

BROOME PORT AUTHORITY

FLORISTIC COMMUNITY TYPES OF THE BROOME PENINSULA



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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 27th – 31st August 2007, with a second field survey conducted by Greg Woodman, Bianca Taylor, Kylie Greenacre and Brendan Stratton from 7th – 11th 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 its 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).

Month	Average Max. (°C)	Average Min. (°C)	Rainfall (mm)
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

Month	Average Max. (°C)	Average Min. (°C)	Rainfall (mm)
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*, *Gyroparpus 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 sedgelandes +/- 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.

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 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 beaglensis</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.

Vegetation Type	Description
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>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. Pleistocene dunes which are older and less exposed, have more species in common with the inland; 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 *Lysiphillum 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.

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. dampieri</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> .

Group	Vegetation Unit	Description
	EcAbFv: <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> .
	LcOaMn: <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> .
	GaPaFvGb: <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> .
	TpMc: <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> .
	LcGbFv: <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> .
	FvLcAb: <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> .

Group	Vegetation Unit	Description
Vine Thickets and deciduous woodlands to forests (cont.)	TPMaFv: <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> .
	Ah: <i>Atalaya hemiglauca</i> low open forest to low closed forest	Two stands of this unit were recorded, with dense cover of <i>Atalaya hemiglauca</i> over very sparse understorey.
<i>Terminalia ferdinandiana</i> ('Gubinge') Woodlands	Tf: <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> .
	TfEcEdPs: <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>Lysiphylum 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	AtGp: <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.
	EahPh: <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> .
	EcPh: <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> .

Group	Vegetation Unit	Description
Pindan (cont.)	EcTfE: <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> .
	EcAhPh: <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>Lysiphillum 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.
	EdHaPh: <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> .
	EdAeAPh: <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> .
	EdAeHPh: <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>Lysiphillum cunninghamii</i> and <i>Ehretia saligna</i> over <i>Plectrachne helmsii</i> and other grasses.
Melaleuca woodlands to forests	Md: <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.
Degraded Areas	CC: * <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> .
	Am: <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.

Ecosystem (DEC 2006b; 2008)	Ecosystem Description	Conservation Status
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.

TEC / PEC	Description	Conservation Status
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 son 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)

Species	Conservation Status	Comments
<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

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).

Species	Common Name	Status	DAFWA Control Code (Appendix E)	Description
<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 27th – 31st August 2007, with a second field survey conducted by Greg Woodman, Bianca Taylor, Kylie Greenacre and Brendan Stratton from 7th – 11th 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.

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.

Species	Quadrats Recorded	Opportunistic GPS locations*	Floristic Community Type(s) (Section 4.2)
<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* (siratro), *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.

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 kernal; 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-histimine
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 +/- 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 ± 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 ± 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 pyriformis* 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 *Cassythia 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

The Staff of Woodman Environmental would like to thank the following people for their assistance in this project:

Captain Vic Justice (Chief Executive Officer – Port of Broome)

Mr Neil McKenzie (Traditional Owner)

Mr David Dureau (Broome Botanic Society)

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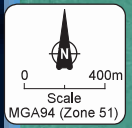
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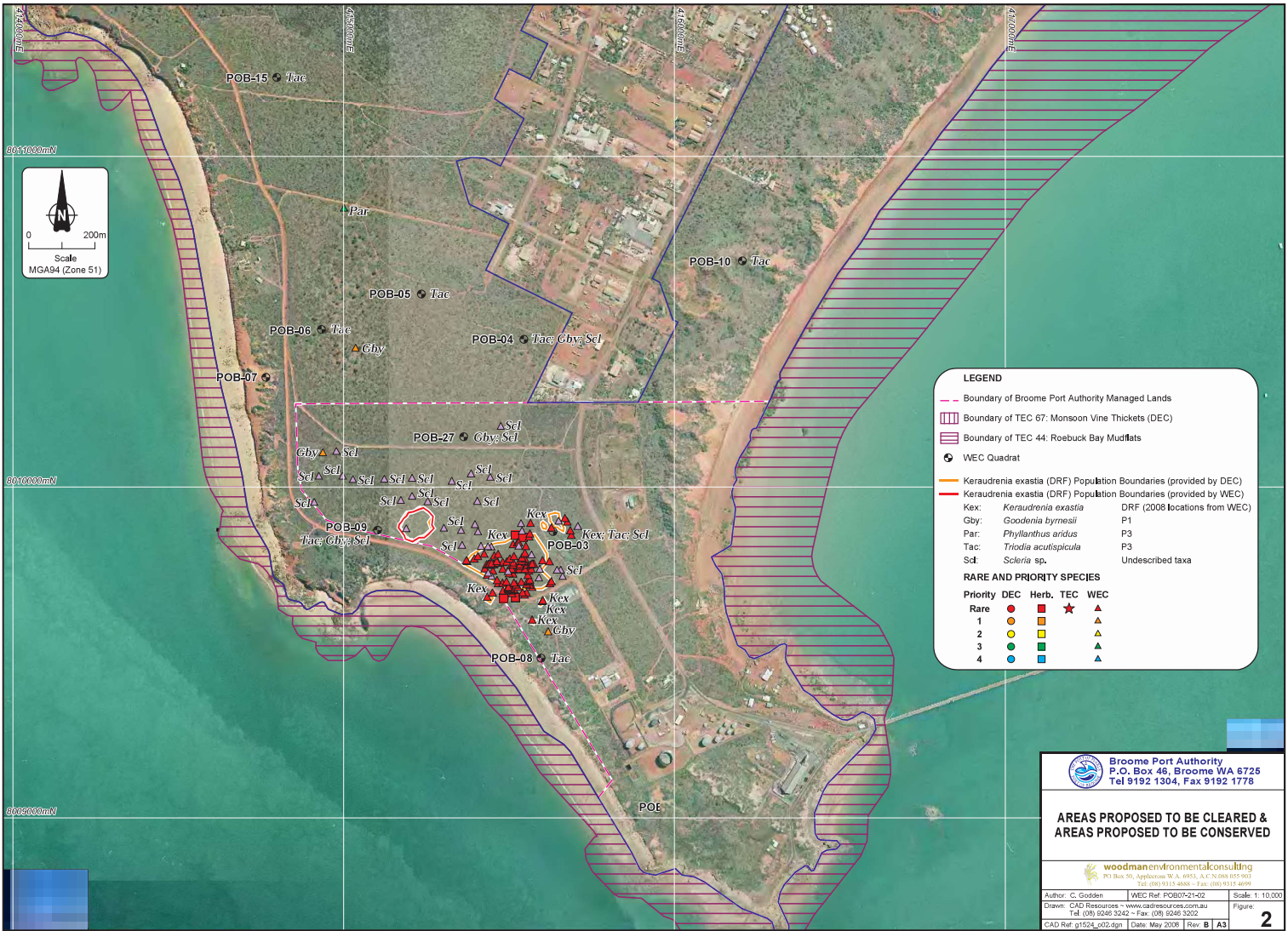
- Limit of Broome Port Authority Survey Area
- - - Boundary of Broome Port Authority Managed Lands

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FLORISTIC COMMUNITY TYPE SURVEY AREA

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LEGEND

- - - Boundary of Broome Port Authority Managed Lands
- ▭ Boundary of TEC 67: Monsoon Vine Thickets (DEC)
- ▭ Boundary of TEC 44: Roeback Bay Mudflats
- ⊙ WEC Quadrat
- Kerandrenia exastia (DRF) Population Boundaries (provided by DEC)
- Kerandrenia exastia (DRF) Population Boundaries (provided by WEC)


Kex: *Keraudrenia exastia* DRF (2008 locations from WEC)
 Gby: *Goodenia byrnesii* P1
 Par: *Phyllanthus aridus* P3
 Tac: *Triodia acutispicula* P3
 Scl: *Scleria* sp. Undescribed taxa

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	●	■	★	▲
1	●	■	★	▲
2	●	■	★	▲
3	●	■	★	▲
4	●	■	★	▲

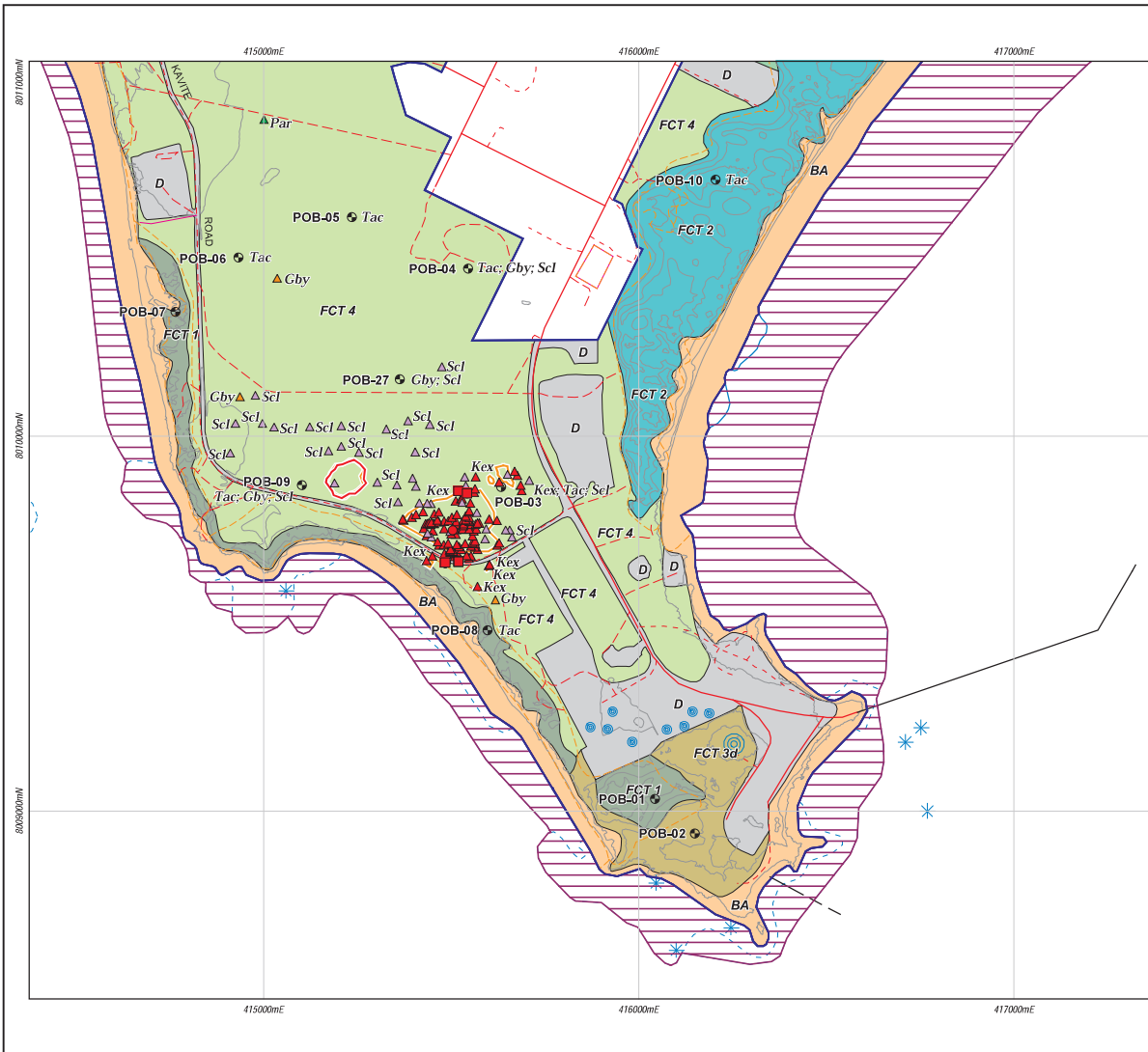

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AREAS PROPOSED TO BE CLEARED & AREAS PROPOSED TO BE CONSERVED


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 CAD Ref: g1524_g02.dgn | Date: May 2008 | Rev: **B** | **A3**

2



LEGEND

- FCT 1** Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Sporobolus longicaulis* on pale brown sand on foredunes and on leeward side of foredunes
- 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 *Poa* sp. 2 on orange sand on secondary dunes
- FCT 3** Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia pedunculata* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghillii* and *Albus pectoratus* subsp. *pectatorius* 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 *Corymbia* spp., *Haakea macrocarpa* and *Pterocarya falcata* over shrubland dominated by *Acacia colei* var. *colei* and other species such as *Enriola saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia purpurea* and *Triodia acutispicula* on orange to red pinak soils on lower to upper slope positions
- FCT 5** Open Woodland of *Corymbia dampieri* and *Corymbia zyzyriana* over species Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula*, *Triodia monosulcata* or *Triodia purpurea* on orange to red pinak soils on lower to upper slope positions
- FCT 6** Dense Low Heath of *Acacia tumida* var. *kulpari* over mixed shrubs including *Cassipoua filiformis*, *Mulka maderasoniana* and *Pterocarya sphacelatum* over Open Hummock Grassland of *Triodia purpurea* and *Triodia schinzii* on red to brown pinak soils on rocky headlands
- FCT 6d** Disturbed areas of FCT 6

Other

- BA** Bare Areas
- D** Disturbed Areas

Conservation Significant Species

- Kex** *Keratulenia exaltata* DRF (2008 locations from WEC)
- Gby** *Gossypium byrsoni* P1
- Par** *Phyllanthus andrus* P3
- Tac** *Triodia acutispicula* P3
- Scl** *Scleria* sp. Undescribed taxa

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
1	Red circle	Red square	Red star	Red triangle
2	Blue circle	Blue square	Blue star	Blue triangle
3	Green circle	Green square	Green star	Green triangle
4	Yellow circle	Yellow square	Yellow star	Yellow triangle

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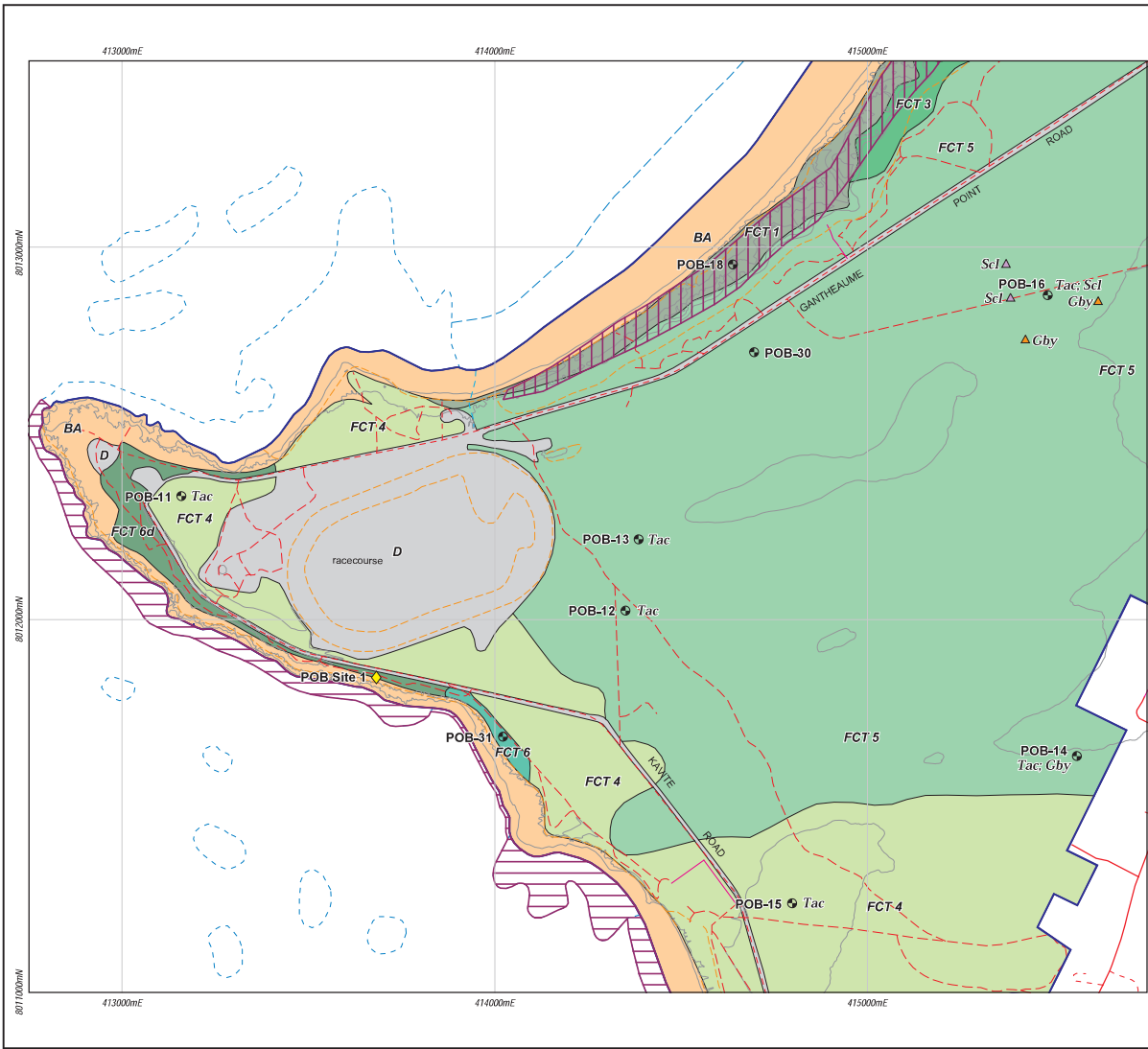
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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES
AUGUST 2007
Sheet 1 of 5

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3a



LEGEND

- FCT 1** Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Sporobolus longifolius* on pale brown sand on foredunes and on leeward side of foredunes
- FCT 2** Open Woodland of *Corymbia polyactis* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and *Poa* sp. 2 on orange sand on secondary dunes
- FCT 3** Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia pedunculata* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghillii* and *Albus pectoratus* subsp. *pectatorius* 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 *Corymbia* spp., *Haakea macrocarpa* and *Pterocarpus saligna* over shrubland dominated by *Acacia colorata* var. *colorata* and other species such as *Eriola saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia purgens* and *Triodia acutispicula* on orange to red pin dunes on lower to upper slope positions
- FCT 5** Open Woodland of *Corymbia dampieri* and *Corymbia zyzygylla* over species Shrubland of *Acacia colorata* var. *colorata* and *Acacia eripoda* over grassland dominated by *Triodia purgens* or *Triodia acutispicula* on orange to red pin dunes on lower to upper slope positions
- FCT 6** Dense Low Heath of *Acacia tumida* var. *kulbarn* over mixed shrubs including *Cassipoua filiformis*, *Mulca maderosperma* and *Pterocarpus saligna* over Open Hummock Grassland of *Triodia purgens* and *Triodia schinzii* on red to brown pin dunes on rocky headlands
- FCT 6d** Disturbed areas of FCT 6
- Other**
 - BA** Bare Areas
 - D** Disturbed Areas
- Quadrat** Detailed Recording Site
- Conservation Significant Species**
 - Ker**: *Keraudenia exarata* DRF (2008 locations from WEC)
 - Gby**: *Gaolania byrnallii* P1
 - Pha**: *Phyllanthus aridus* P3
 - Tac**: *Triodia acutispicula* P3
 - Sol**: *Solenia* sp. Undescribed taxa
- Limit of Broome Port Authority Survey Area**
- Keraudenia exarata** (DRF) Population Boundaries (provided by DEC)
- DEC TEC 67**: Monsoon Vine Thickets
- DEC TEC 44**: Roebuck Bay Muffets

RARE AND PRIORITY SPECIES

Priority	DEC	Herb	TEC	WEC
Rare	1	Red circle	Red star	Red triangle
2	2	Yellow circle	Yellow star	Yellow triangle
3	3	Green circle	Green star	Green triangle
4	4	Blue circle	Blue star	Blue triangle

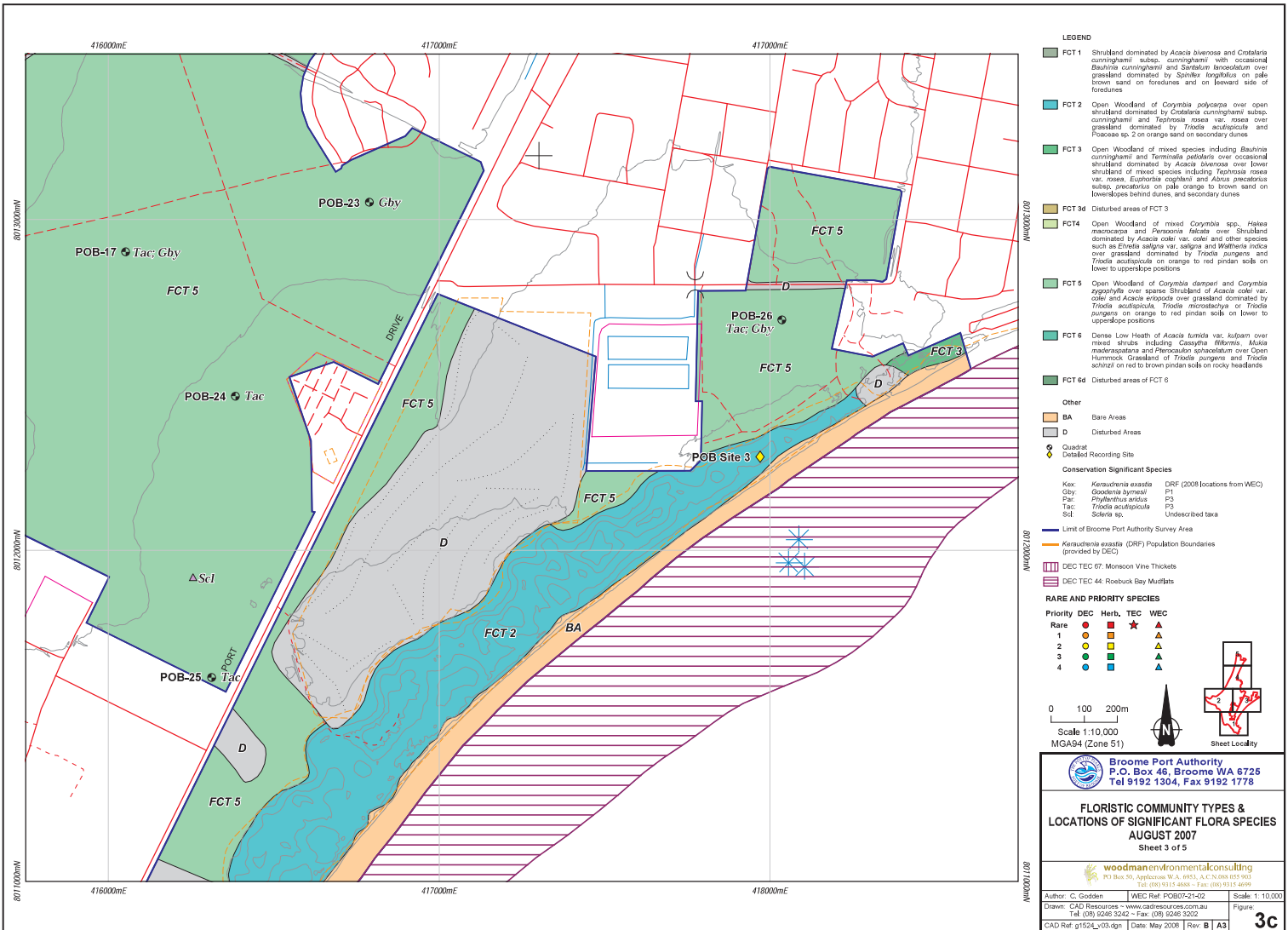
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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES AUGUST 2007
Sheet 2 of 5

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LEGEND

- FCT 1** Shrubland dominated by *Acacia divaricata* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Sporobolus longifolius* on pale brown sand on foredunes and on leeward side of foredunes
- 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 *Poa* sp. 2 on orange sand on secondary dunes
- FCT 3** Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia pedunculata* over occasional shrubland dominated by *Acacia divaricata* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia cognata* and *Albus pectoratus* subsp. *pectatorius* 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 *Corymbia* spp., *Haakea macrocarpa* and *Pterocarya falcata* over shrubland dominated by *Acacia colei* var. *colei* and other species such as *Eriola saigna* var. *saigna* 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 5** Open Woodland of *Corymbia dampieri* and *Corymbia zygophylla* over species Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula*, *Triodia microcarpa* or *Triodia pungens* on orange to red pindan soils on lower to upper slope positions
- FCT 6** Dense Low Heath of *Acacia turbinata* var. *kulbarn* over mixed shrubs including *Cassipoua filiformis*, *Mulka maderaspatana* and *Pterocarya sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schirzi* on red to brown pindan soils on rocky headlands
- FCT 6d** Disturbed areas of FCT 6
- Other**
 - BA** Bare Areas
 - D** Disturbed Areas
- Conservation Significant Species**
 - Ker:** *Keraudenia exata* DRF (2006 locations from WEC)
 - Ghy:** *Gonolobus byrnei* P1
 - Tac:** *Phyllanthus andrus* P3
 - Tac:** *Triodia acutispicula* P3
 - Sol:** *Soliera* sp. Undescribed taxa
- RARE AND PRIORITY SPECIES**

Priority	DEC	Herb	TEC	WEC
1	Red circle	Red square	Red star	Red triangle
2	Yellow circle	Yellow square	Yellow star	Yellow triangle
3	Green circle	Green square	Green star	Green triangle
4	Blue circle	Blue square	Blue star	Blue triangle

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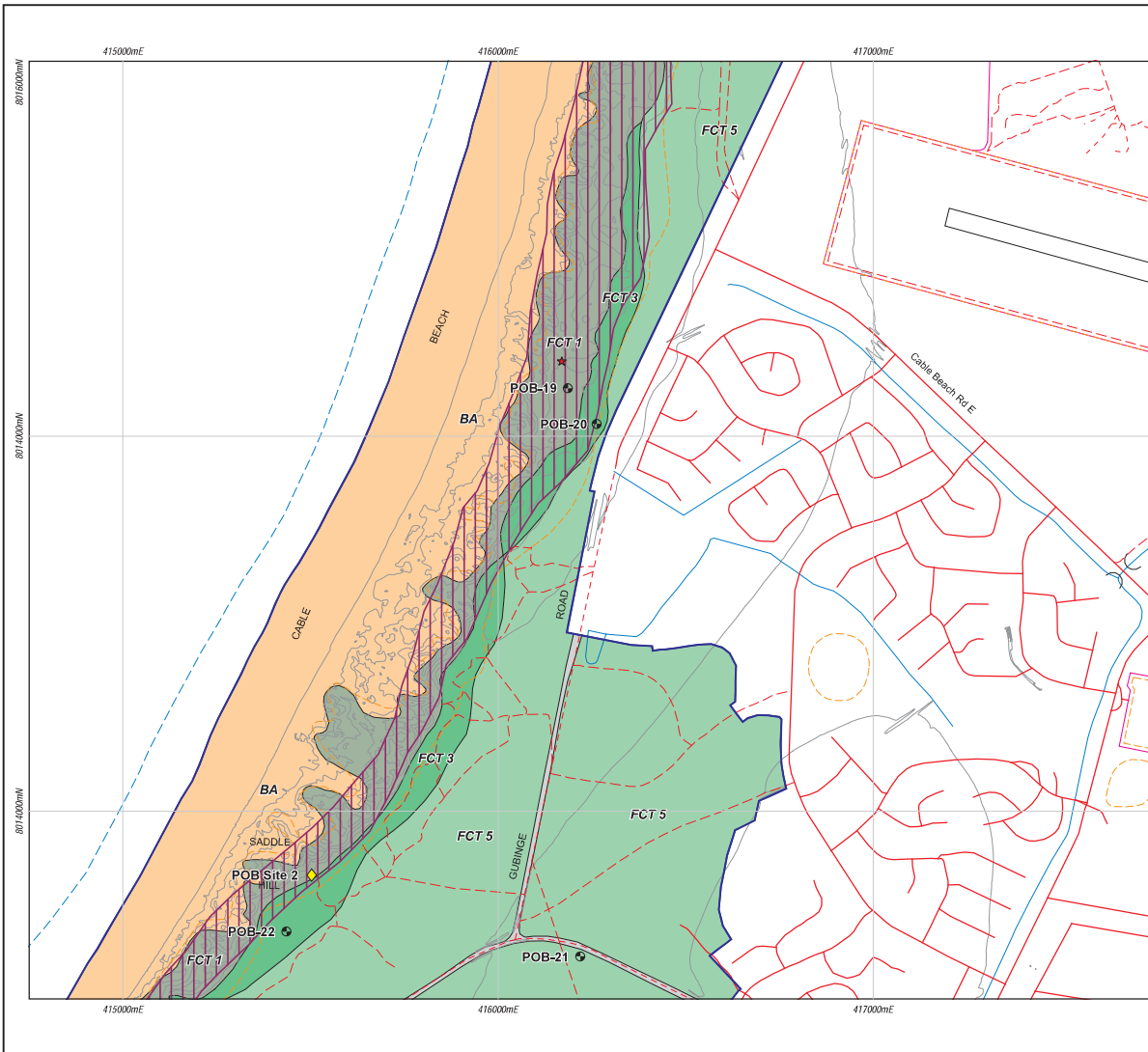
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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES
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 Sheet 3 of 5

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3c



LEGEND

- FCT 1 Shrubland dominated by *Acacia divaricata* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Sporobolus longifolius* on pale brown sand on foredunes and on leeward side of foredunes
- FCT 2 Open Woodland of *Corymbia polyactis* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and *Poa* sp. 2 on orange sand on secondary dunes
- FCT 3 Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia pedunculata* over occasional shrubland dominated by *Acacia divaricata* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghillii* and *Albus pectoratus* ssp. *pectoretus* 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 *Corymbia* spp., *Haakea macrocarpa* and *Pterocarya falcata* over shrubland dominated by *Acacia colei* var. *colei* and other species such as *Eriola saigna* var. *saigna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pinak soils on lower to upper slope positions
- FCT 5 Open Woodland of *Corymbia dampieri* and *Corymbia zyzyrii* over species Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula*, *Triodia monosperma* or *Triodia pungens* on orange to red pinak soils on lower to upper slope positions
- FCT 6 Dense Low Heath of *Acacia tumida* var. *kulbarn* over mixed shrubs including *Cassipoua filiformis*, *Mulka maderuana* and *Pterocarya septentrionalis* over Open Hummock Grassland of *Triodia pungens* and *Triodia schirreni* on red to brown pinak soils on rocky headlands
- FCT 6d Disturbed areas of FCT 6

Other

- BA Bare Areas
- D Disturbed Areas
- Q Detailed Recording Site

Conservation Significant Species

Ker:	<i>Keraudrenia exarata</i>	DRF (2008 locations from WEC)
Gby:	<i>Gonolobus byrnesii</i>	P1
Pal:	<i>Phyllanthus andrusii</i>	P3
Tac:	<i>Triodia acutispicula</i>	P3
Sol:	<i>Solenia</i> sp.	Undescribed taxa

— Limit of Broome Port Authority Survey Area
 — Keraudrenia exarata (DRF) Population Boundaries (provided by DEC)
 — DEC TEC 67: Monsoon Vine Thickets
 — DEC TEC 44: Roebuck Bay Mufflets

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	1	2	3	4
1	2	3	4	5
2	3	4	5	6
3	4	5	6	7
4	5	6	7	8

0 100 200m
 Scale 1:10,000
 MG94 (Zone 51)

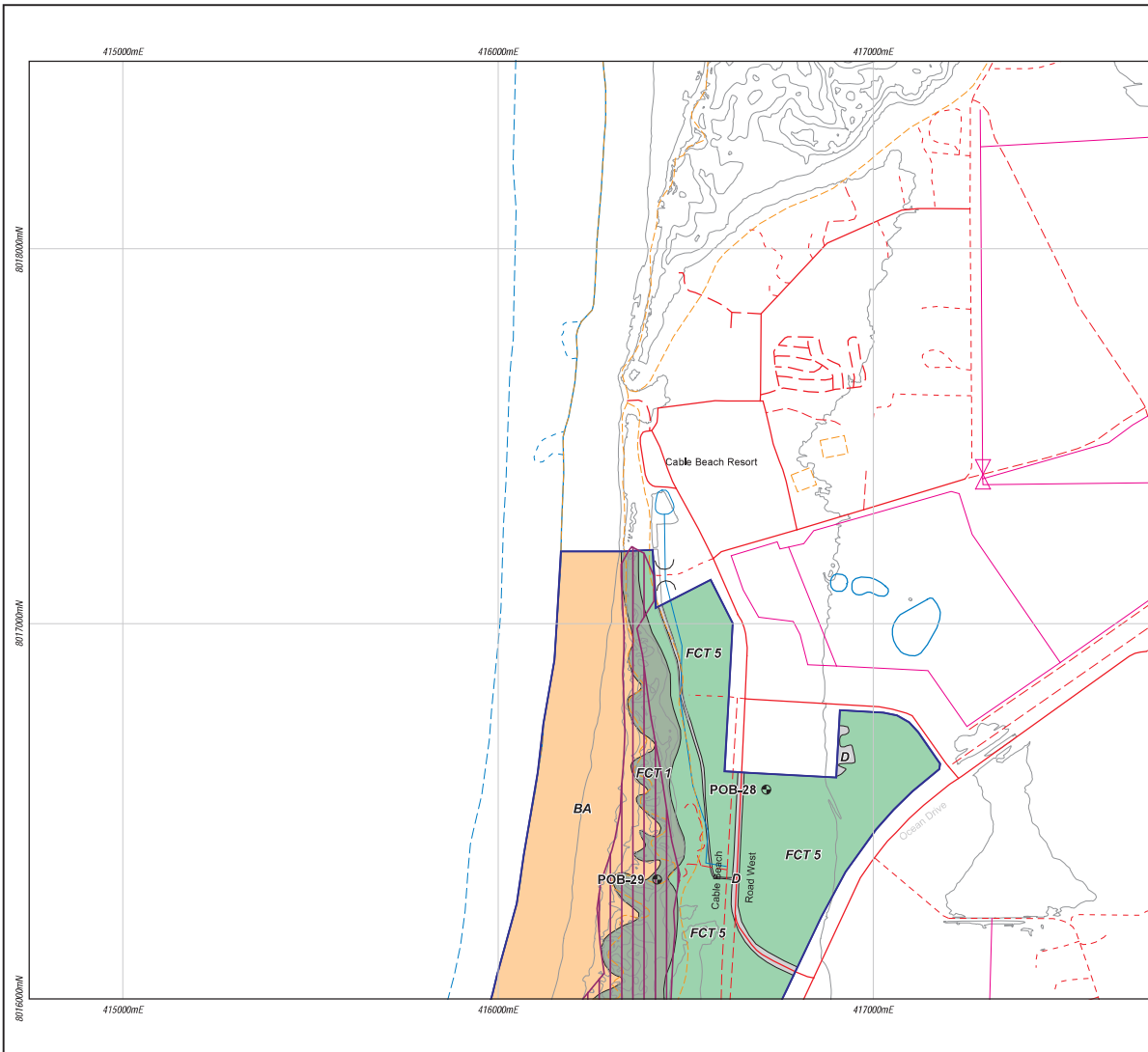
Broome Port Authority
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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES AUGUST 2007
 Sheet 4 of 5

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 CAD Ref: g1524_v04.dgn | Date: May 2008 | Rev: B A3

3d



LEGEND

- FCT 1** Shrubland dominated by *Acacia divaricata* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Sporobolus longifolius* on pale brown sand on foredunes and on leeward side of foredunes
- FCT 2** Open Woodland of *Corymbia polyactis* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and *Poa* sp. 2 on orange sand on secondary dunes
- FCT 3** Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia pedunculata* over occasional shrubland dominated by *Acacia divaricata* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlani* and *Albus pectoratus* subsp. *pectatorius* 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 *Corymbia* spp., *Haakea macrocarpa* and *Pterocarya falcata* over shrubland dominated by *Acacia colei* var. *colei* and other species such as *Enriola saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia jungeri* and *Triodia acutispicula* on orange to red pindan soils on lower to upper slope positions
- FCT 5** Open Woodland of *Corymbia dampieri* and *Corymbia zygodonta* over species Shrubland of *Acacia colei* var. *colei* and *Acacia eripoda* over grassland dominated by *Triodia acutispicula*, *Triodia microcarpa* or *Triodia jungeri* on orange to red pindan soils on lower to upper slope positions
- FCT 6** Dense Low Heath of *Acacia tumida* var. *kulbarn* over mixed shrubs including *Cassipoua filiformis*, *Mitrasacme maderianensis* and *Pterocarya aquatilis* over Open Hummock Grassland of *Triodia jungeri* and *Triodia schirzi* on red to brown pindan soils on rocky headlands
- FCT 6d** Disturbed areas of FCT 6
- Other**
 - BA** Bare Areas
 - D** Disturbed Areas
 - Quadrat
 - Detailed Recording Site

Conservation Significant Species

Ker:	<i>Keraudenia exarata</i>	DRF (2008 locations from WEC)
Gby:	<i>Gonolobus byrnei</i>	P1
Pal:	<i>Phyllanthus andrusii</i>	P3
Tac:	<i>Triodia acutispicula</i>	P3
Sol:	<i>Soliera</i> sp.	Undescribed taxa

- Limit of Broome Port Authority Survey Area
- Keraudenia exarata* (DRF) Population Boundaries (provided by DEC)
- DEC TEC 67: Monsoon Vine Thickets
- DEC TEC 44: Roebuck Bay Mufflats

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	1	●	★	▲
2	2	●	★	▲
3	3	●	★	▲
4	4	●	★	▲

0 100 200m
Scale 1:10,000
MGA94 (Zone 51)

Broome Port Authority
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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES
AUGUST 2007
Sheet 5 of 5

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3e

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 ?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>Corynotheca 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</i> ? <i>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>Melhamia 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 ?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 tectifera</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



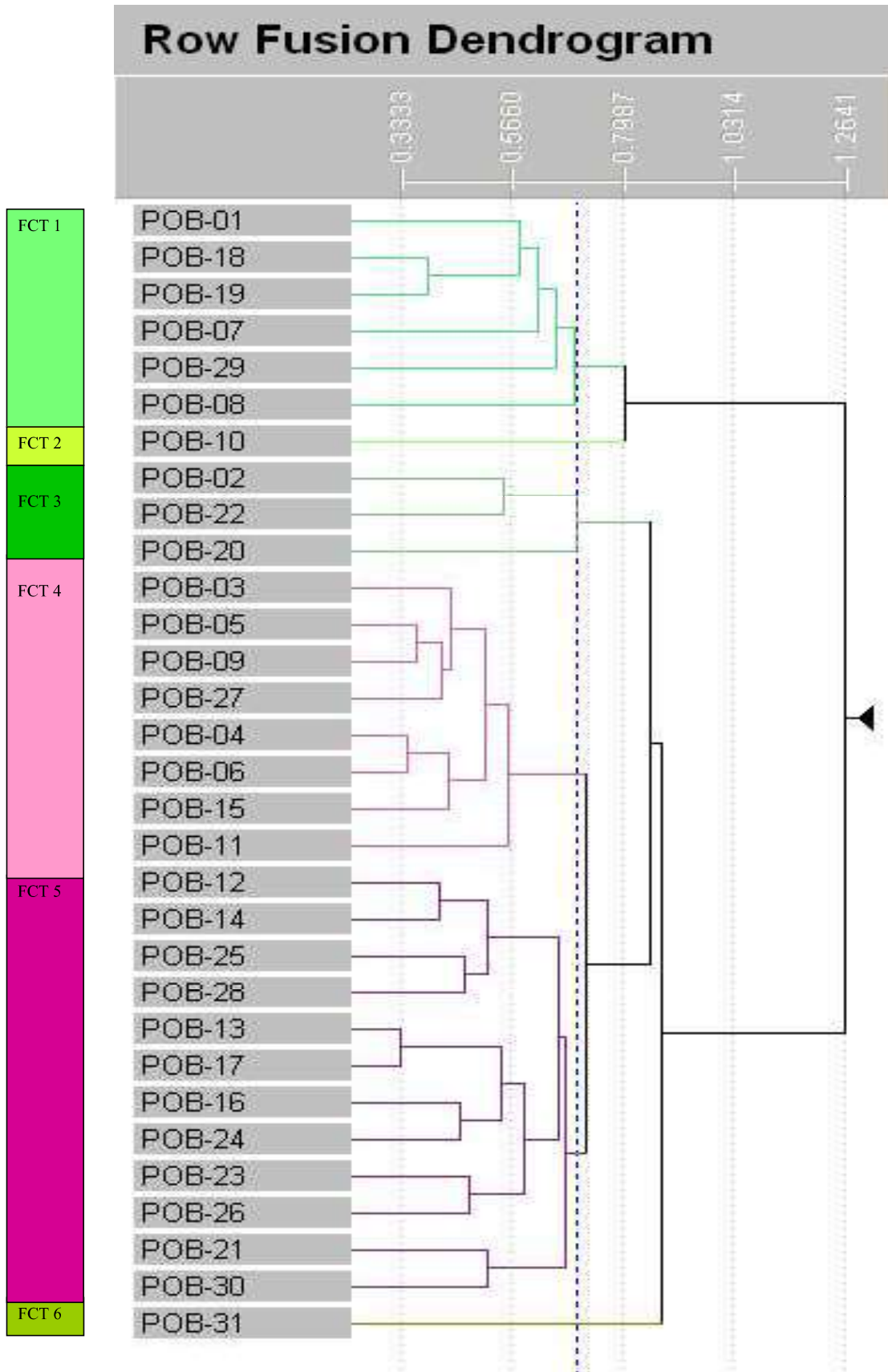
Plate 50: Site POB-02

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



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>Psyrax 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
Total		911

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
Introduction	
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.
Existing Environment	
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.
Stakeholders	
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.
Significant Environmental Factors and Risks	
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.
Management	
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"> • Protection from clearing or indirect impact; • Monitoring of population health; • Research to identify management practices that will ensure the sustainability of populations; and

SECTION	DESCRIPTION
	<ul style="list-style-type: none"> • Cooperative management of populations with stakeholder groups.
Weed Management Plan	<p>This plan should address the following aspects:</p> <ul style="list-style-type: none"> • Port of Broome road verge and cleared area weed spraying program; • Application of lease conditions to manage weeds on developed areas; • Machine and vehicle hygiene conditions for earthworks and transportation contractors; • Annual monitoring of weed populations to determine the efficacy of spraying programs.
Fire Management Plan	<p>This plan should address the following aspects:</p> <ul style="list-style-type: none"> • Responsibility for fire prevention and response on Port of Broome managed lands; • 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).
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"> • Groundwater quality; • Roebuck Bay Threatened Ecological Community; • Vegetation health; and • Rare Flora
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"> • Retention or protection of particular sites or plants; • Inclusion of particular plants in landscaping projects; • Access to lands at particular times or for particular purposes.
Review and Reporting	
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>