Department of Parks and Wildlife (DPaW) Technical Guide Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment.

Methods employed for this study were developed in conjunction with regional science staff of Department of Parks and Wildlife (DPaW); DPaW conducted a study concurrent to this survey in the northern sections of the Neerabup National Park. Results from the DPaW study have been incorporated in to the results and discussion for this study.

GHD Ecologists hold all the appropriate permits and have followed the DPaW Standard operating procedures for the survey. Sampling methods used in this survey included a variety of trapping methods, aural and visual surveys (conducted at during night and day periods), motion sensor cameras assessments and deploying bat detectors.

Three types of woodland habitat are present in the proposed road alignment and this habitat is generally in good to excellent condition. The habitat provides a broad range of resources for a diverse range of fauna species. The proposed alignment is within a broadly continuous area of native vegetation that consists of the Neerabup National Park, several Bush Forever sites and is part of Greenways links 35, 2 and 5.

The survey resulted in 114 vertebrate fauna species being recorded comprising 1485 individuals. This included 70 birds, 29 reptiles, one amphibian, eight native mammals (including bats) and six introduced mammals.

A total of five species were recorded of conservation significance that afford some level of protection under the WA Wildlife Conservation Act 1950 (WC Act), listed by DPaW as a priority or listed under the Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). These species were Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Rainbow Bee Eater (*Merops ornatus*), Carpet Python (*Morelia spilota imbricata*), Southern Brown Bandicoot (*Isodon obesulus fusciventer*) and the Western Brush Wallaby (*Macropus Irma*). A further six conservation significant species are considered likely or possible to occur in the Study Area.

There have been limited previous systematic surveys conducted in the Neerabup National Park. Results from this survey are reasonably consistent with surveys conducted in other large continuous tracts of native vegetation on the Swan Coastal Plain.

The suite of species that occurs in the Neerabup National Park is expected to be more diverse than those recorded during this survey given the temporal limitations of this one-off study.

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1. Introduction

1.1 Background

The Mitchell Freeway provides the primary road access route from the Perth north-west corridor towards the City of Perth. The freeway currently terminates at Burns Beach Road. The freeway has been constructed in several stages since the 1960s, with further extensions and widening works are planned. The Mitchell Freeway Extension has been the subject of a planning process undertaken by Main Roads Western Australia (Main Roads).

The business case prepared for the project divides the project into three stages to be completed over a period of time. These stages are:

- Stage 1 – Freeway extension from Burns Beach Road to Hester Avenue and the connecting roads (Neerabup Road and Hester Avenue) 2015–2017
- Stage 2 – Freeway extension from Hester Avenue to Romeo Road and connecting road (Romeo Road) 2017–2021
- Stage 3 – Wanneroo Road duplication from Joondalup Drive to Hall Road 2027–2029

This component of the project focuses on the Neerabup Road extension which bisects 2.0 km of natural vegetation within the Neerabup National Park.

The Neerabup Road is an important east-west link connecting the industrial and residential areas east of Wanneroo Road with the Mitchell Freeway and areas west of the freeway. The link is necessary as the existing Burns Beach Road / Joondalup Drive link will reach capacity as urban development proceeds. Neerabup Road will be a significant freight route for the efficient movement of goods and people into and out of the Neerabup industrial area.

Neerabup Road is planned as a four lane dual carriageway (two lanes each way with a central median). The width of the road is dictated by geometric factors based on the traffic mix likely to be carried. The cross section would typically comprise:

- Number of lanes: 4
- Cross section: 2.0 m shoulder + 2 x 3.5 m lanes + median + 2 x 3.5 m lanes + 2.0 m shoulder
- Shared path: 3.0 m on north side.

Main Roads commissioned GHD Pty Ltd (GHD) to undertake a Level 2 fauna study for the proposed Neerabup Road Extension. This fauna survey is a requirement of Environmental Protection Authority Amendment No. 992/33.

1.2 Study Area

The Neerabup Road extension alignment is located approximately 30 km north of Perth, Western Australia (within the City of Wanneroo). The Study Area extends from the eastern end of the existing Neerabup Road, east to Wanneroo Road and comprised numerous dirt tracks.

The Study Area boundary and sampling locations are shown on Figure 1, Appendix A.

1.3 Purpose of this report

The purpose of this report is to identify fauna usage within the area and within the proposed Neerabup Road Extension impact area. This data can then be used to inform the approvals process.

1.4 Scope

The scope of works for this project was to undertake a single season Level 2 fauna survey in accordance with EPA Guidance statement 56 (EPA 2004). The fauna survey included:

- Trapping program conducted over eight consecutive nights (minimum) within and immediately adjacent to the proposed Neerabup Road extension.
- A review of fauna species in the National Park and those considered to be rare or in need of special protection. (it should be noted that a separate scope of works and reporting was undertaken on Black Cockatoos (GHD 2013a).
- A review of the presence and abundance of introduced fauna species.
- Identification of any habitat of significance.

1.5 Limitations

This report has been prepared by GHD for Main Roads Western Australia and may only be used and relied on by Main Roads Western Australia for the purpose agreed between GHD and the Main Roads Western Australia as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Main Roads Western Australia arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services conducted by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Main Roads Western Australia and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing conducted at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations conducted in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.6 Assumptions

This report has assessed the fauna and habitat types within the Study Area (Figure 1, Appendix A). Should the Study Area change or be refined, further assessment may be required.

2. Methodology

2.1 Permits

A Regulation 17 Licence to Take Fauna for Scientific Purposes was obtained from Department of Parks and Wildlife (DPaW) prior to undertaking the fauna surveys (Licence Number: SF009505). Additionally due to the project location being within Neerabup National Park a Regulation 4 permit was also required (Licence Number: CE004159). A copy of the Licence is provided in Appendix C.

The fauna surveys (specifically trapping and animal handling) were undertaken in accordance with Standard Operating Procedures (SOPs) which were required to be followed under the conditions of GHD's fauna trapping permit. At the time of survey, compliance with these SOPs was accepted by DPaW as evidence of ethical treatment of animals:

- SOP No. 9.1 Elliott traps for live capture of terrestrial vertebrates (DEC 2009a).
- SOP No. 9.3 Dry pitfall trapping for vertebrates and invertebrates (DEC 2009b).
- SOP No. 9.2 Cage traps for live capture of terrestrial vertebrates (DEC 2009c).
- SOP No. 9.6 Hand capture of wildlife (DEC 2009d).
- SOP No. 10.1 Animal handling/restraint using soft containment (DEC 2009e).
- SOP No. 10.2 Hand restraint of wildlife (DEC 2009f).
- SOP No. 14.2 First Aid for animals (DEC 2009g).

2.2 Guiding documents

The survey methodology and data collection GHD employed was consistent with:

- EPA Guidance Statement No. 56, Terrestrial Fauna and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004).
- Environmental Protection Authority and Department of Environment and Conservation (DEC) 2010, 'Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment', Perth, Western Australia.

2.3 Additional Data

GHD has previously undertaken Level 1 surveys of the Neerabup area within the Study Area. The Department of Parks and Wildlife (DPaW) undertook a fauna survey in conjunction with this survey. The report from the DPaW survey and a previously existing report from the Neerabup National Park (northern area and the adjacent water reserve) were also reviewed and included in the report. These reports are cited as;

- GHD Pty Ltd (GHD) 2013a, Mitchell Freeway Extension: Black Cockatoo assessment, unpublished report prepared for Main Roads Western Australia.
- GHD Pty Ltd (GHD) 2013b. Main Roads Western Australia Mitchell Freeway extension flora & fauna assessment report
- DPaW 2013. Trapping results for Neerabup National Park, Raw data provided.
- CALM 1993, Fauna studies in Water Supply reserve 34537, Adjacent to Neerabup National Park. Prepared for Water Authority of Western Australia by Conservation and Land Management.

* DPaW was formerly the Department of Conservation and Land Management (CALM) and the Department of Environment and Conservation (DEC)

2.4 Fauna identification and nomenclature

Nomenclature used in this report follows the WA Museum as reported on *NatureMap* (DPaW 2007–). This nomenclature is deemed the most up-to-date species information for Western Australia groups: Reptiles, Amphibians, Invertebrates and Mammals. All Aves nomenclature follows Christidis and Boles (2008). Other reference materials used are presented in Table 1.

Table 1 Fauna references

Fauna Group	Field Guide
Mammals	Menkhorst and Knight (2004), (2010), Van Dyck and Strahan (2008), (2013)
Bats	Churchill (2008), Menkhorst and Knight (2010)
Birds	Morcombe (2004)
Geckos	Wilson and Swan (2013)
Skinks	Storr et al. (1999), Wilson and Swan (2013)
Dragons	Wilson and Swan (2013)
Varanids	Wilson and Swan (2013)
Legless Lizards	Wilson and Swan (2013)
Snakes	Storr et al. (2002), Wilson and Swan (2013)
Amphibians	Tyler and Doughty (2009)

2.5 Fauna survey limitations

Guidance Statement No. 56 (EPA 2004) states that fauna and faunal assemblage survey reports for environmental impact assessment in Western Australia should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with the fauna component of this field survey are discussed in Table 2.

Table 2 Fauna survey constraints and limitations

Limitation	Constraint	Impact on Survey Outcomes
Limitation to the faunal groups sampled and sampling methods not able to be employed because of constraints such as weather, e.g. pitfall trapping in waterlogged soils or inability to use pitfall traps in rocky terrain)	Minor	Multiple trapping and survey methods were employed to sample a wide range of fauna groups (including nocturnal species) All trapping and survey methods were able to be implemented with no constraints. Additionally traps remained open for 8 nights under agreed methodology with DPaW, see section 2.6. Fauna assessments that capture the full spectrum of species in an area often include numerous surveys over different seasons over a number of years. This survey was limited to one survey session, in one seasons and although meets the guideline requirements for terrestrial surveys on the Swan Coastal Plain may not identify all species present or that utilise the Study Area. Additionally this assessment was restricted to vertebrate fauna and did not include invertebrates.
Proportion of fauna identified, recorded and/or collected	Nil	All fauna was identified and released on site. If difficulty was noted in identification photographs of the specimen was taken and identified by a Principal Zoologist.
Sources of information and availability of contextual	Minor	The Study Area has been poorly surveyed in the past with little published information available. Most works have been undertaken north in Yanchep National Park.

Limitation	Constraint	Impact on Survey Outcomes
information		
Proportion of the task achieved and further work which might be needed	Minor	<p>Fauna assessments that capture the full spectrum of species in an area often include numerous surveys over different season over a number of years. This survey includes one survey session conducted in one season and although meets the guideline requirements for terrestrial surveys may not identify all species present or that utilise the Study Area.</p> <p>Additionally little information is available for the Neerabup area and this survey is the first comprehensive sampling undertaken with the National Park.</p>
Remoteness and/or access problems	Minor	<p>The Study Area was easily accessed, however this meant that due to the proximity of urban areas a number of members of the public and pets were noted walking through the area. Potentially this may have impacted on capture rates due to disturbance.</p>

2.6 Approved DPaW survey methodology

Prior to the trapping program undertaken, DPaW and GHD agreed on trapping methodology for this project (see methodology in section 2.8). It was agreed that GHD would establish 6 sites within and close to the proposed Neerabup alignment in areas of good remnant vegetation. This consisted of two trapping quadrats per habitat type. Additionally DPaW adopted the same methodology to sample the remainder of the National Park at the same time to get a greater understanding of the fauna assemblages in the area. DPaW undertook trapping at eight sites in the northern portion of the National Park comprising of four habitat types. DPaW and GHD have agreed to share data from the two sampling locations; as such the additional survey data from the DPaW trapping program is included in this report.

2.7 Survey period

The level 2 fauna survey was undertaken from the 30th October to the 7th November by GHD Zoologists Glen Gaikhorst, Jo Kuiper, Craig Grabham and Laura Zimmermann. All traps were open for eight nights and survey effort is shown in section 2.9. An additional 5 days were spent conducting active searches in the Study Area in conjunction with a print survey. All species identified over this period were also recorded.

2.8 Overview of trapping Program

Trapping for terrestrial fauna was undertaken using a series of standardised systematic trapping quadrat sites comprising of pit-fall traps, Elliot box traps, cage traps and funnel traps. Details of each trap type used are provided below. Two quadrats were used per habitat type (three broad habitats exist along the Neerabup alignment) and each systematic trapping quadrat was surveyed (trapped) for eight nights. Traps were checked twice daily, early in the morning before the heat of the day and in the late afternoon.

2.8.1 Pit-trap with drift fence

Five pit-traps were established at each quadrat within the Study Area. Pit-traps comprised of three PVC pipes (30 cm diameter, minimum 60 cm deep), and two 20 L plastic buckets (30 cm diameter, 40 cm deep) at each quadrat. A 50 m long flywire drift fence (30 cm high) bisected the pits; directing fauna into them. Pits were spaced at eight meter intervals along the fence. Soil and egg crate was placed within each pit to provide shade and protection for captured animals.

2.8.2 Funnel traps

Ten funnel traps were used along each drift fence. Traps were placed such that animals were directed into them from the drift fence in between the pit traps. Funnel traps were covered with insulating materials to minimise heat or cold exposure to animals.

2.8.3 Elliot box traps

Twenty Elliot box traps were used at each quadrat site. Traps were placed approximately ten metres apart and baited with universal bait (a mixture of peanut butter, rolled oats and sardines). Elliot traps were located within shady areas or covered with vegetation to minimise exposure to captured animals. Two lines of 10 Elliott traps were used per site (20 Elliott's per site). Each 100 meter line was positioned 25 meters either side of (and parallel to) the drift fence.

2.8.4 Cage traps

Four cage traps were located at each quadrat site. These traps were placed at each end of the two lines of Elliot traps. Cage traps were baited with universal bait.

Ten additional cage traps were also placed along the main access track between the six quadrat sites; these traps aimed to capture more widely dispersed species that may pass through the broader area and that may have otherwise been missed in the six quadrat sites.

2.8.5 Bat sampling

Assessment of bats was undertaken using an MX2 Song meter and Anabat bat detector across the study area. A minimum of one night assessment was undertaken at each quadrat with additional assessments undertaken in areas of heavily wooded habitats.

2.8.6 Avifauna

Avifauna surveys were undertaken at each of the quadrat sites. Each survey comprised of a 20 minute census of birds within an unbounded 2 ha area, which is the standard method used by Birds Australia for the Bird Atlas project. Birds detected visually (using binoculars) and/or aurally over a 20 minute period were recorded. Numbers of each species observed were also recorded.

All systematic bird surveys were undertaken within four hours of dawn or two hours of dusk, as these are the times of day when birds are most active. In addition to systematic surveys, observations of birds were also made opportunistically.

2.8.7 Camera Traps

Remote cameras that are triggered by motion were positioned in areas that contain optimal habitat for threatened fauna. These cameras were set to target the Chuditch and Western Brush Wallaby, but also collected information on all species that are active in the range of the camera. Cameras were set with a lure (such as sardines, peanut butter and universal bait) to increase the rate of encounter. Cameras were set up to spatially complement other survey efforts.

2.8.8 Others Searches

Rare and threatened species may have a patchy, disparate distribution through landscapes. To provide the best opportunity to determine the presence and relative prevalence of these species, this study employed a variety of sampling methods. The systematic sampling was applied through the trapping program with additional sampling methods also applied at these sites. Furthermore, other areas that were not assessed through the systematic trapping effort were also surveyed using non-systematic techniques. Non-systematic sampling was undertaken at each of the sites noted above and comprised of the following:

Diurnal searching

Each site was searched for amphibians, reptiles, and mammals. Surveys comprised of searching ground layer (overturning logs, rocks and leaf litter) and low vegetation (under bark and in tree stumps) and recording all individuals observed. Species presence was also determined via secondary evidence, in the form of scats, tracks, feathers, burrows and remains. A minimum of 1 hour was spent at each quadrat site and within the general area.

Nocturnal searching

Nocturnal surveys were conducted using hand held spotlights during the survey. Spot lighting was undertaken to locate nocturnal species that may not be sampled by other techniques. A minimum of 1 hour was spent at each quadrat and within the general area.

Opportunistic observations

While conducting any activities in the Study Area, opportunistic observations were made of any other vertebrates (or signs of their presence). Fauna taxa observed or heard were noted, and

indirect evidence (such as scats, tracks, diggings, nests, feathers, bones, pellets [Triggs, 1996]) indicating the current or recent presence of a species also noted. Wherever possible, numbers of individuals, microhabitat use and other relevant information was recorded.



2.9 Site Locations and Survey Effort

The site locations and sampling effort, timing and duration of the survey was undertaken with regard to the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2010) and via consultation with DPaW staff (see section 2.6).

2.9.1 Site Locations





Site locations were chosen by GHD and DPaW prior to trapping occurring (refer Figure 2). The Neerabup National Park has historically had no comprehensive fauna survey undertaken; therefore the trapping program was aimed at identifying the biodiversity of the area and targeting suitable habitat for threatened fauna. Within the proposed alignment and greater area, six locations were selected for trapping. These are shown below in Table 3. In addition to the trapping quadrat sites there were four motion sensor camera survey locations and these are shown in Table 4.


Table 3 Trapping and Camera Site Locations

Site Number Habitat type Location	Image
Site 1 Banksia Woodland on deep sands Easting; 562840 Northing; 8221638	
Site 2 Banksia Woodland on deep sands Easting; 564240 Northing; 8220893	

Site Number Habitat type Location	Image
<p>Site 3</p> <p>Tuart Woodland</p> <p>Easting; 564498 Northing; 8221477</p>	
<p>Site 4</p> <p>Tuart Woodland</p> <p>Easting; 381680 Northing; 6493022</p>	
<p>Site 5</p> <p>Jarrah–Banksia woodland</p> <p>Easting; 382114 Northing; 6493030</p>	
<p>Site 6</p> <p>Jarrah–Banksia woodland</p> <p>Easting; 382290 Northing; 6493027</p>	

Table 4 Locations of motion sensor cameras

<p>Site Number</p> <p>Habitat type</p> <p>Location</p>	<p>Indicative image</p>
<p>Camera 1</p> <p>Tuart Woodland</p> <p>Easting; 382145</p> <p>Northing; 6492925</p>	
<p>Camera 2</p> <p>Tuart Woodland</p> <p>Easting; 381894</p> <p>Northing; 6492889</p>	
<p>Camera 3</p> <p>Banksia Woodland on deep sands</p> <p>Easting; 381572</p> <p>Northing; 6492966</p>	
<p>Camera 4</p> <p>Banksia Woodland on deep sands</p> <p>Easting; 381140</p> <p>Northing; 6492933</p>	

Site Number Habitat type Location	Indicative image
Camera 5 Jarrah–Banksia woodland Easting; 382269 Northing; 6493026	
Camera 6 Jarrah–Banksia woodland Easting; 382251 Northing; 6493041	No photo available

2.9.2 Survey Effort

The survey effort is summarised in Table 5. Each of the six trapping quadrat sites was sampled for eight consecutive trap-nights including bucket, cage, funnel and Elliott traps. Additionally a minimum of one night was sampled for bat acoustics, 60 minutes of night search, 60 minutes of active search and 120 minutes of bird assessments undertaken at each site. The total trapping effort consisted of 1952 trap-nights (total trap effort), 790 minutes of bird assessments, 440 minutes of active searches, 420 minutes of night searches and 108 camera nights.

Table 5 Trapping effort



Fauna Trapping		Elliot traps		Pit Traps		Cage Traps		Funnel traps		Bat survey	Birds search	Active search	Night search
Sites	Nights Open	Number of traps	Total trap nights	Number of traps	Total trap nights	Number of traps	Total trap nights	Number of traps	Total trap nights	(night)	(min)	(min)	(min)
Site 1	8	20	160	5	40	4	32	10	80	1	120	60	90
Site 2	8	20	160	5	40	4	32	10	80	1	190	60	60
Site 3	8	20	160	5	40	4	32	10	80	2	120	60	60
Site 4	8	20	160	5	40	4	32	10	80	1	120	60	60
Site 5	8	20	160	5	40	4	32	10	80	1	120	80	90
Site 6	8	20	160	5	40	4	32	10	80	1	120	120	60
Access track						10	80						
TOTAL	(trap nights)		960		240		272		480	7	790 min.	440 min.	420 min.
Motion sensor cameras													
Camera 1	Camera 2	Camera 3	Camera 4	Camera 5	Camera 6	Total							
25	25	25	25	4	4	108							


3. Results

3.1 Fauna Habitat

Three broad fauna habitat types were identified within the study area, including Banksia Woodland, Tuart Forest and Jarrah–Banksia Woodland. The study area also contains areas that have been cleared and disturbed. These disturbed areas provide little to no habitat value and principally comprise of vehicle tracks, and historical cleared areas. The fauna habitat types identified within the study area are mapped in Figure 3 in Appendix A. A brief description of each fauna habitat type is provided in Table 6.

Table 6 Fauna Habitats in the Study Area

Habitat	Description	Image
Banksia Woodland	<p>Woodland of <i>Banksia attenuata</i>/<i>B. menziesii</i> (with occasional <i>Eucalyptus/Corymbia</i> species and <i>Allocasuarina fraseriana</i>) over shrubland of <i>Hibbertia hypericoides</i>, <i>Xanthorrhoea preissii</i> and <i>Acacia pulchella</i> over dense understorey of <i>Mesomelaena pseudostygia</i>, weedy grasses and herbs and <i>Desmocladius flexuosus</i> on grey to brown sand.</p> <p>This habitat type contains good structural diversity and a variety of micro-habitat types including patches of thick leaf litter, fallen logs and branches.</p>	
Tuart Woodland	<p>Woodland of <i>Eucalyptus gomphocephala</i> over sparse shrubland of <i>Xanthorrhoea preissii</i>, <i>Acacia saligna</i>, <i>Rhagodia baccata</i> and <i>Hakea lissocarpa</i> over sparse understorey of weedy grasses and herbs in deep dark brown sand.</p> <p>This habitat type contains good structural diversity and a mosaic of micro-habitat types which are closely associated with the fire history in the area. There are patches of this habitat that have been recently burnt and as a result the availability of leaf litter and debris is limited. In parts of this habitat where fires are not recent the abundance and variety of micro habitats is good.</p>	

Habitat	Description	Image
Jarrah– Banksia Woodland	<p>Woodland of <i>Eucalyptus marginata</i> and <i>Banksia attenuata</i>/<i>B. menziesii</i> over shrubland of <i>Hibbertia hypericoides</i>, <i>Xanthorrhoea preissii</i> and <i>Acacia pulchella</i> over dense understorey of <i>Mesomelaena pseudostygia</i>, weedy grasses and herbs and <i>Desmocladius flexuosus</i> on grey to brown sand and Limestone incursion.</p> <p>The habitat values of this habitat type varies according to the complex combination of fire and logging history, condition (structural and species diversity) of the vegetation and the proximity of the habitat to existing tracks. Some patches of this habitat type have structural complexity and provide a variety of resources.</p>	

The native vegetation within the Study Area consists predominantly of a combination of mixed Eucalypt woodlands and Banksia woodlands. These habitat types consist of a dominant overstorey of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah), *Banksia attenuata* and *B. menziesii* and were generally associated with grey sandy soils on plains or low undulating dune systems. The Eucalypt and Banksia woodlands ranged from very good to excellent condition and provide particularly high habitat value for fauna species due to the variety of microhabitats and various resource niches available (i.e. fallen logs, hollows, leaf litter, sandy soil).

The woodlands (all three habitat types) would be expected to support a high diversity of bird species. Across these woodlands there are areas of sandy soils that are particularly suitable for burrowing reptiles. The connectivity of canopy cover in the woodland varies and the mid-layer of the habitat is relatively sparse. The woodland has patches of thick leaf litter and ground cover. This ground cover would provide foraging opportunities and refuge areas for ground-dwelling mammals such as the Echidna, Southern Brown Bandicoot/Quenda and Western Brush Wallaby and reptiles such as goannas and skinks. Micro-habitat features such as tree hollows and cavities provide habitat for a number of birds, reptiles and small mammal species. The presence of tuart, jarrah, banksia and other proteaceous species provides key foraging habitat for conservation significant black cockatoo species. Some of the larger Eucalypts also provide potential breeding and roosting habitat for black cockatoos.

3.2 Fauna habitat connectivity

Habitat linkages are important to allow animals to move between areas of resource availability. They are important for ground and aerial fauna, providing cover, resources, and linking areas suitable for rest and reproduction. Fragmentation of habitat limits the resources available to species, particularly sedentary species, which means they may be more vulnerable to natural disasters or habitat changes over time. Fragmentation of habitat can also lead to edge effects, leading to degradation of the habitat. The Western Australian EPA aims to maintain representation, diversity, viability and ecological function at the species, population and assemblage level of intact naturally vegetated areas (EPA, 2013). Furthermore the EPA recognises that large consolidated naturally vegetated areas are the most resilient in protecting

Biodiversity in the long term and generally have lower management requirements (costs) than smaller and fragmented areas of vegetation. The EPA recommends that development projects should aim to retain naturally vegetated areas in large consolidated blocks to avoid fragmentation or isolation. Where the distance between habitat fragments is small, species may still be able to move between these habitat areas (particularly birds), but may be more exposed to predation pressures in the cleared areas.

The Study Area is bounded to the west by a 2.5 m high chain mesh fencing which presents a barrier to movement of ground dwelling fauna. The fence runs parallel to the railway which presents further restrictions in movement. The majority of the Study Area west of the railway has been cleared (or is currently being cleared) for urban development, with only small patches of remnant vegetation remaining.

The areas of remnant vegetation in the Study Area to the east of the railway are part of a regionally significant contiguous bushland/wetland linkage (Bush Forever, 2000), with a large proportion of this vegetation currently protected as national park and a series of Bush Forever sites (Bush Forever, 2000). There are several surrounding linkages; the habitat within Neerabup National Park (Bush Forever site 383) is linked to bushland:

- to the north is Yanchep National Park
- to the south is Bush Forever site 299 (which is across Wanneroo road)
- to the east and west is Site 323 and through bushland to Site 397

The Study Area is part of Greenways links 35, 2 and 5 (Tingay, Alan and Associates, 1998). Neerabup National Park provides a narrow corridor of habitat which would allow movement of animals through the local area.

3.3 Fauna Assemblages and Abundance

The suite of fauna species identified in this trapping survey includes 114 vertebrate fauna species comprising 1485 individuals from both opportunistic and trapping survey results (Combined DPaW and GHD results).

Vertebrate fauna identified includes 70 birds, 29 reptiles, one amphibian, eight native mammals (including bats) and six introduced mammals. Trapping data and abundance of species for both DPaW and GHD programs is presented in Appendix B. A breakdown of each group is presented below.

3.3.1 Mammals

The survey recorded a total of eight native mammal species within the study area. The most specious family was the Macropodidae (Kangaroos and Wallabies) and Vespertilionidae (Bats). A total of 122 individual mammals (excluding bats) were recorded over the trapping program with the most abundant species including;

- Western Grey Kangaroo (*Macropus fuliginosus*) with 100 records (81.9% of total mammal recordings)
- Common Brushtail Possum (*Trichosurus vulpecula*) with 10 records (8.2% of total mammal recordings)
- Southern Brown Bandicoot (*Isodon obesulus fusciventer*) with nine records (7.4% of total mammal recordings).

A breakdown of native mammal families recorded during the survey is provided in Table 7.

Table 7 Mammal families recorded during the field survey

Family	Number of Species
Macropodae (Kangaroos)	2
Molossidae (Freetail Bat)	1
Peramelidae (Bandicoot)	1
Phalangeridae (Possums)	1
Tachyglossidae (Echidna)	1
Vespertilionidae (Bats)	2
	Total =8

3.3.2 Birds

Over 536 birds were recorded within the study area during the trapping program. The bird surveys identified 70 bird species from 32 families. The most specious families were the Meliphagidae (seven species), Columbidae (five species), Accanthizidae (five species) and Artamidae (five species). The most abundant species were the Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) with 47 records (8.8% of total bird recordings), Galah (*Eolophus roseicapillus*) with 44 records (8.2% of total bird recordings) and the Little Corella (*Cacatua sanguinea*) with 43 records (8% of total bird recordings). A breakdown of bird families recorded during the survey is provided in Table 8.

Table 8 Bird families recorded during the field survey

Family	Number of Species
Accanthizidae (Weebill/Gerygone)	5
Accipitridae (Diurnal birds of prey)	4
Aegothelidae (Owlet Nightjar)	1
Artamidae (Magpie group)	5
Cacatuidae (Cockatoo group)	4
Campephagidae (Cuckoo-shrikes)	2
Casuariidae (Emu)	1
Columbidae (Pigeons/Dove)	5
Corvidae (Crow)	1
Cuculidae (Cuckoos)	3
Eurostopodidae (Spotted Nightjar)	1
Falconidae (Falcons)	2
Halcyonidae (Kingfishers)	2
Hirundinidae (Swallows)	2
Maluridae (Wrens)	1
Meliphagidae (Honeyeaters)	7

Family	Number of Species
Meropidae (Bee eater)	1
Monarchidae (Lark)	1
Motacillidae (Pipit)	1
Nectariniidae (Mistletoebird)	1
Neosittidae (Sittella)	1
Pachycephalidae (Whistlers)	3
Pardalotidae (Pardalotes)	1
Petroicidae (Robin)	3
Phasianidae (Quail)	1
Podargidae (Frogmouth)	1
Psittacidae (Parrots)	4
Rhipiduridae (Fantail)	2
Strigidae (Owl)	1
Tytonidae (Barn Owl)	1
Timalidae (White-eye)	1
Tunicidae (Button-quail)	1
Total 70	Total 70

3.3.3 Reptiles

A total of 29 reptile species were recorded during the field survey. The most specious families were the Scincidae (13 species), and Elapidae (five species). A total of 726 individual reptiles were recorded within the study area over the trapping program. The most abundant species were the Two-toed Mulch Skink (*Hemiergus quadrilineata*) with 310 records (42.7% of total reptile recordings), Bobtail (*Tiliqua rugosa rugosa*) with 94 records (12.9% of total reptile recordings), and Shrubland Snake-eyed Skink (*Morethia obscura*) with 64 records (8.8% of total reptile recordings).

A Blind snake was collected from trap site 1 that was keyed to the Fat Blind Snake (*Anilius pinguis*); however this species typically is restricted to the Darling Range in lateritic soils. The habitat type this individual was recorded in was Banksia Woodland on deep sands. The West Australian Museum has two other records of this species on the Swan Coastal Plain, one from Carabooda near to Yanchep National Park (Algaba 2005) and the other near to Gin Gin. This record extends the distribution of this species slightly south on the Swan Coastal Plain. A second blind snake (*Anilius waitii*) species was collected from trap site 2 (Banksia Woodland) this species also has not been recorded in the area and the closest known record is the foothills near to Ellenbrook. Typically this species is distributed in the Wheatbelt region and north including Geraldton and extending into the Murchison and Goldfields. This record is a slight range extension west onto the Swan Coastal Plain.

A breakdown of reptile families recorded during the survey is provided in Table 9.

Table 9 Reptile families recorded during the field survey

Family	Number of Species
Agamidae (Dragons)	1
Boidae (Pythons)	1
Diplodactylidae (Ground Gecko)	1
Elapidae (Snakes)	5
Gekkonidae (Geckos)	1
Pygopodidae (Legless Lizards)	3
Scincidae (Skinks)	13
Typhlopidae (Blindsnakes)	3
Varanidae (Monitors)	1
	Total 29

3.3.4 Amphibians

One record of an amphibian species was recorded in the study area during the trapping program. This was a single Turtle Frog (*Myobatrachus gouldii*) observed in a pit trap. It is highly likely that additional species of amphibians are present in the study area however due to the timing of the survey (season) and dryness of the area activity was reduced.

3.4 Conservation Significant Species

3.4.1 Relevant legislation

In Western Australia conservation significant fauna are protected under both Federal and State legislation.

The Federal conservation level of fauna species and their significance status is currently assessed under the *Environmental Protection and Biodiversity Conservation Act (1999)* (EPBC) by the Department of the Environment (DotE). The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN).

The State conservation level of fauna species and their significance status is currently assessed under the *Wildlife Conservation Act (1950)* (Wildlife Conservation (Specially Protected Fauna) Notice 2010(2)) (WC Act). The WC Act uses a set of Schedules but also classifies species using some of the IUCN categories. Schedule 3 fauna species are those which are subject to agreements between the government of Australia and the governments of Japan, China and the Republic of Korea relating to the protection of migratory birds and are declared to be fauna that is in need of special protection.

The DPaW produces a supplementary list of Priority Fauna, these being species that are not considered Threatened under the WC Act but for which the Department feels there is a cause for concern. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. These species have no special legislative protection, but their presence would normally be considered relevant to an assessment of the conservation status of an area.

3.4.2 Survey Results

A total of four Threatened and Priority listed species were recorded from the study area or immediate surrounds during the survey. These species locations are mapped and presented in Figure 4.

Species listed as Threatened under the EPBC Act and WC Act is:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) - Endangered (EPBC Act), Schedule 1 (WC Act);
- Rainbow Bee Eater (*Merops ornatus*) – Marine/Migratory (EPBC Act), Schedule 3 (WC Act).

Species listed as Specially Protected under the WC Act is:

- Carpet Python (*Morelia spilota imbricata*) – Schedule 4.

Species listed as Priority by DPaW are:

- Southern Brown Bandicoot (*Isodon obesulus fusciventer*) – Priority 5.
- Western Brush Wallaby (*Macropus irma*) – Priority 4.

A brief description of each of these species and their associated habitat types within the Study Area are described below.

Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)

The Carnaby's Black Cockatoo is listed Endangered under the EPBC Act and Threatened (Schedule 1) under the WC Act. It is distributed across the south-west of Western Australia in uncleared or remnant areas of *Eucalyptus* woodland and shrubland of kwongan heath.

The Carnaby's Black Cockatoo was recorded multiple times in the Study Area during the field survey and was the most seen species of all birds recorded. Numbers of birds recorded at each sighting ranged from a pair of birds to flocks of just over 10 individuals. However GHD 2013a identified flocks of over 100 birds using the Neerabup National Park. DPaW also recorded the species in other areas of the Neerabup National Park

The Study Area contains native vegetation that is considered to represent suitable feeding habitat for Carnaby's Black Cockatoo. The most dominant/obvious species include *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah), *E. todtiana* (coastal blackbutt), *Corymbia calophylla* (marri), *Banksia grandis*, *B. menziesii*, *B. attenuata*, *B. sessilis* and *Allocasuarina fraseriana* (sheoak).

The Study Area is partially located within the known breeding range for the Carnaby's Black Cockatoo (DotE, 2012). It nests in hollows in live or dead trees of *E. salmonophloia* (Salmon gum), *E. wandoo* (Wandoo), tuart, jarrah, *E. rudis* (Flooded gum), *E. loxophleba* subsp. *loxophleba* (York gum), *E. accedens* (Powderbark), *E. diversicolor* (Karri) and Marri. Of these species, Tuart, Jarrah, and Marri were all recorded from the Study Area. The Tuart woodlands and to a lesser extent, the Jarrah-*Banksia* woodlands are considered to be the most valuable habitat types in terms of providing potential breeding habitat for black cockatoos within the Study Area.

The Study Area (inclusive of all three habitat types) is considered to be of high value to Carnaby's Black Cockatoo.

Rainbow Bee Eater (*Merops ornatus*)

The Rainbow Bee Eater is listed as Schedule 3 (protected fauna under international agreement) under the WC Act also marine/migratory under the EPBC Act. The species is widespread across Australia that migrates north over the winter period returning in spring and their breeding

season. The species prefers open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It also inhabits sand dune systems in coastal areas and at inland sites that are in close proximity to water (DotE 2013). Breeding occurs in burrows dug by parent birds on flat open areas by preferably in raised spoils, banks or other man made soil deposits.

During the survey a pair of Rainbow Bee Eaters was observed within the Tuart Woodland. Additionally DPaW also recorded the species in other areas of the Neerabup National Park.

The Study Area (inclusive of all three habitat types) is considered to be of high value to Rainbow Bee Eater.

Carpet Python (*Morelia spilota imbricata*)

The Carpet Python is listed as Schedule 4 (other specially protected fauna) under the WC Act. This subspecies inhabits temperate climatic areas with good winter rains and dry summers. It occurs in south-west Western Australia, from Northampton, south to Albany and eastwards to Plumridge Lakes, including undisturbed remnant bushland near Perth and the Darling Ranges, Yanchep National Park, and Garden Island. It has been recorded in semi-arid coastal and inland habitats consisting of *Banksia* woodland, Eucalypt woodlands, and grasslands (DEC, 2012a).

This species was identified in the Study Area crossing the track during the day opposite trap site 3 (Plate 1). GHD 2013b also recorded the species from a snake dropping within a tree hollow in the northern portion of Neerabup National Park. The majority of the Study Area containing remnant native vegetation provides suitable habitat for this species. It is likely that this species would generally inhabit the larger areas of contiguous native vegetation within the Study Area.

The Study Area (Tuart Woodland and Banksia- Jarrah Woodland) is considered high value to Carpet Python. Banksia Woodland is Moderate value to Carpet Python.



Plate 1 Sub Adult Carpet Python within the Study Area

Quenda/Southern Brown Bandicoot (*Isodon obesulus fusciventer*)

The Quenda, or Southern Brown Bandicoot, is listed as a Priority 5 by the DPaW. This species is widely distributed in the south west of the state from Guilderton, north of Perth, to east of Esperance. They are patchily distributed through the Swan Coastal Plain where they are often associated with wetlands. Quenda inhabit scrubby, often swampy, vegetation with dense cover up to 1 m high and often feed in adjacent forest and woodland (Van Dyck and Strahan, 2008).

The GHD trapping program in the proposed Neerabup Road failed to capture any Southern Brown Bandicoots however three individuals were recorded opportunistically via night spotting and print identification. Additionally DPaW caught numerous individuals in the northern portion of Neerabup National Park and GHD 2013b recorded two distinctive conical diggings in the central portion of Neerabup National Park, consistent with Bandicoot diggings. Due to the availability of suitable habitat for the Quenda a high rate of occurrence was expected. However large numbers of introduced predators (mainly foxes) were recorded which are known to predate on the Quenda; this predation would limited the rate of occurrence of Quenda and is the likely reason for the poor trap success of Quenda in this study. Although there are no wetlands or wetland associated vegetation within the Study Area, the Tuart and Jarrah- *Banksia* woodlands provide good suitable habitat for Quenda, particularly areas with a dense understorey.

The Study Area (inclusive of all three habitat types) is considered to be of high value to Quenda.

Western Brush Wallaby (*Macropus irma*)

The Western Brush Wallaby is listed as a Priority 4 by the DPaW. This species is widely distributed in the south west of the state from about Kalbarri to east of Esperance, excluding the extreme south west wet forests. They are patchily distributed through the Swan Coastal Plain

where they now only persist in large remnant areas of natural vegetation. Habitat includes open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets. The species is also found in some areas of mallee and heathland, and is uncommon in Karri forest (Van Dyck and Strahan 2008).

One report of this species was recorded by DPaW on camera trap. As is the case with the Quenda (discussed above) the limited records of this species is likely to be associated with the large numbers of feral predators reported within the National Park.

The Study Area (inclusive of all three habitat types) is considered to be of high value to the Western Brush Wallaby.

3.4.3 Previously identified Conservation Significant Species.

GHD 2013b undertook a likelihood of occurrence assessment that identified a number of conservation significant species that possibly or are likely to occur within the Study Area. These species were not recorded during this survey; however they potentially occur in the National Park and Study Area. These species include:

- Peregrine Falcon (*Falco peregrinus*) - Schedule 4 (WC Act).
- Fork-tailed Swift (*Apus pacificus*) - Schedule 3 (WC Act), Migratory/Marine (EPBC Act).
- Jewelled Ctenotus (*Ctenotus gemmula*) (Swan Coastal Plain pop.) - Priority 3 (DPaW).
- Black-striped Snake (*Neelaps calonotos*) - Priority 3 (DPaW).

In addition the above species, the Chuditch is also considered to potentially occur within the Study Area. The previous GHD 2013b report determined that the Chuditch was unlikely to occur within the Study Area, however since this report, GHD has been given anecdotal evidence of a road mortality Chuditch being reported just north of the proposed Neerabup Road extension on Wanneroo Road (DPaW, Alice Reaveley pers. comm.). The Chuditch (*Dasyurus geoffroii* or Western Quoll) is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act.

A brief description of each of these species and their associated habitat types within the Study Area are described below.

Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is listed as Schedule 4 under the WC Act. This species is known to be uncommon but wide-ranging across Australia. Habitat is extremely diverse, from rainforest to arid scrub, from coastal heath to alpine. The Peregrine Falcon nests primarily on ledges of cliffs, shallow tree hollows, and ledges of buildings in cities (Morcombe 2004).

The Peregrine Falcon was not observed during the survey however the species is known to be in the region. Breeding habitat is present in hollows of large Tuarts and all of the alignment would be used as foraging area.

The Study Area (all three habitat types) is considered high value to Peregrine Falcon.

Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is listed Schedule 3 (WC Act) and Migratory/Marine (EPBC Act). In the south-west of Western Australia, including the Perth region and there are sparsely scattered records of this species; these records are mainly along the south coast, ranging from the Eyre Bird Observatory and west to Denmark. During storm events the species can be widespread in coastal and sub-coastal areas between Augusta and the North West, including near-shore and offshore islands. This species is almost exclusively aerial, flying less than 1 m to at least 300 m above ground. This species is considered rare in the south-west region (DSEWPaC 2013).

This species was not observed during the survey and due to the exclusive aerial nature of the species is unlikely to utilise the terrestrial habitat within the Study Area. The habitat within the Study Area maybe opportunistically utilised by the species but only on rare occasions.

The Study Area (all three habitat types) is considered low value to Fork-tailed Swift.

Jewelled Ctenotus (*Ctenotus gemmula*) (Swan Coastal Plain population)

The Jewelled Ctenotus (Swan Coastal Plain population) is listed as Priority 3 by Department of Parks and Wildlife. This species has scattered populations:

- Along the lower west coastal plain from Cataby and south to Perth.
- Along the south coast and adjacent interior, from Rocky Gully east to the beginning of the Great Australian Bight, and inland to Lake Magenta (Maryan and Shea 2010).

The northern population is the only population listed and is likely to be a different species to the southern population. The Jewelled Ctenotus occurs on pale sandplains supporting heaths in association with Banksia or Mallee woodlands on the Swan Coastal Plain (Wilson and Swan, 2013). The closest known records to the Study Area are records from Ellenbrook and Melaleuca Park along Neaves Road approximately 10 kilometres east of the Study Area. Habitat is present for this species within the Study Area particularly in the Banksia Woodland in the western portion of the proposed road alignment. No specimens were captured during this study, however due to the shy nature of the species and scattered distribution of its populations, the species may be present.

The Study Area (all three habitat types) is considered high value to the Jewelled Ctenotus.

Black-striped Snake (*Neelaps calonotos*)

The Black-striped Snake is listed as Priority 3 by Department of Parks and Wildlife. This species is restricted to the sandy coastal strip, between Mandurah and Dongara. It occurs on dunes and sand-plains vegetated with heaths and eucalypt/banksia woodlands. This species is seriously threatened by increasing development and habitat loss within its restricted distribution (Wilson and Swan, 2013).

No specimens were collected during the survey however DPaW records (reported in the NatureMap search) show specimens captured approximately four kilometres west, seven kilometres south and 5.5 kilometres south east of the Study Area. Habitat is present for this species particularly in the Banksia Woodland in the western portion of the proposed road alignment. Given the surrounding records of occurrence and the suitability of habitat within the Study Area the Black-striped Snake is expected to occur in the Study Area.

The Study Area (particularly the Banksia Woodland) is considered high value to Black-striped Snake. The Tuart Woodland and Banksia-Jarrah Woodland are considered moderate value to the Black-striped Snake.

Chuditch (*Dasyurus geoffroi*)

The Chuditch is listed Vulnerable under the EPBC Act and Threatened (Schedule 1) under the WC Act. The Chuditch or Western Quoll formerly ranged over nearly 70 % of Australia but now retains only a patchy distribution through Eucalypt forest (especially Jarrah, *Eucalyptus marginata*), dry woodland and mallee shrublands in Western Australia. In the Jarrah forest, Chuditch populations occur in both moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest (Orell and Morris, 1994). Most diurnal resting sites in sclerophyll forest consist of hollow logs or earth burrows (Van Dyke & Strahan, 2008). The species can travel large distances, has a large home range (15 km² for males =1500 ha and 4 km² for females = 400 ha) and is sparsely populated through a large portion of its range (Orell and Morris, 1994).

The reduction in range and decline in population numbers have been caused by habitat alteration, impacts from the introduction of foxes and cats, hunting and poisoning (Orell and Morris, 1994).

More recently (from 2006) the species is also known to occur in Julimar Nature Reserve (near Bindoon) and Kalbarri area (both via a reintroduction program) and Forestonia area east of Hyden (natural population). On the Swan Coastal Plain Chuditch have been recorded in the Byford area and adjoining areas of the Darling Range, more recently the species was captured in Paganoni Reserve south of Perth. The species is known to move large distances where habitat is available and predation is reduced or managed via predator control programs such as baiting.

No Chuditch were recorded during the survey however a specimen was recorded as a road fatality on Wanneroo Road just north of the Study Area. Chuditch require very large areas of habitat to persist and the Neerabup National Park size (1069 ha, excluding the proposed extensions) may only support a small population.

The Study Area (all three habitat types) is considered high value to Chuditch, however due to the size of the Neerabup National Park the carry capacity of a population would be limited and a long term population may not be viable.

3.4.4 Locally significant fauna

Locally significant fauna are those which are not formally listed under State or Commonwealth legislation or listed as Priority fauna by the DPaW but are considered to have a restricted distribution on the Swan Coastal Plain or have dramatically declined in numbers since European settlement (Bush Forever 2000).

Nineteen bird species recorded during the survey are considered to be significant birds of the Swan Coastal Plain portion of the Perth Metropolitan Region (Bush Forever, 2000). This includes;

- Eleven birds listed as category 3: Yellow-rumped Thornbill, Western Thornbill, Weebill, White-browed Scrubwren, Common Bronzewing, Splendid Fairy-wren, Varied Sittella, Grey Shrike-thrush, Golden Whistler, Western Yellow Robin and Scarlet Robin.
- Nine birds listed under category 4: Brown Goshawk, Wedge-tailed Eagle, Whistling Kite, Carnaby's Black Cockatoo, Emu, New Holland Honeyeater, White-cheeked Honeyeater, Grey Currawong and Little Wattlebird.

These species are either habitat specialists with a reduced distribution on the Swan Coastal Plain or are wide-ranging species with reduced populations on the Swan Coastal Plain.

Additionally the Carpet Python, Reticulated Whip Snake, Western Slender Blue-tongue, Fat Blind Snake, Southern Beaked Blindsnake, Black-napped Snake, White-striped Freetail Bat and Echidna would also be considered to be locally significant fauna, even though they have large distributions they have declined or have limited distribution on the Swan Coastal Plain.

The Study Area is also considered to contain suitable habitat for a number of other fauna species identified by GHD 2013b via the DPaW NatureMap search. A number of these species are considered to be locally significant under the above criteria and include the Honey Possum, Speckled Granite Gecko (Swan Coastal Plain population), Yellow Throated Miner, Collared Sparrowhawk, Inland Thornbill, Black-faced Woodswallow, Restless Flycatcher, White-breasted Robin, Brush Bronzewing, White-winged Fairy-wren, Variegated Fairy-wren and Little Eagle.

3.4.5 Introduced Species

One hundred records of six non-native mammal species were recorded in the study area over the trapping program. The species recorded were six Dogs (*Canus lupis domesticus*), 64 Red Foxes (*Vulpes vulpes*), six Cats (*Felis catus*) eight European Rabbits (*Oryctolagus cuniculus*), two Black Rats (*Rattus rattus*) and 14 House Mice (*Mus musculus*).

Multiple dog, fox and cat prints were observed on fine sands throughout the Study Area. House mice were captured in buckets and Elliot traps. Two naturalised bird species were recorded in the Study Area. These include three Rainbow Lorikeets (*Trichoglossus haematodus*) and three Laughing Kookaburras (*Dacelo novaeguineae*).

3.5 Accumulation Curves

The number and type of species trapped each day was recorded and species accumulation curves were created for each fauna habitat; these curves are presented below in Plate 2 to Plate 4. Mammal curves show very little variation, which is a reflection of the lack of diversity of species captured over the trapping program. The reptile curves reach a curve asymptote (no more new species were recorded) after trap night 3 to 4; however all trap sites show some incline and levelling towards the end of the trapping program. This is probably due to temperature variation through the trapping program; with a cooling of minimum temperatures towards the middle of the trapping program which then increased slightly towards the end, this resulted in increasing reptile activity and capture rate. These small inclines can also represent cryptic species that aren't readily captured at the beginning of a trapping program. Such species include small elapids, blind snakes and geckos. Most bird curves show levelling by the 4 to 6 night.

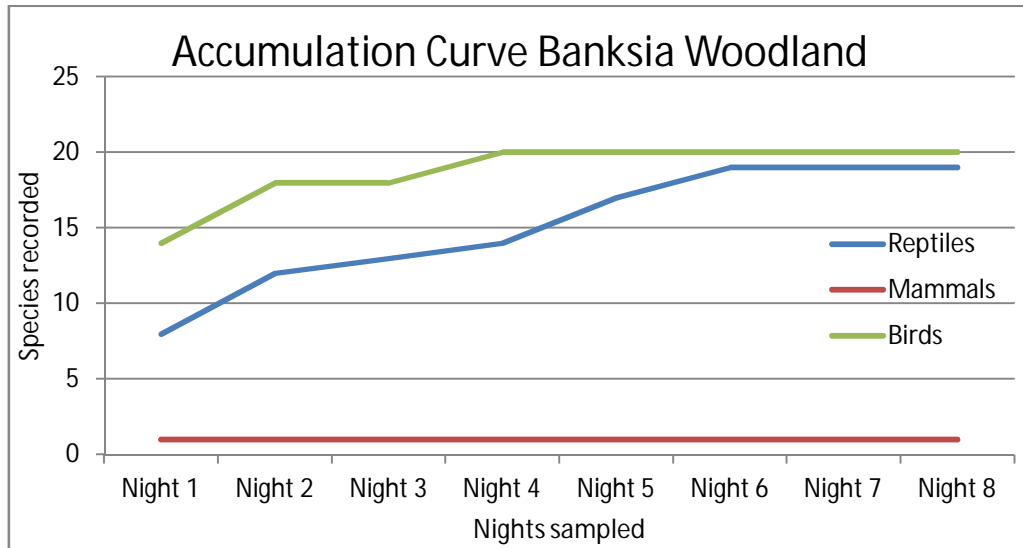


Plate 2 Accumulation Curve for Banksia Woodland Habitat

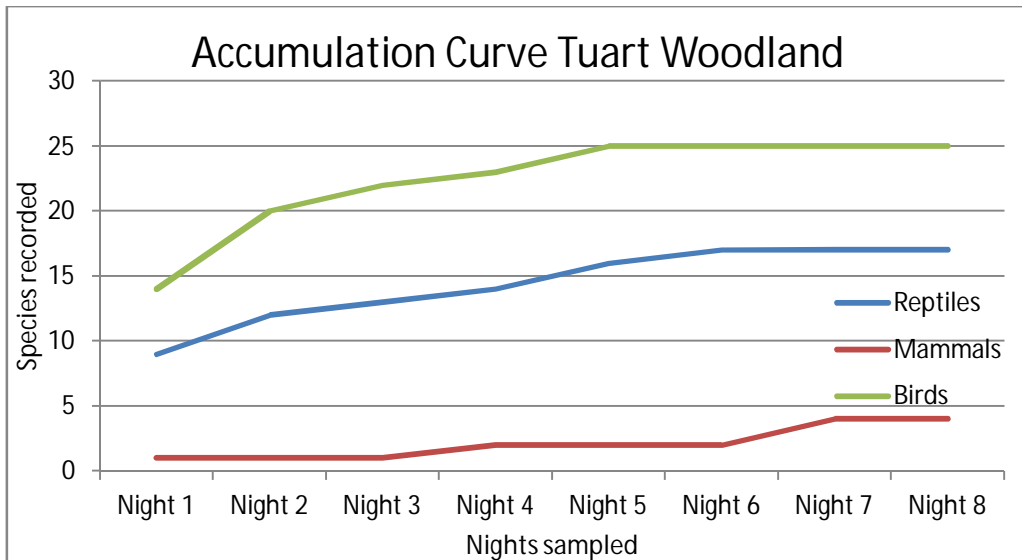


Plate 3 Accumulation Curve for Tuart Woodland Habitat

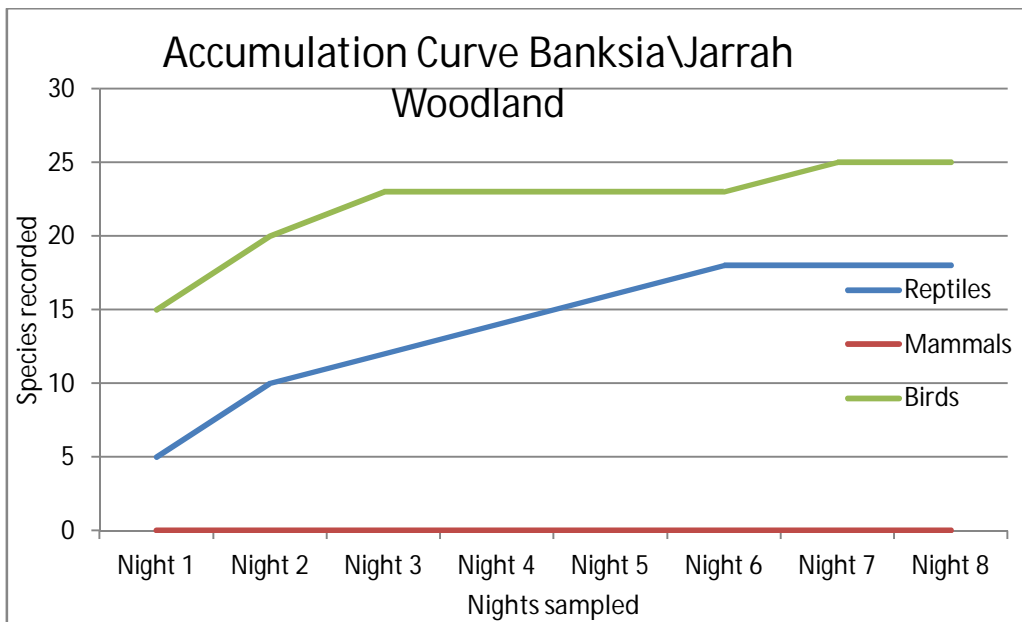


Plate 4 Accumulation Curve for Banksia\Jarrah Woodland Habitat

3.6 CALM 1993 Trapping Data

In 1993 Department of Conservation and Land Management (now DPaW) undertook a single season trapping program in water supply reserve 34537 (approximately 30 ha) which is approximately 1.4 km south of this Study Area. An additional quadrat was established in Neerabup National Park adjacent to the water reserve as a comparison of fauna assemblage. Trapping was undertaken for 11 nights using pit and Elliot traps, mist netting, nocturnal searches and daytime active searches. In total 39 birds, 15 reptiles, two amphibians and eight mammals (four native, four introduced) were recorded. In the conclusion of the report, CALM 1993 comments that these numbers demonstrate reasonable richness of fauna for this area. Additionally the White Breasted Robin was recorded which is a significant extension of habitat use and range on the Swan Coastal Plain.

The report identifies a number of conservation significant species under both EPBC Act and WC Act, priority fauna and Bush Forever listings. These species are;

Species listed as Threatened under the EPBC Act and WC Act are:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) - Endangered (EPBC Act), Schedule 1 (WC Act).
- Rainbow Bee Eater (*Merops ornatus*) – Marine/Migratory (EPBC Act), Schedule 3 (WC Act).

Species listed as Priority by DPaW are:

- Western Brush Wallaby (*Macropus irma*) – Priority 4.

Species identified under the Bush Forever 2000 include 17 birds listed as category 3 (Yellow-rumped Thornbill, Inland Thornbill, Western Thornbill, Weebill, White-browed Scrubwren, Common Bronzewing, Splendid Fairy-wren, Varied Sittella, Grey Shrike-thrush, Golden Whistler, White Breasted Robin and Scarlet Robin and category 4 Little Eagle, Collared Sparrowhawk, Carnaby's Black Cockatoo, New Holland Honeyeater, Little Wattlebird.

The CALM 1993 data is presented in Appendix B as a consolidated list of all species recorded in Neerabup National Park by GHD, DPaW and CALM data.

3.7 Diversity comparison

Results from this study and results from similar studies in other naturally vegetation areas in the region are similar:

- Bold Park is 28 km south of the Study Area, smaller in size and has been extensively surveyed since the 1970s and the park is one of the most surveyed bushland areas on the Swan Coastal Plain (How et al 1996). This reserve has 99 species in total. The existing data demonstrated higher diversity in the Neerabup National Park than Bold Park.
- Whiteman Park and Yanchep National Park are much closer to Neerabup National Park (12 km south east and 5 km north respectively) and are much larger than Neerabup National Park. Results from previous studies at these two vegetated reserves show approximately 20% more fauna diversity than the Neerabup National Park results. However (as stated above), Neerabup National Park is expected to have higher diversity than that reported from this assessment and it is likely comparable to both Whiteman Park and Yanchep National Park.

Table 10 shows the difference in faunal assemblage in these remnant bushland areas.

Table 10 Comparison of Fauna diversity of Neerabup National Park.

Faunal Groups	Bold Park	Whiteman Park	Yanchep National Park	Neerabup National Park (This Study)
Size	437 ha	3935 ha (just over half is remnant vegetation)	2877 ha	1069 ha
Native mammals	1	8	17	9
Birds	65	104	86 (bush birds only)	78
Reptiles	30	32	44	32
Amphibians	3	7	8	3
Fish	0	0	2	0
Total	99	151	157	122

4. Conclusion

The Study Area consists of three major fauna habitat types: Banksia Woodland, Tuart Woodland and Jarrah–Banksia Woodland.

The conservation value of each habitat type has been rated based on condition, structural complexity, faunal diversity and habitat for significant fauna (i.e. contains essential habitat for breeding and/or feeding). Habitat values for the three types are all considered high value. A very small amount of the Study Area is disturbed and comprises of existing tracks, old fencing and historical cleared areas near to the Light Horse Trail.

GHD 2013b identified, via DPaW NatureMap search that 379 vertebrate fauna species have previously been recorded within 10 km of the Study Area, of which 361 species are native and 18 are pest (introduced) species. The Study Area could expect 263 terrestrial vertebrate species present. This consists of 171 birds, 18 mammals, 65 reptiles, two amphibians and two fish species. The 10 kilometre buffer applied to the NatureMap search also includes local wetlands and other habitats greatly increasing the diversity of fauna in the search, there are no wetland habitats within the Study Area.

The total species identified in this study for the Neerabup National Park is 128 fauna species, consisting of 78 birds, 32 reptiles, three amphibian, nine native mammals (including bats) and six introduced mammals (including DPaW's and CALM data).

The trapping program recorded 108 species (excluding introduced mammals) which is considered good diversity of species for the three habitat types (particularly given that the Study Area contains no wetlands or water courses). Additionally it is expected that the diversity of the broader Neerabup National Park be much higher than that recorded in this study give the temporal limitations of the study (and those reviewed). It is likely that a different suite of faunal groups would be present in other times in the year i.e. amphibians in autumn/winter and seasonally moving or migratory birds. Additionally, Neerabup Nature Reserve has not been subject to previous comprehensive or systematic surveys and as such the opportunities to compare results to other studies in the area are limited.

A total of 10 conservation significant fauna have been identified as present or potentially occurring in the study area based on a combination of observations and habitat assessment. This includes two species listed as Threatened (EPBC Act/WC Act), two species listed as Specially Protected (WC Act), four species listed as Priority (DPaW) and two species listed as Migratory (EPBC Act) and Schedule 3 (WC Act).

Species listed as Threatened under the EPBC Act and WC Act are:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) - Endangered (EPBC Act), Schedule 1 (WC Act).
- Chuditch (*Dasyurus geoffroi*) – Vulnerable (EPBC Act), Schedule 1 (WC Act).

Species listed as Specially Protected under the WC Act is:

- Carpet Python (*Morelia spilota imbricata*) – Schedule 4.
- Peregrine Falcon (*Falco peregrinus*) - Schedule 4.

Species listed as Priority by DPaW are:

- Southern Brown Bandicoot (*Isodon obesulus fusciventer*) – Priority 5.
- Jewelled Ctenotus (*Ctenotus gemmula*) (Swan Coastal Plain pop.) - Priority 3.
- Western Brush Wallaby (*Macropus Irma*) – Priority 4.

- Black-striped Snake (*Neelaps calonotos*) - Priority 3.

Species listed as Specially Protected under the WC Act and Migratory under EPBC Act:

- Rainbow Bee Eater (*Merops ornatus*) –Migratory/Marine (EPBC Act), Schedule 3 (WC Act).
- Fork-tailed Swift (*Apus pacificus*) - Migratory/Marine (EPBC Act), Schedule 3 (WC Act).

Of the conservation significant species, the Carnaby's Black Cockatoo, Carpet Python, Southern Brown Bandicoot and Western Brush Wallaby would rely on the resources of the Study Area to persist. Additionally Western Brush Wallaby's on the Swan Coastal Plain are only known to persist in large remnant areas (Bush Forever 2000).

Twenty three bird species recorded during the survey are considered to be significant birds of the Swan Coastal Plain. These species are listed either category 3 or 4 under the Bush Forever Project. Additionally a further 15 species could also be included into these categories as being restricted in range or decreasing in populations on the Swan Coastal Plain. In total 38 species recorded in the Study Area (listed under Bush Forever) are significant to the Swan Coastal Plain.

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Appendices

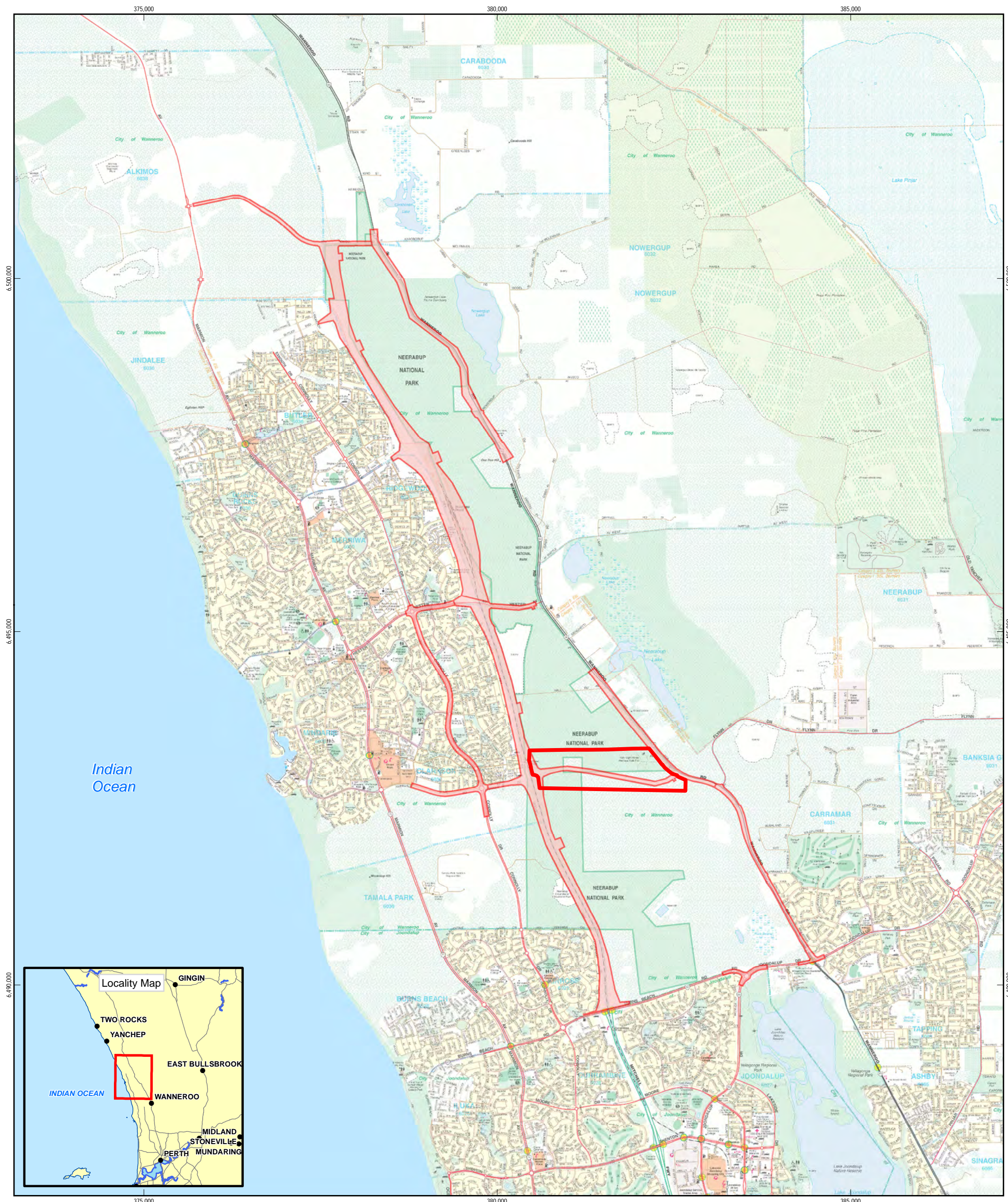
Appendix A - Figures

Figure 1 Study Area Location

Figure 2 Trapping Locations

Figure 3 Fauna Habitat Types

Figure 4 Significant Fauna Locations in the Study Area



LEGEND

Study area

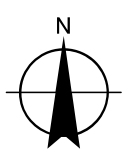
Broader project area

1: 50,000 (at A3)

0 0.25 0.5 1 1.5 2 2.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

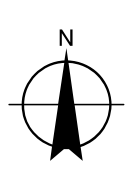
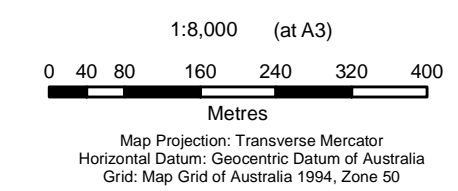


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Locality

Figure 1



LEGEND

Bat site	Cage trap	Broader project area
Camera location	Study area	
Trap site		



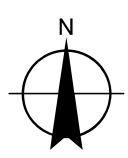
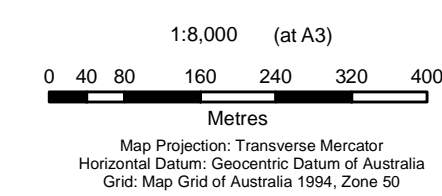
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Mitchell Freeway - Level 2 fauna survey

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Trap sites and locations

Figure 2

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Data source: GHD: Location - 20140130, Study area - 20140130; Landgate: Metro Central Mosaic - Feb 2013; MRWA: Roads - 2013. Created by: vdinh



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Fauna habitat type

 Banksia Woodland	 Study area
 Banksia / Jarrah Woodland	
 Tuart Woodland	

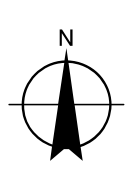
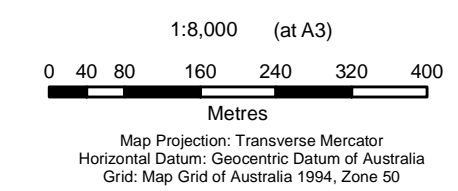


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Revision	0
Date	06 Mar 2014

Fauna habitat types

Figure 3



LEGEND

Observed significant fauna	Carnaby Black Cockatoo use observations in area
Carpet python	Study area
Rainbow bee eater	Broader project area
Southern brown bandicoot	



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Conservation significant fauna observed within the study area

Figure 4

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Data source: GHD: Location - 20140130; Study area - 20140130; Landgate: Metro Central Mosaic - Feb 2013; MRWA: Roads - 2013. Created by: vdinh

Appendix B - Tables

[Consolidated Species List](#)

[GHD Trapping Data](#)

[DPaW Trapping Data](#)

Consolidated Species List for GHD and DPaW (CALM) Trapping Data

Family	Taxon	Common Name	Listing	CALM	GHD	DPaW	This
				1993	2013b	2013	survey
				Level 2	Level 1	Level 2	Level 2
Birds							
Acanthizidae	<i>Acanthiza apicalis</i>	Inland Thornbill	SB3	X			
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	SB3	X	X		X
Acanthizidae	<i>Acanthiza inornata</i>	Western Thornbill	SB3	X			X
Acanthizidae	<i>Gerygone fusca</i>	Western Gerygone		X	X	X	X
Acanthizidae	<i>Smicrornis brevirostris occidentalis</i>	Weebill	SB3	X	X	X	X
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren	SB3	X			X
Accipitridae	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	SB4	X			
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk	SB4		X		X
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle	SB4				X
Accipitridae	<i>Hieraaetus morphnoides</i>	Little Eagle	SB4	X			
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite	SB4		X		X
Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite			X		
Aegothelidae	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar					X
Artamidae	<i>Artamus personatus</i>	Masked Woodswallow			X		
Artamidae	<i>Cracticus tiibicen dorsalis</i>	Australian Magpie		X	X	X	X
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird			X		
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird		X	X		X
Artamidae	<i>Strepera versicolor</i>	Grey Currawong	SB4				X
Cacatuidae	<i>Cacatua pastinator butleri</i>	Western Corella			X		
Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella			X		X
Cacatuidae	<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	En, T	X	X	X	X
Cacatuidae	<i>Eolophus roseicapilla</i>	Galah		X	X	X	X
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		X	X	X	X
Campephagidae	<i>Lalage sueurii</i>	White-winged Triller					X

Family	Taxon	Common Name	Listing	CALM	GHD	DPaW	This
				1993	2013b	2013	survey
				Level 2	Level 1	Level 2	Level 2
Casuariidae	<i>Dromaius novaehollandiae</i>	Emu	SB4		X	X	X
Columbidae	<i>Columbia livia</i>	Feral Pigeon	int		X		X
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon			X		X
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing	SB3	X	X	X	X
Columbidae	<i>Streptopelia senegalensis</i>	Laughing Dove	int	X	X		
Columbidae	<i>Streptopelia chinensis</i>	Spotted Dove	int		X		
Corvidae	<i>Corvus coronoides perplexus</i>	Australian Raven		X	X	X	X
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo		X	X		X
Cuculidae	<i>Chalcites lucidus</i>	Shining Bronze-cuckoo		X			
Cuculidae	<i>Chalcites osculans</i>	Black-eared Cuckoo				X	
Cuculidae	<i>Chrysococcyx basalis</i>	Horsefield's Bronze Cuckoo					X
Eurostopodidae	<i>Eurostopodus argus</i>	Spotted Nightjar					X
Falconidae	<i>Falco cenchroides cenchroides</i>	Nankeen Kestrel			X		
Falconidae	<i>Falco longipennis</i>	Hobby Falcon					X
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	int	X	X		X
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher		X			X
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow		X	X		X
Hirundinidae	<i>Petrochelidon nigricans</i>	Tree Martin			X		X
Maluridae	<i>Malurus splendens</i>	Splendid Fairy-wren	SB3	X	X	X	X
Meliphagidae	<i>Acanthorhynchus superciliosus</i>	Western Spinebill		X			
Meliphagidae	<i>Anthochaera carunculata</i>	Red Wattlebird		X	X		X
Meliphagidae	<i>Anthochaera lunulata</i>	Western Little Wattlebird	SB4	X			X
Meliphagidae	<i>Lichenostomus virescens virescens</i>	Singing Honeyeater		X	X	X	X
Meliphagidae	<i>Lichmera indistincta</i>	Brown Honeyeater		X	X	X	X
Meliphagidae	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater					X
Meliphagidae	<i>Phylidonyris niger</i>	White-cheeked Honeyeater	SB4		X		X

Family	Taxon	Common Name	Listing	CALM	GHD	DPaW	This
				1993	2013b	2013	survey
				Level 2	Level 1	Level 2	Level 2
Meliphagidae	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	SB4	X	X		
Meropidae	<i>Merops ornatus</i>	Rainbow bee-eater	Ma, Mi	X		X	X
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark			X		X
Motacillidae	<i>Anthus novaeseelandiae</i>	Richards Pipit			X		
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird					X
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella	SB3	X			X
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	SB3	X	X	X	X
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	SB3	X	X		X
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler		X	X		X
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote		X			
Pardalotidae	<i>Pardalotus striatus</i>	Striated Pardalote		X	X	X	X
Petroicidae	<i>Eopsaltria georgiana</i>	White-breasted Robin	SB3	X			
Petroicidae	<i>Eopsaltria griseogularis</i>	Western Yellow Robin	SB3				X
Petroicidae	<i>Petroica boodang</i>	Scarlet Robin	SB3	X	X	X	X
Petroicidae	<i>Microeca fascinans</i>	Jacky Winter			X		X
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail					X
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth			X		X
Psittacidae	<i>Barnadius zonarius semitorquatus</i>	Australian Ringneck		X	X	X	X
Psittacidae	<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet					X
Psittacidae	<i>Neophema elegans</i>	Elegant Parrot		X			
Psittacidae	<i>Purpureicephalus spurius</i>	Red-capped Parrot		X	X		X
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	int		X		X
Rhipiduridae	<i>Rhipidura leucophrys leucophrys</i>	Willie Wagtail			X		X
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail		X	X	X	X
Strigidae	<i>Ninox novaeseelandiae</i>	Boobook Owl		X			X
Tytonidae	<i>Tyto javanica</i>	Barn Owl					X

Family	Taxon	Common Name	Listing	CALM 1993	GHD 2013b	DPaW 2013	This survey
				Level 2	Level 1	Level 2	Level 2
Timaliidae	<i>Zosterops lateralis</i>	Silvereeye		X	X		X
Turnicidae	<i>Turnix velox</i>	Little Button Quail				X	
Reptiles							
Agamidae	<i>Pogona minor minor</i>	Western Bearded Dragon		X	X	X	X
Boidae	<i>Morelia spilota imbricata</i>	Carpet Python	S4		X		X
Diplodactylidae	<i>Strophurus spinigerus spinigerus</i>	Soft Spiny-tailed Gecko				X	X
Elapidae	<i>Brachyuropsis semifasciatus</i>	Southern Shovel-nosed Snake					X
Elapidae	<i>Demansia psammophis reticulata</i>	Reticulated Whip Snake				X	
Elapidae	<i>Peudonaja affinis affinis</i>	Dugite		X			X
Elapidae	<i>Neelaps bimaculatus</i>	Black-napped Snake			X		
Elapidae	<i>Simoselaps bertholdi</i>	Jan's Banded Snake				X	X
Gekkonidae	<i>Christinus marmoratus</i>	Marbled Gecko					X
Pygopodidae	<i>Aprasia repens</i>	Sand-plain Worm Lizard		X			X
Pygopodidae	<i>Delma fraseri</i>	Frasier's Legless Lizard		X			
Pygopodidae	<i>Lialis burtonis</i>	Burton's Legless Lizard		X		X	X
Pygopodidae	<i>Pygopus lepidopodus</i>	Common Scalyfoot				X	
Scincidae	<i>Cryptoblephorus buchananii</i>	Buchanan's Snake-eyed Skink		X	X	X	X
Scincidae	<i>Ctenotus australis</i>	West Coast Long-tailed Ctenotus				X	X
Scincidae	<i>Ctenotus fallens</i>	West Coast Ctenotus		X		X	X
Scincidae	<i>Cyclodomorphus celatus</i>	Western Slender Blue-tongue			X		
Scincidae	<i>Egernia napoleonis</i>	Napoleon Skink		X			
Scincidae	<i>Hemiergis quadrilineata</i>	Two-toed Earless Skink		X	X	X	X
Scincidae	<i>Lerista distinguenda</i>	South-west Four-toed Lerista				X	X
Scincidae	<i>Lerista elegans</i>	West Coast Four-toed Skink		X		X	X
Scincidae	<i>Lerista praepedita</i>	West Coast Worm-slider		X		X	X
Scincidae	<i>Menetia greyii</i>	Common Dwarf Skink		X		X	X

Family	Taxon	Common Name	Listing	CALM 1993	GHD 2013b	DPaW 2013	This survey
				Level 2	Level 1	Level 2	Level 2
Scincidae	<i>Morethia lineocellata</i>	Pale-flecked Snake-eyed Skink				X	X
Scincidae	<i>Morethia obscura</i>	Shrubland Snake-eyed Skink		X		X	X
Scincidae	<i>Tiliqua occipitalis</i>	Western Bluetongue					X
Scincidae	<i>Tiliqua rugosa</i>	Bobtail		X	X	X	X
Typhlopidae	<i>Anilius australis</i>	Southern Blind Snake					X
Typhlopidae	<i>Anilius pinguis</i>	Fat Blind Snake					X
Typhlopidae	<i>Anilius waitii</i>	Southern Beaked Blindsnake					X
Varanidae	<i>Varanus gouldii gouldii</i>	Gould's Monitor				X	X
Varanidae	<i>Varanus tristis tristis</i>	Black-headed Monitor		X			
Mammals							
Canidae	<i>Canis domesticus</i>	Domestic Dog	int		X	X	X
Canidae	<i>Vulpes vulpes</i>	Red Fox	int	X	X	X	X
Felidae	<i>Felis catus</i>	Cat	int	X	X	X	X
Leporidae	<i>Oryctolagus cuniculus</i>	European Rabbit	int	X	X	X	X
Macropodidae	<i>Macropus fuliginosus</i>	Western Grey Kangaroo		X	X	X	X
Macropodidae	<i>Macropus irma</i>	Western Brush Wallaby	P4	X		X	
Molossidae	<i>Tadarida australis</i>	White-striped Freetail Bat		X			X
Muridae	<i>Mus musculus</i>	House Mouse	int	X		X	X
Muridae	<i>Rattus rattus</i>	Black Rat	int			X	X
Peramelidae	<i>Isodon obesulus fusciventor</i>	Southern Brown Bandicoot	P5			X	X
Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum			X		X
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Echidna			X	X	X
Tarsipedidae	<i>Tarsipes rostratus</i>	Honey Possum		X			
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattle Bat					X
Vespertilionidae	<i>Nyctophilus geoffroyi or gouldii</i>	Long-eared Bats					X
Amphibians							

Family	Taxon	Common Name	Listing	CALM 1993	GHD 2013b	DPaW 2013	This survey
				Level 2	Level 1	Level 2	Level 2
Myobatrachidae	<i>Heleioporus eyrei</i>	Moaning Frog		X			
Myobatrachidae	<i>Limnodynastes dorsalis</i>	Pobblebonk		X			
Myobatrachidae	<i>Myobatrachus gouldii</i>	Turtle Frog					X

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- T = Threatened under WC Act
- SB = Significant Bird under Bush Forever 2000
- X = Identified species

GHD Trapping and Abundance Data within the Study Area

Genus	Species	Common Name	Status	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Cameras	Opportunistic	Totals
				Banksia woodland	Banksia woodland	Tuart Forest	Tuart Forest	Jarrah-Banksia woodland	Jarrah-Banksia woodland	(Hits)		
Birds												
<i>Acanthiza</i>	<i>chrysorrhoa</i>	Yellow-rumped Thornbill	SB3			4	4	8	8		1	25
<i>Acanthiza</i>	<i>inornata</i>	Western Thornbill	SB3								1	1
<i>Gerygone</i>	<i>fusca</i>	Western Gerygone			1	5	6	12	10		1	35
<i>Sericornis</i>	<i>brevirostris</i>	Weebill	SB3	8							1	9
<i>Sericornis</i>	<i>frontalis</i>	White-browed Scrubwren	SB3				2		2		1	5
<i>Accipiter</i>	<i>fasciatus fasciatus</i>	Brown Goshawk	SB4		1	1					1	3
<i>Aquila</i>	<i>audax</i>	Wedge-tailed Eagle	SB4		1							1
<i>Haliastur</i>	<i>sphenurus</i>	Whistling Kite	SB4			1						1
<i>Aegotheles</i>	<i>cristatus</i>	Australian Owlet-nightjar									1	1
<i>Cracticus</i>	<i>tibicen</i>	Australian Magpie		4	2	9	4			3	12	34
<i>Cracticus</i>	<i>torquatus</i>	Grey Butcherbird			1				1		1	3
<i>Strepera</i>	<i>versicolor</i>	Grey Currawong	SB4								1	1
<i>Cacatua</i>	<i>sanguinea</i>	Little Corella		2	20	6	2	4	8		1	43
<i>Calyptorhynchus</i>	<i>latirostris</i>	Carnaby's Black Cockatoo	T, En	12			3	19	12		1	47
<i>Eolophus</i>	<i>roseicapillus</i>	Galah		6	4	7	8	8	10		1	44
<i>Coracina</i>	<i>novaehollandiae</i>	Black-faced Cuckoo-shrike				1		1	2		1	5
<i>Lalage</i>	<i>sueurii</i>	White-winged Triller									1	1
<i>Dromaius</i>	<i>novaehollandiae</i>	Emu	SB4							3	9	12
<i>Columbia</i>	<i>livia</i>	Feral Pigeon									1	1
<i>Ocyphaps</i>	<i>lophotes</i>	Crested Pigeon									1	1
<i>Phaps</i>	<i>chalcoptera</i>	Common Bronzewing	SB3	2			2				1	5
<i>Corvus</i>	<i>coronoides</i>	Australian Raven		4		4	4	4	1		14	31
<i>Cacomantis</i>	<i>flabelliformis</i>	Fan-tailed Cuckoo			1		1					2
<i>Chrysococcyx</i>	<i>basalis</i>	Horsefield's Bronze Cuckoo									1	1
<i>Eurostopodus</i>	<i>argus</i>	Spotted Nightjar		1								1
<i>Falco</i>	<i>longipennis</i>	Hobby Falcon									1	1
<i>Dacelo</i>	<i>novaeguineae</i>	Laughing Kookaburra	int		2						1	3
<i>Todiramphus</i>	<i>sanctus</i>	Sacred Kingfisher					1		2		1	4
<i>Hirundo</i>	<i>neoxena</i>	Welcome Swallow									1	1
<i>Petrochelidon</i>	<i>nigricans</i>	Tree Martin									5	5
<i>Malurus</i>	<i>splendens</i>	Splendid Fairy-wren	SB3	4	2	6	4	3	6	2	1	28

Genus	Species	Common Name	Status	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Cameras	Opportunistic	Totals
				Banksia woodland	Banksia woodland	Tuart Forest	Tuart Forest	Jarrah-Banksia woodland	Jarrah-Banksia woodland	(Hits)		
<i>Anthochaera</i>	<i>carunculata</i>	Red Wattlebird		2	1	3	5	2			1	14
<i>Anthochaera</i>	<i>lunulata</i>	Western Little Wattlebird	SB4						2			2
<i>Lichenostomus</i>	<i>virescens</i>	Singing Honeyeater							1		1	2
<i>Lichmera</i>	<i>indistincta</i>	Brown Honeyeater							6		1	7
<i>Melithreptus</i>	<i>brevirostris</i>	Brown-headed Honeyeater									1	1
<i>Phylidonyris</i>	<i>niger</i>	White-cheeked Honeyeater									1	1
<i>Merops</i>	<i>ornatus</i>	Rainbow Bee-eater	Ma, Mi				2				1	3
<i>Grallina</i>	<i>cyanoleuca</i>	Magpie-lark									1	1
<i>Dicaeum</i>	<i>hirundinaceum</i>	Mistletoebird									1	1
<i>Daphoenositta</i>	<i>chrysoptera</i>	Varied Sittella	SB3			4		6	4			14
<i>Colluricincla</i>	<i>harmonica</i>	Grey-shrike Thrush	SB3			1	2				1	4
<i>Pachycephala</i>	<i>pectoralis</i>	Golden Whistler	SB3		1	5	1		2			9
<i>Pachycephala</i>	<i>rufiventris</i>	Rufous Whistler			2		10	4	4		1	21
<i>Pardalotus</i>	<i>striatus</i>	Striated Pardalote		2	5	2	5	7	7		1	29
<i>Microeca</i>	<i>fascinans</i>	Jacky Winter									2	2
<i>Petroica</i>	<i>boodang</i>	Scarlet Robin	SB3								1	1
<i>Eopsaltria</i>	<i>griseogularis</i>	Western Yellow Robin	SB3								1	1
<i>Coturnix</i>	<i>ypsilophora</i>	Brown Quail			4						1	5
<i>podargus</i>	<i>strigoides</i>	Tawny Frogmouth		1							1	2
<i>Barnardius</i>	<i>zonarius semitorquatus</i>	Twenty-eight Parrot			4	5	4	7	2		1	23
<i>Glossopsitta</i>	<i>porphyrocephala</i>	Purple-crowned Lorikeet		6								6
<i>Purpureicephalus</i>	<i>spurius</i>	Red-capped Parrot									1	1
<i>Trichoglossus</i>	<i>haematodus</i>	Rainbow Lorikeet	int				2				1	3
<i>Rhipidura</i>	<i>albiscapa</i>	Grey Fantail					2		3		1	6
<i>Rhipidura</i>	<i>leucophrys</i>	Willie Wagtail									3	3
<i>Ninox</i>	<i>novaeseelandiae</i>	Boobook Owl						1			2	3
<i>Tyto</i>	<i>javanica</i>	Barn Owl									1	1
<i>Zosterops</i>	<i>lateralis</i>	Silvereye							9		1	10
Reptiles												
<i>Pogona</i>	<i>minor minor</i>	Bearded Dragon		2	1							3
<i>Morelia</i>	<i>spilota imbricata</i>	South West Carpet Python	S4			1						1
<i>Strophurus</i>	<i>spinigerus spinigerus</i>	Soft Spiny-tailed Gecko							3			3
<i>Brachyurophis</i>	<i>semifasciatus</i>	Southern Shovel-nosed Snake		2				1				3
<i>Pseudonaja</i>	<i>affinis affinis</i>	Dugite			1	1			3			5

Genus	Species	Common Name	Status	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Cameras	Opportunistic	Totals
				Banksia woodland	Banksia woodland	Tuart Forest	Tuart Forest	Jarrah–Banksia woodland	Jarrah–Banksia woodland	(Hits)		
Amphibians												
<i>Myobatrachus</i>	<i>gouldii</i>	Turtle Frog		1								1

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- X = Identified from ecolocation or heard
- 5 = Numbers recorded

DPaW Trapping and Abundance Data within the Neerabup National Park

Genus	Species	Common Name	Status	JH1	JH2	HT3	HT4	TD5	TD6	BK7	BK8	Cameras (Hits)	Opp. Bird Data	Totals
				Jarrah	Jarrah	Heath	Heath	<i>Euc. todtiana</i>	<i>Euc. todtiana</i>	<i>Banksia attenuata/menzesii</i>	<i>Banksia attenuata/menzesii</i>			
Birds														
<i>Gerygone</i>	<i>fusca</i>	Western Gerygone											X	X
<i>Smicromnis</i>	<i>brevirostris</i>	Weebill	SB3										X	X
<i>Cracticus</i>	<i>tibicen</i>	Australian Magpie											X	X
<i>Calyptornis</i>	<i>latirostris</i>	Carnaby's Black Cockatoo	T, En										X	X
<i>Eolophus</i>	<i>roseicapilla</i>	Galah											X	X
<i>Coracina</i>	<i>novaeollandiae</i>	Black-faced Cuckoo-shrike											X	X
<i>Dromaius</i>	<i>novaeollandiae</i>	Emu	SB4										X	X
<i>Phaps</i>	<i>chalcoptera</i>	Common Bronzewing	SB3										X	X
<i>Corvus</i>	<i>coronoides</i>	Australian Raven										1	X	2
<i>Chalcites</i>	<i>osculans</i>	Black-eared Cuckoo											X	X
<i>Malurus</i>	<i>splendens</i>	Splendid fairy-wren	SB3										X	X
<i>Lichmera</i>	<i>indistincta</i>	Brown Honeyeater											X	X
<i>Lichenostomus</i>	<i>virescens</i>	Singing Honeyeater											X	X
<i>Merops</i>	<i>ornatus</i>	Rainbow bee-eater	Ma, Mi										X	X
<i>Colluricincla</i>	<i>harmonica</i>	Grey Shrike Thrush	SB3									1	X	2
<i>Pardalotus</i>	<i>striatus</i>	Striated Pardalote											X	X
<i>Petroica</i>	<i>boodang</i>	Scarlet Robin	SB3										X	X
<i>Barnadius</i>	<i>zonarius semitorquatus</i>	Australian Ringneck											X	X
<i>Rhipidura</i>	<i>albiscapa</i>	Grey Fantail											X	X
<i>Turnix</i>	<i>velox</i>	Little button Quail			1									1
Reptiles														
<i>Pogona</i>	<i>minor minor</i>	Western Bearded Dragon			2							1		3
<i>Strophurus</i>	<i>spinigerus spinigerus</i>	Soft Spiny-tailed Gecko							1			1		2
<i>Demansia</i>	<i>psammophis reticulata</i>	Reticulated Whip Snake					1							1
<i>Simoselaps</i>	<i>bertholdi</i>	Jan's Banded Snake			1			2	1	3	3			10
<i>Pygopus</i>	<i>lepidopodus</i>	Common Scalyfoot						1						1
<i>Lialis</i>	<i>burtonis</i>	Burton's Legless Lizard		1	3		1							5
<i>Cryptoblepharus</i>	<i>buchananii</i>	Buchanan Snake-eyed Skink		1	1									2
<i>Ctenotus</i>	<i>australis</i>	West Coast Long-tailed Ctenotus									3			3

Genus	Species	Common Name	Status	JH1	JH2	HT3	HT4	TD5	TD6	BK7	BK8	Cameras (Hits)	Opp. Bird Data	Totals
				Jarrah	Jarrah	Heath	Heath	<i>Euc. todtiana</i>	<i>Euc. todtiana</i>	<i>Banksia attenuata/menzesii</i>	<i>Banksia attenuata/menzesii</i>			
<i>Ctenotus</i>	<i>fallens</i>	West Coast Ctenotus		4		3	4		1		3			15
<i>Hemiergis</i>	<i>quadrilineata</i>	Two-toed Mulch Skink		5	5	4	12	9	5	6	6			52
<i>Lerista</i>	<i>distinguenda</i>	South-west Four-toed Lerista		1										1
<i>Lerista</i>	<i>elegans</i>	West Coast Four-toed Skink		2	1					1				4
<i>Lerista</i>	<i>praepedita</i>	West Coast Worm-slider					3	1		1				5
<i>Menetia</i>	<i>greyii</i>	Common Dwarf Skink		2										2
<i>Morethia</i>	<i>lineocellata</i>	Pale-flecked Snake-eyed Skink			2				1					3
<i>Morethia</i>	<i>obscura</i>	Shrubland Snake-eyed Skink				1					1			2
<i>Tiliqua</i>	<i>rugosa rugosa</i>	Bobtail		10	6	2	9	2	1	5	4			39
<i>Varanus</i>	<i>gouldii gouldii</i>	Gould's Monitor		1					1	7				9
Mammals														
<i>Canus</i>	<i>domesticus</i>	Dog	int									2		2
<i>Vulpes</i>	<i>vulpes</i>	Red Fox	int									5		5
<i>Isoodon</i>	<i>obesulus fusciventor</i>	Southern Brown Bandicoot	P5				4		2					6
<i>Tachyglossus</i>	<i>aculeatus</i>	Echidna		1										1
<i>Macropus</i>	<i>fuliginosus</i>	Western Grey Kangaroo										6		6
<i>Macropus</i>	<i>irma</i>	Western Brush Wallaby	P4									1		1
<i>Felis</i>	<i>catus</i>	Feral Cat	int							1				1
<i>Oryctolagus</i>	<i>cuniculus</i>	European rabbit	int									2		2
<i>Mus</i>	<i>musculus</i>	House Mouse	int	1	2	2		2	6					13
<i>Rattus</i>	<i>rattus</i>	Black Rat	int									1		1

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X = Identified
5 = Numbers recorded

Appendix C - Permits

[DPaW Reg 17 Permit](#)

[DPaW Reg 4 Permit](#)

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