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## Lot 652 Native Vegetation Clearing Permit

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**Kimberly Port Authority**

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Template 2.8.1



## Contents

<b>1. Introduction .....</b>	<b>1</b>
1.1 Proposal description .....	1
1.2 Clearing of native vegetation .....	1
<b>2. Physical environment .....</b>	<b>3</b>
2.1 Biogeographic and regional setting .....	3
2.2 Geology, landform and soils .....	3
2.3 Hydrology .....	4
2.3.1 Surface water .....	4
2.3.2 Groundwater .....	4
<b>3. Biological Environment .....</b>	<b>4</b>
3.1 Flora .....	4
3.1.1 Threatened and Priority Flora .....	5
3.1.2 Invasive Flora .....	5
3.2 Vegetation .....	5
3.2.1 Regional vegetation .....	5
3.2.2 Vegetation assessment .....	5
3.2.3 Vegetation condition .....	6
3.2.4 Threatened and Priority Ecological Communities .....	7
3.3 Terrestrial Fauna .....	7
3.3.1 Fauna habitats .....	7
3.3.2 Threatened and Priority Fauna .....	7
<b>4. Assessment against the Ten Clearing Principles .....</b>	<b>9</b>
4.1 Comprise high level of biological diversity .....	10
4.2 Potential impact to any significant habitat for fauna indigenous to Western Australia .....	10
4.3 Potential impact to any rare flora .....	10
4.4 Potential to any threatened ecological communities .....	11
4.5 Significance as a remnant of native vegetation in the area that has been extensively cleared .....	11
4.6 Impacts on any watercourses and/or wetlands .....	11
4.7 Potential to cause appreciable land degradation .....	12
4.8 Potential to impact on the environmental values of adjacent or nearby conservation areas .....	12
4.9 Potential deterioration in the quality of surface or underground water .....	12
4.10 Potential of clearing to cause, or exacerbate, the incidence of flooding .....	12
<b>5. References .....</b>	<b>14</b>
<b>Appendix A Animal Plant Mineral (2020) – Kimberley Marine Offloading Facility Terrestrial Biological Survey .....</b>	<b>16</b>

<b>Appendix B Eco logical Australia (2019) – Kabbarli Road Biological Survey – Field Survey Results.....</b>	<b>17</b>
<b>Appendix C Woodman (2008) – Broome Port Authority – Floristic Community Types of the Broome Peninsula .....</b>	<b>18</b>
<b>Appendix D Bamford (2010) – Fauna Assessment of the Broome Port Area .....</b>	<b>19</b>

## List of Figures

Figure 1: Native Vegetation Clearing Permit Proposal Area .....	2
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## List of Tables

Table 1: Vegetation Association and Complex mapping units occurring within the reserve (Government of Western Australia 2019) .....	5
Table 2: Vegetation associations within the Proposal area .....	6
Table 3: Vegetation condition of the Proposal Area (APM 2020).....	6
Table 4: Summary of assessment against the ten clearing principals .....	9

## 1. Introduction

The Kimberley Ports Authority (KPA; the Proponent) is seeking approval to undertake the removal of 0.17 ha of native vegetation at Lot 652 Kabbarli Road (the Proposal Area) within the KPA Port Management Area of the Port of Broome, to support the development of the proposed Kimberley Marine Offloading Facility (the proposed development; Figure 1).

A number of studies have previously been undertaken to support the proposed development. Animal Plant Mineral (APM) undertook a biological assessment at the Port of Broome, which included the Proposal Area in March 2020 (APM 2020; Appendix A). Eco Logical Australia (2019; Appendix B) and Woodman Environmental Consulting (2008; Appendix C) have also undertaken previous detailed assessments that included the Proposal Area. Bamford Consulting Ecologists (Bamford) undertook an extensive fauna assessment across the entirety of the Port of Broome (Bamford 2010; Appendix D).

As the development requires the removal of native vegetation, an assessment of the proposed clearing against the ten native vegetation clearing principles contained in Schedule 5 of the *Environmental Protection Act 1986* (EP Act) is required. This Native Vegetation Clearing Permit (NVCP) application has been prepared for the Department of Water and Environmental Regulation (DWER) to address this requirement.

### 1.1 Proposal description

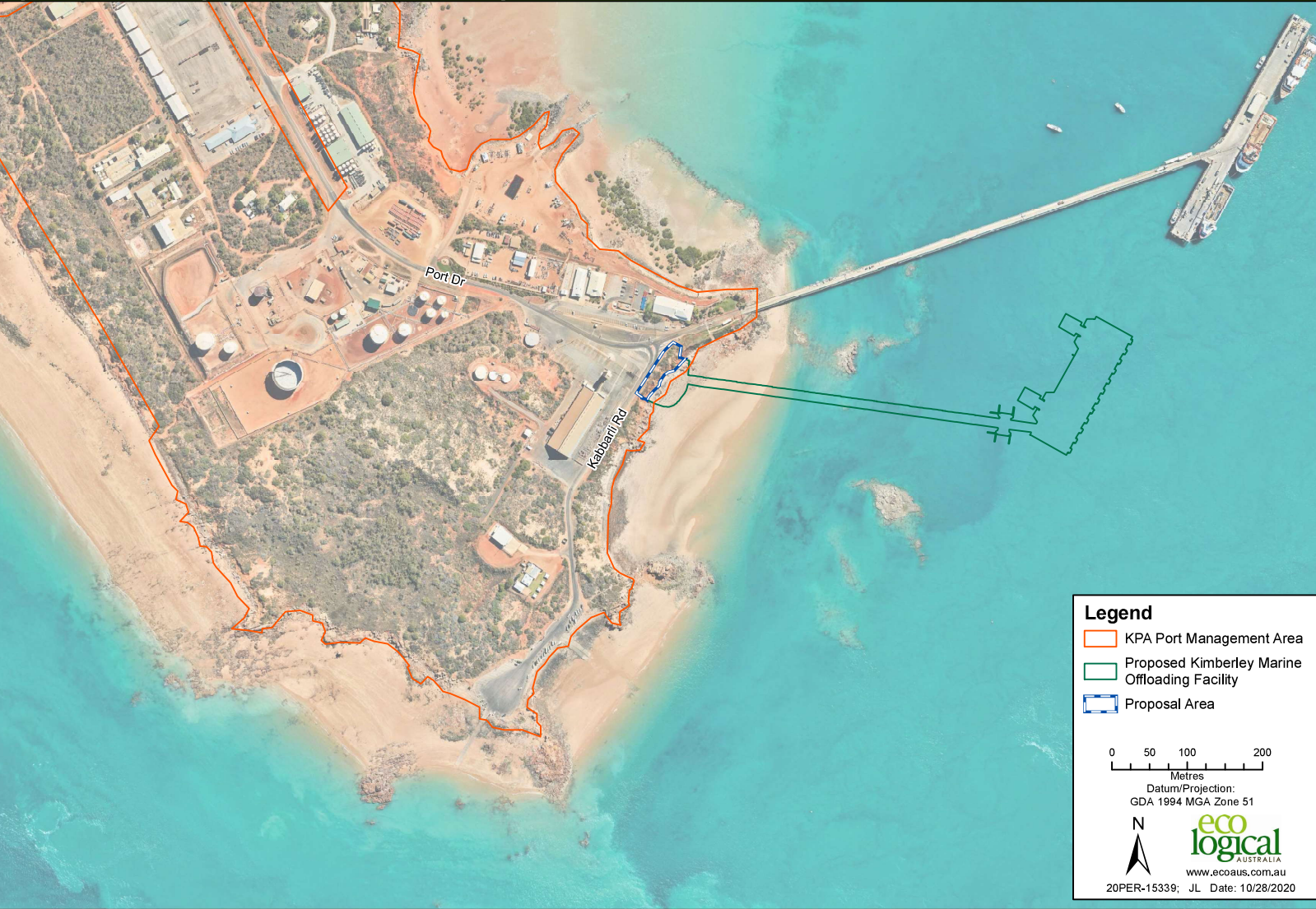
The proposed development will consist of a floating deep-water wharf and associated hardstand facilities suitable for the loading and discharge of containers and general cargo into coastal vessels as well as berthing and mooring of cruise vessels and roll-on/roll-off ships. The proposed development will also provide general logistics and refuelling services to berthed vessels.

Native vegetation within the Proposal Area is required to be cleared to support the proposed development. The area will be cleared, levelled and backfilled in order to support construction of the floating deep-water wharf and associated hardstand facilities (i.e. the proposed development; Figure 1). A portion of earthworks will occur within the tidal zone but will be appropriately bordered/ armoured to avoid erosion. This NVCP application relates to the Proposal Area only. Clearing of native vegetation will be managed by undertaking the standard avoidance and mitigation measures applicable to construction activities as described in KPA's Environmental Management Plan (KPA 2020).

### 1.2 Clearing of native vegetation

Excluding activities that are exempt under the clearing regulations (Section 5: Prescribed Clearing), all native vegetation clearing completed by the Proponent will be undertaken in accordance with this NVCP.

Figure 1: Native Vegetation Clearing Permit Proposal Area



## 2. Physical environment

### 2.1 Biogeographic and regional setting

The Port of Broome, located within the Kimberley region of Western Australia, is characterised as within the Dampierland Interim Biogeographic Regionalisation, which retains 99% of pre-European vegetation extent (Beard 1980). This area is classified as having a “Pindan Woodland” or “Pindan with low trees” physiognomic vegetation type characterised by wattle thicket with eucalypt woodland or scattered low trees over spinifex (Beard et al. 2013).

The Kimberley region experiences very hot wet summers and mild dry winters. Maximum mean monthly temperatures range from 28.9°C (July) to 33.9°C (December) (Bureau of Meteorology [BoM] 2020). The Broome Airport weather station (station number 3003; climate data 1939-2020), located approximately 6.5 kilometres (km) north of the Proposal, reports that on average, Broome received 628.1 millimetres (mm) of rain per annum; with 75% of this rain falling between January to March each year (BoM 2020). Any rainfall generated is quickly discharged via evaporation, soil infiltration and percolation into the groundwater (Laws 1991).

### 2.2 Geology, landform and soils

Schoknecht *et al.* (2004) describes the Port of Broome as located within the Ayers-Canning Province with low tablelands of ferruginous and kaolinized materials with laterite and silcrete, resulting from deep weathering of Permian, Jurassic and Cretaceous sandstone and Tertiary siltstones.

Topography for the Broome area is characterised by a low-lying, gently undulating plain of red Pindan dunes rising to between 3 and 8 metres (m) Australian Height Datum (AHD; APM 2020). The Pindan dunes were formed during the Quaternary and are composed of iron rich fine-grained sand to silt sediments known as Pindan soils. On the Broome Peninsular the Pindan soils overlay the cretaceous Broome Sandstone (APM 2020).

The Broome Sandstone forms the bedrock over a large portion of the Dampier Peninsula which was formed from terrestrial sediments deposited in a deltaic environment. The Sandstone deposit extends down to a depth ~300 m; however, surficial exposure of the Broome Sandstone is generally limited to the nearshore environment. Outcrops of the Broome Sandstone within the proposed development area occur offshore where they form a series of complex reefs, and onshore where it forms headlands and bluff features which are overlain with vegetated dunes of Pindan (APM 2020).

The Proposal Area itself is mapped as 335Cr: Carpentaria system, which is described as ‘*coastal plains, extensive bare mud flats, associated sandy margins and minor dunes, saline sands and muds, supporting paperbark thickets, samphire shrublands and fringing mangrove forests*’ (Schoknecht *et al.* 2004).

The Land Systems of the Kimberley Region were mapped by the Department of Agriculture and Food Western Australia, in Technical Bulletin No 98 (DAF 2012). The Study Area is designated as ‘Carpentaria 1 Low Capacity System’ described as bare coastal mudflats, minor sandy margins and seaward margins, little vegetation except for mangrove fringing thickets; Coastal plains, beaches, dunes, mudflats and cliffs; Various coastal vegetation. The land is considered unsuitable for grazing.



## 2.3 Hydrology

### 2.3.1 Surface water

Surface water runoff in the Broome area is only generated after periods of heavy rainfall (typically associated with cyclone events) and is quickly discharged from the area, often as sheet wash (APM 2020). These freshwater runoff events are known to strongly influence marine, surface and groundwater turbidity and nutrient concentrations (Eco Logical Australia [ELA] 2017).

Seaward flows of surface and ground water are considered to strongly influence the ecological character of Roebuck Bay through changes in salinity (that affect the distribution of species such as mangroves) and the transport of dissolved and particulate nutrients and carbon (ELA 2017).

There are no watercourses or wetlands within the Proposal Area and surface water flows are limited to natural stormwater runoff through the sand dunes onto the beach. The nearest wetland of significance is at Roebuck Bay conservation reserve approximately 7 km northeast of the Proposal Area.

### 2.3.2 Groundwater

The Proposal Area occurs within the proclaimed Broome Groundwater Area. Groundwater resources in the Broome region comprise of both confined and unconfined aquifers (Laws 1991). The Cretaceous Broome Sandstone aquifer is an unconfined aquifer and the most utilised in the region. It comprises fine to coarse grained quartzose sandstone with minor beds and/or pebble conglomerate of grey siltstone and claystone. This aquifer is separated from the underlying aquifers by an aquiclude (the Jaremai Siltstone) and two confined aquifers, Alexander Formation and the Wallal Sandstone (Laws 1991). Direct filtration from rainfall is the main recharge to the aquifer. A saltwater wedge occurs in the aquifer near Broome around the coast (Laws 1991). The regional groundwater moves with the gradient towards the coast (Laws 1991), west towards the Indian Ocean and south towards Roebuck Bay. Groundwater levels in the area are at approximately 2-3 m AHD and vary seasonally with highest levels in April and lowest in November/December (APM 2020).

## 3. Biological Environment

### 3.1 Flora

A number of flora and vegetation surveys have previously been undertaken within the Port of Broome which encompass the Proposal Area: AMP undertook a flora and vegetation assessment at the Port of Broome in March 2020 (AMP 2020; Appendix A); ELA undertook a Detailed and Targeted flora survey in December 2018 to support the potential clearing of the Kabbarli Road foreshore (ELA 2019; Appendix B); and Woodman Environmental Consulting (Woodman) conducted a Level 2 flora and vegetation survey in 2007 and 2008 (Woodman 2008; Appendix C). A total of 17 taxa from 15 genera and seven families were recorded from within the ELA study area which encompassed an approximate 2 ha area, including the current Proposal Area. Fabaceae had the highest number of species (seven species) with Acacia and Crotalaria being the best represented genera.

The AMP (2020) and Woodman (2008) surveys recorded a higher number of taxa; however, both surveys included much larger study areas (i.e. 7.4 ha and 128 ha respectively). AMP found a total of 56 discrete vascular plant taxa, with the most represented families being Fabaceae (13 taxa), Poaceae (9 taxa,

including 3 introduced taxa) and Malvaceae (5 taxa) (AMP 2020), whereas Woodman (2008) recorded 167 taxa across the entire peninsular.

### 3.1.1 Threatened and Priority Flora

No Federal or State listed Threatened or Priority flora species have been recorded in the Proposal Area during any of the previous studies. Both ELA (2018) and APM (2020) identified 13 conservation listed flora species from the desktop assessment as possibly occurring in the wider survey area; however, based on lack of suitable habitat as well as adequate survey effort, all 13 conservation significant species were considered unlikely to occur within the Proposal Area itself.

### 3.1.2 Invasive Flora

Five introduced species, *\*Aerva javanica*, *\*Cenchrus biflorus*, *\*Cenchrus ciliaris*, *\*Cenchrus setiger* and *\*Passiflora foetida* have previously been recorded within the Proposal Area in a range of densities (APM 2020, ELA 2019). None of these species are listed as Declared Plants under the *Biosecurity and Agricultural Management Act 2007*.

## 3.2 Vegetation

### 3.2.1 Regional vegetation

Vegetation type and extent in WA has been mapped at a regional scale by Beard (1979), who categorised vegetation into broad vegetation associations. Based on this mapping at a scale of 1:1,000,000, the Department of Agriculture and Food, Western Australia (DAFWA) has compiled a list of vegetation extent and types across WA (Shepherd *et al.* 2002). The Proposal has not been mapped within a broad vegetation association due to the scale of the mapping, however, it is reasonable to assume that the Proposal Area intersects one vegetation system association:

*Dampierland 750: Shrublands, pindan; Acacia tumida shrubland with grey box & cabbage gum medium woodland over ribbon grass & curly spinifex*

The pre-European and current extent of native vegetation associations in WA has been interpreted by Shepherd *et al.* (2002) using data from Beard's (1979) regional vegetation mapping, along with other vegetation mapping and satellite imagery and orthophoto interpretation. A summary of the pre-European and current extent of native vegetation associations within the reserve is provided in Table 1.

**Table 1: Vegetation Association and Complex mapping units occurring within the reserve (Government of Western Australia 2019)**

Vegetation Association (Beard 1979)	Pre-European extent (ha) (Government of WA 2019)	Current extent (ha) (% remaining) (Government of WA 2019)	Extent within the site (ha) (% of current extent)
Dampierland System - 750	1,223,884.58	1,218,427.52 (99.55%)	0.17 (0.000014%)

### 3.2.2 Vegetation assessment

One vegetation community has been mapped within the Proposal Area by both APM (2020) and ELA (2019; Table 2). The vegetation community identified by APM (2020) is considered representative of

the vegetation previously identified by ELA (2019) due to the dominant species identified in both. In addition, APM (2020) also mapped areas devoid of native vegetation; Sand and Rock outcrops (Table 2).

**Table 2: Vegetation associations within the Proposal area**

Vegetation Association (ELA 2019)	Vegetation association (APM 2020)	Extent (ha)	Portion of proposed clearing (%)
Vegetation Community 3 - <i>Acacia bivenosa</i> , <i>Acacia ampliceps</i> , <i>Crotalaria cunninghamii</i> tall sparse shrubland over <i>Ipomoea pes-caprae</i> , <i>Tinospora smilacina</i> , <i>Euphorbia myrtilloides</i> low isolated shrubs and <i>*Cenchrus ciliaris</i> , <i>Spinifex longifolius</i> low sparse tussock grassland.	Vegetation association 1 (VA1) – <i>Acacia bivenosa</i> and <i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i> shrubland over <i>Spinifex longifolius</i> and <i>Panicum decompositum</i> grassland.	0.11	62.71
Not mapped	Sand and Rock outcrops – no vegetation	0.05	27.11
Cleared/ disturbed	Cleared/ disturbed	0.01	10.17
<b>Total</b>		<b>0.17</b>	<b>100</b>

The vegetation community defined by APM and ELA is considered representative of Woodman's Floristic Community Types (FCT) 1 (Woodman 2008):

FCT 1 – Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes.

### 3.2.3 Vegetation condition

Vegetation condition within the Proposal Area was classified by both ELA (2019) and APM (2020) as being mostly in Very Good to Good condition based on the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016; Table 3). Evidence of disturbance included impacts from heat stress, weeds (in particular, the grass weed *\*Cenchrus ciliaris*), tracks and erosion. Areas classified as Completely Degraded were mainly associated with Kabbarli Road, and areas with no vegetation were associated with Sand and Rocky outcrops (Table 2 and Table 3).

**Table 3: Vegetation condition of the Proposal Area (APM 2020)**

Vegetation condition (APM 2020)	Extent (ha)	Portion of proposed clearing (%)
Pristine	-	-
Excellent	-	-
Very Good	0.09	52.9
Good	0.02	11.8
Degraded	-	-
Completely Degraded	-	-



Vegetation condition (APM 2020)	Extent (ha)	Portion of proposed clearing (%)
Cleared/ developed	0.02	11.8
No vegetation/ rocky outcrop	0.04	23.5

### 3.2.4 Threatened and Priority Ecological Communities

No Threatened Ecological Communities (TEC) or Priority Ecological Communities (PEC) have been identified within the Proposal Area (APM 2020; ELA 2017; Woodman 2008).

APM recorded the *Monsoon Vine thickets of the coastal sand dunes of the Dampier Peninsula* TEC, listed as Endangered under the EPBC Act), approximately 126 m to the north-west of the Proposal Area and a pocket of the *Corymbia paractia* woodland (listed as Priority 1) PEC, approximately 323 m to the south-west of the Proposal Area; however, the vegetation community within the Proposal Area does not represent either the TEC or the PEC.

## 3.3 Terrestrial Fauna

A survey of the wider Broome Port Area, determined vertebrate fauna assemblages within the Port are typical of the region (Bamford 2010).

A total of one amphibian, 10 reptile, 34 bird and five mammal species were recorded during the survey, many of which have widespread distributions through the region, and/or are migratory species. APM undertook a desktop assessment to determine likelihood of conservation species within their survey area (APM 2020).

### 3.3.1 Fauna habitats

Bamford identified one fauna habitat within the Proposal Area: 'Coastal Shrubland on Primary Dunes' (Bamford 2010), whereas APM identified two fauna habitats: 'Dunes' and 'Sand and rocky outcrops' (APM 2020).

The Proposal Area is a small site with native vegetation in Very Good to Good condition; however, the site is heavily disturbed with the presence of *\*Cenchrus ciliaris* and is highly fragmented, being surrounded by cleared areas and industrial land use. The Proposal Area is therefore considered to be of low value as habitat for conservation significant fauna (APM 2020, ELA 2019).

### 3.3.2 Threatened and Priority Fauna

Bamford (2010) originally identified 10 conservation significant fauna species that could potentially occur within their subject site, including within the Proposal Area, however, recent changes in conservation status has brought this down to nine including:

- Bilby (*Macrotis lagotis*) - listed as Vulnerable under both the EPBC Act and BC Act;
- Grey Falcon (*Falco hypoleucos*) – listed as Vulnerable under the BC Act;
- Dampierland Burrowing Snake (*Simoselaps minimus*) – listed as Priority (P) 2 by Department of Biodiversity, Conservation and Attractions (DBCA);
- Dampierland Plain Slider (*Lerista separanda*) – listed as P2 by DBCA;

- Peregrine Falcon (*Falco peregrinus*) – listed as Other specially protected fauna under Schedule 7 of the BC Act;
- Barn Swallow (*Hirundo rustica*) – listed as a Migratory (Mi) species protected by International Agreement IA) under both the EPBC and BC Act (Schedule [S5]);
- Fork-tailed Swift (*Apus pacificus*) – listed as Mi under both EPBC Act and BC Act (S5));
- Oriental Cuckoo (*Cuculus saturates*) – listed as MI under both the EPBC and BC Act (S5); ; and
- White throated Needletail (*Hirundapus caudacutusi*) – listed as Mi under both the EPBC and BC Act (S5).

In addition to the above species, APM considered an additional four species as likely to occur in and around the Proposal Area including:

- Osprey (*Pandion cristatus*) – listed as Mi under both the EPBC Act and BC Act (S5);
- Red-rumped Swallow (*Cecropis daurica*) – listed as Mi under the BC Act (S5);
- Grey Wagtail (*Motacilla cinerea*) – listed as Mi under both the EPBC Act and BC Act (S5); ; and
- Yellow Wagtail (*Motacilla flava*) - listed as Mi under both the EPBC Act and BC Act (S5).

Given that the Proposal Area is very small in size and is highly fragmented by Kabbarli Road and the surrounding Port facilities, the vegetation within the Proposal Area is not expected to provide core habitat for any of the above-mentioned species. There are portions of vegetation that are of higher significant value to fauna species to the west of the Proposal Area.

## 4. Assessment against the Ten Clearing Principles

An assessment of the proposed vegetation clearing against the ten native vegetation Clearing Principles contained in Schedule 5 of the EP Act is provided in Sections 3.1 to 3.10. Table 4 contains a summary of the assessment.

The proposed clearing is not considered to be at variance with any of the Principles.

**Table 4: Summary of assessment against the ten clearing principals**

Clearing Principle	Is not at variance	May be at variance
a) Native vegetation should not be cleared if it comprises a high level of biological diversity	<input checked="" type="checkbox"/>	<input type="checkbox"/>
b) Native vegetation should not be cleared if it comprises the whole, or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia	<input checked="" type="checkbox"/>	<input type="checkbox"/>
c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of Rare flora	<input checked="" type="checkbox"/>	<input type="checkbox"/>
d) Native vegetation should not be cleared if it comprises the whole, or part of, or is necessary for the maintenance of a threatened ecological community (TEC)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
e) Native vegetation should not be cleared if it is significant as remnant vegetation in an area that has been extensively cleared	<input checked="" type="checkbox"/>	<input type="checkbox"/>
f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland	<input checked="" type="checkbox"/>	<input type="checkbox"/>
g) Native vegetation should not be cleared if the clearing of vegetation is likely to cause appreciable land degradation	<input checked="" type="checkbox"/>	<input type="checkbox"/>
h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area	<input checked="" type="checkbox"/>	<input type="checkbox"/>
i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water	<input checked="" type="checkbox"/>	<input type="checkbox"/>
j) Native vegetation should not be cleared if the clearing of vegetation is likely to cause, or exacerbate, the incidence of flooding	<input checked="" type="checkbox"/>	<input type="checkbox"/>

#### 4.1 Comprise high level of biological diversity

*Principle (a): Native vegetation should not be cleared if it comprises a high level of biological diversity.*

APM (2020) recorded a total of 56 taxa over a 7.4 ha area; ELA recorded 17 taxa over a 2 ha area and Woodman (2008) recorded a total of 167 taxa over the entire Peninsula. The number of taxa found during these surveys demonstrates that the surrounding area does not comprise a high level of biological diversity. No conservation listed flora species were recorded from within the vicinity or directly in the Proposal Area and State or Federally listed TECs or PECs have been recorded within the 1.7 ha Proposal Area. Given the small nature of the Proposal Area and high level of disturbance, the native vegetation within the Proposal area does not comprise a high level of species diversity.

As the proposed clearing does not comprise a high level of biological diversity, the proposed clearing is not considered to be at variance with this Principle.

#### 4.2 Potential impact to any significant habitat for fauna indigenous to Western Australia

*Principle (b): Native vegetation should not be cleared if it comprises the whole, or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.*

No conservation significant fauna have been recorded within the Proposal Area, either during previous surveys or from database searches.

A total of 13 conservation significant fauna species have been identified as possibly occurring within the Proposal Area given the proximity of nearby records and/or availability of suitable habitat; however, given the small nature of the Proposal Area, the high level of disturbance and fragmentation and the availability of suitable, higher value habitat to the south west of the Proposal Area, the native vegetation located within the Proposal Area is unlikely to provide core habitat for any of the 13 possibly occurring species.

The proximity of intact vegetation to the west, provides an ecological corridor allowing fauna movement from the southern tip of the peninsula to a larger area of native vegetation located on the western edge of the Broome Peninsula.

As the native vegetation in the Proposal Area is not considered significant habitat for fauna indigenous to Western Australia, the proposed clearing is not considered to be at variance with this Principle.

#### 4.3 Potential impact to any rare flora

*Principle (c): Native vegetation should not be cleared if it includes, or is necessary for the continued existence of Rare flora.*

No Threatened or Priority flora species have been recorded in the Proposal Area, despite three surveys having previously been undertaken.

A desktop assessment conducted by ELA (2019) identified 13 conservation listed flora taxa as possibly occurring within the Proposal Area, however all were considered as unlikely to occur, based on adequate survey effort and/or lack of suitable habitat.

The proposed clearing is not considered to be at variance with this Principle.

#### 4.4 Potential to any threatened ecological communities

*Principle (d): Native vegetation should not be cleared if it comprises the whole, or part of, or is necessary for the maintenance of a threatened ecological community (TEC).*

No State or Federally listed TECs or PECs have been recorded within the Proposal Area. The closest TEC is approximately 126 m to the north-west and the closest PEC is approximately 323m to the south-west of the Proposal Area.

The proposed clearing is not considered to be at variance with this Principle.

#### 4.5 Significance as a remnant of native vegetation in the area that has been extensively cleared

*Principle (e): Native vegetation should not be cleared if it is significant as remnant vegetation in an area that has been extensively cleared.*

The Proposal Area is outside the current mapping extent of the broad-scale mapping; however, it is considered to represent vegetation system association 750.1 (Pindan shrublands: *Acacia tumida* shrubland with Grey Box and Cabbage Gum medium woodland over Ribbon Grass and Curly Spinifex). Of this vegetation system, 99.6% is remaining from the pre-European extent within the IBRA sub-region of Pindanland, within the Damperierland system (Government of Western Australia 2019).

The State Government is committed to the National Objectives and Targets for Biodiversity Conservation (Commonwealth of Australia 2001) that includes a target of avoiding additional clearance of ecological communities with an extent below 30% of that present prior to European settlement. The proposed clearing, within the Proposal Area will reduce the extent of the Pindan Shrublands association by 0.000014%, therefore not reducing the extent of remnant vegetation to below 30%.

The proposed clearing is not considered to be at variance with this Principle.

#### 4.6 Impacts on any watercourses and/or wetlands

*Principle (f): Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.*

The native vegetation located within the Proposal Area is not growing in, or in association with, an environment associated with a watercourse or wetland. The Proposal Area is located on Pindan soils which are free draining, silty sands of fine to very fine grain (Laws 1991). The rainfall leaves the Proposal Area via soil infiltration and percolation into the groundwater and evaporation after a rainfall event.

There are no watercourses or wetlands within or nearby the Proposal Area. Roebuck Bay Ramsar wetland is the nearest nationally important wetland and is located approximately 7 km northeast of the Proposal Area and will not be directly or indirectly impacted by the clearing within the Proposal Area.

The vegetation is representative of coastal vegetation, however, the proposed clearing within the Proposal Area, will not have an impact on the ocean and beach landscape. The vegetation is raised above the water line.

The proposed clearing is not considered to be at variance with this principle.

#### 4.7 Potential to cause appreciable land degradation

*Principle (g): Native vegetation should not be cleared if the clearing of vegetation is likely to cause appreciable land degradation.*

The Proposal Area occurs within an area that can receive heavy rainfall and cyclonic activities and as a result can cause excessive erosion and degradation of the land. To reduce the likelihood of erosion and land degradation, the clearing of native vegetation shall coincide with the dry season (May-October).

The potential impacts of clearing and construction, such as land degradation from erosion and sedimentation, will be managed by undertaking the standard avoidance and mitigation measures as outlined in the Environmental Management Plan (KPA 2020) and applicable to all activities undertaken by KPA.

The proposed clearing is not anticipated to cause appreciable land degradation and is not considered to be at variance to this Principle.

#### 4.8 Potential to impact on the environmental values of adjacent or nearby conservation areas

*Principle (h): Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.*

There are no conservation reserves within the Proposal Area; therefore, the proposed clearing is not considered to be at variance with this Principle.

#### 4.9 Potential deterioration in the quality of surface or underground water

*Principle (i): Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.*

The Proposal Area is not located in a proclaimed surface water management area (Department of Water 2009), nor is there any watercourses or wetlands located within the Proposal Area. The Proposal Area is located on Pindan soils which are free draining, silty sands of fine to very fine grain (Laws 1991). The rainfall leaves the Proposal Area via soil infiltration and percolation into the groundwater and evaporation after a rainfall event.

The Proposal Area is located within a proclaimed Groundwater area, however no deterioration in the quality of surface or groundwater is expected given the small area of clearing required. Any potential environmental impacts will be managed in accordance with KPA's Environmental Management Plan (KPA 2019).

The proposed clearing is not at variance with this Principle.

#### 4.10 Potential of clearing to cause, or exacerbate, the incidence of flooding

*Principle (j): Native vegetation should not be cleared if the clearing of vegetation is likely to cause, or exacerbate, the incidence of flooding.*

The clearing of native vegetation is not expected to cause or exacerbate the incidence of flooding within the Port area. The Proposal Area is located on Pindan soils which are free draining, silty sands of fine to very fine grain (Laws 1991). Rainfall leaves the Proposal Area via soil infiltration and percolation into the groundwater and evaporation after a rainfall event. The clearing of native vegetation and management of the Proposal Area will be undertaken in accordance with KPA's Environmental Management Plan (KPA 2019).

The proposed clearing is not anticipated to cause or exacerbate flooding and is not considered to be at variance to this Principle.

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## Appendix A Animal Plant Mineral (2020) – *Kimberley Marine Offloading Facility Terrestrial Biological Survey*

April  
2020

# Kimberley Marine Offloading Facility Terrestrial Biological Survey

## Broome, WA

Prepared for O2 Marine on behalf of Kimberley Marine  
Offloading Facility Pty Ltd by:



**Animal Plant Mineral Pty Ltd**

Port Of Broome

Completed by: Animal Plant Mineral Pty Ltd



For further information on this report please contact:



## EXECUTIVE SUMMARY

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Kimberley Marine Offloading Facility Pty Ltd is proposing to develop the Kimberley Marine Offloading Facility (KMOF) at the Port of Broome. Animal Plant Mineral was engaged by O2 Marine (O2M) to provide a Biological Survey of the Study Area. A Detailed Survey for flora and vegetation and an assessment of the habitat suitability for conservation significant fauna was made within the Study Area. A reconnaissance survey in the surrounding area was used to identify the presence of conservation significant values.

A number of locations in and surrounding the Study Area have been described here as the Threatened Ecological Community (TEC) 'Monsoon vine thickets on the coastal sand dunes of the Dampier Peninsula', despite previously not attracting this description from other flora surveys. The TEC in this area is of the type Group B as described by Black et al (2010) and accepted in the Interim Recovery Plan (DBCA 2018a) as the TEC. The Monsoon Vine Thicket in the Study Area was found to be in Very Good to Good condition. The main disturbance type was the presence of weed species. Where moderate threat weeds are present the vegetation condition is Very Good. Where high threat weeds are present the vegetation condition is Good.

A 430 m<sup>2</sup> area of Monsoon Vine Thicket in Poor condition occurs within the Disturbance Envelope. This small area occurs at the tail end of the vegetation type extent and consists of a few isolated shrubs that are common to the Vine Thicket vegetation type. The vegetation in this location is transitioning towards VA1 sand dune vegetation. The area is bordered by disturbed areas on the north and south and has a high density of the weed species *Cenchrus biflorus*. The landform appears to be previously disturbed or part of a built landform and the vegetation is likely spontaneous regeneration.

No conservation significant flora was recorded in the Disturbance Envelope. One species of conservation significant flora was recorded on the boundary of the Study Area. The Priority 3 *Acacia monticola* x *Tumida* var *kulparn* individuals are outside of the Development Envelope and are unlikely to be impacted by the proposed project.

No weeds declared under the Biosecurity and Agricultural Management Act were recorded.

Database searches identified 82 conservation significant (CS) terrestrial fauna species (excluding shorebirds) with records in the area, including 3 records within the Study Area all for *Sula leucogaster* (Brown Booby) listed under International Agreements (IA) under State and Federal legislation and as a Marine (M) bird under Federal legislation.

The Study Area contains suitable foraging habitat for 7 CS bird species with a High likelihood of occurrence and suitable foraging habitat for 4 CS bird species with a Moderate likelihood of occurrence. No suitable habitat occurs for nesting or breeding for conservation significant birds within the Study Area. The small amount of habitat area to be cleared is very small and in poor condition in comparison to the adjoining vegetation which is larger and of higher quality. All potential bird users are highly mobile and will move away from any disturbance.

No Database records of conservation significant reptiles or mammals occur within the Study Area. The Dampierland Burrowing Snake (P2) and Dampierland Plains Slider (P2) are known to occur in the region and potentially suitable habitat exists in the dunes of the Study Area. Prior to vegetation clearing the dune vegetation should be checked for the presence of these species.

Of the conservation significant mammals known from the area, suitable habitat is present in the Study Area only for the Bilby. Given the small area and degraded condition of the Dunes vegetation within the Development Envelope, it is very unlikely to provide suitable habitat for the Bilby.

## CONTENTS

<b>PROJECT TERMS</b>	<b>vi</b>
<b>UNITS OF MEASURE</b>	<b>vi</b>
<b>LIST OF ABBREVIATIONS</b>	<b>vi</b>
<b>1 Introduction</b>	<b>7</b>
1.1 Project and Location	7
1.2 Scope of Work	9
<b>2 Existing Environment</b>	<b>11</b>
2.1 Bioregion	11
2.2 Climate	11
2.3 Geology	12
2.4 Land Systems	12
2.5 Surface Water and Ground Water	12
2.6 Wetlands	12
2.7 Environmentally Sensitive Areas	13
<b>3 Methodology</b>	<b>14</b>
3.1 Contributing Authors	14
3.2 Constraints	14
3.3 Database Searches	15
3.4 Prior Surveys	15
3.5 Field Survey	15
3.5.1 Flora and Vegetation Survey Methodology	15
3.5.2 Flora and Vegetation Data Analysis	17
3.5.3 Terrestrial Vertebrate Fauna Habitat Survey Methodology	17
<b>4 Flora and Vegetation Results</b>	<b>18</b>
4.1 Desktop Survey	18
4.1.1 General Site Description	18
4.1.2 Previous Vegetation Surveys	18
4.1.3 Conservation Significant Vegetation	23
4.1.4 Conservation Significant Flora	24
4.1.5 Introduced Flora	28
4.2 Field Survey	29
4.2.1 Summary of the Quadrat data	29
4.2.2 Conservation Significant Flora	29

4.2.3	Introduced Flora .....	29
4.2.4	Vegetation Associations.....	29
<b>5</b>	<b>Terrestrial Vertebrate Fauna Results .....</b>	<b>41</b>
5.1	Desktop Survey .....	41
5.1.1	Conservation Significant Fauna.....	41
5.1.2	Fauna Habitats .....	58
<b>6</b>	<b>Conclusions .....</b>	<b>60</b>
6.1	Vegetation of Conservation Significance .....	60
6.2	Flora of Conservation Significance.....	61
6.3	Fauna Habitats of Conservation Significance.....	61
<b>7</b>	<b>References.....</b>	<b>63</b>
	<b>Appendices .....</b>	<b>67</b>

## APPENDICES

Appendix A: DBCA Categories.....	68
Appendix B: PMST Search Results .....	71
Appendix C: Survey Site Details .....	72
Appendix D: Species by Site Matrix .....	73
Appendix E: Flora Species Accumulation Curve.....	75

## FIGURES

Figure 1-1: Project Location.....	8
Figure 1-2: Kimberley Marine Offloading Facility Study Area.....	10
Figure 4-1: Vegetation mapping of the Port of Broome area by Woodman (2008).....	22
Figure 4-2: Threatened flora database records .....	25
Figure 4-3: Quadrat locations and vegetation mapping .....	30
Figure 4-4: Locations of conservation significant flora and weeds .....	31
Figure 4-5:Vegetation Condition .....	38
Figure 5-1: Database bird records excluding Shorebirds.....	42
Figure 5-2: Database reptile and terrestrial mammal records .....	43
Figure 5-3: Fauna Habitat .....	59

**TABLES**

---

Table 3-1: Constraints.....	14
Table 3-2: Vegetation Condition Rating Scale .....	16
Table 3-3: Threat level of weed species .....	17
Table 4-1: Vegetation types of the Dampier Peninsula as described by Kenneally et al. (1996). ....	18
Table 4-2: Vegetation of the Port Management Area as described by Trudgen (1988).....	20
Table 4-3: Vegetation types of the Broome Peninsula as described by Woodman (2008). ....	21
Table 4-4: Conservation significant flora identified from database searches. Likelihood of occurrence assessed for the habitats present in the Study Area. ....	26
Table 4-5: Extent of vegetation types in the Study Area .....	37
Table 5-1. Conservation significant fauna species identified in Database Searches .....	44
Table 5-2: Fauna Habitat extents in the Study Area .....	58



## PROJECT TERMS

Abbreviation	Meaning
The Project	Kimberley Marine Offloading Facility (KMOF) Project

## UNITS OF MEASURE

Unit	Measure
%	Percentage
°C	Degrees Celsius
ha	Hectare
km	Kilometre
m	Metre
m <sup>2</sup>	Square meters

## LIST OF ABBREVIATIONS

Abbreviation	Meaning
AHD	Australian Height Datum
APM	Animal Plant Mineral Pty Ltd
BAM Act	<i>Biosecurity and Agricultural Management Act 2007</i>
BC Act	<i>Biodiversity Conservation Act 2016</i> (Western Australia)
BoM	Bureau of Meteorology
DBCA	Department of Biological Conservation and Attractions
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth)
ESA	Environmentally Sensitive Area
IBRA	Interim Biogeographic Regionalisation for Australia
KMOF	Kimberley Marine Offloading Facility
PEC	Priority Ecological Community
P	Priority Flora, Fauna or Ecosystems
RAMSAR	The Ramsar Convention on Wetlands of International Importance
TEC	Threatened Ecological Community
T	Threatened Flora, Fauna or Ecosystems
WA	Western Australia
WONS	Weeds of National Significance
Woodman	Woodman Environmental Consulting Pty Ltd

## 1 INTRODUCTION

### 1.1 PROJECT AND LOCATION

Kimberley Marine Offloading Facility Pty Ltd is proposing to develop the Kimberley Marine Offloading Facility (KMOF) at the Port of Broome, approximately 200 m south of the existing Broome Wharf (Figure 1-1). The proposed development will consist of a floating deep-water wharf and associated hardstand facilities suitable for the loading and discharge of containers and general cargo into coastal vessels as well as berthing and mooring of Cruise Vessels and Roll-on/Roll-off ships. The KMOF will also provide general logistics and refuelling services to berthed vessels. The land is a small area of remnant dune system and sandy beach surrounded by disturbed areas used for Port related infrastructure.



Figure 1-1: Project Location.

## 1.2 SCOPE OF WORK

Animal Plant Mineral was engaged by O2 Marine (O2M) to provide a Biological Survey of the Terrestrial section of the 7.4 ha Study Area (Figure 1-2). The aim of this survey was to complete a Detailed flora and vegetation survey and an assessment of the suitability of habitat for fauna of conservation significance. Specifically, the objectives of the survey of the KMOF Study Area included:

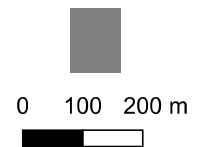
- Undertake a desktop assessment to evaluate the known botanical values of the KMOF Study Area and surrounds to identify any matters of conservation significance.
- Review previous literature and data.
- Assess the potential for conservation significant species and communities to be present at the Study Area.
- Collect botanical data collection in quadrats that are representative of all potential vegetation communities within the Study Area of sufficient detail to permit appropriate analyses.
- Collect and identify the vascular plant species present in vegetation survey quadrats, as well as opportunistically within the KMOF Study Area to provide an inventory of flora species for the site.
- Within the KMOF Study Area, identify and record the locations of any Declared Organisms under the Biosecurity and Agricultural Management Act (BAM Act).
- Define and prepare a vegetation map of the vegetation communities within the KMOF Study Area.
- Assess the condition of the vegetation communities within the Study Area.
- Assess the fauna habitat suitability and the likelihood of occurrence of conservation significant fauna.
- Perform a reconnaissance survey in the area surrounding the KMOF Study Area to identify any Threatened flora or Threatened or Priority Ecological Communities; and
- Prepare a report detailing the findings.



Figure 1-2: Kimberley Marine Offloading Facility Study Area

Legend

- KMOF Study Area
- KMOF Development Envelope
- Reconnaissance Survey routes



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Date: 15/05/2020  
Coordinate Reference System: GDA94 / MGA Zone 51

## 2 EXISTING ENVIRONMENT

### 2.1 BIOREGION

The Interim Biogeographic Regionalisation for Australia (IBRA) provides the planning framework for the systematic development of a comprehensive, adequate and representative national reserve system. There are 89 recognised IBRA regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna.

The Study Area lies within the Pindanland subregion of the Dampierland Bioregion. Dampierland, described by Cotching (2006) is in the Kimberley region and has a semi-arid monsoonal climate where rainfall occurs predominantly between December and April. The area includes the Canning Basin with dunefields and intermittent swales. The surface of the Canning Basin is gently undulating Aeolian sand plains that slope gently towards the coast. Isolated mesas and hills feature in the landscape as do dunefields of long linear sand dunes.

Dampierland is divided into two subregions, the Fitzroy Trough and Pindanland. The Pindanland subregion, described by Graham (2001), is the coastal semi-arid north-western margin of the Canning Basin comprised of Quaternary sandplains mantling Jurassic and Mesozoic sandstones. The major landforms of the subregion include sandplains with hummock grasslands, marine deposits on coastal plains with mangroves and Samphire and alluvial plains of tree savannahs and ribbon grass with riparian forests fringing the drainage channels.

The dominant land use is grazing and crown Reserve. Rare features include patches of rainforest found behind the coastal primary dune system, extensive mudflats of Roebuck Bay and Eighty Mile Beach, migratory birds of Roebuck Bay and Eighty Mile Beach, rare flora, vast grasslands of Roebuck Plains, coastal swamps adjacent to Eighty Mile Beach and claypans supporting uncommon aquatic plants.

### 2.2 CLIMATE

Broome experiences a dry hot sub-tropical climate dominated by two seasons the wet (warm) season and the dry (cool) season (Wright, 2013). The wet season extends from November to April and the dry season from May to October. Rainfall during the wet season is highly variable, primarily due to passage of tropical cyclones and thunderstorms that typically occur between November and April (BOM, 2020). The Broome Airport Weather Station (Bureau of Meteorology Station Number 3003) opened in 1939 and has recorded average annual rainfall of 623 mm. Rainfall in the January to March period for 2020 was 433 mm, near to the long-term average of 470 mm.

Hotter temperatures (Average daily minimum and maximum: ~25 and 34°C) and high humidity are also experienced during the wet season compared to the low rainfall (~1–26 mm) and moderate temperatures (Average daily minimum and maximum: ~13°C and 34°C) during the dry season from (April to October) (BoM, 2020).

Analysis of annual winds show that north-east winds predominate in the morning and north-westerlies in the late afternoon (BoM, 2019). Winds vary seasonally with winds generally from the west (ranging from south west to north west) during the wet season and during the dry season south easterly winds prevail with these south easterly winds being strongest towards the end of the dry season. Most cyclones in the region pass to the north and west of Broome.



## 2.3 GEOLOGY

The Broome area is characterised by a low-lying, gently undulating plain of red Pindan dunes rising to between 3 and 8 m AHD (Cardno, 2014). The Pindan dunes were formed during the Quaternary and are composed of iron rich fine-grained sand to silt sediments. On the Broome Peninsular the Pindan soils overlay the cretaceous Broome Sandstone (Wright, 2013).

The Broome Sandstone forms the bedrock over a large part of the Dampier Peninsula and is formed from terrestrial sediments which were deposited in a deltaic environment (Salisbury & Romilio, 2018). Surficial exposure of the Broome Sandstone is generally limited to the nearshore environment, but the Sandstone deposit extends down to a depth ~300 m. Outcrops of the Broome Sandstone at the project site occur offshore where they form a series of complex reefs and onshore where it forms headlands and bluff features (which are overlain with vegetated dunes of Pindan).

## 2.4 LAND SYSTEMS

The Land Systems of the Kimberley Region were mapped by the Department of Agriculture and Food Western Australia, in Technical Bulletin No 98 (DAF, 2012). The Study Area is designated as 'Carpentaria 1 Low Capacity System' described as Bare coastal mudflats, minor sandy margins and seaward margins, little vegetation except for mangrove fringing thickets; Coastal plains, beaches, dunes, mudflats and cliffs; Various coastal vegetation. The land is considered unsuitable for grazing.

## 2.5 SURFACE WATER AND GROUND WATER

Surface water runoff in the Broome area is only generated after periods of heavy rainfall (typically associated with cyclone events) and is quickly discharged from the area, often as sheet wash (Laws, 1991; Kelly, 2015). These freshwater runoff events are known to strongly influence marine, surface and groundwater turbidity and nutrient concentrations (Bennelongia et al., 2009).

There are no wetlands or watercourses at the Study Area and surface water flows are limited to natural stormwater runoff through the sand dunes onto the beach.

The Pindan sands supports a fresh superficial aquifer which is underlain by the Broome Sandstone aquifer (Kelly, 2015). The Broome Sandstone aquifer is a shallow, fresh to brackish, unconfined aquifer system which is recharged by direct infiltration from rainfall and influenced by tides (Bennelongia et al., 2009; Ecological Australia, 2016; Wright, 2013). Both aquifers discharge to the coast, with some Broome Sandstone aquifer discharged below the low tide mark within Roebuck deeps (Wright, 2013). Groundwater levels in the area are at approximately +2 to 3 m AHD and vary seasonally with highest levels in April and lowest in November/December (Kelly, 2015).

Seaward flows of surface and ground water are considered to strongly influence the ecological character of Roebuck Bay through changes in salinity (that affect the distribution of species such as mangroves) and the transport of dissolved and particulate nutrients and carbon (Bennelongia et al., 2009; Ecological Australia, 2018).

## 2.6 WETLANDS

The Study Area is located approximately 10 km west of the Roebuck Bay RAMSAR Wetland. The Roebuck Bay RAMSAR Wetland is a tropical marine embayment with extensive, biologically diverse intertidal mudflats.

The Wetland is recognised as a site of international importance for at least 20 species of migratory shorebirds with total numbers of waders using the site each year estimated at over 300,000. This makes the Roebuck Bay RAMSAR Wetland one of the most important sites for shorebird conservation in the World.

## 2.7 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally sensitive areas (ESAs) are declared by the Minister for Environment under section 51B of the Environmental Protection Act.

Within the Study Area three environmentally sensitive areas are identified near the Port of Broome. One is the reserves that contain the Threatened Ecological Community (TEC) Monsoon Vine Thickets. The second is the Landscape Protection Area which is considered to have high aesthetic value under the Broome town planning scheme No 6. The third is the 50 m buffer areas surrounding locations of the Threatened (T) flora *Seringia extasia*.



### 3 METHODOLOGY

The survey was completed to the standards set out in Technical Guide – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016) and Guidance Statement 56: Technical Guidance – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia June 2004.

#### 3.1 CONTRIBUTING AUTHORS

Environmental Scientist Arlen Hogan-West conducted and collated database searches and drafted the desktop report. Dr. Eleanor Hoy conducted fieldwork and taxonomy, statistical analysis, vegetation mapping and the final report. Dr. Genevieve Hayes assessed the habitat suitability for conservation significant fauna and completed the fauna likelihood of occurrence table. Dr Mitchell Ladyman provided expertise in the design and review phases.

#### 3.2 CONSTRAINTS

There were no constraints in the delivery of the Biological Survey, as detailed in Table 3-1.

**Table 3-1: Constraints**

Factor	Impact of survey outcomes
Access Problems	Not a constraint. The entire Study Area was accessible on foot.
Experience levels	Not a constraint. Sufficient expertise and experience were available. Dr Eleanor Hoy has more than 10 years' industry experience and Dr Mitchell Ladyman has over 20 years industry experience. Dr Genevieve Hayes has 5 years industry experience and Arlen Hogan West has 2 years industry experience.
Scope: Flora	Not a constraint. The entire site was visited on foot at high resolution to identify the presence of conservation significant flora and provide a complete flora inventory.
Scope: Vegetation	Not a constraint. The entire site was visited on foot. Detailed survey was conducted at a suitable number of sites to adequately describe the vegetation and determine the conservation significance.
Scope: Fauna	No fauna inventory was completed for the site. Survey effort focused on assessing the suitability of habitat for conservation significant terrestrial vertebrate fauna.
Timing, weather, season, cycle	Not a constraint. Rainfall prior to survey was close to the long-term average for the January to March period. Field survey was completed on the 21-22 March 2020. EPA (2016) Guidelines suggest appropriate survey timing for flora and vegetation between January and March.
Sources of information	Not a constraint. The regional vegetation was mapped by Keneally et al (1996) and Trudgen (1988) and the Port of Broome was mapped by Woodman (2008). Current information is available for the identification of TEC's (DBCA 2018a) and PEC's in the region (DBCA 2020a).
Completeness: Flora and vegetation	Not a constraint. The average species diversity was 16.5 and 21.5 species in VA1 and VA2 respectively, comparative to 18.17 and 26.33 (respectively) recorded in the same vegetation types by Woodman (2008; FCT1 and FCT3) over a broader geographical area. The species accumulation curves show the observed number of species is equal to the expected number of species.

Factor	Impact of survey outcomes
Completeness: Fauna	No fauna inventory was made for the Study Area. An assessment of the suitability of the habitat for conservation significant fauna was made for which there was no constraint. All habitat types were visited on foot.

### 3.3 DATABASE SEARCHES

The desktop assessment was undertaken using the DBCA (2007-, 2018b, 2020a, 2020b, 2020c, 2020d) and DotE (2020a, 2020b) databases. A 50 km search radius about the approximate centre point of the Study Area was used. These databases were used to identify the known occurrences of threatened and priority flora and fauna, threatened and priority ecological communities and any other matters protected under the Biodiversity Conservation Act (BC Act) and the Environmental Protection and Biodiversity Conservation Act (EPBC Act) within and/or surrounding the Study Area.

Definitions of conservation categories are listed in Appendix A. Protected Matter Search Tool (PMST) Database Search results are included in Appendix B.

### 3.4 PRIOR SURVEYS

Vegetation surveys previously conducted in the area were consulted to obtain an idea of the expected vegetation types and condition in the Study Area. The previous surveys consulted for this report are:

- Trudgen (1988) surveyed the Broome coastline extending northwards from Riddell Point to a location 3.5km north of the Cable Beach resort area,
- McKenzie et al (1991) surveyed the Rainforests of the Kimberley including the vine thickets of the Dampier Peninsula,
- Woodman (2008) surveyed the Port of Broome and the coastal area to Cable Beach ,
- Black et al (2010) completed a comprehensive survey of the vine thickets on coastal sand dunes of the Dampier Peninsula.

### 3.5 FIELD SURVEY

#### 3.5.1 Flora and Vegetation Survey Methodology

##### 3.5.1.1 Study Area Detailed Survey

A Detailed Survey (EPA 2016) was conducted in the Study Area. The survey occurred over the 21<sup>st</sup> and 22<sup>nd</sup> March 2020. The rainfall for the period January to March was near the long-term average and conditions were suitable for survey.

An initial reconnaissance survey across the Study Area identified the presence of different landforms and vegetation types. Eight 50 m x 50 m quadrats were allocated to these to represent the diversity of vegetation at the site. As the site is small, quadrat boundaries went beyond the Study Area boundary where necessary. Two quadrats were covering patches where a 50 m x 50 m quadrat was not suitable, the dimensions were altered but the 2500 m<sup>2</sup> area was maintained.

Information collected in each quadrat included:

- site code
- location, with GPS coordinates, estimate of their accuracy and datum
- size and shape of quadrat
- photograph/s from north-west corner plus other aspects that best show the vegetation type
- landform and soil description
- dominant growth form, height, cover and species for the three traditional strata (upper, mid and ground) compatible with NVIS Level V (Executive Steering Committee for Australian Vegetation Information ESCAVI 2003)
- any other location information that might be useful in vegetation classification including slope, aspect, litter, fire history, vegetation/landform/soil correlations
- assessment of vegetation condition and description of disturbances
- a comprehensive species list, including weeds; and
- quadrat marking method.

Quadrats were scored for vegetation condition using the scale recommended in EPA (2018a) for the Northern and Eremaen provinces. The Condition rating scale is shown in Table 3-2.

**Table 3-2: Vegetation Condition Rating Scale**

Vegetation Condition	Description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs

Threat level of weeds was allocated using the designation of Environs Kimberly (2010) and adopted by DBCA (2018a). Threat level of weeds and their status as a Weed of National Significance (WONS) and/or declared status under the BAM Act is listed in Table 3-3.

**Table 3-3: Threat level of weed species**

High threat species	Moderate threat species
<ul style="list-style-type: none"> <li>• coffee bush (<i>Leucaena leucocephala</i>)</li> <li>• buffel grass (<i>Cenchrus ciliaris</i>) WONS</li> <li>• morning glory (<i>Ipomoea quamoclit</i>)</li> <li>• lantana (<i>Lantana camara</i>) WONS/Declared Weed</li> <li>• white convolvulus creeper (<i>Merremia dissecta</i>)</li> <li>• hairy Merremia (<i>Merremia aegyptia</i>)</li> <li>• bellyache bush (<i>Jatropha gossypifolia</i>) Declared Weed</li> <li>• mint weed (<i>Mesosphaerum suaveolens</i>)</li> <li>• Gallon's curse (<i>Cenchrus biflorus</i>)</li> <li>• neem (<i>Azadirachta indica</i>)</li> <li>• siratro (<i>Macroptilium atropurpureum</i>)</li> <li>• passion vine (<i>Passiflora foetida</i>)</li> </ul>	<ul style="list-style-type: none"> <li>• Darwin pea (<i>Clitoria ternatea</i>)</li> <li>• caltrop (<i>Tribulus terrestris</i>)</li> <li>• snakeweed (<i>Stachytarpheta cayennensis</i>)</li> <li>• pie melon (<i>Citrullus lanatus</i>)</li> <li>• vinca (<i>Vinca major</i>)</li> <li>• rubber tree (<i>Calotropis procera</i>)</li> <li>• kapok (<i>Aerva javanica</i>)</li> <li>• coral vine (<i>Antigonon leptopus</i>)</li> </ul>

Targeted searches were conducted on foot at intervals of approximately 20 m, searching 10 m either side for conservation significant flora, weeds and any flora species not recorded during the Quadrat sampling.

### 3.5.1.2 Surrounding area Reconnaissance Survey

A Reconnaissance Survey (EPA 2016) was conducted in the area surrounding the Study Area using the routes shown in Figure 1-2. Conservation significant features were identified.

### 3.5.2 Flora and Vegetation Data Analysis

As the vegetation in the locality and region has been frequently surveyed before from larger areas, a Structural vegetation classification system was used. This allows the small area mapped in this survey to be compared to broader, more regional survey efforts.

Species Accumulation Curves were calculated using the Primer 7 Statistical Package (Clarke & Gorley 2015), using the Species Accum Plot routines and selecting the S and UGE Indices. The S index plots the number of species observed in each quadrat by permuting the order of the plots 999 times. The UGE Index calculated the expected number of species using the methodology derived by Ugland et al (2003).

### 3.5.3 Terrestrial Vertebrate Fauna Habitat Survey Methodology

The Desktop investigation identified fauna of conservation significance that is known to occur in the local area. The habitat preferences of these species were investigated. The vegetation, landforms and habitats present in the Study Area were noted for their suitability for conservation significant species.

Habitat types present at the Study Area were mapped during a reconnaissance of the Study Area and in consideration of the vegetation, condition and landforms present.

## 4 FLORA AND VEGETATION RESULTS

### 4.1 DESKTOP SURVEY

#### 4.1.1 General Site Description

The Study Area is on the outskirts of the Broome township, currently zoned for industrial and port facilities under the Broome Shire Town Planning Scheme No.4. Both the marine and terrestrial development envelopes are located within the Port of Broome jurisdiction. The Study Area consists of coastal dune with rock outcrops and an intertidal sandy beach area. The marine portion of the Project consists of sand and rock reef.

#### 4.1.2 Previous Vegetation Surveys

Several Flora and Vegetation surveys have been conducted over the Broome Peninsular, including within the Study Area.

Within the Dampier Peninsula, the vegetation derives from a mix of species from the deserts to the south, and monsoonal areas to the north. Kenneally et. al. (1996) distinguished 11 vegetation types on the Dampier Peninsula, the majority of which occur on coastal and marine environments on the edge of the Peninsula, with the Pindan dominating the interior. A description of these plant communities are given in Table 4-1.

**Table 4-1: Vegetation types of the Dampier Peninsula as described by Kenneally et al. (1996).**

Vegetation Type	Description
Pindan	Dominates the red sandplains of the Peninsula. It is composed of a grassed woodland, with a sparse upper layer of mainly eucalyptus over dense thicket of wattles. Fire is the main controlling agent, with the density of particularly the wattles relating directly to the fire cycle. <i>Acacia eriopoda</i> dominates the middle stratum in the southern half of the Peninsula, with <i>Acacia tumida</i> dominating the northern half.
Fitzroy Sandplain	Occurs north-east of Broome towards Derby, the Fitzroy sandplain is associated with the Fitzroy drainage basin, with an obvious change being the introduction of <i>Adansonia gregorii</i> (boabs). The soils are mainly heavy yellow clay loams. Savanna dominated by <i>Eucalyptus tectifera</i> and <i>Lysiphyllum cunninghamii</i> replaces pindan vegetation and is generally heavily grazed.
Rocky Outcrops	Rare on the Peninsula, and include coastal limestones and sandstones, some of which are heavily ferruginised. Broome Sandstone is exposed on the coast as mudstone and red eroding claystone, and can support thickets of <i>Acacia tumida</i> , with <i>Gyrocarpus americanus</i> and <i>Ficus opposita</i> being common. Melligo Sandstone supports various types of vegetation depending upon location. The Emeriau Sandstone outcrops are heavily ferruginised, with few locations, best seen at the Carnot-Kings Peak area. Vine thickets are found in these areas.
Creeks, wetlands and seepage areas	Low-lying sandplains associated with sub-coastal drainage valleys and seasonally swampy areas occur on the northern peninsula, including near Martins Well, just north of Pender Bay, south of Rumble Bay, areas inland of Beagle Bay and Pender Bay.  Riverine communities also occur in the Coulomb Point Nature Reserve, supporting low closed forests of <i>Melaleuca acacioides</i> . Freshwater swamps occur in areas where coastal dunes truncate drainage lines, supporting low woodlands of <i>Lophostemon grandiflorus</i>

Vegetation Type	Description
	subsp. <i>grandiflorus</i> , fringed by <i>Melaleuca nervosa</i> and <i>M. acacioides</i> . Small seasonal claypans and swamps occurring further inland also occur, supporting a fringing low woodland of <i>Lophostemon grandiflora</i> and/or <i>Melaleuca acacioides</i> with <i>M. viridiflora</i> or <i>M. nervosa</i> . <i>Melaleuca cajuputi</i> and <i>M. viridiflora</i> groves are supported near areas of permanent fresh water; these areas also contain <i>Nymphoides beaglenensis</i> , which is endemic to the Peninsula. Mound springs, including the Bunda- Bunda mound spring also locally occur, as well as Nimalaica Claypan, inland from Willie Creek. The Fitzroy River is one of the largest permanent rivers in the Kimberley, supporting dense riverine vegetation found nowhere else on the Peninsula.
Vine Thickets	Vine thickets are found in discontinuous and discrete pockets of relatively dense vegetation directly behind coastal dune systems. They are allied to rainforest and contain a predominance of Indo-Malesian plant species. Further north from the Peninsula vine thickets are not associated with coastal dunes, but with rocky sites. Vine Thickets are best developed northwards along the Peninsula and are an important habitat for species such as the great bower bird, rose-crowned fruit pigeon and agile wallaby.
Coastal dunes, beaches and limestone outcrops	<p>Holocene sand dunes run parallel to the coast, with large areas of mobile dunes encroaching inland in the northern Peninsula. Foredunes are sparsely vegetated, predominantly with <i>Spinifx longifolius</i>, and more patchily with <i>Fimbristylis cymosa</i>, <i>F. sericea</i> and <i>Cyperus bulbosus</i>. <i>Acacia bivenosa</i>, <i>Lysiophyllum cunninghamii</i> and <i>Canavalia rosea</i> are found on areas of more established dunes. Dense shrub communities are found behind the dune crests, on backslopes and hollows.</p> <p>Pleistocene dunes which are older and less exposed, have more species in common with the pindan; they are dominated by <i>Acacia monticola</i> and <i>Gyrostemon tepperi</i>, as well as <i>Plectrachne schinzii</i> in areas that have not been burnt. These areas can also contain the locally important community containing an open eucalypt community with several bloodwood species. Coastal and sub-coastal limestone outcrops occur sporadically, with <i>Acacia bivenosa</i> characteristic of these areas south of Barred Creek. North of Barred Creek <i>Acacia bivenosa</i> does not occur and the area is poorly vegetated. A karst formation is found on Packer Island.</p>
Saline grasslands	<p><i>Sporobolus virginicus</i> grasslands are found on tidal flats above the high-water mark.</p> <p>Near Broome this is best developed on the Roebuck Plains, inland from Crab Creek. This formation is found widely across the Peninsula. These areas are subject to flooding and ponding after monsoonal rains.</p>
Saltwater paperbark thickets	Fringing stands of <i>Melaleuca acacioides</i> are found on the inner, landward margin of saline grasslands; the width and density of this community varies from a discontinuous line to half a kilometre thick.
Samphire flats	<p>Tidal flats occurring behind Mangroves feature wide expanses of bare mud, with <i>Cerriops tagal</i> and <i>Excoecaria agallocha</i> found on the seaward margins of the mud flats.</p> <p>Samphire species dominate the landward side, including <i>Halosarcia halocnemoides</i>, <i>Neobassia astrocarpa</i> and <i>Suaeda arbusculoides</i>.</p>

Vegetation Type	Description
Mangroves	12 of the 17 mangrove species known in the State are located within the Peninsula. <i>Avicennia marina</i> is the commonest species. These areas are located between high spring tide and mean sea level.
Seagrass Meadows	Most species of seagrass occur on a wide range of sediments in the Peninsula. Extensive seagrass banks are found at Roebuck Bay, with <i>Halophila ovalis</i> and <i>Halodule uninervis</i> common in this area.

Vegetation of the Port Management Area was described by Trudgen (1988) as falling into 5 groups. These are described in Table 4-2 below.

**Table 4-2: Vegetation of the Port Management Area as described by Trudgen (1988)**

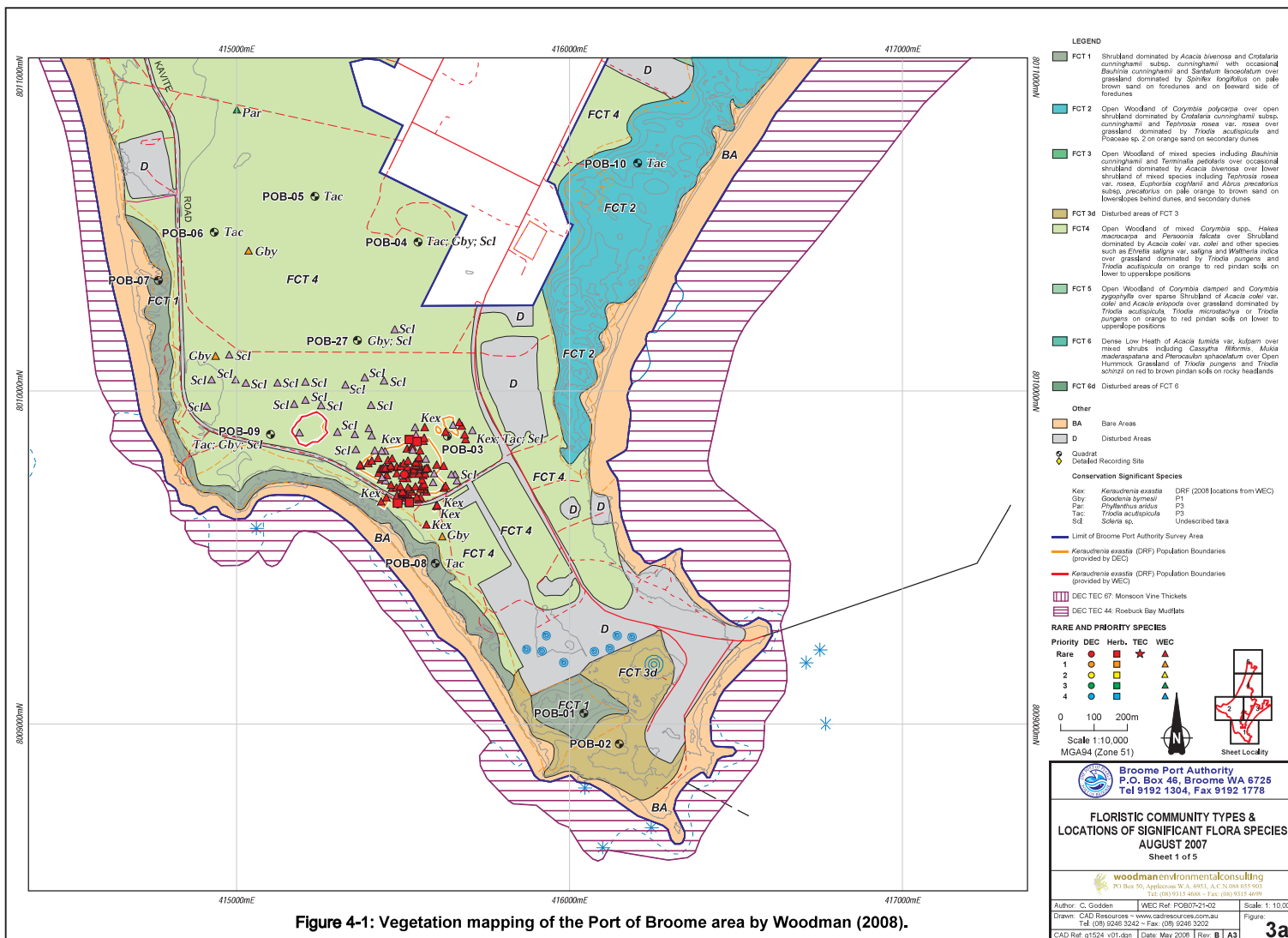
Vegetation Type	Description
Dune Vegetation	Dunal vegetation varies with dune aspect, slope and shoreline proximity, with species such as <i>Spinifex longifolius</i> , <i>Canavalia rosea</i> and <i>Acacia bivenosa</i> colonising eroding seaward faces; whereas the seaward ridge and backslopes are colonised by species such as <i>Crotolaria cunninghamii</i> , <i>Marsdenia cinerascens</i> , <i>Santalum lanceolatum</i> and <i>Acacia bivenosa</i>
Vine Thickets	Discontinuous vine thickets occur in depressions and swales between dune ridges, with species such as <i>Gyrocarpus americanus</i> , <i>Abrus precatorius</i> , <i>Passiflora foetida</i> , <i>Tinospora smilacina</i> and <i>Capparis lasiantha</i> present.
Woodland	Eucalypt and Gubinge woodland over hummock grassland of <i>Plectrachne pungens</i> occur on inland dune ridge and slopes, with other species such as <i>Gardenia pyrifolia</i> and <i>Clerodendrum tomentosum</i> also present. These woodlands merge with Pindan vegetation where the rearward dunes slope down onto the Pindan plain.
Pindan	Pindan vegetation present lying between Port Drive and the base of the dunes is typical of the area and is comprised of mixed Acacia/Eucalypt woodland including <i>Acacia eriopoda</i> , <i>Eucalyptus dampieri</i> and <i>Terminalia petiolaris</i> with scattered shrubs and grasses including <i>Lysiphyllum cunninghamii</i> , <i>Hakea macrocarpa</i> and <i>Ventilago viminalis</i> .
Mangrove	Mangrove communities in the PMA are limited to minor patches along the Roebuck Bay shoreline.

Woodman (2008) defined six floristic community types (FCT's) and two sub-groups across the Port Management Area and the coastal area to Cable Beach. These are listed in Table 4-3. Woodman (2008) mapped the area within the Study Area as a combination of bare areas, disturbed areas and FCT 3d and is shown in Figure 4-1.

**Table 4-3: Vegetation types of the Broome Peninsula as described by Woodman (2008).**

Vegetation Code	Description
FCT 1	Shrubland dominated by <i>Acacia bivenosa</i> and <i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i> with occasional <i>Bauhinia cunninghamii</i> and <i>Santalum lanceolatum</i> over grassland dominated by <i>Spinifex longifolius</i> on pale brown sand on foredunes and on leeward side of foredunes
FCT 2	Open Woodland of <i>Corymbia polycarpa</i> over open shrubland dominated by <i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i> and <i>Tephrosia rosea</i> var. <i>rosea</i> over grassland dominated by <i>Triodia acutispicula</i> and Poaceae sp. 2 on orange sand on secondary dunes
FCT 3	Open Woodland of mixed species including <i>Bauhinia cunninghamii</i> and <i>Terminalia petiolaris</i> over occasional shrubland dominated by <i>Acacia bivenosa</i> over lower shrubland of mixed species including <i>Tephrosia rosea</i> var. <i>rosea</i> , <i>Euphorbia coghlanii</i> and <i>Abrus precatorius</i> subsp. <i>precatorius</i> on pale orange to brown sand on lower slopes behind dunes and secondary dunes
FCT 3d	Disturbed areas of FCT 3
FCT 4	Open Woodland of mixed <i>Corymbia</i> spp., <i>Hakea macrocarpa</i> and <i>Persoonia falcata</i> over Shrubland dominated by <i>Acacia colei</i> var. <i>colei</i> and other species such as <i>Ehretia saligna</i> var. <i>saligna</i> and <i>Waltheria indica</i> over grassland dominated by <i>Triodia pungens</i> and <i>Triodia acutispicula</i> on orange to red pindan soils on lower to upper slope positions
FCT 5	Open Woodland of <i>Corymbia damperi</i> and <i>Corymbia zygophylla</i> over sparse Shrubland of <i>Acacia colei</i> var. <i>colei</i> and <i>Acacia eriopoda</i> over grassland dominated by <i>Triodia acutispicula</i> , <i>Triodia microstachya</i> or <i>Triodia pungens</i> on orange to red pindan soils on lower to upper slope positions
FCT 6	Dense Low Heath of <i>Acacia tumida</i> var. <i>kulparn</i> over mixed shrubs including <i>Cassytha filiformis</i> , <i>Mukia maderaspatana</i> and <i>Pterocaulon sphacelatum</i> over Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia schinzii</i> on red to brown pindan soils on rocky headlands
FCT 6d	Disturbed areas of FCT 6





#### 4.1.3 Conservation Significant Vegetation

One Threatened Ecological Community (TEC) listed under the EPBC Act is known to occur within the Port of Broome (TEC 67). Two TECs are listed under the BC Act are known to occur within the Port of Broome. These are:

- Monsoon Vine Thickets of the Coastal Sand Dunes Dampier Peninsula ranked Endangered in February 2013 under the EPBC Act.** TEC 67: The TEC occurs as discontinuous patches of dense vegetation usually occurring on the leeward slopes and swales and sometimes the exposed crests of the coastal Holocene dune systems. Some patches may extend landward onto the red soil pindan plains. The canopy of the TEC is typically dominated by a mix of several tree or tall shrub species, including Goolnji, Ebony Wood, Mamajen, Mangarr, Gubinge and Blackberry Tree/Marool/Nawalu. The mid layer, when present, can contain semi-deciduous fruiting shrubs and small trees. The ground layer contains about 6 cm of organic matter and may have little cover where the canopy is intact. Vines and climber species may be present throughout all layers of the TEC. The relatively dense and closed nature of the TEC creates a shady and humid microclimate, with many species taking advantage of the abundance of fruiting species. The Protected Matters Search Tool (PMST) identified that this TEC is Likely to occur within a 5 km area of the Project.

**Monsoon vine thickets on the coastal sand dunes of the Dampier Peninsula Ranked as Vulnerable in Western Australia in 2001 under the (now) BC Act** is described in the Interim Recovery Plan 2018-2023 (DBCA 2018). The community occurs as semi-deciduous vine thicket on leeward slopes of coastal sand dunes on the Dampier Peninsula. Many occurrences include scattered discrete vine thicket patches located in swales throughout the dune system and are likely to be indicators of the movement of the dune system over time. The community generally occurs on deep dune sands with a dark superficial grey organic layer, with a surface layer of moist leaf litter, but it can occur on other substrates due to other influences.

The two are synonymous (DBCA 2018).

- (BC Act) Roebuck Bay Mudflats.** TEC 44: species-rich faunal community of the intertidal mudflats of Roebuck bay. The intertidal sand flats of the Study Area are comprised of much coarser mobile sands than the characteristic mudflats which are found in the sheltered waters of Roebuck Bay. As such the sand flats of the Study Area do not support the same species-rich faunal community that is characteristic of the Roebuck Bay Mudflat TEC44 (O2 Marine 2019). The scope of this report is restricted to terrestrial habitats.

Two Priority Ecological Communities (PECs) are known to occur within the Port of Broome. These are:

- Kimberley Community #11.** Priority 1: *Corymbia paractia dominated community on dunes.* *Corymbia paractia* occurs mostly behind the dunes, Broome township area and Dampier Peninsula. A transitional zone is evident where the coastal dunes, with vine thickets, merge with Pindan (desert) vegetation.
- Kimberley Community #12.** Priority 1: Relict dune system dominated by extensive stands of *Sersalisia* (formerly *Pouteria*) *sericea* (Mangarr) (Plate 3 and 4). The community is recorded as a Eucalyptus, *Sersalisia* low woodland unit that occurs on parallel dunes in the area south east of Gantheaume Point. The community also contains numerous woodland species such as: *Erythroleum chlorostachys*

(ironwood), *Eucalyptus zygophylla* (Broome bloodwood), *Hakea macrocarpa* and *Corynotheca micrantha* (zig-zag Lilly).

#### 4.1.4 Conservation Significant Flora

DBCA Database Searches identified 19 Priority flora species and their locations previously recorded within 50 km of the Port of Broom. Record Locations are shown in Figure 4-2. No records occur in the Study Area.

Table 4-4 identifies known habitat associations, distribution and flowering times of these taxa and makes an assessment of the likelihood of occurrence for each taxon given the habitats present in the Study Area and an assessment is made about the likelihood of detection given the climatic conditions during survey, habit and phenology of the species.

##### 4.1.4.1 *Seringia exastia*

One flora species, *Seringia exastia*, declared Critically Endangered under the *BC Act* is known from the Port of Brome. The species is also listed as Critically Endangered under the *EPBC Act* under its former name *Keraudrenia exastia*. The species is known from one small area approximately 650 m north east of the Study Area. The known location was visited during the field survey and healthy plants with immature flowers were observed (Plate 4-1). The species was in a suitable condition for detection during targeted search of the Study Area.

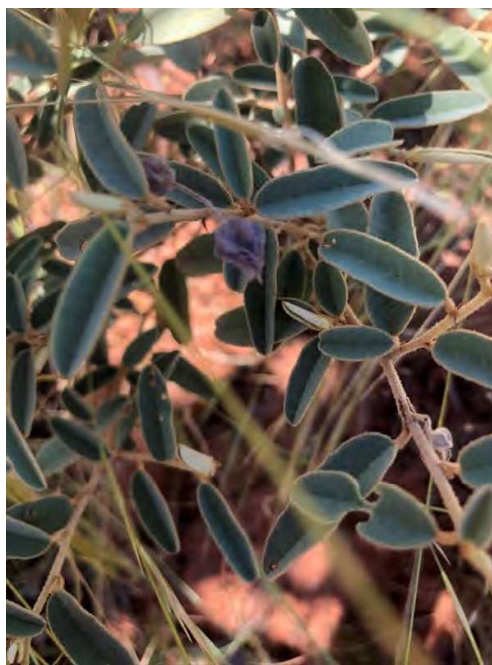


Plate 4-1. *Seringia exastia* observed during Reconnaissance survey from a known location 650 m north east of the Study Area.

*S. exastia* is an erect, compact, multi-stemmed shrub 0.7 to 0.9 m high. It flowers purple from April to December (DBCA 2007-). The species grows in relict desert dune swale in red sand (pindan), in *Acacia* shrubland, with *Gyrostemon*, *Triodia*, *Hakea* and *Eucalyptus*. Associated species include *Acacia coleii* var. *coleii*, *A. adoxa*, *Sida cardiophylla*, *Corchorus sidoides*, *Yakirra australiensis* var. *australiensis*, *Cucumis maderaspatana* and *Carissa lanceolata* (Trudgen 2006). The main threats to the species are road maintenance, inappropriate fire regimes, lack of tenure security, industrial development, competition, weeds, poor genetic diversity and recreational use.

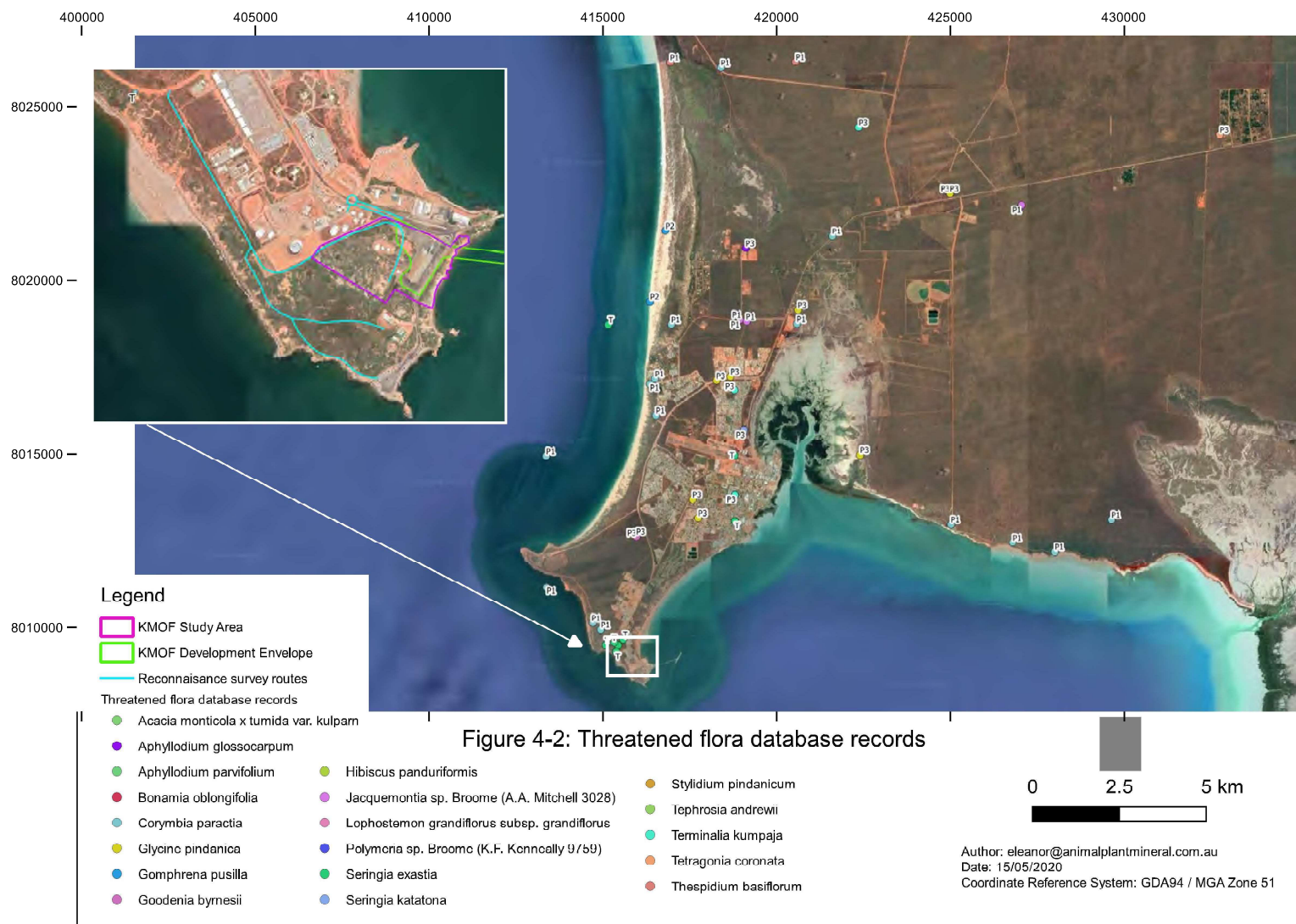


Table 4-4: Conservation significant flora identified from database searches. Likelihood of occurrence assessed for the habitats present in the Study Area.

Species	Current WA Conservation Status	Description & Habitat	Likelihood of Occurrence in Study Area and likelihood of Detection if Present
<i>Seringia exastia</i>	T	Erect, compact, multi-stemmed shrub that can grow to 0.9 m high. The flowers are purple and the flowering period is from April to December. Pindan heathland.	Possibly occurs, High chance of detection
<i>Aphyllodium parvifolium</i>	P1	Trailing shrub, to 0.3 m high. Fl. purple-pink, Apr or Jul. Sand. Sandhills.	Possibly occurs, High chance of detection
<i>Corymbia paractia</i>	P1	Tree (often several-stemmed), 4-6(-12) m high, bark smooth, white, shedding in thin scales. Fl. white, Apr to May or Oct to Dec. Skeletal soils. In transition zone between coastal beach dunes & red pindan soils.	Possibly occurs. High chance of detection
<i>Jacquemontia</i> sp. Broome (A.A. Mitchell 3028)	P1	Brown orange sand on plains.	Possibly occurs, High chance of detection
<i>Thespidium basiflorum</i>	P1	Densely tufted, multi-stemmed perennial, herb, to 0.2 m high. Fl. green, May to Aug. Sandy soils. Creeks.	Possibly occurs, Moderate chance of detection
<i>Gomphrena pusilla</i>	P2	Slender branching annual, herb, to 0.2 m high. Fl. white, Mar to Apr or Jun. Fine beach sand. Behind foredune, on limestone.	Possibly occurs, High chance of detection
<i>Acacia monticola</i> x <i>tumida</i> var. <i>kulparn</i>	P3	Plants of this presumed hybrid that occur in wind-swept coastal habitats such as Point Gantheaume, Broome, often grow as low-domed (semi-prostrate), spreading shrubs; these individuals were formerly known under the Phrase Name, <i>Acacia</i> sp. Riddell Beach (T. Willing 71). Further inland, however, the plants assume a taller habit (reaching 4 m in some places); these individuals were formerly known under the Phrase Name, <i>Acacia</i> sp. Broome (B.R. Maslin 4918).	Possibly occurs, High chance of detection
<i>Aphyllodium glossocarpum</i>	P3	Spreading or erect shrub, to 1.2 m high. Fl. pink-purple, Apr to Oct. Sand. Pindan.	Possibly occurs, High chance of detection
<i>Bonamia oblongifolia</i>	P3	Perennial, herb or shrub. Fl. blue, Feb. Sandy or gravelly soils.	Possibly occurs, High chance of detection
<i>Glycine pindanica</i>	P3	Prostrate or scrambling perennial, herb or climber. Fl. pink/blue-purple, Feb to Mar or Jun. Pindan soils.	Possibly occurs, High chance of detection

Species	Current WA Conservation Status	Description & Habitat	Likelihood of Occurrence in Study Area and likelihood of Detection if Present
<i>Goodenia byrnesii</i>	P3	Prostrate to decumbent herb, stems to 30 cm. Fl. yellow, Jan to Feb. Sand. Edge of creek.	Possibly occurs. Moderate chance of detection
<i>Hibiscus panduriformis</i>	P3	Shrub to 2.5 m. Flowers May to September. Sandplain.	Possibly occurs. High chance of detection
<i>Lophostemon grandiflorus</i> subsp. <i>grandiflorus</i>	P3	Tree, 4-8 m high. Fl. cream-white, apparently Jan to Dec. Damp habitats (swamps, seepages).	Unlikely to occur. High chance of detection
<i>Polymeria</i> sp. Broome (K.F. Kenneally 9759)	P3	Trailing herb, leaves greyish green, flowers mauve, March, May. In red pindan soil on road verge and in drain; near coastal plain.	Possibly occurs. High chance of detection
<i>Seringia katatona</i>	P3	Erect, multi-stemmed shrub to 40 cm high, 4-5-merous flowers with pink/purple calyx, May. Pindan, red sand	Possibly occurs. Moderate chance of detection
<i>Stylidium pindanicum</i>	P3	Annual herb to 25 cm. Flowers pink, May. Clay flat.	Unlikely to occur. Low chance of detection
<i>Tephrosia andrewii</i>	P3	Ascending, multistemmed shrub, to 0.8 m high. Fl. orange, Apr or Oct. Sand. In pindan country.	Possibly occurs. High chance of detection
<i>Terminalia kumpaja</i>	P3	Tree to 6 m, bark deeply fissured and corky.	Possibly occurs. High chance of detection
<i>Tetragonia coronata</i>	P3	Decumbent annual, herb. Fl. yellow, Jul. Red clay loam. Calcrete outcrops.	Unlikely to occur. Low chance of detection

#### 4.1.5 Introduced Flora

Environmental weeds were identified during a 2004 survey of the Broome townsite (Shire of Broome, 2004), the most common of which included:

- *Leucaena leucocephala* (Coffee Bush)
- *Azadirachta indica* (Neem)
- *Jatropha gossypifolia* (Bellyache Bush)
- *Macroptilium atropurpureum* (Siratro)
- *Merremia aegyptia*
- *Merremia dissecta*
- *Passiflora foetida* (wild passionfruit)
- *Tribulus terrestris* (Caltrop)
- *Alternanthera pungens* (Khaki weed)
- *Cenchrus biflorus* (Gallon's curse)
- *Cenchrus ciliaris* (Buffel Grass)
- *Parkinsonia aculeata* (Jerusalem Thorn)
- *Prosopis* spp. (Mesquite)

Environs Kimberly (2010) nominated the weeds listed in Table 3-3 as being present in the TEC Monsoon Vine Thickets of the Coastal Sand Dunes.

The invasive flora species listed in the PMST as Species or Species Habitat likely to occur within 40 km of the Port of Broome are:

- *Cenchrus ciliaris*
- *Dolichandra unguis-cati*
- *Jatropha gossypifolia*
- *Prosopis* spp.



## 4.2 FIELD SURVEY

### 4.2.1 Summary of the Quadrat data

A total of 56 vascular plant taxa, from 23 families, were recorded from the quadrat surveys and opportunistic collections during the detailed survey. The most well-represented families were Fabaceae (13 taxa), Poaceae (9 taxa, including 3 introduced taxa) and Malvaceae (5 taxa). Appendix C displays the site data for each quadrat. Appendix D presents a list of vascular plant taxa recorded during the survey. Figure 4-3 shows the locations of quadrats. Appendix E shows the Species Accumulation Curve calculated from the data collected in the Detailed Survey quadrats, and indicates the observed number of species is equal to the expected number of species.

### 4.2.2 Conservation Significant Flora

One conservation significant flora taxa was recorded in the detailed survey – the Priority 3 *Acacia monticola* x *Tumida* var *kulparn*. This putative hybrid is described by Maslin (2018) as being sometimes similar to *A. eriopoda* x *monticola* which has generally narrower phyllodes. The relationship between these two putative hybrids needs further study.

The characters of bark morphology (i.e. pseudo Minni Ritchi), phyllode nervature (i.e. sparingly anastomosing) and short spikes (c. 1 cm long) are all intermediate between *A. monticola* and *A. tumida* var. *kulparn* and suggest possible hybrid origin for plants assigned to this entity. *Acacia monticola* and *A. tumida* var. *kulparn* are relatively common in the west Kimberley area and are sympatric with the putative hybrid, at least around Broome. Pods are unknown for this entity, perhaps indicating that it is a sterile hybrid. Further field and laboratory studies are needed to assess this presumed hybridity.

Plants of this presumed hybrid that occur in wind-swept coastal habitats such as Point Gantheaume, Broome, often grow as low-domed (semi-prostrate), spreading shrubs; these individuals were formerly known under the Phrase Name, *Acacia* sp. Riddell Beach (T. Willing 71). Further inland, however, the plants assume a taller habit (reaching 4 m in some places); these individuals were formerly known under the Phrase Name, *Acacia* sp. Broome (B.R. Maslin 4918). The 4 plants recorded in the survey are of the latter, taller habit.

Two conservation significant taxa were recorded in the reconnaissance survey of the surrounding area. The Threatened flora *Seringia extasia* was observed in a known location 250 m from the Study area. The Priority 1 *Corymbia paractia* was recorded approximately 50 m from the Study Area.

### 4.2.3 Introduced Flora

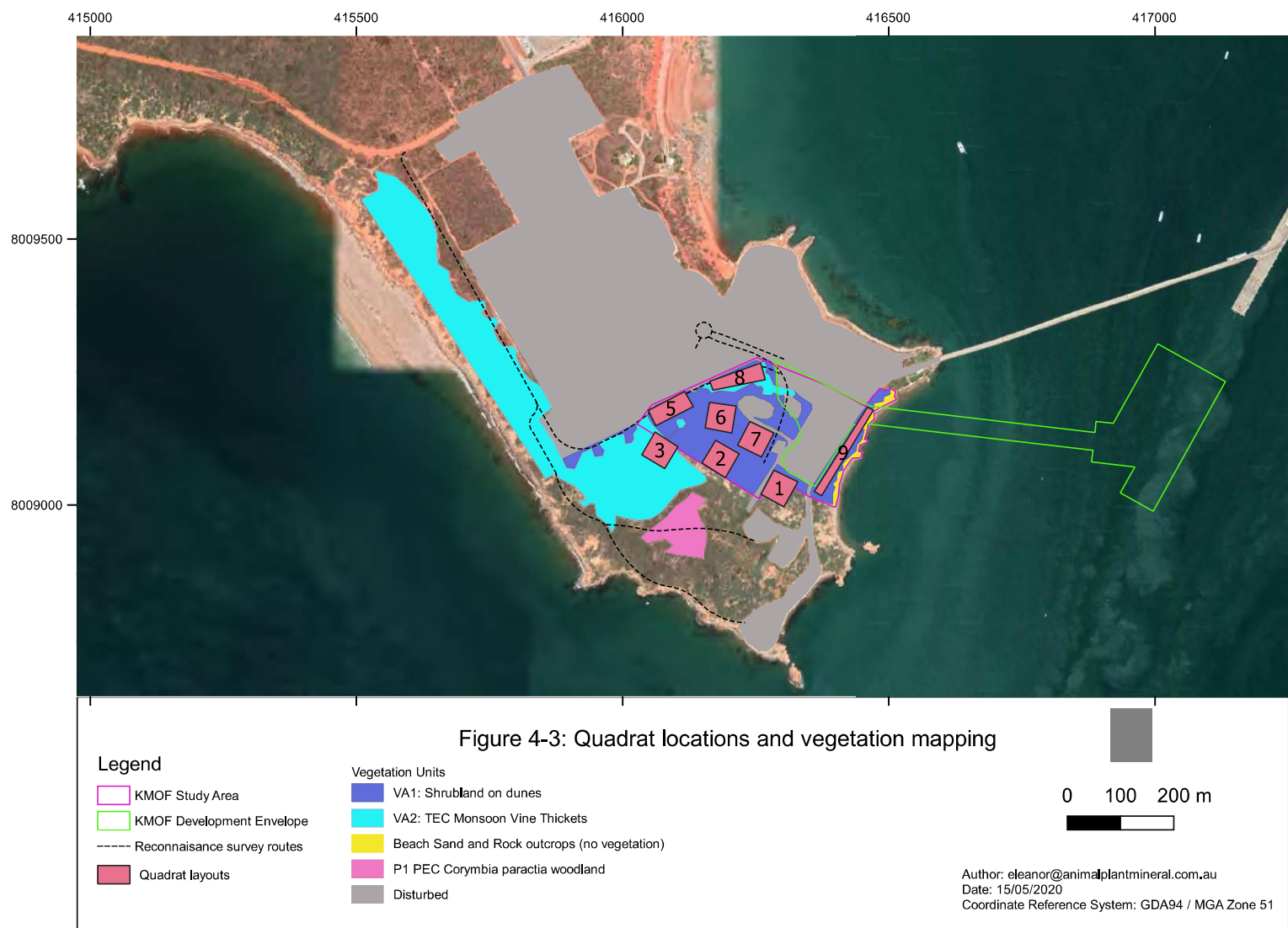
A total of 7 introduced (weed) species were recorded during the detailed survey. These species and their recording locations are shown in Figure 4-4, and their species names are also listed in Appendix D, denoted with a \* prior to the species. None of these species are listed as Declared Plants. \**Cenchrus ciliaris* is listed as a WONS.

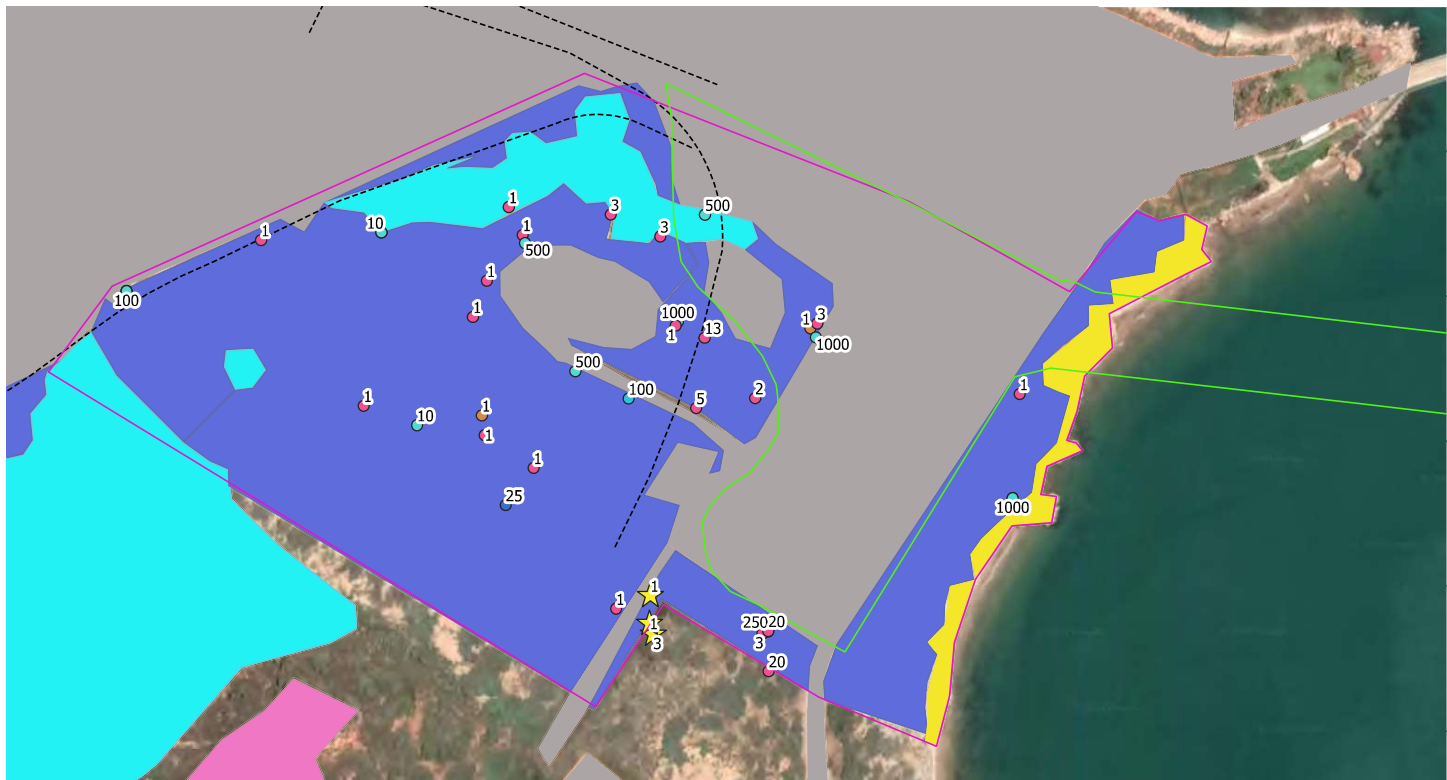
Environs Kimberley (2010) considers \**Passiflora foetida* \**Mesosphaerum suaveolens* and \**Cenchrus ciliaris* to be High Threat weeds and \**Aerva javanica* and \**Tribulus terrestris* to be Moderate Threat weeds to the Monsoon Vine Thicket vegetation.

### 4.2.4 Vegetation Associations

The vegetation within the Study Area is described in 2 Vegetation Associations (VA), with the remainder of the area being beach sand and rocky outcrops (vegetation free) or disturbed (Figure 4-3).







#### Legend

- KMOF Study Area
- KMOF Development Envelope
- - - Targeted Search tracklogs
- Threatened flora**
- ★ *Acacia monticola* x *Tumida* var *kulparn*
- Corymbia paractia*

- Weeds**
- *Aerva javanica*
  - *Cenchrus bifforus*
  - *Cenchrus ciliaris*
  - *Cenchrus setiger*
  - *Passiflora foetida*
  - *Tribulus terrestris*

- Vegetation units**
- VA1
  - VA2
  - Beach sand and rock outcrops
  - Disturbed

Figure 4-4: Locations of conservation significant flora and weeds

0 50 100 m

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 Date: 13/04/2020  
 Coordinate Reference System: GDA94 / MGA Zone 51

## VA 1

VA 1 was described by 6 quadrats (1, 2, 5, 6, 7, 9) and contained *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* shrubland over *Spinifex longifolius* and *Panicum decompositum* grassland. Common species included *Ipomoea pes-caprae* subsp. *brasiliensis*, *Rhynchosia minima*, *Tephrosia rosea*, *Euphorbia coghlanii* and *Boerhavia gardneri*. This vegetation type was present on the foredune and the leeward dunes on deep sandy soils of the undulating sand dunes.

This vegetation fits within the description by Kenneally et al (1996) of coastal dunes, beaches and outcrops - on areas of more established dunes, and of Dune vegetation as described by Trudgen (1988), and FCT1 as described by Woodman Environmental Consulting (2008).

This vegetation type was generally in Very Good condition. Disturbances include occasional weeds (including *\*Aerva javanica*, *\*Cenchrus biflorus*, *\*Cenchrus ciliaris*, *\*Cenchrus setiger* and *\*Tribulus terrestris*) in low densities through the greater undisturbed vegetation with *\*Cenchrus echinatus* being more frequent next to disturbed areas.

The area of VA1 inside the Development Envelope is of Poor condition, having frequent disturbances including erosion and a high density of the weed *\*Cenchrus biflorus*.

This vegetation type was sampled from 6 quadrats. Quadrats 1 and 5 included a number of herbaceous and small shrub species more frequently found in sandplain vegetation (Woodman Environmental Consulting 2008), however the dominant species in all strata remained those found on the dune systems. The areas covered by Quadrats 1 and 5 show some transition towards sandplain vegetation.

Elements of Vine Thicket vegetation were also recorded in this vegetation type such as occasional *Terminalia ferdinandiana*, *Gyrocarpus americanus* subsp *pachyphyllus* and *Tinospora smilacina* but not to an extent where they were the dominant species.

The distribution of VA1 is shown in Figure 4-3 and Plate 4-1.



**Plate 4-1: Vegetation Association 1, looking towards Quadrat 2 towards the Toll shed to the east.**

#### VA2

VA2 was described by 2 quadrats (3 and 8) and contained *Gyrocarpus americanus* subsp. *pachyphyllus* and *Bauhinia cunninghamii* closed woodland with *Ficus aculeata* var. *indecora* open shrubland and *Spinifex longifolius* and *Triodia microstachya* grassland. Common species included *Abrus precatorius* subsp. *precatorius*, *Jasminum didymum* subsp. *lineare* and *Tinospora smilacina*. This vegetation was present in 2 areas of the leeward dunes, on deep sands with a litter layer.

This vegetation fits within the Vine Thickets description by Kenneally et al (1996) and Trudgen (1988) and FCT3 as described by Woodman Environmental Consulting (2008).

This vegetation is accepted as one of the floristic associations of the TEC Monsoon Vine Thickets on the coastal sand dunes of the Dampier Peninsula (DBCA 2018). This floristic association is described by Black et al (2010) as Group B. Group B patches occur at and towards the southern end of the distribution of thickets on each of the west and east coasts of the Peninsula. In comparison with the other patch groups of the TEC, Group B patches are situated on low dunes and other relatively exposed locations, are depauperate in evergreen trees, and have a more open shrubby structure.

This vegetation type was generally in Very Good condition. Disturbances include occasional weeds (including *\*Passiflora foetida* and *\*Cenchrus echinatus*) in low densities. The area of VA2 inside the Disturbance Envelope is in Poor condition – it is the tail end of the vegetation type, is disturbed on the northern and southern edges and is very sparse, transitioning into VA1 which is also in Poor condition in this area.



Quadrats of this vegetation type included species from the surrounding VA1 including *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* as the areas containing this vegetation are small. Quadrat 8 also contained a few species more common to sandplain vegetation such as *Hakea macrocarpa* and *Solanum cunninghamii* – it is likely that prior to development on the northern and western sides some sandplain vegetation was present.

The distribution of VA2 is shown in Figure 4-3 and Plate 4-2, Plate 4-3, and Plate 4-4.



**Plate 4-2: VA2 vegetation at Quadrat 8.**



**Plate 4-3: VA2 Vegetation at Quadrat 3.**





**Plate 4-4: Litter accumulation in VA2 vegetation at Quadrat 3.**

Beach sand and rocky outcrops on the margin of the intertidal zone did not have any vegetation but are mapped in Figure 4-3 and shown in Plate 4-5. The extent of the vegetation types within the Study Area are shown in Table 4-5. Vegetation condition is shown in Figure 4-5.

**Table 4-5: Extent of vegetation types in the Study Area**

Type	Condition	Extent in Study Area (ha)	Extent in Development Envelope (ha)
VA1	Very Good	2.985	0.031
	Good	0.698	0.013
	Poor	0.197	0.118
VA2	Very Good	0.465	0.000
	Good	0.028	0.000
	Poor	0.053	0.043
Beaches and Rocky Outcrops	NA	0.204	0.026
Disturbed	Completely Degraded	2.770	1.834



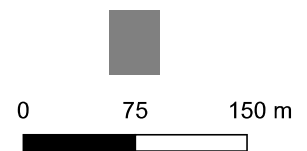


Figure 4-5: Vegetation condition

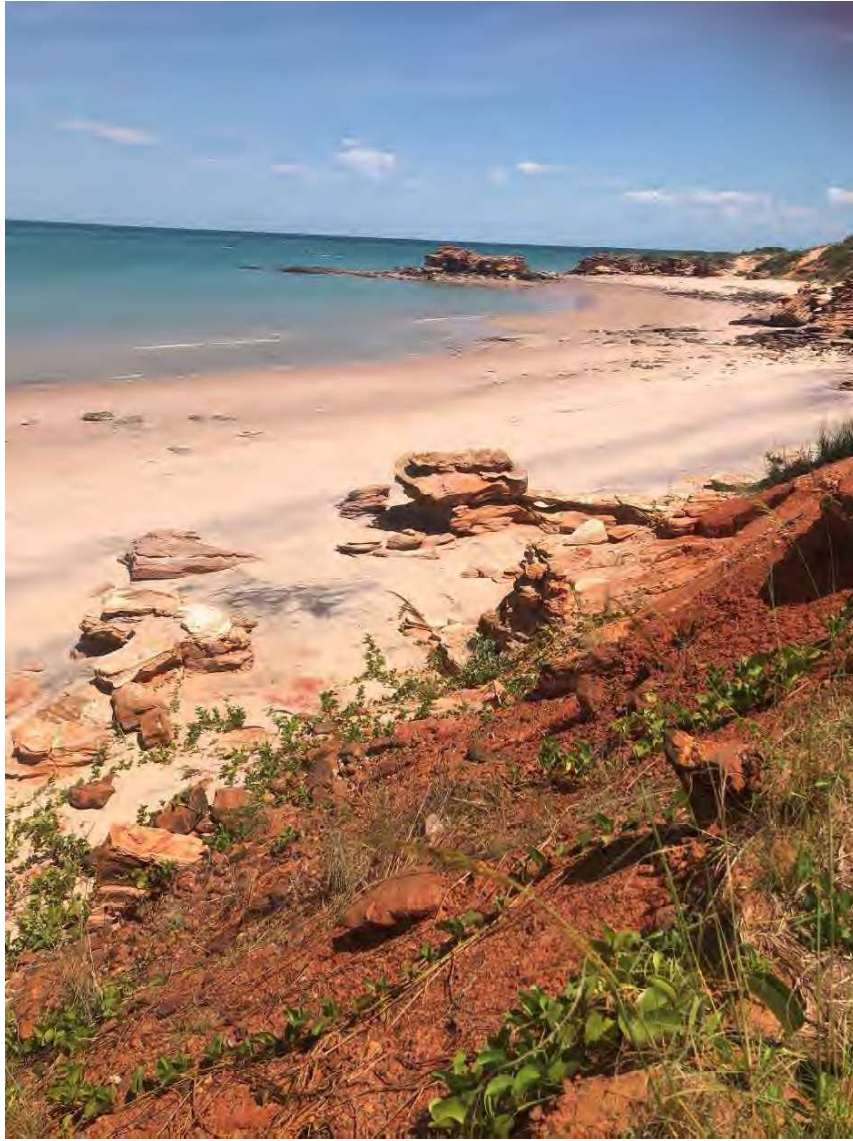
Legend

- KMOF Study Area
- KMOF Development Envelope

- Vegetation Condition
- Very Good
  - Good
  - Poor
  - Completely Degraded
  - No Vegetation



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 Coordinate Reference System: GDA94 / MGA Zone 51



**Plate 4-5: The narrow band of sand and rock outcrops between the vegetated dunes and the intertidal zone.**

During the reconnaissance survey of the surrounding area the Priority 1 PEC *Corymbia paractia* woodland was also recorded (Figure 4-3, Plate 4-6). The occurrence is located approximately 50 m to the south of the Study Area. The Kimberley Region PEC number 11: *Corymbia paractia* dominated community on dunes is common between Gantheaume Point and Cable Beach, however it is apparently restricted to a narrow coastal zone in the Broome area where beach dunes merge into pindan soils (Kenneally et. al., 1996). The weed *Passiflora foetida* was recorded in this PEC in low densities.





Plate 4-6: *Corymbia paractia* woodland recorded 50 m south of the Study Area.

## 5 TERRESTRIAL VERTEBRATE FAUNA RESULTS

### 5.1 DESKTOP SURVEY

Shorebirds have been omitted from this assessment as a detailed shorebird assessment for the Project has been completed separately.

#### 5.1.1 Conservation Significant Fauna

Database searches identified 82 conservation significant terrestrial species (excluding shorebirds) that may occur in the area. Table 5-1 lists these species, the conservation significant category they are listed in for both Western Australia and the Commonwealth, notes on known habitat preferences, whether suitable habitat occurs in the Study Area and an assessment of the likelihood of occurrence.

Table 5-1 lists 75 bird species, including seven state-listed, 14 federally listed threatened species and 14 non-migratory and 61 migratory species. For some of these species suitable foraging habitat may occur in the sand dunes. No suitable habitat occurs for nesting or breeding within the Study Area. Figure 5-1 shows the location of records from the database searches for birds of conservation significance. There are 3 records within the Study Area all for *Sula leucogaster* (Brown Booby) listed under International Agreements (IA) and as a Marine (M) bird under State and Federal legislation. Multiple observations of *Pandion cristatus* (Osprey) and one observation of *Apus pacificus* (Fork-tailed Swift) have been recorded in close proximity to the Study Area.

No Database records of conservation significant reptiles occur within the Study Area. The Dampierland Burrowing Snake (P2) and Dampierland Plains Slider (P2) are known to occur in the region and potentially suitable habitat exists in the dunes of the Study Area.

There are no terrestrial mammal records in the DBCA conservation significant fauna database for the Study Area. Records from the Broome area are shown in Figure 5-2. Of the conservation significant mammals known from the area, suitable habitat is present only for the Bilby.



Figure 5-1. Database bird records excluding Shorebirds

### Legend

KMOF Study Area

KMOF Development Envelope

### Conservation Category

★ CR

★ EN

★ VU

● P1

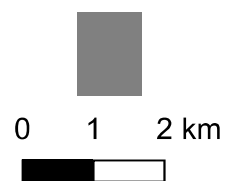
● P2

● P3

● P4

● IA

● OS



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Date: 13/04/2020

Coordinate Reference System: GDA94 / MGA Zone 51



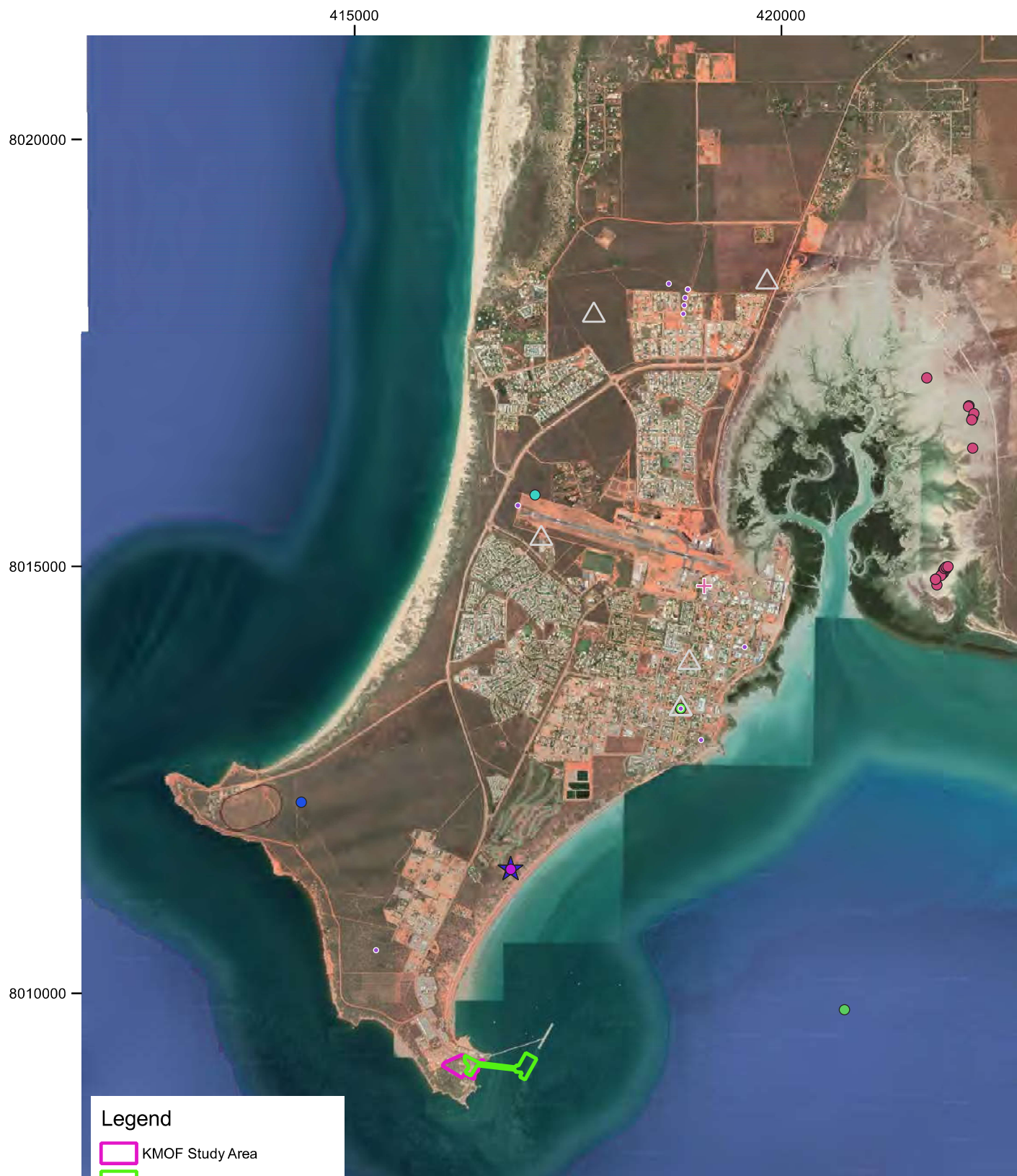


Figure 5-2. Database terrestrial reptile and mammal records

Table 5-1. Conservation significant fauna species identified in Database Searches

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat				Comments
			Cth	WA			Beach	Rocky outcrops	Dunes	Disturbed areas	
BIRDS											
APODIFORMES											
<i>Apus pacificus</i>	Fork-tailed Swift		IA, M	IA	The Fork-tailed Swift is a non-breeding migrant to Australia (arrive: October; leave: April). In WA, this species is widespread between Augusta and Carnarvon, including subcoastal areas, and some nearshore and offshore islands, with scattered records along the remaining coast and some inland areas (DoE, 2020a). It occupies low to very high airspace over a range of habitat types, from rainforest to semi-arid environments (Morcombe, 2010).	High	Y	Y	Y	-	Suitable foraging habitat exists in the Study Area and nearby recordings exist. This species is <b>likely to occur</b> in the airspace over the Study Area.
<i>Hirundapus caudacutus</i>	White-throated Needletail		VU, IA, M	IA	The White-throated Needletail is a non-breeding migrant to Australia (arrive: October; leave: March/April). It hawks for prey high in open spaces of sky above most habitat types, including oceans (Morcombe, 2010).	High	Y	Y	Y	-	Suitable foraging habitat exists in the Study Area and nearby recordings exist. This species is <b>likely to occur</b> in the Study Area.
CICONIIFORMES											
<i>Ixobrychus dubius</i>	Australian Little Bittern		-	P4	The Australian Little Bittern inhabits freshwater swamps, lakes, and rivers with dense reedbeds, tall sedges, and well-vegetated margins. It also	Low	-	-	-	-	No suitable habitat exists in the Study Area; however, the species has previously been

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
			Cth	WA			Beach	Rocky outcrops	Dunes	Disturbed areas		
					occurs in brackish and saline wetlands, such as mangroves, saltmarsh, and coastal lagoons. Populations tend to be localised (Morcombe, 2010).						recorded nearby. This species is <b>unlikely</b> to occur in the Study Area.	
<i>Ixobrychus flavicollis australis</i> (southwest subpop.)	Black Bittern (southwest subpop.)	-	P2		The Black Bittern inhabits various wetlands. It requires dense water-edge vegetation, and inhabits freshwater springs and billabongs, and tidal reaches of creeks and rivers (Morcombe, 2010). It nests in trees, and largely forages from shady trees over water, as well as in open areas of short, marshy vegetation (Australian Museum, 2020b).	Low	-	-	-	-	No suitable habitat exists in the Study Area; however, the (broader) species has previously been recorded nearby. This species is <b>unlikely</b> to occur in the Study Area..	
<i>Plegadis falcinellus</i>	Glossy Ibis	IA, M	IA		The Glossy Ibis inhabits shallows of swamps, floodwaters, sewage ponds, and flooded or irrigated pastures. It occasionally feeds on moist pastures or in sheltered marine habitats (Morcombe, 2010).	Low	-	-	-	-	While this species is common across the coastal north of Australia, no suitable habitat exists in the Study Area. This species is <b>unlikely to occur</b> in the Study Area.	
CUCULIFORMES												
<i>Cuculus optatus</i>	Oriental Cuckoo	IA	IA		The Oriental Cuckoo migrates to Australia during the northern autumn and leaves during the southern autumn/winter. It inhabits rainforest margins, monsoon forest,	Low	-	-	-	-	No suitable habitat exists in the Study Area. This species is <b>unlikely to occur</b> in the Study Area.	



Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat				Comments
			Cth	WA			Beach	Rocky outcrops	Dunes	Disturbed areas	
					vine scrubs, riverine thickets, wetter, densely-canopied Eucalypt forests, paperbark swamps, and mangroves (Morcombe, 2010).						
FALCONIFORMES											
<i>Elanus scriptus</i>	Letter-winged Kite	-	P4	The Letter-winged Kite occurs in semi-arid and arid areas in Australia. It inhabits tree-lined creeks, and hunts over low vegetation, such as grasslands (Morcombe, 2010). It roosts by day in the high canopy of leafy trees.	Moderate	-	-	Y	-	Suitable foraging habitat may exist in the Study Area; however, roost sites are unlikely to exist. This species <b>may occur</b> in the Study Area when foraging.	
<i>Falco hypoleucos</i>	Grey Falcon	-	VU	The Grey Falcon typically inhabits lightly timbered country, especially stony plains and lightly timbered Acacia scrublands (Morcombe, 2010). It is usually found in shrubland, grassland, and wooded areas of arid/semi-arid regions, although it also occurs in open, coastal woodlands (OEH, 2017).	Moderate	-	-	Y	-	Suitable habitat exists in the Study Area. This species <b>may occur</b> in the Study Area.	
<i>Falco peregrinus</i>	Peregrine Falcon	-	OS	The Peregrine Falcon inhabits diverse environments, from rainforest to arid scrublands, and altitudes, from coastal heath to alpine; it prefers coastal and inland cliffs, or open woodlands near water. It requires abundant prey (birds) and secure nest sites (Morcombe, 2010).	Moderate	-	Y	Y	-	Suitable foraging habitat may exist in the Study Area, but appropriate trees for nesting are not available. This species <b>may occur</b> in the Study Area when foraging.	

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
	Cth		WA	Beach			Rocky outcrops	Dunes	Disturbed areas			
<i>Pandion cristatus</i>	Osprey		IA*, M*	IA	The Osprey is typically associated with water around coastal Australia and is common in northern Australia. It inhabits littoral and coastal habitats, and terrestrial wetlands in tropical and temperate Australia, and prefers coastal cliffs and elevated islands (DoE, 2020f). It is also known to follow major water bodies inland, even into arid regions (Morcombe, 2010). This species requires open water for foraging (DoE, 2020f).	High	-	Y	Y	-	Suitable habitat exists in the Study Area. This species is <b>likely to occur</b> in the Study Area.	
PASSERIFORMES												
<i>Erythrura gouldiae</i>	Gouldian Finch		EN	P4	The Gouldian Finch is sparsely distributed across northern Australia. The species is dependent on select grasses for its diet, especially native Sorghum and Spinifex species, and nearby water sources. During the breeding season, the species inhabits small patches of open woodland, with hollow-bearing Eucalyptus trees (required for nests) and a grassy understorey (TSSC, 2016).	Low	-	-	Y	-	Suitable foraging habitat may exist in the Study Area but of low quality. Although there are recordings nearby, this species is <b>unlikely to occur</b> in the Study Area.	
<i>Cecropis daurica</i>	Red-rumped Swallow		IA*, M*	IA	The Red-rumped Swallow inhabits open country, coastal grasslands, forest, shrubland, and rocky areas. It	High	-	Y	Y	-	Suitable habitat exists in the Study Area. This	

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat				Comments
	Cth		WA	Beach			Rocky outcrops	Dunes	Disturbed areas		
					is a rare vagrant in Australia (Morcombe, 2010).						species is <b>likely to occur</b> in the Study Area.
<i>Hirundo rustica</i>	Barn Swallow	IA	IA	The Barn Swallow inhabits open country, often near water, and can be found in/near towns; it tends to be noticed when perched on overhead wires. It is a vagrant species in Australia but is seen regularly in the north and northeast of Australia (Morcombe, 2010).	High	Y	Y	Y	Y	Suitable habitat exists in the Study Area. This species is <b>likely to occur</b> in the Study Area.	
<i>Motacilla cinerea</i>	Grey Wagtail	IA, M	IA	The Grey Wagtail is a vagrant to Australia, with rare, disjunct records along the coast of the mainland. In Australia, it has been recorded near fresh sandy or rocky streams, as well as on disturbed land (Morcombe, 2010).	High	-	-	-	Y	Suitable habitat may exist in the Study Area. This species has been recorded nearby and is <b>likely to occur</b> in the Study Area.	
<i>Motacilla flava</i>	Yellow Wagtail	IA, M	IA	The Yellow Wagtail is a summer migrant to northern Australia, especially in the northwest between Broome and Darwin. It inhabits open habitats, often near water, including disturbed and undisturbed habitats, and occasionally inhabits drier inland plains (Morcombe, 2010).	High	Y	Y	-	Y	Suitable habitat exists in the Study Area. This species is <b>likely to occur</b> during migration periods in the Study Area.	
PELECANIFORMES											
<i>Fregata ariel</i>	Lesser Frigatebird	IA, M	IA	The Lesser Frigatebird is common in northern Australia. It inhabits marine environments, including airspace	Low	-	-	-	-	This species typically only comes ashore to breed and only breeds on	

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
	Cth		WA	Beach			Rocky outcrops	Dunes	Disturbed areas			
					over tropical seas, and is usually pelagic. It is often encountered far from land, as well as over shelf waters, in places close inshore, and inland over continental coastlines (Morcombe, 2010).						remote islands. This species is <b>unlikely to occur</b> in the Study Area.	
<i>Fregata minor</i>	Greater Frigatebird	IA, M	IA		The Greater Frigatebird is regularly encountered around northern, tropical coasts of Australia, from Pt Cloates, WA, to North Stradbroke, QLD (Morcombe, 2010). It is a marine species, but breeds on small, remote tropical and sub-tropical islands, in mangroves or bushes, or occasionally on bare ground (BirdLife International, 2012).	Low	-	-	-	-	This species typically only comes ashore to breed and only breeds on remote islands. This species is <b>unlikely to occur</b> in the Study Area.	
<i>Papasula abbotti</i>	Abbott’s Booby	EN, M			The Abbott’s Booby is endemic to Christmas Island and its surrounding seas (Morcombe, 2010). It is a marine species, but comes to shore to breed. It nests in tall plateau forest and upper terrace forest on Christmas Island, where the trees are associated with uneven terrain and uneven canopy (DoE, 2020g).	Low	-	-	-	-	This species only comes to shore to breed, and no suitable breeding habitat exists in the Study Area. While it is only known to breed on Christmas Island, this species has previously been recorded at Eco Beach, south of Broome (the first recording of the species outside of Christmas Island and	

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
	Cth		WA	Beach			Rocky outcrops	Dunes	Disturbed areas			
												surrounding waters). This species is <b>unlikely to occur</b> in the Study Area.
<i>Sula leucogaster</i>	Brown Booby		IA, M	IA	The Brown Booby is a marine, largely tropical species, associated with deep waters and inshore shallows. It is common along the northern coast of Australia, from North West Cape, WA, to southeast QLD (Morcombe, 2010).	Moderate	Y	Y	-	-		This species breeds on islands and does not typically come within 18 km of mainland. However, suitable habitat may exist in the Study Area. This species <b>may occur</b> in the Study Area.
PROCELLARIIFORMES												
<i>Ardenna pacifica</i>	Wedge-tailed Shearwater		IA, M	IA	The Wedge-tailed Shearwater is a pelagic species and inhabits tropical and subtropical seas. It is common in coastal and oceanic waters of east and west Australia (Morcombe, 2010).	Low	-	-	-	-		This species only comes ashore to breed. No suitable breeding habitat exists in the Study Area, and, as such, this species is <b>unlikely to occur</b> in the Study Area.
<i>Ardenna tenuirostris</i>	Short-tailed Shearwater		IA, M	IA	The Short-tailed Shearwater is a marine, pelagic species. It is typically found over continental shelf waters (Morcombe, 2010).	Low	-	-	-	-		This species is not typically found along the west coast and is <b>unlikely to occur</b> in the Study Area.
<i>Bulweria bulwerii</i>	Bulwer's Petrel		IA, M	IA	The Bulwer's Petrel is a marine, pelagic species. It is typically found over warmer waters. It may be quite common from Sep to Apr in	Low	-	-	-	-		This species only comes ashore to breed. No suitable breeding habitat exists in the Study Area,

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat				Comments
			Cth	WA			Beach	Rocky outcrops	Dunes	Disturbed areas	
					northwest waters of Australia (Morcombe, 2010).						and, as such, this species is <b>unlikely to occur</b> in the Study Area.
<i>Calonectris leucomelas</i>	Streaked Shearwater	IA, M	IA		The Streaked Shearwater is a pelagic species, found over shelf water and further out, and rarely inshore. It is a common summer-autumn visitor to the north, west, and east coasts of Australia (Morcombe, 2010).	Low	-	-	-	-	This species only comes ashore to breed. No suitable breeding habitat exists in the Study Area, and, as such, this species is <b>unlikely to occur</b> in the Study Area.
<i>Oceanites oceanicus</i>	Wilson's Storm-petrel	IA, M	IA		The Wilson's Storm-petrel is found over deep pelagic seas, shelf slopes, and shallower shelf and inshore waters. Its range extends from Antarctic pack-ice to subtropical areas. It is widespread and abundant (Morcombe, 2010).	Low	-	-	-	-	This species only comes ashore to breed. No suitable breeding habitat exists in the Study Area, and, as such, this species is <b>unlikely to occur</b> in the Study Area.
<i>Puffinus huttoni</i>	Hutton's Shearwater	M	EN		The Hutton's Shearwater is preferentially found in continental shelf waters; however, it can also occur in estuaries, bays, and channels. It is migratory around most of the Australian coast (Morcombe, 2010). It digs burrows high on gentle mountain slopes, under tussock grass or low alpine scrubland in New Zealand (BirdLife International, 2019).	Low	-	-	Y	-	Suitable burrowing habitat does not exist in the Study Area. This species is <b>unlikely to occur</b> in the Study Area.

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
	Cth		WA	Beach			Rocky outcrops	Dunes	Disturbed areas			
PSITTACIFORMES												
<i>Polytelis alexandrae</i>	Princess Parrot	VU	P4	The Princess Parrot is sparsely distributed across arid regions of WA, SA, and the NT. It inhabits sand dunes and sand flats and occurs in open savanna woodlands and shrublands. It requires hollowing-bearing Eucalyptus trees near waterways for nesting but will occasionally nest in <i>Allocasuarina decasneana</i> trees away from water (TSSC, 2018).	Low	-	-	Y	-	Suitable foraging habitat may exist in the Study Area, but no hollow-bearing trees exist or proximity to freshwater. This species is <b>unlikely</b> to occur in the Study Area.		
STRIGIFORMES												
<i>Ninox connivens connivens</i>	Barking Owl	-	P3	The Barking Owl inhabits open country, with stands of trees, tree-lined watercourses, or paperbark swamps in north and northwest Australia (Morcombe, 2010). It is most common in savannah woodland, as well as forested hill and riverine woodlands. It nests in hollows of tree trunks (Australian Museum, 2020a).	Low	-	-	-	-	Suitable habitat exists in the Study Area. This species <b>may occur</b> .		
<i>Tyto novaehollandiae kimberli</i>	Masked Owl (northern)	VU	P1	The Masked Owl roosts and nests in heavy forests, and hunts over open woodlands or farmlands. It is uncommon to rare in Australia (Morcombe, 2010). The distribution of the northern subspecies is poorly	Low	-	-	-	-	No suitable habitat in the Study Area. This species is <b>unlikely</b> to occur in the Study Area.		

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
			Cth	WA			Beach	Rocky outcrops	Dunes	Disturbed areas		
					known, but three subpopulations have been suggested: Kimberley, NT, and Cape York. The subspecies has been recorded in riparian, rain-, and open forest, Melaleuca swamps, and the edges of mangroves (DoE, 2020h).							
<i>Tyto novaehollandiae novaehollandiae</i>	Masked Owl (southern)	-	P3	The Masked Owl roosts and nests in heavy forests, and hunts over open woodlands or farmlands. It is uncommon to rare in Australia (Morcombe, 2010).	Low	-	-	-	-	No suitable habitat exists at the Study Area. This subspecies has not been recorded in northern Australia and is <b>unlikely to occur</b> in the Study Area.		
REPTILES												
ELAPIDAE												
<i>Simoselaps minimus</i>	Dampierland Burrowing Snake	-	P2	The Dampierland Burrowing Snake is known only from Dampier Land, in the southwest Kimberley. It inhabits coastal dunes and sandy junctions between dunes and adjacent Acacia shrublands (Wilson and Swan, 2010).	High	-	-	Y	-	Suitable habitat exists in the Study Area. This species is <b>likely to occur</b> .		
SCINCIDAE												
<i>Ctenotus angusticeps</i>	Airlie Island Ctenotus	-	P3	The Airlie Island Ctenotus is known from 12 localities in WA. Roebuck Bay individuals inhabit coastal mudflats vegetated with samphire, while other mainland populations inhabit fringes of salt marsh	Low	-	-	-	-	No suitable habitat exists in the Study Area. This species is <b>unlikely</b> to occur.		



Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
	Cth		WA	Beach			Rocky outcrops	Dunes	Disturbed areas			
					communities in samphire shrubland or marine couch grassland (Wilson and Swan, 2010; DoE, 2020c).							
<i>Lerista separanda</i>	Dampierland Plain Slider	-	P2	The Dampierland Plain Slider inhabits sandy areas of the southwest Kimberley coast, between Kimbolton and Nita Downs (Wilson and Swan, 2010).	High	-	-	Y	-	Suitable habitat exists in the Study Area. This species is <b>likely to occur</b> .		
MAMMALS												
EMBALLONURIDAE												
<i>Saccolaimus saccolaimus nudicluniatu</i>	Bare-rumped Sheath-tailed Bat	VU	P3	The Bare-rumped Sheath-tailed Bat is uncommon, with deficient information. it inhabits lowland areas, typically in a range of woodland, forest, and open environments (DoE, 2020i). It roosts in tree hollows, and forages above the canopy or lower in forest clearings (Menkhorst and Knight, 2011).	Low	-	-	Y	-	The species’ range is not known to extend to the southwest Kimberley. However, suitable habitat may occur within the Study Area, if nearby trees are hollow-bearing. The species is <b>may occur</b> .		
MOLOSSIDAE												
<i>Ozimops cobourgianus</i>	North-western Free-tailed Bat	-	P1*	The North-western Free-tailed Bat typically inhabits forests and woodlands, as well as near-coastal Melaleuca forests, rainforests, Eucalypt forests, woodlands, open floodplains, and saline coastal flats (Reardon <i>et al.</i> , 2017).	Low	-	-	Y	-	Suitable habitat may exist in the Study Area. This species is <b>may occur</b> .		

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
			Cth	WA			Beach	Rocky outcrops	Dunes	Disturbed areas		
MURIDAE												
<i>Hydromys chrysogaster</i>	Water-rat (Rakali)	-	P4	The Rakali is widespread and common in much of coastal north, east, and southwest Australia. It inhabits a variety of aquatic environments, including subalpine streams, slow inland rivers, lakes, farm dams, and sheltered marine waters. It typically forages in water or adjacent vegetation, and lives in burrows alongside rivers or lake banks (Menkhorst and Knight, 2011).	Low	-	-	-	-	This species has not been recorded on the Dampier Peninsula. This species is <b>unlikely to occur</b> in the Study Area.		
<i>Mesembriomys macrurus</i>	Golden-backed Tree-rat	-	P4	The Golden-backed Tree-rat is restricted to the northwest Kimberley. It is arboreal, but spends a large amount of time on the ground; it shelters and nests in tree hollows or in dense cover, such as pandanus foliage (Menkhorst and Knight, 2011). It inhabits rainforest and riparian areas, Eucalypt-dominated woodlands and savannas, <i>Livistona</i> palm woodlands, and rugged sandstone plateaux and screes (TSSC, 2019).	Low	-	-	-	-	This species’ range no longer includes the Study Area, and suitable habitat does not exist. This species is <b>unlikely to occur</b> in the Study Area.		
<i>Xeromys myoides</i>	Water Mouse, False Water-rat	VU	-	The Water Mouse occurs in the NT and QLD. It inhabits saline grassland, mangroves, margins of freshwater swamps, and lakes close to	Low	-	-	-	-	While suitable habitat may exist in the northern Kimberley, this species has never been recorded		

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
	Cth		WA	Beach			Rocky outcrops	Dunes	Disturbed areas			
					foredunes. It constructs leaf nests in networks of burrows in muddy banks or clay mounds, with entrances in raised mounds (Menkhorst and Knight, 2011).						in WA, and suitable habitat does not exist in the Study Area. This species is <b>unlikely to occur</b> in the Study Area.	
DASYURIDAE												
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	EN	The Northern Quoll is predominantly nocturnal. It dens in rock crevices, tree holes or occasionally termite mounds (TSSC, 2005). In WA, it is restricted to the Pilbara and Kimberley regions (TSSC, 2005). The Northern Quoll occurs in a variety of habitats across their range, including low open eucalypt woodland and hummock grass, and deciduous vine thicket and open eucalypt woodland over dense grasses. Rocky habitat constitutes habitat critical to the survival of this species (Hill and Ward, 2010).	Low	-	-	-	-	No suitable habitat exists in the Study Area. This species has not previously been recorded on the Dampier Peninsula, and is <b>unlikely to occur</b> in the Study Area.		
PHALANGERIDAE												
<i>Trichosurus vulpecula arnhemensis</i>	Northern Brushtail Possum	-	VU	The Northern Brushtail Possum occurs in northern WA and the NT. It inhabits most treed environments in Australia, including closed and open forests and woodlands in sub-/tropical areas (AFD, 2015). It dens in tree hollows or other sheltered	Low	-	-	-	-	This species has been recorded near Broome previously; however, no suitable habitat exists in the Study Area. This species is <b>unlikely to occur</b> .		

Scientific	Species	Common	Cons. Code		Habitat	Likelihood of Occurrence	Suitable Habitat					Comments
			Cth	WA			Beach	Rocky outcrops	Dunes	Disturbed areas		
					areas, sometimes at ground level (Menkhorst and Knight, 2011).							
<i>Wyulda squamicaudata</i>	Scaly-tailed Possum	-	P4	The Scaly-tailed Possum is patchily distributed in the northwest Kimberley in low open woodlands, riparian forest, and vine thickets where tumbled boulders provide shelter. It shelters in rock crevices during the day, and is active nocturnally (Menkhorst and Knight, 2011).	Low	-	-	-	-	No suitable habitat exists in the Study Area. This species has not been recorded on the Dampier Peninsula, and is <b>unlikely to occur</b> in the Study Area.		
THYLACOMYIDAE												
<i>Macrotis lagotis</i>	Bilby	VU	VU	The distribution of the Greater Bilby has greatly declined since European settlement, with populations now restricted to the north of Australia. Currently, this species occupies three habitat types: i) open tussock grassland on uplands and hills; ii) mulga woodland/shrubland on ridges and rises; and iii) hummock grassland on sand plains and dunes, drainage systems, salt lake systems, and other alluvial areas. The species is solitary and shelters in burrows during daylight (Pavey, 2006a).	High	-	-	Y	-	Suitable habitat is known to occur, and the current range of the species includes the Study Area. This species is considered <b>likely to occur</b> in the Study Area.		

CR Critically Endangered; EN Endangered; VU Vulnerable, NT Near Threatened. IA Listed as a 'Migratory species' under International Agreement under the EPBC Act. M Listed as a 'Marine species' under the EPBC Act. OS Listed as 'Other specially protected fauna' under the BC Act. P1-3 Listed as 'Priority 1-3: Poorly-known species' under the BC Act. P4 Listed as 'Priority 4: Rare, Near Threatened and other species in need of monitoring' under the BC Act. \* Listed under a different scientific name.

### 5.1.2 Fauna Habitats

Four habitat types occur in the Study Area – Beach, Rocky Outcrops, Dunes and Disturbed Areas. Fauna Habitats are shown in Figure 5-3. Within the Disturbance Envelope there are all four habitat types, with Disturbed Areas being the predominant type, a small area of degraded dunes habitat and a small area of beach and rocky outcrop (Table 5-2).







**Table 5-2: Fauna Habitat extents in the Study Area**

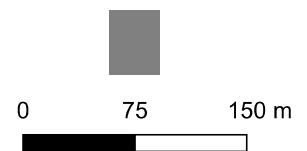
Habitat Type	Extent in the Study Area (ha)	Extent in the Development Envelope (ha)
Dunes	2.426	0.205
Beaches and Rocky Outcrops	0.204	0.026
Disturbed Areas.	2.770	1.834



Figure 5-3. Fauna Habitat

Legend

- |   |   |
|---|---|
|  KMOF Study Area           |  Fauna Habitat           |
|  KMOF Development Envelope |  Dunes                   |
|   |  Sand and Rocky Outcrops |
|   |  Disturbed Areas         |



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Date: 15/05/2020  
Coordinate Reference System: GDA94 / MGA Zone 51

## 6 CONCLUSIONS

### 6.1 VEGETATION OF CONSERVATION SIGNIFICANCE

Woodman (2008) noted that vegetation communities vary significantly on the Broome Peninsula moving northwards from the Port of Broome, due to the effect of the ocean on the climate at either end of the Broome Peninsula. The location of the Port of Broome is at the southernmost extent of the Dampier Peninsula, and as such is the driest.

A number of locations have been described here as the Threatened Ecological Community 'Monsoon vine thickets on the coastal sand dunes of the Dampier Peninsula', despite previously not attracting this description from other flora surveys.

Black et al., (2010) describe the TEC in this location as Group B. Group B patches occur at and towards the southern end of the distribution of thickets on each of the west and east coasts of the Peninsula. In comparison with the other patch groups, Group B patches are situated on low dunes and other relatively exposed locations, are depauperate in evergreen trees, and have a more open shrubby structure. The observed occurrences in this survey are of this structure. Prior to the comprehensive survey and description of the TEC by Black et al (2010), previous surveys may have considered the density of vine thicket species in this area to be insufficient to merit designation as the TEC. Description of the Group B by Black et al (2010) and acceptance of those occurrences in the Interim Recovery Plan (DBCA 2018) lead to a reinterpretation of the vegetation as the TEC.

Woodman Environmental Consultants (2008) mapped the area in the south western corner of the peninsula as being FCT1 and FCT3d. Woodman Environmental Consultants (2008) considered the vegetation 3d to be disturbed. It is possible that the development area to the north has altered the surface and groundwater flows in the locality such that the remnant dunes no longer receive runoff from the north. This would reduce the available water and lead to a reduction in the condition of the vegetation. However, the vine thickets of the Dampier Peninsula were on the margins of the sites sampled by McKenzie et al., (1991) in the assessment of Kimberly Rainforest, as well as the margin of rainforest distribution in the south western Kimberley. It is considered here that the sparser canopy and occurrence of non-vine thicket species is more a reflection of the marginal suitability of the site rather than any human induced disturbance, and the vegetation is considered to be generally in Very Good to Good condition.

There are approximately 2,887 hectares in 90 occurrences of the Monsoon Vine Thicket community recorded on Biodiversity, Conservation and Attractions' TEC database. The average area of occurrences is about 33ha (DBCA. 2018). The occurrences in the Broome Port Authority area are comparatively small.

The main disturbance is the presence of weeds considered High Threat by Environs Kimberly (2010). Although present their distribution is generally quite restricted and much of the vegetation is weed free and in Very Good condition.

Yet the area of Monsoon Vine Thicket within the Disturbance Envelope is in Poor condition. This small area (430 m<sup>2</sup>) occurs at the tail end of the vegetation type extent and consists of a few isolated shrubs that are common to the Vine Thicket vegetation type. The vegetation in this location is transitioning towards VA1 sand dune vegetation. The area is bordered by disturbed areas on the north and south and has a high density of the weed species *Cenchrus biflorus*. The landform appears to be previously disturbed or part of a built landform and the vegetation is likely spontaneous regeneration.



An area of the P1 PEC *Corymbia paractia* woodland was recorded outside of the Study Area. This area is unlikely to be impacted by the Proposed KMOF Project, given the majority of the Disturbance Envelope is on previously disturbed land.

A small area of VA1 vegetation in Poor condition is within the Disturbance Envelope, this vegetation is not of conservation significance.

## 6.2 FLORA OF CONSERVATION SIGNIFICANCE

No conservation significant flora was recorded in the Disturbance Envelope.

One species of conservation significant flora was recorded on the boundary of the Study Area. The Priority 3 *Acacia monticola* x *Tumida* var *kulparn* individuals are outside of the Development Envelope and are unlikely to be impacted by the proposed KMOF project. The hybrid is common in the Broome area.

The Threatened flora *Seringia extasia* was observed from a known location 250 m from the Study Area. This area is unlikely to be impacted by the Proposed KMOF Project. The species was found to be in a healthy condition and immature flowers were present on the shrubs. The species was in a suitable condition to be detected during targeted searches. The species was not recorded within the Study Area or in any new locations during the reconnaissance survey. The species does not occur in the Development Envelope and habitat within the Development envelope is not suitable, given the known and highly restricted distribution.

The P1 flora *Corymbia paractia* was recorded outside of the Study Area. This area is unlikely to be impacted by the Proposed KMOF Project. The species does not occur within the Development Envelope or the Study Area. Suitable habitat does not occur within the Development Envelope.

Of the 16 conservation significant flora assessed as possibly present in the Study Area from the desktop study, 11 species are known to inhabit pindan or sandplain. These species were included despite the majority of the landform being deep sand dunes. That was due to a very small amount of area near Quadrats 1 and 5 having some transition towards sandplain soil and vegetation. These species were not recorded in the Study Area during the Targeted Searches. The land within the Disturbance Envelope is not suitable habitat for these species.

## 6.3 FAUNA HABITATS OF CONSERVATION SIGNIFICANCE

Database searches identified 82 conservation significant terrestrial species (excluding shorebirds) that may occur in the area. Within the DBCA conservation significant fauna database there are 3 records within the Study Area all for *Sula leucogaster* (Brown Booby) listed under International Agreements (IA) under State and Federal legislation and as a Marine (M) bird under Federal legislation.

The Study Area contains suitable foraging habitat for 7 bird species with a High likelihood of occurrence and suitable foraging habitat for 4 bird species with a Moderate likelihood of occurrence. No suitable habitat occurs for nesting or breeding for conservation significant birds within the Study Area.

No Database records of conservation significant reptiles occur within the Study Area. The Dampierland Burrowing Snake (P2) and Dampierland Plains Slider (P2) are known to occur in the region and potentially suitable habitat exists in the dunes of the Study Area.

There are no terrestrial mammal records in the DBCA conservation significant fauna database for the Study Area. Records from the Broome area are shown in Figure 5-2. Of the conservation significant mammals known from the area, suitable habitat is present only for the Bilby.

Given the small area and degraded condition of the Dunes vegetation within the Development Envelope, it is very unlikely to provide suitable habitat for the Bilby. Prior to vegetation clearing the dune vegetation should be checked for the presence of Dampierland Burrowing Snake (P2) and Dampierland Plains Slider (P2) and any individuals translocated under appropriate licenses. The small amount of area to be cleared is very small and in poor condition in comparison to the adjoining vegetation which is larger and of higher quality.

Whilst a number of conservation significant bird species may find the area within the Development Envelope potentially suitable habitat for foraging, the small amount of area to be cleared is very small and in poor condition in comparison to the adjoining vegetation which is larger and of higher quality. All potential bird users are highly mobile and will move away from any disturbance.

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## APPENDICES



## **APPENDIX A: DBCA CATEGORIES**



Department of Biodiversity,  
Conservation and Attractions

## CONSERVATION CODES

### For Western Australian Flora and Fauna

Threatened, Extinct and Specially Protected fauna or flora<sup>1</sup> are species<sup>2</sup> which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

#### **T** **Threatened species**

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

**Threatened fauna** is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

**Threatened flora** is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

#### **CR** **Critically endangered species**

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

#### **EN** **Endangered species**

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

#### **VU** **Vulnerable species**

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

### **Extinct species**

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

#### **EX Extinct species**

Species where *"there is no reasonable doubt that the last member of the species has died"*, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

#### **EW Extinct in the wild species**

Species that *"is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form"*, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

### **Specially protected species**

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

#### **MI Migratory species**

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

#### **CD Species of special conservation interest (conservation dependent fauna)**

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

#### **OS Other specially protected species**

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.



**P Priority species**

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists 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 fauna or flora.

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 species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

**1 Priority 1: Poorly-known species**

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

**2 Priority 2: Poorly-known species**

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

**3 Priority 3: Poorly-known species**

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations 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 locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

**4 Priority 4: 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 are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

<sup>1</sup> The definition of flora includes algae, fungi and lichens

<sup>2</sup> Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

## **APPENDIX B: PMST SEARCH RESULTS**



# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 17/03/20 14:14:34

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



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[Coordinates](#)

Buffer: 40.0Km





# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	1
<a href="#">Wetlands of International Importance:</a>	1
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	1
<a href="#">Listed Threatened Ecological Communities:</a>	1
<a href="#">Listed Threatened Species:</a>	30
<a href="#">Listed Migratory Species:</a>	67

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Land:</a>	2
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	104
<a href="#">Whales and Other Cetaceans:</a>	13
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	1

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<a href="#">State and Territory Reserves:</a>	10
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	19
<a href="#">Nationally Important Wetlands:</a>	3
<a href="#">Key Ecological Features (Marine)</a>	None

# Details

## Matters of National Environmental Significance

### National Heritage Properties [\[ Resource Information \]](#)

Name	State	Status
Natural		
<a href="#">The West Kimberley</a>	WA	Listed place

### Wetlands of International Importance (Ramsar) [\[ Resource Information \]](#)

Name	Proximity
<a href="#">Roebuck bay</a>	Within Ramsar site

### Commonwealth Marine Area [\[ Resource Information \]](#)

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

### Marine Regions [\[ Resource Information \]](#)

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
<a href="#">North-west</a>

### Listed Threatened Ecological Communities [\[ Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
<a href="#">Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula</a>	Endangered	Community likely to occur within area

### Listed Threatened Species [\[ Resource Information \]](#)

Name	Status	Type of Presence
Birds		

<a href="#">Calidris canutus</a>		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area

<a href="#">Calidris ferruginea</a>		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

<a href="#">Calidris tenuirostris</a>		
Great Knot [862]	Critically Endangered	Roosting known to occur within area

<a href="#">Charadrius leschenaultii</a>		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area

<a href="#">Charadrius mongolus</a>		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area

<a href="#">Erythrura gouldiae</a>		
Gouldian Finch [413]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
<a href="#">Limosa lapponica baueri</a> Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Limosa lapponica menzbieri</a> Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Papasula abbotti</a> Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
<a href="#">Polytelis alexandrae</a> Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Rostratula australis</a> Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
<a href="#">Tyto novaehollandiae kimberli</a> Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#">Balaenoptera musculus</a> Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
<a href="#">Macrotis lagotis</a> Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Breeding known to occur within area
<a href="#">Saccolaimus saccolaimus nudicluniatus</a> Bare-rumped Sheath-tailed Bat, Bare-rumped Sheath-tail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Xeromys myoides</a> Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
<b>Plants</b>		
<a href="#">Keraudrenia exastia</a> Fringed Keraudrenia [66301]	Critically Endangered	Species or species habitat known to occur within area
<b>Reptiles</b>		
<a href="#">Aipysurus apraefrontalis</a> Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Breeding known to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Breeding likely to occur within area

Name	Status	Type of Presence
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
<b>Sharks</b>		
<a href="#">Carcharodon carcharias</a> White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
<a href="#">Pristis clavata</a> Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis pristis</a> Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis zijsron</a> Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
<a href="#">Rhincodon typus</a> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

#### Listed Migratory Species [ Resource Information ]

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Migratory Marine Birds</b>		
<a href="#">Anous stolidus</a> Common Noddy [825]		Species or species habitat likely to occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Calonectris leucomelas</a> Streaked Shearwater [1077]		Species or species habitat known to occur within area
<a href="#">Fregata ariel</a> Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
<a href="#">Fregata minor</a> Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
<a href="#">Sternula albifrons</a> Little Tern [82849]		Breeding known to occur within area
<b>Migratory Marine Species</b>		
<a href="#">Anoxypristis cuspidata</a> Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
<a href="#">Balaenoptera edeni</a> Bryde's Whale [35]		Species or species habitat may occur within area
<a href="#">Balaenoptera musculus</a> Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
<a href="#">Carcharodon carcharias</a> White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Breeding known to occur within area
<a href="#">Crocodylus porosus</a> Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
<a href="#">Dugong dugon</a> Dugong [28]		Foraging, feeding or related behaviour known to occur within area
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Breeding likely to occur within area
<a href="#">Isurus oxyrinchus</a> Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
<a href="#">Isurus paucus</a> Longfin Mako [82947]		Species or species habitat likely to occur within area
<a href="#">Manta alfredi</a> Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
<a href="#">Manta birostris</a> Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Breeding known to occur within area
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
<a href="#">Orcaella heinsohni</a> Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
<a href="#">Orcinus orca</a> Killer Whale, Orca [46]		Species or species habitat may occur within area
<a href="#">Pristis clavata</a> Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis pristis</a> Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis zijsron</a> Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
<a href="#">Rhincodon typus</a> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
<a href="#">Sousa chinensis</a> Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
<a href="#">Tursiops aduncus (Arafura/Timor Sea populations)</a> Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
<b>Migratory Terrestrial Species</b>		
<a href="#">Cecropis daurica</a> Red-rumped Swallow [80610]		Species or species habitat known to occur

Name	Threatened	Type of Presence
<a href="#">Cuculus optatus</a> Oriental Cuckoo, Horsfield's Cuckoo [86651]		within area  Species or species habitat known to occur within area
<a href="#">Hirundo rustica</a> Barn Swallow [662]		Species or species habitat known to occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat known to occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat known to occur within area
<b>Migratory Wetlands Species</b>		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat known to occur within area
<a href="#">Arenaria interpres</a> Ruddy Turnstone [872]		Roosting known to occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Roosting known to occur within area
<a href="#">Calidris alba</a> Sanderling [875]		Roosting known to occur within area
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat known to occur within area
<a href="#">Calidris ruficollis</a> Red-necked Stint [860]		Roosting known to occur within area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Roosting known to occur within area
<a href="#">Charadrius bicinctus</a> Double-banded Plover [895]		Roosting known to occur within area
<a href="#">Charadrius leschenaultii</a> Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
<a href="#">Gallinago megala</a> Swinhoe's Snipe [864]		Roosting likely to occur within area
<a href="#">Gallinago stenura</a> Pin-tailed Snipe [841]		Roosting likely to occur within area
<a href="#">Glareola maldivarum</a> Oriental Pratincole [840]		Roosting known to occur within area
<a href="#">Limicola falcinellus</a> Broad-billed Sandpiper [842]		Roosting known to occur

Name	Threatened	Type of Presence
<a href="#">Limnodromus semipalmatus</a> Asian Dowitcher [843]		within area  Roosting known to occur within area
<a href="#">Limosa lapponica</a> Bar-tailed Godwit [844]		Species or species habitat known to occur within area
<a href="#">Limosa limosa</a> Black-tailed Godwit [845]		Roosting known to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Numenius minutus</a> Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
<a href="#">Numenius phaeopus</a> Whimbrel [849]		Roosting known to occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Breeding known to occur within area
<a href="#">Pluvialis fulva</a> Pacific Golden Plover [25545]		Roosting known to occur within area
<a href="#">Pluvialis squatarola</a> Grey Plover [865]		Roosting known to occur within area
<a href="#">Tringa brevipes</a> Grey-tailed Tattler [851]		Roosting known to occur within area
<a href="#">Tringa glareola</a> Wood Sandpiper [829]		Roosting known to occur within area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
<a href="#">Tringa stagnatilis</a> Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
<a href="#">Tringa totanus</a> Common Redshank, Redshank [835]		Roosting known to occur within area
<a href="#">Xenus cinereus</a> Terek Sandpiper [59300]		Roosting known to occur within area

## Other Matters Protected by the EPBC Act

### Commonwealth Land [\[ Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Defence - BROOME TRAINING DEPOT

### Listed Marine Species [\[ Resource Information \]](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Birds</b>		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat known to occur within area



Name	Threatened	Type of Presence
<a href="#">Anous stolidus</a> Common Noddy [825]		Species or species habitat likely to occur within area
<a href="#">Anseranas semipalmata</a> Magpie Goose [978]		Species or species habitat may occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Breeding known to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Arenaria interpres</a> Ruddy Turnstone [872]		Roosting known to occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Roosting known to occur within area
<a href="#">Calidris alba</a> Sanderling [875]		Roosting known to occur within area
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat known to occur within area
<a href="#">Calidris ruficollis</a> Red-necked Stint [860]		Roosting known to occur within area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Roosting known to occur within area
<a href="#">Calonectris leucomelas</a> Streaked Shearwater [1077]		Species or species habitat known to occur within area
<a href="#">Charadrius bicinctus</a> Double-banded Plover [895]		Roosting known to occur within area
<a href="#">Charadrius leschenaultii</a> Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
<a href="#">Charadrius ruficapillus</a> Red-capped Plover [881]		Roosting known to occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
<a href="#">Chrysococcyx osculans</a> Black-eared Cuckoo [705]		Species or species habitat known to occur within area
<a href="#">Fregata ariel</a> Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
<a href="#">Fregata minor</a> Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
<a href="#">Gallinago megala</a> Swinhoe's Snipe [864]		Roosting likely to occur within area
<a href="#">Gallinago stenura</a> Pin-tailed Snipe [841]		Roosting likely to occur within area
<a href="#">Glareola maldivarum</a> Oriental Pratincole [840]		Roosting known to occur within area
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
<a href="#">Heteroscelus brevipes</a> Grey-tailed Tattler [59311]		Roosting known to occur within area
<a href="#">Himantopus himantopus</a> Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
<a href="#">Hirundo daurica</a> Red-rumped Swallow [59480]		Species or species habitat known to occur within area
<a href="#">Hirundo rustica</a> Barn Swallow [662]		Species or species habitat known to occur within area
<a href="#">Limicola falcinellus</a> Broad-billed Sandpiper [842]		Roosting known to occur within area
<a href="#">Limnodromus semipalmatus</a> Asian Dowitcher [843]		Roosting known to occur within area
<a href="#">Limosa lapponica</a> Bar-tailed Godwit [844]		Species or species habitat known to occur within area
<a href="#">Limosa limosa</a> Black-tailed Godwit [845]		Roosting known to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat known to occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat known to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Numenius minutus</a> Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
<a href="#">Numenius phaeopus</a> Whimbrel [849]		Roosting known to occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Breeding known to occur within area
<a href="#">Papasula abbotti</a> Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
<a href="#">Pluvialis fulva</a> Pacific Golden Plover [25545]		Roosting known to occur within area
<a href="#">Pluvialis squatarola</a> Grey Plover [865]		Roosting known to occur within area
<a href="#">Recurvirostra novaehollandiae</a> Red-necked Avocet [871]		Roosting known to occur within area
<a href="#">Rostratula benghalensis (sensu lato)</a> Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
<a href="#">Sterna albifrons</a> Little Tern [813]		Breeding known to occur within area
<a href="#">Tringa glareola</a> Wood Sandpiper [829]		Roosting known to occur within area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
<a href="#">Tringa stagnatilis</a> Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
<a href="#">Tringa totanus</a> Common Redshank, Redshank [835]		Roosting known to occur within area
<a href="#">Xenus cinereus</a> Terek Sandpiper [59300]		Roosting known to occur within area
<b>Fish</b>		
<a href="#">Campichthys tricarinatus</a> Three-keel Pipefish [66192]		Species or species habitat may occur within area
<a href="#">Choeroichthys brachysoma</a> Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
<a href="#">Choeroichthys suillus</a> Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
<a href="#">Corythoichthys flavofasciatus</a> Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
<a href="#">Cosmocampus banneri</a> Roughridge Pipefish [66206]		Species or species habitat may occur within area
<a href="#">Doryrhamphus excisus</a> Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
<a href="#">Doryrhamphus janssi</a> Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
<a href="#">Filicampus tigris</a> Tiger Pipefish [66217]		Species or species habitat may occur within area
<a href="#">Halicampus brocki</a> Brock's Pipefish [66219]		Species or species habitat may occur within area
<a href="#">Halicampus grayi</a> Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
<a href="#">Halicampus nitidus</a> Glittering Pipefish [66224]		Species or species habitat may occur within area
<a href="#">Halicampus spinirostris</a> Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
<a href="#">Haliichthys taeniophorus</a> Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
<a href="#">Hippichthys penicillus</a> Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
<a href="#">Hippocampus histrix</a> Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
<a href="#">Hippocampus kuda</a> Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
<a href="#">Hippocampus planifrons</a> Flat-face Seahorse [66238]		Species or species habitat may occur within area
<a href="#">Hippocampus spinosissimus</a> Hedgehog Seahorse [66239]		Species or species habitat may occur within area
<a href="#">Hippocampus trimaculatus</a> Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
<a href="#">Micrognathus micronotopterus</a> Tidepool Pipefish [66255]		Species or species habitat may occur within area
<a href="#">Solegnathus hardwickii</a> Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
<a href="#">Solegnathus lettiensis</a> Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
<a href="#">Solenostomus cyanopterus</a> Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
<a href="#">Syngnathoides biaculeatus</a> Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
<a href="#">Trachyrhamphus bicoarctatus</a> Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
<a href="#">Trachyrhamphus longirostris</a> Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#">Dugong dugon</a> Dugong [28]		Foraging, feeding or related behaviour known to occur within area
<b>Reptiles</b>		
<a href="#">Acalyptophis peronii</a> Horned Seasnake [1114]		Species or species habitat may occur within

Name	Threatened	Type of Presence area
<a href="#">Aipysurus apraefrontalis</a> Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Aipysurus duboisii</a> Dubois' Seasnake [1116]		Species or species habitat may occur within area
<a href="#">Aipysurus eydouxii</a> Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
<a href="#">Aipysurus laevis</a> Olive Seasnake [1120]		Species or species habitat may occur within area
<a href="#">Aipysurus tenuis</a> Brown-lined Seasnake [1121]		Species or species habitat may occur within area
<a href="#">Astrotia stokesii</a> Stokes' Seasnake [1122]		Species or species habitat may occur within area
<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Breeding known to occur within area
<a href="#">Crocodylus johnstoni</a> Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
<a href="#">Crocodylus porosus</a> Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
<a href="#">Disteira kingii</a> Spectacled Seasnake [1123]		Species or species habitat may occur within area
<a href="#">Disteira major</a> Olive-headed Seasnake [1124]		Species or species habitat may occur within area
<a href="#">Emydocephalus annulatus</a> Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
<a href="#">Ephalophis greyi</a> North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Breeding likely to occur within area
<a href="#">Hydrelaps darwiniensis</a> Black-ringed Seasnake [1100]		Species or species habitat may occur within area
<a href="#">Hydrophis elegans</a> Elegant Seasnake [1104]		Species or species habitat may occur within area
<a href="#">Hydrophis mcdowelli</a> null [25926]		Species or species habitat may occur within

Name	Threatened	Type of Presence
<a href="#">Hydrophis ornatus</a> Spotted Seasnake, Ornate Reef Seasnake [1111]		area  Species or species habitat may occur within area
<a href="#">Lapemis hardwickii</a> Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
<a href="#">Pelamis platurus</a> Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

## Whales and other Cetaceans [ Resource Information ]

Name	Status	Type of Presence
<b>Mammals</b>		
<a href="#">Balaenoptera edeni</a> Bryde's Whale [35]		Species or species habitat may occur within area
<a href="#">Balaenoptera musculus</a> Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
<a href="#">Delphinus delphis</a> Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
<a href="#">Grampus griseus</a> Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Breeding known to occur within area
<a href="#">Orcaella brevirostris</a> Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
<a href="#">Orcinus orca</a> Killer Whale, Orca [46]		Species or species habitat may occur within area
<a href="#">Pseudorca crassidens</a> False Killer Whale [48]		Species or species habitat likely to occur within area
<a href="#">Sousa chinensis</a> Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
<a href="#">Stenella attenuata</a> Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
<a href="#">Tursiops aduncus</a> Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
<a href="#">Tursiops aduncus (Arafura/Timor Sea populations)</a> Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
<a href="#">Tursiops truncatus s. str.</a> Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Australian Marine Parks		[ Resource Information ]
Name	Label	
Roebuck	Multiple Use Zone (IUCN VI)	

## Extra Information

State and Territory Reserves		[ Resource Information ]
Name	State	
Broome Bird Observatory	WA	
Broome Wildlife Centre	WA	
Unnamed WA51105	WA	
Unnamed WA51162	WA	
Unnamed WA51497	WA	
Unnamed WA51583	WA	
Unnamed WA51617	WA	
Unnamed WA51932	WA	
Unnamed WA52354	WA	
Yawuru	WA	

Invasive Species	[ Resource Information ]
Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.	

Name	Status	Type of Presence
<b>Birds</b>		
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Sturnus vulgaris		
Common Starling [389]		Species or species habitat likely to occur within area
<b>Frogs</b>		
Rhinella marina		
Cane Toad [83218]		Species or species habitat may occur within area
<b>Mammals</b>		
Camelus dromedarius		
Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris		
Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus		
Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus		
Horse [5]		Species or species habitat likely to occur



Name	Status	Type of Presence
<i>Felis catus</i> Cat, House Cat, Domestic Cat [19]		within area  Species or species habitat likely to occur within area
<i>Mus musculus</i> House Mouse [120]		Species or species habitat likely to occur within area
<i>Oryctolagus cuniculus</i> Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
<i>Rattus rattus</i> Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
<i>Sus scrofa</i> Pig [6]		Species or species habitat likely to occur within area
<i>Vulpes vulpes</i> Red Fox, Fox [18]		Species or species habitat likely to occur within area

#### Plants

<i>Cenchrus ciliaris</i> Buffel-grass, Black Buffel-grass [20213]	Species or species habitat likely to occur within area
<i>Dolichandra unguis-cati</i> Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]	Species or species habitat likely to occur within area
<i>Jatropha gossypifolia</i> Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf <i>Jatropha</i> , Black Physic Nut [7507]	Species or species habitat likely to occur within area
<i>Prosopis</i> spp. Mesquite, Algaroba [68407]	Species or species habitat likely to occur within area

#### Reptiles

<i>Hemidactylus frenatus</i> Asian House Gecko [1708]	Species or species habitat likely to occur within area
<i>Ramphotyphlops braminus</i> Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]	Species or species habitat known to occur within area

#### Nationally Important Wetlands

#### [ Resource Information ]

Name	State
<a href="#">Roebuck Bay</a>	WA
<a href="#">Roebuck Plains System</a>	WA
<a href="#">Willie Creek Wetlands</a>	WA

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

## Coordinates

-18.00536 122.21101

# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [Office of Environment and Heritage, New South Wales](#)
- [Department of Environment and Primary Industries, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment, Water and Natural Resources, South Australia](#)
- [Department of Land and Resource Management, Northern Territory](#)
- [Department of Environmental and Heritage Protection, Queensland](#)
- [Department of Parks and Wildlife, Western Australia](#)
- [Environment and Planning Directorate, ACT](#)
- [Birdlife Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [South Australian Museum](#)
- [Queensland Museum](#)
- [Online Zoological Collections of Australian Museums](#)
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
- [State Herbarium of South Australia](#)
- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- [Australian Tropical Herbarium, Cairns](#)
- [eBird Australia](#)
- [Australian Government – Australian Antarctic Data Centre](#)
- [Museum and Art Gallery of the Northern Territory](#)
- [Australian Government National Environmental Science Program](#)
- [Australian Institute of Marine Science](#)
- [Reef Life Survey Australia](#)
- [American Museum of Natural History](#)
- [Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

## **APPENDIX C: SURVEY SITE DETAILS**

Kimberley Marine Support Base - Biological Survey  
Appendix C - Quadrat Site Data

Quadrat	Date	Site Type	Datum	x	y	Landscape position	Aspect
1	21/03/2020	Quadrat 50 x 50 m	GDA 94 UTM Zone 50	416254	8009066	Sandplain	none, probably very gently slope to water in the south
2	21/03/2020	Quadrat 50 x 50 m	GDA 94 UTM Zone 50	416176	8009122	Sand dune	undulating
3	21/03/2020	Quadrat 70 x 30 m	GDA 94 UTM Zone 50	416061	8009135	Sand dune	undulating
5	21/03/2020	Quadrat 50 x 50 m	GDA 94 UTM Zone 50	416049	8009180	Sand dune	undulating
6	21/03/2020	Quadrat 50 x 50 m	GDA 94 UTM Zone 50	416162	8009192	Sand dune	undulating
7	21/03/2020	Quadrat 50 x 50 m	GDA 94 UTM Zone 50	416238	8009159	Sand dune	undulating
8	21/03/2020	Quadrat 100 x 25 m	GDA 94 UTM Zone 50	416165	8009232	Swale	low point between dunes and plain
9	21/03/2020	Quadrat 50 x 50 m	GDA 94 UTM Zone 50	416459	8009182	Foredune	south east
Quadrat	Vegetation	Condition	Disturbances	Time since fire		Soil texture	Soil colour
1	VA1	Very Good	Occasional weeds	Long unburned		Clay sand/sand	Red brown
2	VA1	Very Good	Occasional weeds			Sand	Pale brown
3	VA3	Very Good	Occasional weeds			Sand	Pale brown
5	VA1	Very Good	Occasional weeds			Sand	Pale brown
6	VA1	Very Good	Occasional weeds			Sand	Pale brown
7	VA1	Very Good	Occasional weeds			Sand	Red brown
8	VA3	Very Good	Occasional weeds			Sand	Red brown
9	VA1	Good	Occasional weeds high			Sand	Red brown
Quadrat	Litter			Comments			
1				Some elements of sandplain			
2							
3	litter 100% cover under canopy to 5 cm deep						
5				Some elements of sandplain			
6				Has a rock armoured drain			
7				Has a rock armoured drain			
8							
9							

Kimberley Marine Support Base - Biological Survey  
Appendix C - Quadrat Site Data

Quadrat	Vegetation unit	Condition	Disturbances	Time since fire	Soil texture	Soil colour	Litter
1	VA1	Very Good	Occasional weeds	Long unburned	Clay sand/sand	Red brown	
2	VA1	Very Good	Occasional weeds	Long unburned	Sand	Pale brown	
3	VA3	Very Good	Occasional weeds	Long unburned	Sand	Pale brown	litter 100% cover under canopy to 5 cm deep
5	VA1	Very Good	Occasional weeds	Long unburned	Sand	Pale brown	
6	VA1	Very Good	Occasional weeds	Long unburned	Sand	Pale brown	
7	VA1	Very Good	Occasional weeds	Long unburned	Sand	Red brown	
8	VA3	Very Good	Occasional weeds	Long unburned	Sand	Red brown	
9	VA1	Good	Occasional weeds highly fragmented	Long unburned	Sand	Red brown	
Quadrat							
1							
2							
3							
5							
6							
7							
8							
9							
Quadrat							
1							
2							
3							
5							
6							
7							
8							
9							

Kimberley Marine Support Base - Biological Survey  
Appendix C - Quadrat Site Data

Quadrat	Comments
1	Some elements of sandplain
2	
3	
5	Some elements of sandplain
6	Has a rock armoured drain
7	Has a rock armoured drain
8	
9	
Quadrat	
1	
2	
3	
5	
6	
7	
8	
9	
Quadrat	
1	
2	
3	
5	
6	
7	
8	
9	



## APPENDIX D: SPECIES BY SITE MATRIX

## Kimberley Marine Support Base - Biological Survey

## Appendix D - Flora species by site matrix

Family	Taxon	1	2	3	5	6	7	8	9	Opportunistic records
Amaranthaceae	<i>*Aerva javanica</i>	0.1			0.1	0.01	0.1		0.01	
Apocynaceae	<i>Carissa lanceolata</i>			0.1				0.1		
Arecaceae	<i>Livistona</i> sp.									Y
Boraginaceae	<i>Ehretia saligna</i>							1		
	<i>Heliotropium leptaleum</i>						0.01			
	<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>						5	0.1		
Cleomaceae	<i>Cleome viscosa</i>	0.1	0.1	0.1		1	0.1		1	
Combretaceae	<i>Terminalia ferdinandiana</i>						0.1			
	<i>Terminalia petiolaris</i>									
Convolvulaceae	<i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i>	5			1	20	5	1	30	
Euphorbiaceae	<i>Euphorbia coghlanii</i>	0.1	0.05	1	2		0.1		0.1	
	<i>Mallotus nesophilus</i>				0.1			2		
Fabaceae	<i>Abrus precatorius</i> subsp. <i>precatorius</i>			1				1		
	<i>Acacia bivenosa</i>	50	1	1	15	20	20	0.1	2	
	<i>Acacia monticola</i> x <i>Tumida</i> var <i>kulparn</i>	0.1								
	<i>Acacia monticola</i>	0.5								
	<i>Acacia pyrifolia</i> var <i>pyrifolia</i>	0.1								
	<i>Bauhinia cunninghamii</i>			60				5		
	<i>Canavalia rosea</i>		25							
	<i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i>	0.1	40	0.1	30	20	5	1	15	
	<i>Crotalaria medicaginea</i>							0.1		
	<i>Cullen martinii</i>	1							0.1	
	<i>Indigofera hirsuta</i>				1					
	<i>Rhynchosia minima</i>	0.5			0.1		5		0.1	
	<i>Tephrosia rosea</i>	0.5	0.1		0.1			0.1	0.1	
Goodeniaceae	<i>Goodenia armitiana</i>									Y
Hernandiaceae	<i>Gyrocarpus americanus</i> subsp <i>pachyphyllus</i>		0.1	30			1	70		
Lamiaceae	<i>*Mesosphaerum suaveolens</i>									Y
Lauraceae	<i>Cassytha filiformis</i>			0.1	0.1			0.1	1	
Malvaceae	<i>Adansonia gregorii</i>					0.5				
	<i>Corchorus sidoides</i>	0.5								
	<i>Gossypium australe</i>			25						
	<i>Grewia savannicola</i>							0.1		
	<i>Sida rohlenae</i> subsp. <i>occidentalis</i>				0.01			0.1		
Menispermaceae	<i>Tinospora smilacina</i>	0.5	0.1	1	1	10	20	30	1	
Myrtaceae	<i>Corymbia paractia</i>									Y
Moraceae	<i>Ficus aculeata</i> var. <i>indecora</i>	0.1	0.5	30	0.1			5	1	
Nyctaginaceae	<i>Boerhavia gardneri</i>	0.1	0.1	1	2	1	0.1	0.1		
Oleaceae	<i>Jasminum didymum</i> subsp <i>lineare</i>			0.1				0.1		
Passifloraceae	<i>*Passiflora foetida</i> var. <i>hispida</i>							0.1		
Phyllanthaceae	<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>	0.1								
Poaceae	<i>*Cenchrus ciliaris</i>						1			
	<i>*Cenchrus echinatus</i>									Y
	<i>*Cenchrus biflorus</i>	20			5		3	0.1	5	
	<i>*Cenchrus setiger</i>				0.2					
	<i>Aristida holathera</i> var <i>holathera</i>	0.5			0.1		5		0.1	
	<i>Panicum decompositum</i>	0.1	20		30	20	20	0.1	20	
	<i>Sorghum stipoides</i>								0.01	
	<i>Spinifex longifolius</i>		0.1	30	50	5	1	30	20	

Kimberley Marine Support Base - Biological Survey

Appendix D - Flora species by site matrix

Family	Taxon	1	2	3	5	6	7	8	9	Opportunistic records
	<i>Triodia microstachya</i>			20				1		
	<i>Eragrostis eriopoda</i>									Y
Proteaceae	<i>Hakea macrocarpa</i>							0.1		
Solanaceae	<i>Seringia extasia</i>									Y
	<i>Solanum cunninghamii</i>							0.1		
Zygophyllaceae	<i>*Tribulus terrestris</i>		0.1				0.1			

## **APPENDIX E: FLORA SPECIES ACCUMULATION CURVE**

The Species Accumulation Curves calculated from the data collected in the Detailed Survey show the observed number of species (Sobs) to be equal to the expected number of species (UGE) (Figure 1).

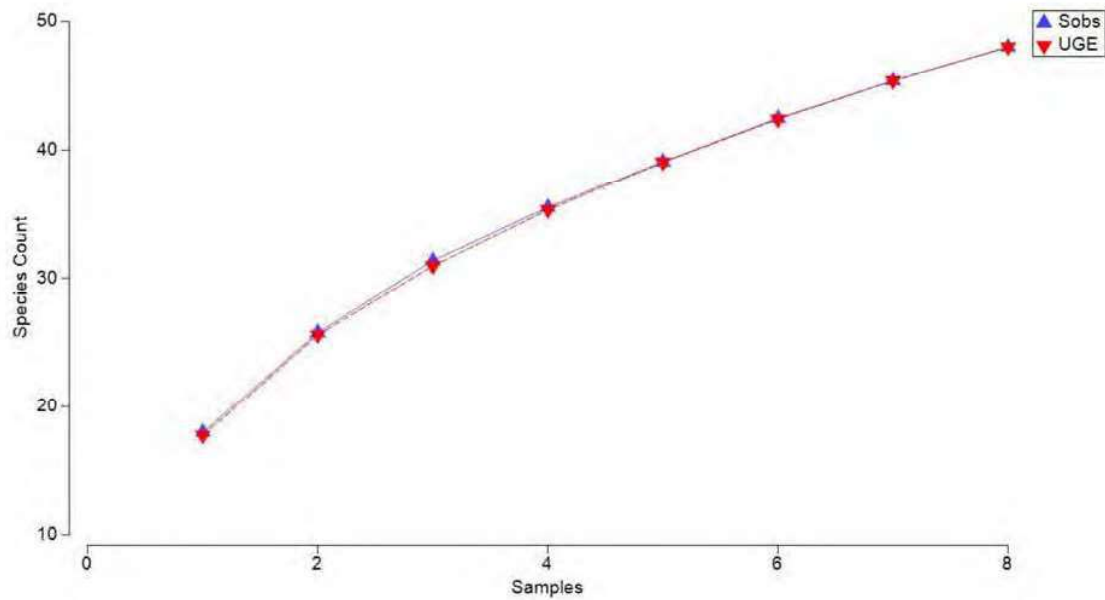


Figure 1. Flora species accumulation curve for the Kimberly Marine Support Base Detailed Survey. Sobs is the observed species diversity from 8 detailed quadrat surveys. UGE is the derived expected species diversity calculated using the Primer 7 statistics package using the method published in Ugland et al (2003).

#### References:

Ugland K, Gray JS, Ellingsen K (2003) *Journal of Animal Ecology* 72: 888-897.

## Appendix B Eco logical Australia (2019) – *Kabbarli Road Biological Survey* – *Field Survey Results*

## MEMORANDUM

TO	Kimberley Ports Authority
FROM	Eco Logical Australia
DATE	15 January 2019
SUBJECT	Kabbarli Road foreshore – Field Survey Results

### Introduction

Eco Logical Australia (ELA) was engaged by Kimberley Ports Authority (KPA) to undertake a field survey to support a clearing permit for Kabbarli Road foreshore (the study area) which may need to be cleared to support a new pontoon jetty in the future.

Specifically the scope of work was to undertake a targeted conservation listed flora survey and detailed (level two) vegetation survey.

The study area is approximately 2.0 hectares and is located approximately 6.3 kilometres south west of the Broome town centre, Western Australia

### Methods

#### *Desktop review and likelihood of occurrence*

Prior to the survey, ELA conducted a desktop assessment to gather information on potentially occurring conservation listed flora, vegetation and fauna within the study area. The following databases were searched:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) for Threatened species and communities listed under the EPBC Act (Department of the Environment and Energy [DoEE] 2019); and
- Department of Biodiversity Conservation and Attractions (DBCA) and WA Museum's NatureMap database (DBCA 2007 –).

A 20 km buffer around the study area was used for each of the above database searches. This buffer is considered suitable based on flora expected to occur within the study area. An initial 13 conservation listed flora taxa were identified as possibly occurring within the study area based on database searches.

In addition, a review of previous studies relevant to the study area was also undertaken where applicable, including:



- *Floristic Community Types of the Broome Peninsula* (Woodman Environmental Consulting [Woodman] 2008)

### ***Survey team and timing***

The survey was undertaken over a single day by ELA Senior Ecologist Dr Jeff Cargill on the 4 December 2018. The flora survey was conducted in accordance with the Environmental Protection Authority (EPA) *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

The Kimberley region experiences very hot wet summers and mild dry winters. The Broome Airport weather station (station number 3003; climate data 1939-2018), located approximately 5 kilometres north east of the survey area, reports that on average, Broome receives 628.1 millimetres (mm) of rain per annum; with 75% of this rain falling between January to March each year (Bureau of Meteorology (BoM) 2019). Maximum mean monthly temperatures range from 28.9°C (July) to 33.9°C (December). The temperature during the survey was hot, with a maximum temperature experienced during the survey of 33.5°C. No rain was recorded during this time.

A total of 4.8 mm of rain was recorded in the three calendar months prior to the surveys (Sep-Nov; BoM 2019). This is lower than the long-term average for the same period (11.8 mm; BoM 2019).

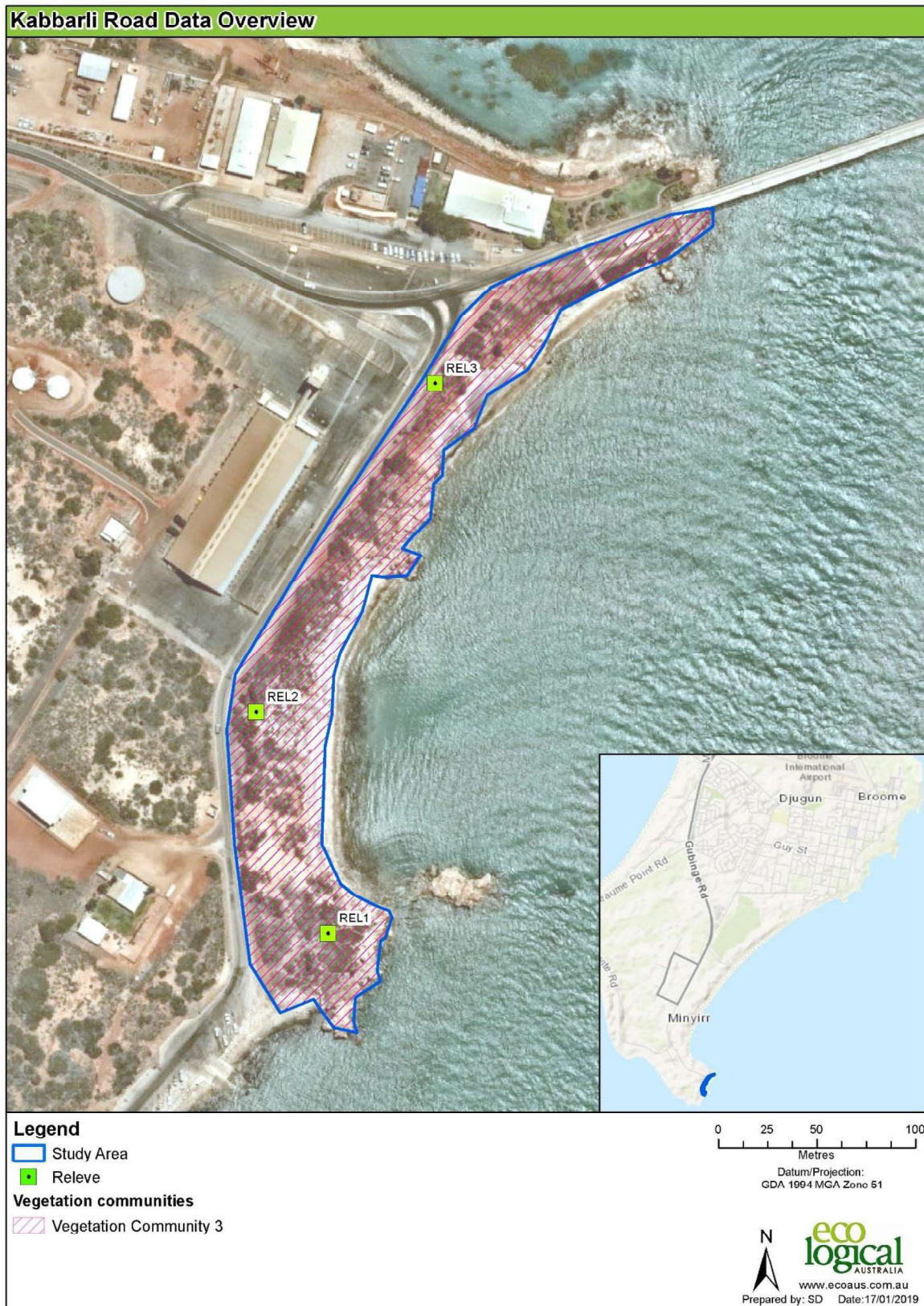
Although rainfall was below average and the survey was conducted outside of the optimum survey timing for flora in the region, this was not a limitation for the purposes of the survey. Specifically, the preferred survey timing for the Northern Botanical Province is post wet-season (January to March), however the timing of a supplementary survey post wet season is considered satisfactory as the expected vegetation and species present would be actively growing and able to be correctly identified.

### ***Flora***

The desktop review, including review of aerial imagery and previous background survey reports, informed the approximate number of sites required to describe vegetation communities within the study area. Three unbound 'releve' sites were established (REL1, REL2, REL3) to delineate and characterise vegetation communities within the study area. Relevés were used to sample the study area due to safety concerns with accessing suitable areas to establish quadrats. The location of the relevés is shown in Figure 1.

The following tasks were undertaken as part of the flora and vegetation survey:

- Vegetation assessment to delineate and characterise vegetation communities within the study area including vegetation condition assessment in accordance with *EPA Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016);
- Survey for conservation significant flora and vegetation communities; and
- Record opportunistic introduced flora, specifically Weeds of National Significance and Declared Pests under the *Biosecurity and Agriculture Management Act 2007*.



**Figure 1:** Site overview and survey effort



## Results

A total of 17 taxa from 15 genera and seven families were recorded from within the study area. A complete flora species list is provided in **Appendix A**. Fabaceae had the highest number of species (seven species) and *Acacia* and *Crotalaria* were the best represented genera with two taxa recorded each. Site data is presented in **Appendix B**.

No Federal or State listed Threatened or Priority flora species were recorded within the study area. Of the 13 conservation listed flora species identified in the desktop assessment as possibly occurring, all were considered as unlikely to occur, based adequate survey effort and/or lack of suitable habitat. The flora likelihood of occurrence assessment is presented in **Appendix C**.

Two introduced flora species, *\*Cenchrus ciliaris* and *\*Aerva javanica* were recorded within the study area. *\*Cenchrus ciliaris* was dominant in parts occurring with cover ranging from 0.50% - 20.00% while *\*Aerva javanica* was sparse with cover ranging from 0.01% - 0.30%.

One vegetation community was identified within the study area (**Figure 2**):

- **Vegetation Community 3** - *Acacia bivenosa*, *Acacia ampliceps*, *Crotalaria cunninghamii* tall sparse shrubland over *Ipomoea pes-caprae*, *Tinospora smilacina*, *Euphorbia myrtilloides* low isolated shrubs and *\*Cenchrus ciliaris*, *Spinifex longifolius* low sparse tussock grassland.



Figure 2 – Vegetation community 3 within the Kabbarli Road Foreshore site.

No vegetation has been mapped in previous studies covering the study area, specifically, Woodman (2008) mapped the entire study area as 'bare areas' and did not assign a vegetation type.

Vegetation recorded within the study area does not constitute any known Threatened Ecological Communities (TECs) listed under the EPBC Act or *Biodiversity Conservation Act 2016* or Priority Ecological Communities (PECs) listed by DBCA.

Vegetation within the study area was classed as being in Very Good - Good condition throughout based on the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). Evidence of disturbance included impacts from grazing, heat stress, weeds, tracks and erosion. The study area was estimated to have been burnt > 20 years ago.

### **Summary**

No Federal or State listed Threatened or Priority flora species listed by DBCA were recorded within the study area. All conservation significant flora species identified in the database searches were considered unlikely to occur due to adequate survey effort and high detectability of the species (e.g. perennial shrubs) and/or lack of core habitat for these species.

One vegetation community was identified within the study area. This vegetation community does not represent any known TECs or PECs. Vegetation condition was Good – Very Good with disturbances including impacts from grazing, heat stress, weeds, tracks and erosion. In particular, the grass weed \**Cenchrus ciliaris* was dominant in parts occurring with cover up to 20% in parts of the study area.

## References

Bureau of Meteorology (BOM). 2019. *Climate Data Online*. Available from: <http://www.bom.gov.au/climate/data/>. Accessed January 2019.

Department of the Environment and Energy (DoEE). 2019. *EPBC Act Protected Matters Search Tool*. Available from: <http://www.environment.gov.au/epbc/pmst/index.html> . Accessed January 2019.

Department of Biodiversity, Conservation and Attractions (DBCA). 2007 -. *NatureMap*. Department of Parks and Wildlife and WA Museum. Available from: <http://naturemap.dpaw.wa.gov.au/default.aspx>. Accessed January 2019.

Environmental Protection Authority (EPA). 2016. Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment. Perth, Western Australia.

Woodman. 2008. *Broome Port Authority – Floristic Community Types of the Broome Peninsula*. Unpublished Report by Woodman Environmental Consulting Pty Ltd for the Broome Port Authority, Broome, WA.

## Appendix A: Flora species list

Family	Confirmed Name
Amaranthaceae	<i>*Aerva javanica</i>
Convolvulaceae	<i>Ipomoea pes-caprae</i>
Euphorbiaceae	<i>Euphorbia ?myrtoides</i>
Fabaceae	<i>Acacia ampliceps</i>
	<i>Acacia bivenosa</i>
	<i>Canavalia rosea</i>
	<i>Crotalaria cunninghamii</i>
	<i>Crotalaria medicaginea</i>
	<i>Rhyncosia minima</i>
	<i>Tephrosia</i> sp.
Lauraceae	<i>Cassytha</i> sp.
Menispermaceae	<i>Tinospora smilacina</i>
Poaceae	<i>*Cenchrus ciliaris</i>
	<i>Aristida holathera</i>
	<i>Poaceae</i> sp.
	<i>Spinifex longifolius</i>
	<i>Triodia</i> sp.

## Appendix B: Flora site data

Site name and number	Date	Site type	Observer
REL07	04/12/2018	Releve	JC
Condition	Disturbance	Fire history - years	Landscape type
Good - Very Good	Grazing, heat stress, weeds and tracks	Old >20	Dune
Soil type/geology	Soil colour	Outcropping (%)	Slope (%) / aspect
Fine sand, ironstone	Very light red	<2	5%, E
Easting		Northing	
416402		8008902	



Species	Height (cm)	Cover (%)
<i>*Aerva javanica</i>	30	0.01
<i>*Cenchrus ciliaris</i>	50	0.5
<i>Acacia bivenosa</i>	180	10
<i>Aristida holathera</i>	25	0.01
<i>Canavalia rosea</i>	40	3
<i>Crotalaria cunninghamii</i>	100	0.2
<i>Crotalaria medicaginea</i>	55	0.2
<i>Euphorbia ?myrtoides</i>	25	0.01
<i>Ipomoea pes-caprae</i>	20	0.05
<i>Poaceae</i> sp.	70	0.15
<i>Spinifex longifolius</i>	50	2

Species	Height (cm)	Cover (%)
<i>Tephrosia</i> sp.	20	0.01
<i>Tinospora smilacina</i>	30	0.15
<i>Triodia</i> sp.	40	10



Site name and number	Date	Site type	Observer
REL08	04/12/2018	Releve	JC
Condition	Disturbance	Fire history - years	Landscape type
Good - Very Good	Erosion and weeds	Old >20	Dune
Soil type/geology	Soil colour	Outcropping (%)	Slope (%) / aspect
Fine sand	Very light red	0	20%, E
Easting		Northing	
416367		8009015	



Species	Height (cm)	Cover (%)
<i>*Aerva javanica</i>	40	0.3
<i>*Cenchrus ciliaris</i>	35	1
<i>Acacia ampliceps</i>	300	10
<i>Acacia bivenosa</i>	160	8
<i>Cassytha</i> sp.	cl	0.01
<i>Crotalaria cunninghamii</i>	110	0.15
<i>Euphorbia ?myrtoides</i>	25	0.1
<i>Ipomoea pes-caprae</i>	40	2.5
<i>Poaceae</i> sp.	35	0.1
<i>Rhyncosia minima</i>	cl	0.02
<i>Spinifex longifolius</i>	50	5
<i>Tinospora smilacina</i>	cl	0.2

Site name and number	Date	Site type	Observer
REL09	04/12/2018	Releve	JC
Condition	Disturbance	Fire history - years	Landscape type
Good	Erosion and weeds	Old >20	Dune
Soil type/geology	Soil colour	Outcropping (%)	Slope (%) / aspect
Fine sand, ironstone	Very light red	0	20%, E
Easting		Northing	
416457		8009181	



Species	Height (cm)	Cover (%)
<i>*Aerva javanica</i>	35	0.1
<i>*Cenchrus ciliaris</i>	40	20
<i>Acacia ampliceps</i>	200	3.5
<i>Acacia bivenosa</i>	150	10
<i>Aristida holathera</i>	35	0.3
<i>Cassytha</i> sp.	cl	0.01
<i>Crotalaria cunninghamii</i>	120	0.1
<i>Crotalaria medicaginea</i>	45	0.05
<i>Euphorbia</i> ?myrtoides	25	0.01
<i>Ipomoea pes-caprae</i>	35	2
<i>Poaceae</i> sp.	45	0.2
<i>Tinospora smilacina</i>	cl	0.05

## Appendix C: Flora likelihood assessment

Species Name	EPBC Act <sup>1</sup>	BC Act <sup>2</sup>	DBCA <sup>3</sup>	Source <sup>4</sup>	Lifeform/Habitat	Likelihood
<i>Seringia exastia</i> (Fringed fire-bush)	CR	CR	T	NatureMap PMST	Pindan (red soil) heathland. North-facing dune slope and flats.	<b>Unlikely.</b> Habitat is marginally suitable and the closest record is approx. 1.2 km away, however this species is a shrub that grows to 0.9 m high and would have been visible if present.
<i>Corymbia paractia</i>			P1	NatureMap	Skeletal soils. In transition zone between coastal beach dunes & red pindan soils.	<b>Unlikely.</b> Habitat is potentially suitable and the closest record is approx. 2.0 km away, however this species is a tree that grows 4-6 m high and would have been visible if present.
<i>Jacquemontia</i> sp. Broome (A.A. Mitchell 3028)			P1	NatureMap	Sandy soils, red pindan soils.	<b>Unlikely.</b> Habitat is marginally suitable however the closest record is approx. 17 km away, and this species is a low perennial herb/shrub that would have been visible if present.
<i>Thespidium basiflorum</i>			P1	NatureMap	Sandy soils. Creeks.	<b>Unlikely.</b> Habitat is marginally suitable however the closest record is approx. 18 km away, and this species is a low perennial herb/shrub that would have been visible if present.
<i>Gomphrena pusilla</i>			P2	NatureMap	Fine beach sand. Behind foredune, on limestone.	<b>Unlikely.</b> Habitat potentially suitable however the closest record is approx. 10 km away and this species has not been recorded in other targeted flora surveys in the area.
<i>Acacia monticola</i> x <i>tumida</i> var. <i>kulparn</i>			P3	NatureMap	Coastal cliffs, sand.	<b>Unlikely.</b> Habitat is not suitable and the closest record is approx. 3.6 km away, this species is also a shrub and would have been visible if present.

Species Name	EPBC Act <sup>1</sup>	BC Act <sup>2</sup>	DBCA <sup>3</sup>	Source <sup>4</sup>	Lifeform/Habitat	Likelihood
<i>Aphyllodium glossocarpum</i>			P3	NatureMap	Sand. Pindan.	<b>Unlikely.</b> Habitat is marginally suitable, the closest record is approx. 12 km away and this species is a shrub that grows to 1.2 m high and would have been visible if present.
<i>Glycine pindanica</i>			P3	NatureMap	Pindan soils.	<b>Unlikely.</b> Habitat is marginally suitable and the closest record is approx. 4.6 km away, however this species is a low scrambling perennial herb and would have been visible if present.
<i>Goodenia byrnesii</i>			P3	NatureMap	Sand. Edge of creek.	<b>Unlikely.</b> Habitat is not suitable and the closest record is approx. 1.8 km away, however although this species is a herb it would have been actively growing and visible at the time of the survey.
<i>Nicotiana heterantha</i>			P3	NatureMap	Black clay. Seasonally wet flats.	<b>Unlikely.</b> Habitat not suitable and closest record is approx. 14 km away.
<i>Polymeria</i> sp. Broome (K.F. Kenneally 9759)			P3	NatureMap	Plain, dune swale, orange/red sand.	<b>Unlikely.</b> Habitat is potentially suitable and the closest record is approx. 5.1 km away, however this species is a low trailing herb and would have been visible at the time of the survey.
<i>Seringia katatona</i> (Red dune fire-bush)			P3	NatureMap	Dunes, red sand.	<b>Unlikely.</b> Habitat is potentially suitable and the closest record is approx. 8 km away, however this species is a shrub and would have been visible at the time of the survey.
<i>Terminalia kumpaja</i>			P3	NatureMap	Red sand, flats, dunes.	<b>Unlikely.</b> Habitat is potentially suitable and the closest record is approx. 6 km away, however this species is a tree and would have been visible at the time of the survey.

<sup>1</sup>EPBC Act = Flora listed under the Environment Protection and Biodiversity Conservation Act 1999.

CR = listed as Critically Endangered under the EPBC Act

<sup>2</sup>BC Act = Flora listed under the Biodiversity Conservation Act 2016. NB: the BC Act currently provides for species, subspecies or populations of native animals (fauna) to be listed as Specially Protected, Threatened (Critically Endangered, Endangered or Vulnerable) or Extinct in Western Australia however the Wildlife Conservation (Specially Protected Fauna) Notice 2018 was issued prior to the BC Act coming into effect and therefore WC Act codes have been included in the likelihood table.

CR = Critically Endangered species : Threatened species considered to be “facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines”.

<sup>3</sup>DBCA = Flora listed as Priority species under the Department of Biodiversity, Conservation and Attractions

P1 = Priority 1: Species that are known from one or a few locations (generally five or less) which are potentially at risk. Listed by DBCA

P2 = Priority 2: Poorly known species that are known from one or a few locations. Listed by DBCA.

P3 = Priority 3: Poorly known species that are known from several locations and the species does not appear to be under imminent threat. Listed by DBCA.

<sup>4</sup>NatureMap = NatureMap database search (DBCA 2007-)

PMST = EPBC Act Protected Matters Search Tool report (DoEE 2019).

Appendix C Woodman (2008) – *Broome Port Authority – Floristic  
Community Types of the Broome Peninsula*

# **BROOME PORT AUTHORITY**

## **FLORISTIC COMMUNITY TYPES OF THE BROOME PENINSULA**



**May 2008**



**woodmanenvironmentalconsulting**

**A.C.N. 088 055 903**



**DOCUMENT REVISION HISTORY**

<b>Revision</b>	<b>Description</b>	<b>Originator</b>	<b>Reviewed</b>	<b>Date</b>
A	Draft Report to Client	CG/KG	GW	21-05-08
0	Final Report	CG/KG	GW/ Capt. Vic Justice	30-05-08

WEC REF: POB07-21-01

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# TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>I</b>
<b>1. INTRODUCTION .....</b>	<b>4</b>
1.1 AIMS OF CURRENT REPORT.....	5
<b>2. BACKGROUND.....</b>	<b>5</b>
2.1 CLIMATE.....	5
2.2 GEOLOGY AND SOILS .....	6
2.3 VEGETATION.....	6
2.3.1 <i>Regional Vegetation Units</i> .....	6
2.3.2 <i>Local Vegetation Units</i> .....	11
2.3.3 <i>Threatened and Priority Ecological Communities</i> .....	16
2.4 FLORA.....	18
2.4.1 <i>Regional and Local Flora</i> .....	18
2.4.2 <i>Declared Rare and Priority Flora</i> .....	19
2.4.3 <i>Introduced Species</i> .....	21
2.5 WETLANDS OF SIGNIFICANCE.....	22
<b>2. METHODS.....</b>	<b>22</b>
2.1 COLLECTING LICENSES.....	23
2.2 FIELD SURVEY .....	23
2.3 PLANT COLLECTION AND IDENTIFICATION .....	24
2.4 STATISTICAL ANALYSIS .....	25
2.5 BOUNDARY MAPPING .....	25
<b>3. RESULTS.....</b>	<b>25</b>
4.1 FLORA.....	25
4.1.1 <i>Conservation Significant Species</i> .....	25
4.1.2 <i>Introduced Species</i> .....	27
4.1.3 <i>Notes on Indigenous Use of Plant Species in Survey Area</i> .....	29
4.2 VEGETATION.....	32
4.2.1 <i>Floristic Community Types</i> .....	32
<b>5. DISCUSSION .....</b>	<b>36</b>
5.1 CONSERVATION SIGNIFICANT FLORA .....	36
5.2 CONSERVATION SIGNIFICANT VEGETATION .....	37
5.3 PORT OF BROOME PROPOSED DEVELOPMENTS.....	38
<b>6. RECOMMENDATIONS.....</b>	<b>38</b>
<b>7. ACKNOWLEDGEMENTS.....</b>	<b>39</b>
<b>8. REFERENCES .....</b>	<b>40</b>

## Tables

Table 1:	Average Maximum and Minimum Temperatures (°C) and Rainfall (mm) at Broome Airport
Table 2:	Vegetation Types of the Dampier Peninsula (Kenneally <i>et. al.</i> 1996)
Table 3:	Vegetation Units on the Broome Coastline as described by Trudgen (1988)
Table 4:	Threatened Ecological Communities (TECs) and other Ecosystems at Risk known in the DL2 Subregion (Graham 2001)
Table 5:	Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) listed within the Dampierland Region (DEC 2006; 2008a)
Table 6:	Declared Rare and Priority flora known from the Dampierland Subregion (Graham 2001)
Table 7:	Invasive weed species known from the Survey Area (Department of Environment and Heritage 2008)
Table 8:	Location of Significant Flora Species Recorded during the Survey, August 2007 and April 2008
Table 9:	Location of Introduced Flora Species Recorded during the Survey, August 2007 and April 2008
Table 10:	Traditional Uses of Plant Species Recorded during the field survey, August 2007

## Appendices

Appendix A:	Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (Department of Environment and Conservation 2007)
Appendix B:	Description of Conservation Codes (Department of Environment and Conservation 2008b)
Appendix C:	GPS Locations of All Quadrats Established in August 2007 and April 2008, Port of Broome
Appendix D:	Vascular Plant Taxa recorded Within the Port of Broome Survey Area, August 2007 and April 2008
Appendix E:	Standard Control Codes for Declared Plants (Department of Agriculture and Food 2008)
Appendix F:	Vascular Plant Taxa Recorded Within Quadrats, Within each Floristic Community Type, August 2007 and April 2008

- Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008
- Appendix H: Summary Dendrogram of Relationships between Floristic Community Types, Port of Broome Quadrat Data
- Appendix I: Two-way Table, Ordination of Port of Broome Quadrat Data (PATN: Belbin 1989)
- Appendix J: Indicator Species Values (Monte Carlo Test), Port of Broome Quadrat Data
- Appendix K: Locations and Plant Numbers of *Keraudrenia exastia*, Port of Broome
- Appendix L: Proposed Environmental Management Plan Outline – Native Vegetation, Port of Broome

## Figures

- Figure 1: Broome Port Authority - Floristic Community Type Survey Area
- Figure 2: Broome Port Authority - Areas Proposed to be Cleared and Areas Proposed to be Conserved
- Figure 3a: Broome Port Authority - Floristic Community Types and Locations of Significant Flora Species Sheet 1 of 5
- Figure 3b: Broome Port Authority - Floristic Community Types and Locations of Significant Flora Species Sheet 2 of 5
- Figure 3c: Broome Port Authority - Floristic Community Types and Locations of Significant Flora Species Sheet 3 of 5
- Figure 3d: Broome Port Authority - Floristic Community Types and Locations of Significant Flora Species Sheet 4 of 5
- Figure 3e: Broome Port Authority - Floristic Community Types and Locations of Significant Flora Species Sheet 5 of 5

## EXECUTIVE SUMMARY

The Broome Port Authority (BPA) manages the Port of Broome, located approximately 2200 km north north-east of Perth, and is the largest port within the Kimberley Region. Approximately 128.1 ha of land is currently managed by the BPA, situated on the southern extremity of the Broome Peninsula on the south-west side of the township of Broome. The BPA are proposing to expand currently existing laydown areas for off-shore maritime industry support. A total of 30 ha of native vegetation is proposed to be cleared by the BPA as part of this project. Additionally, a further 43.85ha of native vegetation is proposed to be transferred into the Minyirr Park, as an environmental corridor.

Woodman Environmental Consulting Pty Ltd (Woodman Environmental) was commissioned by the BPA to provide a staged flora and vegetation review of the BPA managed lands. The survey area included in this report also included UCL to the north of this area. The main aims of this report were to describe and map the Floristic Community Types (FCTs) of the survey area, and to provide details regarding the impacts of the BPA proposal on the distribution of these FCTs, and known locations of Threatened Ecological Communities (TECs), Declared Rare Flora (DRF) and other conservation significant flora species known from the area.

The original field survey was conducted by Catherine Godden and Bianca Taylor from 27<sup>th</sup> – 31<sup>st</sup> August 2007, with a second field survey conducted by Greg Woodman, Bianca Taylor, Kylie Greenacre and Brendan Stratton from 7<sup>th</sup> – 11<sup>th</sup> April 2008. Assistance was provided by Mr. Neil McKenzie, an elder of the Yawuru tribe. A series of 31 20m x 20m permanent quadrats were established, from which information regarding height and percentage foliage cover of all alive species was recorded. Statistical analysis using PATN on presence/absence species data was undertaken in the field to determine FCTs present in the survey area. Aerial photography at a scale of 1:10 000 was utilised in conjunction with this data to determine FCT boundaries within the survey area.

A total of two Sub-groups and eight FCTs were determined from the statistical analysis. The two Sub-groups were composed of quadrats located in either coastal sites (sub-group 1) or on pindan soils (Sub-group 2). Three FCTs were identified within each Sub-group.

A total of 167 discrete vascular plant taxa, from 113 genera and 53 families, were recorded during the surveys conducted in August 2007 and April 2008.

Five conservation significant flora species were recorded during the surveys in August 2007 and April 2008. *Keraudrenia exastia*, a DRF taxon, was recorded in one quadrat. This species is known from the survey area, and it's current known distribution is restricted to this area. The plot was located near a known population, however was just outside of this area. Additional searching for this species found a total population within the Port of Broome managed lands of approximately 21,000 individuals.

*Goodenia byrnesii*(P1) was recorded in seven of the 31 quadrats established during the survey and also at various locations throughout the survey area. The distribution of this

species is restricted to the Northern Botanical Province, mostly near Broome and to north of Halls Creek (DEC 2008c).

*Triodia acutispicula* (P3) was also recorded in 17 of 31 quadrats established during this survey. This species is fairly widespread through the Kimberley region, and has previously been recorded by Woodman Environmental from sites to the east of Broome during other surveys. This species should be reviewed with a view to removing it from the Priority Flora list.

*Phyllanthus aridus*, a Priority 3 species, was recorded in one location in the Broome survey area, with Woodman Environmental Consulting previously recording several locations between Broome and Port Headland in 2007 (Woodman Environmental 2007e).

*Scleria* sp., a possible new taxon, was recorded in two of the 31 quadrats established. This taxon was also previously recorded by Woodman Environmental during a survey near Stokes Bay earlier in 2007, and requires more extensive survey and collecting in order to determine its taxonomic status.

The vegetation of the project area displayed the effects of long term disturbance associated with proximity to development with introduced species common. However the condition of the vegetation was mainly in Very Good Condition, with the exceptions being the edges of tracks and developed areas where weeds such as *Cenchrus ciliaris* (Buffel Grass) and *Aerva javanica* (Kapok) were common.

From this study it can be seen that the floristic groupings respond to a combination of soil type (pindan associations versus coastal dune sand associations), hydrology (dune crest associations versus vine thickets of the dune base) and climate factors (FCT 4 at the exposed southern end of the Peninsula on pindan soils versus FCT 5 on northern sections of the Peninsula on pindan soils).

This study has identified several floristic community types of conservation significance. FCT 3, which is representative of TEC 67 (Monsoon Thickets) is located on the inland side of coastal dunes along the Dampier Peninsula, and tend to become larger and have greater species diversity in a northwards direction. No intact areas of this FCT are located within the Port of Broome managed lands, though areas near the southern tip of the peninsula may have been representative of this FCT in the past prior to the severe disturbance associated with the Port and related activities since settlement.

The PEC 11 Kimberley (*Corymbia paractia* dominated community on dunes) is reportedly common between Gantheaume Point and Cable Beach, however it is apparently restricted to a narrow coastal zone in the Broome area where beach dunes merge into pindan soils (Kenneally *et. al.* 1996), and is often found mixed with rainforest (monsoon) species (Kevin Kenneally and Val English *pers. comm*). This community is likely to be either a subset of the TEC 67 community or to occur as a mosaic within it. This community could not be identified as a separate entity during this study and as such has not been mapped. This community is not located within the Port of Broome managed lands.

PEC 10 Kimberley (Dwarf pindan heath community of Broome coast). This community was described by Trudgen (1988) as 'AtGp' on pindan soils (Table 3), and is a reference to *Acacia tumida* var. *kulpan*, which occurs on coastal cliffs at Gantheaume Point and James Price Point as a wind pruned shrub to 50cm in height (Kevin Kenneally and Val English, *pers. comm.*). This vegetation type is discussed in Broome Botanical Society Inc. (1995), where it is located on the near-coastal hinterland from Gantheaume Point past Riddell Beach towards the Port of Broome. PEC 10's characteristics include low-profile wind-sheared shrubs, small areas of almost monotypic spinifex grasslands and traces of residual Pleistocene linear dunes. This community was mapped as FCT 6 and is not located within the Port of Broome managed lands.

FCT 4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions. This FCT is likely to be restricted to the southern end of the Broome Peninsula as it potentially occurs as a result of the unique climate of this area, being surrounded in close proximity on 3 sides by the Indian Ocean and Roebuck Bay. This has also been reported by Malcolm Trudgeon in his survey of the Broome Peninsula. Additional clearing of this FCT within the Port of Broome managed lands should concentrate on areas of degraded vegetation and be offset by areas of this community in Good condition or better being preserved within a reserve system.

The following recommendations are given:

#### **Keraudrenia exastia**

- Areas of proposed development should be re-designed to avoid all locations of this species, preferably leaving a buffer of approximately 50m.
- Conditions should be placed on all developments in the vicinity of this species to ensure the plants are protected from direct and indirect impacts such as dust and drainage from industrial sites.
- The populations of this species should be monitored every 3 years.
- The Port of Broome should liaise with the Broome Botanical Society and the Department of Environment and Conservation regarding the preservation of this species with the objective of identifying and funding appropriate research on the ecology and propagation strategies of the species. The results of this research to be used as part of a management/recovery plan for the species on the Broome Peninsula.

#### **Port of Broome Environmental Management Programme**

- An Environmental Management Plan (EMP) should be developed to address the on-going management of the Environmental Cultural Corridor and the remaining vegetation of the Port of Broome managed lands. This document should include sections on weed management, fire management, drainage, cultural aspects and monitoring. An outline for this EMP is provided in Appendix L.



## 1. Introduction

The Broome Port Authority (BPA) manages the Port of Broome, located approximately 2200 km north north-east of Perth, and is the largest port within the Kimberley Region. The Port currently handles a wide range of imports into and exports from Broome and supports many industries, including pearling, offshore oil and gas supply vessels, livestock exports and cruise liners, as well as being the largest fuel and container port for the region. The total length of the jetty was extended to 331m in 2005, to allow a greater volume of imports and exports, and to allow for correct segregation of non-compatible industries (Port of Broome 2008).

Approximately 128.1 ha of land is currently managed by the BPA, situated on the southern extremity of the Broome Peninsula on the south-west side of the township of Broome. The BPA are proposing to expand currently existing laydown areas for off-shore maritime industry support. A previous application to clear 3.3ha of native vegetation was approved in 2006, however advice from the Environmental Protection Authority (EPA) determined that the BPA was to prepare an environmental management plan to address the following issues:

- Protection of declared rare flora and locally significant vegetation
- Consideration of culturally significant vegetation
- Spatial arrangement of agreed environmental cultural corridors (ECCs) and commitments and to manage their on-going maintenance as ECCs;
- Weed management
- Impact of proposed land-use (EPA 2006).

Approximately 30 ha of native vegetation is proposed to be cleared by the BPA as part of this project. Additionally, approximately 43.85ha of native vegetation is proposed to be transferred into the Minyirr Park, as an environmental corridor. The Minyirr Park is situated on coastal country near Cable Beach and Roebuck Bay (Western Australian Planning Commission 2007). A Shire Coastal Management Committee has been established, composed of Rubibi and Shire of Broome representatives, working together with other groups and agencies to protect and promote Aboriginal culture and heritage, maintain the environmental integrity of the coastal areas and provide appropriate recreational activities (WAPC 2007).

Woodman Environmental Consulting Pty Ltd (Woodman Environmental) was commissioned by the BPA to provide the following:

- Field survey for *Keraudrenia exastia* (DRF) and other conservation significant species within the Port of Broome managed/owned lands, as well as in the region;
- Plant community mapping throughout the Port of Broome managed/owned lands, including searching for the known TEC in the area;
- Map location of all significant flora colonies;
- Establish the potential impact of proposed land use within Port Lands and adjacent lands;

- Formulate outline of a management plan for the environmental corridor (including strategies to encourage endangered flora species within the corridor)
- Formulate outline of a weed management plan.

The survey area utilised was located on the Broome Peninsula, extending northwards from the Port area to the south of the Broome township, to Gantheaume Point, extending just north of the airstrip, ending at Cable Beach Road. A small area of intact bushland was also included along the coastline to the south of the township. Only BPA-managed lands, and UCL were included in this survey. Figure 1 presents the survey area of the Broome Peninsula comprising 1400 ha.

## 1.1 Aims of Current Report

The aims of this report are to:

- Describe and map the Floristic Community Types (FCTs) of the Broome Peninsula (survey area)
- Report on potential impacts of the proposed development to DRF and Priority flora species in the area, as well as FCTs and known Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) known from the area.

## 2. Background

### 2.1 Climate

The climate of the Dampierland Region is Dry Hot Tropical, with 7-8 dry months per year (Beard 1990). The vast majority of the average annual rainfall is experienced in the months January – March, with lesser rainfall also experienced in December, and April – June (Table 1). Average maximum temperatures are hot, with little variation between months; the highest average maximum temperature occurs in March with 33.9°C, in comparison with lowest average maximum temperature of 28.8°C in July). There is more variation in the average minimum temperature, ranging between 26.4°C in December, and 13.6°C in July (Table 1).

<b>Table 1: Average Maximum and Minimum Temperatures (°C) and Rainfall (mm) at Broome Airport</b>			
<b>Month</b>	<b>Average Max. (°C)</b>	<b>Average Min. (°C)</b>	<b>Rainfall (mm)</b>
Jan	33.3	26.3	175.1
Feb	32.9	26	178.3
Mar	33.9	25.4	103.4
Apr	34.3	22.6	26.9
May	31.5	18.3	27.5
Jun	29.1	15.1	18.7
Jul	28.8	13.6	6
Aug	30.2	14.9	1.8
Sep	31.7	18.4	1.4
Oct	32.8	22.3	1.3
Nov	33.6	25	7.9

<b>Table 1: Average Maximum and Minimum Temperatures (°C) and Rainfall (mm) at Broome Airport</b>			
<b>Month</b>	<b>Average Max. (°C)</b>	<b>Average Min. (°C)</b>	<b>Rainfall (mm)</b>
Dec	33.8	26.4	53.1
Annual	32.2	21.2	599.9

Note: Data for Broome Airport; Temperature data averaged over years 1939 – 2007; Rainfall data averaged over years 1939 – 2008

Note: Data in red reflects the highest maximum and minimum temperatures and highest recorded rainfall; Data in blue reflects the lowest maximum and minimum temperatures and lowest recorded rainfall.

## 2.2 Geology and Soils

The survey area is situated on the Canning Basin, which contains Phanerozoic rocks laid down upon a Precambrian basement in various epochs, underlying plains or relatively low hills (Beard 1979). The sediments in the Canning Basin have remained largely flat-lying and unfolded, because the area has been relatively tectonically stable (Beard 1979). These Phanerozoic sedimentary basins were created at approximately the end of the Proterozoic time but subsidence of the crust to the southwest of the King Leopold mobile zone. This area has mainly been above sea level since the late Cretaceous period. The Kimberley area as a whole existed as an island separated from the rest of Western Australia by a marine gulf during the Palaeozoic and Mesozoic eras.

In the Canning Basin the earliest sediments are of Ordovician age, and comprise of limestone, dolomite and sandstone. Reef limestones of the Devonian area are known from the Canning Basin. Within the Canning Basin, laterite areas are overlain by sand with sandplains and dunefields occupying nearly all of the Dampier Peninsula and the western Fitzroy Basin, with the dunefields being linear and parallel.

The survey area is located on the Coastal Plains Region of the Dampierland Province of the Fitzroyland Physiographic Division (Beard 1979). The Dampierland Province is comprised of sandplains and dunefields underlain by Jurassic-Cretaceous sequences of conglomerate, sandstone and siltstone, with rocks being lateritised in many areas. The majority of the Province is less than 120m above current sea-levels, with slight relief (Beard 1979).

The main soil type of the Dampier Peninsula is the pindan, which developed over the Quaternary period. Red earthy sands predominate, and are formed from coherent clayish sands. There is little or no organised surface drainage, with seasonal runoff forming sheets of water behind the coastal dune systems. A more recent and coarser sand layer is also found around Broome (Kenneally *et. al.* 1996).

## 2.3 Vegetation

### 2.3.1 Regional Vegetation Units

The survey area is located within the Dampier Botanical District (Dampierland Region), of the Northern Province (Beard 1990). The Northern Province comprises approximately 12% of the land mass of the state of Western Australia. Most of the Northern Province is covered in grassland vegetation, with tropical savannas dominating the area, and spinifex grasslands

found on the fringes of the desert and on shallow, sandy or rocky soils (Beard 1990). Tropical savannahs usually consist of a tree stratum and grass stratum, however in areas either stratum may not be locally present, with a shrub stratum also sometimes occurring. Usually one or a few species will dominate the biomass of each stratum, with species dominating tree and grass strata being independent of each other.

The Dampierland Region extends from Eighty Mile Beach in the west to include Derby and Fitzroy Crossing in the east, and is bounded to the south by the Great Sandy Desert. The topography and soils of the Dampier Botanical District are composed of extensive riverine plains with grey and brown cracking clays, extensive sandplains on red earthy sands, low uplands of sandstone and limestone with shallow stony soils (Beard 1990). The area is underlain by a mixture of quaternary sandplain overlying jurassic sandstones; quaternary marine deposits on coastal plains, with devonian reef limestones and extensive alluvial river plains (Beard 1990).

The vegetation of the Dampier Botanical District was described by Beard (1990) as ‘Tree savannah of *Chrysopogon-Dichanthium* with scattered *Eucalyptus microtheca* and *Lysiphyllum cunninghamii* on river plains; pindan on sandplains. The latter is a ‘three-layered community, an open upper stratum of low trees, a closed middle layer of *Acacia* and an open ground layer of curly spinifex; hummock grassland with scattered trees on uplands’.

Pindan vegetation is characteristic of Dampierland, and occurs on all sandy plains. The pindan is a woody grassland, with a sparse upper layer of trees and a dense middle stratum of *Acacia* species. Fire is a major characteristic of the area, with the ground stratum of grasses and middle stratum of *Acacia* being periodically destroyed by fire; the grasses regenerate from seed or rhizomes which establish before the *Acacia* stratum does, giving rise to a savanna. After several years the *Acacia*-dominated stratum again comes to prominence and suppresses grasses, herbs and smaller woody plants (Beard 1990).

Heading north from Broome the pindan changes with increasing rainfall, with *Acacia tumida* replacing *Acacia eriopoda* as the dominant species in the middle-stratum and *Eucalyptus tectifera* and *Eucalyptus grandifolia* replacing tree species such as *Dolichandrone heterophylla*, *Erythrophleum chlorostachys*, *Gardenia keartlandii*, *Gyrocarpus americanus* and *Lysiphyllum cunninghamii*, which are dominant in the tree stratum further south of Broome. *Plectrachne pungens* and *Chrysopogon fallax* are also dominant grass species north of Broome, replacing *Triodia pungens* and *Plectrachne schinzii* which dominate further south.

On the coast *Spinifex longifolius* is the principal coloniser of beach dunes, especially the foredunes. On the Dampier Peninsula thickets of *Acacia ampliceps* dominate the leeward sides of the dunes, and also mixed vine thickets occur, which are best developed in the northern peninsula, but do extend as far south as Broome (Beard 1990). Typical components in the Broome area include *Terminalia petiolaris*, *Grewia breviflora*, *Pouteria sericea* and *Celtis philippinensis* with other pindan species and *Acacia* species.

Beard (1979) split the Dampier Botanical District into eight different Regions, including the Dampier Peninsula. The vegetation of the sandplain area is covered by pindan formation, which differs from the pindan further south (of the La Grange Plateau Region). The

vegetation is characteristically an open layer of trees (12-15m high) over typical pindan layer of dense *Acacia* (to 5m) over sparse grassy ground layer.

Heading north of Broome towards Beagle Bay the dominant tree species are *Eucalyptus polycarpa* and *E. papuana* forma with *E. setosa*, *Erythrophleum chlorostachys*, *Gyropcarpus americanus* and *Lysiphyllum cunninghamii*. *Acacia eriopoda* (with occasional *A. holosericea*), *Dolichandrone heterophylla*, *Gardenia keartlandii*, *Grevillea refracta*, *G. heliosperma*, *Hakea arborescens*, *H. macrocarpa*, *Petalostigma pubescens* and *Terminalia circumalata* dominate the pindan layer, over *Plectachne pungens* and *Chrysopogon* (Beard 1979). Approximately 25km north of Broome the vegetation changes, with the tree stratum increasing in height and consisting of *Eucalyptus tectifica* and *E. grandifolia*, and *Acacia tumida* replaces *Acacia eriopoda*. Beard (1979) mapped the survey area as Pindan woodland on extensive monotonous sandplain.

The survey area is situated in the Dampierland IBRA Region (Department of Environment and Heritage 2000), specifically within the DL2 (Pindanland) Subregion (Graham 2001). Broadscale mapping of the DL2 Subregion includes the following vegetation types:

- Mangroves
- Coastal dune communities
- Ephemeral herblands and/or grasslands with scattered low trees
- Mixed species tussock grasslands or sedgeland +/- emergent *Pandanus* sp. (screw palm)
- *Eucalyptus tectifera* (Darwin Box), *Corymbia flavescens* woodland with *Acacia tumida* (pindan wattle) open scrub and *Chrysopogon* spp. (ribbon grass) and *Triodia bitextura* grasses
- *Eucalyptus tetradonta* (Darwin stringybark), *Eucalyptus miniata* (Darwin woollybutt) +/- *Eucalyptus* spp. +/- *Livistona* spp. (fan palms) woodlands with a ground layer of tussock grasses and *Triodia bitextura*
- *Melaleuca citrolens* (lemon-scented teatree) with *Melaleuca* spp. (paperbark) low woodland with sparse *Chrysopogon fallax* (golden beard grass) tussock grasses
- *Adansonia gregorii* (boab), *Bauhinia cunninghamii* and *Grevillea striata* (beefwood) grassy low open-woodland
- *Corymbia dampieri* low open-woodland with *Acacia* spp. shrubs and *Triodia pungens* (soft spinifex) and *Triodia bitextura* hummock grasses
- *Eucalyptus brevifolia* (snappy gum) low open woodland with *Triodia* spp. (spinifex) hummock grasses or sometimes a hummock grassland without trees
- *Acacia ancistrocarpa* (Fitzroy Wattle) and/or *Acacia eriopoda* (Broome pindan wattle) and/or *Acacia monticola* (Gawar) tall shrubland with *Triodia intermedia* (lobed spinifex) and *Triodia pungens* (soft spinifex) hummock grasses
- *Grevillea refracta* +/- *Hakea lorea* corkwood open-shrubland with *Triodia pungens* (soft spinifex) hummock grasses
- *Triodia pungens* (soft spinifex) and/or *Triodia schinzii* hummock grassland wooded with low trees and *Acacia* spp. shrubs

Within the Dampier Peninsula, the vegetation derives from a mix of species from the deserts to the south, and monsoonal areas to the north (Kenneally *et. al.* 1996); there is a scarcity of

endemic flora species as a result. A total of 11 vegetation types are known from the Dampier Peninsula, the majority of which occur on coastal and marine environments on the edge of the Peninsula, with the Pindan dominating the interior. A brief description of these plant communities are given in Table 2.

<b>Table 2: Vegetation Types of the Dampier Peninsula (Kenneally <i>et. al.</i> 1996)</b>	
<b>Vegetation Type</b>	<b>Description</b>
Pindan	Dominates the red sandplains of the Peninsula. It is composed of a grassed woodland, with a sparse upper layer of mainly eucalyptus over dense thicket of wattles. Fire is the main controlling agent, with the density of particularly the wattles relating directly to the fire cycle. <i>Acacia eriopoda</i> dominates the middle stratum in the southern half of the Peninsula, with <i>Acacia tumida</i> dominating the northern half.
Fitzroy sandplains	Occurs north-east of Broome towards Derby, the Fitzroy sandplain is associated with the Fitzroy drainage basin, with an obvious change being the introduction of <i>Adansonia gregorii</i> (boabs). The soils are mainly heavy yellow clay loams. Savanna dominated by <i>Eucalyptus tectifera</i> and <i>Lysiphyllum cunninghamii</i> replaces pindan vegetation, and is generally heavily grazed.
Rocky outcrops	Rare on the Peninsula, and include coastal limestones and sandstones, some of which are heavily ferruginised. Broome Sandstone is exposed on the coast as mudstone and red eroding claystone, and can support thickets of <i>Acacia tumida</i> , with <i>Gyrocarpus americanus</i> and <i>Ficus opposita</i> being common. Melligo Sandstone supports various types of vegetation depending upon location. The Emeriau Sandstone outcrops are heavily ferruginised, with few locations, best seen at the Carnot-Kings Peak area. Vine thickets are found in these areas.
Creeks, wetlands and seepage areas	Low-lying sandplains associated with sub-coastal drainage valleys and seasonally swampy areas occur on the northern peninsula, including near Martins Well, just north of Pender Bay, south of Rumble Bay, areas inland of Beagle Bay and Pender Bay. Riverine communities also occur in the Coulomb Point Nature Reserve, supporting low closed forests of <i>Melaleuca acacioides</i> . Freshwater swamps occur in areas where coastal dunes truncate drainage lines, supporting low woodlands of <i>Lophostemon grandiflorus</i> subsp. <i>grandiflorus</i> , fringed by <i>Melaleuca nervosa</i> and <i>M. acacioides</i> . Small seasonal claypans and swamps occurring further inland also occur, supporting a fringing low woodland of <i>Lophostemon grandiflora</i> and/or <i>Melaleuca acacioides</i> with <i>M. viridiflora</i> or <i>M. nervosa</i> . <i>Melaleuca cajuputi</i> and <i>M. viridiflora</i> groves are supported near areas of permanent fresh water; these areas also contain <i>Nymphoides beaglenensis</i> , which is endemic to the Peninsula. Mound springs, including the Bunda-Bunda mound spring also locally occur, as well as Nimalaica Claypan, inland from Willie Creek. The Fitzroy River is one of the largest permanent rivers in the Kimberley, supporting dense riverine vegetation found nowhere else on the Peninsula.
Vine Thickets	Vine thickets are found in discontinuous and discrete pockets of relatively dense vegetation directly behind coastal dune systems. They are allied to rainforest, and contain a predominance of Indo-Malesian plant species. Further north from the Peninsula vine thickets are not associated with coastal dunes, but with rocky sites. Vine Thickets are best developed northwards along the Peninsula, and are an important habitat for species such as the great bower bird, rose-crowned fruit pigeon and agile wallaby.

<b>Table 2: Vegetation Types of the Dampier Peninsula (Kenneally <i>et. al.</i> 1996)</b>	
<b>Vegetation Type</b>	<b>Description</b>
Coastal dunes, beaches and limestone outcrops	Holocene sand dunes run parallel to the coast, with large areas of mobile dunes encroaching inland in the northern Peninsula. Foredunes are sparsely vegetated, predominantly with <i>Spinifex longifolius</i> , and more patchily with <i>Fimbristylis cymosa</i> , <i>F. sericea</i> and <i>Cyperus bulbosus</i> . <i>Acacia bivenosa</i> , <i>Lysiophyllum cunninghamii</i> and <i>Canavalia rosea</i> are found on areas of more established dunes. Dense shrub communities are found behind the dune crests, on backslopes and hollows. Pleistocene dunes which are older and less exposed, have more species in common with the pindan; they are dominated by <i>Acacia monticola</i> and <i>Gyrostemon tepperi</i> , as well as <i>Plectrachne schinzii</i> in areas that have not been burnt. These areas can also contain the locally important community containing an open eucalypt community with several bloodwood species. Coastal and sub-coastal limestone outcrops occur sporadically, with <i>Acacia bivenosa</i> characteristic of these areas south of Barred Creek. North of Barred Creek <i>Acacia bivenosa</i> does not occur and the area is poorly vegetated. A karst formation is found on Packer Island.
Saline grasslands	<i>Sporobolus virginicus</i> grasslands are found on tidal flats above the high-water mark. Near Broome this is best developed on the Roebuck Plains, inland from Crab Creek. This formation is found widely across the Peninsula. These areas are subject to flooding and ponding after monsoonal rains.
Saltwater paperbark thickets	Fringing stands of <i>Melaleuca acacioides</i> are found on the inner, landward margin of saline grasslands; the width and density of this community varies from a discontinuous line to half a kilometre thick.
Samphire flats	Tidal flats occurring behind Mangroves feature wide expanses of bare mud, with <i>Ceriops tagal</i> and <i>Excoecaria agallocha</i> found on the seaward margins of the mud flats. Samphire species dominate the landward side, including <i>Halosarcia halocnemoides</i> , <i>Neobassia astrocarpa</i> and <i>Suaeda arbusculoides</i> .
Mangroves	12 of the 17 mangrove species known in the State are located within the Peninsula. <i>Avicennia marina</i> is the commonest species. These areas are located between high spring tide and mean sea level.
Seagrass Meadows	Most species of seagrass occur on a wide range of sediments in the Peninsula. Extensive seagrass banks are found at Roebuck Bay, with <i>Halophila ovalis</i> and <i>Halodule uninervis</i> common in this area.

### 2.3.2 Local Vegetation Units

Trudgen (1988) undertook a flora and vegetation survey of the Broome coastline extending northwards from Riddell Point to a location 3.5km north of the Cable Beach resort area. The vegetation was initially split up into categories including vegetation of the Strand area, Dunal vegetation, Pindan vegetation, Vine Thicket and related vegetation (Gubinge Woodlands), and *Melaleuca* open forest. These vegetation units are presented in Table 3.

A short description of vegetation communities within the Port Management Area (PMA) is given in URS (2004), as described below.

- Dunal vegetation varies with dune aspect, slope and shoreline proximity, with species such as *Spinifex longifolius*, *Canavalia rosea* and *Acacia bivenosa* colonising eroding seaward faces; whereas the seaward ridge and backslopes are colonised by species such as *Crotolaria cunninghamii*, *Marsdenia cinerascens*, *Santalum lanceolatum* and *Acacia bivenosa*.
- Discontinuous vine thickets occur in depressions and swales between dune ridges, with species such as *Gyrocarpus americanus*, *Abrus precatorius*, *Passiflora foetida*, *Tinospora smilacina* and *Capparis lasiantha* present.
- Eucalypt and Gubinge woodland over hummock grassland of *Plectrachne pungens* occur on inland dune ridge and slopes, with other species such as *Gardenia pyriformis* and *Clerodendrum tomentosum* also present. These woodlands merge with Pindan vegetation where the rearward dunes slope down onto the Pindan plain.
- Pindan vegetation present lying between Port Drive and the base of the dunes is typical of the area, and is comprised of mixed Acacia/Eucalypt woodland including *Acacia eriopoda*, *Eucalyptus dampieri* and *Terminalia petiolaris* with scattered shrubs and grasses including *Lysiphyllum cunninghamii*, *Hakea macrocarpa* and *Ventilago viminalis*.
- Mangrove communities in the PMA were noted by URS (2004) to be limited to minor patches along the Roebuck Bay shoreline.

It has been noted that vegetation communities vary significantly on the Broome Peninsula moving northwards from the Port of Broome (Urbanplan 2006). This is due to the effect of the ocean on the climate at either end of the Broome Peninsula.



Table 3: Vegetation Units on the Broome Coastline as described by Trudgen (1988)		
Group	Vegetation Unit	Description
The Strand	Cm: <i>Canavallia rosea</i> herbland	Unit occurred on a narrow strip along the base of the dunes; consisted of very open vegetation with small amounts of <i>Canavallia rosea</i> , <i>Spinifex longifolius</i> and <i>Salsola kali</i> ; <i>Ipomoea pes-caprae</i> was also present
Holocene and Pleistocene Dunes (Coastal)	Sl: <i>Spinifex longifolius</i> dense hummock grassland	Unit occurred on very small and young dunes of white beach sand on base of low Pindan cliff; dense cover of <i>Spinifex longifolius</i> with <i>Canavallia rosea</i> and small amounts of <i>Salsola kali</i> and <i>Panicum</i> sp.
	AbCcSl: <i>Acacia bivenosa</i> , <i>Crotalaria cunninghamii</i> shrubland over <i>Spinifex longifolius</i> mid-dense hummock grassland	Unit occurred on Holocene white sand dunes fronting on Cable Beach, extending to the swale to the second stabilised dune; upper shrub layer of <i>Acacia bivenosa</i> and <i>Crotalaria cunninghamii</i> over mid-dense layer of <i>Spinifex longifolius</i> with <i>Chamaesyce</i> sp., <i>Salsola kali</i> and <i>Canavallia rosea</i> .
	AbCc: <i>Acacia bivenosa</i> , <i>Crotalaria cunninghamii</i> shrubland	Unit occurred on seaward face and crest of second stabilised dune; shrub layer of <i>Acacia bivenosa</i> and <i>Crotalaria cunninghamii</i> ; no layer of <i>Spinifex longifolius</i> , and <i>Canavallia rosea</i> and <i>Salsola kali</i> occur only on disturbed areas; other species noted were <i>Santalum lanceolatum</i> , <i>Tephrosia rosea</i> , <i>Mallotus nesophilus</i> , <i>Whiteochloa airoides</i> , <i>Chamaesyce</i> sp., <i>Boerhavia</i> sp. and <i>Tinospora smilacina</i>
	AbSl: <i>Acacia bivenosa</i> , <i>Crotalaria cunninghamii</i> open heath over <i>Spinifex longifolius</i> hummock grassland	Unit occurred on Pleistocene dunes close to the beach; has shrub layer of <i>Acacia bivenosa</i> and <i>Crotalaria cunninghamii</i> over hummock grassland of <i>Spinifex longifolius</i> ; other species present including <i>Tinospora smilacina</i> , <i>Mukia maderaspatana</i> , <i>Chamaesyce</i> sp., <i>Tephrosia rosea</i> , <i>Gyrostemon tepperi</i> , <i>Crotalaria medicaginea</i> , <i>Lysiana spathulata</i>
	AbPh: <i>Acacia bivenosa</i> , <i>Crotalaria cunninghamii</i> shrubland over <i>Plectrachne helmsii</i> mid dense hummock grassland	Unit occurred behind AbSl, with same dominant species in the shrub layer; <i>Plectrachne helmsii</i> however is dominant understorey species; <i>Tephrosia rosea</i> , <i>Chamaesyce</i> sp. and <i>Gyrostemon tepperi</i> also present.
	LcAbCcWa: <i>Lysiphyllum cunninghamii</i> high open shrubland over <i>Acacia bivenosa</i> , <i>Crotalaria cunninghamii</i> open shrubland to open heath over <i>Whiteochloa airoides</i> open grassland to grassland	Unit occurred on irregular upper parts of Pleistocene dunes along the east side of 'Hidden Valley'; species included <i>Lysiphyllum cunninghamii</i> , <i>Terminalia petiolaris</i> , <i>Acacia bivenosa</i> , <i>Crotalaria cunninghamii</i> , <i>Marsdenia cinerascens</i> , <i>Tephrosia rosea</i> and <i>Whiteochloa airoides</i> .
Inland Dunes	PtEzPh: <i>Pouteria sericea</i> , <i>Eucalyptus zygophylla</i> , <i>E. damperi</i> low woodland over <i>Plectrachne helmsii</i> mid dense hummock grassland	Unit occurred on dune that runs roughly WSW-ENE in the area of Gantheaume Point; open woodland of <i>Pouteria sericea</i> , <i>Eucalyptus zygophylla</i> and <i>Eucalyptus dampieri</i> with occasional <i>Lysiphyllum cunninghamii</i> and <i>Gyrocarpus americanus</i> ; with a shrub layer of <i>Carissa lanceolata</i> , <i>Santalum lanceolatum</i> , <i>Acacia holosericea</i> , <i>Acacia tumida</i> , <i>Distichostemon hispidulus</i> , <i>Hakea macrocarpa</i> and <i>Erythrophloeum chlorostachys</i> .
Vine Thickets and deciduous woodlands to forests	Mn: <i>Mallotus nesophilus</i> open scrub	Unit occurred on the lee slope of the second dune from the beach near the southern end of Cable Beach; moderately dense cover of <i>Mallotus nesophilus</i> , above <i>Flueggea virosa</i> , <i>Santalum lanceolatum</i> and <i>Grewia breviflora</i> .

Table 3: Vegetation Units on the Broome Coastline as described by Trudgen (1988)		
Group	Vegetation Unit	Description
	<u>EcAbFv</u> : <i>Eucalyptus confertiflora</i> low open woodland over <i>Acacia bivenosa</i> , <i>Flueggea virosa</i> open heath	Unit occurred on the bottom of the lee side of the inland dune at the south end of Cable Beach on pindan soil; scattered <i>Eucalyptus confertiflora</i> over <i>Acacia bivenosa</i> , <i>Flueggea virosa</i> , <i>Grewia breviflora</i> , <i>Carissa lanceolata</i> , <i>Jasminum didymum</i> , <i>Marsdenia cinerascens</i> , <i>Plectrachne helmsii</i> .
	<u>LcOaMn</u> : <i>Lysiphyllum cunninghamii</i> , <i>Opilia amentacea</i> , <i>Mallotus nesophilus</i> open heath	Unit occurred on the leeward slope of the inland dune behind Cable Beach; contains <i>Lysiphyllum cunninghamii</i> , <i>Mallotus nesophilus</i> , <i>Opilia amentacea</i> , <i>Myopogon acuminatum</i> , <i>Marsdenia cinerascens</i> , <i>Carissa lanceolata</i> , <i>Jasminum didymum</i> , <i>Amyema benthamii</i> , <i>Whiteochloa airoides</i> , <i>Santalum lanceolatum</i> , <i>Opilia amentacea</i> .
	<u>GaPaFvGb</u> : <i>Gyrocarpus americanus</i> , <i>Premna acuminata</i> , <i>Lysiphyllum cunninghamii</i> low woodland over <i>Flueggea virosa</i> , <i>Grewia breviflora</i> high shrubland to open scrub	Unit occurred on the flat area of Pindan soil behind dunes parallel to Cable Beach, on richer soil and higher moisture availability; contained <i>Gyrocarpus americanus</i> , <i>Premna acuminata</i> , <i>Ehretia saligna</i> , <i>Eucalyptus confertiflora</i> , <i>Pouteria sericea</i> , <i>Lysiphyllum cunninghamii</i> , over shrubs of <i>Grewia breviflora</i> and <i>Flueggea virosa</i> ; other species present including <i>Terminalia ferdinandiana</i> , <i>Mallotus mesophilus</i> , <i>Marsdenia cinerascens</i> , <i>Carissa lanceolata</i> , <i>Abutilon indicum</i> , <i>*Passiflora foetida</i> , <i>Plectrachne helmsii</i> .
	<u>TpMc</u> : <i>Terminalia petiolaris</i> , <i>Clerodendrum tomentosum</i> , <i>Pouteria sericea</i> low woodland over <i>Grewia breviflora</i> , <i>Marsdenia cinerascens</i> high shrubland over <i>Triodia pungens</i> hummock grassland	Unit occurred on dunes behind Cable Beach on white sand over orange-pink sand; tree layer of <i>Terminalia petiolaris</i> , <i>Clerodendrum tomentosum</i> , <i>Pouteria sericea</i> over open shrub/vine layer of <i>Grewia breviflora</i> , <i>Marsdenia cinerascens</i> , <i>Flueggea virosa</i> with other species such as <i>Amyema benthamii</i> , <i>Acacia bivenosa</i> , <i>Myoporum acuminatum</i> , <i>Santalum lanceolatum</i> and <i>Tephrosia rosea</i> present, over <i>Triodia pungens</i> and <i>Whiteochloa airoides</i> .
	<u>LcGbFv</u> : <i>Lysiphyllum cunninghamii</i> high open shrubland over <i>Grewia breviflora</i> , <i>Mallotus nesophilus</i> high shrubland over <i>Flueggea virosa</i> shrubland	Unit occurred in a swale between two dunes next to Cable Beach; scattered <i>Terminalia petiolaris</i> with <i>Lysiphyllum cunninghamii</i> over <i>Mallotus nesophilus</i> and <i>Grewia breviflora</i> over lower shrub/vine layer of <i>Flueggea virosa</i> , <i>Tinospora smilacina</i> , <i>Myoporum acuminatum</i> , <i>Opilia amentacea</i> and <i>Tephrosia rosea</i> .
	<u>FvLcAb</u> : <i>Flueggea virosa</i> , <i>Lysiphyllum cunninghamii</i> , <i>Acacia bivenosa</i> open scrub	Unit occurred Top of south-east facing slope of Pleistocene dune inland from Bali-Hai; transitional from the heath/shrubland vine thicket to the <i>Acacia bivenosa</i> units of the dunes; <i>Flueggea virosa</i> , <i>Lysiphyllum cunninghamii</i> , <i>Acacia bivenosa</i> and <i>Grewia breviflora</i> with <i>Tinospora smilacina</i> , also <i>Crotalaria cunninghamii</i> , <i>*Passiflora foetida</i> , <i>Chamaesyce</i> sp., <i>Ficus opposita</i> , <i>Marsdenia cinerascens</i> , <i>Tephrosia rosea</i> , <i>Bridelia tomentosa</i> , <i>Trichodesma zeylanica</i> , <i>Caesalpinia major</i> , <i>Terminalia petiolaris</i> , <i>Lysiana spathulata</i> , <i>Jasminum didymum</i> and <i>Whiteochloa airoides</i> .

Table 3: Vegetation Units on the Broome Coastline as described by Trudgen (1988)		
Group	Vegetation Unit	Description
Vine Thickets and deciduous woodlands to forests (cont.)	<u>TPMaFv</u> : <i>Terminalia petiolaris</i> low open woodland over <i>Myoporum acuminatum</i> high shrubland to open scrub over <i>Flueggea virosa</i> high shrubland	Observed at 'Hidden Valley', broad swale between Holocene and Pleistocene dunes to the north of Bali-Hai; scattered <i>Terminalia petiolaris</i> over <i>Myoporum acuminatum</i> , <i>Grewia breviflora</i> and <i>Mallotus nesophilus</i> ; over <i>Flueggea virosa</i> ; with other species including <i>Ficus opposita</i> , <i>Exocarpos latifolius</i> , <i>Acacia bivenosa</i> , <i>Bridelia tomentosa</i> , <i>Marsdenia cinerascens</i> , <i>Adriana tomentosa</i> , <i>Hypoestes floribunda</i> , <i>Plectrachne helmsii</i> , <i>Clerodendrum tomentosum</i> and <i>Caesalpinia major</i> .
	<u>Ah</u> : <i>Atalaya hemiglauc</i> low open forest to low closed forest	Two stands of this unit were recorded, with dense cover of <i>Atalaya hemiglauc</i> over very sparse understorey.
<i>Terminalia ferdinandiana</i> ('Gubinge') Woodlands	<u>Tf</u> : <i>Terminalia ferdinandiana</i> open woodland over <i>Eucalyptus confertiflora</i> , <i>Pouteria sericea</i> low open woodland	Unit occurred on pindan soils; open cover of <i>Terminalia ferdinandiana</i> over <i>Pouteria sericea</i> and <i>Eucalyptus confertiflora</i> , over mixed shrub layer with <i>Hakea arborescens</i> , <i>Ficus opposita</i> , <i>Jasminum didymum</i> , <i>Ehretia saligna</i> , <i>Flueggea virosa</i> , <i>Grewia polygama</i> , <i>Carissa lanceolata</i> and <i>Streptoglossa macrocephalus</i> over <i>Plectrachne helmsii</i> .
	<u>TfEcEdPs</u> : <i>Terminalia ferdinandiana</i> , <i>Eucalyptus confertiflora</i> , <i>Eucalyptus dampieri</i> , <i>Pouteria sericea</i> low woodland	Unit occurred on pindan soils on flat to slightly sloping area behind dunes next to Cable Beach; tree layer including <i>Terminalia ferdinandiana</i> , <i>T. petiolaris</i> , <i>Pouteria sericea</i> , <i>Eucalyptus dampieri</i> , <i>Eucalyptus confertiflora</i> , <i>Exocarpos latifolius</i> , <i>Ehretia saligna</i> and <i>Lysiphyllum cunninghamii</i> over diverse shrub layer of various species over grass layer dominated by <i>Plectrachne helmsii</i> with <i>Aristida brownii</i> and <i>Eriachne</i> sp.
Pindan	<u>AtGp</u> : <i>Acacia tumida</i> , <i>Grevillea pyramidalis</i> open heath over <i>Plectrachne helmsii</i> hummock grassland with <i>Eriachne</i> sp. and <i>Eragrostis eriopoda</i>	Unit occurred on pindan with thin sand overlay with no dunal protection from winds, dominated by <i>Acacia tumida</i> and <i>Grevillea pyramidalis</i> with scattered <i>Eucalyptus confertiflora</i> and <i>Gyrostemon tepperi</i> , <i>Distichostemon hispidulus</i> , <i>Solanum cunninghamii</i> , <i>Persoonia falcata</i> , <i>Dolichandrone heterophylla</i> , <i>Gardenia pyriformis</i> and <i>Terminalia ferdinandiana</i> , over <i>Plectrachne helmsii</i> with other species such as <i>Triodia pungens</i> , <i>Eragrostis eriopoda</i> and <i>Eriachne</i> sp.
	<u>EahPh</u> : <i>Eucalyptus</i> aff. <i>aspera</i> , <i>Eucalyptus zygophylla</i> low open woodland over <i>Acacia holosericea</i> shrubland to open heath over <i>Plectrachne helmsii</i> hummock grassland to mid dense hummock grassland	Unit abuts Pleistocene dunes, however can also abut Holocene dunes; tree layer of <i>Eucalyptus</i> aff. <i>aspera</i> and <i>Eucalyptus zygophylla</i> with <i>Hakea macrocarpa</i> and <i>Erythrophleum chlorostachys</i> over shrubland to open heath of <i>Acacia holosericea</i> , with other shrubs including <i>Grevillea pyramidalis</i> , <i>Ehretia saligna</i> , <i>Ficus opposita</i> , <i>Persoonia falcata</i> and <i>Terminalia ferdinandiana</i> , <i>Dolichandrone heterophylla</i> , <i>Gardenia pyriformis</i> and <i>Gyrostemon tepperi</i> , over <i>Plectrachne helmsii</i> .
	<u>EcPh</u> : <i>Eucalyptus confertiflora</i> , <i>E. dampieri</i> and <i>E. zygophylla</i> low open woodland over <i>Plectrachne helmsii</i> mid dense hummock grassland	Unit occurred on flat to gently sloping Pindan; low <i>Eucalyptus</i> trees with <i>Eucalyptus confertiflora</i> being most dominant over mixed shrub layer including <i>Ehretia saligna</i> , <i>Ficus opposita</i> , <i>Erythrophleum chlorostachys</i> , <i>Gardenia pyriformis</i> , <i>Grewia polygama</i> , <i>Gossypium australe</i> , <i>Dolichandrone heterophylla</i> and <i>Persoonia falcata</i> over <i>Plectrachne helmsii</i> .

Table 3: Vegetation Units on the Broome Coastline as described by Trudgen (1988)		
Group	Vegetation Unit	Description
<b>Pindan (cont.)</b>	<b>EcTfE:</b> <i>Eucalyptus confertiflora</i> , <i>Terminalia ferdinandiana</i> shrubland over <i>Eriachne</i> sp. and <i>Plectrachne helmsii</i> grassland	Unit occurred on pindan slope above the beach on the north side of Gantheaume Point; dominated by <i>Eucalyptus confertiflora</i> and <i>Terminalia ferdinandiana</i> with <i>Persoonia falcata</i> , <i>Santalum lanceolatum</i> and <i>Grevillea pyramidalis</i> over <i>Eriachne</i> sp. and <i>Plectrachne helmsii</i> .
	<b>EcAhPh:</b> <i>Eucalyptus confertiflora</i> low open woodland over <i>Acacia holosericea</i> high open shrubland over <i>Plectrachne helmsii</i> mid dense hummock grassland	Unit occurred upslope of EcTfE; has a taller and more open stratum of <i>Eucalyptus confertiflora</i> over <i>Acacia holosericea</i> and <i>Lysiphyllum cunninghamii</i> over shrubs including <i>Terminalia ferdinandiana</i> , <i>Santalum lanceolatum</i> , <i>Gardenia pyriformis</i> , <i>Hakea macrocarpa</i> , <i>Grevillea pyramidalis</i> , <i>Erythrophleum chlorostachys</i> and <i>Distichostemon hispidulus</i> , over <i>Plectrachne helmsii</i> with <i>Eragrostis eriopoda</i> and <i>Eriachne</i> sp.
	<b>EdHaPh:</b> <i>Eucalyptus dampieri</i> low woodland over <i>Hakea arborescens</i> high shrubland over <i>Plectrachne helmsii</i> mid dense hummock grassland	Unit occurred on pindan red sand gently sloping to the base of dunes behind Cable Beach; <i>Eucalyptus dampieri</i> is the most abundant tree with <i>Eucalyptus confertiflora</i> and <i>Eucalyptus zygophylla</i> also present, over a shrub layer dominated by <i>Hakea arborescens</i> with <i>Acacia holosericea</i> and other shrub species over <i>Plectrachne helmsii</i> .
	<b>EdAeAPh:</b> <i>Eucalyptus dampieri</i> low open woodland over <i>Acacia eriopoda</i> open scrub over <i>Adriana tomentosa</i> shrubland over <i>Plectrachne helmsii</i> mid-dense hummock grassland	Unit occurred on undulating pindan soil in 'Hidden Valley' enclosed by Holocene and Pleistocene dunes; open tree layer of <i>Eucalyptus dampieri</i> over upper shrub layer of <i>Acacia eriopoda</i> and some <i>Hakea arborescens</i> , above <i>Adriana tomentosa</i> , <i>Tephrosia rosea</i> and <i>Crotalaria medicaginea</i> over <i>Plectrachne helmsii</i> .
	<b>EdAeHPh:</b> <i>Eucalyptus dampieri</i> low open woodland over <i>Acacia eriopoda</i> , <i>Hakea macrocarpa</i> , <i>Hakea arborescens</i> open scrub over <i>Plectrachne helmsii</i> mid dense hummock grassland	Unit occurred on pindan soil on a slight slope into the vine thicket area; open tree layer of <i>Eucalyptus dampieri</i> with occasional <i>Eucalyptus confertiflora</i> over shrubs dominated by <i>Acacia eriopoda</i> with <i>Hakea macrocarpa</i> , <i>Hakea arborescens</i> , and <i>Acacia holosericea</i> , <i>Ventilago viminalis</i> , <i>Lysiphyllum cunninghamii</i> and <i>Ehretia saligna</i> over <i>Plectrachne helmsii</i> and other grasses.
<b>Melaleuca woodlands to forests</b>	<b>Md:</b> <i>Melaleuca dealbata</i> low open forest	Unit occurred in 'Hidden Valley' on and between Holocene dunes; dense areas contain <i>Melaleuca dealbata</i> over <i>Terminalia petiolaris</i> , <i>Mallotus nesophilus</i> , <i>Myoporum acuminatum</i> , <i>Flueggea virosa</i> , <i>Marsdenia cinerascens</i> , <i>Jasminum didymum</i> , <i>Cassytha filiformis</i> , <i>Ptilotus exaltatus</i> , <i>Acacia bivenosa</i> and <i>Whiteochloa airoides</i> ; in areas of less-dense <i>Melaleuca</i> cover, the cover is predominantly dune vegetation species such as <i>Acacia bivenosa</i> and <i>Myoporum acuminatum</i> rather than vine thicket species.
<b>Degraded Areas</b>	<b>CC:</b> <i>*Cenchrus ciliaris</i> grassland	Occurred in an area on Gantheaume point that had been badly degraded with the shrub layer removed; also included what was thought to be a native grass of the genus <i>Sorghum</i> .
	<b>Am:</b> <i>Acacia monticola</i> 'heath'	Occurred around Gantheaume Point, in an area where stripping of a layer of lateritic material for roadworks had occurred; <i>Acacia monticola</i> with <i>Goodenia scaevolina</i> , <i>Cassytha filiformis</i> and <i>Gyrostemon tepperi</i> were still present.

### 2.3.3 Threatened and Priority Ecological Communities

A total of five Threatened Ecological Communities (TECs) and eight other ecosystems at risk are also listed for the DL2 Subregion, as listed on Table 4 (based on information from Graham (2001); cross-checked against DEC 2006 (b)). TECs and Priority Ecological Community (PEC) conservation status descriptions are given in Appendix A.

<b>Table 4: Threatened Ecological Communities (TECs) and other Ecosystems at Risk known in the DL2 Subregion (Graham 2001)</b>		
<b>Ecosystem (DEC 2006b; 2008)</b>	<b>Ecosystem Description</b>	<b>Conservation Status</b>
67. Monsoon Thickets	Monsoon (vine) thickets on coastal sand dunes of the Dampier Peninsula	V
44. Roebuck Bay Mudflats	Species-rich faunal community of the intertidal flats of Roebuck Bay	V
85. Bunda Bunda	Bunda Bunda organic mound spring communities	V
95. Mandora Mound	Assemblages of the organic springs and mound springs of the Mandora Marsh area	V
13. Kimberley	Disaster Bay organic mound spring communities	Priority 3 (iii) *
	Assemblages of permanent/ephemeral wetlands, damplands, and riparian habitat of the Dampierland Region	V **
14. Kimberley	Organic mound spring communities of the Lolly Well spring	P3 (ii) *
15. Kimberley	Nimalaica clay pan community, inland from Willie Creek	P4 (b)
	Saline grasslands on tidal flats above high water mark ( <i>Sporobolus virginicus</i> dominated) on Dampier Peninsula/Broome area	P1
	Vine thickets on heavily ferruginised Emeriau sandstone on Dampier Peninsula	
	Flora and Fauna assemblages of of spring communities Logues Spring, south-west Kimberley Edgar Range near Dampier Downs	
	Assemblages of Culla Culla Creek – unusual spring site in Dampierland	
	Assemblages of Taylors Lagoon, Lake Campion, and Lake Eda	V **

Note: \* Conservation Status listing as per DEC (2006b; 2008)

Note: \*\* Noted as 'V' (Vulnerable) by Graham (2001); no such listing under DEC (2006b; 2008)

The TEC and PEC listings (DEC 2006; 2008a) list five TECs and five PECS in the Dampierland Region, as listed in Table 5. Of these, TEC 67 (Monsoon Thickets), and PECS 10. Kimberley (Dwarf pindan heath community of Broome coast) and 11. Kimberley (*Corymbia paractia* dominated community on dunes) are known from within the survey area.



<b>Table 5: Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) listed within the Dampierland Region (DEC 2006; 2008b)</b>		
<b>TEC / PEC</b>	<b>Description</b>	<b>Conservation Status</b>
44. Roebuck Bay Mudflats	Species-rich faunal community of the intertidal mudflats of Roebuck Bay	VU B)
67. Monsoon Thickets	Monsoon (vine) thickets on coastal sand dunes of Dampier Peninsula	VU C)
85. Bunda Bunda	Assemblages of Bunda Bunda organic mound spring	VU A); VU B)
86. Big Springs	Assemblages of Big Springs organic mound springs	VU A); VU B)
95. Mandora Mounds	Assemblages of the organic springs and mound springs of the Mandora Marsh area	EN B) iii)
10. Kimberley	Dwarf pindan heath community of Broome coast	Priority 1
11. Kimberley	<i>Corymbia paractia</i> dominated community on dunes	Priority 1
13. Kimberley	Assemblages of Disaster Bay organic mound springs. Organic mound spring on tidal flat with <i>Melaleuca acacioides</i> , <i>Timontius timon</i> , <i>Pandanus spiralis</i> , <i>Melaleuca viridiflora</i> , <i>Acacia neurocarpa</i> and <i>Lumnitzera racemosa</i> (mangrove) woodland with <i>Typha domingensis</i> and sedges, including <i>Schoenoplectus litoralis</i>	Priority 3 (iii)
14. Kimberley	Assemblages of Lolly Well Springs wetland complex. Wetland complex containing numerous low organic mound springs with moats.	Priority 3 (ii)
15. Kimberley	Nimalaica clay pan community. Inland from Willie Creek.	Priority 4 (b)

TEC 67 (Monsoon Thickets) are located on the inland side of coastal dunes along the Dampier Peninsula, and tend to become larger and have greater species diversity in a northwards direction. Near Broome distinctive components of this community include *Pouteria sericea*, *Exocarpos latifolius*, *Grewia breviflora*, *Grewia retusifolia*, *Pavetta kimberleyana*, *Bridelia tomentosa*, *Premna acuminata*, *Terminalia petiolaris* and *Terminalia ferdinandiana*. Another significant area of vine thickets includes an area northwards from Barred Creek towards Quondong to James Price Point, where *Diospyros ferrea* var. *humilis*, *Mimusops elengi*, *Celtis philippensis*, *Melaleuca dealbata* and more rarely *Parinari nonda* and *Pittosporum molluccanum* are located, as well as *Glycosmis* spp. and *Croton habrophyllus*. Common vines located within Vine Thickets include *Abrus precatorius*, *Gymnanthera oblonga*, *Jacquemontia paniculata*, *Passiflora foetida*, *Tinospora smilacina*, *Tylophora cineracens* and *Operculina brownii*, *Opilia amentacea*, *Caesalpinia major*, *Capparis lasiantha*, *C. sepiaria*, *Paramignya trimera* and *Protasparagus racemosus* (Kenneally *et. al.* 1996).

PEC 11. Kimberley (*Corymbia paractia* dominated community on dunes) is common between Gantheaume Point and Cable Beach, however it is apparently restricted to a narrow coastal zone in the Broome area where beach dunes merge into pindan soils (Kenneally *et. al.* 1996), and is often found mixed with rainforest (monsoon) species (Kevin Kenneally and Val English *pers. comm.*).

PEC 10 Kimberley (Dwarf pindan heath community of Broome coast). This community was described by Trudgen (1988) as 'AtGp' on pindan soils (Table 3), and is a reference to *Acacia tumida* var. *kulpan*, which occurs on coastal cliffs at Gantheaume Point and James Price Point as a wind pruned shrub to 50cm in height (Kevin Kenneally and Val English, *pers. comm.*). This vegetation type is discussed in Broome Botanical Society Inc. (1995), where it is located on the near-coastal hinterland from Gantheaume Point past Riddell Beach towards the Port of Broome. PEC 10's characteristics include low-profile wind-sheared shrubs, small areas of almost monotypic spinifex grasslands and traces of residual Pleistocene linear dunes.

## 2.4 Flora

### 2.4.1 Regional and Local Flora

Beard (1990) described the flora species of the Northern Province as being classified as either:

- Perennial drought-resisting species (all leaves and stems remain in a growing condition throughout the year; includes most tree and shrub species, as well as *Triodia* spp.);
- Perennial drought-evading species (leaves die at the end of the wet season, with new growth occurring the following wet season originating from vegetative organs; includes most perennial tussock grasses, and deciduous trees and shrubs); and
- Annual drought-evading species (plants germinate from seed each growing season; includes most forbs and short grasses, however also some tall annual grasses).

Kenneally *et. al.* (1996) record a total of 717 known plant taxa occurring on the Dampier Peninsula, of which 649 are native, and 68 are introduced. The largest families include Poaceae (84 taxa), Papilionaceae (50 taxa) and Cyperaceae (36 taxa). A total of 2080 plant taxa, including 1973 native and 108 introduced plant taxa, are recorded in the Kimberley Region (Wheeler J. R. (ed) (1992)).

Trudgen (1988) recorded a total of 117 native plant taxa, from 50 families, during his survey of the Broome Coastline. The most commonly recorded families were Poaceae (11 taxa), Euphorbiaceae (8 taxa), Papilionaceae (8 taxa), Mimosaceae (7 taxa) and Malvaceae (7 taxa). None of the taxa collected were known to be rare or geographically restricted, however the vine thicket areas near Broome are the most southerly-known in Western Australia and contain the most southerly populations of many species contained within them (Trudgen 1988).

### 2.4.2 Declared Rare and Priority Flora

A relatively small proportion of the State's conservation significant (Declared Rare Flora (DRF) and Priority Flora) species are located within the Kimberley Region, with 158 of the 2813 State-listed species known from the Region (5.6%) (DEC 2008a). Appendix B presents descriptions of DRF and Priority flora conservation status.

Within the DL2 (Pindanland) Subregion, 19 species of conservation significance are known, including two DRF species, as listed in Table 6 (Graham 2001; DEC 2008c)

<b>Table 6: Declared Rare and Priority flora known from the Dampierland Subregion (Graham 2001; DEC 2008c)</b>		
<b>Species</b>	<b>Conservation Status</b>	<b>Comments</b>
<i>Keraudrenia exastia</i>	DRF (CR)	Perennial shrub; flowering April-December; red sand in pindan, coastal site, relict desert dune swale; known from Broome area
<i>Pandanus spiralis</i> var. <i>flammeus</i>	DRF (E)	Perennial tree-like monocot; white clay, springs; known from Edgar Range, south-east of Broome
<i>Cullen candidum</i>	P1	Perennial shrub; flowering May-October, clayey sand; known from northern tip of Dampierland
<i>Glycine pandanica</i>	P1	Perennial herbaceous climber; flowering February-March/June; pindan soils; known from vicinity of Broome
<i>Ipomaea</i> sp. Kimberley Flora (L. J. Penn 84)	P1	Creeping/twining perennial herb; flowering June; shallow soils on sandstone; known from north-east of Broome
<i>Nicotiana heteranthera</i>	P1	Short-lived annual or perennial herb; flowering March-June/September; black clay, seasonally wet flats; known from vicinity of Broome
<i>Sauropus salignus</i>	P1	Annual herb; flowering March-June; basalt rocks
<i>Tephrosia andrewii</i>	P1	Perennial shrub; flowering April/October; sand, pindan; known from south of Broome
<i>Tetragonia coronata</i>	P1	Annual herb; flowering June; red clay-loam, calcrete outcrops; known from vicinity of Broome
<i>Gomphrena pusilla</i>	P2	Annual; flowering March-June; fine beach sand, on limestone behind foredune
<i>Nymphoides beaglensis</i>	P2	Aquatic annual herb; flowering March-June; shallow freshwater, edges of permanent waterholes or seasonally inundated claypans and depressions
<i>Pterocaulon</i> sp. A. Kimberley Flora (B. J. Carter 599)	P2	Perennial shrub; flowering April-August; coastal areas, saline flats, pindan sandplain; known from vicinity of Broome, and north of Broome
<i>Aphyllodium glossocarpum</i>	P3	Perennial shrub; flowering April-October; sand, pindan; known from north of Broome
<i>Acacia glaucocaesia</i>	P3	Perennial shrub; flowering July – September; red loam, sandy loam, clay, floodplains; known from south-west of Broome



Table 6: Declared Rare and Priority flora known from the Dampierland Subregion (Graham 2001; DEC 2008c)		
Species	Conservation Status	Comments
<i>Goodenia sepalosa</i> var. <i>glandulosa</i>	P3	Sprawling herb; flowering January-December; red sand or loam; known from east of Broome
<i>Fuirena incrassata</i>	P3	Annual sedge; flowering May-August; sand, sandy clay, swamps, creekbeds, claypans, semi-saline lakes; known from east-north-east of Broome
<i>Keraudrenia katatona</i>	P3	Perennial shrub; flowering March-August; red sand, desert dunes in pindan, ranges, disturbed areas; known from vicinity of Broome
<i>Phyllanthus aridus</i>	P3	Perennial shrub; flowering May-June; sandstone, gravel, red sand; known from vicinity of Broome
<i>Stylidium costulatum</i>	P3	Annual herb; flowering April-August; sandy or clayey soils, creeks or seasonally wet areas; known from north of Broome
<i>Triodia acutispicula</i>	P3	Tussock-forming perennial grass; flowering January-April; sandy soils, river levees, pindan plains, rocky hillslopes and outcrops; known from east of Broome
<i>Pittosporum moluccanum</i>	P4	Perennial tree; flowering February-August; white sand, sand dunes; known from north of Broome

*Keraudrenia exastia* (DRF) is known directly from within BPA-managed lands, within the survey area. This species is known only from the Broome Peninsula, and was listed as DRF in 1999. The species is an erect, compact multistemmed shrub to 90cm high. The stems have apical branchlets with a tomentum of pale tan to white stellate hairs. The leaves are narrowly ovate, elliptic or oblong, alternate and spreading, with an entire margin, and both surfaces are covered in a pale grey-green tomentum of stellate hairs. The inflorescence is a 7-9 flowered cyme, with a purple calyx, and a usually absent corolla. The species is known from relict desert dune swale in red pindan sand, mainly in *Acacia* shrubland (Wilkins 1999).

Several surveys to examine the range of this species have been undertaken. The Broome Botanical Society (Inc.) mapped seven discrete populations of this species in the vicinity of Kavite Road after field work undertaken in September 1995. Each population differed in size and density of individuals. A total number of 3360 individuals were estimated to occur in these populations. Associated vegetation was mainly relatively uniform pindan heathland, characterised by *Plectrachne schinzii* and scattered trees of *Acacia colei* and *Eucalyptus dampieri*. Threats to existing known populations included spread of introduced species (including *Aerva javanica* and *Cenchrus setiger*), presence of infrastructure such as rubbish tip, borrow pits and Kavite Road (including maintenance of the road).

Further survey of *Keraudrenia exastia* populations was undertaken by Trudgen (2006). Populations of this species were found to grow in stands of at least three different fire ages, where individuals were healthy and showed no sign of senescence. It may be that this species is not fire sensitive, and population sizes may not be significantly altered by fire. Trudgen (2006) noted that it is likely that soil or water availability habitat factors restrict the current distribution of this species, and that these factors may have some relationship to the presence

of the Holocene dunes lying to the south of the main populations of this species. Although the species was seen to grow in several vegetation types, appeared to be associated with *Acacia colei* var. *colei*. It may also be possible that microclimate factors related to the influence of the sea on the climate of the southern end of the Peninsula may also be important in influencing the distribution of *Keraudrenia exastia*.

It is also noted by Trudgen (2006) that a population of *Leptosema anomala* is located near the known populations of *Keraudrenia exastia*, and this population is disjunct from the main population of *Leptosema anomala*.

No flora species listed under the Common Environmental Protection and Biodiversity Conservation Act (1999) are present within the survey area (Department of Environment and Heritage 2008).

### 2.4.3 Introduced Species

Three invasive plant species or Weeds of National Significance (WONS) are either known from or have suitable habitat in the survey area, as recorded on the Commonwealth Department of Environment and Heritage databases (Department of Environment and Heritage 2008). These are detailed in Table 7, with control codes (where applicable) under the Department of Agriculture and Food (DAFWA 2008).

<b>Table 7: Invasive weed species known from the Survey Area (Department of Environment and Heritage 2008)</b>				
<b>Species</b>	<b>Common Name</b>	<b>Status</b>	<b>DAFWA Control Code (Appendix E)</b>	<b>Description</b>
<i>Cenchrus ciliaris</i>	Buffel Grass	Invasive	-	Widely planted as pasture grass; widespread weed of roadsides, creeklines, river edges and most vegetation types
<i>Parkinsonia aculeata</i>	Parkinsonia; Jerusalem Thorn	WONS; Declared Plant (WA)	P1 (whole of State); P4 (Broome Shire)	Grows in moist conditions along river banks and does well on tropical black soils; withstands heat and drought; Serious weed in pastoral areas in Kimberley and Pilbara Regions
<i>Prosopis</i> spp.	Mesquite	Declared Plant (WA)	P1 (whole of State); P2 (whole of State excluding P1 areas)	Can grow on drier soils, on floodplains and near permanent water; Reproduces by seed and suckers; Is known to lightly infest areas south of Broome

25 environmental weeds were identified during a 2004 survey of the Broome townsite (Shire of Broome 2004), the most common of which included:

- *Leucaena leucocephala* (Coffee Bush)
- *Azadirachta indica* (Neem)
- *Jatropha gossypifolia* (Bellyache Bush) (Declared Plant under the *Agriculture and Related Resources Act 1974*)
- *Macroptilium atropurpureum* (Siratro)

- *Merremia aegyptia*
- *Merremia dissecta*
- *Passiflora foetida* (wild passionfruit)
- *Tribulus terrestris* (Caltrop)
- *Alternanthera pungens* (Khaki weed)
- *Cenchrus biflorus* (Gallon's curse)

## 2.5 Wetlands of Significance

Five Wetlands of National Significance are known from the DL2 Subregion, including the Bunda Bund Mound Springs, Eighty Mile Beach System, Roebuck Bay, Roebuck Plains System and Willie Creek Wetlands (Graham 2001).

Roebuck Bay is a listed RAMSAR wetland (Number 33) (DEH 2008). This site is located on Roebuck Bay, extending from Fisherman's Bend (immediately east of the Broome township) to south of Sandy Point. It is described as a tropical marine embayment with extensive, highly biologically diverse, intertidal mudflats, which is internationally important for at least 20 species of migratory shorebirds; it is one of the most important sites for shorebird conservation in the East Asian-Australian Flyway (DEH 2008).

Roebuck Bay is also listed under the Directory of Important Wetlands in Australia (DEH 2008) (WA020). The limits to this site are Entrance Point in the north-west, and Cape Villaret in the south-west. No threatened flora species are known from the site.

## 2. Methods

Floristic Community Type (FCT) mapping was undertaken throughout the survey area. This method utilises recording of data from standard-sized quadrats distributed throughout the survey area, with the presence/absence of flora species being analysed by a computer based statistical analysis program (PATN) to determine floristic relationships between quadrats. The groupings are then verified against field data and FCT descriptions determined from final groupings of quadrats. Boundaries of FCTs within the survey area have also been mapped using a combination of aerial photography of the survey area, descriptions of FCTs, topography and locations of quadrats. The method of analysis of FCTs is currently being undertaken by the DEC over a variety of projects in the State, including vegetation surveys of Banded Ironstone Formations (BIF) in the Mid-West (Markey and Dillon 2006).

This survey undertook to describe and map FCTs throughout the survey area. The survey area was determined to include the Port of Broome-managed lands, and areas of intact vegetation in UCL further north in the Broome Peninsula, to determine the extent of FCTs within the Peninsula. Three detailed recording sites were also surveyed. These were undertaken in areas where the vegetation was very narrow, and therefore the quadrat size used (20m x 20m) would not fit (particularly in coastal areas). Also, in one area the establishment of quadrats would disturb local people that were at the time camping in the area.

A Level 2 Survey, as defined by the Environmental Protection Authority (2004), was determined to be the appropriate level of survey for this project as the scale and nature of the

impact is likely to have ‘high’ and ‘moderate’ characteristics (EPA 2004; Appendix 2; Table 3) and the survey area is within a Group 3 bioregion (Dampierland Bioregion).

A Level 2 survey consists of either a detailed or comprehensive survey. The purpose of a comprehensive survey is to enhance the level of knowledge at the locality scale, and the context in the local scale. A comprehensive survey involves one or more visit/s in the main flowering season and visit/s in other seasons; replication of plots in vegetation units, and greater coverage of plots over the target area (in comparison to a Level 1 survey), over the locality and part of the local area. Multiple visits are also required (EPA 2004).

## 2.1 Collecting Licenses

All plant material was collected under the following licenses:

Personnel	DRF Collecting Permit	Flora Collecting Permit
Catherine Godden	162 – 06/07	SL00 7778
Bianca Taylor	165 – 06/07	SL00 7678
Kylie Greenacre	78-0708	SL00 8064
Brendan Stratton		SL00 8068
Greg Woodman	75-0708	SL00 8043

No Regulation 4 permits were required as part of this survey.

## 2.2 Field Survey

The original field survey was conducted by Catherine Godden and Bianca Taylor from 27<sup>th</sup> – 31<sup>st</sup> August 2007, with a second field survey conducted by Greg Woodman, Bianca Taylor, Kylie Greenacre and Brendan Stratton from 7<sup>th</sup> – 11<sup>th</sup> April 2008. Assistance was provided in the field by Mr. Neil McKenzie. A series of 31 quadrats, each measuring 20m x 20m, were established throughout the survey area. All corners to each of the plots were marked using steel fence droppers during the survey, with only one corner left in for perpetuity (Appendix C). Figures 3a – 3e present the locations of quadrats established during this survey.

All species that were collectable and identifiable within each quadrat were recorded, and collected as necessary. The following information was recorded at each quadrat:

- Personnel;
- Date of survey;
- Location (GDA94);
- Photograph;
- Topography;
- Soil type and soil colour;
- Vegetation condition (Scale – see Government of Western Australia 2000);
- Approximate time since fire;
- Percentage foliage cover (for each species); and
- Height (m) (for each species, excluding climbers).

A total of 3 detailed recording sites were also undertaken during the survey. As described under Section 2. (Methods), these were undertaken in areas where the plant community was either too narrow to permit the establishment of a 20m x 20m quadrat, or the establishment of such would impact negatively upon local people in the area. Although the same data as described above was recorded, as the site area was not a standard 20m x 20m area (detailed site recording measures plant species within approximately a 10m radius of the centre point instead), this data has not been used during statistical analysis.

During the April 2008 survey, all quadrats established in August 2007 were re-visited for further searching, specifically annual species which are only present during and at the end of the wet season. An additional quadrat was established in one location to further develop the understanding of this particular community type. As a result of this second survey it is thought that approximately 80% of the flora of the study area were identified.

Two proposed development areas with the potential to contain the DRF species *Keraudrenia exastia* were searched for significant flora (including DRF and priority species), with an emphasis placed on the locating and counting of *Keraudrenia exastia* individuals. These entire areas were walked in transects 20m apart, with each individual significant flora location and population number recorded.

In addition to the above targetted searching, all areas within the project area were searched opportunistically for significant flora locations.

Neil McKenzie, an elder of the Yawuru tribe, kindly provided information regarding local Aboriginal usage of plant species in terms of food, medicine and other cultural aspects during our field studies. All information volunteered by Mr McKenzie regarding native flora was recorded and is presented in this report.

### **2.3 Plant Collection and Identification**

Specimens were collected for identification at the WAHerb where flora species unknown to the surveyors were encountered during the survey. The locations of all DRF, Priority flora and other species of interest observed were noted. All plant identifications were undertaken by Lorraine Cobb and Sharyna Thomson; with assistance from experts in the relative fields of taxonomy, including Malcolm Trudgen.

Plant species nomenclature used in this report follows Packowska and Chapman (2000). All names were checked using the Max Database to ensure their validity. The conservation status of all species collected was checked using the current Department of Environment and Conservation list (DEC 2008a).

Specimens of species of interest (Priority Flora species, range extensions and those that are potentially new species) will be submitted to the WAHerb for inclusion into the collections at the end of this project. Rare Flora Report Forms (RFRF) will be submitted for locations of Priority Flora species recorded within detailed sites, quadrats, and for opportunistic recordings for species that were not collected in sites or quadrats.

## 2.4 Statistical Analysis

Statistical analysis and determination of FCTs were conducted using quadrat data only. Statistical analysis of the quadrat derived data was conducted using methods similar to those used by Markey and Dillon (2006). In the DEC studies quadrat data was analysed statistically using three separate statistical packages and following a method utilised in previous regional floristic surveys (Gibson 2004 and references therein).

Classification and ordination analyses were conducted on a data matrix compiled from the quadrat data, with introduced, annual and singleton (taxa occurring once in the dataset) taxa omitted prior to analysis. Various taxa were grouped together within the data matrix for the analyses where taxonomy was unclear or where different infra-taxa were identified within the dataset and not correlated to community type.

Pattern analysis was conducted using PATN (V3.03) (Belbin 1989). The Bray-Curtis coefficient was used to generate an association matrix for classification and ordination analyses. Within PATN the agglomerative hierarchical clustering method using flexible UPGMA ( $\beta=-0.1$ ) was used to generate a species by site classification (Sneath and Sokal 1973) and two way tables.

Indicator species analysis (INDVAL) was conducted using PC-Ord (McCune and Mefford 1999) using the method of Dufrene and Legendre (1997). The INDVAL measures were used to determine the indicator species for each FCT and a Monte Carlo permutation test was used to test for the significance of the indicator species.

## 2.5 Boundary Mapping

Boundary mapping of FCTs was undertaken after statistical analysis of quadrat data, and interpretation of aerial photography at a scale of 1:10 000, in relation to location of quadrats, and topographical data.

# 3. Results

## 4.1 Flora

A total of 167 discrete vascular plant taxa, from 113 genera and 53 families, were recorded during the surveys conducted in August 2007 and April 2008. The most well-represented families were Poaceae (23 taxa, including 3 introduced taxa), Papilionaceae (16 taxa, including 2 introduced taxa), Mimosaceae (9 taxa), Malvaceae (8 taxa, including 1 introduced taxa) and Myrtaceae (7 taxa). Appendix D presents a list of vascular plant taxa recorded during the survey.

### 4.1.1 Conservation Significant Species

Five conservation significant flora species were recorded during the surveys in August 2007 and April 2008. The locations of these are presented in Table 8, and on Figures 3a – 3e.

One location of *Keraudrenia exastia* (DRF) was recorded during the survey, near but just outside of the location known as Population ‘C’ (Broome Botanical Society Inc. 1995), and Population ‘2’ (Urbanplan 2006). This was located at quadrat POB-03 (Appendix C; Figure 3a). Individuals of this species in this area looked healthy, however there has been some general previous disturbance in this area. Appendix G presents a photograph of *Keraudrenia exastia* (Plate 1).

During the survey in April 2008, individuals of *Keraudrenia exastia* known in Population ‘C’ were located and counted using methods described in Section 2.2. Approximately 21,000 individual plants were recorded in this area and these locations are shown on Figures 2 and 3a.

*Goodenia byrnesii* is a small herb which grows in sand and on the edges of creeks, usually flowering from January – February. The distribution of this priority 1 species is restricted to the Northern Botanical Province, mostly near Broome and to the north of Halls Creek (DEC 2008c). This species was recorded in 7 of the 31 quadrats established during the survey (Figures 3a-e), and also at various locations throughout the survey area. Woodman Environmental also recorded *Goodenia byrnesii* in 1 location near Derby during a survey in 2007 (Woodman Environmental 2007c).

The Priority 3 species *Triodia acutispicula* was recorded in 17 of the 31 quadrats established during the survey (Figures 3a-e). The percentage foliage cover for this species ranged from 1% – 60%, and it was usually a co-dominant of hummock grassland stratum with *Triodia pungens*, or more rarely *Triodia microstachya*.

*Triodia acutispicula* is a tussock-forming resinous perennial grass, growing to a height of 1.5m, and usually flowers from January – April. It has a relatively wide distribution, including the Drysdale River, Cape Leveque, Derby, Prince Regent River, Beverley Springs Station and Mitchell Plateau (DEC 2008c). This species was recorded at several locations by Woodman Environmental near Stokes Bay and between Derby and Fitzroy Crossing (Woodman Environmental 2007a-c). This species has been shown to be relatively common in the Kimberley region of WA and should be reviewed by the DEC for removal from the Priority Flora list.

*Phyllanthus aridus*, a Priority 3 species, is a small shrub growing to 0.25m high on sandstone, gravel and red sand. The distribution of this species in Western Australia ranges from Halls Creek to Karratha (DEC 2008c), with Woodman Environmental Consulting previously recording several locations between Broome and Port Headland in 2007 (Woodman Environmental 2007e). *Phyllanthus aridus* was recorded in one location in the Broome survey area, which was in FCT 4 and is shown in Figure 3a.

A potentially new taxa, *Scleria* sp., was recorded in two quadrats (POB-03 and POB-16) during the survey (Table 8; Appendix C) and at various other locations throughout the study area (Figures 3a to 3e). The percentage foliage cover of this species at each of these locations was very small, at 0.1% cover, and the height of this species ranges from between 0.3m – 0.4m. The vegetation at quadrat POB-03 was dominated by an open woodland of *Corymbia dampieri*, *Corymbia paractia* and *Erythrophleum chlorostachys* over an open shrubland dominated by *Acacia tumida* var. *tumida* and *Acacia colei* var. *colei* over *Acacia adoxa* var.

*subglabra* over a grassland of *Triodia pungens*, *Aristida holathera* ?var. *holathera* and *Triodia acutispicula*. The vegetation at quadrat POB-16 was dominated by an open woodland of *Corymbia dampieri* with *Bauhinia cunninghamii*, over a shrub layer dominated by *Acacia colei* var. *colei*, *Acacia eriopoda* and *Psydrax attenuata* var. *tenella* over a hummock grassland dominated by *Triodia acutispicula*.

This potentially new taxa was also recorded by Woodman Environmental during a survey for Arc Energy near Stokes Bay in 2007 (Woodman Environmental 2007a). This species was recorded in plant community 'S1: Shrubland of *Acacia tumida* var. *tumida* over Dense Grassland of *Chrysopogon fallax* and *Triodia acutispicula* with occasional mixed shrub species on red-brown sands on midslopes', and was located close to an existing access track from Point Torment Road. Four *Scleria* species are known from the Dampierland and Central Kimberley Regions, 3 of which occur only in damp areas and along watercourses (DEC 2008c). This potentially new species has a larger, hairy nut which is not known from other *Scleria* species.

Table 8: Location of Significant Flora Species Recorded during the Surveys, August 2007 and April 2008			
Species	Conservation Status	Quadrats Recorded	Floristic Community Type(s) (Section 4.2)
<i>Keraudrenia exastia</i>	DRF	POB-03	FCT 4
<i>Goodenia byrnesii</i>	P1	POB-04, POB-09, POB-14, POB-17, POB-23, POB-26, POB-27	FCT 4; FCT 5
<i>Triodia acutispicula</i>	P3	POB-03; POB-04; POB-05; POB-06; POB-08; POB-09; POB-10; POB-11; POB-12; POB-13; POB-14; POB-15; POB-16; POB-17; POB-24; POB-25; POB-26	FCT 1; FCT 2; FCT 4; FCT 5
<i>Phyllanthus aridus</i>	P3	North of POB-05 at GPS location (GDA94, Zone 51): 415001, 8010841	FCT 4
<i>Scleria</i> sp.	-	POB-03; POB-16	FCT 4; FCT 5

Three species were recorded as range extensions; *Panicum effusum*, *Amaranthus mitchellii*, and *\*Ziziphus mauritania*. *Panicum effusum* is known from areas near Halls Creek and Newman but has not previously been recorded near Broome, whilst *Amaranthus mitchellii* has been recorded near Karratha and many other areas in the Eremaean botanical province (DEC 2008c). In 2007 Woodman Environmental recorded this species approximately 110km north east of Marble Bar (Woodman Environmental 2007d), making the latest recording a range extension to the north east of approximately 320km. *\*Ziziphus mauritania*, an introduced species was recorded at quadrat POB-29 (Appendix C). See Section 4.1.2 for more information regarding this species.

#### 4.1.2 Introduced Species

A total of 14 introduced (weed) species were recorded during the survey. These species and their recording locations are shown in Table 9, and their species names are also listed in



Appendix D, denoted with a \* prior to the species. Two of these species are listed as Declared Plants under the *Department of Agriculture and Related Resources Act 1976* (Department of Agriculture and Food 2008). Declared Plants are subject to standard control codes throughout the State, which are described in Appendix E.

<b>Table 9: Location of Introduced Flora Species Recorded during the Surveys, August 2007 and April 2008</b>			
<b>Species</b>	<b>Quadrats Recorded</b>	<b>Opportunistic GPS locations*</b>	<b>Floristic Community Type(s) (Section 4.2)</b>
<i>Aerva javanica</i>	POB-01, POB-20	415621, 8009817 415988, 8009693 415966, 8009655	FCT 1, FCT 3
<i>Cenchrus ciliaris</i>	POB-02, POB-20, POB-22	415662, 8007849 415988, 8009693	FCT 3
<i>Chloris barbata</i>	POB-20	-	FCT 3
<i>Clitoria ternatea</i>	POB-19, POB-20	-	FCT 1, FCT 3
<i>Emilia sonchifolia</i>	POB-20	-	FCT 3
<i>Hyptis suaveolens</i>	POB-20	-	FCT 3
<i>Jatropha gossypifolia</i>	POB-22, POB-30	-	FCT 3, FCT 5
<i>Macroptilium atropurpureum</i>	POB-20	-	FCT 3
<i>Merremia dissecta</i>	POB-04, POB-22	414882, 8009805	FCT 3, FCT 4
<i>Passiflora foetida</i> var. <i>hispida</i>	POB-01, POB-03, POB-04, POB-07, POB-10, POB-11, POB-12, POB-20, POB-22, POB-24, POB-25, POB-27	POB Site 02	FCT 1, FCT 2, FCT 3, FCT 4, FCT 5, FCT 6
<i>Setaria verticillata</i>	POB-03	-	FCT 4
<i>Sida cordifolia</i>	POB-10	416108, 8010666	FCT 2
<i>Tridax procumbens</i>	-	415697, 8009706	FCT 4
<i>Ziziphus mauritiana</i>	POB-29	-	FCT 1

\*Note: All GPS locations are GDA94, Zone 51.

*Jatropha gossypifolia* (Bellyache Bush) is an erect shrub or small tree to approximately 4m high, and is originally a native of tropical Central and South America, and the Caribbean. It is deciduous in dry conditions. The leaves are sticky, and palmate in three segments. Flowers appear from February to May. This species is a weed of grazed woodlands, creeklines and wasteland in the Kimberley Region (Hussey *et. al.* 1997). This species is listed as Control Code P1 (for the whole of the State), and category P4 for the Broome Shire (Appendix E). This species was recorded at quadrats POB-22 and POB-30 (Appendix C).

*Ziziphus mauritiana* (Chinese date, Indian jujube) is a thorny spreading tree native to Asia, growing to 6m with a canopy of up to 10m wide. The stems have large thorn, and the flowers are green and inconspicuous. The fruit is edible, with a woody stone covered with white flesh. This species is naturalised around Broome and Derby (Hussey *et. al.* 1997). This species is listed as Control Code P1 and P2 for the Broome Shire. This species was recorded at quadrat POB-29 (Appendix C).

Two other weed species recorded during the survey are highly invasive species, including *Cenchrus ciliaris* (Buffel Grass) and *Aerva javanica* (Kapok bush). These species will invade native bushland from established populations within disturbed areas and it is recommended that populations of these species are also controlled on Broome Port Authority-managed lands. *Cenchrus ciliaris* was recorded at quadrats POB-02, POB020 and POB-22; *Aerva javanica* was recorded at quadrats POB-01 and POB-20 (Appendix C); however both species are fairly widespread, especially near disturbed areas.

Other weed species recorded during the survey, including *Chloris barbata* (purpletop chloris), *Setaria verticillata* (whorled pigeon grass), *Clitoria ternata* (butterfly pea), *Macroptilium atropurpureum* (siratiro), *Passiflora foetida* var. *hispida* (stinking passion flower), *Merremia dissecta*, *Hyptis suaveolens* (hyptis, mintweed) and *Emilia sonchifolia* (red tassel flower), *Setaria verticillata* (whorled pigeon grass), *Sida cordifolia* (sida), *Tridax procumbens* (tridax) are widespread through the tropics and/or Kimberley region (Hussey *et. al.* 1997).

#### **4.1.3 Notes on Indigenous Use of Plant Species in Survey Area**

Mr. Neil McKenzie provided information regarding a range of food, medicinal and cultural uses for plant species encountered during the survey. These are described in Table 10. This listing is by no means exhaustive. For further information a comprehensive range of information is presented in Kenneally *et. al.* (1996).

Traditional uses of plant species as per Table 10 are of the Yawuru people. Appendix G presents photos of some of these species.

Table 10: Indigenous Uses of Plant Species Recorded during the field surveys, August 2007			
Common Name	Family	Plant Taxa	Traditional Uses
Conkerberry	Apocynaceae	<i>Carissa lanceolata</i>	Ceremonial wood; Edible fruits sweet when ripe (black berries)
Bush Banana	Asclepiadaceae	<i>Marsdenia viridiflora</i> subsp. <i>tropica</i>	Young fruit eaten
Mother-in-law tree; Jigal Tree; Kimberley Bauhinia	Caesalpiniaceae	<i>Bauhinia cunninghamii</i>	Use of nectar from flowers in drink, with a similar effect to Red-Bull
Gubinge	Combretaceae	<i>Terminalia ferdinandiana</i>	Edible berries with a very high Vitamin C content; edible sap (roast hard sap and chew); edible seed kernel; mix fruit with hot water to make a drink; bark infused in tea (turns purple) for medicinal use - dries up cuts, sores, etc on skin
Marool; Blackberry Tree	Combretaceae	<i>Terminalia petiolaris</i>	Edible fruits with a high level of Vitamin C
Helicopter Tree; Coolaman Tree; Gold and Silver Tree	Gyrostemonaceae	<i>Gyrocarpus americanus</i> subsp. <i>pachyphyllus</i>	Bark used for shields and coolamans (carriers); bark also used to treat prickly rash, with the charcoal acting as an anti-histamine
Firestick Tree	Lamiaceae	<i>Premna acuminata</i>	Wood used in making spears and fire sticks; used in making of fire; use in ornamental traditional dress
Yugulu	Lauraceae	<i>Cassytha filiformis</i>	Use of dense tangled stems in fishing nets; use of tangled stems into making footwear; edible seeds
Yellow Ball Flower	Menispermaceae	<i>Mallotus nesophilus</i>	Edible fruits
Snake Vine	Menispermaceae	<i>Tinospora smilacina</i>	Used in ceremony to stop rain
Dune Wattle	Mimosaceae	<i>Acacia bivenosa</i>	Grinding of seeds to make biscuits
Sandpaper Fig	Moraceae	<i>Ficus aculeata</i> var. <i>orbicularis</i> ms	Stimulates milk production; scraping of skin with leaves helps eczema and ringworm
Bloodwood	Myrtaceae	<i>Corymbia</i> spp.	Medicinal antiseptic sap for toothache; bloodwood 'apples' for food; sugary gum from insects for candy; firewood
Crabs Eye Bean	Papilionaceae	<i>Abrus precatorius</i> subsp. <i>precatorius</i>	Seeds are very poisonous
Green Birdflower	Papilionaceae	<i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i>	Edible nectar; base of flower tastes like snowpea; when dead trunks have grubs inside base for eating
Flinders river poison	Papilionaceae	<i>Tephrosia rosea</i> var. <i>rosea</i>	Use as a fish poison - smash roots, mix with sand, then put in rock pools and the poison coats gills of fish
Gummy Spinifex	Poaceae	<i>Triodia pугens</i>	Protection from insects; use in making of thatch for shelter and shade

Table 10: Indigeneous Uses of Plant Species Recorded during the field surveys, August 2007			
Common Name	Family	Plant Taxa	Traditional Uses
Caustic Tree	Proteaceae	<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>	Paint used in ceremonies (turns white when applied); resin of seed pods is caustic and can burn
	Proteaceae	<i>Hakea macrocarpa</i>	Use of charcoal during ceremonies
Geebung	Proteaceae	<i>Persoonia falcata</i>	Sweet seeds ground into a paste and made into a pudding; do not eat flowers
Supplejack	Rhamnaceae	<i>Ventilago viminalis</i>	Medicine bark, used as an infusion and applied to deep cuts, sores and swellings; use in manufacture of boomerangs
Tropical Sandalwood	Santalaceae	<i>Santalum lanceolatum</i>	Bark burnt to heal cuts and sores and repel mosquitoes; edible soft flesh around seed

## 4.2 Vegetation

Analysis of the PATN generated dendrogram identified 2 super-groups with the initial dissection occurring at the group 6 level. The two super-groups reflect the two broad landscape types of the survey area – coastal dunes and pindan soils.

Super-group 1: Open Woodlands and Shrublands over grasslands on pale brown to orange sands on foredunes, immediately behind foredunes and other dunal areas

A total of 37 plant taxa were recorded within quadrats grouped into super-group 1 that were not recorded in super-group 2 (Appendix F).

Super-group 2: Open Woodlands over Shrublands over grasslands on orange to red pindan soils on lowerslopes to crests

A total of 73 plant taxa were recorded within quadrats grouped into super-group 2 that were not recorded in super-group 1 (Appendix F).

### 4.2.1 Floristic Community Types

A total of 6 FCTs are described within the survey area, as a result of statistical analysis from quadrat data collected in August 2007 and April 2008. An additional 2 FCTs are disturbed variants of 2 main FCTs and are also described within the survey area in small patches. A total of 172 plant taxa were recorded within quadrats, with a listing of each of these plant taxa located within quadrats within each FCT presented in Appendix F. Of these taxa, a total of 102 taxa were used to define FCTs during the statistical analysis. Appendix C presents the FCT to which each quadrat was grouped.

Appendix H presents a summary dendrogram of the floristic relationships between each of the quadrats established in August 2007 and April 2008.

Appendix I presents a two-way table of plant taxa used during the statistical analysis, with recordings of taxa against individual quadrats within each FCT grouping. This details groups of plant taxa which are related within each FCT, which have been split into groups A-K (Appendix I). Generally, super-group 1 is most-represented by species from groups A, B and C, whereas super-group 2 is most-represented by species from groups E-K (Appendix I).

Indicator species resulting from the INDVAL measures and Monte Carlo permutation test are presented in Appendix J. Please note that as FCT 2 and FCT 6 contained only one quadrat each (POB-10 and POB 31 respectively), no indicator species are available for these FCTs.

#### Super-group 1

FCT 1: Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes

FCT 1 was represented by six quadrats, all located on the crests of foredunes or on the leeward side of the foredune, on the western coastline of the survey area, north of Gantheaume Point along Cable Beach (Figures 3a-3e). A single site was also conducted in this area (Figure 3d). A total of 52 native plant taxa were recorded within quadrats within this FCT (Appendix F). FCT 1 is most-represented by species from group C, with no representation of groups E, F or J (Appendix I). The average species richness of FCT 1 was 18.17  $\pm$  6.34 taxa.

Indicator species for this FCT included *Acacia bivenosa*, *Boerhavia gardneri*, *Canavalia rosea*, *Crotalaria cunninghamii* subsp. *cunninghamii*, *Malotis nesophilus*, *Myoporum monatum*, and *Spinifex longifolius* (Appendix J). All of these species are coastal species, with *Spinifex longifolius* occurring on coastal sand dunes within Western Australia from the Kimberley region southwards to Cape Leeuwin. *Acacia bivenosa* is common in calcareous sand near Willie Creek and Cable Beach. Occurs south to Exmouth and also in the Northern Territory and Queensland. *Boerhavia gardneri* has been recorded as common in pindan near Broome, Gallen Well and One Arm Point. *Canavalia rosea* occurs in Western Australia on coastal beaches and sand dunes among limestone rocks, along the coast in and between the Northern Kimberley and Canarvon regions. *Crotalaria cunninghamii* subsp. *cunninghamii* is located on sand dunes and coastal dunes in the Victoria Bonaparte region along the coast south into the Dampierland region (DEC 2008c). *Malotis nesophilus* is found commonly in near coastal areas on the peninsula, predominantly on the leeward side of coastal sand dunes. *Myoporum monatum* is common in coastal pindan and vine thickets near Broome.

**FCT 2:** Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. 2 on orange sand on secondary dunes

FCT 2 was represented by one quadrat only (POB-10), located on secondary dunes on the sheltered eastern side of the southern Broome Peninsula, on Roebuck Bay. One site was also undertaken within this area (Figures 3a and 3c). A total of 25 native plant taxa were recorded within the quadrat established in FCT 2, including the P3 species *Triodia acutispicula* (Appendix F).

Although FCT 2 is grouped into super-group 1 with other coastal quadrats, this FCT is the least floristically-related of the group (Appendix H). *Corymbia polycarpa* was also recorded in FCT 5, which along with FCT 4 and FCT 6 form super-group 2. FCT 2 however did include species from group C, which were more typically recorded in super-group 1 (Appendix I). The only species recorded in FCT 2 and in no other FCT was *Cyperus conicus*, which Kenneally *et. al.* (1996) notes as occurring in pindan at Broome.

**FCT 3:** Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lower slopes behind dunes, and secondary dunes

FCT 3 was represented by three plots, one in a disturbed area at the very southern end of the survey area (POB-02), and two on the western coast along Cable Beach (POB-20) and (POB-22) (Figures 3a-3e), which were located within a vine thicket. A total of 57 plant taxa, including ten introduced taxa, were recorded within FCT 3 (Appendix F). The average species richness of FCT 3 was 26.33  $\pm$  0.6 taxa. This FCT equates to the TEC 67 (Monsoon Thickets).

FCT 3 is most represented by group A, with no representation from groups D-G and J (Appendix I).

*Carissa lanceolata*, *Cassytha capillaris*, *Exocarpos latifolius*, *Grewia brevifolia*, and *Tephrosia remotiflora* are the main indicator species for FCT 3 (Appendix J). *Exocarpos latifolius* is restricted to sandstone gullies, sand dunes and river banks in the Northern botanical province of Western Australia, whilst *Tephrosia remotiflora* occurs on pindan and sand dunes in the Northern botanical province, as well as inland in the Pilbara region (DEC 2008c). *Carissa lanceolata* is a tree of the pindan on the peninsula and is also known from the Northern Territory, while *Cassytha capillaris* is a parasitic twiner known from WA, NT, QLD, New Guinea, Indonesia and Sri Lanka. *Grewia breviflora* is known mainly from vine thicket communities on the Broome peninsula and the NT.

**FCT3d:** FCT 3d is a small area of disturbed FCT 3 vegetation, located at the very southern tip of the peninsula (Figure 3a). Clearing and developmental activities have led to the quality of the vegetation in this area to decline.

## Super-group 2

**FCT 4:** Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upper slope positions

FCT 4 was represented by 8 quadrats located on pindan soil on the southern half of the survey area (Figures 3a, 3b, 3e). A total of 90 plant taxa were recorded within quadrats in this FCT. This includes five conservation significant species, *Keraudrenia exastia* (DRF), *Goodenia byrnesii* (P1), *Triodia acutispicula* (P3), *Phyllanthus aridus* (P3) and the potentially new species, *Scleria* sp. (Appendix F). Four introduced species, *Merremia dissecta*, *Passiflora foetida* var. *hispida*, *Setaria verticillata* and *Tridax procumbens* were also recorded in FCT 4.

The average species richness of FCT 4 was 30.87  $\pm$  6.00 taxa. Species in FCT 4 were most highly represented by group H, with scattered

representation in groups G and I, and negligible representation from other groups (Appendix I).

Indicator species for FCT 4 included *Cassytha filiformis*, *Erythrophleum chlorostachys*, *Gardenia pyrifolia* subsp. *keartlandii*, *Goodenia armitiana*, *Gyrostemon tepperi*, *Hibiscus leptocladus*, *Persoonia falcata*, *Scaevola parvifolia* subsp. *parvifolia*, *Scleria* sp., *Sida* sp. B (Kimberley Flora (A.A. Mitchell 2745), *Triodia acutispicula*, *Triodia pungens*, *Waltheria indica* and *Zornia prostrata* var. *prostrata* (Appendix I).

**FCT 5:** Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula*, *Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions

FCT 5 was represented by 12 quadrats, with nine plots located on pindan soils north of Gantheaume Point (Figures 3b-3e), two east of Gantheaume Point in the centre of the survey area (POB-12 and POB-14), and one on the western edge of the survey area (POB-25). A total of 107 plant taxa were recorded in this FCT, including the conservation significant species *Goodenia byrnesii* (P1), *Triodia acutispicula* (P3) and the potential new species *Scleria* sp (Appendix F). Two introduced species, *Jatropha gossypifolia* and *Passiflora foetida* var. *hispida*, were recorded in this FCT.

The total species richness of FCT 5 was 27.17 +/- 5.57 taxa. Species in FCT 6 were most-represented by species group H, with scattered representation from species group G and K, similar to FCT 4 and 5 (Appendix I). However, there was some representation from groups A and E which were not recorded in FCT 4, indicating FCT 5 is much more floristically diverse than FCT 4.

The only three indicator species for this FCT were *Acacia colei* var. *colei*, *Acacia eriopoda* and *Psydrax attenuata* var. *tenella*.

**FCT 6:** Dense Low Heath of *Acacia tumida* var. *kulparn* over mixed shrubs including *Cassytha filiformis*, *Mukia maderaspatana* and *Pterocaulon sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on red to brown pindan soils on rocky headland positions.

FCT 6 was represented by one quadrat (POB-31) located on coastal edge near James Price Point. Including the introduced species *Passiflora foetida* var. *hispida*, a total of 22 plant taxa were recorded in this FCT.

No indicator species were identified statistically for this FCT because it was represented by only a single quadrat. However a good indicator species for this FCT would be *Acacia tumida* var. *kulparn*, a windswept and low shrub found on pindan soil in the Northern Botanical Province and inland south in the Great Sandy Desert region. This species was only found associated with this FCT during the survey.

**FCT 6d:** FCT 6d is a disturbed area of FCT 6, located in a narrow strip between the coastal cliffs and Kavite Road from James Price Point to Gantheaume Point (Figure 3b). This area has a powerline running through it and activities



relating to this powerline, the Kavite Road and historical clearing at Gantheaume Point have resulted in the vegetation degenerating.

The vegetation of the project area displayed the effects of long term disturbance associated with proximity to development with introduced species common. However the condition of the vegetation was mainly in Very Good Condition (Government of Western Australia 2000), with the exceptions being the edges of tracks and developed areas where weeds such as *Cenchrus ciliaris* (Buffel Grass) and *Aerva javanica* (Kapok) were common.

## 5. Discussion

This study sampled flora of the southern Broome Peninsula over two occasions prior to and following seasonal rains. As a result a significant percentage of the flora of the study area were identified, however due to the large size of the study area and the time available to undertake the studies it would be desirable in future to sample the vegetation units identified during the survey to more fully describe their flora.

From this study it can be seen that the floristic groupings respond to a combination of soil type (pindan associations versus coastal dune sand associations), hydrology (dune crest associations versus vine thickets of the dune base) and climate factors (FCT 4 at the exposed southern end of the Peninsula on pindan soils versus FCT 5 on northern sections of the Peninsula on pindan soils).

### 5.1 Conservation Significant Flora

Five conservation significant flora species were recorded during the surveys in August 2007 and April 2008. Species recorded within the Port of Broome managed lands include:

*Keraudrenia exastia* (DRF)

*Goodenia byrnesii* (P1)

*Triodia acutispicula* (P3)

*Scleria* sp.

It is possible that *Phyllanthus aridus* (P3) is also present within FCT 4 within the Port of Broome managed lands although at low density.

All of these species with the exception of the *K. exastia* are new records for the Broome Peninsula. Also, these species were recorded commonly elsewhere within the broader study area on pindan soils and as such any proposed developments within the Port of Broome lands would not have significant impacts on the conservation status of each.

This study identified new locations of *K. exastia* plants in the vicinity of existing populations, however no new populations were recorded during 2007 and 2008. All plants appeared to be in good health and all populations were in flower with the exception of the north-western most population which appeared to be sterile. The condition of vegetation surrounding the *K. exastia* populations appeared to be only Good as a result of previous disturbance and altered fire regimes resulting in a dominance of *Acacia* species and dense covers of *Cassytha filiformis*. Research is

required into the ecology and propagation of *K. exastia* to identify mechanisms for protection of the existing populations and also to identify management strategies that will promote the long term sustainability of the species.

## 5.2 Conservation Significant Vegetation

This study has identified several floristic community types of conservation significance. FCT 3, which is representative of TEC 67 (Monsoon Thickets) is located on the inland side of coastal dunes along the Dampier Peninsula, and tend to become larger and have greater species diversity in a northwards direction. Near Broome distinctive components of this community include *Pouteria sericea*, *Exocarpos latifolius*, *Grewia breviflora*, *Grewia retusifolia*, *Pavetta kimberleyana*, *Bridelia tomentosa*, *Premna acuminata*, *Terminalia petiolaris* and *Terminalia ferdinandiana*. No intact areas of this FCT are located within the Port of Broome managed lands, though areas near the southern tip of the peninsula may have been representative of this FCT in the past prior to the severe disturbance associated with the Port and related activities since settlement.

The PEC 11 Kimberley (*Corymbia paractia* dominated community on dunes) is reportedly common between Gantheaume Point and Cable Beach, however it is apparently restricted to a narrow coastal zone in the Broome area where beach dunes merge into pindan soils (Kenneally *et. al.* 1996), and is often found mixed with rainforest (monsoon) species (Kevin Kenneally and Val English *pers. comm.*). This community is likely to be either a subset of the TEC 67 community or to occur as a mosaic within it. This community could not be identified as a separate entity during this study and as such has not been mapped. This community is not located within the Port of Broome managed lands.

PEC 10 Kimberley (Dwarf pindan heath community of Broome coast). This community was described by Trudgen (1988) as 'AtGp' on pindan soils (Table 3), and is a reference to *Acacia tumida* var. *kulpan*, which occurs on coastal cliffs at Gantheaume Point and James Price Point as a wind pruned shrub to 50cm in height (Kevin Kenneally and Val English, *pers. comm.*). This vegetation type is discussed in Broome Botanical Society Inc. (1995), where it is located on the near-coastal hinterland from Gantheaume Point past Riddell Beach towards the Port of Broome. PEC 10's characteristics include low-profile wind-sheared shrubs, small areas of almost monotypic spinifex grasslands and traces of residual Pleistocene linear dunes. This community was mapped as FCT 6 and is not located within the Port of Broome managed lands.

FCT 4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions. This FCT is likely to be restricted to the southern end of the Broome Peninsula as it potentially occurs as a result of the unique climate of this area, being surrounded in close proximity on 3 sides by the Indian Ocean and Roebuck Bay. This has also been reported by Malcolm Trudgeon in his survey of the Broome Peninsula. Additional clearing of this FCT within the Port of Broome managed lands should concentrate on areas of degraded vegetation and be offset by areas of this community in Good condition or better being preserved within a reserve system.

### 5.3 Port of Broome Proposed Developments

The Port of Broome currently proposes to develop two additional areas within its currently managed lands totalling approximately 30 ha. The Port has also made commitments to relinquish approximately 44 ha of remnant vegetation including areas of FCTs 1, 2 3d and 4 into the existing Minyirr Park Reserve. This land would provide linkage along the coast to the southern tip of the peninsula and also a corridor across the peninsula in the vicinity of the current alignment of Kavite Road to connect the western side of the peninsula to the eastern shore. The Port has also committed to the rehabilitation of Kavite Road on its lands west of the current limit of development.

Surveys within areas of proposed development identified and mapped the flora species of conservation significance listed in section 5.1. The location of *K. exastia* plants within a portion of this area should be avoided and proposed development boundaries amended in accordance with recommendations in the following section.

The currently proposed vegetated corridor would provide valuable linkage and habitat on the peninsula, however the currently proposed east to west linkage contains a very narrow section adjacent to the stockyards. This section contains quite degraded vegetation and the narrow width in combination with the existing Port Road alignment limits the potential of this area to act as a true linkage for fauna species. The inclusion of additional vegetation to increase the linkage width in this area in combination with the development and implementation of an environmental management programme that addresses weed management and rehabilitation of disturbed areas within the proposed corridors would provide the potential to significantly improve the quality of the vegetation and habitats on the southern end of the peninsula.

The proposed involvement of the Port of Broome with the future of the traditionally managed Minyirr Park and the ongoing consultation and involvement of the traditional owners with the Authority regarding future developments and management of the peninsula will ensure that traditional uses of the peninsula are not significantly impacted by Port of Broome operations.

## 6. Recommendations

The following recommendations are given:

### *Keraudrenia exastia*

- Areas of proposed development should be re-designed to avoid all locations of this species, preferably leaving a buffer of approximately 50m.
- Conditions should be placed on all developments in the vicinity of this species to ensure the plants are protected from direct and indirect impacts such as dust and drainage from industrial sites.
- The populations of this species should be monitored every 3 years.
- The Port of Broome should liaise with the Broome Botanical Society and the Department of Environment and Conservation regarding the preservation of this species with the objective of identifying and funding appropriate research on the

ecology and propagation strategies of the species. The results of this research to be used as part of a management/recovery plan for the species on the Broome Peninsula.

### **Port of Broome Environmental Management Programme**

- An Environmental Management Plan (EMP) should be developed to address the on-going management of the Environmental Cultural Corridor and the remaining vegetation of the Port of Broome managed lands. This document should include sections on weed management, fire management, drainage, cultural aspects and monitoring. An outline for this EMP is provided in Appendix L.

## **7. Acknowledgements**

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Mr Neil McKenzie (Traditional Owner)

Mr David Dureau (Broome Botanic Society)

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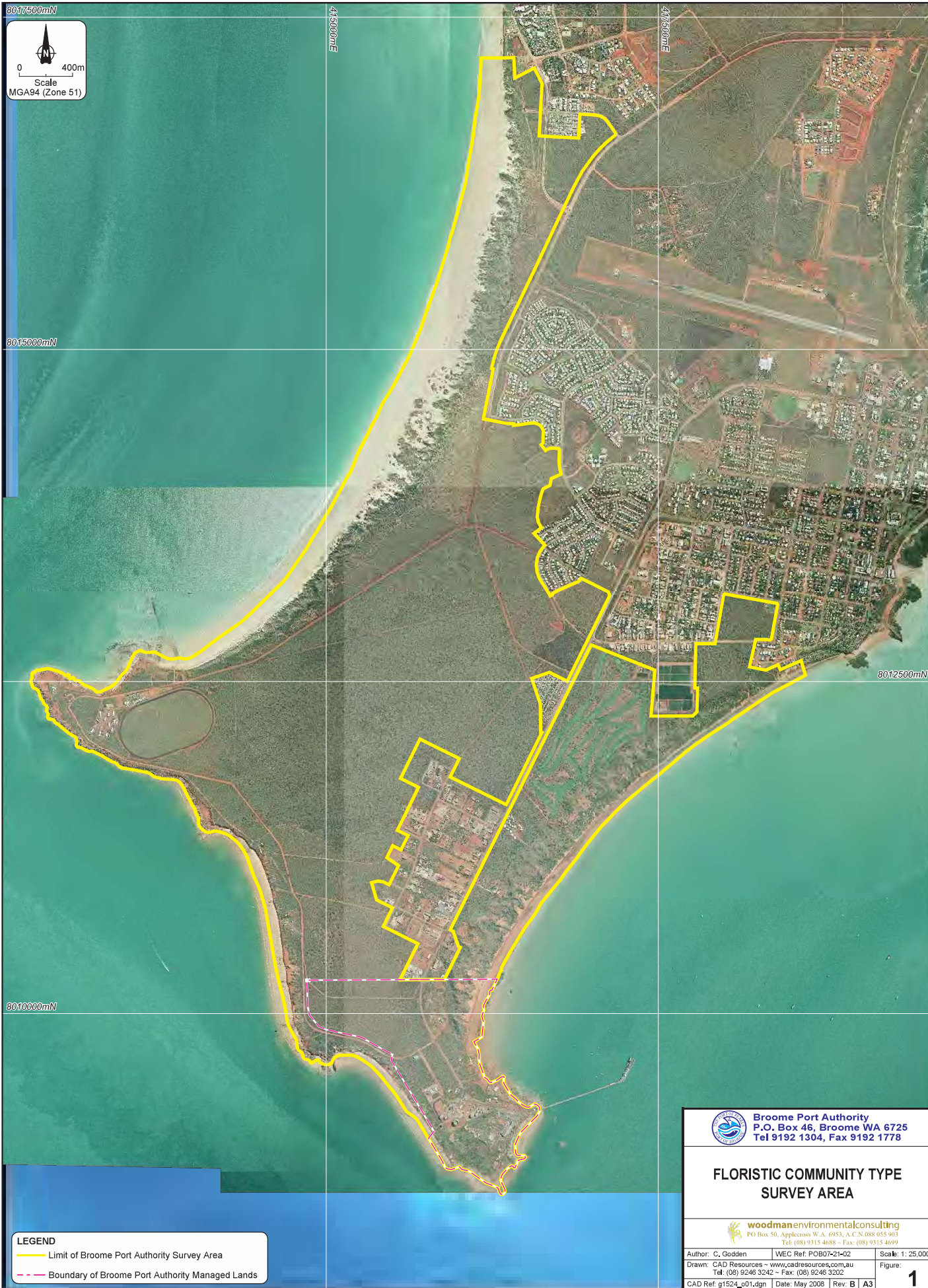
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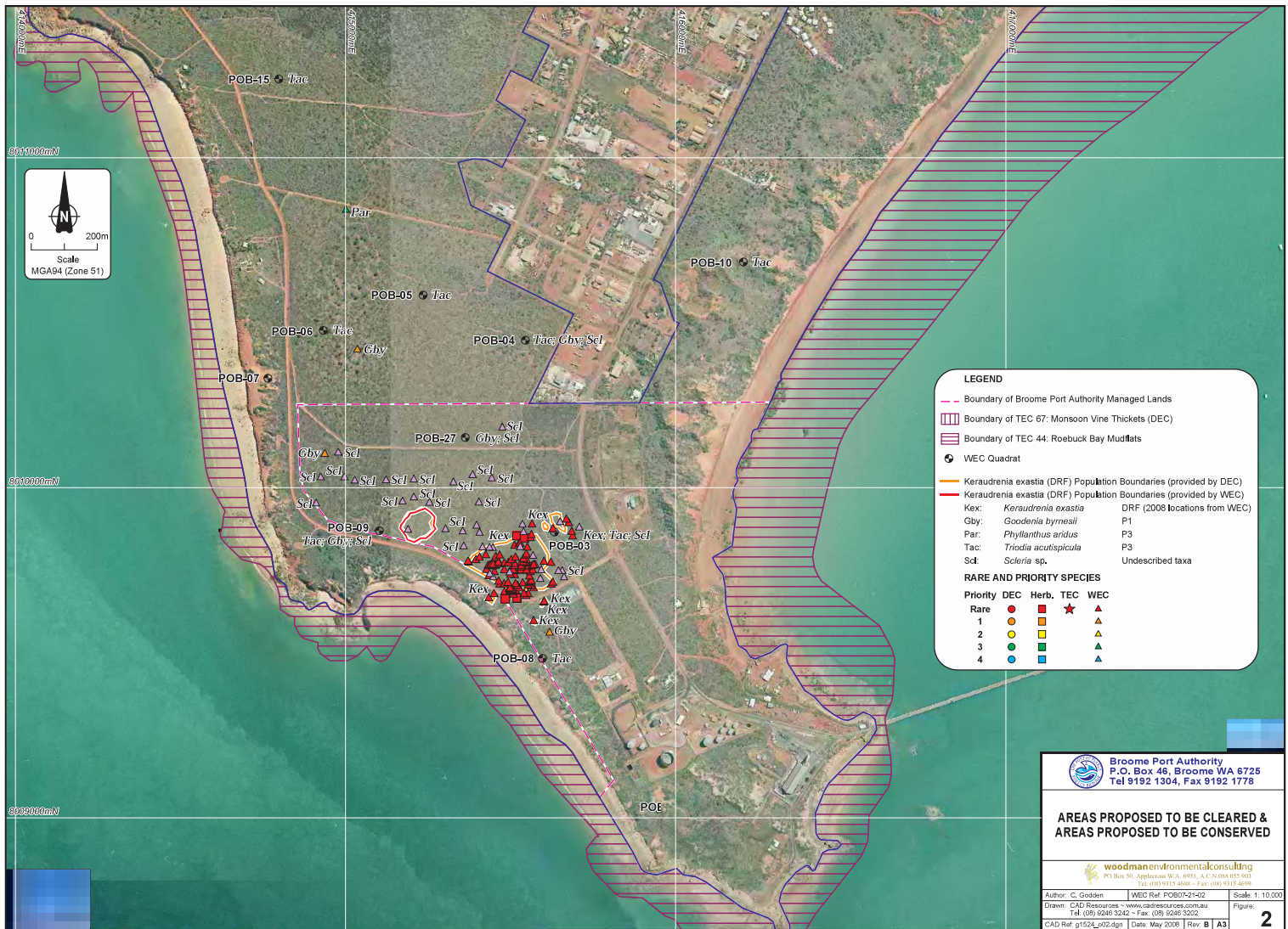


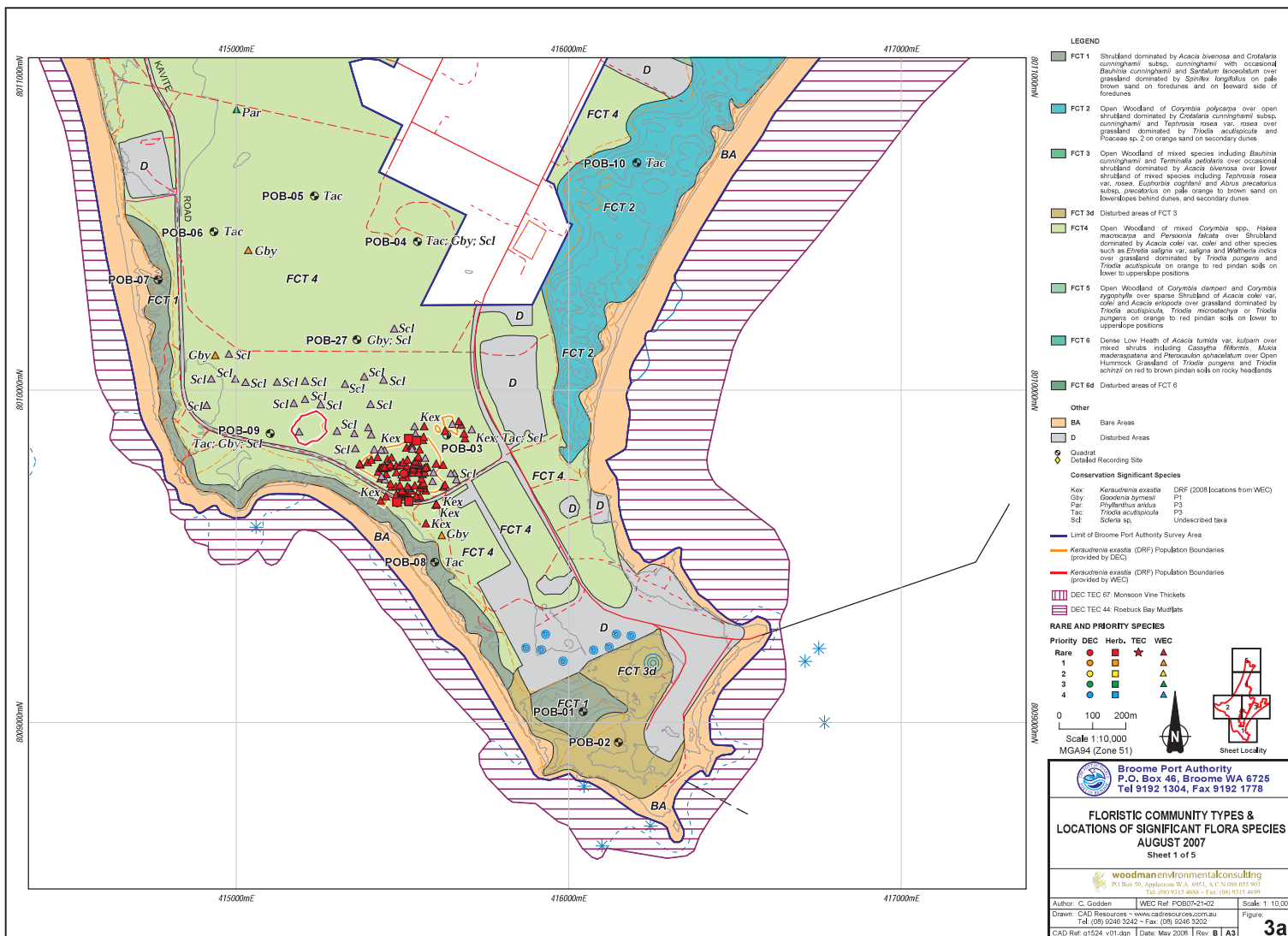
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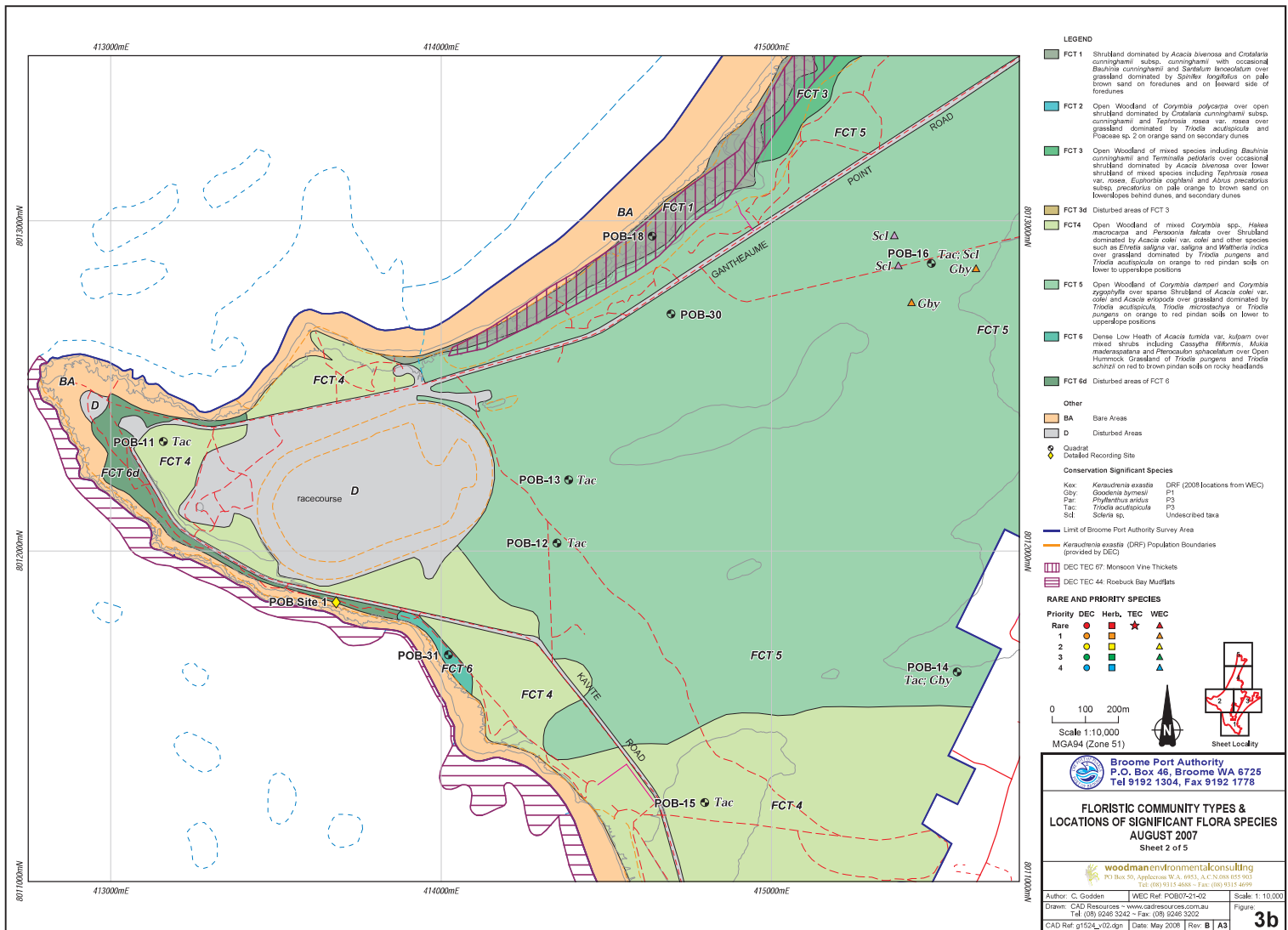
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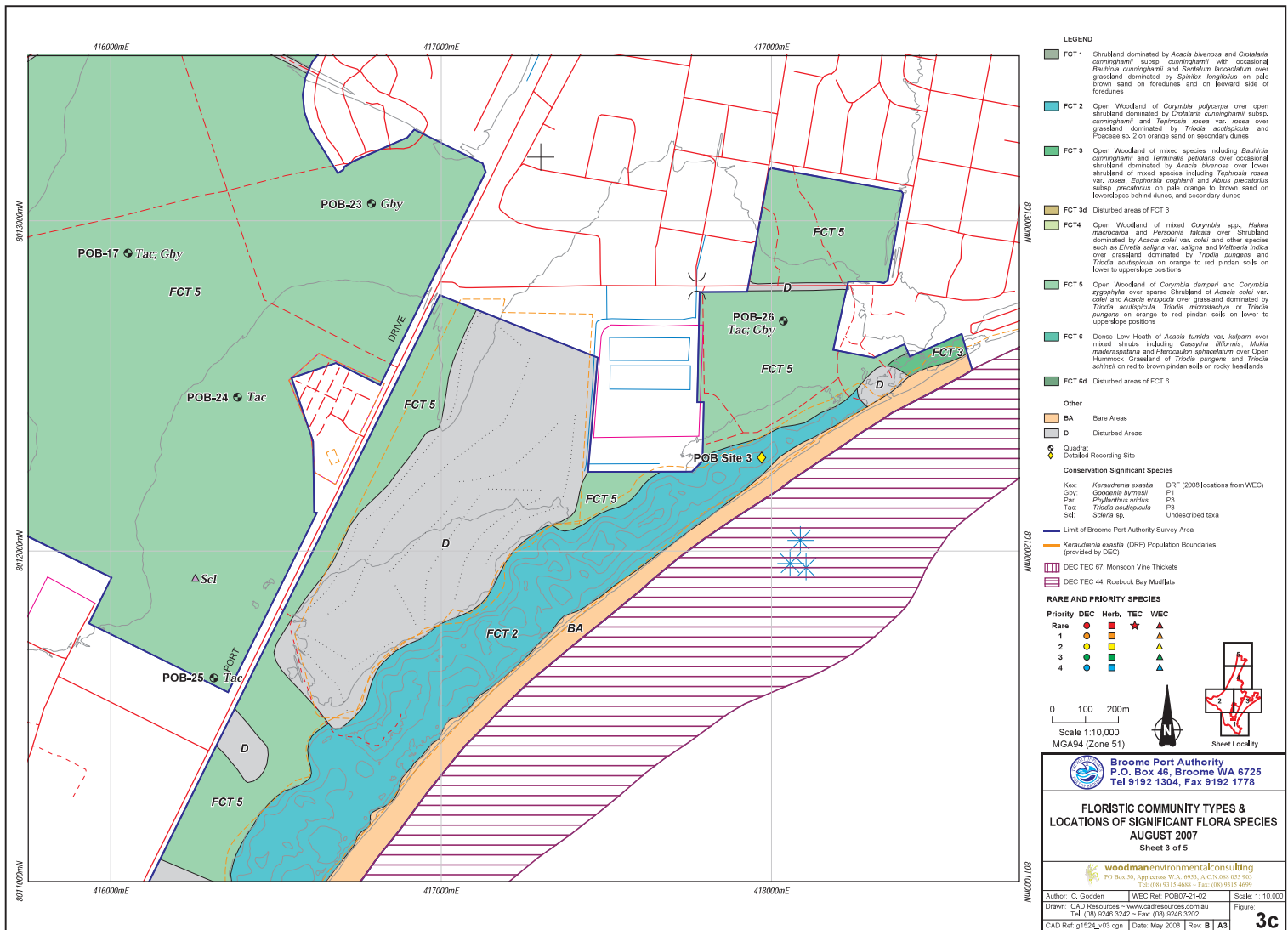
 <b>Broome Port Authority</b> P.O. Box 46, Broome WA 6725 Tel 9192 1304, Fax 9192 1778		
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Author: C. Godden Drawn: CAD Resources - <a href="http://www.cadresources.com.au">www.cadresources.com.au</a> CAD Ref: g1524_p01.dgn	WEC Ref: POB07-21-02 Tel: (08) 9246 3242 - Fax: (08) 9246 3202 Date: May 2008	Scale: 1: 25,000 Figure: <b>1</b> Rev: B A3



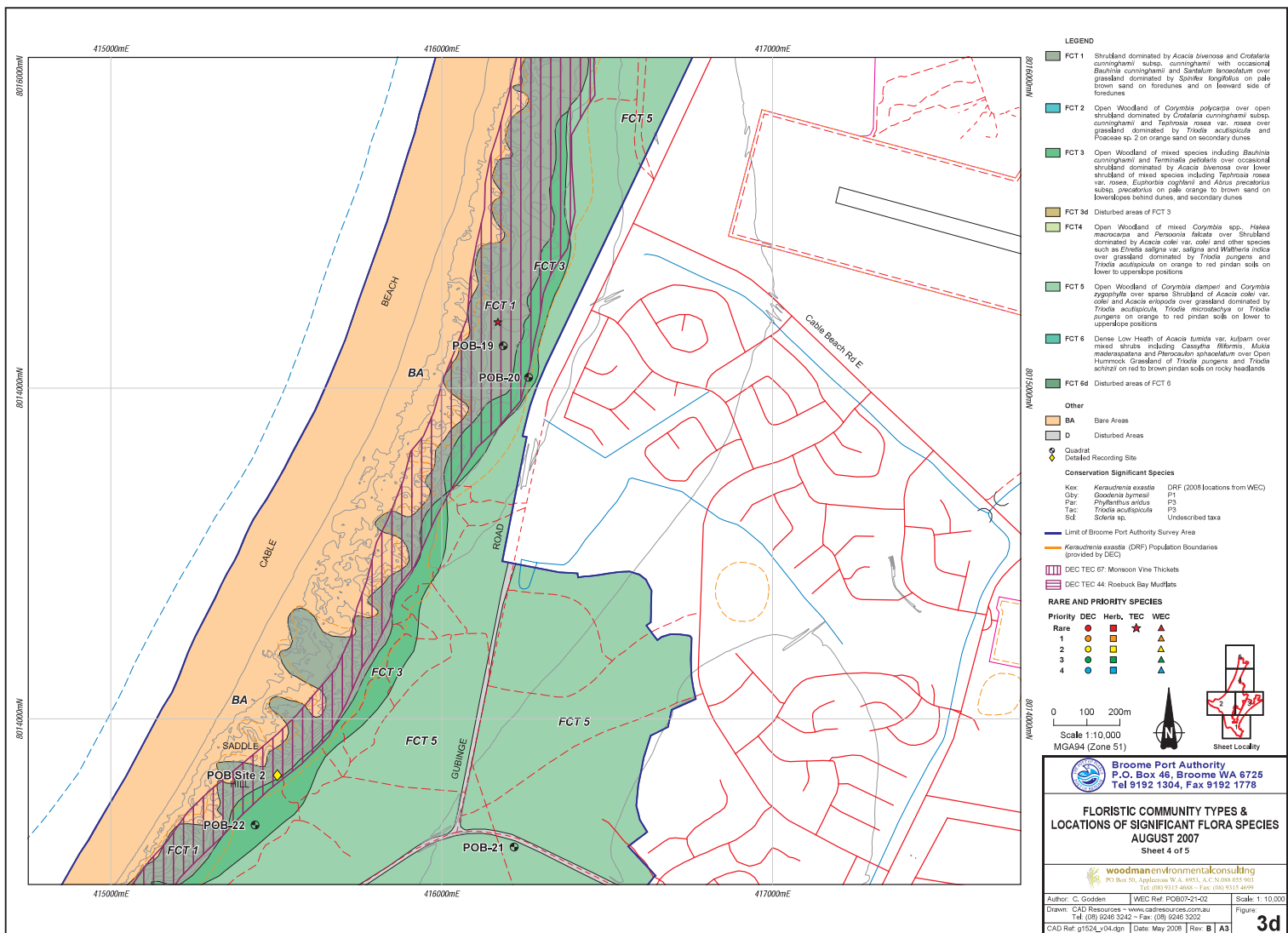


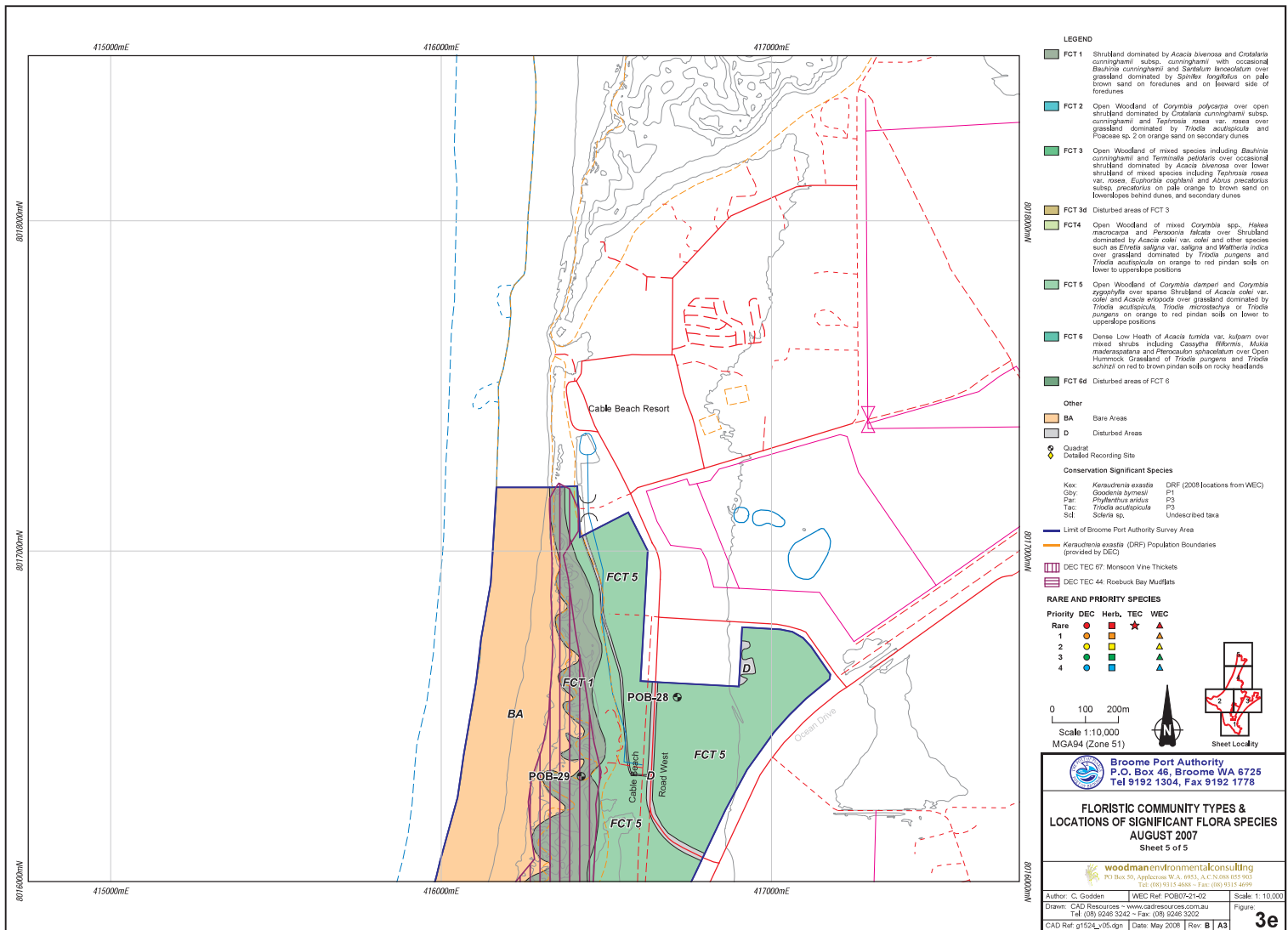












## **Appendix A: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (Department of Environment and Conservation 2007)**

### **2: Definitions and Criteria for Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable Ecological Communities**

#### **Presumed Totally Destroyed (PD)**

An ecological community which 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.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies ( A or B):

- A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**
- B) All occurrences recorded within the last 50 years have since been destroyed

#### **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.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C):

- A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):
  - i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);
  - ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.



- B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):
- i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);
  - ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;
  - iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.
- C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

### **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.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B, or C):

- A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):
- i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);
  - ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.
- B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

- i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);
  - ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;
  - iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.
- C The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

### **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.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

- A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.
- B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.
- C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

### **3: Definitions and Criteria for Priority Ecological Communities**

#### **Priority One: Poorly-Known ecological communities**

Ecological communities with apparently few, small occurrences, all or mostly not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases), and for which current threats exist. 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 small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State Forest, unallocated Crown Land, water reserves, etc.) and not 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 immediate threat from known threatening processes.

#### **Priority Three: Poorly-Known ecological communities**

- (i.) Communities that are known from several to many occurrences, a significant number of 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 within significant remaining areas of habitat in which other occurrences may occur, much of it not under immediate threat, or,
- (iii.) communities made up of large, and/or widespread occurrences, that may or 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: Poorly-Known ecological communities**

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.

- (a) Rare. Ecological communities known from a 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.

- (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close for qualifying for Vulnerable.
- (c) 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 B: Description of Conservation Codes (Department of Environment and Conservation 2008b)**

### **R: Declared Rare Flora – Extant Taxa**

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.

### **X: Declared Rare Flora – Presumed Extinct Taxa**

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

### **1: Priority One – Poorly Known Taxa**

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

### **2: Priority Two – Poorly Known Taxa**

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

### **3: Priority Three – Poorly Known Taxa**

Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

### **4: Priority Four – Rare Taxa**

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

## Appendix C: GPS Locations of All Quadrats and Sites Established in August 2007, Port of Broome

Note: All datum presented in GDA94

Quadrat	Zone	Easting	Northing	Corner Permanently Pegged	Floristic Community Type
POB-01	51	416043	8009033	South-east	1
POB-02	51	416149	8008941	South-east	3
POB-03	51	415633	8009865	South-west	4
POB-04	51	415545	8010447	South-west	4
POB-05	51	415235	8010584	North-west	4
POB-06	51	414933	8010477	North-west	4
POB-07	51	414765	8010332	North-west	1
POB-08	51	415597	8009483	Northern; plot extends at 135° and 225° from peg	1
POB-09	51	415102	8009870	North-west	4
POB-10	51	416205	8010684	North-west	2
POB-11	51	413159	8012332	North-west	4
POB-12	51	414351	8012024	North-west	5
POB-13	51	414386	8012216	South-west	5
POB-14	51	415562	8011634	South-east	5
POB-15	51	414798	8011239	South-west	4
POB-16	51	415484	8012871	North-west	5
POB-17	51	416052	8012902	South-east	5
POB-18	51	414639	8012954	North-east	1
POB-19	51	416186	8015128	North-east	1
POB-20	51	416263	8015033	North-west	3
POB-21	51	416219	8013613	North-west	5
POB-22	51	415436	8013679	North-east	3
POB-23	51	416789	8013052	South-east	5
POB-24	51	416384	8012466	South-east	5
POB-25	51	416312	8011616	South-west	5
POB-26	51	418036	8012697	South-east	5
POB-27	51	415363	8010152	South-west	4
POB-28	51	416715	8016558	North-west	5
POB-29	51	416424	8016318	South-east	1
POB-30	51	414696	8012718	South-east	5
POB-31	51	414022	8011686	-	6
Site-01	51	413682	8011845	-	
Site-02	51	415503	8013830	-	
Site-03	51	417970	8012283	-	

## Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Poaceae	<i>Aristida holathera</i> var. ? <i>holathera</i>	
	<i>Aristida holathera</i> var. <i>latifolia</i>	
	* <i>Cenchrus ciliaris</i>	
	* <i>Chloris barbata</i>	
	<i>Chrysopogon fallax</i>	
	<i>Cymbopogon procerus</i>	
	<i>Eragrostis eriopoda</i>	
	<i>Eragrostis</i> sp.	
	<i>Eriachne melicacea</i>	
	<i>Eriachne obtusa</i>	
	<i>Eriachne semiciliata</i>	
	<i>Panicum</i> ? <i>decompositum</i>	
	<i>Panicum effusum</i>	
	<i>Panicum laevinode</i>	
	Poaceae sp. 1	
	Poaceae sp. 2	
	<i>Setaria dielsii</i>	
	* <i>Setaria verticillata</i>	
	<i>Sorghum stipoides</i>	
	<i>Spinifex longifolius</i>	
	<i>Sporobolus australasicus</i>	
	<i>Triodia acutispicula</i>	P3
	<i>Triodia microstachya</i>	
	<i>Triodia pungens</i>	
	<i>Triodia schinzii</i>	
Cyperaceae	<i>Bulbostylis barbata</i>	
	<i>Cyperus conicus</i>	
	<i>Fimbristylis ammobia</i>	
	<i>Fimbristylis</i> sp.	
	<i>Scleria</i> sp.	
Commelinaceae	<i>Murdannia graminea</i>	
Anthericaceae	<i>Corynothea micrantha</i> var. <i>gracilis</i>	
Moraceae	<i>Ficus aculeata</i> var. <i>indecora</i>	

## Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Proteaceae	<i>Grevillea pyramidalis</i> <i>Grevillea refracta</i> subsp. <i>refracta</i> <i>Hakea arborescens</i> <i>Hakea macrocarpa</i> <i>Persoonia falcata</i>	
Santalaceae	<i>Exocarpos latifolius</i> <i>Santalum lanceolatum</i>	
Loranthaceae	<i>Amyema benthamii</i> <i>Lysiana spathulata</i> subsp. <i>spathulata</i>	
Chenopodiaceae	<i>Salsola tragus</i> subsp. <i>grandiflora</i>	
Amaranthaceae	<i>Achyranthes aspera</i> * <i>Aerva javanica</i> <i>Amaranthus mitchellii</i> <i>Ptilotus lanatus</i> var. <i>lanatus</i> <i>Ptilotus polystachyus</i> var. <i>arthrotrichus</i>	
Nyctaginaceae	<i>Boerhavia gardneri</i>	
Gyrostemonaceae	<i>Gyrostemon tepperi</i>	
Aizoaceae	<i>Trianthema pilosa</i>	
Portulacaceae	<i>Calandrinia strophiolata</i>	
Caryophyllaceae	<i>Polycarpaea corymbosa</i> <i>Polycarpaea longiflora</i>	
Menispermaceae	<i>Tinospora smilacina</i>	
Lauraceae	<i>Cassytha capillaris</i> <i>Cassytha filiformis</i>	
Hernandiaceae	<i>Gyrocarpus americanus</i> subsp. <i>pachyphyllus</i>	
Capparaceae	<i>Capparis lasiantha</i>	



## Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Byblidaceae	<i>Byblis rorida</i>	
Mimosaceae	<i>Acacia adoxa</i> var. <i>subglabra</i> <i>Acacia ampliceps</i> <i>Acacia bivenosa</i> <i>Acacia colei</i> var. <i>colei</i> <i>Acacia eriopoda</i> <i>Acacia monticola</i> <i>Acacia ?monticola</i> x <i>tumida</i> <i>Acacia tumida</i> var. <i>kulparn</i> <i>Acacia tumida</i> var. <i>tumida</i>	
Caesalpiniaceae	<i>Bauhinia cunninghamii</i> <i>Caesalpinia major</i> <i>Erythrophleum chlorostachys</i> <i>Senna costata</i> <i>Senna notabilis</i> <i>Senna oligoclada</i>	
Papilionaceae	<i>Abrus precatorius</i> subsp. <i>precatorius</i> <i>Cajanus marmoratus</i> <i>Canavalia rosea</i> * <i>Clitoria ternatea</i> <i>Crotalaria brevis</i> <i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i> <i>Crotalaria medicaginea</i> var. <i>neglecta</i> <i>Crotalaria ramosissima</i> <i>Cullen martinii</i> <i>Indigofera linifolia</i> * <i>Macroptilium atropurpureum</i> <i>Rhynchosia minima</i> <i>Tephrosia leptoclada</i> <i>Tephrosia remotiflora</i> <i>Tephrosia rosea</i> var. <i>rosea</i> <i>Zornia prostrata</i> var. <i>prostrata</i>	
Zygophyllaceae	<i>Tribulopsis angustifolia</i>	
Meliaceae	<i>Melia azedarach</i>	

## Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Polygalaceae	<i>Polygala tepperi</i>	
Euphorbiaceae	<i>Euphorbia alsiniflora</i> <i>Euphorbia coghlanii</i> <i>Flueggea virosa</i> subsp. <i>melanthesoides</i> * <i>Jatropha gossypifolia</i> <i>Mallotus nesophilus</i> <i>Phyllanthus aridus</i> <i>Phyllanthus exilis</i> <i>Phyllanthus maderaspatensis</i> ? <i>Phyllanthus</i> sp.	P3
Stackhousiaceae	<i>Stackhousia intermedia</i>	
Sapindaceae	<i>Distichostemon hispidulus</i> var. <i>aridus</i>	
Rhamnaceae	<i>Ventilago viminalis</i> * <i>Ziziphus mauritiana</i>	
Tiliaceae	<i>Corchorus sidoides</i> subsp. <i>vermicularis</i> <i>Grewia breviflora</i> <i>Grewia retusifolia</i>	
Malvaceae	<i>Abutilon indicum</i> var. <i>australiense</i> <i>Abutilon otocarpum</i> <i>Gossypium australe</i> <i>Hibiscus leptocladus</i> <i>Sida</i> ? <i>arenicola</i> * <i>Sida cordifolia</i> <i>Sida rohlenae</i> subsp. <i>occidentalis</i> <i>Sida</i> sp. B Kimberley Flora (A.A. Mitchell 2745)	
Sterculiaceae	<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i> <i>Keraudrenia exastia</i> <i>Keraudrenia</i> ? <i>nephrosperma</i> <i>Melhaniea oblongifolia</i> <i>Waltheria indica</i>	R
Violaceae	<i>Hybanthus aurantiacus</i>	

## Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Passifloraceae	<i>*Passiflora foetida</i> var. <i>hispida</i>	
Combretaceae	<i>Terminalia ferdinandiana</i> <i>Terminalia ferdinandiana</i> x <i>petiolaris</i> <i>?Terminalia latipes</i> <i>Terminalia petiolaris</i>	
Myrtaceae	<i>Corymbia dampieri</i> <i>Corymbia flavescens</i> <i>Corymbia grandifolia</i> subsp. <i>longa</i> <i>Corymbia paractia</i> <i>Corymbia polycarpa</i> <i>Corymbia zygophylla</i> <i>Eucalyptus tectifera</i>	
Sapotaceae	<i>Sersalisia sericea</i>	
Oleaceae	<i>Jasminum didymum</i> subsp. <i>lineare</i>	
Apocynaceae	<i>Carissa lanceolata</i>	
Asclepiadaceae	<i>Marsdenia viridiflora</i> subsp. <i>tropica</i> <i>Marsdenia geminata</i> <i>Tylophora cinerascens</i>	
Convolvulaceae	<i>Bonamia linearis</i> <i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i> <i>Jacquemontia paniculata</i> <i>*Merremia dissecta</i> <i>Polymeria ambigua</i>	
Boraginaceae	<i>Ehretia saligna</i> var. <i>saligna</i> <i>Heliotropium foliatum</i> <i>Heliotropium leptaleum</i> <i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>	
Lamiaceae	<i>Clerodendrum tomentosum</i> var. <i>?mollissima</i> <i>*Hyptis suaveolens</i> <i>Premna acuminata</i>	

## Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Solanaceae	<i>Solanum cunninghamii</i>	
Scrophulariaceae	<i>Striga curviflora</i>	
Bignoniaceae	<i>Dolichandrone heterophylla</i>	
Acanthaceae	<i>Hypoestes floribunda</i> var. <i>varia</i>	
Myoporaceae	<i>Myoporum montanum</i>	
Rubiaceae	<i>Gardenia pyriformis</i> subsp. <i>keartlandii</i> <i>Psydrax attenuata</i> var. <i>tenella</i> <i>Spermacoce</i> aff. <i>brachystema</i> <i>Spermacoce laevigata</i>	
Cucurbitaceae	<i>Mukia maderaspatana</i>	
Goodeniaceae	<i>Goodenia armitiana</i> <i>Goodenia byrnesii</i> <i>Goodenia sepalosa</i> var. <i>sepalosa</i> <i>Scaevola parvifolia</i> subsp. <i>parvifolia</i> <i>Velleia panduriformis</i>	P1
Asteraceae	* <i>Emilia sonchifolia</i> <i>Pterocaulon sphacelatum</i> * <i>Tridax procumbens</i>	

Note: \* denotes introduced taxa

### Appendix E: Standard Control Codes for Declared Plants (Department of Agriculture and Food 2008)

Standard Control Code	Aim	Required Control
P1	Prohibits Movement	Movement of plants or their seed is prohibited within the state
		Prohibits the movement of contaminated machinery and produce including livestock and fodder
P2	Aim is to Eradicate Infestation	Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery
P3	Aims to control infestation by reducing area and/or density of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.
		Treat to destroy and prevent seed set all plants: - within 100 metres inside of the boundaries of the infested property within 50 metres of roads and highwater mark on waterways within 50 metres of sheds, stock yards and houses
		Of the remaining infested area: where plant density is 1 - 10 per hectare treat 100% of infestation where plant density is 11 - 100 per hectare treat 50% of infestation where plant density is 101 - 1000 per hectare treat 10% of infestation
		Properties with less than 2 hectares of infestation must treat the entire infestation
		Additional areas may be ordered to be treated
P4	Aims to prevent infestation spreading beyond existing boundaries of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery
		Treat to destroy and prevent seed set all plants: - within 100 metres inside of the boundaries of the infested property within 50 metres of roads and highwater mark on waterways within 50 metres of sheds, stock yards and houses
		Treatment must be done prior to seed set each year. Properties with less than 2 hectares of infestation must treat the entire infestation.
		Additional areas may be ordered to be treated.
		In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.

**Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007**

Species Name	FCT					
	1	2	3	4	5	6
<i>Abrus precatorius</i> subsp. <i>precatorius</i>	X		X		X	
<i>Abutilon indicum</i> var. <i>australiense</i>	X					
<i>Abutilon otocarpum</i>		X			X	
<i>Acacia adoxa</i> var. <i>subglabra</i>				X	X	
<i>Acacia ampliceps</i>			X			
<i>Acacia bivenosa</i>	X		X			
<i>Acacia colei</i> var. <i>colei</i>	X	X	X	X	X	
<i>Acacia eriopoda</i>				X	X	
<i>Acacia monticola</i>	X				X	
<i>Acacia</i> ? <i>monticola</i> x <i>tumida</i>					X	
<i>Acacia tumida</i> var. <i>kulparn</i>						X
<i>Acacia tumida</i> var. <i>tumida</i>	X			X		
<i>Achyranthes aspera</i>	X					
* <i>Aerva javanica</i>	X		X			
<i>Amaranthus mitchellii</i>	X	X				
<i>Amyema benthamii</i>	X		X			
<i>Aristida holathera</i> var. ? <i>holathera</i>	X		X	X	X	
<i>Aristida holathera</i> var. <i>latifolia</i>						X
<i>Bauhinia cunninghamii</i>	X		X	X	X	
<i>Boerhavia gardneri</i>	X	X				
<i>Bonamia linearis</i>					X	
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>					X	
<i>Bulbostylis barbata</i>	X			X	X	
<i>Byblis rorida</i>					X	
<i>Caesalpinia major</i>	X					
<i>Cajanus marmoratus</i>			X		X	X
<i>Calandrinia strophiolata</i>	X			X	X	
<i>Canavalia rosea</i>	X					
<i>Capparis lasiantha</i>		X	X			
<i>Carissa lanceolata</i>			X	X	X	X
<i>Cassytha capillaris</i>			X	X	X	
<i>Cassytha filiformis</i>	X			X	X	X
* <i>Cenchrus ciliaris</i>			X			

**Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007**

Species Name	FCT					
	1	2	3	4	5	6
<i>*Chloris barbata</i>			X			
<i>Chrysopogon fallax</i>			X	X	X	
<i>Clerodendrum tomentosum</i> var. <i>?mollissima</i>	X			X		
<i>*Clitoria ternatea</i>	X		X			
<i>Corchorus sidoides</i> subsp. <i>vermicularis</i>	X		X	X	X	
<i>Corymbia dampieri</i>			X	X	X	
<i>Corymbia flavescens</i>	X		X	X		
<i>Corymbia grandifolia</i> subsp. <i>longa</i>			X			
<i>Corymbia paractia</i>				X		
<i>Corymbia polycarpa</i>		X			X	
<i>Corymbia zygophylla</i>				X	X	
<i>Corynotheca micrantha</i> var. <i>gracilis</i>				X		
<i>Crotalaria brevis</i>		X			X	
<i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i>	X	X			X	
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	X		X	X	X	
<i>Crotalaria ramosissima</i>					X	
<i>Cullen martinii</i>			X			
<i>Cymbopogon procerus</i>				X	X	
<i>Cyperus conicus</i>		X				
<i>Distichostemon hispidulus</i> var. <i>aridus</i>					X	
<i>Dolichandrone heterophylla</i>				X	X	
<i>Ehretia saligna</i> var. <i>saligna</i>			X	X	X	
<i>*Emilia sonchifolia</i>			X			
<i>Eragrostis eriopoda</i>	X	X		X	X	
<i>Eragrostis</i> sp.					X	
<i>Eriachne melicacea</i>				X		
<i>Eriachne obtusa</i>				X	X	X
<i>Eriachne semiciliata</i>				X		
<i>Erythrophleum chlorostachys</i>				X		X
<i>Eucalyptus tectifica</i>			X		X	
<i>Euphorbia alsiniflora</i>				X	X	X
<i>Euphorbia coghlanii</i>	X	X	X	X		
<i>Exocarpos latifolius</i>			X			

**Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007**

Species Name	FCT					
	1	2	3	4	5	6
<i>Ficus aculeata</i> var. <i>indecora</i>	X	X	X	X	X	
<i>Fimbristylis ammobia</i>					X	
<i>Fimbristylis</i> sp.					X	
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>		X			X	
<i>Gardenia pyriformis</i> subsp. <i>keartlandii</i>			X	X	X	X
<i>Goodenia armitiana</i>				X		
<i>Goodenia byrnesii</i>				X	X	
<i>Goodenia sepalosa</i> var. <i>sepalosa</i>				X		
<i>Gossypium australe</i>					X	
<i>Grevillea pyramidalis</i>				X	X	X
<i>Grevillea refracta</i> subsp. <i>refracta</i>					X	
<i>Grewia breviflora</i>	X		X			
<i>Grewia retusifolia</i>					X	
<i>Gyrocarpus americanus</i> subsp. <i>pachyphyllus</i>	X		X	X	X	
<i>Gyrostemon tepperi</i>	X	X		X	X	
<i>Hakea arborescens</i>			X		X	
<i>Hakea macrocarpa</i>	X			X	X	
<i>Heliotropium foliatum</i>					X	
<i>Heliotropium leptaleum</i>	X			X	X	
<i>Hibiscus leptocladus</i>				X	X	X
<i>Hybanthus aurantiacus</i>				X	X	X
<i>Hypoestes floribunda</i> var. <i>varia</i>	X					
* <i>Hyptis suaveolens</i>			X			
<i>Indigofera linifolia</i>				X	X	
<i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i>	X					
<i>Jacquemontia paniculata</i>			X		X	
<i>Jasminum didymum</i> subsp. <i>lineare</i>		X	X	X	X	
* <i>Jatropha gossypifolia</i>			X		X	
<i>Keraudrenia exastia</i>				X		
<i>Keraudrenia ?nephrosperma</i>					X	
<i>Lysiana spathulata</i> subsp. <i>spathulata</i>	X			X	X	
* <i>Macroptilium atropurpureum</i>			X			
<i>Mallotus nesophilus</i>	X					



**Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007**

Species Name	FCT					
	1	2	3	4	5	6
<i>Marsdenia geminata</i>		X				
<i>Marsdenia viridiflora</i> subsp. <i>tropica</i>					X	
<i>Melhania oblongifolia</i>	X			X	X	
<i>Melia azedarach</i>			X			
* <i>Merremia dissecta</i>			X	X		
<i>Mukia maderaspatana</i>	X			X	X	X
<i>Murdannia graminea</i>				X	X	X
<i>Myoporum montanum</i>	X					
<i>Panicum ?decompositum</i>			X			
<i>Panicum effusum</i>				X	X	
<i>Panicum laevinode</i>	X	X	X			
* <i>Passiflora foetida</i> var. <i>hispida</i>	X	X	X	X	X	X
<i>Persoonia falcata</i>				X	X	
<i>Phyllanthus aridus</i>				X		
<i>Phyllanthus exilis</i>				X	X	
<i>Phyllanthus maderaspatensis</i>				X	X	
? <i>Phyllanthus</i> sp.				X		
Poaceae sp. 1	X					
Poaceae sp. 2	X					
<i>Polycarpaea corymbosa</i>					X	
<i>Polycarpaea longiflora</i>				X	X	
<i>Polygala tepperi</i>				X	X	
<i>Polymeria ambigua</i>			X	X	X	
<i>Premna acuminata</i>	X			X		
<i>Psydrax attenuata</i> var. <i>tenella</i>				X	X	
<i>Pterocaulon sphacelatum</i>				X	X	X
<i>Ptilotus lanatus</i> var. <i>lanatus</i>				X	X	
<i>Ptilotus polystachyus</i> var. <i>arthrotrichus</i>					X	
<i>Rhynchosia minima</i>					X	
<i>Salsola tragus</i> subsp. <i>grandiflora</i>				X		
<i>Santalum lanceolatum</i>	X		X	X	X	
<i>Scaevola parvifolia</i> subsp. <i>parvifolia</i>				X		
<i>Scleria</i> sp.				X	X	

**Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007**

Species Name	FCT					
	1	2	3	4	5	6
<i>Senna costata</i>				X	X	
<i>Senna notabilis</i>					X	
<i>Senna oligoclada</i>					X	
<i>Sersalisia sericea</i>			X	X	X	
<i>Setaria dielsii</i>						X
* <i>Setaria verticillata</i>				X		
<i>Sida ?arenicola</i>					X	
* <i>Sida cordifolia</i>		X				
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>				X	X	
<i>Sida</i> sp. B Kimberley Flora (A.A. Mitchell 2745)				X	X	
<i>Solanum cunninghamii</i>				X	X	
<i>Sorghum stipoideum</i>			X			
<i>Spermacoce</i> aff. <i>brachystema</i>	X			X	X	
<i>Spermacoce laevigata</i>	X			X	X	
<i>Spinifex longifolius</i>	X	X				
<i>Sporobolus australasicus</i>			X			
<i>Stackhousia intermedia</i>					X	
<i>Striga curviflora</i>					X	
<i>Tephrosia leptoclada</i>			X	X	X	
<i>Tephrosia remotiflora</i>			X		X	
<i>Tephrosia rosea</i> var. <i>rosea</i>	X	X	X	X		
<i>Terminalia ferdinandiana</i>			X	X	X	
<i>Terminalia ferdinandiana</i> x <i>petiolaris</i>						X
? <i>Terminalia latipes</i>		X			X	
<i>Terminalia petiolaris</i>	X		X	X	X	
<i>Tinospora smilacina</i>	X		X	X		
<i>Trianthema pilosa</i>	X	X		X	X	
<i>Tribulopsis angustifolia</i>					X	
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>		X	X	X	X	
* <i>Tridax procumbens</i>				X		
<i>Triodia acutispicula</i>	X	X		X	X	
<i>Triodia microstachya</i>					X	
<i>Triodia pungens</i>	X		X	X	X	X

**Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007**

Species Name	FCT					
	1	2	3	4	5	6
<i>Triodia schinzii</i>					X	X
<i>Tylophora cinerascens</i>	X	X			X	
<i>Velleia panduriformis</i>				X		
<i>Ventilago viminalis</i>				X	X	X
<i>Waltheria indica</i>		X	X	X	X	
* <i>Ziziphus mauritiana</i>	X					
<i>Zornia prostrata</i> var. <i>prostrata</i>			X	X	X	X

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008



Plate 1: *Keraudrenia exastia* (Declared Rare Flora) (Section 4.1.1)



Plate 2: *Abrus precatorius* subsp. *precatorius* (Table 10)

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 3: *Ficus aculeata* var. *orbicularis* ms (Table 10)



Plate 4: *Persoonia falcata* (Table 10)



Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008



Plate 5: *Tephrosia rosea* var. *rosea* (Table 10)



Plate 6: *Tephrosia rosea* var. *rosea* (Table 10)

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 7: *Grevillea pyramidalis* subsp. *pyramidalis* (Table 10)



Plate 8: *Mallotus nesophilus* (Table 10)



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 9: *Ventilago viminalis* (Table 10)



Plate 10: *Ventilago viminalis* (Table 10)



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 11: *Bauhinia cunninghamii* (Table 10)



Plate 12: *Bauhinia cunninghamii* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008



Plate 13: *Carissa lanceolata* (Table 10)



Plate 14: *Crotalaria cunninghamii* subsp. *cunninghamii* (Table 10)



Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008



Plate 15: *Tinospora smilacina* (Table 10)



Plate 16: *Hakea macrocarpa* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008



Plate 17: *Santalum lanceolatum* (Table 10)



Plate 18: *Santalum lanceolatum* (Table 10)



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 19: Quadrat POB-01



Plate 20: Quadrat POB-02

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 21: Quadrat POB-03



Plate 22: Quadrat POB-04



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 23: Quadrat POB-05



Plate 24: Quadrat POB-06

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 25: Quadrat POB-07



Plate 26: Quadrat POB-08



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 27: Quadrat POB-09



Plate 28: Quadrat POB-10

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 29: Quadrat POB-11



Plate 30: Quadrat POB-12



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 31: Quadrat POB-13



Plate 32: Quadrat POB-14

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 33: Quadrat POB-15



Plate 34: Quadrat POB-16



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 35: Quadrat POB-17



Plate 36: Quadrat POB-18

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 37: Quadrat POB-19



Plate 38: Quadrat POB-20



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 39: Quadrat POB-21



Plate 40: Quadrat POB-22



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 41: Quadrat POB-23



Plate 42: Quadrat POB-24

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 43: Quadrat POB-25



Plate 44: Quadrat POB-26



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 45:      Quadrat POB-27



Plate 46:      Quadrat POB-28

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 47: Quadrat POB-29



Plate 48: Quadrat POB-30



**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 49: Quadrat POB-31



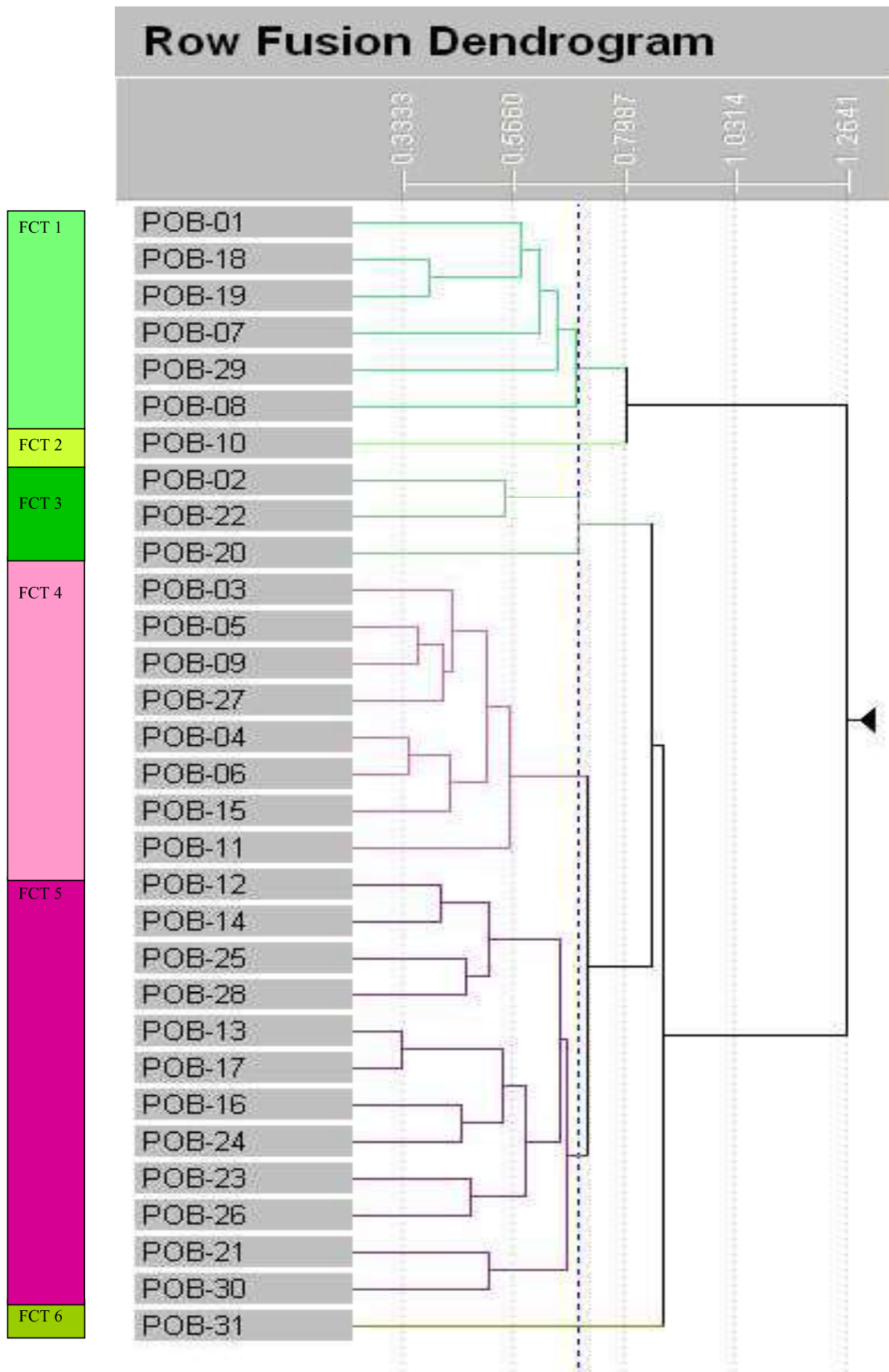
Plate 50: Site POB-02

**Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008**



Plate 51: Site POB-03

# Appendix H: Summary Dendrogram of Relationships between Floristic Community Types, Broome Port Authority Quadrat Data





[illegible]

## Appendix J: Indicator Species Values (Monte Carlo Test), Broome Port Authority Quadrat Data

Note: Shading denotes highest indicator values per taxon. Indicator values (%) are shown only for taxa which were significant at  $p < 0.05$  (Monte Carlo permutation tests: \* =  $p < 0.05$ ; \*\* =  $p < 0.01$ ; \*\*\* =  $p < 0.001$ )

Species	1	3	4	5
<i>Acacia bivenosa</i> *	60	27		
<i>Acacia colei</i> var. <i>colei</i> ***		5	35	45
<i>Acacia eriopoda</i> ***			5	72
<i>Boerhavia gardneri</i> *	50	0	0	0
<i>Canavalia rosea</i> ***	83	0	0	0
<i>Carissa lanceolata</i> *	0	41	16	28
<i>Cassytha capillaris</i> *	0	44	6	1
<i>Cassytha filiformis</i> **	7	0	50	7
<i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i> **	76	0	0	1
<i>Erythrophleum chlorostachys</i> **	0	0	75	0
<i>Exocarpos latifolius</i> **	0	67	0	0
<i>Gardenia pyriformis</i> subsp. <i>keartlandii</i> ***	0	7	67	2
<i>Goodenia armitiana</i> *	0	0	38	0
<i>Grewia breviflora</i> *	3	53	0	0
<i>Gyrostemon tepperi</i> *	9	0	45	2
<i>Hibiscus leptocladus</i> *	0	0	38	0
<i>Mallotus nesophilus</i> *	33	0	0	0
<i>Myoporum monatum</i> *	33	0	0	0
<i>Persoonia falcata</i> ***	0	0	63	9
<i>Psydrax attenuata</i> var. <i>tenella</i> *	0	0	3	40
<i>Scaevola parvifolia</i> subsp. <i>parvifolia</i> *	0	0	38	0
<i>Scleria</i> sp. *	0	0	43	1
<i>Sida</i> sp. B Kimberley Flora (A.A. Mitchell 2745) *	0	0	45	7
<i>Spinifex longifolius</i> **	67	0	0	0
<i>Tephrosia remotiflora</i> **	0	53	0	3
<i>Triodia acutispicula</i> **	2	0	47	21
<i>Triodia pungens</i> *	5	21	46	1
<i>Waltheria indica</i> **	0	5	48	27
<i>Zornia prostrata</i> var. <i>prostrata</i> *	0	9	45	2

**Appendix K: Locations and Plant Numbers of *Keraudrenia exastia* , Port of Broome**

Location 1 (Population 'C')		
GPS Easting	GPS Northing	Number of plants
415567	8009749	4
415560	8009744	18
415548	8009749	6
415539	8009748	6
415531	8009749	4
415513	8009747	3
415508	8009750	14
415481	8009750	6
415451	8009744	3
415427	8009751	2
415512	8009824	4
415676	8009892	15
415565	8009888	2
415622	8009772	1
415601	8009775	2
415575	8009765	2
415570	8009765	2
415565	8009762	3
415554	8009761	3
415549	8009770	1
415545	8009773	2
415539	8009774	2
415532	8009773	2
415532	8009758	8
415533	8009763	5
415513	8009769	1
415512	8009762	5
415493	8009771	3
415481	8009770	4
415467	8009768	2
415463	8009773	10
415455	8009764	10
415452	8009764	10
415447	8009766	10
415445	8009761	6
415441	8009765	10
415437	8009764	10
415432	8009763	4
415373	8009773	50
415526	8009830	1

GPS Easting	GPS Northing	Number of plants
415529	8009830	1
415551	8009818	1
415669	8009903	5
415541	8009678	1
415515	8009688	20
415509	8009676	1
415508	8009684	10
415508	8009686	30
415505	8009690	25
415498	8009687	17
415498	8009690	12
415496	8009693	6
415498	8009695	7
415450	8009677	3
415482	8009684	1
415467	8009706	7
415561	8009847	4
415563	8009856	1
415688	8009852	15
415570	8009596	20
415602	8009654	30
415434	8009665	3
415628	8009712	8
415623	8009706	7
415563	8009710	12
415563	8009717	8
415557	8009731	30
415557	8009714	14
415553	8009704	17
415563	8009701	9
415570	8009695	9
415553	8009677	20
415547	8009672	7
415537	8009710	8
415527	8009695	38
415521	8009702	23
415515	8009708	17
415512	8009735	11
415500	8009736	3
415492	8009711	1
415480	8009707	18
415464	8009715	20
415434	8009732	14
415371	8009775	20

GPS Easting	GPS Northing	Number of plants
415395	8009780	5
415406	8009788	22
415425	8009795	2
415455	8009789	2
415467	8009794	7
415502	8009780	1
415515	8009788	5
415539	8009784	2
415548	8009798	20
415548	8009794	18
415548	8009780	20
415685	8009866	9
415628	8009874	8
<b>Total</b>		<b>911</b>

Note: The following locations provide the boundary of the second *Keraudrenia exastia* population (North-western most population). Approximately 20,000 individuals occur in this population.

Location 2	
GPS Easting	GPS Northing
415187	8009843
415208	8009835
415221	8009855
415228	8009847
415244	8009847
415257	8009858
415273	8009875
415267	8009885
415264	8009903
415267	8009910
415270	8009911
415183	8009854
415196	8009861
415166	8009877
415168	8009887
415176	8009896
415181	8009905
415190	8009912
415196	8009923
415210	8009925
415226	8009932
415241	8009937
415257	8009926
415261	8009918
415267	8009871
415247	8009867
415189	8009872
415167	8009879

## Appendix L: Proposed Environmental Management Plan Outline – Native Vegetation, Port of Broome

Two objectives of the project were:

- Formulate outline of a management plan for the environmental corridor (including strategies to encourage endangered flora species within the corridor)
- Formulate outline of a weed management plan.

This appendix addresses these objectives by providing an outline of an Environmental Management Plan (EMP) for remnant native vegetation on Port of Broome managed lands and including brief descriptions of potential content of the various sections of the EMP.

### **EMP OUTLINE**

SECTION	DESCRIPTION
<b>Introduction</b>	
Scope of the document	This EMP addresses the management of the remnant native vegetation of the Port of Broome managed lands with special emphasis placed on the environmental corridor.
Background	A description of the Port of Broome operations and the formation of the environment corridor.
Objectives	A list of key objectives of the EMP. This section should focus on the envisaged outcomes generated by the EMP such as; Improved stakeholder engagement regarding management of remnant vegetation on the Broome Peninsula.
<b>Existing Environment</b>	
Climate	A general description of the climate of the Broome Peninsula and how this may affect land management practices.
Soils	A general description of the soils of the Broome Peninsula and how this may affect land management practices.
Vegetation	A description of the vegetation and flora of the peninsula with emphasis on the Port of Broome managed lands. This section should be taken directly from this report.
Fauna	A description of the fauna of the peninsula with emphasis on the Port of Broome managed lands. This section should be taken directly from the Bamford report and relate to fauna

SECTION	DESCRIPTION
	habitats and their management.
Social	A description of the social environment of the Peninsula, both traditional and European.
<b>Stakeholders</b>	
Stakeholder groups	This section should identify the relevant stakeholder groups with an interest in the ongoing management of the remnant vegetation on the Port of Broome managed lands. It should include Government and Non-government groups and should describe the framework for stakeholder input to management.
<b>Significant Environmental Factors and Risks</b>	
Environmental values	This section should identify key environmental values of the area such as Declared Rare Flora, Environmental linkage, Fauna Habitat values, traditional use etc.
Risk Assessment	This section should identify threatening processes to the identified environmental values and rate them on a risk basis for management priority.
<b>Management</b>	
Management Objectives	This section should list specific objectives of managing the Port of Broome remnant native vegetation related to each identified threatening process. Each process should have a unique management plan developed to address its unique potential impacts. Some examples follow.
Rare Flora Management Plan	<p>This plan should address protection of the existing populations through the identification of strategies and implementation of procedures. This plan does not address a threatening process as such, but due to the unique nature of Rare Flora and their governing legislation addresses the value itself. Features of this plan should include:</p> <ul style="list-style-type: none"> <li>• Protection from clearing or indirect impact;</li> <li>• Monitoring of population health;</li> <li>• Research to identify management practices that will ensure the sustainability of populations; and</li> </ul>



SECTION	DESCRIPTION
	<ul style="list-style-type: none"> <li>Cooperative management of populations with stakeholder groups.</li> </ul>
Weed Management Plan	<p>This plan should address the following aspects:</p> <ul style="list-style-type: none"> <li>Port of Broome road verge and cleared area weed spraying program;</li> <li>Application of lease conditions to manage weeds on developed areas;</li> <li>Machine and vehicle hygiene conditions for earthworks and transportation contractors;</li> <li>Annual monitoring of weed populations to determine the efficacy of spraying programs.</li> </ul>
Fire Management Plan	<p>This plan should address the following aspects:</p> <ul style="list-style-type: none"> <li>Responsibility for fire prevention and response on Port of Broome managed lands;</li> <li>Mosaic burning of remnant native vegetation to address protection of infrastructure, traditional uses of the environmental corridor, management and regeneration of native vegetation and fauna habitat, management and regeneration of Rare Flora (research pending).</li> </ul>
Drainage Management Plan	<p>This plan should address management of run-off and discharged water from industrial sites to protect:</p> <ul style="list-style-type: none"> <li>Groundwater quality;</li> <li>Roebuck Bay Threatened Ecological Community;</li> <li>Vegetation health; and</li> <li>Rare Flora</li> </ul>
Traditional Uses Management Plan	<p>This plan should focus on consultation processes to identify the required traditional uses of the environmental corridor and flora of the Port of Broome managed lands in general. Management processes to address concerns or</p>

SECTION	DESCRIPTION
	<p>particular requirements can then be formulated and implemented during reviews of the document. Issues may include:</p> <ul style="list-style-type: none"> <li>• Retention or protection of particular sites or plants;</li> <li>• Inclusion of particular plants in landscaping projects;</li> <li>• Access to lands at particular times or for particular purposes.</li> </ul>
<b>Review and Reporting</b>	
Review Period	<p>A review period at which time the entire EMP should be reviewed should be identified to ensure that recent improvements or changes in management strategy or conditions are incorporated into the document. this will ensure that the document remains dynamic and relevant to Port of Broome operations and to the requirements of the stakeholder group. A review period of 3 years is recommended as an initial arbitrary period pending development and implementation of the EMP.</p>
Reporting	<p>This EMP is not currently proposed to be a legally binding document under any legislation, however it has direct relevance to both the stakeholder groups and the Broome Port Authority. Therefore the implementation and success of management activities should be discussed and reviewed annually in conjunction with a meeting of the stakeholder management group, with the outcomes to be reported to the Board of the Broome Port Authority for inclusion in annual reports.</p>

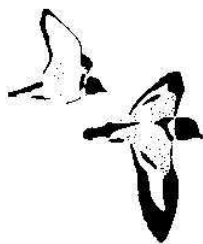
## Appendix D Bamford (2010) – *Fauna Assessment of the Broome Port Area*

## **Fauna Assessment of the Broome Port Area**

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22<sup>nd</sup> January 2010

## **EXECUTIVE SUMMARY**

The Broome Port Authority (BrPA) manages the Port of Broome, located approximately 2200 km north north-east of Perth and the largest port within the Kimberley Region. The port situated on the southern extremity of the Broome Peninsula on the south-west side of the township of Broome. The BrPA is proposing to expand existing laydown areas for off-shore maritime industry support. Approximately 54 ha (inclusive of roads) of native vegetation are proposed to be cleared by the BrPA as part of this project. An additional 8 ha may be cleared by the Yawuru Native Title Holders (RNTBC) Aboriginal Corporation or its nominated entity for related purposes.

As part of the environmental impact assessment for this expansion, Bamford Consulting Ecologists was commissioned by Coffey Natural Systems (Coffey) on behalf of the BrPA to conduct a literature review, desktop survey and site inspection to identify fauna and habitat values of the Broome Port area, and in particular the areas subject to the expansion plan. The aims of fauna assessments such as this include:

- review the list of fauna expected to occur on the site in the light of fauna habitats present, with a focus on investigating the likelihood of significant species being present;
- identify significant or fragile fauna habitats within the study area;
- identify any ecological processes in the study area upon which fauna may depend;
- identify general patterns of biodiversity within or adjacent to the study area, and
- identify potential impacts upon fauna and propose recommendations to minimise impacts.

The review of databases, literature and habitats present indicated that a total of 385 native vertebrate fauna species may occur on the Broome Peninsula or utilise a home range that includes the Broome Peninsula.

Based on available habitats, 15 conservation significant species are considered likely to utilise the Project Area. Of these, five are of high significance (Conservation Significance Level 1), being listed under legislation, three are of moderate conservation significance (Conservation Significance Level 2), being listed as priority species by the Department of Environment and Conservation, and seven are of local significance (Conservation Significance Level 3), because they have restricted distributions or occur as isolated populations on the edge of their range. An additional five species have the potential to be rare visitors to the Project Area. However these species are not expected to be dependent on habitat within the Project Area.

Impacts upon fauna due to the construction and operation of the Project are likely to include: some localised loss of habitat, fragmentation of habitats, impacts from roadkill, and changes in hydrology, the fire regime and the abundance of introduced predators. The significance of these impacts and recommendations for their minimisation are discussed.

## CONTENTS

1. INTRODUCTION	4
1.1 Introduction	4
1.2 Study Objectives	6
2. BACKGROUND	7
2.1 Regional Description	7
2.2 Description of the Project Area	9
2.3 Assessment of Conservation Significance	11
3. METHODS	13
3.1 Approach	13
3.2 Personnel	13
3.3 Nomenclature and taxonomy	14
3.4 Sources of Information for desktop assessment	14
3.5 Reconnaissance Survey.	14
4. RESULTS	18
4.1 Fauna Habitats	18
4.2 Vertebrate fauna	23
4.2.1 Freshwater Fish	23
4.2.2 Amphibians	24
4.2.3 Reptiles	24
4.2.4 Birds	27
4.2.5 Mammals	35
4.2.6 Listed conservation significance and short-range endemic invertebrates	39
5. IMPACT ASSESSMENT	40
5.1 Habitat Types	41
5.2 Significant species	46
5.3 Ecological processes	48
5.3.1 Increased mortality	48
5.3.2 Loss of habitat affecting population survival	48
5.3.3 Loss of habitat affecting population movements and gene flow	49
5.3.4 Species interactions, including predators and other feral species	50
5.3.5 Hydroecology	50
5.3.5 Climate change	50
5.3.6 Fire	50
5.3.7 Light, noise and disturbance	50
6. MANAGEMENT AND MONITORING RECOMMENDATIONS	51
7. CONCLUSIONS	53
TABLE 1.	54
TABLE 2.	55
TABLE 3.	58
TABLE 4.	64
TABLE 5.	66
TABLE 6.	68
REFERENCES	71
Appendix 1. Categories used in the assessment of conservation status.	74
Appendix 2. Ecological Processes	75

## 1. INTRODUCTION

### *1.1 Introduction*

The Broome Port Authority (BrPA) manages the Port of Broome (see Figure 1), located approximately 2200 km north north-east of Perth and the largest port within the Kimberley Region. The Port currently handles a wide range of imports into and exports from Broome and supports many industries, including pearling, offshore oil and gas supply vessels, livestock exports and cruise liners, as well as being the largest fuel and container port for the region. The total length of the Port of Broome jetty was extended to 331m in 2005, to allow a greater volume of imports and exports, and to allow for correct segregation of non-compatible industries (Port of Broome 2008).

The port situated on the southern extremity of the Broome Peninsula on the south-west side of the township of Broome. The BrPA is proposing to expand existing laydown areas for off-shore maritime industry support.

The BrPA is making an application to the Shire of Broome to re-zone approximately 70 ha of land located immediately to the north of BrPA lands between Port Rd and Kavite Rd as delineated in yellow on Figure 1.1. If the rezoning application is successful then the BrPA will seek a vegetation clearance permit for between 54 and 62 ha within this rezoning area. For the purposes of this report, the 70 ha rezoning area is referred to as the Project Area (i.e., the area in which vegetation clearing and direct impact may occur). The balance of the 70 ha which will not be cleared, and has been incorporated to accommodate a reasonable boundary and any heritage areas. This area will revert to reserve once the final boundaries of the area to be developed are determined.

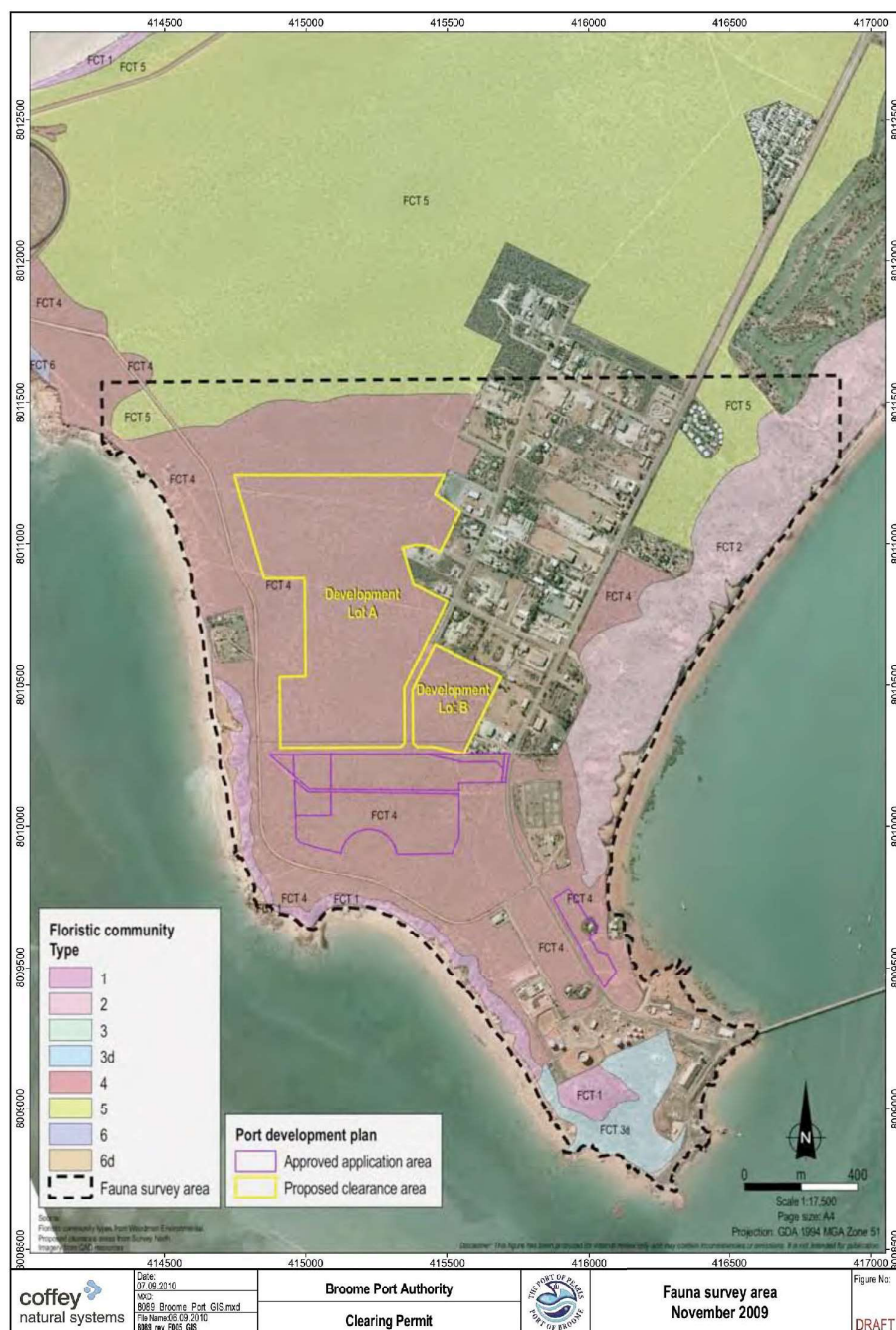
As part of the environmental impact assessment for this expansion, Bamford Consulting Ecologists was commissioned by Coffey Natural Systems (Coffey) on behalf of the BrPA to conduct a literature review, desktop survey and site inspection to identify fauna and habitat values of the Broome Port area, and in particular the Project Area.

The BrPA has also indicated that a native vegetation corridor will be established on the western side of the Project Area to maintain the vegetation link to the rest of the peninsula. Approximately 44 ha of native vegetation on land currently vested in BrPA are proposed to be transferred into an environmental reserve. As part of the assessment the values of this area were compared with those of the Project Area.

Finally, it is understood that the outcomes from this report will be used by the BrPA to ensure clearing occurs in a manner that avoids or minimises impacts as far as practicable, i.e., not all the 'Project Area' will be cleared.



**Figure 1. Survey Area.** Note the Fauna survey area is delineated by the dashed black line while the Project Area is enclosed by the yellow border. The vegetation within the proposed Project Area is classified as FCT4, with FCT1, 2, 3 and 5 occurring nearby (see 2.2).



## *1.2 Study Objectives*

The objectives of fauna studies in the Environmental Impact Assessment (“EIA”) process are broadly to determine the fauna values of a site and the likely impacts of a proposed development. This provides government agencies with the information needed to assess the significance of impacts under state and government legislation. The key objectives of fauna studies are to:

- review the list of fauna expected to occur on the site in the light of fauna habitats present, with a focus on investigating the likelihood of significant species being present;
- investigate the likelihood of significant species being present in the study area;
- identify significant or fragile fauna habitats within the study area;
- identify any ecological processes in the study area upon which fauna may depend;
- identify general patterns of biodiversity within or adjacent to the study area, and
- identify potential impacts upon fauna and propose recommendations to minimise impacts.

## 2. BACKGROUND

### 2.1 Regional Description

The Project Area lies within the Pindanland subregion of the Dampierland Bioregion of the Interim Biogeographical Regionalisation for Australia (IBRA) classification system (EA 2000; McKenzie *et al.* 2003, See Figure 2). The Dampierland Bioregion falls within the Bioregion Group 3 classification of EPA (2004). This group is described as:

“Bioregions of the Northern Botanical Province, native vegetation is largely contiguous but is used for commercial grazing.”

The general features of this region are summarised by Graham (2001). The climate is dry hot tropical and semi-arid with summer rainfall (averaging between 450 – 700 mm). The Pindanland Subregion covers an area of 5 198 904 ha with four basic components:

1. Quaternary sandplain overlying Jurassic and Mesozoic sandstones with Pindan and hummock grasslands on hills.
2. Quaternary marine deposits on coastal plains, with mangal, samphire – *Sporobolus* spp. grasslands, *Melaleuca alsophila* low forests, and *Spinifex* spp. – *Crotalaria* spp. strand communities.
3. Quaternary alluvial plains associated with the Permian and Mesozoic sediments of Fitzroy Trough support tree savannahs of ribbon grass (*Chrysopogon* spp.)/ bluegrass (*Dichanthium* spp.) grasses with scattered Coolibah (*Eucalyptus microtheca*) and *Bauhinia cunninghamii*.
4. Riparian forests of river red gum (*Eucalyptus camaldulensis*) and Cadjeput (*Melaleuca* spp.) fringing drainages.

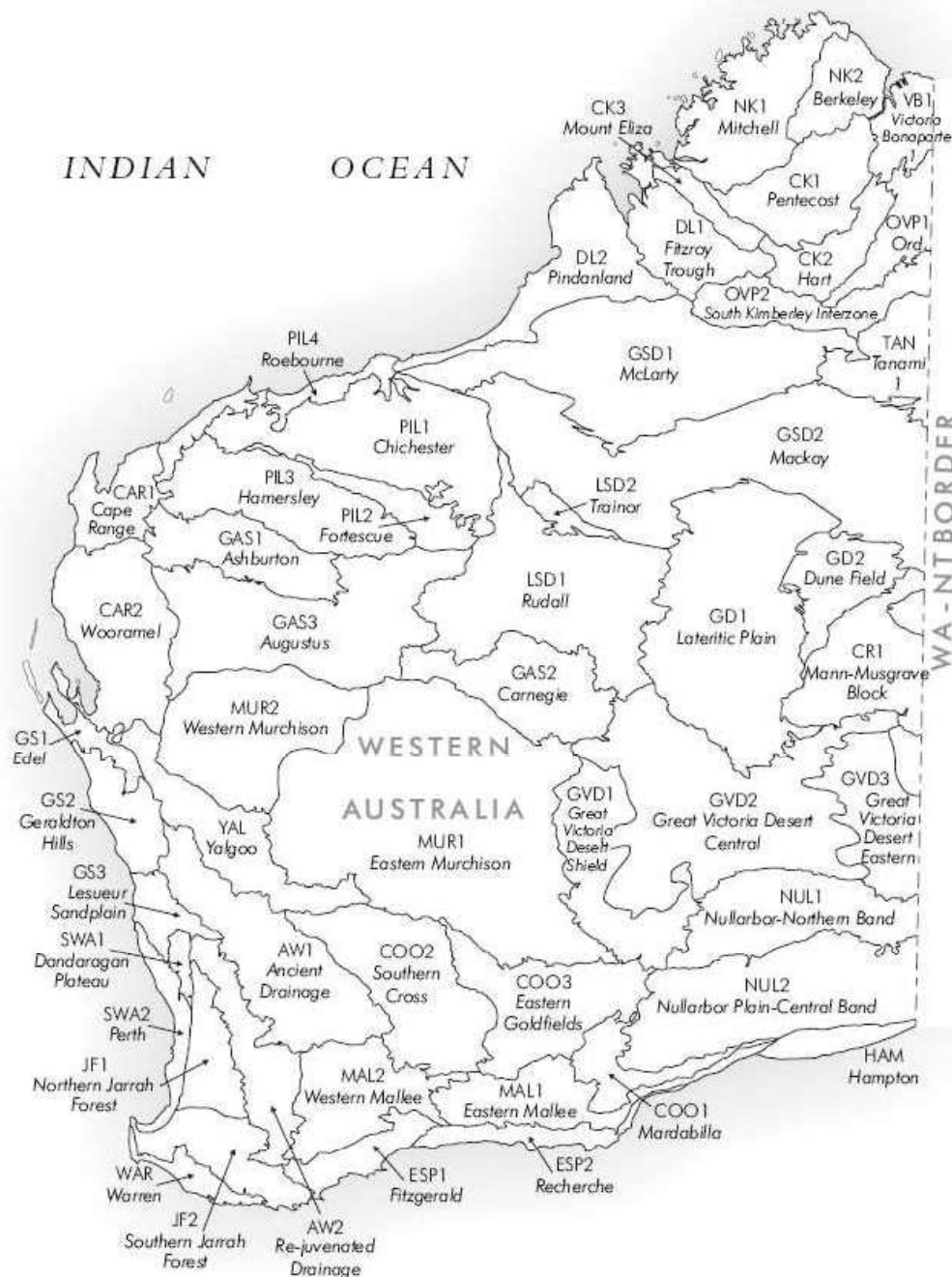
The vegetation of the Pindanland Subregion is described primarily as Pindan on sandplain. Beard (1979) describes the Pindan vegetation as an open layer of trees (typically *Eucalyptus tectifica* and *Corymbia dampieri*, 12-15 metres in height) over a dense layer of *Acacia* species and a sparse ground covering. The Pindan vegetation of the Peninsula represents a significant transition zone between the deserts to the south and the sub-tropics to the north.

Graham (2001) provides a detailed description of special values and features of the region with respect to fauna and environments, including endemism, refugia, significant species and important wetlands. Rainforest patches, mangroves, riparian zones and springs provide dry season refuges in the subregion.

Terrestrial fauna species of conservation significance found in the Pindanland Subregion include:

- ☐ Bilby (*Macrotis lagotis*)
- ☐ Gouldian Finch (*Erythrura gouldiae*)
- ☐ Red Goshawk (*Erythrorhynchus radiatus*)
- ☐ Freshwater Crocodile (*Crocodylus johnstoni*)
- ☐ Saltwater Crocodile (*Crocodylus porosus*)
- ☐ Flock Bronzewing (*Phaps histrionica*)

- ☐ Australian Bustard (*Ardeotis australis*)
- ☐ Pictorella Mannikin (*Heteromunia pectoralis*)
- ☐ Star Finch (*Neochmia ruficauda subclarescens*)
- ☐ Orange Leaf-nosed Bat (*Rhinonictus aurantius*)



**Figure 2** IBRA Subregions in Western Australia. Note the project lies in DL2: Pindanland.

In addition, large numbers of migratory waterbirds have been recorded along the shoreline and mud flats of Roebuck Bay, an area recognised internationally as

significant for such species. These species are listed under the Japan – Australia Migratory Bird Agreement (JAMA), China- Australia Migratory Bird Agreement (CAMBA) and the Bonn Convention of Migratory species have been recorded in the area, and therefore are migratory under the federal EPBC Act. These species are listed in Table 3.

## 2.2 Description of the Project Area

The Port of Broome is found on the western edge of the Dampierland Bioregion, on the northern tip of Roebuck Bay. The topography and soils of the region are composed of extensive riverine plains with grey and brown cracking clays, extensive sandplains on red earthy sands, low uplands of sandstone and limestone with shallow stony soils (Beard 1990). The area is underlain by a mixture of quaternary sandplain overlying jurassic sandstones; quaternary marine deposits on coastal plains, with devonian reef limestones and extensive alluvial river plains (Beard 1990).

Trudgen (1988) undertook a flora and vegetation survey of the Broome coastline. The vegetation was split into a number of categories including: vegetation of the Strand area, Dunal vegetation, Pindan vegetation, Vine Thicket and related vegetation (Gubinge Woodlands), and Melaleuca open forest.

A short description of vegetation communities within the Port Management Area (PMA) is given in URS (2004), as described below:

- Dunal vegetation varies with dune aspect, slope and shoreline proximity, with species such as *Spinifex longifolius*, *Canavalia rosea* and *Acacia bivenosa* colonising eroding seaward faces; whereas the seaward ridge and backslopes are colonised by species such as *Crotolaria cunninghamii*, *Marsdenia cinerascens*, *Santalum lanceolatum* and *Acacia bivenosa*.
- Discontinuous vine thickets occur in depressions and swales between dune ridges, with species such as *Gyrocarpus americanus*, *Abrus precatorius*, *Passiflora foetida*, *Tinospora smilacina* and *Capparis lasiantha* present.
- Eucalypt and Gubinge woodland over hummock grassland of *Plectrachne pungens* occur on inland dune ridge and slopes, with other species such as *Gardenia pyriformis* and *Clerodendrum tomentosum* also present. These woodlands merge with Pindan vegetation where the rearward dunes slope down onto the Pindan plain.
- Pindan vegetation present lying between Port Drive and the base of the dunes is typical of the area, and is comprised of mixed Acacia/Eucalypt woodland including *Acacia eriopoda*, *Eucalyptus dampieri* and *Terminalia petiolaris* with scattered shrubs and grasses including *Lysiphyllum cunninghamii*, *Hakea macrocarpa* and *Ventilago viminalis*.
- Mangrove communities in the PMA were noted by URS (2004) to be limited to minor patches along the Roebuck Bay shoreline.

The vegetation communities vary significantly on the Broome Peninsula moving northwards from the Port of Broome (Urbanplan 2006). This is due to the effect of the ocean on the climate at either end of the Broome Peninsula. Woodman (2008) describes two broad landscape types in the survey area – coastal dunes and pindan soils:

1. Open Woodlands and Shrublands over grasslands on pale brown to orange sands on foredunes, immediately behind foredunes and other dunal areas.
2. Open Woodlands over Shrublands over grasslands on orange to red pindan soils on lowerslopes to crests.

The broad landscape types are further broken into Floristic Community Types (FCTs, Woodman, 2008, see Figure 1). Five major vegetation types (FCTs) are described by Woodman (2008) for the Port of Broome area:

- FCT1. Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes. This habitat occurs on the crests of foredunes or on the leeward side of the foredune, on the western coastline of the survey area, north of Gantheaume Point along Cable Beach.
- FCT2. Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and *Poaceae* sp. 2 on orange sand on secondary dunes. This habitat occurs on the sheltered eastern side of the southern Broome Peninsula, on Roebuck Bay (see Figure 1).
- FCT3. Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlani* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lowerslopes behind dunes, and secondary dunes. This habitat occurs on the western coast along Cable Beach. A small area of disturbed vegetation of this habitat type occurs at the very southern tip of the peninsula. Clearing and developmental activities have led to the quality of the vegetation in this area to decline. This habitat equates to Monsoon (vine) thickets on coastal sand dunes of Dampier Peninsula. Discontinuous vine thickets occur in depressions and swales between dune ridges (see Figure 1).
- FCT4. Pindan 1: Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions. This habitat occurs on pindan soil on the southern half of the survey area (see Figure 1).
- FCT5. Pindan 2: Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula*, *Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions. This habitat occurs on pindan soils north and east of Gantheaume Point (Figure 1).

The proposed area of disturbance is mapped by Woodman (2008) as FCT4.



### 2.3 Assessment of Conservation Significance

The conservation status of fauna species is assessed under Commonwealth and State Acts such as the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950*. 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) and reviewed by Mace and Stuart (1994). The Wildlife Conservation Act uses a set of Schedules but also classifies species using some of the IUCN categories. These categories and Schedules are described in Appendix One.

The EPBC Act also has lists of migratory species that are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). In addition, the federal Department of Environment, Water, Heritage and the Arts (DEWHA, formerly Environment Australia) has supported the publication of reports on the conservation status of most vertebrate fauna species e.g. reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999); while the Threatened Species and Communities Section of Environment Australia has produced a list of Threatened Australian Fauna (Environment Australia 1999), although this list is effectively a precursor to the list produced under the EPBC Act. These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) and Wager and Jackson (1993) differ in some respects as these reports pre-date Mace and Stuart's review (1994).

In Western Australia, the Department of Environment and Conservation (DEC) has produced a supplementary list of Priority Fauna, being species that are not considered Threatened under the *Wildlife Conservation Act* but for which the DEC feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. Levels of Priority are described in Appendix One.

Fauna species included under conservation acts and/or agreements are formally recognised as of conservation significance under state or federal legislation. Species listed only as Priority by DEC, or that are included in publications such as Garnett and Crowley (2000) and Cogger *et al.* (1993) but not in State or Commonwealth Acts, are also of recognised conservation significance. In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur in breeding colonies, such as some waterbirds, can be considered of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. The WA Department of Environmental Protection (2000, now DEC) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan.

On the basis of the above comments, three levels of conservation significance are recognised in this report:

1. **Conservation Significance (CS) 1:** Species listed under State or Commonwealth Acts.
2. **Conservation Significance (CS) 2:** Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by the DEC.
3. **Conservation Significance (CS) 3:** Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution. This level may have links to preserving biodiversity at the genetic level (EPA 2002). For example, if a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3.

In addition to these conservation levels, species that have been introduced (INT) are indicated.

### 3. METHODS

#### 3.1 Approach

This fauna assessment and report preparation were carried out with reference to guidance and position statements published by the WA Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (e.g. EPA 2002; EPA 2004). The level of fauna assessment required by the EPA is determined by the size and location of the proposed disturbance and the sensitivity of the surrounding environment in which the disturbance is planned.

The Project Area lies within Bioregion Group 3 as classified by the EPA (EPA 2004), described as bioregions of the Northern Botanical Province with native vegetation largely contiguous but used for commercial grazing. Due to the scale of the proposed disturbance Coffey commissioned Bamford Consulting Ecologists to undertake an extended Level 1 Fauna Assessment (a desktop study and reconnaissance survey).

A Level 1 Survey is described as a:

“Background research or ‘desktop’ study with the purpose to gather background information on the target area (usually at the locality scale). This involves a search of all sources for literature, data and map-based information (EPA, 2004).”

The purpose of a Reconnaissance Survey is to verify the accuracy of the background study; to further delineate and characterise the fauna and faunal assemblages present in the target area; and to identify potential impacts.

This involves:

“a target area visit by suitably qualified personnel to undertake selective, low intensity sampling of the fauna and faunal assemblages, and to provide habitat descriptions and habitat maps of the Project Area”.

The area proposed to be cleared by the BrPA was visited during October 2009 as well as adjacent areas. The survey area for this assessment is located on the Broome Peninsula. The Port of Broome lies at the northern end of Roebuck Bay, a wetland of international significance.

#### 3.2 Personnel

The Broome Port Fauna Assessment was undertaken from 30<sup>th</sup> October till 1<sup>st</sup> November 2009 by the following personnel:

- Jeff Turpin (B.Sc. Zoology)
- Carly Bishop (B. Sc. Hons Environmental Management)

The field survey was conducted under DEC Regulation 17 (Licence to take Fauna for Scientific Purposes) licence number SF007106. This fauna assessment document was prepared by Mr Jeff Turpin (B.Sc.) and Dr Mike Bamford (B.Sc. Hons. Ph.D).

### 3.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based largely on the Western Australian Museum's *Checklist of the Vertebrates of Western Australia*. The authorities used for each vertebrate group are: amphibians and reptiles (Aplin and Smith 2001), birds (Christidis and Boles 1994; Johnstone 2001), and mammals (How *et al.* 2001).

### 3.4 Sources of Information for desktop assessment

Information for this fauna assessment was drawn primarily from the DEC's NatureMap ([www.naturemap.dec.wa.gov.au](http://www.naturemap.dec.wa.gov.au), 2009). Additional information was obtained from the Birds Australia Atlas Database, DEC Threatened Fauna Database and EPBC Protected Matters Search Tool, and all databases were interrogated in October 2009 (see below). This information was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were: freshwater fish (Allen *et al.* 2002), frogs (Tyler *et al.* 2000), reptiles (Storr *et al.* 1983, 1990, 1999 and 2002), birds (Blakers *et al.* 1984; Johnstone and Storr 1998; Johnstone and Storr, 2003; Storr, 1984), and mammals (Churchill 1998; Strahan 1995; Menkhorst and Knight 2001).

Database	Type of records held on database	Area searched
NatureMap (DEC and WA Museum)	Records on DEC Fauna database plus records of specimens held in the WA Museum. Includes historical data.	-16.5 S, 122.000 E and -18.5 S, 123.5 E
Birds Australia Atlas Database	Records of bird observations in Australia, 1998-2009.	Species list for the 1 degree grid cell containing -18.00341E, 122.21039S
DEC Threatened and Priority Fauna Database	Information and records on Threatened and Priority species in Western Australia	-17.88553E, 122.2717S with a 30 km buffer
EPBC Protected Matters Search Tool	Records on matters protected under the EPBC Act, including threatened species and conservation estate.	18.00341E, 122.21039S with a 30 km buffer

The desktop review generated a large species list that is likely to include vagrants to the region (such as some birds) and species that do occur in the region (and greater survey area), but for which there may or may not be suitable habitat within the Project Area (the proposed area of disturbance). With respect to conservation significant species identified from the desktop review, the precautionary approach is taken and all are discussed in this report.

### 3.5 Reconnaissance Survey.

During the Broome Port Fauna Assessment each major habitat type within the survey area was visited to develop an understanding of habitats present and to assess the

likelihood of conservation significant species present in the area. All fauna species observed during surveying were recorded.

Sixteen opportunistic fauna sites were selected, assessed for fauna habitat types and sampled opportunistically for fauna. At each Opportunistic Fauna Site a 20 minute, 2 ha Bird Survey was undertaken (following the standardised Birds Australia survey format), as well as searching for significant fauna, habitat assessments and microhabitat searching for smaller vertebrates and invertebrates. The locations of the Opportunistic Fauna Sites are detailed below.

Site	Easting Zone	Northing 51K	Habitat	Comments
1	415038	8010737	Pindan, Eastern Fig thicket	Bird 1
2	414742	8011006	Pindan, North-West	Bird 2
3	415516	8010396	Pindan, South-east	Bird 3
4	414974	8010402	Pindan, South-west, Fig Thicket	Bird 4
5	415286	8011160	Pindan, North, FCT5	Bird 5
6	414816	8011388	Pindan, North, FCT5	Bird 6
7	415074	8010949	Pindan	Bird 7
8	415032	8010124	Pindan	Approved Clearance 1
9	415549	8010117	Pindan	Approved Clearance 2
10	414868	8009750	Coastal Shrubland	Reddel Beach Car park
11	415025	8009688	Monsoon Thicket	Reddel Beach Vine Thicket
12	416033	8009058	Monsoon Thicket	Port Monsoon Thicket
13	414811	8009819	Reddell Beach	Reddell Beach
14	416202	8009538	Intertidal zone	Intertidal Zone near Port
15	416144	8009583	Beach, Mangrove, mudflat	Port Beach
16	416647	8011153	Tall Secondary Dune	Tall Eastern Dune
17	416738	8011101	Beach, mudflat	Roebuck Bay

### 3.5.1 Fauna Sampling Techniques

The aim of the field survey was to develop an understanding of the fauna habitats of the site, and to search for evidence of conservation significant species. All habitats encountered were assessed as to the likelihood of supporting species of conservation significance known to occur in the region. These species include the Bilby (*Macrotis lagotis*), Peregrine Falcon (*Falco peregrinus*), Bush Stone-curlew (*Burhinus grallarius*) and a number of migratory birds listed under the EPBC Act. All fauna species observed during surveying were also recorded.

Sampling consisted of:

- Searching for evidence of significant fauna species
- Microhabitat searching for smaller vertebrate animals (e.g. reptiles and mammals) and invertebrates (specifically short-range endemic invertebrates such as land snails, millipedes and mygalomorph spiders);
- Bird censusing (Birds Australia 20 minute, 2 ha search)
- Habitat assessment
- Opportunistic observations
- Spotlighting

- Call playback
- Acoustic recordings of bats
- Motion-sensitive cameras

#### Searching for significant species

Significant species identified in the desktop assessment that may occur in the Project Area include several that can be found by searching for evidence of their activities. These include the Bilby (diggings and burrows), Bush Stone-curlew (call play-back) and other species (scats, tracks shelters etc.). Searching for evidence of significant fauna was therefore undertaken by walking through habitat considered suitable for such species.

#### Micro-habitat searching

Micro-habitat searching was carried at each opportunistic fauna survey site within the survey area. Searching involved raking through leaf-litter, breaking into dead trees, looking under bark, digging up burrows and turning over rocks, logs and dead Spinifex.

#### Bird Surveys

At each survey site a standardised bird census was undertaken. Each bird survey followed the standardised technique used by Birds Australia: a 20 minute, 2 Hectare search. Opportunistic bird surveys were conducted at least once in each habitat present within the Project Area. All opportunistic bird observations were also recorded.

#### Habitat Assessment

Each habitat visited was assessed as to the suitability of supporting threatened fauna. Habitat was assessed according to vegetation, landform, geology and soils.

#### Opportunistic surveys

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while travelling through the site and also secondary evidence of fauna including tracks, scats, shelters and burrows.

#### Spotlighting

Spotlighting was conducted both on foot, using head-torches (referred to as head-torching), and from the vehicle using the vehicle headlights and a hand-held spotlight. Where necessary, animals were captured for identification and then released. Spotlighting was conducted on the nights of the 30<sup>th</sup> and 31<sup>st</sup> of October 2009.

#### Call playback

The broadcasting of bird vocalisations is an efficient and effective survey method to detect many species, particularly nocturnal species such as owls and the Bush Stone-curlew. Several bird species respond to species specific calls broadcast over a loud speaker system (using MP3 recordings broadcast through loud speakers).

The conservation significant Bush Stone-curlew and Barking Owl are known to respond to call playback (J. Turpin, pers. obs.). Call playback was conducted for both species at sites deemed suitable, including at:

- 415038N, 8010737E, in Pindan within the survey area
- 415574N, 8010390E, in Pindan within the survey area
- 415032N, 8010124E, in Pindan outside the survey area

#### Bat surveys

Bats were surveyed using electronic AnaBat bat call recorders (Titley Scientific, Brisbane). Ultrasonic echolocation calls of bats were recorded with an AnaBat II bat detector connected to an audio recorder, and later processed using AnalookW software. Identification of species was assisted by measuring the following echolocation call parameters:

- Fmax Maximum call frequency (kHz)
- Fmin Maximum call frequency (kHz)
- Fc Characteristic frequency (kHz)
- Fpeak Frequency with peak number of cycles (kHz)
- DUR Duration of call (ms)

The AnaBat detector was deployed overnight at two sites:

- 415038N, 8010737E, in Pindan within the survey area
- 415574N, 8010390E, in Pindan within the survey area

#### Motion-sensitive cameras

Two motion sensitive cameras were established within the survey area to record fauna. Motion cameras have been used successfully on fauna surveys to record mammals (such as Macropods, Possums, Bandicoots and Dasyurids) and birds (J. Turpin, pers. obs.) Two motion cameras were established at the base of Fig trees with large hollows and were baited with universal bait (sardines, peanut butter, rolled oats). Both motion cameras sampled over two nights (30<sup>th</sup> and 31<sup>st</sup> October 2009) and were installed at:

- 415103E, 8010755N, Fig Thicket in Pindan;
- 415588E, 8010433N, Fig Thicket in Pindan.



## 4. RESULTS

### 4.1 Fauna Habitats

The major fauna habitats occurring within the study area reflect the major vegetation types present (Floristic Community Types – FCTs, see Figure 1). Nine major fauna habitats were recorded from the greater survey area. These are:

1. **Pindan Vegetation. (FCT4)** Pindan 1 – mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils. This is the major habitat type within the Project Area (see Figure 1) .



2. **Thickets and large shrubs of *Ficus aculeata* var. *indecora*.** (within FCT4 and 5). This Fig species occurs in thickets or single shrubs and is scattered throughout the survey area. Large stands occur within the proposed Project Area, particularly in the eastern parts. This habitat is significant as large mature trees and shrubs contain hollows suitable for birds and arboreal mammals.



3. **Monsoon Thickets.** Monsoon Thickets occur on the inland side of coastal dunes along the Dampier Peninsula, and tend to become larger and have greater species diversity in the north of the region compared with the south. This habitat type is reflected by FCT 3 and elements of FCT 1 (see Figure 1). A large degraded area occurs on the southern tip of the Broome Peninsula, with smaller areas occurring near the Reddell Beach Car Park. Monsoon Thickets are also recognised as a Threatened Ecological Community (TEC).





4. **Pindan Vegetation.** (FCT5) Pindan 2: Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula*, *Triodia microstachya* or *Triodia pungens* on orange to red pindan soils. This habitat occurs in the northern parts of the survey area.



5. **Tall Dunes on the eastern margin of the peninsula** (FCT2) – supporting Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and *Poaceae* sp. 2 on orange sand on secondary dunes. This habitat occurs on the sheltered eastern side of the southern Broome Peninsula, on Roebuck Bay (see Figure 1).



6. **Coastal Shrubland on Primary Dunes** (FCT1, western side of the peninsula): dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes. This habitat type occurs mostly outside the Project Area however intergrades with the Pindan vegetation on the western margins of the project (see Figure 1).



7. **Mangrove communities.** This habitat is limited to patches along the Roebuck Bay shoreline (see Figure 1)..





8. **Beaches and mud flats.** Occur along the coastline with an extensive area of intertidal mudflats occurring the eastern shoreline of the Broome Peninsula, adjacent to and north of the Broome Port.



9. **Minor Rocky Headlands.** Rocky Headlands occur along the coastline.

Additionally, some disturbed areas occur within the Project Area, particularly around the Broome Port. Several tracks also cross the Project Area.

Project Area.

Within the Project Area four of the above fauna habitats were recognised. These were:

1. Pindan Vegetation: Pindan 1
2. Pindan Vegetation: Pindan 2.
3. Thickets and large shrubs of *Ficus aculeata* var. *indecora*
4. An intergrade of Pindan vegetation with coastal shrublands on the projects western margins.

#### 4.2 Vertebrate fauna

The desktop survey identified 385 fauna species potentially occurring in the Broome region and greater study area. This comprised 11 Frog, 82 Reptile, 255 Bird and 37 Mammal species (see Tables 1 - 4). These lists are based largely upon known species distributions and available habitats. Table 5 lists those species considered to be of conservation significance and details their respective conservation status. The faunal assemblage shows components of both the arid zone to the south and the tropical Kimberley to the north-east, reflecting the transition zone of climate in the area. As a result, most fauna species expected to occur in the Project Area are widespread but some are also restricted to the Dampier Peninsula. The fauna lists also include a number of migratory species, including waterbirds, waders and marine birds. These species may periodically occur within the vicinity of the Port of Broome and some may utilise the coastal mud flats, beaches and mangroves. A number of migratory waders were also observed flying over the Project Area.

Overall, the assemblage of vertebrate fauna expected in the Project Area is typical of the region. Most fauna species occurring or expected to occur in the Project Area are widespread but some species may have restricted or habitat limited distributions, and some fauna species expected have declined in the region. Conservation significant fauna species occurring or likely to occur in the Project Area are discussed below.

The vertebrate fauna expected to occur within the region have the following composition (see Tables 1, 2 and 3):

Taxon	Number of species expected in Survey Area	Significant fauna expected: Survey Area				Significant fauna expected: Project Area			
		CS1	CS2	CS3	INT	CS1	CS2	CS3	INT
Frogs	11	-	-	-	-	-	-	-	-
Reptiles	82	1	2	4	1	1	2	4	1
Birds	255	59	7	3	1	6	2	1	1
Mammals	33 (native) 4 (feral species)	2	4	3	3	1	-	3	3
Total	385	62	13	10	5	8	4	8	5

A total of 85 conservation significant vertebrate species are expected to occur in the Broome area based on database searches (62 CS1, 13 CS2, 10 CS3 species). However many species are expected to occur in habitats absent from the Project Area. For example large numbers of migratory waterbirds are expected to occur along the adjacent coastline however are not expected to occur within the Project Area. A total of 20 conservation significant species are expected at the project.

##### 4.2.1 Freshwater Fish

No species of freshwater fish are expected to occur in the study area. There are no freshwater habitats within the Project Area.

#### 4.2.2 Amphibians

A total of eleven frog species may occur in the Broome area (see Table 2). One frog species, *Litoria caerulea*, was recorded from the survey area.

There are three frog species of conservation significance in the Broome area:

<u>Conservation Significance Level 3</u>	
Derby Toadlet	<i>Uperoleia aspera</i>
Mjoberg's Toadlet	<i>Uperoleia mjobergi</i>
Mole Toadlet	<i>Uperoleia talpa</i>
These species have restricted distributions and occur on floodplains and flooded areas in the vicinity of Broome. They are not expected to occur within the Pindan habitat and coastal dunes within the survey area and are therefore not expected within the Project Area.	

#### 4.2.3 Reptiles

A total of 82 reptile species may occur in the Project Area (see Table 3). This includes 13 geckoes, two pygopods, 10 agamids, seven varanids, 26 skinks, three blind snakes, five pythons and 13 elapid snakes. This list includes the recently described *Cryptoblepharus metallicus*, *Cryptoblepharus rubber* and *Cryptoblepharus tythos* (Horner, 2007).

Ten reptile species were recorded during the 2009 field survey. These were:

<i>Gehyra australis</i>	Recorded from Pindan vegetation within the Project Area
<i>Hemidactylus frenatus</i>	Recorded within survey area.
<i>Amphibolurus gilberti</i>	Recorded from dense vegetation.
<i>Diporiphora pindan</i>	Recorded from tall coastal dune (eastern side of peninsula)
<i>Varanus gouldii</i>	Recorded from Pindan vegetation within the clearance area
<i>Varanus tristis tristis</i>	Recorded from Pindan vegetation within the clearance area
<i>Cryptoblepharus ruber</i>	Recorded from Ficus thicket within the clearance area
<i>Ctenotus inornatus</i>	Recorded from Pindan vegetation within the clearance area
<i>Glaphyromorphus isolepis</i>	Recorded from Pindan vegetation within the clearance area
<i>Tiliqua scincoides</i>	Recorded from Pindan vegetation within the clearance area

An additional seven reptile species have been recorded within the fauna survey area (from database searches and local records). This includes two conservation significant species:

- *Lerista separanda* (Priority 2) recorded from Triodia hummock
- *Simoselaps minimus* (Priority 2) recorded from Triodia hummock
- *Lialis burtonis* recorded from Pindan
- *Chlamydosaurus kingii* recorded from Pindan
- *Aspidites melanocephalus* recorded from Pindan
- *Furina ornata* recorded from Pindan
- *Pseudechis australis* recorded from Pindan



Seven conservation significant reptile species occur or are considered to have the potential to occur within the Project Area. They are discussed below.

#### Conservation Significance Level 1

Airlie Island Ctenotus

*Ctenotus angusticeps*

*Ctenotus angusticeps* is listed as Vulnerable under the EPBC act and Wildlife Conservation Act. This species occurs on Airlie Island, north-east of Onslow, the mainland adjacent to Airlie Island and has been recorded south of Broome at Roebuck Bay (DEWHA, 2008). At Roebuck Bay, lizards have been found on coastal mudflats vegetated with Spinifex (Wilson and Swan, 2003). On Airlie Island this species has been recorded in low *Acacia coriacea* shrubland with coastal Spinifex and limestone formations (Browne-Cooper and Maryan, 1990). This species has the potential to occur in the Project Area.

#### Conservation Significance Level 2

a skink

*Lerista separanda*

a snake

*Simoselaps minimus*

*Lerista separanda* is listed as Priority 2 by DEC. It has a restricted range within the Semiarid and arid southwest Kimberley. This species has been previously recorded from the survey area (on the Broome Peninsula) within leaf litter and under *Triodia* sp. (NatureMap, 2009). This record lies approximately 1km north-east of the proposed Project Area.

*Lerista separanda* has also been recorded at Kimbolton, Point Coulomb and Nita Downs (Storr *et al.*, 1999). Wilson and Swan (2008) suggest this species occurs in sandy areas along the south-west Kimberly coast. This species occurs near the Project Area and is likely to occur across the Project Area within the Pindan vegetation.

*Simoselaps minimus* is listed as Priority 2 by DEC. It is restricted range to the Dampier Peninsula. *Simoselaps minimus* has been recorded from the fauna survey area, within soil under a *Triodia* clump approximately 1km north-east of the proposed Project Area (DEC, 2009). Wilson and Swan (2008) suggest this species occurs in coastal dunes and sandy junction between dunes and adjacent acacia shrublands. This species is likely to occur within the Project Area.

#### Conservation Significance Level 3

a dragon

*Diporiphora pindan*

a skink

*Ctenotus colletti*

a skink

*Lerista apoda*

a skink

*Morethia storri*

*Diporiphora pindan* is restricted to Dampier Land and adjacent coast and hinterland. It occurs mainly in Pindan (a thicket mostly of *Acacia* species growing on light red

soils, Cogger, 2000). This species was recorded during the field survey and is likely to occur within the Project Area.

*Ctenotus colletti* is known only from the southwest Kimberley between Beagle Bay and Bidyadanga. It occurs in semiarid acacia scrub (Pindan) on red sandy soils (Storr *et al.*, 1999). This species is likely to occur within the Project Area.

*Lerista apoda* is confined to the Dampier Peninsula in the semi-arid southwest Kimberley (Storr *et al.*, 1999). Wilson and Swan (2008) suggest this species occurs in sandy areas (of Dampier Land) particularly along the transition zone between coastal dunes and red sands supporting *Acacia* thickets. This species may occur in the Project Area.

*Morethia storri* has a very restricted distribution in Western Australia. This species is confined to the semiarid areas of the northern Dampier Peninsula, and is also known from northern areas of the Northern Territory (Storr *et al.*, 1999). This species may occur in the Project Area within woodlands and shrublands.

One introduced gecko species, *Hemidactylus frenatus*, was recorded in the Project Area during the site visit.

#### 4.2.4 Birds

A total of at least 255 bird species may occur in the survey area (see Table 3). This list excludes species that may occur as vagrants but does include waterbirds that may fly over the project, including migratory wader species and marine seabirds. The nationally vulnerable Princess Parrot (*Polytelis alexandrae*) has been recorded from the Broome area, although this record may be of an aviary escapee (Broome Bird Observatory, 2007) and has not been included in this list. Forty three migratory and/or marine species may utilise habitat on the fringes of the study area, the coastal beaches, mud flats and coastal waters. These species are listed in Table A.

A total of 76 bird species were recorded from the fauna survey area during the 2009 survey. This includes 34 species recorded from the Project Area, with the additional species recorded in adjacent habitats – mangroves, mudflats, coastal dunes and beaches (Survey Area, see Table A).

Tables A lists the bird species recorded from the Project Area and the greater survey area. This lists includes 21 species of conservation significance, all listed under the EPBC Act. Of the conservation significant species recorded, all migratory waders were on the intertidal mudflats of Roebuck Bay (approximately 500m from the Project Area), however two species were observed flying over the Project Area. The migratory marine species (Osprey, Lesser Frigatebird, White-bellied Sea-Eagle and Brown Booby) were recorded along the peninsula coastline. Small parties of the Barn Swallow were observed foraging along coastal dunes. One conservation significant bird, the Rainbow Bee-eater, was recorded from the project area.

**Table A.** Bird Species recorded during the 2009 Inspection.

Common Name	Species Name	Status	Project Area	Survey Area
Plumed Whistling-Duck	<i>Dendrocygna eytoni</i>			X
Wandering Whistling-Duck	<i>Dendrocygna arcuata</i>			X
Pacific Black Duck	<i>Anas superciliosa</i>			X
Grey Teal	<i>Anas gracilis</i>			X
Brown Booby	<i>Sula leucogaster</i>	EPBC MIG		X
Lesser Frigatebird	<i>Fregata ariel</i>	EPBC MIG		X
Eastern Reef Egret	<i>Egretta sacra</i>		X (fly over)	X
Striated Heron	<i>Butorides striatus</i>			X
Australian White Ibis	<i>Threskiornis moluaca</i>			X
Eastern Osprey	<i>Pandion cristatus</i>	EPBC MIG		X
Black-shouldered Kite	<i>Elanus axillaris</i>		X	
Black (Fork-tailed) Kite	<i>Milvus migrans</i>			X
Whistling Kite	<i>Haliastur sphenurus</i>			X
Brahminy Kite	<i>Haliastur indus</i>			X
White bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	EPBC MIG		X
Brown Goshawk	<i>Accipiter fasciatus</i>		X	X
Nankeen Kestrel	<i>Falco cenchroides</i>			X
Black-tailed Godwit	<i>Limosa limosa</i>	EPBC MIG		X
Bar-tailed Godwit	<i>Limosa lapponica</i>	EPBC MIG		X
Whimbrel	<i>Numenius phaeopus</i>	EPBC MIG		X
Eastern Curlew	<i>Numenius madagascariensis</i>	EPBC MIG		X
Common Greenshank	<i>Tringa nebularia</i>	EPBC MIG		X
Terek Sandpiper	<i>Xenus cinereus</i>	EPBC MIG		X
Common Sandpiper	<i>Actitis hypoleucos</i>	EPBC MIG	X (fly over)	X
Grey-tailed Tattler	<i>Heteroscelus brevipes</i>	EPBC MIG		X
Ruddy Turnstone	<i>Arenaria interpres</i>	EPBC MIG		X

Common Name	Species Name	Status	Project Area	Survey Area
Great Knot	<i>Calidris tenuirostris</i>	EPBC MIG		X
Red-necked Stint	<i>Calidris ruficollis</i>	EPBC MIG		X
Curlew Sandpiper	<i>Calidris ferruginea</i>	EPBC MIG		X
Pied Oystercatcher	<i>Haematopus longirostris</i>			X
Black-winged Stilt	<i>Himantopus himantopus</i>			X
Pacific Golden Plover	<i>Pluvialis fulva</i>	EPBC MIG		X
Grey Plover	<i>Pluvialis squatarola</i>	EPBC MIG		X
Red-capped Plover	<i>Charadrius ruficapillus</i>			X
Greater Sand Plover	<i>Charadrius leschenaultii</i>	EPBC MIG		X
Masked Lapwing	<i>Vanellus miles</i>			X
Silver Gull	<i>Larus novaehollandiae</i>			X
Gull-billed Tern	<i>Sterna nilotica</i>			X
Crested Tern	<i>Sterna bergii</i>			X
Whiskered Tern	<i>Chlidonias hybridus</i>			X
Peaceful Dove	<i>Geopelia placida</i>		X	X
Bar-shouldered Dove	<i>Geopelia humeralis</i>		X	X
Crested Pigeon	<i>Ocyphaps lophotes</i>		X	X
Little Corella	<i>Cacatua sanguinea</i>			X
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>		X	X
Red-winged Parrot	<i>Aprosmictus erythropterus</i>		X	X
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>		X	X
Pheasant Coucal	<i>Centropus phasianinus</i>		X	X
Tawny Frogmouth	<i>Podargus strigoides</i>		X	X
Blue-winged Kookaburra	<i>Dacelo leachii</i>		X	X
Sacred Kingfisher	<i>Todiramphus sanctus</i>		X	
Rainbow Bee-eater	<i>Merops ornatus</i>	EPBC MIG	X	X
Dollarbird	<i>Eurystomus orientalis</i>			X
Variegated Fairy-wren	<i>Malurus lamberti</i>		X	X
Red backed Fairy-wren	<i>Malurus melanocephalus</i>		X	X
White throated Gerygone	<i>Gerygone olivacea</i>		X	X
Dusky Gerygone	<i>Gerygone tenebrosa</i>			X
Little Friarbird	<i>Philemon citreogularis</i>		X	X
Singing Honeyeater	<i>Lichenostomus virescens</i>		X	X
Yellow-tinted Honeyeater	<i>Lichenostomus flavescens</i>		X	X
Black-chinned Honeyeater	<i>Melithreptus gularis</i>		X	X
Brown Honeyeater	<i>Lichmera indistincta</i>		X	X
Rufous-throated Honeyeater	<i>Conopophila rufogularis</i>			X
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>		X	X
Rufous Whistler	<i>Pachycephala rufiventris</i>		X	X
Mangrove Golden Whistler	<i>Pachycephala melanura</i>			X
Grey Shrike-thrush	<i>Colluricincla harmonica</i>		X	X
Broad-billed Flycatcher	<i>Myiagra ruficollis</i>			X
Restless Flycatcher	<i>Myiagra inquieta</i>			X
Magpie-lark	<i>Grallina cyanoleuca</i>		X	X
Willie Wagtail	<i>Rhipidura leucophrys</i>		X	X
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>		X	X
Black-faced Woodswallow	<i>Artamus cinereus</i>		X	
Pied Butcherbird	<i>Cracticus nigrogularis</i>		X	X
Torresian Crow	<i>Corvus orru</i>			X
Great Bowerbird	<i>Chlamydera nuchalis</i>		X	X
Zebra Finch	<i>Taeniopygia guttata</i>			X
Mistletoebird	<i>Dicaeum hirundinaceum</i>		X	X
Barn Swallow	<i>Hirundo rustica</i>	EPBC MIG		X
Tree Martin	<i>Hirundo nigricans</i>		X	X

Conservation significant bird species occurring in the Broome area are discussed below.

Conservation Significance Level 1

Magpie Goose	<i>Anseranas semipalmata</i>
Eastern Great Egret	<i>Ardea modesta (alba)</i>
Cattle Egret	<i>Ardea ibis</i>
Glossy Ibis	<i>Plegadis falcinellus</i>
Eastern Osprey	<i>Pandion cristatus</i>
White bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>
Oriental Pratincole	<i>Glareola maldivarum</i>
Oriental Cuckoo	<i>Cuculus saturatus</i>
Fork-tailed Swift	<i>Apus pacificus</i>
Rainbow Bee-eater	<i>Merops ornatus</i>
White throated Needletail	<i>Hirundapus caudacutus</i>
Barn Swallow	<i>Hirundo rustica</i>
Yellow Wagtail	<i>Motacilla flava</i>

These 13 bird species are listed as Migratory under the JAMBA, CAMBA and/or Bonn Convention, and as such are also protected under the EPBC Act. Those species covered under JAMBA are also protected under Schedule 3 of the Wildlife Conservation Act. The majority of these species occur seasonally in the Broome area.

The Oriental Pratincole inhabits wetlands, open plains, tidal flats and beaches and has been recorded from Entrance Point and beaches fringing the Broome Port (Birds Australia, 2009). The Barn Swallow inhabits open areas and has been recorded from the Port of Broome area (Birds Australia, 2009). This species was recorded during the fauna survey foraging along coastal dunes.

The Osprey and White-bellied Sea Eagle are coastal and marine species. Both species were recorded along the coastline surrounding the Port of Broome.

The Fork-tailed Swift and White-throated Needletail are aerial species largely independent of terrestrial habitat types, and are likely to be seasonal visitors to the Project Area. The Fork-tailed Swift has been recorded from the Port of Broome while the White-throated Needletail has been recorded from the Broome Bird Observatory (Birds Australia, 2009).

The Magpie Goose, Great Egret, Cattle Egret, Glossy Ibis and Yellow Wagtail generally are associated with wetlands. This habitat is absent from the Project Area.

The Oriental Cuckoo inhabits rainforest margins, monsoon forest, vine thicket, Paperbark swamps and mangroves. This species has been recorded from the Broome Bird Observatory (Birds Australia, 2009), but is probably only an occasional visitor in small numbers to the region.

The Rainbow Bee-eater occurs in the better watered parts of Western Australia, between the Kimberley and south-west, preferring lightly wooded, preferably sandy country near water (Johnstone and Storr, 1998). This species can occur as a resident, breeding visitor, postnuptial nomad, passage migrant or winter visitor. It nests in

burrows dug usually at a slight angle in flat ground, gently elevated slopes, sandy banks or cuttings, and often at the margins of roads or tracks. The Rainbow Bee-eater has been recorded from the Port of Broome area (Birds Australia, 2009) and was recorded from the Project Area during the 2009 survey.

The Oriental Pratincole, Great Egret, Osprey and White-bellied Sea-Eagle are likely to utilise habitat on the margins of the Project Area – the coastal beaches and inshore coastal waters. The Rainbow Bee-eater has been recorded within the Project Area and Oriental Cuckoo may occur within the vicinity of Project Area in dense vegetation such as vine thickets.

Red Goshawk *Erythrorhynchus radiatus*

The Red Goshawk is listed as Vulnerable under the *EPBC Act* and *Wildlife Conservation Act*. This species is a rare inhabitant of undisturbed forest or woodland across northern Australia. There is only one recent record for the Red Goshawk within 30 km of Broome (in 1976). This species is unlikely to utilise habitat within the Project Area. It generally favours tall eucalypt and Melaleuca woodland (M. Bamford pers. obs., J. Turpin, pers. obs.).

Peregrine Falcon *Falco peregrinus*

The Peregrine Falcon is classified as Specially Protected Fauna under Schedule 4 of the *Wildlife Conservation Act*. This species is found in a variety of habitats, including rocky ledges, cliffs, watercourses, open woodland acacia shrublands and may occur in the study area. The Peregrine Falcon has been recorded near the study area with three recent records from within 10 km of Broome (Birds Australia, 2009). The species has been recorded within the fauna survey area on the eastern side of the Peninsula near Roebuck Bay (Birds Australia, 2009). The Project Area may be a small component of the foraging range of a pair of Peregrine Falcons. However, this species is unlikely to be dependent on habitat within the Project Area.

Gouldian Finch *Erythrura gouldiae*

The Gouldian Finch is listed as Endangered under the *EPBC Act* and *WA Wildlife Conservation Act*. The Gouldian Finch occurs in open tropical woodlands, riparian vegetation, and hummock grasslands across northern Australia. The Project Area lies outside the core distribution of this species and as such it is unlikely to occur in the area. On Dampier Peninsula the Gouldian Finch has been recorded from One Arm Point (Birds Australia, 2009).

EPBC Listed Migratory Species

A high number of migratory wader species listed under the *EPBC Act* have been previously recorded from the Survey Area (Birds Australia, 2009). These are listed in Table B.



Table B: Migratory bird species listed under the EPBC Act previously recorded from the Broome area (Birds Australia, 2009). The majority of species have been recorded from the eastern coastline of the Broome Peninsula (along Roebuck Bay) in the vicinity of the Port of Broome near Entrance Pt.

Common Name	Species Name	Records
Common Sandpiper	<i>Actitis hypoleucos</i>	Broome Port (many)
Ruddy Turnstone	<i>Arenaria interpres</i>	Broome Port (many)
Sanderling	<i>Calidris alba</i>	Broome Port
Red Knot	<i>Calidris canutus</i>	Broome Port
Curlew Sandpiper	<i>Calidris ferruginea</i>	Broome Port (many)
Red-necked Stint	<i>Calidris ruficollis</i>	Broome Port (many)
Great Knot	<i>Calidris tenuirostris</i>	Broome Port (many)
Greater Sand Plover	<i>Charadrius leschenaultia</i>	Broome Port (many)
Lesser Sand Plover	<i>Charadrius mongolus</i>	Broome Port
Oriental Plover	<i>Charadrius veredus</i>	Broome
Oriental Pratincole	<i>Glareola maldivarum</i>	Entrance Point (Port)
Grey-tailed Tattler	<i>Heteroscelus brevipes</i>	Broome Port (many)
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	Broome Port
Bar-tailed Godwit	<i>Limosa lapponica</i>	Broome Port (many)
Black-tailed Godwit	<i>Limosa limosa</i>	Broome Port (many)
Eastern Curlew	<i>Numenius madagascariensis</i>	Broome Port
Little Curlew	<i>Numenius minutus</i>	Broome Port (many)
Whimbrel	<i>Numenius phaeopus</i>	Broome Port (many)
Grey Plover	<i>Pluvialis squatarola</i>	Broome Port (many)
Painted Snipe	<i>Rostratula benghalensis</i>	Roebuck Plains
Common Greenshank	<i>Tringa nebularia</i>	Broome Port (many)
Terek Sandpiper	<i>Xenus cinereus</i>	Broome Port
Streaked Shearwater	<i>Calonectris leucomelas</i>	Cable Beach
Little Tern	<i>Sterna albifrons</i>	Broome Port (many)
Pin-tailed Snipe	<i>Gallinago stemura</i>	Broome
Swinhoe's Snipe	<i>Gallinago megala</i>	Broome
Common Redshank	<i>Tringa totanus</i>	Broome Bird Observatory
Marsh Sandpiper	<i>Tringa stagnatilis</i>	Broome Port (many)
Wood Sandpiper	<i>Tringa glareola</i>	Broome Port
Asian Dowitcher	<i>Limnodromus semipalmatus</i>	Broome Bird Observatory
Long-toed Stint	<i>Calidris subminuta</i>	Broome Port
Pectoral Sandpiper	<i>Calidris melanotos</i>	Broome Port
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	Broome Port
Ruff	<i>Philomachus pugnax</i>	Broome Port
Common Tern	<i>Sterna hirundo</i>	Broome Port
Bridled Tern	<i>Sterna anaethetus</i>	Broome Port
White-winged Black Tern	<i>Chlidonias leucopterus</i>	Broome Port (many)
Common Noddy	<i>Anous stolidus</i>	Broome Port
Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	Yardoogarra, 50 km south
Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>	Broome Port
Lesser Frigatebird	<i>Fregata ariel</i>	Broome Port (many)
Masked Booby	<i>Sula dactylatra</i>	No local records
Brown Booby	<i>Sula leucogaster</i>	Broome Port (many)

Many of the wader species listed in Table B have been recorded from the beaches and mud flats in the vicinity of the Port of Broome (see plates 1 to 4). Some species have been recorded in the area in large numbers such as the Ruddy Turnstone, Curlew Sandpiper, Greater Sand Plover and Grey-tailed Tattler. In all, 43 migratory wader or marine species listed under the EPBC Act have been recorded in the Broome area. Many of these species have been recorded along the Beaches and coastline surrounding the Project Area (such as Ruddy Turnstone, Curlew Sandpiper, Greater Sand Plover and Grey-tailed Tattler). The Beaches and mudflats surrounding the Port of Broome area lie outside the Project Area for the project – occurring 500m to the east. As a result habitat supporting numerous conservation significant migratory waterbird species is unlikely to be impacted by the proposed project. A number of individual Common Sandpipers were observed flying over the proposed Project Area, moving from one side of the peninsula to the other.

Painted Snipe have been recorded from the Roebuck Plains (Birds Australia, 2009). This species inhabits the surrounds and shallows of wetlands and marshlands and so is unlikely to occur within the Project Area. The Pin-tailed Snipe and Swinhoe's Snipe have been recorded from Broome (few records). These species inhabit coastal freshwater wetlands and so are unlikely to occur within the Project Area. The Shearwaters, Storm Petrel, Masked Booby, Brown Booby, Frigatebird are largely marine species, mostly breeding on off-shore islands. They are unlikely to utilise habitat within the Project Area.

#### Conservation Significance Level 2

##### Grey Falcon

##### *Falco hypoleucos*

The Grey Falcon is nomadic, inhabiting lightly timbered riverine plains. It appears to have a distribution centred around ephemeral or permanent drainage lines, utilising old nests of other species situated in the tallest trees along the river systems (Garnett and Crowley 2000). The Grey Falcon has been recorded at the Broome Bird Observatory, 15 km east of the Project Area. This species is unlikely to rely on the Pindan in the vicinity of the Project Area, however may occur as a rare visitor.

##### Australian Bustard

##### *Ardeotis australis*

The Australian Bustard is listed as Priority 4 by the DEC and Near Threatened by Garnett and Crowley (2000). This species is a large, ground-dwelling bird known to occur in open or lightly-wooded country in Australia (extinct in south-eastern Australia) and southern New Guinea. It is nomadic and may range over very large areas, largely dependent on rainfall and hence food availability. The Australian Bustard has been recorded from the Broome Bird Observatory and from Willie Creek, 15 km north-west of the Project Area. This species prefers open grasslands and woodlands and as such is unlikely to occur within the Project Area.

##### Bush Stone-curlew

##### *Burhinus grallarius*

The ground-dwelling Bush Stone-curlew is listed as Priority 4 by the DEC and Near Threatened by Garnett and Crowley (2000). This species has a distribution covering the majority of the continent with preferred habitat being grassy woodland (Frith, 1976). Three recent records of the Bush –Stone-curlew come from within 10 km of

Broome, from habitats including Pindan (Birds Australia, 2009). The Bush Stone-curlew has been recorded from the survey area, near Reddell Beach (Birds Australia, 2009). This species is likely to occur within the Project Area.

Chestnut backed Button-quail

*Turnix castanota magnifica*

The Chestnut-backed Button-quail is classified as Priority 4 by the DEC. This species is known from the northern Kimberley and was recorded from the Roebuck Plains in 2000 (DEC Threatened Species Database, 2007). This species generally occurs in eucalypt woodland and open forest. It is not expected to occur within the Project Area as there are no local records.

Flock Bronzewing

*Phaps histrionica*

The Flock Bronzewing is listed as Priority 4 by the DEC. This species inhabits treeless or sparsely wooded grassy plains within reach of open water (DEC, 2007). The Flock Bronzewing has been recorded from the Roebuck Plains 35 km south-east of the Project Area (Birds Australia, 2009). However, due to a lack of suitable habitat this species is unlikely to occur in the study area.

Pictorella Mannikin

*Heteromunia pectoralis*

The Pictorella Mannikin is listed as Priority 4 by the DEC. This species of finch occurs in the drier northern tropical grasslands of Australia (DEC, 2007). This species has been recorded from Broome in 2005 (DEC Threatened Species Database, 2007), however is not likely to occur in the Pindan within the study area.

Masked Owl

*Tyto novaehollandiae*

The northern subspecies of the Masked Owl is listed as Priority 1 by the DEC. This subspecies occurs in dense forest and woodland across northern Australia. Since the study area lies outside the core range and lacks suitable habitat for this species, the Masked Owl is unlikely to occur in the Project Area.

Conservation Significance Level 3

Letter-winged Kite

*Elanus scriptus*

Grey Goshawk

*Accipiter novaehollandiae*

Yellow Chat

*Ephthianura crocea*

The above species have scattered distributions and have been recorded from the Broome region (Grey Goshawk from Roebuck, Yellow Chat from Broome Bird Observatory and Letter-winged Kite from Broome). However these species do not typically occur in Pindan vegetation and are unlikely to depend on habitat within the study area.



**Plate 1:** Hundreds of waders recorded in a roost along the coastline Roebuck Bay



**Plate 2.** Terek Sandpiper (with yellow leg band) on coastline adjacent to the Port.



**Plate 3.** Mixed wader flocks along Roebuck Bay.



**Plate 4.** Mixed Wader Flock

#### 4.2.5 Mammals

A total of 37 mammal species may occur in the study area, including 35 native and four introduced species (see Table 5). Five native mammal species were recorded from within the Project Area. These were:

1. Northern Brushtail Possum (*Trichosurus arnhemensis*)
2. Agile Wallaby (*Macropus agilis*)
3. Black Flying-fox (*Pteropus alecto*)
4. Northern Freetail Bat (*Chaerephon jobensis*)
5. Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*)

The Black Flying-fox (*Pteropus alecto*) and Agile Wallaby (*Macropus agilis*) were both observed within Pindan vegetation during spotlighting. Scats attributable to the Northern Brush-tailed Possum (*Trichosurus arnhemensis*) were recorded on a number of occasions both within the Project Area and adjacent areas (see Plate 5, Table C). Possum scats were recorded mostly under Fig trees, below large hollows within Figs or on Fig branches.



Plate 5. Brush-tailed Possum scats collected from the Project Area.



Plate 6. Hollow within Fig Tree.

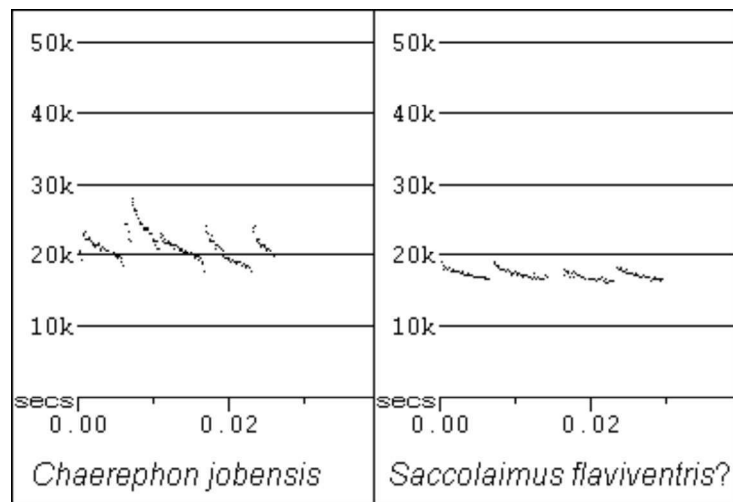
**Table C.** Possum records and significant hollows within the Project Area

Record	Easting	Northing	Comments
Possum Scats	414801.1	8010895	Scat pile
Possum Scats	414974.4	8010403	Scat pile
Possum Scats	415287	8011160	Scat pile
Possum Scats	415588.3	8010433	Scat pile
Possum Scats	414816.6	8011389	Scat pile
Tree Hollow	415103.4	8010756	Scat pile
Tree Hollow	415069.9	8010746	Fig Hollow
Tree Hollow	415454.3	8010411	Fig Hollow
Tree Hollow	415482.5	8010416	Fig Hollow
Tree Hollow	415588.3	8010433	Fig Hollow
Tree Hollow	414754.5	8011457	Fig Hollow
Tree Hollow	415018.9	8010706	Fig Hollow

Note Table B lists records obtained opportunistically, and does not include all tree hollows contained within the Project Area.

Two bat species, the Northern Freetail Bat and the Yellow-bellied Sheathail Bat were recorded using the ANABAT Bat detector. Only a small number of calls were recorded using the ANABAT of which two sequences were sufficient length and quality for analysis. The details of the ANABAT analysis are listed below:

Species Name	Fmax (kHz)	Fmin (kHz)	DUR (ms)
Northern Freetail Bat <i>Chaerephon jobensis</i>	23.3 (±3.5)	21.6 (±2.3)	6.8 (±2.6)
Yellow-bellied Sheathail Bat <i>Saccolaimus flaviventris</i>	18.6 (±0.7)	16.3 (±0.2)	11.2 (±0.9)





Ten mammal species of conservation significant have been recorded from the Broome region. These species are discussed below. A total of seven conservation significant mammal species may occur within the Project Area or have a home range that includes the study area.

#### Conservation Significance Level 1

##### **Bilby**

##### *Macrotis lagotis*

The Bilby is listed as Vulnerable by Maxwell *et al.* (1996) and the relevant state and commonwealth acts. The species formerly utilised a wide range of habitat types across the continent. Extant populations are restricted to a variety of “tall shrublands, open woodlands, hummock grasslands and sparse forblands” (Maxwell *et al.*, 1996). Threats to the species include altered fire regimes, introduced grazers and predators. The species appears to remain widespread in the Great Sandy Desert (M. Bamford pers. obs.) and scattered populations occur across the northern Pilbara, including close to Port Hedland. In the Great Sandy Desert, the species appears most common in acacia shrublands associated with paleo-drainage lines, where the soils are sandy loams.

There have been a number of recent sightings of Bilbies near Broome including records from Roebuck (25km east of Broome) in 1998 (DEC Threatened Fauna Database, 2009). Observations made by staff of the Broome Bird Observatory have been in Pindan, however this species is unlikely to occur on site due to the proximity to disturbances and feral predators. No sign of this species was recorded during the field survey. There is a low potential that this species could be a rare visitor to the site.

##### **Northern Marsupial Mole**

##### *Notoryctes caurinus*

The Northern Marsupial Mole is listed as Endangered under the *EPBC Act* and *WA Wildlife Conservation Act*. This blind marsupial lives mostly underground in sand dunes, interdune flats and sandy soils along river flats. It occasionally comes to the surface, apparently more frequently after rain (Maxwell *et al.* 1996). The Northern Marsupial Mole has been collected from six localities in the Gibson and Great Sandy Deserts. However this species is poorly known with very few recent records. The Project Area lies outside the known range for this species with the closest records coming from the Great Sandy Desert.

##### **Golden Bandicoot**

##### *Isodon auratus auratus*

The Golden Bandicoot (*Isodon auratus auratus*) formerly occurred in the Broome area. This species persists has undergone a large range reduction and has not been recorded near Broome since 1895 (Department of Environment and Conservation Threatened Fauna Database, 2008). The Golden Bandicoot persists in small, fragmented populations on the Dampier Peninsula. This species is unlikely to occur within the Project Area. No signs of bandicoots were observed from the Project Area.

The Golden-backed Tree-rat (*Mesembriomys macrurus*, CS1) formerly occurred across much of northern Australia, including the Dampier Peninsula (recorded from Waterbank in 1895). This species previously inhabited hollows within Eucalypt-acacia woodland on red sandy plains (Strahan, 1995). In Western Australia the Golden-backed Tree-rat is now confined to near-coastal areas in the north-western



Kimberley. The south-western Kimberley population, which includes Dampierland, is now considered extinct (Strahan, 1995).

#### Conservation Significance Level 2

Spectacled Hare-Wallaby (mainland subsp)     *Lagorchestes conspicillatus leichardtii*

The Spectacled Hare-Wallaby (mainland subsp.) is listed as Priority 3 by the DEC and Lower Risk (near threatened) by Maxwell *et al.* (1996). Within Western Australia, this species is now restricted to a few small isolated patches in the Pilbara and Kimberley. It inhabits tropical grasslands and long unburnt Spinifex. Threats to the species may include those that alter habitat, such as altered fire regimes and introduced grazers e.g. cattle and rabbits; and introduced predators e.g. foxes and feral cats (Maxwell *et al.* 1996). It can also be vulnerable to roadkill and also suffers from the impacts of frequent fires. The Spectacled Hare-Wallaby has been recorded near Broome with two records from the Roebuck Plains in 2004 (DEC Threatened Species Database, 2009). The Project Area probably lacks suitable dense grassland for the species.

Kerakenga/Lakeland Downs Mouse     *Leggadina lakedownensis*

The Lakeland Downs Mouse is classified as Priority 4 by the DEC. Populations of the Lakeland Downs Mouse appear to fluctuate dramatically, probably in response to environmental conditions and food availability. This species is known to occur on sandy soils and cracking clays in Western Australia, and tropical tussock grasslands or woodlands in Queensland (DEC, 2009). The study area lies within the current range of *Leggadina lakedownensis* however due to a lack of suitable habitat this species is unlikely to occur within the Project Area.

Scaly-tailed Possum     *Wyulda squamicaudata*

The Scaly-tailed Possum is listed as Priority 3 by the DEC. This species is patchily distributed in the coastal north-west Kimberley in low open woodland, riparian forest, and vine thicket (Menkhorst and Knight, 2004). The Scaly-tailed Possum formerly occurred in the region however currently appears to be confined to the coastal Kimberley, including Prince Regent River Reserve, Mitchell Plateau, Kalumburu, Bigge Island and Boongaree Island (Menkhorst and Knight, 2004). There are two records from the Broome area in 1970 (DEC, 2009). However, the Project Area lies outside the current recognised distribution of the Scaly-tailed Possum.

Water Rat     *Hydromys chrysogaster*

The Water Rat is listed as Priority 4 by DEC and is found in Australia, New Guinea, and a number of adjacent islands. In Western Australia, isolated populations occur in south-west, and on a number of offshore islands, including Barrow, Bernier, and Dorre Islands (Olsen 1983). The Water-rat generally occupies habitat in the vicinity of permanent water (fresh or brackish), although it can also be found in marine environments, including mangroves and occurs along the Pilbara coastline (DEC, 2008). Substantial declines have been noted in south-western Western Australia and along inland waterways affected by salinity and degradation (DEC, 2008). The Water

Rat has been recorded from the Broome area (DEC, 2009) however is unlikely to occur within the proposed Project Area due to a lack of suitable habitat.

#### Conservation Significance Level 3

Northern Brush-tailed Possum	<i>Trichosurus vulpecula arnhemensis</i>
Northern Pipistrelle	<i>Pipistrellus westralis</i>
Northern Blossom Bat	<i>Macroglossus minimus</i>

The northern Pipistrelle has a scattered distribution along the north-coast of Australia. The Northern Pipistrelle occurs primarily within mangroves however in the south-western Kimberley (Dampier Peninsula) this species also occurs in Pindan vegetation (Strahan, 1995). This species may occur within the study area.

The Northern Brush-tailed Possum has a scattered distribution across the north of Western Australia (Kimberley) and the Northern Territory. Its distribution includes Pindan vegetation on the Dampier Peninsula. In Western Australia, the Brush-tailed Possum has declined over much of its range, especially in arid and semi-arid areas (Strahan, 1995). This species was recorded from the Project Area.

The Northern Blossom Bat is considered locally common in rainforest, tropical riverine woodland and mangroves across northern Australia (Menkhorst and Knight, 2004). This species roosts in trees under large leaves in dense cover, under loose bark or in the entrance of large hollows. Broome lies at the western extremity of this species range. This species may occur within the study area.

#### 4.2.6 Listed conservation significance and short-range endemic invertebrates

Invertebrates in general are beyond the scope of environmental impact assessment because there are so many species and their taxonomy is so poorly understood, but it is possible to focus on a small range of taxa that are short-range endemics, and those species that are of listed conservation significance. Harvey (2002) notes that the majority of invertebrate species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Schizomida (schizomids; spider-like arachnids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish).

The Broome Peninsula area contains some habitat suitable to support short-range endemic species. Such habitat includes monsoon thickets, rocky outcrops and rock crevices, and areas within depressions where moisture is concentrated. However the proposed Project Area comprises Pindan vegetation, a habitat not known to promote short-range endemism.

Conservation of short-range endemic invertebrates may be achieved by protecting habitat with little knowledge of the species present. Disturbances to vine thickets, coastal dunes and rocky outcrops should be avoided.

## **5. IMPACT ASSESSMENT**

The Broome Port Authority proposes to clear approximately 54 ha (inclusive of roads) of vegetation within the Project Area. An additional 8 hectares may be cleared by the Yawuru Native Title Holders (RNTBC) Aboriginal Corporation (or its nominated entity) for related purposes. The Project Area is situated between the Port Drive and Kavite Road and comprises mostly Pindan vegetation (Pindan 1, FCT4, see Figure 1).

Development of the Project Area can potentially adversely impact upon fauna in a number of ways. For example:

- Death/injury of fauna during clearing, grading and impacts with vehicles/machinery;
- Loss of habitat (clearing);
- Fragmentation of habitat;
- Obstructions (e.g. pipes on ground, roads) to the movements of terrestrial fauna;
- Impacts to surface and groundwater flows (through vegetation clearing)
- Introduction of permanent water storages;
- Disturbance of fauna in nearby areas from light, noise;
- Changes in the abundance of feral species;
- Direct and indirect impacts of dust.

The DEC has also highlighted several key issues relevant to the environmental management and environmental impact assessment of local fauna populations on the Broome Peninsula (Coffey Natural Systems, 2009). These include:

1. Disturbances to hollow-bearing trees - a significant habitat for fauna in the region. Such habitat provides value for hollow roosting species such as bats, some birds, pythons and arboreal mammals
2. Loss of habitat supporting conservation significant species, particularly the Peregrine Falcon and Bush Stone-Curlew
3. Removal of vegetation and habitat connectivity, reduction of faunal dispersal capabilities and impendence to fauna movement across the Peninsula
4. Edge effects and degradation of remaining vegetated fragments and faunal habitats.

Some impacts upon fauna are unavoidable. Of concern are long-term, deleterious impacts upon biodiversity. These are discussed below under the following categories:

- Habitats. Impacts may be significant if the habitat is rare, a large proportion of the habitat is affected and/or the habitat supports significant fauna.
- Significant fauna. Impacts may be significant if species of conservation importance are affected.
- Processes. Ecological processes are complex and can include hydrology, fire, predator/prey relationships and spatial distribution of a population (see discussion below). Impacts upon ecological processes may be significant if large numbers of species or large proportions of populations are affected.

- Patterns of biodiversity. Species are not distributed evenly across the landscape or even within one vegetation/landform type. There may be zones of high biodiversity such as particular habitats or ecotones (transitions between habitats).

### 5.1 Habitat Types

The main habitat types of the Port of Broome area are described in section 4.1 (above). These are:

1. **Pindan Vegetation.** Pindan 1. This is the major habitat type within the Project Area.
2. **Pindan Vegetation.** Pindan 2: This habitat occurs in the northern parts of the survey area.
3. **Thickets and large shrubs of *Ficus aculeata* var. *indecora*.** This habitat is significant as large mature trees and shrubs contain hollows suitable for birds and arboreal mammals ( a significant resource flagged by DEC)..
4. **Monsoon Thickets.** This habitat type occurs outside the Project Area.
5. **Coastal Shrubland on Primary Dunes** This habitat occurs mostly outside the Project Area however intergrades with Pindan 1 on the projects western margins.
6. **Tall Dunes on the eastern margin of the peninsula.** This habitat occurs on the sheltered eastern side of the southern Broome Peninsula outside of the Project Area.
7. **Mangrove communities.** This habitat is limited to patches along the Roebuck Bay shoreline. It does not occur within the Project Area.
8. **Beaches and mud flats.** Occur along the coastline with an extensive area of intertidal mudflats occurring the eastern shoreline of the Broome Peninsula, adjacent to and north of the Broome Port.
9. **Minor Rocky Headlands.** Rocky Headlands occur along the coastline.

The extent and impact on each habitat type can be summarised as follows:

1. Pindan 1 (FCT4):
  - Representation. Widespread in region, this habitat occurs on pindan soil on the southern half of the survey area.
  - Conservation significance. Some significant species may be present. Likely species include: *Lerista separanda*, *Simoselaps minimus*, *Ctenotus colletti*, *Morethia storri*, Bush Stone-curlew and Northern Blossom Bat. *Diporiphora pindan*, Rainbow Bee-eater and the Northern Brushtail Possum were recorded within this habitat. The Bush Stone-curlew has been recorded on site in this habitat (Birds Australia, 2009). This habitat contains some large hollow-bearing trees (particularly within Eucalypt and Fig species), a significant habitat for fauna in the region. Such habitat provides value for hollow roosting species such as bats, some birds, pythons and arboreal mammals (Coffey Natural Systems, 2009)
  - Impact. Most of the Project Area contains this habitat.
  - Significance of impact. Moderate. The clearance of up to 62 ha of vegetation within the Dampierland Bioregion (bioregion group 3) is considered by the EPA to be a “high” impact under the category of size and scale of a proposal

(EPA Guidance Statement 56), but the loss is localised and the habitat is widespread in the region. The habitat may support some species of conservation significance such as the Bush Stone-curlew. Disturbances to large hollow-bearing trees should be avoided, a significant resource flagged by the DEC.

2. Pindan 2 (FCT5):

- Representation. Widespread in region, this habitat occurs on pindan soils north of Gantheaume Point, east of Gantheaume Point in the centre of the survey area and one on the western edge of the survey area.
- Conservation significance. Some significant species may be present. Likely species include: *Diporiphora pindan*, *Ctenotus colletti*, *Morethia storri*, Rainbow Bee-eater, Northern Brushtail Possum, Bush Stone-curlew and Northern Blossom Bat. This habitat contains some large hollow-bearing trees (particularly within Eucalypt, Corymbia and Fig species), a significant fauna resource in the region. Such habitat provides value for hollow roosting and breeding species (such as bats, some birds, pythons and arboreal mammals, Coffey Natural Systems, 2009).
- Impact. FCT5 lies outside the Project Area.
- Significance of impact. Low as small area of habitat expected to be disturbed and habitat is widespread in local area.

3. Thickets and large shrubs of *Ficus aculeata* var. *indecora* (occurs within FCT4 and FCT5).

- Representation. This Fig species occurs in thickets or single shrubs and is scattered throughout the survey area. Large stands occur within the Project Area, particularly in the eastern parts. Scattered areas also occur north of Gantheaume Point, east of Gantheaume Point in the centre of the survey area and a small area within the western vegetated corridor.
- Conservation significance. This habitat is significant as large mature trees and shrubs contain hollows providing roosting, sheltering and breeding opportunities for many birds, bats, pythons and arboreal mammals such as possums. DEC has also flagged tree hollows as a significant habitat in the Broome area (Coffey Natural Systems, 2009). Some significant species are likely to utilise thickets and large shrubs of *Ficus aculeata* var. *indecora* including the Bush Stone-curlew. Within the Project Area numerous Fig stands observed had scat piles of Brush-tail Possums underneath - evidence of their use of this habitat.
- Impact. This habitat will be impacted by the proposed disturbance. Two areas containing Fig thickets are proposed to be disturbed. The retention of stands of Fig trees on the western side of the Project Area is recommended to retain some hollows in the local area.
- Significance of impact. Moderate. Habitat is significant however the retention of some habitat will ensure some tree hollows remain in the local area.

4. Open Woodland of mixed species and monsoon thicket on lower slopes behind dunes and secondary dunes (FCT3 and small areas of FCT1).

- Representation. Scattered along the margins of Dampier Peninsula particularly the western side. On the Broome Peninsula this habitat occurs on

the western coast along Cable Beach. Discontinuous vine thickets occur in depressions and swales between dune ridges. A small area of disturbed vegetation of this habitat type occurs at the very southern tip of the peninsula. Clearing and developmental activities have led to the quality of the vegetation in this area to decline.

- Conservation significance. This habitat equates to DEC TEC (Threatened Ecological Community) 67 Monsoon Vine thickets on coastal sand dunes of Dampier Peninsula. This habitat is classified as Vulnerable. The remnant vine thicket patches of Dampier Peninsula support many species which are at the southern limits of their range and are more often found in rainforest vegetation associated with the wetter parts of northern Australia. Vine thickets provide a significant fauna habitat and many species are restricted to this habitat in the region. Some significant species may be present. Likely species include: *Simoselaps minimus*, *Lerista apoda*, Oriental Cuckoo, Rainbow Bee-eater, Northern Brushtail Possum and Northern Blossom Bat.
  - Impact. This habitat lies outside the Project Area.
  - Significance of impact. None anticipated.
5. Coastal Shrublands on Primary Dunes (FCT1):
- Representation. Widespread in region, this habitat occurs on the crests of foredunes or on the leeward side of the foredune, on the western coastline of the survey area, north of Gantheaume Point along Cable Beach and to the west of Entrance Point along the coastline.
  - Conservation significance. Coastal dunes are a significant and disturbance sensitive habitat in the area. A number of conservation species may be present and some fauna species are likely to be restricted to this habitat type. Coastal dunes also provide habitat to a number of marine species such as turtles and marine birds. Some significant species may be present. *Ctenopus angusticeps* has been recorded in similar habitat in the region. Other conservation significant species include *Lerista separanda* and *Simoselaps minimus*.
  - Impact. This habitat lies outside the Project Area.
  - Significance of impact. None anticipated.
6. Open Woodland of *Corymbia polycarpa* tall secondary dunes (FCT2):
- Representation. This habitat occurs on the sheltered eastern side of the southern Broome Peninsula, on Roebuck Bay.
  - Conservation significance. Some significant species may be present. Likely species include: *Lerista separanda*, *Simoselaps minimus*, *Lerista apoda*, *Morethia storri*, Rainbow Bee-eater, Bush Stone Curlew, Northern Brushtail Possum and Northern Blossom Bat. This habitat may contain some large hollow-bearing trees, a significant fauna resource in the region. Such habitat provides value for hollow roosting species (such as bats, some birds, pythons and arboreal mammals).
  - Impact. This habitat will not be impacted by the proposed disturbance.
  - Significance of impact. None anticipated.
7. Mangrove communities:
- Representation. Scattered in region. Small areas of Mangrove communities occur along the Roebuck Bay shoreline.



- ☐ Conservation significance. Highly significant habitat supporting a fauna assemblage largely restricted to this habitat type including several mangrove bird species. This habitat is also sensitive to disturbance. Numerous conservation significant species are likely to utilise this habitat including the Water Rat, Northern Pipistrelle, Northern Blossom Bat and a large number of migratory bird species listed under the EPBC Act.
  - ☐ Impact. This habitat will not be impacted by the proposed disturbance.
  - ☐ Significance of impact. None anticipated.
8. Beaches and mud flats along the coastline.
- ☐ Representation. Widespread in region, beaches and mudflats fringe the majority of the peninsula and also fringe the majority of the Port of Broome management area.
  - ☐ Conservation significance. Highly significant habitat supporting a fauna assemblage largely restricted to this habitat type. This habitat is also sensitive to disturbance. Numerous conservation significant species are likely to utilise this habitat including the Water Rat, Oriental Pratincole and a large number of migratory bird species listed under the EPBC Act. Many conservation significant migratory wader species have been recorded in this habitat on site including the Common Sandpiper, Ruddy Turnstone, Curlew Sandpiper, Red-necked Stint, Great Knot, Greater Sand Plover, Grey-tailed Tattler, Whimbrel, Little Tern and Common Greenshank.
  - ☐ Impact. This habitat will not be impacted by the proposed disturbance.
  - ☐ Significance of impact. None anticipated.

Minor areas of rocky headlands also lie outside the Project Area.

### Fig Thickets

Fig thickets and tree hollows are a significant and relatively sparse fauna resource in the local area (DEC comments within Coffey Natural Systems, 2009). Aerial imagery shows thickets of *Ficus aculeata* var. *indecora* to have a clumped and localised distribution on the Broome Peninsula. Tree hollows provide breeding, roosting and sheltering opportunities for many local fauna species including parrots, bats, possums and arboreal reptiles such as some pythons and varanids. Conservation significant fauna known to inhabit tree hollows include the locally significant Northern Brush-tailed Possum and Northern Blossom Bat.

A number of fig thickets with tree hollows occur within the Project Area (Table B lists some of the locations). An area on the western side of the Project Area contains several Fig thickets with numerous hollows as well as a smaller area on the eastern side (see Figure 4). Importantly, not all Fig trees contain hollows. Hollows were only observed in old, mature trees.

**Figure 4.** Areas of Pindan with Fig thickets in the Project Area. The green polygons enclose the stands of Fig trees.



The retention of a north-south corridor west of Kavite Rd is proposed to retain some of the fauna values of the site and to sustain some movement of fauna and genetic flow along the Broome Peninsula. It is recommended that some areas of Fig trees be included in this corridor to retain some tree hollows in the local area, if possible.

## 5.2 Significant species

The desktop review found that 88 significant fauna species expected to occur within the Survey Area. Conservation significant fauna in the region includes three Frog, six reptile, 69 bird and 10 mammal species. However, some species are likely to be infrequent visitors to the site and many of these species are unlikely to be present in habitats found within the Project Area. For example, the majority of these species are conservation significant migratory waterbirds.

Forty three species listed as migratory or marine under the EPBC Act (CS1) have been recorded along the Broome Port shoreline near the proposed project. The Broome area is recognised internationally as an important area for many of these bird species. These populations are supported by the large intertidal mud flats of Roebuck Bay including in the Broome Port area.

Despite these records, the occurrence of migratory, marine and coastal species within the Project Area is likely to be minimal, with these species unlikely to be dependent on habitats occurring within the proposed Project Area. Occasional sandpipers and terns were observed flying over the Project Area during the site inspection. Indirect impacts on wader populations may arise during the construction of the project through elevated noise, dust and lighting and elevated number of people visiting and utilising the local area. Increased human activity within Roebuck Bay is a concern for the long-term viability of wader populations in the local area.

Conservation significant species expected to occur in the local area are listed in Table 5 and impacts anticipated to arise from the proposed project discussed in Table 6. Of the conservation significant species expected, 15 were recorded in the Project Area or are considered likely to utilise habitat within the Project Area. These are:

- Peregrine Falcon (CS1: recorded in survey area)
- Fork-tailed Swift (CS1, recorded in survey area)
- Rainbow Bee-eater (CS1, recorded in Project Area)
- Bush Stone-curlew (CS2, recorded at Project Area)
- Barn Swallow (CS1, recorded at project)
- Northern Brush-tailed Possum (CS3, recorded at project)
- Northern Pipistrelle (CS3, likely, suitable habitat)
- Northern Blossom Bat (CS3, likely, suitable habitat)
- *Ctenotus angusticeps* (CS1, recorded in region)
- *Lerista separanda* (CS2, recorded 1km from project)
- *Simoselaps minimus* (CS2, recorded 1km from project)
- *Diporiphora pindan* (CS3, recorded at project)
- *Ctenotus colletti* (CS3, potential to occur, recorded in region)
- *Lerista apoda* (CS3, suitable habitat present)
- *Morethia storri* (CS3, suitable habitat present)

An additional five species have the potential to be rare visitors to the Project Area. However these species are not expected to be dependent on habitat within the Project Area. These are

- Oriental Cuckoo (CS1, recorded in greater region)
- Grey Falcon (CS1, recorded in greater region)
- Letter-winged Kite (CS3, rare nomad to Broome area)
- White throated Needletail (CS1, recorded in greater region)
- Bilby (CS1, some records near Broome)

These species are briefly described above (Sections 4.2), listed in Table 5 and impacts are summarised in Table 6.

Impacts on all significant species except the Northern Brush-tail Possum are expected to be low because of the small size of the proposed project and the availability of similar habitat outside the impact zone. The Project Area is likely to form only a component of the foraging range of the Peregrine Falcon, Rainbow Bee-eater, Northern Pipistrelle, Fork-tailed Swift and Barn Swallow. Disturbances to breeding habitat of these species within the Project Area are unlikely, although the Rainbow Bee-eater may nest within the Project Area. The Northern Blossom Bat may utilise tree hollows within the Project Area. Additionally, more sedentary species, such as the Bush Stone-curlew, *Lerista separanda*, *Diporiphora pindan*, *Ctenopus colletti*, *Lerista apoda*, *Morethia storri* and *Simoselaps minimus*, are likely to reside within the Project Area.

The potential impact on the Brush-tail Possum is considered to be higher than for other significant species because it is sedentary, is a large mammal that is likely to be present in only small numbers, and it is vulnerable to a number of impacting processes such as loss of shelter sites, predation by feral species and roadkill.

The proposed development may impact on these species and species that are not considered to be of conservation significance in several ways:

- Increased road-kill of slow-moving or ground dwelling species e.g. pythons;
- Loss of habitat;
- Increasing the number of introduced predators e.g. feral cats and foxes; and
- Altering the local fire regime.
- Alteration of local hydrology
- Disturbance or loss of breeding sites

To minimise these potential impacts, a number of recommendations are made (see Recommendations).

### *Ecological processes*

Many of the potential impacts of proposed developments upon fauna can be related to ecological processes, and this is recognised under the EPBC Act, in which threatening processes are listed, and in the literature (see **Appendix 2**). A number of ecological processes can be related to the impacts upon fauna of the project, and these are discussed below.

#### 5.3.1 Increased mortality

Direct mortality of common species during clearing is unavoidable but can be minimised (see below). Direct mortality of rare species, and ongoing mortality such as due to roadkill, may have a significant impact. Fragmentation of habitat can severely affect wildlife and lead to mortality through collision with vehicles (Jackson and Griffen 2000; Scheik and Jones 1999; Clevenger and Waltho 2000). Dufty (1989) suggested that the greatest cause of adult mortality in populations of Eastern Barred Bandicoots (*Perameles gunni*) was due to collisions with vehicles. Jones (2000) documented the sudden decline in a population of Eastern Quolls (*Dasyurus viverrinus*) and Tasmanian Devils (*Sarcophilus harrisii*) directly attributed to increased road mortality following the upgrade of a local road. Direct and ongoing mortality (in particular from road collisions) may be a concern for the viability of species that occur at low population densities in areas adjacent to the lease area. This could be a concern, for example, for the Bush Stone-curlew.

#### 5.3.2 Loss of habitat affecting population survival

Some loss of habitat is inevitable but can be minimised through controls during clearing. Rehabilitation of disturbed areas may also be implemented. The small area of impact in relation to the surrounding landscape means that loss of habitat is unlikely to have short-term adverse impacts upon fauna populations in the region. However, ongoing vegetation clearing in the Broome Port area is a concern. Approximately 30 ha have been approved for clearing adjacent to the proposed project resulting in over 80 hectares of native vegetation loss in the local area. Other areas adjacent to the Port have been cleared in recent years. These successive clearing events result in the cumulative loss and increasing fragmentation of habitat along the Broome Peninsula, and the proposal represents further loss.

The DEC has identified habitat fragmentation as a concern for fauna conservation on the Broome Peninsula. The retention of native vegetation in areas assigned for conservation will retain some of the fauna values of the local area, particularly if the conservation areas contain significant fauna habitats (eg. monsoon thickets). If further areas are planned to be cleared then long-term planning should consider the careful placement of environmental corridors and conservation reserves to maximise the fauna values of the local area. In the future, intensive fauna studies may be valuable to identify the fauna values of conservation areas and the effectiveness of fauna corridors, and to enhance the knowledge of the local terrestrial fauna.

The Broome Peninsula appears to have been relatively under surveyed considering the level of disturbance in the local area, with few terrestrial fauna records for the region on NatureMap (DEC, 2009). Due to the size and scale of the project, an extended Level 1 Fauna Assessment was commissioned by Coffey Natural Systems. A Level 1 survey provides basic fauna information for environmental impact assessment.

Further fauna studies should be considered if additional vegetation clearance is planned and to monitor fauna populations in adjacent areas.

#### 5.3.3 Loss of habitat affecting population movements and gene flow

The Project Area forms part of a continuous strip of native vegetation extending north-south along the western side of the Broome Peninsula. This area of intact vegetation allows for the movement of fauna, and is likely to facilitate population movements and genetic flow. A continuous corridor of vegetation along the Broome Peninsula is likely to be important for local fauna, particularly by allowing for genetic exchange in more sedentary species.

The proposed clearing of up to 62 ha of Pindan vegetation extends approximately 700m east – west across the Broome Peninsula. In this area, the Broome Peninsula is narrow (approximately 1.5km east – west) and contains numerous cleared or developed areas associated with the Port and industry.

The DEC has identified habitat fragmentation as a concern for fauna conservation on the Broome Peninsula. The proposed project will result in habitat loss and there reduce habitat connectivity, reduce fauna dispersal capabilities and create and impedance to fauna movement. This impact can however be reduced by the retention of vegetated corridors allowing for fauna movement. The Port of Broome has suggested a western vegetated corridor will remain along the western margins of the Project Area.

To minimise habitat loss and fragmentation and sustain the movement of some fauna along the peninsula it is recommended that the western margin of the Project Area be retained. The retention of a corridor of vegetation extending north –south through the proposed Project Area should be considered. This should occur parallel to and east of Kavite Rd and be wide enough to include some stands of Figs to preserve some hollows – a significant habitat in the area. This will also enhance and buffer the significant coastline vegetation which includes monsoon thickets (a TEC) on the western edge of the Broome Peninsula.

A narrow strip of intact native vegetation occurs along the coastline in the vicinity of the proposed project (west of Kavite Rd). This narrow strip may be susceptible to degradation and edge effects. The retention of vegetation on the eastern side of Kavite Rd (within the Project Area) will increase the size and width of this environmental corridor (which in turn is likely to increase the corridor's capacity for fauna movement and genetic flow) and will also enhance and buffer habitat along the coastline.

A number of significant habitats occur in adjacent areas. Habitats such as the mangrove communities, coastal mud flats, beaches and vine thicket are recognised as significant fauna habitat in the region, supporting numerous species of conservation significance. Some of these habitats fall within the proposed Environmental Corridor as part of the Port of Broome's environmental management plan.

#### 5.3.4 Species interactions, including predators and other feral species

Introduced species, including the Feral Cat and Fox, may have adverse impacts upon native species. In particular, several mammal species expected in the area are sensitive to predation by Cats and Foxes. The Feral Cat is present in the area and the Fox has spread to the northern edge of the Great Sandy Desert in recent years, including Dampier Downs Station (M. Bamford pers. obs). Both can increase in abundance around industrial areas due either to the inadvertent increase in food supply from scraps and increases in the abundance of rodents, or to deliberate feeding by personnel. The Cane Toad may potentially colonise the region in the next 10 years and poses a threat to several species.

#### 5.3.5 Hydroecology

Interruptions of hydroecological processes can have massive effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Roads may alter both surface and sub-surface hydrology. However, hydroecological impacts from the proposed expansion are likely to be minimal, mainly because of the small scale of the project within the surrounding landscape.

#### 5.3.6 Climate change

As a result of human-induced climate change, the climatic ‘envelope’ (the climatic zone within which a species exists, Soule *et al.* 2004) of many species will physically shift or even cease to exist. Some species may not be able to keep pace with the geographical movement (or disappearance) of their climatic envelope. Conversely, climate change may exacerbate the spread of other species or disease into areas where they currently do not occur. Loss of coastal habitats due to sea level rise may need to be considered, especially as this may affect proposed conservation areas west of Kavite Road.

#### 5.3.7 Fire

Fire is a natural feature of the environment on the Dampier Peninsula, but frequent, extensive fires may adversely impact some fauna, particularly mammals. Fire Management strategies may be implemented as part of management of the Project Area to protect long-unburnt habitats that may be important for fauna.

#### 5.3.8 Light, noise and disturbance

Impacts of light and noise upon fauna are difficult to predict. As such, it is best to take a precautionary approach. The death of very large numbers of insects has been reported around some remote minesites and attracts other fauna (including introduced predators), as well as presumably reducing the populations of insects in surrounding habitats. These factors may need to be considered in the local area. The impact of disturbance is also hard to gauge, but this may be an important consideration because of roosting of migratory waterbirds along Roebuck Bay just east of the Project Area. Roosting waterbirds are sensitive to disturbance, such as from people walking along the beach, and there may be an increase in this sort of disturbance as a result of the project.



## 6. MANAGEMENT AND MONITORING RECOMMENDATIONS

Impacts upon fauna due to the construction and operation of the Project that are of particular concern relate to loss and fragmentation of habitat, and increased disturbance. Also of concern are, potential impacts from roadkill, and changes in hydrology, the fire regime and the abundance of introduced predators. Recommendations to minimise potential impacts are discussed below.

### **Recommendation 1:**

Limit loss of habitat by minimising clearing of native vegetation. This includes the regrowth areas which may contribute to fauna habitat. Also, prevent degradation of vegetation surrounding study areas by increasing the awareness of personnel and restricting access to areas of adjacent vegetation.

#### **Reason:**

Retain as much habitat as possible, in the best condition possible. This will help retain the fauna values already present at the site and facilitate rehabilitation.

### **Recommendation 2:**

Retain a corridor of vegetation extending north – south through the Project Area. This should occur parallel to and east of Kavite Rd and be wide enough to include some stands of Figs to preserve some hollows – a significant habitat in the area.

#### **Reason:**

The removal of vegetation and habitat connectivity, reduction of faunal dispersal capabilities and impendence to fauna movement across the Peninsula are key issues raised by the DEC in relation to environmental impact assessment. , The retention of vegetation along the western side of the proposed project will retain some habitat connectivity along the peninsula and maintain some faunal dispersal capabilities. . This will also enhance and buffer the significant coastline vegetation which includes monsoon thickets (a TEC) on the western edge of the Broome Peninsula. The exact size and location of a western vegetated corridor should be determined in consultation with DEC.

### **Recommendation 3:**

Consider Environmental Corridors and significant fauna habitats in the long-term planning of the Port's development.

#### **Reason:**

A number of significant fauna habitats occur in the local area, including intertidal mudflats, mangroves, coastal dunes and monsoon thickets. The preservation and management of these areas should be considered by the Port of Broome.

### **Recommendation 4:**

Large hollow bearing trees should be retained. Fig thickets should be included within any areas set aside for conservation.

#### **Reason:**

The clearance of such habitat should be avoided as hollows provides habitat to many species such as bats, some birds, pythons and arboreal mammals.

**Recommendation 5:**

Feral fauna, particularly Cats (and Foxes if they become established around Broome), should not be encouraged. Feral animal control strategies should be implemented where necessary.

**Reason:**

Cats and Foxes are significant predators of native wildlife.

**Recommendation 6:**

Although hydrological impacts are considered unlikely, any effects on groundwater or surface hydrology should be minimised.

**Reason:**

Hydrological changes can have far-reaching consequences on surrounding ecosystems.

**Recommendation 7:**

Conduct fauna monitoring as part of ongoing management of the port area..

**Reason:**

A number of conservation significant species may occur in the area. By increasing the knowledge of fauna in the area local (including within areas set aside for conservation) biodiversity and habitat values can be better managed. Additionally a fauna survey of the Environmental Corridor may assist in future management practices.

## 7. CONCLUSIONS

- A total of 385 native vertebrate fauna species may occur on the Broome Peninsula or utilise a home range that includes the Broome Peninsula, based on distribution and possible habitat types.
- Fifteen conservation significant species are likely to occur in the study area or utilise a home range that includes the study area. These include: 5 CS1 species (Rainbow Bee-eater, Fork-tailed Swift, Peregrine Falcon, Barn Swallow, *Ctenotus angusticeps*), 3 CS2 species (*Lerista separanda*, *Simoselaps minimus*, Bush Stone-curlew) and 7 CS3 species (*Ctenotus colletti*, *Diporiphora pindan*, *Lerista apoda*, *Morethia storri*, Northern Brushtail Possum, Northern Pipistrelle, Northern Blossom Bat).
- The Bush Stone-curlew, Rainbow Bee-eater, Barn Swallow, Peregrine Falcon and Fork-tailed Swift have been recorded within the vicinity of the Project Area.
- A number of conservation significant migratory waterbirds have been recorded from the beaches and mudflats within the Port of Broome area.
- Large, hollow bearing trees (Figs and *Corymbia* sp.) are present within the Project Area. The loss of these trees should be avoided if possible. Hollows provides habitat to many species such as bats, some birds, pythons and arboreal mammals.
- The establishment of an environmental corridor within the proposed project is recommended to minimise the impacts on local fauna.
- A fauna survey of the Environmental Corridor may assist in future management practises.

Impacts are summarised in accordance with EPA Guidance in Table 6.

**TABLE 1. Frogs Expected in the Broome area.** Expected occurrence is primarily based on known species distributions and available habitats. Levels of Conservation Significance are discussed in the “Assessment of Conservation Significance” section. Species recorded during the site inspection are listed (x) as well as species recorded on site by databases, literature or by personnel communication (R).

<b>FROGS</b>	<b>Conservation Significance</b>	<b>Survey Area 2009</b>
<b>Hylidae (tree-frogs)</b>		
Giant Frog <i>Cyclorana australis</i>		
Long-footed Frog <i>Cyclorana longipes</i>		
Green Tree Frog <i>Litoria caerulea</i>		X
Rocket Frog <i>Litoria nasuta</i>		
Desert Tree Frog <i>Litoria rubella</i>		
Roth’s Tree Frog <i>Litoria rothi</i>		
<b>Myobatrachidae (ground-frogs)</b>		
Ornate Frog <i>Limnodynastes ornatus</i>		
Desert Spadefoot <i>Notaden nichollsi</i>		
Derby Toadlet <i>Uperoleia aspera</i>	CS3*	
Mjoberg’s Toadlet <i>Uperoleia mjobergi</i>	CS3*	
Mole Toadlet <i>Uperoleia talpa</i>	CS3*	
<b>Total Number of Species Expected</b>	<b>11</b>	<b>1</b>

\* Restricted to bioregion

**TABLE 2. Reptiles Expected in the Broome area.** Expected occurrence is primarily based on known species distributions and available habitats. Levels of Conservation Significance are discussed in the “Assessment of Conservation Significance” section. Species recorded during the site inspection are indicated (X). Species previously recorded on-site by NatureMap, personal communication or literature are also indicated (R).

<b>Reptiles</b>				
<b>Common Name</b>	<b>Species Name</b>	<b>Conservation Significance</b>	<b>2009 Survey</b>	<b>Previous Records</b>
<b>Gekkonidae</b> (geckoes)				
Fat-tailed Gecko	<i>Diplodactylus conspicillatus</i>			
	<i>Diplodactylus stenodactylus</i>			
Northern Dtella	<i>Gehyra australis</i>		X	
	<i>Gehyra nana</i>			
Pilbara Dtella	<i>Gehyra pilbara</i>			
	<i>Gehyra purpurascens</i>			
Tree Dtella	<i>Gehyra variegata</i>			
Asian House Gecko	<i>Hemidactylus frenatus</i>	Introduced	X	
Bynoe’s Gecko	<i>Heteronotia binoei</i>			
	<i>Oedura rhombifera</i>			
Beaked Gecko	<i>Rhynchoedura ornata</i>			
	<i>Strophurus ciliaris aberrans</i>			
	<i>Strophurus jeanae</i>			
<b>Pygopodidae</b> (legless-lizards)				
	<i>Delma tincta</i>			
Burton’s Legless Lizard	<i>Lialis burtonis</i>			R
<b>Agamidae</b> (dragon lizards)				
Gilbert’s Dragon	<i>Amphibolurus gilberti</i>		X	
Long-nosed Dragon	<i>Amphibolurus longirostris</i>			
Chameleon Dragon	<i>Chelosania brunnea</i>			
Friiled Lizard	<i>Chlamydosaurus kingii</i>			R
Ring-tailed Dragon	<i>Ctenophorus caudicinctus</i>			
Military Dragon	<i>Ctenophorus isolepis</i>			
Central Netted Dragon	<i>Ctenophorus nuchalis</i>			
Pindan Dragon	<i>Diporiphora pindan</i>	CS3: restricted	X	
	<i>Diporiphora winneckeii</i>			
Dwarf Bearded Dragon	<i>Pogona minor mitchelli</i>			
<b>Varanidae</b> (goannas or monitor lizards)				
Ridge-tailed Monitor	<i>Varanus acanthurus</i>			
	<i>Varanus breviceauda</i>			
Pygmy Mulga-monitor	<i>Varanus gilleni</i>			
Sand Goanna	<i>Varanus gouldii</i>		X	
	<i>Varanus panoptes panoptes</i>			
Spotted Tree Monitor	<i>Varanus scalaris</i>			
	<i>Varanus tristis tristis</i>		X	
<b>Scincidae</b> (skink lizards)				
	<i>Carlia munda</i>			
	<i>Carlia rufilatus</i>			

<b>Reptiles</b>				
<b>Common Name</b>	<b>Species Name</b>	<b>Conservation Significance</b>	<b>2009 Survey</b>	<b>Previous Records</b>
	<i>Carlia triacantha</i>			
	<i>Cryptoblepharus metallicus</i>			
	<i>Cryptoblepharus ruber</i>		X	
	<i>Cryptoblepharus tythos</i>			
	<i>Ctenotus angusticeps</i>	CS1		
	<i>Ctenotus colletti</i>	CS3: restricted		
	<i>Ctenotus inornatus</i>		X	
	<i>Ctenotus pantherinus ocellifer</i>			
	<i>Ctenotus serventyi</i>			
Broad-Banded Sandswimmer	<i>Eremiascincus richardsonii</i>			
	<i>Glaphyromorphus isolepis</i>		X	
	<i>Lerista apoda</i>	CS3: restricted		
	<i>Lerista bipes</i>			
	<i>Lerista greeri</i>			
	<i>Lerista griffini</i>			
	<i>Lerista labialis</i>			
	<i>Lerista separanda</i>	CS2		R
	<i>Menetia greyii</i>			
	<i>Menetia maini</i>			
	<i>Morethia ruficauda ruficauda</i>			
	<i>Morethia storri</i>	CS3: restricted		
	<i>Notoscincus ornatus wotjulum</i>			
	<i>Proablepharus tenuis</i>			
Centralian Blue-tongue	<i>Tiliqua multifasciata</i>			
Eastern Blue-tongue	<i>Tiliqua scincoides intermedia</i>		X	
<b>Typhlopidae</b> (blind snakes)				
	<i>Ramphotyphlops braminus</i>			
	<i>Ramphotyphlops diversus</i>			
	<i>Ramphotyphlops gryp</i>			
<b>Boidae</b> (pythons)				
Children's Python	<i>Antaresia childreni</i>			
Stimson's Python	<i>Antaresia stimsoni stimsoni</i>			
Black-headed Python	<i>Aspidites melanocephalus</i>			R
Water Python	<i>Liasis mackloti</i>			
Olive Python	<i>Liasis olivaceus olivaceus</i>			
<b>Colubridae</b> (rear-fanged snakes)				
Common Tree Snake	<i>Dendrelaphis punctulata</i>			
White-bellied Mangrove Snake	<i>Fordonia leucobalia</i>			
<b>Elapidae</b> (front-fanged snakes)				
Desert Death Adder	<i>Acanthophis pyrrhus</i>			
	<i>Brachyuropsis roperi</i>			
Half-girdled Snake	<i>Brachyuropsis semifasciatus</i>			
Olive Whip Snake	<i>Demansia olivacea</i>			
Yellow-faced Whip	<i>Demansia psammophis</i>			
	<i>Demansia reticulata</i>			
Moon Snake	<i>Furina ornata</i>			R

Reptiles				
Common Name	Species Name	Conservation Significance	2009 Survey	Previous Records
Mulga Snake	<i>Pseudechis australis</i>			R
Ringed Brown Snake	<i>Pseudonaja modesta</i>			
Western Brown Snake	<i>Pseudonaja nuchalis</i>			
	<i>Simoselaps anomalus</i>			
	<i>Simoselaps minimus</i>	CS2		R
Little Spotted Snake	<i>Suta punctata</i>			
Total Number of Species Expected		82		
Total Number of Species Recorded during Site Inspection: 10				
Total Number of Species Recorded in Survey Area: 17				



**TABLE 3. Birds Expected in the Broome area.** Expected occurrence is primarily based on known species distributions and available habitats. Levels of Conservation Significance are discussed in the “Assessment of Conservation Significance” section. Species recorded during the 2009 site inspection are listed (x) as well as species recorded on site by databases, literature or by personal communication (R). Those species recorded within the proposed area of disturbance are listed under the column “Project Area” with species recorded outside this area listed under “Survey Area”.

<b>Birds</b>				
<b>Common Name</b>	<b>Species Name</b>	<b>Conservation Significance</b>	<b>Project Area</b>	<b>Survey Area</b>
<b>Phasianidae</b> (pheasants and quails)				
Brown Quail	<i>Coturnix ypsilophora</i>			
<b>Anseranatidae</b> (Magpie Goose)				
Magpie Goose	<i>Anseranas semipalmata</i>	EPBC Marine		
<b>Anatidae</b> (ducks and swans)				
Hardhead	<i>Aythya australis</i>			
Plumed Whistling-Duck	<i>Dendrocygna eytoni</i>			X
Wandering Whistling-Duck	<i>Dendrocygna arcuata</i>			X
Freckled Duck	<i>Stictonetta naevosa</i>			
Black Swan	<i>Cygnus atratus</i>			
Radjah Shelduck	<i>Tadorna radjah</i>			
Australian Wood Duck	<i>Chenonetta jubata</i>			
Green Pygmy-goose	<i>Nettapus pulchellus</i>			
Pacific Black Duck	<i>Anas superciliosa</i>			X
Australasian Shoveler	<i>Anas rhynchos</i>			
Grey Teal	<i>Anas gracilis</i>			X
Chestnut Teal	<i>Anas castanea</i>			
Garganey	<i>Anas querquedula</i>			
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>			
<b>Podicipedidae</b> (grebes)				
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>			
Hoary-headed Grebe	<i>Poliocephalus poliocephalus</i>			
Great Crested Grebe	<i>Podiceps cristatus</i>			
<b>Procellariidae</b> (Petrels, Shearwaters, Diving-Petrels)				
Streaked Shearwater	<i>Calonectris leucomelas</i>	EPBC MIG		
Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	EPBC MIG		
Hutton's Shearwater	<i>Puffinus huttoni</i>			
Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>	EPBC MIG		
<b>Sulidae</b> (Gannets, Boobies)				
Masked Booby	<i>Sula dactylatra</i>	EPBC MIG		
Brown Booby	<i>Sula leucogaster</i>	EPBC MIG		X
<b>Fregatidae</b> (Frigatebirds)				
Lesser Frigatebird	<i>Fregata ariel</i>	EPBC MIG		X
<b>Anhinga</b>				
Darter	<i>Anhinga melanogaster</i>			
<b>Phalacrocoracidae</b> (cormorants)				
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>			
Pied Cormorant	<i>Phalacrocorax varius</i>			
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>			
Great Cormorant	<i>Phalacrocorax carbo</i>			
<b>Pelecanidae</b> (pelicans)				
Australian Pelican	<i>Pelecanus conspicillatus</i>			

<b>Ardeidae</b> (herons and egrets)				
White-faced Heron	<i>Egretta novaehollandiae</i>			
Little Egret	<i>Egretta garzetta</i>			
White-necked Heron	<i>Ardea pacifica</i>			
Eastern Reef Egret	<i>Egretta sacra</i>		X	X
Great Egret	<i>Ardea alba</i>	CS1		
Intermediate Egret	<i>Ardea intermedia</i>			
Cattle Egret	<i>Ardea ibis</i>	CS1		
Striated Heron	<i>Butorides striatus</i>			X
Nankeen Night Heron	<i>Nycticorax caledonicus</i>			
<b>Threskiornithidae</b> (ibis and spoonbills)				
Glossy Ibis	<i>Plegadis falcinellus</i>	CS1		
Australian White Ibis	<i>Threskiornis molucca</i>			X
Straw-necked Ibis	<i>Threskiornis spinicollis</i>			
Royal Spoonbill	<i>Platalea regia</i>			
Yellow-billed Spoonbill	<i>Platalea flavipes</i>			
<b>Ciconiidae</b> (storks)				
Black-necked Stork	<i>Ephippiorynchus asiaticus</i>			
<b>Accipitridae</b> (kites, hawks and eagles)				
Eastern Osprey	<i>Pandion cristatus</i>	CS1		X
Black-shouldered Kite	<i>Elanus axillaris</i>		X	
Letter-winged Kite	<i>Elanus scriptus</i>	CS3: nomadic, fewer than 5 records per year		
Square tailed Kite	<i>Lophoictinia isura</i>			
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>			
Black (Fork-tailed) Kite	<i>Milvus migrans</i>			X
Whistling Kite	<i>Haliastur sphenurus</i>			X
Brahminy Kite	<i>Haliastur indus</i>			X
White bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	CS1: EPBC MIG		X
Swamp Harrier	<i>Circus approximans</i>			
Spotted Harrier	<i>Circus assimilis</i>			
Brown Goshawk	<i>Accipiter fasciatus</i>		X	X
Grey Goshawk	<i>Accipiter novaehollandiae</i>	CS3: few records for subregion		
Red Goshawk	<i>Erythroriorchus radiatus</i>	CS1		
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>			
Wedge-tailed Eagle	<i>Aquila audax</i>			
Little Eagle	<i>Hieraaetus morphnoides</i>			
<b>Falconidae</b> (falcons)				
Black Falcon	<i>Falco subniger</i>			
Peregrine Falcon	<i>Falco peregrinus</i>	CS1		
Australian Hobby	<i>Falco longipennis</i>			
Grey Falcon	<i>Falco hypoleucos</i>	CS2		
Brown Falcon	<i>Falco berigora</i>			
Nankeen Kestrel	<i>Falco cenchroides</i>			X
<b>Gruidae</b> (cranes)				
Brolga	<i>Grus rubicunda</i>			
<b>Rallidae</b> (Rails, Crakes)				
Buff-banded Rail	<i>Gallirallus philippensis</i>			
Black-tailed Native-hen	<i>Gallinula ventralis</i>			
<b>Otididae</b> (bustards)				
Australian Bustard	<i>Ardeotis australis</i>	CS2		
<b>Turnicidae</b> (button-quails)				
Little Button-quail	<i>Turnix velox</i>			
Red-backed Button-quail	<i>Turnix maculosa</i>			
Chestnut-backed Button-quail	<i>Turnix castanota magnifica</i>	CS2		

Red-chested Button-quail	<i>Turnix pyrrhotorax</i>			
<b>Scolopacidae</b> (Curlews, Sandpipers, Snipes, Godwits)				
Pin-tailed Snipe	<i>Gallinago stenura</i>	EPBC MIG		
Swinhoe's Snipe	<i>Gallinago megala</i>	EPBC MIG		
Black-tailed Godwit	<i>Limosa limosa</i>	EPBC MIG		X
Bar-tailed Godwit	<i>Limosa lapponica</i>	EPBC MIG		X
Little Curlew	<i>Numenius minutus</i>	EPBC MIG		
Whimbrel	<i>Numenius phaeopus</i>	EPBC MIG		X
Eastern Curlew	<i>Numenius madagascariensis</i>	EPBC MIG		X
Common Redshank	<i>Tringa totanus</i>	EPBC MIG		
Marsh Sandpiper	<i>Tringa stagnatilis</i>	EPBC MIG		
Common Greenshank	<i>Tringa nebularia</i>	EPBC MIG		X
Wood Sandpiper	<i>Tringa glareola</i>	EPBC MIG		
Terek Sandpiper	<i>Xenus cinereus</i>	EPBC MIG		X
Common Sandpiper	<i>Actitis hypoleucos</i>	EPBC MIG	X	X
Grey-tailed Tattler	<i>Heteroscelus brevipes</i>	EPBC MIG		X
Ruddy Turnstone	<i>Arenaria interpres</i>	EPBC MIG		X
Asian Dowitcher	<i>Limnodromus semipalmatus</i>	EPBC MIG		
Great Knot	<i>Calidris tenuirostris</i>	EPBC MIG		X
Red Knot	<i>Calidris canutus</i>	EPBC MIG		
Sanderling	<i>Calidris alba</i>	EPBC MIG		
Red-necked Stint	<i>Calidris ruficollis</i>	EPBC MIG		X
Long-toed Stint	<i>Calidris subminuta</i>	EPBC MIG		
Pectoral Sandpiper	<i>Calidris melanotos</i>	EPBC MIG		
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	EPBC MIG		
Curlew Sandpiper	<i>Calidris ferruginea</i>	EPBC MIG		X
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	EPBC MIG		
Ruff	<i>Philomachus pugnax</i>	EPBC MIG		
<b>Rostratulidae</b> (Painted Snipe)				
Painted Snipe	<i>Rostratula benghalensis</i>	EPBC MIG		
<b>Burhinidae</b> (stone-curlews)				
Bush Stone-curlew	<i>Burhinus grallarius</i>	CS2		
Beach Stone-curlew	<i>Esacus neglectus</i>			
<b>Haematopodidae</b> (Oystercatchers)				
Pied Oystercatcher	<i>Haematopus longirostris</i>			X
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>			
<b>Charadriidae</b> (Lapwings, Plovers, Dotterels)				
Black-winged Stilt	<i>Himantopus himantopus</i>			X
Pacific Golden Plover	<i>Pluvialis fulva</i>	EPBC MIG		X
Grey Plover	<i>Pluvialis squatarola</i>	EPBC MIG		X
Red-capped Plover	<i>Charadrius ruficapillus</i>			X
Lesser Sand Plover	<i>Charadrius mongolus</i>	EPBC MIG		
Greater Sand Plover	<i>Charadrius leschenaultii</i>	EPBC MIG		X
Oriental Plover	<i>Charadrius veredus</i>	EPBC MIG		
Black-fronted Dotterel	<i>Euseyonis melanops</i>			
Red-kneed Dotterel	<i>Erythronyx cinctus</i>			
Masked Lapwing	<i>Vanellus miles</i>			X
<b>Glareolidae</b> (pratincoles)				
Oriental Pratincole	<i>Glareola maldivarum</i>	CS1 EPBC MIG		
Australian Pratincole	<i>Stiltia isabellae</i>			
<b>Laridae</b> (Gulls, Terns)				
Silver Gull	<i>Larus novaehollandiae</i>			X
Gull-billed Tern	<i>Sterna nilotica</i>			X
Caspian Tern	<i>Sterna caspia</i>			
Lesser Crested Tern	<i>Sterna bengalensis</i>			
Crested Tern	<i>Sterna bergii</i>			X
Roseate Tern	<i>Sterna dougallii</i>			

Common Tern	<i>Sterna hirundo</i>	EPBC MIG		
Little Tern	<i>Sterna albifrons</i>	EPBC MIG		
Fairy Tern	<i>Sterna nereis</i>			
Bridled Tern	<i>Sterna anaethetus</i>	EPBC MIG		
Whiskered Tern	<i>Chlidonias hybridus</i>			X
White-winged Tern	<i>Chlidonias leucopterus</i>	EPBC MIG		
Sooty Tern	<i>Sterna fuscata</i>			
Common Noddy	<i>Anous stolidus</i>	EPBC MIG		
<b>Columbidae</b> (pigeons and doves)				
Rock Dove	<i>Columba livia</i>	Introduced		
Flock Bronzewing	<i>Phaps histrionica</i>	CS2		
Peaceful Dove	<i>Geopelia placida</i>		X	X
Diamond Dove	<i>Geopelia cuneata</i>			
Bar-shouldered Dove	<i>Geopelia humeralis</i>		X	X
Common Bronzewing	<i>Phaps chalcoptera</i>			
Crested Pigeon	<i>Ocyphaps lophotes</i>		X	X
Pied Imperial Pigeon	<i>Ducula bicolor</i>			
<b>Cacatuidae</b> (cockatoos)				
Red-tailed Black-Cockatoo	<i>Calyptorhynchus banksii</i>			
Galah	<i>Cacatua roseicapilla</i>			
Little Corella	<i>Cacatua sanguinea</i>			X
<b>Psittacidae</b> (lorikeets and parrots)				
Cockatiel (wiero)	<i>Nymphicus hollandicus</i>			
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>		X	X
Varied Lorikeet	<i>Psitteuteles versicolor</i>			
Red-winged Parrot	<i>Aprosmictus erythropterus</i>		X	X
Budgerigar	<i>Melopsittacus undulatus</i>			
<b>Cuculidae</b> (cuckoos)				
Oriental Cuckoo	<i>Cuculus saturatus</i>	CS1		
Pallid Cuckoo	<i>Cuculus pallidus</i>			
Brush Cuckoo	<i>Cacomantis variolosus</i>			
Black-eared Cuckoo	<i>Chrysococcyx osculans</i>			
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>		X	X
Little Bronze-Cuckoo	<i>Chrysococcyx minutillus</i>			R
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>			
<b>Centropidae</b> (Coucals)				
Pheasant Coucal	<i>Centropus phasianinus</i>		X	X
<b>Strigidae</b> (hawk-owls)				
Southern Boobook Owl	<i>Ninox novaeseelandiae</i>			
Barking Owl	<i>Ninox connivens</i>			R
<b>Tytonidae</b> (barn owls)				
Barn Owl	<i>Tyto alba</i>			
Grass Owl	<i>Tyto capensis</i>			
Masked Owl	<i>Tyto novaehollandiae kimberli</i>	CS2		
<b>Podargidae</b> (frogmouths)				
Tawny Frogmouth	<i>Podargus strigoides</i>		X	X
<b>Aegothelidae</b> (owlet-nightjars)				
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>			
<b>Caprimulgidae</b> (nightjars)				
Spotted Nightjar	<i>Eurostopodus argus</i>			
<b>Apodidae</b> (swifts)				
Fork-tailed Swift	<i>Apus pacificus</i>	CS1		
White-throated Needletail	<i>Hirundapus caudacutus</i>	CS1		

House Swift	<i>Apus affinis</i>			
<b>Halcyonidae</b> (forest kingfishers)				
Blue-winged Kookaburra	<i>Dacelo leachii</i>		X	X
Red-backed Kingfisher	<i>Todiramphus pyrrhopygia</i>			
Sacred Kingfisher	<i>Todiramphus sanctus</i>		X	
<b>Meropidae</b> (bee-eaters)				
Rainbow Bee-eater	<i>Merops ornatus</i>	CS1	X	X
<b>Coraciidae</b> (Rolers)				
Dollarbird	<i>Eurystomus orientalis</i>			X
<b>Climacteridae</b> (treecreepers)				
Black-tailed Treecreeper	<i>Climacteris melanura</i>			
<b>Maluridae</b> (fairy-wrens)				
Variegated Fairy-wren	<i>Malurus lamberti</i>		X	X
Red backed Fairy-wren	<i>Malurus melanocephalus</i>		X	X
<b>Pardalotidae</b> (pardalotes)				
Red-browed Pardalote	<i>Pardalotus rubricatus</i>			
Striated Pardalote	<i>Pardalotus striatus</i>			
<b>Acanthizidae</b> (Gerygones, Thornbills)				
Weebill	<i>Smicrornis brevirostris</i>			
White throated Gerygone	<i>Gerygone olivacea</i>		X	X
Mangrove Gerygone	<i>Gerygone levigaster</i>			
Western Gerygone	<i>Gerygone fusca</i>			
Dusky Gerygone	<i>Gerygone tenebrosa</i>			X
<b>Meliphagidae</b> (honeyeaters)				
Spiny-cheeked Honeyeater	<i>Acanthagenys rufogularis</i>			
Little Friarbird	<i>Philemon citreogularis</i>		X	X
Yellow-throated Miner	<i>Manorina flavigula</i>			
Singing Honeyeater	<i>Lichenostomus virescens</i>		X	X
White-gaped Honeyeater	<i>Lichenostomus unicolor</i>			
Grey-headed Honeyeater	<i>Lichenostomus keartlandi</i>			
Yellow-tinted Honeyeater	<i>Lichenostomus flavescens</i>		X	X
Black-chinned Honeyeater	<i>Melithreptus gularis</i>		X	X
White-throated Honeyeater	<i>Melithreptus albogularis</i>			
Brown Honeyeater	<i>Lichmera indistincta</i>		X	X
Rufous-throated Honeyeater	<i>Conopophila rufogularis</i>			X
Banded Honeyeater	<i>Certhionyx pectoralis</i>			
Red-headed Honeyeater	<i>Myzomela erythrocephala</i>			R
Black Honeyeater	<i>Certhionyx niger</i>			
Pied Honeyeater	<i>Certhionyx variegatus</i>			
Yellow Chat	<i>Ephthianura crocea</i>	CS3: restricted range		
<b>Petroicidae</b> (Australian robins)				
Jacky Winter	<i>Microeca fascians</i>			
Lemon-bellied Flycatcher	<i>Microeca flavigaster</i>			R
Red-capped Robin	<i>Petroica goodenovii</i>			
Hooded Robin	<i>Melanodryas cucullata</i>			
<b>Pomatostomidae</b> (Australian babblers)				
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>		X	X
<b>Neosittidae</b> (sittellas)				
Varied Sittella	<i>Daphoenositta chrysoptera</i>			
<b>Pachycephalidae</b> (whistlers)				
Rufous Whistler	<i>Pachycephala rufiventris</i>		X	X
Mangrove Golden Whistler	<i>Pachycephala melanura</i>			X
White-breasted Whistler	<i>Pachycephala lanioides</i>			R
Grey Shrike-thrush	<i>Colluricincla harmonica</i>		X	X
Crested Bellbird	<i>Oreoica gutturalis</i>			
<b>Dicruridae</b> (flycatchers)				
Broad-billed Flycatcher	<i>Myiagra ruficollis</i>			X

Leaden Flycatcher	<i>Myiagra rubecula</i>			
Restless Flycatcher	<i>Myiagra inquieta</i>			X
Magpie-lark	<i>Grallina cyanoleuca</i>		X	X
Grey Fantail	<i>Rhipidura albiscapa</i>			
Northern Fantail	<i>Rhipidura rufiventris</i>			
Mangrove Grey Fantail	<i>Rhipidura phasiana</i>			R
Willie Wagtail	<i>Rhipidura leucophrys</i>		X	X
<b>Campephagidae</b> (cuckoo-shrikes trillers)				
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>		X	X
White bellied Cuckoo-shrike	<i>Coracina papuensis</i>			
White-winged Triller	<i>Lalage sueurii</i>			
<b>Oriolidae</b> (Orioles)				
Olive backed Oriole	<i>Oriolus sagittatus</i>			
<b>Artamidae</b> (woodswallows, butcherbirds)				
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>			
Masked Woodswallow	<i>Artamus personatus</i>			
White-browed Woodswallow	<i>Artamus superciliosus</i>			
Black-faced Woodswallow	<i>Artamus cinereus</i>		X	
Little Woodswallow	<i>Artamus minor</i>			
Grey Butcherbird	<i>Cracticus torquatus</i>			
Pied Butcherbird	<i>Cracticus nigrogularis</i>		X	X
Australian Magpie	<i>Gymnorhina tibicen</i>			
<b>Corvidae</b> (ravens and crows)				
Little Crow	<i>Corvus bennetti</i>			
Torresian Crow	<i>Corvus orru</i>			X
<b>Ptilonorhynchidae</b> (Bowerbirds)				
Great Bowerbird	<i>Chlamydera nuchalis</i>		X	X
<b>Alaudidae</b> (larks)				
Singing Bushlark	<i>Mirafra javanica</i>			
<b>Motacillidae</b> (pipits, wagtails)				
Richard's Pipit	<i>Anthus novaeseelandiae</i>			
Yellow Wagtail	<i>Motacilla flava</i>	CS1		
<b>Passeridae</b> (finches and allies)				
Zebra Finch	<i>Taeniopygia guttata</i>			X
Double-barred Finch	<i>Taeniopygia bichenovii</i>			
Long-tailed Finch	<i>Poephila acuticauda</i>			
Painted Finch	<i>Emblema pictum</i>			
Chestnut-breasted Mannikin	<i>Lonchura castaneothorax</i>			
Pictorella Mannikin	<i>Heteromunia pectoralis</i>	CS2		
Gouldian Finch	<i>Erythrura gouldiae</i>	CS1		
<b>Dicaeidae</b> (flower-peckers)				
Mistletoebird	<i>Dicaeum hirundinaceum</i>		X	X
<b>Hirundinidae</b> (swallows)				
Barn Swallow	<i>Hirundo rustica</i>	CS1: EPBC MIG		X
Welcome Swallow	<i>Hirundo neoxena</i>			
Red-rumped Swallow	<i>Hirundo daurica</i>			
Tree Martin	<i>Hirundo nigricans</i>		X	X
Fairy Martin	<i>Hirundo ariel</i>			
<b>Sylviidae</b> (Old World warblers)				
Rufous Songlark	<i>Cincloramphus mathewsi</i>			
Brown Songlark	<i>Cincloramphus cruralis</i>			
Golden headed Cisticola	<i>Cisticola exilis</i>			
<b>Zosteropidae</b> (White-eyes)				
Yellow White-eye	<i>Zosterops luteus</i>			
<b>Total recorded during site visit</b>			33	76
<b>Total Number of Species Expected: 255</b>				

**TABLE 4. Mammals Expected in the Broome area.** Expected occurrence is primarily based on known species distributions and available habitats. Levels of Conservation Significance are discussed in the “Assessment of Conservation Significance” section. Introduced mammals are indicated by “Int.” in the Conservation Significance column

MAMMALS	Conservation Status	2009 Survey
<b>Tachyglossidae</b> (echidnas)		
Echidna <i>Tachyglossus aculeatus</i>		
<b>Dasyuridae</b>		
Long-tailed Planigale <i>Planigale ingami</i>		
<b>Peramelidae</b> (bandicoots and bilbies)		
Bilby <i>Macrotis lagotis</i>	CS1	
Golden Bandicoot <i>Isodon auratus auratus</i>	CS1	
<b>Phalangeridae</b> (possums)		
Northern Brush-tailed Possum <i>Trichosurus arnhemensis</i>	CS3: declining species	X
Scaly-tailed Possum <i>Wyulda squamicaudata</i>	CS2 (P3)	
<b>Macropodidae</b> (kangaroos and wallabies)		
Spectacled Hare-wallaby <i>Lagorchestes conspicillatus</i>	CS2	
Red Kangaroo <i>Macropus rufus</i>		
Agile Wallaby <i>Macropus agilis</i>		X
Northern Nailtail Wallaby <i>Onychogalea unguifera</i>		
<b>Pteropodidae</b> (fruit bats or flying-foxes)		
Northern Blossom Bat <i>Macroglossus minimus</i>	CS3: edge of range	
Black Flying-fox <i>Pteropus alecto</i>		X
Little Red Flying-fox <i>Pteropus scapulatus</i>		
<b>Emballonuridae</b> (sheath-tail bats)		
Yellow-bellied Sheath-tail Bat <i>Saccolaimus flaviventris</i>		X
Common Sheath-tail Bat <i>Taphozous georgianus</i>		
<b>Mollosidae</b> (mastiff bats)		
Northern Freetail Bat <i>Chaerophon jobensis</i>		X
Beccari's Freetail Bat <i>Mormopterus beccari</i>		
Mangrove Freetail Bat <i>Mormopterus loriae</i>		
<b>Vespertilionidae</b> (vespertilionid bats)		
Gould's Wattled Bat <i>Chalinolobus gouldii</i>		
Hoary Wattled Bat <i>Chalinolobus nigrogriseus</i>		
Common Bentwing-bat <i>Miniopterus schreibersii orianae</i>		
Northern Long-eared Bat <i>Nyctophilus arnhemensis</i>		
Eastern Long-eared Bat <i>Nyctophilus bifax daedalus</i>		
Lesser Long-eared Bat <i>Nyctophilus geoffroyi</i>		
Northern Pipistrelle <i>Pipistrellus westralis</i>	CS3: habitat limited	
Little Broad-nosed Bat <i>Scotorepens greyii</i>		
Northern Broad-nosed Bat <i>Scotorepens sanborni</i>		
Northern Cave Bat <i>Vespadelus caurinus</i>		
Finlayson's Cave Bat <i>Vespadelus finlaysoni llatus</i>		
<b>Muridae</b> (rodents)		
Lakeland Downs Mouse <i>Leggadina lakedownensis</i>	CS2	
Delicate Mouse <i>Pseudomys delicatulus</i>		
Western Chestnut Mouse <i>Pseudomys nanus</i>		
Water Rat <i>Hydromys chrysogaster</i>	CS2	



MAMMALS	Conservation Status	2009 Survey
<b>INTRODUCED MAMMALS</b>		
House Mouse	<i>Mus musculus</i>	
Black Rat	<i>Rattus rattus</i>	
Feral Cat	<i>Felis catus</i>	X
Dog	<i>Canis lupis</i>	X
<b>Total Number of Native Species Expected: 33</b>		7
<b>Total Number of Introduced Species Expected: 4</b>		

TABLE 5. Conservation status of significant fauna species recorded or expected to occur in the Broome Port Project Area. See Appendix 1 for explanation of status codes. Species previously recorded in the Project Area (by Birds Australia, NatureMap) are included.

SPECIES	EPBC	WA Act	JAMBA	CAMBA	BONN	P2	P3	P4	CS3	Likely to occur within Project Area
<b>FROGS</b>										
Derby Toadlet <i>Uperoleia aspera</i>									+	No
Mjoberg's Toadlet <i>Uperoleia mjobergi</i>									+	No
Mole Toadlet <i>Uperoleia talpa</i>									+	No
<b>REPTILES</b>										
Airlie Island Ctenotus <i>Ctenotus angusticeps</i>	VUL	VUL							+	Potential
<i>Lerista separanda</i>						+			+	Recorded
<i>Simoselaps minimus</i>						+			+	Recorded
<i>Lerista apoda</i>									+	Yes
<i>Ctenotus colletti</i>									+	Yes
<i>Morethia storri</i>									+	Potential
Pindan Dragon <i>Diporiphora pindan</i>									+	Recorded
<b>BIRDS</b>										
Great Egret <i>Ardea alba</i>	MIG		+	+	+					No
Cattle Egret <i>Ardea ibis</i>	MIG		+	+	+					No
Glossy Ibis <i>Plegadis falcinellus</i>	MIG			+	+					No
Osprey <i>Pandion haliaetus</i>	MIG									No
Letter-winged Kite <i>Elanus scriptus</i>									+	Rare Vagrant
White bellied Sea-Eagle <i>Haliaeetus leucogaster</i>	MIG			+						No
Red Goshawk <i>Erythrorhynchus radiatus</i>	VUL	VUL								No
Grey Goshawk <i>Accipiter novaehollandiae</i>									+	No
Peregrine Falcon <i>Falco peregrinus</i>		SCH 4								Recorded
Grey Falcon <i>Falco hypoleucos</i>								+		Rare Vagrant
Chestnut backed Button-quail <i>Turnix castanota magnifica</i>								+		Potential

Australian Bustard	<i>Ardeotis australis</i>					+	No
Bush Stone-curlew	<i>Burhinus grallarius</i>					+	<b>Recorded</b>
Oriental Pratincole	<i>Glareola maldivarum</i>	MIG	+	+	+		No
Oriental Cuckoo	<i>Cuculus saturatus</i>	MIG	+	+			Rare Vagrant
Fork-tailed Swift	<i>Apus pacificus</i>	MIG	+	+	+		<b>Recorded</b>
White throated Needletail	<i>Hirundapus caudacutus</i>	MIG		+			Rare Vagrant
Rainbow Bee-eater	<i>Merops ornatus</i>	MIG			+		<b>Recorded</b>
Flock Bronzewing	<i>Phaps histrionica</i>					+	No
Masked Owl	<i>Tyto novaehollandiae kimberli</i>					+	No
Barn Swallow	<i>Hirundo rustica</i>	MIG	+	+			<b>Recorded</b>
Yellow Wagtail	<i>Motacilla flava</i>	MIG	+	+			Rare Vagrant
Gouldian Finch	<i>Erythrura gouldiae</i>	END	END				No
Pictorella Mannikin	<i>Heteromunia pectoralis</i>					+	No
Yellow Chat	<i>Ephthianura crocea</i>					+	No
Magpie Goose	<i>Anseranas semipalmata</i>	Marine					No
Migratory Waterbirds		MIG	+	+	+		Utilise aerial space above Project Area and roost nearby
<b>MAMMALS</b>							
Bilby	<i>Macrotis lagotis</i>	VUL	VUL				Rare Vagrant
Northern Brush-tailed Possum	<i>Trichosurus vulpecula arnhemensis</i>					+	<b>Recorded</b>
Spectacled Hare-wallaby	<i>Lagorchestes conspicillatus</i>					+	No
Northern Marsupial Mole	<i>Notoryctes caurimus</i>	END	END				No
Northern Pipistrelle	<i>Pipistrellus westralis</i>					+	<b>Yes</b>
Lakeland Downs Mouse	<i>Leggadina lakedownensis</i>					+	No
Golden Bandicoot	<i>Isodon auratus auratus</i>	VUL	VUL				No
Scaly-tailed Possum	<i>Wyulda squamicaudata</i>					+	No
Water Rat	<i>Hydromys chrysogaster</i>					+	No
Northern Blossom Bat	<i>Macroglossus minimus</i>					+	<b>Yes</b>

TABLE 6. Impacts upon fauna species of conservation significance expected in the Project Area.

Species Name	Nature and significance of likely impact		Action required
	Nature of impact	Significance	
Peregrine Falcon ( <i>Falco peregrinus</i> )	Minor loss of foraging habitat.	Low (disturbance and habitat loss unlikely)	Retain Fauna Corridor.
Bush Stone-curlew ( <i>Burhinus grallarius</i> )	Some loss of habitat and disturbance. Potential for impacts from introduced predators. Roadkill possible.	Low (disturbance and habitat loss unlikely).	Minimise disturbance footprint Retain Fauna Corridor.
Rainbow Bee-eater ( <i>Merops ornatus</i> )	Negligible.	Negligible (widespread species).	None required, although nesting may occur along roads and grading of road verges during the spring breeding period could be avoided. Retain Fauna Corridor.
Migratory Waders and EPBC listed Birds	No loss of habitat, potential impacts resulting from noise, light, increased human activity.	Low (small area of impact).	Minimise disturbance footprint.
Fork-tailed Swift ( <i>Apus pacificus</i> )	Negligible.	None (aerial species).	Retain Fauna Corridor.
Barn Swallow ( <i>Hirundo rustica</i> )	Negligible.	Negligible	Minimise disturbance footprint. Retain Fauna Corridor.
<i>Diporiphora pindan</i>	Some loss of habitat.	Low (small area of disturbance).	Minimise disturbance footprint. Retain Fauna Corridor.
<i>Ctenopus colletti</i>	Some loss of habitat.	Low (small area of disturbance).	Minimise disturbance footprint. Retain Fauna Corridor.
<i>Lerista separanda</i>	Some loss of habitat.	Low (small area of disturbance).	Minimise disturbance footprint. Retain Fauna Corridor.
<i>Simoselaps minimus</i>	Some loss of habitat.	Low (small area of disturbance).	Minimise disturbance footprint. Retain Fauna Corridor.
Northern Brush-tailed Possum	Some loss of habitat, loss of breeding and roosting sites – tree hollows	Moderate (small area of disturbance, however loss of breeding habitat).	Minimise disturbance footprint. Retain Fig thickets and large hollow bearing trees. Retain Fauna Corridor.
Northern Pipistrelle	Some loss of habitat.	Low (small area of disturbance).	Minimise disturbance footprint. Retain large hollow bearing trees. Retain Fauna Corridor.
Northern Blossom Bat	Some loss of habitat.	Low (small area of disturbance).	Minimise disturbance footprint. Retain large hollow bearing trees. Retain

			Fauna Corridor.
<i>Ctenotus angusticeps</i>	Some loss of habitat.	Low (small area of disturbance, Project Area does not contain habitat known to be preferred by this species, potential for occurrence).	Minimise disturbance footprint. Retain Fauna Corridor.
<i>Morethia storri</i>	Some loss of habitat.	Low (small area of disturbance).	Minimise disturbance footprint. Retain Fauna Corridor.

Note: A fauna corridor should be retained to reduce impacts on local species. It is recommended a fauna corridor be retained to include native vegetation adjacent to and east of Kavite Rd, extend north – south throughout the Project Area and include some stands of Fig trees to retain tree hollows.

**TABLE 7.** The potential impacts to fauna of the proposal as assessed following the guidance of the EPA's Guidance Statement No. 56. (Terrestrial fauna surveys for environmental impact assessment in Western Australia, EPA 2004).

<b>Factor</b>	<b>Impact and explanation</b>
Degree of habitat degradation or clearing within the local area or region.	Moderate (project lies within of a region of continuous habitat however some vegetation clearance and degradation in the immediate vicinity – associated with Port area, size of Project Area is moderate)
Size/scale of proposal/impact.	High (up to 62 ha of remnant native vegetation may be disturbed - Bioregion Group 3).
Rarity of vegetation and landforms.	Low (impacted vegetation and landforms are extensive in sub-region).
Refugia.	Low: Pindan does not promote short-range endemism, habitat is continuous over a larger area.
Fauna protected under international agreements or treaties, Specially Protected or Priority Fauna.	Moderate (faunal assemblage includes species of high conservation significance but impacts on these species is expected to be low (see Table 6)).
Size of remnant and condition/intactness of habitat and faunal assemblage.	Low (Project Area comprises intact remnant vegetation, areas of previously disturbed vegetation occur nearby; as well as regrowth vegetation from a previous disturbance)
Ecological linkage.	Moderate (the Pindan vegetation of the Project Area is continuous with the surrounding landscape, no linear or rare habitats occur within proposed Project Area, however project will reduce linkage along the peninsula, interrupting north –south linkage).
Heterogeneity or complexity of the habitat and faunal assemblage.	Low (Project Area has low habitat heterogeneity and a complex faunal assemblage).

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## Appendix 1. Categories used in the assessment of conservation status.

### **IUCN categories (based on review by Mace and Stuart 1994) as used for the Environmental Protection and Biodiversity Conservation (EPBC) Act and the WA Wildlife Conservation Act.**

**Extinct.** Taxa not definitely located in the wild during the past 50 years.

**Extinct in the Wild.** Taxa known to survive only in captivity.

**Critically Endangered.** Taxa facing an extremely high risk of extinction in the wild in the immediate future.

**Endangered.** Taxa facing a very high risk of extinction in the wild in the near future.

**Vulnerable.** Taxa facing a high risk of extinction in the wild in the medium-term future.

**Near Threatened.** Taxa that risk becoming Vulnerable in the wild.

**Conservation Dependent.** Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

**Data Deficient (Insufficiently Known).** Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

**Least Concern.** Taxa that are not Threatened.

### **Schedules used in the WA Wildlife Conservation Act.**

**Schedule 1.** Rare and Likely to become Extinct.

**Schedule 2.** Extinct.

**Schedule 3.** Migratory species listed under international treaties.

**Schedule 4.** Other Specially Protected Fauna.

### **WA Department of Conservation and Land Management Priority species (species not listed under the Conservation Act, but for which there is some concern).**

**Priority 1.** Taxa with few, poorly known populations on threatened lands.

**Priority 2.** Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.

**Priority 3.** Taxa with several, poorly known populations, some on conservation lands.

**Priority 4.** Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

**Priority 5.** Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

## Appendix 2. Ecological Processes

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

<p><b>Ecological processes relevant to the conservation of biodiversity in Australia</b> (Soule <i>et al.</i> 2004):</p> <ul style="list-style-type: none"> <li>○ Critical species interactions (highly interactive species);</li> <li>○ Long distance biological movement;</li> <li>○ Disturbance at local and regional scales;</li> <li>○ Global climate change;</li> <li>○ Hydroecology;</li> <li>○ Coastal zone fluxes;</li> <li>○ Spatially-dependent evolutionary processes (range expansion and gene flow); and</li> <li>○ Geographic and temporal variation of plant productivity across Australia.</li> </ul> <p>(Taken from <a href="http://www.wilderness.org.au/articles/wc_science">http://www.wilderness.org.au/articles/wc_science</a>, viewed on the 10<sup>th</sup> November 2009)</p>
<p><b>Threatening processes (EPBC Act)</b> Under the EPBC Act (1999), a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 17 key threatening processes listed by the federal Department of the Environment, Water, Heritage and the Arts).</p> <ul style="list-style-type: none"> <li>○ Competition and land degradation by feral/unmanaged Goats (<i>Capra hircus</i>);</li> <li>○ Competition and land degradation by feral Rabbits (<i>Oryctolagus cuniculus</i>);</li> <li>○ Dieback caused by the root-rot fungus (<i>Phytophthora cinnamomi</i>);</li> <li>○ Incidental catch (bycatch) of Sea Turtles during coastal otter-trawling operations within Australian waters north of 28 degrees South;</li> <li>○ Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations;</li> <li>○ Infection of amphibians with chytrid fungus resulting in <i>chytridiomycosis</i>;</li> <li>○ Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris;</li> </ul>

- Land clearance;
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean;
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases;
- Predation by exotic rats on Australian offshore islands of less than 1000 km<sup>2</sup> (100,000 ha);
- Predation by feral Cats (*Felis catus*);
- Predation by the European Red Fox (*Vulpes vulpes*);
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (*Sus scrofa*);
- *Psittacine Circoviral* (beak and feather) Disease affecting endangered *psittacine* species;
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*);
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta*.

(Taken from <http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl> , viewed on the 10<sup>th</sup> November 2009)

