COTERRA
ENVIRONMENT

Detailed Vegetation and Flora Survey

Coral Bay Sites

Revision 1 November 2019

CALIBRE | COMMITMENT | COLLABORATION

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Executive Summary

A detailed flora and vegetation survey was requested for three sites around the small township of Coral Bay for proposed future development. The flora and vegetation survey was undertaken in such a way as to comply with the Environmental Protection Authority (EPA) Technical Guidance document (EPA, 2016).

The Coral Bay survey area consisted of three sites: Sites 1, 2 and 3. The total area of the 3 sites was about 13.3 hectares.

The Coral Bay survey area lies in a geological structure known as the Carnarvon Basin and in a physiographic sub-unit called the 'Coastal Dunes'.

A search of the Department of Biodiversity, Conservation and Attractions (DBCA) databases found that there were no records of Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) in the Coral Bay area and that no Threatened flora, but eight Priority taxa had been recorded in the locality around Coral Bay.

No Nationally Important Wetlands occurred in the Coral Bay locality. An Environmentally Sensitive Area (ESA), the Ningaloo World Heritage area and marine parks, lies offshore from and adjacent to the Coral Bay survey area, but does not directly cover any part of the survey area.

The Coral Bay flora and vegetation field survey was undertaken on the 2nd and 3rd of August, 2019.

Fifty nine species of native flowering plants were recorded in the Coral Bay survey area. In addition, five weed species were recorded. The number of native species recorded in the Coral Bay survey area is a low number for the size of the area. This can be mostly attributed to firstly, the significant portion of Site 1 and Site 3 that was cleared and occupied by infrastructure and secondly, to the fact that most of the remnant vegetation was assessed to be in 'Poor to Degraded' or 'Degraded' condition due to the high cover of the weed **Cenchrus ciliaris* (Buffel grass). Only one quadrat was recorded in the survey area because of the very limited area of remnant vegetation in Good or better condition.

No Threatened Flora were recorded in the Coral Bay survey area. One Priority 2 taxon, (*Acacia ryaniana)*, and one Priority 3 taxon (*Carpobrotus* sp. Thevenard Island (M. White 050)) were recorded in the Coral Bay survey area. *Acacia ryaniana* was recorded at one location in the southern part of Site 1 on the crest of a white calcareous sand dune. One plant was at that location. *Acacia ryaniana* occurs in near-coastal areas between Carnarvon and Exmouth and has been recorded in the locality previously. A white-flowered *Carpobrotus* (Pigface) that also occurred in the survey area was difficult to identify and was submitted to the Western Australian Herbarium identification service. It was tentatively identified as the Priority 3 taxa, *Carpobrotus* sp. Thevenard Island (M. White 050), although more material, including seeds would be required for a more definitive identification (M. Hislop, WA Herbarium identification service. *pers comm*). *Carpobrotus* sp. Thevenard Island (M. White 050) has been previously recorded along the coastline from Exmouth to Kalbari. It was recorded at a releve site in Site 3 and at a quadrat site in Site 1. However, it was observed to be scattered in other parts of the survey area.

No Weeds of National Significance were found in the remnant vegetation in the Coral Bay survey area. However, two notable weeds did occur in the survey area. **Cenchrus ciliaris* (Buffel grass) formed grasslands over much of the survey area and other than amongst and under the scattered cluster of shrubs, principally *Acacia coriacea* subsp. *coriacea* and associated native shrubs, only scattered native taxa occurred within those dense stands of Buffel. The weed **Aerva javanica* (kapok bush) formed dense stands in a few small areas of disturbance.

Three vegetation units were recorded across the three Coral Bay survey area sites (Figure 7). Two of the units were coastal dune vegetation units of *Acacia coriacea* subsp. *coriacea* open shrubland, one unit occurring in a small area of white calcareous sand dune in the south-western part of Site 1 and the other unit occurring on the brown sand dunes further inland and including a grassland of **Cenchrus ciliaris* ('Poor to Degraded' and 'Degraded' condition).

The third vegetation unit was a *Acacia sclerosperma* subsp. *sclerosperma* scrub that occurred in a very small area near the northern boundary of Site 1.

The vegetation units recorded in the Coral Bay survey area have a wide distribution and are not considered to be restricted. The 'Poor to Degraded' and 'Degraded' condition of most of the remnant vegetation in the survey area, together with its wide distribution in the locality and beyond, would make it of low conservation value. The small area of white sand dune vegetation in 'Good' condition in the south-western part of Site 1 has higher conservation values, particularly given that it adjoins an extensive area of remnant vegetation extending along the foredunes that appears to be in 'Good' or better condition.

1 Introduction

1.1 Background

A detailed flora and vegetation survey was requested for three sites around the small township of Coral Bay for proposed future development.

The outcome of the survey will be used to inform the environmental assessment and approvals process and may also assist in the preparation of a Native Vegetation Clearing Permit (NVCP) application.

1.2 Aims of the Study

The Coral Bay flora and vegetation survey included the following elements:

- A desktop assessment
- Sampling the survey area vegetation with quadrats;
- Compiling a species list for the areas and recording any rare flora locations;
- Vegetation unit mapping;
- Vegetation condition mapping;
- Opportunistic searches of the areas and undertake targeted surveys for rare and priority flora as required; and
- Record locations of Weeds of National Significance.

The flora and vegetation survey scope and methods complied, where possible, with the EPA Technical Guidance document (EPA, 2016).

1.3 The Survey Area

The Coral Bay survey area consisted of three sites: Sites 1, 2 and 3 (Figure 1). The total area of the 3 sites was about 13.3 hectares.

2 SITE DESCRIPTION

2.1 Physical Environment

2.1.1 Climate

The climate of the Coral Bay survey area is 'semi-desert bixeric', with average rainfall in the 180 to 300mm per annum range and both summer and winter rainfall peaks (Beard, 1975; Beard, 1990; Table 2-1). The rainfall in summer months is a result of tropical cyclones that occur predominantly between January and March while the winter rains are from the south west. Mean monthly rainfall data for Cardabia station, only 5km north of Coral Bay and about 100km south of Learmonth, shows similar rainfall patterns, but with significantly less cyclonic summer rainfall than Learmonth (Table 2-1). The temperature range is large and the summer maxima are high in the Coral Bay region (Table 2-1).

Table 2-1: Select climate data for Learmonth (105km north of Coral Bay) and Cardabia Station (5km north of Coral Bay) (Bureau of Meteorology, 2019).

Location	Statistic	Jan	Feb	Mar	Apr	May	Jun
Learmonth	Mean monthly max (0C) temperature (All years : 1975-2019)	37.9	37.6	36.5	33.3	28.6	24.8
Learmonth	Mean monthly rainfall (mm) (All years : 1945-2019)	30.5	40.3	40.6	18.0	41.6	43.5
Cardabia Station	Mean monthly rainfall (mm) (All years : 1913-2006)	18.1	29.6	28.2	12.6	42.4	44.3

Table 2-1: (Continued)

Location	Statistic	Jul	Aug	Sept	Oct	Nov	Dec	Annuals
Learmonth	Mean monthly max (0C) temperature (All years : 1975-2019)	24.3	26.4	29.4	32.8	34.6	36.9	31.9
Learmonth	Mean monthly rainfall (mm) (All years : 1945-2019)	22.1	11.3	2.1	1.6	1.8	6.0	255.0
Cardabia Station	Mean monthly rainfall (mm) (All years : 1913-2006)	27.5	13.3	1.8	2.4	1.1	2.6	225.7

[Temperature data is not available for Cardabia}

The rainfall observed in the region prior to the survey is summarised Plate 2-1 below

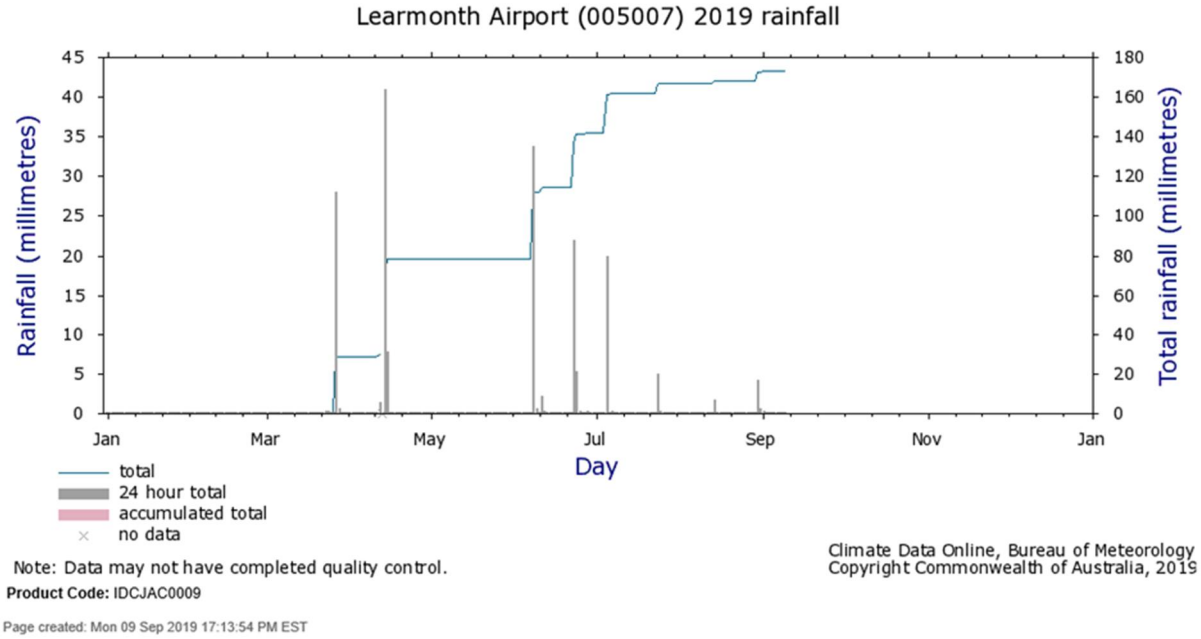

Plate 2-1: 2019 Rainfall Records from Learmonth Weather Station (Source: BoM, 2019)

2.1.2 Geomorphology of the Survey Area

The Coral Bay survey area lies in a geological structure known as the Carnarvon Basin (Beard, 1990). The Carnarvon Basin is a sedimentary basin lying north of the Perth Basin and separated from it by the Hardabut Fault (Beard 1975). The Carnarvon Basin, along with the Canning, Officer and Perth Basins, were intermittently beneath the sea from early Phanerozoic times until the end of the Cretaceous period 65 million years ago, since when they have been dry land (Beard 1990). The Carnarvon Basin contains a column of sediments from Silurian age to Recent, estimated to be up to 4500 metres thick.

Along the west coast from Carnarvon to the base of Cape Range, there is a substantial width (up to 4 km) of recent dunes and along most of unit, there is an additional width of sandhills and sandy country up to 16km in width (Beard, 1975). Coral Bay is located along this section of the coast, in this physiographic sub-unit, referred to as the 'Coastal Dunes'. Topography and soils in this unit includes coastal calcareous sands overlying aeolianite limestone and sand dunes overlying limestone with some areas of loose calcareous sands or read earthy sands and red and brown sands (Beard, 1975).

2.2 Flora and Vegetation

2.2.1 Regional Vegetation

2.2.1.1 Beard's regional vegetation mapping

Beard (1975) defined boundaries for botanical provinces, districts and subdistricts for Western Australia on the basis of his vegetation mapping of the State. In this framework, the Coral Bay survey area lie within Beard's (1975) Carnarvon Region (Carnarvon Botanical District) within the Eremaean Botanical Province. Beard broadly mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The vegetation was described for physiographic units or subdivisions within the Botanical Districts. The Coral Bay survey area is located in the 'Coastal Dunes' physiographic unit.

Beard characterised the vegetation of the red dunes inland of the coastal white sand dunes as carrying a scrub 1.2 to 1.8 metres high, with taxa including *Acacia coriacea*, *Acacia sclerosperma*, *Acacia tetragonophylla, Banksia ashbyi, 'Cassia chatelaineana'* (now *Senna glutinosa* subsp. *chatelaineana*)(Beard, 1975). Vegetation of the stable white sand dunes behind the beach front had a scrub cover to 90cm tall,

'open with much bare sand'. *Acacia coriacea* was dominant and many of the red dune taxa were also present, with *Acacia tetragonophylla* being an exception. There were some taxa found only on the white sands, including *Pileanthus limacis*.

Beard's 1:1 000 000 map series were based on component map sheets of 'vegetation association' units at 1:250 000. Beard's vegetation associations for the Coral Bay region, mapped at the 1:250 000 scale, are shown in Figure 2 and the descriptions of those units are set out in Table 2-2 (from Shepherd et al., 2002).

Table 2-2: Descriptions of Beard's mapping units

Beard's Mapping Units…	Vegetation association description (from Shepherd et al., 2002)
662	Spinifex complexes: Hummock grassland; shrub steppe; mixed acacia scrub & dwarf scrub with soft spinifex & *Triodia basedowii*
676	Succulent steppe; samphire

2.2.1.2 Interim Biogeographical Regionalisation for Australia (IBRA)

The Interim Biogeographic Regionalisation for Australia (IBRA) is a biogeographic representation of Australia that categorizes the Australian continent into 89 bioregions of like climate, geology, landform, native vegetation and species (Thackway and Cresswell, 1995). The Western Australian IBRA region boundaries were largely based on Beard's Botanical District boundaries (Paczkowska and Chapman, 2000).

The Coral Bay survey area lies in the Cape Range sub-region of the Carnarvon bioregion (IBRA 7 (DEE, 2019a); Figure 3).

2.2.1.3 Land Systems

A land system was defined as an 'area with a recurring pattern of topography, soils and vegetation' (Payne et al., 1987). The land systems in the Carnarvon basin were initially identified and mapped from 1:50,000 scale aerial photographs and were then finalized by ground truthing and subsequently published at 1:250,000.

The Coral Bay survey area occurs within the Coast Land System (Figure 4; Payne et al., 1987). The MacLeod and Cardabia Land Systems lie immediately to the west of the survey areas and the Coast Land System. The descriptions of these three land systems are set out in Table 2-3.

Table 2-3: Extracts from descriptions of Land Systems mapped in the locality of the Coral Bay survey area (Payne et al., 1987).

[Notes are targeted at the landforms and associated vegetation relevant to the Coral Bay survey area]

Land System Name	Geomorphology	Vegetation
Cardabia Land System	Mainly undulating sandplains with some parabolic to linear dunes and irregular calcrete outcrops.	Longitudinal dune vegetation is hummock grasslands and scattered shrubs or tall shrublands dominated by *Acacia ramulosa*.
Coast Land System	Quaternary dune and beach deposits to lime sands over limestones. Coastal dunes, mostly very long-walled parabolica and swales.	Dune vegetation is scattered to close low shrublands dominated by *Acacia coriacea* associated with *Banksia ashbyi, Exocarpus aphyllus, Alectryon oleifolius, Rhagodia* spp., *Ptilotus obovatus* with grasses including *Triodia pungens* and **Cenchrus ciliaris.*

Land System Name	Geomorphology	Vegetation
MacLeod Land System	Quaternary deposits forming saline lake beds and dunes over limestone. Flat depositional plains with banks and rises draining onto mud flats and lakebeds	Samphire and Chenopod shrublands.

2.2.2 Rare Vegetation: Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs)

2.2.2.1 State

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat (DBCA website, 2019a). The Biodiversity Conservation Act 2016 provides for the statutory listing of Threatened Ecological Communities (TECs) as Critically Endangered, Endangered, Vulnerable and 'Collapsed' (destroyed). From 1994 up to the implementation of the new Act, TECs had been identified and listed through a non-statutory process. The Department of Biodiversity Conservation and Attractions (DBCA) has developed a procedure for identifying TECs (Department of Environmental Protection 2000; English and Blythe 1997).

DBCA also maintains a Priority Ecological Community (PEC) List, which includes 'possible threatened ecological communities that do not meet survey criteria or that are not adequately defined' (DBCA website, 2019b). PECs are added to the list under Priorities 1, 2 and 3. Priority 4 status is given to "Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list" (DBCA website, 2019b). Conservation Dependent ecological communities are placed in Priority 5 (DEC, unpublished). A DBCA TEC/PEC (State) database search was undertaken for a 10 kilometre buffer area around the Coral Bay survey area. No state listed TECs or PEC had been previously recorded in the search area.

2.2.2.2 Commonwealth

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places—defined in the EPBC Act as Matters of National Environmental Significance (NES) (DEE, 2019b).

The nine matters of NES to which the EPBC Act applies includes nationally Threatened species and TECs. The EPBC Act's Matters of National Environmental Significance includes a list of TECs (although they are not always consistent with DBCA's list), but it does not include any listing of PECs (DEE, 2019b).

A Protected Matters Search was undertaken for the Coral Bay survey area with a 50km buffer. The search found no federally listed TECs occurred within 50 kilometres of the survey areas (Appendix 1).

2.2.3 Threatened and Priority flora

A search of the DBCA Threatened and Priority flora databases was undertaken in May 2019, with a 10 kilometre buffer around the Coral Bay survey area.

The results of the DBCA database search for Threatened and Priority flora records and the Threatened flora results from an EPBC Protected Matters search (Appendix 1) are combined in Table 2-4 below. An assessment of the likelihood of these taxa occurring in the Coral Bay survey area is included in the table. The rare flora status classification definitions are set out in Appendix 2. One Threatened species, *Pityrodia augustensis*, was generated by the EPBC Protected Matters search (50km radius search area; Appendix 1). Eight Priority taxa, but no Threatened taxa, were generated from the DBCA database searches (Table 2-4, Figure 5).

Table 2-4: Threatened and Priority flora which have been recorded in the locality of the Coral Bay survey area

Taxon	**Status**	**Source**	**Likelihood of Occurrence in Survey Areas**	**Comments (Information accessed from Florabase, DBCA website)**
Pityrodia augustensis	Threatened	PMS	Very Low	Occurs 330 km inland from Coral Bay in the Mt Augustus area not on coastal sands.
Cyperus victoriensis	Priority 1	WA Herb	Low	Perennial sedge that grows along creeks: this habitat not in the Coral Bay survey area
Eremophila cuneata	Priority 1	WA Herb	Moderate	Below limestone outcrop- very little limestone outcrop in the Coral Bay survey area.
Indigofera oraria	Priority 1	WA Herb	Moderate to High	Low shrub known from sand dunes immediately adjacent to coastline in the vicinity of Coral Bay and Ningaloo
Acacia ryaniana	Priority 2	TPFL, WA Herb	High	White or red sands; coastal sand dunes.
Acacia startii	Priority 3	TPFL, WA Herb	Low	Occurs on calcareous loam with limestone pebbles. Stony hills & watercourses. Habitat doesn't occur in survey area.
Phyllanthus fuernrohrii	Priority 3	WA Herb	Moderate to High	Recorded in the Coral Bay area. Little information.
Stackhousia umbellata	Priority 3	WA Herb	Moderate	Sandy soils on limestone.
Eremophila youngii subsp. lepidota	Priority 4	WA Herb	Low	Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats. Habitat doesn't occur in survey area.

[Data from DBCA database searches, May 2019]

2.2.4 Other flora and vegetation surveys conducted in the Coral Bay region

Trudgen (1994) conducted a flora and vegetation survey in an area on the north side of Point Maud, about 3 kilometres north of the Coral Bay township and survey area. The 1994 survey area included a relic mud flat and areas of Holocene dunes. Trudgen recorded one hundred and six native taxa in that survey area (hectares unkown), including *Acacia ryaniana* (Priority 2). He included a note that **Cenchrus ciliaris* was common (abundant in places) on the sand dunes in his study area. Trudgen described many plant communities on the foredunes, 'relict foredune plain', parabolic dunes, low lying basins, saline flats and a hypersaline pool that occurred in his survey area. Communities on the parabolic dunes and on the dunes on the 'relict foredune plain' commonly included *Acacia coriacea* subsp*. coriacea*, *Acacia tetragonophylla, Exocarpus aphyllus* and *Santalum spicatum* taxa amongst the dominants of the open shrublands and shrublands described.

Keighery and Gibson (1993) undertook a survey of the Cape Range peninsula, which they considered, for their survey purposes, as north of a line joining Ningaloo Homestead and the base of Exmouth Gulf, 50 to 65 kilometres north of the Coral Bay survey area. They sampled the vegetation of the Cape Range, lower ranges, the coastal plain, coastal strand, mangrove flats and sand plain. They recorded six hundred and thirty taxa and found the flora to be rich. They found that some 50 taxa of southern temperate affinities were at the northern end of their ranges on the peninsula, most of them occurring from the Geraldton area to the North West Cape. They noted that on the western coastal plain, **Cenchrus ciliaris* (Buffel grass) grassland had replaced the native Triodia grassland.

2.3 Wetlands, Environmentally Sensitive Areas (ESAs) and World Heritage

2.3.1 Wetlands

A definition of wetlands used by the Ramsar Convention on Wetlands (UNESCO 1971) was: 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth to which at low water tide does not exceed six metres' (cited in DPW, 2013).

Ramsar wetlands are listed under the EPBC Act and are described as:

- an Australian wetland on the list of Wetlands of International Importance kept under the Ramsar Convention, or
- a wetland declared to be a Ramsar wetland by the Commonwealth Environment Minister.

No Ramsar listed wetlands occur in the locality of the Coral Bay survey area.

A list of nationally important wetlands in Australia has been compiled by the States and Territories, and the Commonwealth Government of Australia as the Directory of Important Wetlands in Australia (DIWA) (DEE, 2019c). The directory used 6 criteria to identify nationally important wetlands. There are more than 900 wetland sites currently on the Directory list,

Western Australia has 120 nationally important wetlands and wetland systems which are listed on the Directory of Important Wetlands in Australia (DBCA website, January 2019). An EPBC Act Protected Matters Search of the Coral Bay survey area locality (Appendix 1) found there were no Nationally Important Wetlands within 50 kilometres of the survey areas and a review of the list of nationally important wetlands also found that there were none in the Coral Bay region (DEE, 2019c).

2.3.2 ESAs

Environmentally Sensitive Areas (ESAs) are areas that have been identified for protection due to their environmental significance as outlined in the Western Australian *Environmental Protection (Environmentally Sensitive Areas) Notice 2005* under Section 51B of the *Environmental Protection Act 1986*. ESAs include the following:

- World Heritage areas
- areas included on the National Estate Register
- defined wetlands and associated buffers
- vegetation within 50 m of a listed Threatened species
- TECs

The Coral Bay survey area do not lie in an ESA, but is adjacent to the ESA that covers the Ningaloo World Heritage area (and Ningaloo Marine Park) (Figure 5)

3 Survey Methods and Limitations

3.1 Timing of Survey

The Coral Bay flora and vegetation field survey was undertaken on the 2nd and 3rd of August, 2019.

The timing of the survey was based on advice from the Exmouth office of DBCA (Heather Barnes pers comm., 13 June 2019), who suggested this survey period based on the June rainfall events being approximately 6-8 weeks prior to this time (see Section 2.1.1).

3.2 Survey Methods

3.2.1 Methods for recording the flora

The flora list for the study area was compiled from records collected at the vegetation unit description sites (quadrats and releves) and from opportunistic records made while traversing the survey areas mapping the vegetation units or looking for additional flora records.

For all recording sites and opportunistic flora records, where a plant species was not well known, a specimen was collected and allocated a specimen number. GPS coordinates were recorded (using a Garmin GPS map 62 hand held GPS unit) whenever it was considered there was a possibility that the plant species may be of particular interest.

The specimens collected were pressed, dried and identified. The identifications were made by comparison to specimens in the reference and research collections of the Western Australian Herbarium, by the use of keys in various papers and books and by relevant experts on various groups of flora that occur on the Swan Coastal Plain.

The DBCA FloraBase website was consulted as required to confirm the status of plant species in the survey area.

3.2.2 Methods for rare flora searching

Before undertaking the field survey, a list of Threatened and Priority taxa previously recorded in the Coral Bay region was generated from a search of DBCA's of database (Section 2.2.3 above). Information was gathered on these taxa and their habitat preferences to ensure some level of familiarity with them and assist with planning any targeted searches.

No targeted rare flora searches were undertaken during the Coral Bay survey. Instead, the survey areas were traversed in a broad grid pattern searching for general flora records as well as looking for any rare flora occurrences. This resulted in good coverage of the survey area.

3.2.3 Methods for describing the vegetation

Vegetation description sites (quadrats and releves) were located so they were representative of observed variations in the vegetation and habitat. Generally, quadrats are placed where the vegetation is in Good or better condition. In the Coral Bay survey area, the vegetation condition was generally 'Poor to Degraded' or 'Degraded', due to the high cover of the weed taxa **Cenchrus ciliaris* (Buffel grass). This meant that only one quadrat and two releves were used to describe the vegetation. Releves ('unbounded') sample sites described around a point) were used where there was insufficient area of vegetation to fit a quadrat or if the vegetation condition was not sufficiently good to be suitable for a quadrat.

The one quadrat recorded in the Coral Bay survey area was recorded in a small area of vegetation in 'Good' condition near the southern boundary of Site 1 (CBQ01). A quadrat size of 30 metres by 30 metres was used (Carnarvon bioregion; EPA, 2016). Quadrats were marked out with a field measuring tape and fence dropper stakes driven into the ground at each corner.

The quadrat was photographed. A description of the quadrat location, the habitat, surface soil texture and colour were all recorded and the time since the site was last burnt was estimated. All plant species occurring in the quadrat were recorded, along with their height, percentage cover and specimen number if collected. The vegetation structure was described with structure based on a modification of Specht's vegetation description table by Aplin (1979, Appendix 3). The condition of vegetation in the quadrat was described using an adaption of the Trudgen classification (Trudgen 1988; EPA, 2016; Appendix 4).

The composition of the releve descriptions was similar to that of the quadrats, but the area described was 'open' and the data recorded not as detailed. At releve sites, dominant and subdominant species and some associated species were recorded, along with site information similar to that recorded at quadrats.

Vegetation units were synthesized from the quadrat and releve vegetation descriptions.

3.2.4 Methods for vegetation mapping

Vegetation units were recorded at the NVIS sub-association level (Level VI; ESCAVI, 2003). The vegetation unit boundaries were drawn in the field on a computer generated aerial photograph while traversing the study area, using GPS coordinate readings and photo interpretation to locate actual boundary positions.

'Vegetation condition' within the survey areas was generally consistent with the condition assessed at each vegetation description site. Therefore, vegetation condition recorded at quadrats and releves was generally extrapolated across the mapped unit polygon. Where the vegetation condition varied from that recorded at the vegetation description sites, the boundaries of the area of varying condition were recorded and the appropriate condition assigned.

3.3 Survey Limitations

The major limitation of the flora survey is that any such survey is a sampling procedure of a variable environment with plant populations of variable growth habit, life span and flowering season. Some species, including annuals, are only available for collection for part of the year. This means that to locate all species that grow in an area is a substantial task, the success of which is related to the time available and the size and diversity of habitat in the survey. Consequently, it is possible that there are species present in the survey area that were not recorded during this survey as they have only low abundance on the land, or were not flowering at the time of the survey, August 2019. In fact, the Coral Bay survey was undertaken in dry but reasonable seasonal conditions, the area having had several significant rain events over the preceding months (June and July 2019).

Survey limitations are addressed more specifically in Table 3-1 below.

Table 3-1: Limitations of the Coral Bay Survey

Survey element	Limitations
1. Availability of contextual information at a regional and local scale Ctrl+Alt+1	Some contextual information was available for vegetation and flora at a locality and regional level. However, limited survey work appears to have been done in the past around the Coral Bay township. Threatened and Priority flora records from past surveys in the sub-region were available. No readily available quadrat data available for the region for floristic analysis.
2. Competency and experience of the team carrying out the survey, including experience in the bioregion surveyed Ctrl+Alt+2	The botanist who undertook the survey has eighteen years of botanical survey experience and has survey experience in the Carnarvon bioregion, having previously undertaken a survey in the Shark Bay area and several surveys around the Onslow area. He has also participated in many surveys in the adjacent Pilbara region.
3. Proportion of flora recorded and/or collected, any identification issues	Given the poor condition of most of the survey areas, it is likely that more than 85% of the vascular flora at the Coral Bay sites was recorded. 93 specimens were collected during the survey.
4. Was the appropriate area fully surveyed (effort and extent)	Heading 4 (numbered; has Keep With Next paragraph attribute applied)
5. Access restrictions within the survey area	There were no access restrictions within the survey area.
6. Survey timing, rainfall, season of survey	Survey timing was the 2nd and 3rd of August 2019. The Coral Bay region is semi-arid with a low rainfall (200 to 300mm), but there had been 50 to 100mm of rainfall over the few months preceding the survey (Learmonth data).
7. Disturbance that may have affected the results of survey such as fire, flood or clearing	High covers of the weed **Cenchrus ciliaris* (grassland) were present in the Coral Bay survey sites and this would have significantly reduced the number of native taxa present at the sites. No recent fire had occurred in the survey areas.

4 Flora of the Survey Area

4.1 Flora List for the Survey Area

Fifty nine (59) species of native flowering plants were recorded in the Coral Bay survey area. In addition, five (5) weed species were recorded in the survey area. A list of species recorded in the survey area is presented in Appendix 5.

The flowering plant families that were represented by most native species in the survey area were:

- the Fabaceae (pea and Acacia family) with seven (7) native species (including 5 Acacia species));
- the Chenopodiaceae with six (6) native species;
- the Poaceae family with five (5) native species;

The number of native species recorded in the Coral Bay survey area is a low number for the size of the area. This can be firstly attributed to the significant portion of Site 1 and Site 3 that was cleared and occupied by infrastructure (5.1 hectares of the total of 13.3 hectares was 'Completely Degraded') and secondly, to the fact that most of the remnant vegetation was in Poor to Degraded condition due to the high cover of the weed **Cenchrus ciliaris* (Buffel grass). The seasonal conditions at the time of the survey were dry but reasonable, with several good rainfall events having occurred over the preceding few months.

Only one quadrat (30 metre x 30 metre) was recorded in the survey area because of the very limited area of remnant vegetation in Good or better condition. That quadrat was centred on the crest and slopes of a white calcareous sand dune. Twenty three (23) native species and three weed species were recorded in that quadrat.

4.2 Significant Flora Recorded in the Survey Area

4.2.1 Threatened Flora (T) in the survey area

No Threatened Flora were recorded in the Coral Bay survey area.

4.2.2 Priority flora species recorded from the survey area

One Priority 2 taxon, (*Acacia ryaniana)-*, and one Priority 3 taxon (Carpobrotus sp. Thevenard Island (m. White 050)) were recorded in the Coral Bay survey area (Figure 6; Appendix 6).

Acacia ryaniana (P2) was recorded at one location in the southern part of Site 1 on the crest of a white calcareous sand dune. It was a prostrate, spreading low shrub about 60cm high. Maslin (1992) commented that this taxon was 'only known from coastal and near-coastal areas between Carnarvon and Exmouth' and 'is not very common at the few localities where it occurs'. Characteristic features of *Acacia ryaniana* include its broad, curved pods, prostrate habit, simple inflorescences, persistent spinose stipules and short, broad phylodes (Maslin, 1992).

Acacia ryaniana has been recorded in the Coral Bay locality previously (Figure 5) and was found by Trudgen in an area just north of Point Maud (Trudgen, 1994).

A while flower pigface taxon was observed and sample in the survey area. A specimen was lodged with the herbarium Identification Service and was tentatively identified by Mr. Mike Hislop as *Carpobrotus* sp. Thevenard Island (M. White 050) (P3). Mike Hislop subsequently consulted Helmutt Toelken, a retired botanist from South Australia who has a special interest in *Carpobrotus*, who could not provide definitive confirmation that the taxon was *Caropbrotus s*p. Thevenard Island (M. White 050), but who did not consider that it could be the one other possible *Carpobrotus* species being considered as a possibility. A request has

been made to sample the Coral Bay *Caropbrotus* again for seeds if the opportunity arises. At this point in time the taxon is being tentatively called *Caropbrotus* sp. Thevenard Island (M. White 050) (P3).

Caropbrotus sp Thevenard Island (M. White 050) has been recorded along the coastline from Exmouth to Kalbari. It was recorded at two locations in the Coral Bay survey area, at releve site CBR01 in Site 1 (Figure 6, Appendix 6). However, it was observed to be scattered in other parts of the survey area, but those locations were not recorded as there was not an awareness of its Priority status (it was not flagged by the DBCA rare flora database search for the area around Coral Bay).

4.2.3 Other taxa of interest recorded in the survey areas

Olearia axillaris was recorded on the coastal dunes in Site 1 during the survey and its identification was confirmed by the Western Australian Herbarium Identification Service. It was pointed out that there are no Herbarium collections of the taxa from as far north as Coral Bay (only collections from as far north as Shark Bay). However, Malcolm Trudgen recorded *Olearia axillaris* var, obovate from a survey just north of Coral Bay in 1994 (Trudgen, 1994).

4.3 Weeds Recorded in the Survey Area

Of the five weed species recorded in the Coral Bay survey area, none are currently listed as Declared Pests (DPIRD, 2019) and none are listed as Weeds of National Significance (DEE, 2019d).

However, two of the weeds occurring in the survey areas are present in significant numbers and are of interest.

- **Cenchrus ciliaris* (Buffel grass) (status 'Permitted – s11') (DPIRD, 2019): this grass was introduced into Australia as a pasture grass in dry areas. It has become a widespread weed of roadsides, creeklines, river banks and many vegetation types from Geraldton to the Pilbara, Kimberley and adjacent desert (Hussey et al., 2007). In the Coral Bay survey area, Buffel grass has become dominant in the lower strata (Plate 8-1) and is the main cause for the poor condition of the remnant vegetation.
- **Aerva javanica* (Kapok bush) (status 'Permitted – s11') (DPIRD, 2019): this taxon was introduced into Australia to assist with stabilizing degraded rangelands and is now widespread over many types of vegetation and in disturbance areas from Carnarvon to the Kimberley (Hussey et al., 2007). **Aerva javanica* was recorded in all three Coral Bay survey area sites, but was notably in large numbers around the margins of the Caltex 24 hour refuel hub in Site 2 (about 600 plants) and along some parts of the western and southern margins of the Ningaloo Reef Resort in Site 1 (Plate 8-2; 1000 plants).

5 Vegetation of the Survey Area

5.1 Vegetation Unit Descriptions

5.1.1 Introduction to vegetation units of the Coral Bay survey area

Three vegetation units were recorded across the three Coral Bay survey area sites (Figure 7). Two of the units were coastal dune vegetation units of *Acacia coriacea* subsp. *coriacea* open shrubland in scattered clusters with other native taxa shrubs. One of these dune units occurred in a small area of white calcareous sand dune in the south-western part of Site 1 and the other unit made up all the area of remnant vegetation in Site 2 and 3 and most of Site 1 and included a **Cenchrus ciliaris* grassland strata and was in Poor to Degraded condition.

The third vegetation unit was *Acacia sclerosperma* subsp*. sclerosperma* scrub that occurred in a small area of Site 1 on the flats immediately behind the beach, with limestone outcropping present.

5.1.2 Detailed descriptions of vegetation units in the Coral Bay survey areas

The quadrat and releve vegetation site descriptions that are referred to in the following section, can be found in Appendix 7 (quadrats) and Appendix 8 (releves).

AcAoRp

Acacia coriacea subsp. coriacea, Alectryon oleifolius subsp. oleifolius, Acacia tetragonophylla, Rhagodia preissii subsp. *obovata* open shrubland over *Roepera fruticulosa Senna glutinosa* subsp. *chatelainiana, Scaevola tomentosa, Threlkeldia diffusa* scattered low shrubs over **Cenchrus ciliaris* grassland.

Habitat and soil: Dune crest and slopes. Pale brown sand.

Notes: This vegetation was recorded on the dune crest and slopes at releve CBR01 in Site 3 (Plate 8-3 and Plate 8-4) (Figure 7). This vegetation unit was mapped over all of the area of Site 2 and Site 3 that was covered by remnant vegetation and most of Site 1 (Plate 8-5) and in total covered about 7.8 hectares. It consisted of scattered remnant shrubs of *Acacia coriacea* subsp. *coriacea* with other shrubs, including *Alectryon oleifolius* subsp. *oleifolius, Rhagodia preissii* subsp*. obovata, Santalum spicatum, Acacia tetragonophylla* and *Roepera fruticulosa*, clustered around and underneath, amongst a grassland of **Cenchrus cilliaris* (Buffel grass) (overall 30 to 40% cover). This unit was assessed as 'Poor to Degraded' condition at Site 3 and the western part of Site 1 and 'Degraded' condition in Site 2. *Acacia tetragonophylla* occurred as a co-dominant mostly on the lower slopes and swales between the dune ridges.

Assoc. species: *Nicotiana occidentalis, Carpobrotus* sp*. Thevenard Island* (M. White 050), *Salsola australis, Solanum cleistogamum, Exocarpos aphyllus, Trichodesma zeylanicum var. zeylanicum, Lotus australis, Gnephosis tenuissima, Heliotropium crispatum, Roepera similis, Ptilotus villosiflorus, Commicarpus australisr, Sclerolaena uniflora, Enchylaena tomentosa, Eragrostis aff. Eriopoda*

AsMm

Acacia sclerosperma subsp. *sclerosperma, (Myoporum montanum*) open to closed scrub over *Rhagodia preissii* subsp. *obovata* scattered shrubs over **Cenchrus ciliaris* open grassland (forms a grassland around the scrub).

Habitat and soil: Very low rise near beach. White to pale yellow-brown sand.

Rock Type: limestone

Notes: This vegetation was recorded at releve CBR02 (Plate 8-6) in a very small (0.1 hectare), slightly elevated area of remnant adjacent to the beach. It was considered to be in Poor to Good condition, with considerable disturbance in the surrounds.

Assoc. species: *Acacia coriacea subsp. coriacea; Stylobasium spathulatum; Abutilon cunninghamii; Threlkeldia diffusa.*

AcRpPL

Acacia coriacea subsp*. coriacea* open shrubland over *Rhagodia preissii* subsp. *obovata, Santalum spicatum*, *Pileanthus limacis, Roepera fruticulosa* low open shrubland over *Threlkeldia diffusa, Carpobrotus* sp Thevenard Island (M. White 050*), Ptilotus villosiflorus* scattered herbs with **Cenchrus ciliaris* very open grassland.

Habitat and soil: Dune crest and slopes. Calcareous white sand.

Notes: This vegetation was described at quadrat CBQ01 (Plate 8-7 and Plate 8-8) on the crest and upper slopes of a secondary dune in Site 1. While having many common elements of flora with unit AcAoRp, it was differentiated by the presence of taxa including *Pileanthus limacis, Senecio pinnatifolius* and *Spinifex longifolius*. This vegetation only occurred in a small area (0.3 hectares) in the south-western part of Site 1. The vegetation condition was assessed as 'Good'.

Assoc. species*: Senecio pinnatifolius, Spinifex longifolius; Acanthocarpus preissii; Roepera similis; Euphorbia sharkoensis; *Flavaria trinerva; Dampiera incana var. incana; Commicarpus australis.*

5.2 Vegetation Condition

Vegetation condition of the Coral Bay survey area is shown in Figure 8. Vegetation condition of most of the remnant vegetation was greatly impacted by high cover of the weed **Cenchrus ciliaris* (Buffel grass) and most of the remnant vegetation area ranged between 'Poor to Degraded' and 'Degraded'. In these areas **Cenchrus ciliaris* formed a grassland with cover in the range of 30% to 40%, with scattered clusters of remnant native plants centred around mostly *Acacia coreacea* subsp. *coreacea* and some scattered herbs and shrubs amongst the Buffel (Plate 8-1, 8-3, 8-4 and 8-5). Between these scattered clusters of native plants, **Cenchrus ciliaris* was dominant, with only scattered native taxa amongst the **Cenchrus ciliaris* grassland. The condition of the vegetation was worst throughout Site 2 ('Degraded', Plate 8-9) and was 'Poor to Degraded' in Site 3 and over much of Site 1.

A small area of dune vegetation in 'Good' condition occurred on white calcareous sand dunes in the south-west corner of Site 1 (Plate 8-7 and Plate 8-8). The **Cenchrus ciliaris* cover was lower in this area – about 5% to 6 %. It was noted that, along the coastline adjacent to the survey areas, the remnant vegetation on the primary dune ridge and parts of the dunes immediately behind them, appeared to be in 'Good' or better condition, much better condition than the **Cenchrus ciliaris* dominated areas on the dunes immediately inland from them.

5.3 Vegetation Conservation Values

5.3.1 Beard's vegetation associations, their pre European and current extent and their area occurring in the survey areas

Shepherd et al. (2002) used Beard's mapping of vegetation associations in the 1:250 000 series across Western Australia and other imagery interpretation to estimate the pre-European and current extent of native vegetation associations in Western Australia.

While the Beard mapping showed some samphire vegetation association in Site 3 (unit 676, Figure 2), no samphire actually occurs there (Figure 7) and so only Beards vegetation association unit 662 has been considered here.

Shepherd et al. (2002) calculated that 100% of their pre-European vegetation cover of the Beard vegetation association 662 had been retained (Table 5-1 below). While Beard's vegetation associations were broad

units, it is still worth noting that the area of Beard's vegetation associations that occurred within the Coral Bay survey area was a very small percentage (0.0027 %) (Table 5-1).

Table 5-1: Pre-European and current extent of the Beard vegetation association that occurs in the Coral Bay survey area (following Sheppard et al., 2002) and their extent across the study area as a percentage of their total area

Beard's Mapping Units…	Pre-European extent (ha)	Current extent (ha)	Percentage of remaining native vegetation for each association	Extent of vegetation association in Coral Bay survey area (ha)	Extent within study area as percentage of current extent of veg. association 9%)
662	308,549	308,549	100	8.2	0.0027%

5.3.2 Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs)

No TECs or PECs have been recorded previously in the locality of the Coral Bay survey area (Section 2.2.2.1). Furthermore, no vegetation was recorded in the Coral Bay survey area that was identifiable as a listed TEC or PEC.

5.3.3 'Other ecosystems at risk': Biodiversity Audit

In the 2002 Biodiversity Audit of the Cape Range subregion, special values in the subregion were listed (Kendrick and Mau, 2002). This list included off-shore islands, the Karst system of Cape Range, the Bunderra Sinkhole, Cameron's cave, the Ningaloo reef complex and mangroves of the western Exmouth Gulf, but did not include terrestrial vegetation associations such as the coastal vegetation types found in the Coral Bay survey area. Similarly, a listing of 'Ecosystems at Risk' did not include the coastal vegetation association. An assessment of Cape Range sub-region ecosystem reservation priorities by Kendrick and Mau (2002), assessed Beard's vegetation association 662 reservation priority as 'Low'.

5.3.4 Conclusions on the vegetation conservation values in the Coral Bay survey area

The vegetation units recorded in the Coral Bay survey area have a wide distribution and are not considered to be restricted. The 'Poor to Degraded' and 'Degraded' condition of most of the remnant vegetation in the survey area, together with its wide distribution in the locality and beyond, would make it of low conservation value.

The small area of white sand dune vegetation in 'Good' condition in the south-western part of Site 1 has higher conservation values, particularly given that it adjoins an extensive area of remnant vegetation extending along the foredunes that appears to be in 'Good' or better condition.

6 Acknowledgements

Simon Crofts, Environ Maps, prepared the GIS maps used in this report.

7 References

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8 Plates

Plate 8-1: *Cenchrus ciliaris* (Buffel grass) grasslands, Site 2 ('Degraded')

Plate 8-2: *The weed Aerva Javanica in a disturbed area in Site 1, on the western side of the Ninglaoo Reef Resort*

Plate 8-3: Vegetation unit 'AcAoRp' at releve CBR01, Site 3 (looking south from near the northern boundary)

Plate 8-4: Vegetation unit 'AcAoRp' at releve CBR01, Site 3 (looking north)

Plate 8-5: Vegetation unit 'AcAoRp' in the western part of Site 1 (looking north towards the lookout)

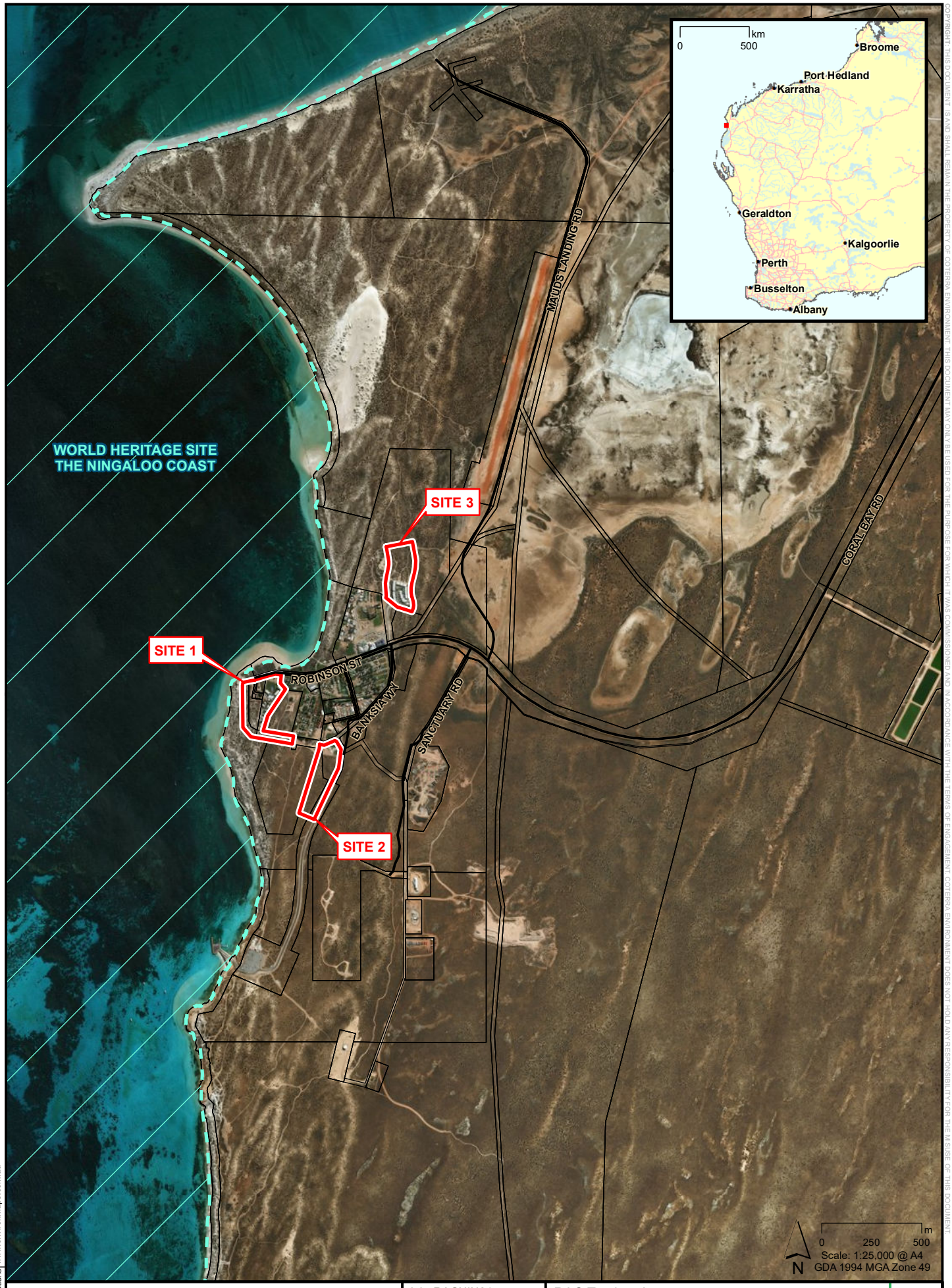
Plate 8-6: Vegetation unit 'AsMm' at releve CBR02, Site 1 (north-western side of Ningaloo Reef Resort)

Plate 8-7: Vegetation unit 'AcRpPl' at quadrat CBQ01 – upper slope

Plate 8-8: Vegetation unit 'AcRpPl' at quadrat CBQ01 – crest

Plate 8-9: Degraded vegetation unit 'AcAoRp' at Site 2, with high ****Cenchrus ciliaris* **(Buffel grass) cover

Figures



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SITE LOCATION

Figure 1

LEGEND

Site Boundary

Cadastre

Pre-European Vegetation Associations

Coastal Dunes 662

Coastal Dunes 676

N

0 25 50 100 150 200 m

Scale: 1:5,000 @ A3

GDA 1994 MGA Zone 49

676

Site 3

MAUDS LANDING RD

CORAL BAY RD

ROBINSON ST

FRENCH ST

BANKSIA WY

662.2

Site 1

SANCTUARY RD

Site 2

Source: Cadastre - Landgate, 2018
Orthophoto - Open Source
Pre-European Vegetation - DAFWA

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PRE-EUROPEAN VEGETATION

Figure 2

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LEGEND

Site Boundary

IBRA7 Subregion Boundary

N

0 2.5 5 10 15 20 km

Scale: 1:500,000 @ A3
GCS GDA 1994

NINGALOO RD
Learmonth
Heron Point
Point Lefroy
Sandy Point
Carbaddaman Passage
Rough Range
Gales Bay
Giralia Bay
Sandalwood Peninsula
Sandalwood Landing
Lefroy Bay
Weajuggoo Hill
Centipede Hill
Norwegian Bay
Sextant Hill
Point Cloates
Black Rock Passage
Boat Passage
NINGALOO MARINE PARK
Whaleback Hill
Hopes Corner
Giralia Range
CAR01
Cape Range
Doublet Hill
Stanley Pool
Remarkable Hill
Airey Hill
Cardabia Passage
Mauds Landing
Point Maud
Coral Bay
Stanley Hill
SITE
Yalobia Hill
Point Anderson
Round Headed Hill
Round Knob
Giralia Range
Milgah
Cockerabinge Outcamp
Alison Point
Amherst Point
Marsh Hill
Cape Farquhar
Gnargoo Range
Gnarraloo Bay
Minilya Roadhouse
CAR02
Wooramel
Gnabbarryarra
Red Bluff

Source: Cadastre - Landgate, 2018
Topographic Base - Open Source
IBRA V7 Subregions - DoE, 2012

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IBRA V7 SUBREGIONS

Figure 3

LEGEND

Site Boundary

Cadastre

Land Systems

204Cs: Coast System

204Mc: MacLeod System

204Ca: Cardabia System

N

0 62.5 125 250 375 500 m

Scale: 1:10,000 @ A3

GDA 1994 MGA Zone 49

MAUDS LANDING RD

204Mc

Site 3

ROBINSON ST

204Cs

FRENCH ST

BANKSIA WY

SANCTUARY RD

CORAL BAY RD

Site 1

Site 2

204Ca

Source: Cadastre - Landgate, 2018
Orthophoto - Open Source
Soil Landscape Mapping - DPIRD, 2018

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LAND SYSTEMS MAP

Figure 4

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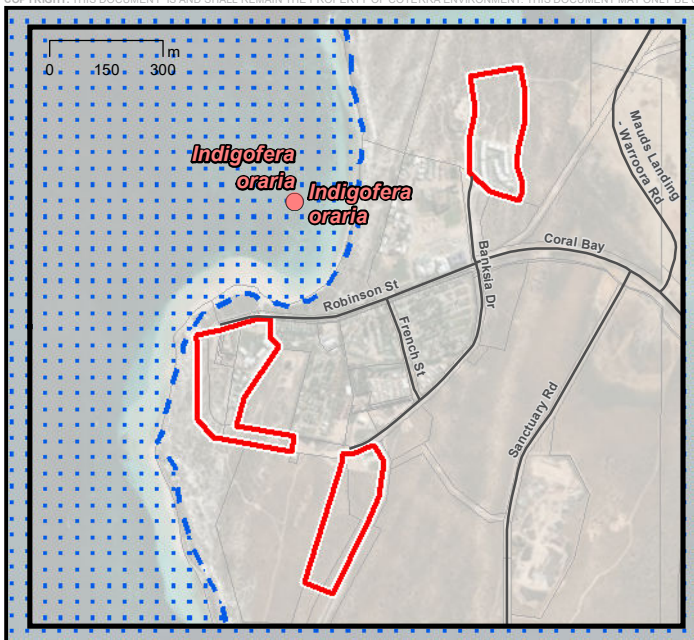

LEGEND

- Site Boundary
- Cadastre
- Environmentally Sensitive Area

Rare Flora

- Priority 1: Poorly-known species
- Priority 2: Poorly-known species
- Priority 3: Poorly-known species

N

0 0.5 1 2 3 4 km

Scale: 1:100,000 @ A3
GDA 1994 MGA Zone 49

Coastal Access Rd
Cardabia Rd
Coral Bay
Minilya Exmouth Rd
Warroora North Rd

Acacia ryaniana
Acacia ryaniana Acacia ryaniana

Indigofera oraria
Indigofera oraria

CORAL BAY

Phyllanthus fuernrohrii

Eremophila cuneata

Phyllanthus fuernrohrii

Acacia startii
Acacia startii

Source: ESA - DER, 2018
Cadastre - Landgate, 2018
Orthophoto - Open Source
Rare Flora - DBCA, 2019

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DBCA RARE FLORA AND ESA RECORDS

Figure 5

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CORAL BAY SURVEY
RARE FLORA

Figure 6

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LEGEND

- Site Boundary
- Cadastre

Sample Sites

- Quadrat
- Releve
- Vegetation Unit Boundary

Vegetation Unit Descriptions

AcAoRp *Acacia coriacea* subsp. *coriacea, Alectryon oleifolius* subsp. *oleifolius, Acacia tetragonophylla, Rhagodia preissii* subsp. *obovata* open shrubland over *Roepera fruticulosa, Senna glutinosa* subsp. *chatelainiana, Scaevola tomentosa, Threlkeldia diffusa* scattered low shrubs over **Cenchrus ciliaris* grassland.

AcRpPl *Acacia coriacea* subsp. *coriacea* open shrubland over *Rhagodia preissii* subsp. *obovata, Santalum spicatum, Pileanthus limacis, Roepera fruticulosa* low open shrubland over *Threlkeldia diffusa, Carpobrotus* sp. Thevenard Island (M. White 050), *Ptilotus villosiflorus* scattered herbs with **Cenchrus ciliaris* very open grassland.

AsMm *Acacia sclerosperma* subsp. *sclerosperma, Myoporum montanum* open to closed scrub over *Rhagodia preissii* subsp. *obovata* scattered shrubs over **Cenchrus ciliaris* open grassland.

CD Completely Degraded vegetation

N

0 25 50 100 150 200 m

Scale: 1:4,000 @ A3
GDA 1994 MGA Zone 49

CBR01
AcAoRp
CD
CORAL BAY RD
ROBINSON ST
AsMm
CBR02
CD
AcAoRp
FRENCH ST
BANKSIA WY
AcRpPl
CBQ01
AcAoRp
CD
AcAoRp
CD
AcAoRp
SANCTUARY RD

Source: Cadastre - Landgate, 2018
Orthophoto - Open Source

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RAC Tourism Assets
FLORA AND VEGETATION ASSESSMENT
CORAL BAY, WESTERN AUSTRALIA

VEGETATION UNIT MAP

Figure 7

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LEGEND

Site Boundary

Cadastre

Sample Sites

Quadrat

Releve

Vegetation Condition scale (from EPA, 2016)

- E: Excellent
- VG: Very Good
- G: Good
- P-G: Poor to Good
- P: Poor
- P-D: Poor to Degraded
- D: Degraded
- D-CD: Degraded to Completely Degraded
- CD: Completely Degraded

N

0 25 50 100 150 200 m

Scale: 1:4,000 @ A3
GDA 1994 MGA Zone 49

CBR01
P-D
D
CD
CBR02
P-G
D-CD
CD
P-D
CBQ01
G
D
P-D
CD
P-D
CD
D
CORAL BAY RD
ROBINSON ST
FRENCH ST
BANKSIA WY
SANCTUARY RD

Source: Cadastre - Landgate, 2018
Orthophoto - Open Source

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RAC Tourism Assets
FLORA AND VEGETATION ASSESSMENT
CORAL BAY, WESTERN AUSTRALIA

VEGETATION CONDITION MAP

Figure 8

Appendix 1 EPBC Act Protected Matters Report

Australian Government
Department of the Environment and Energy

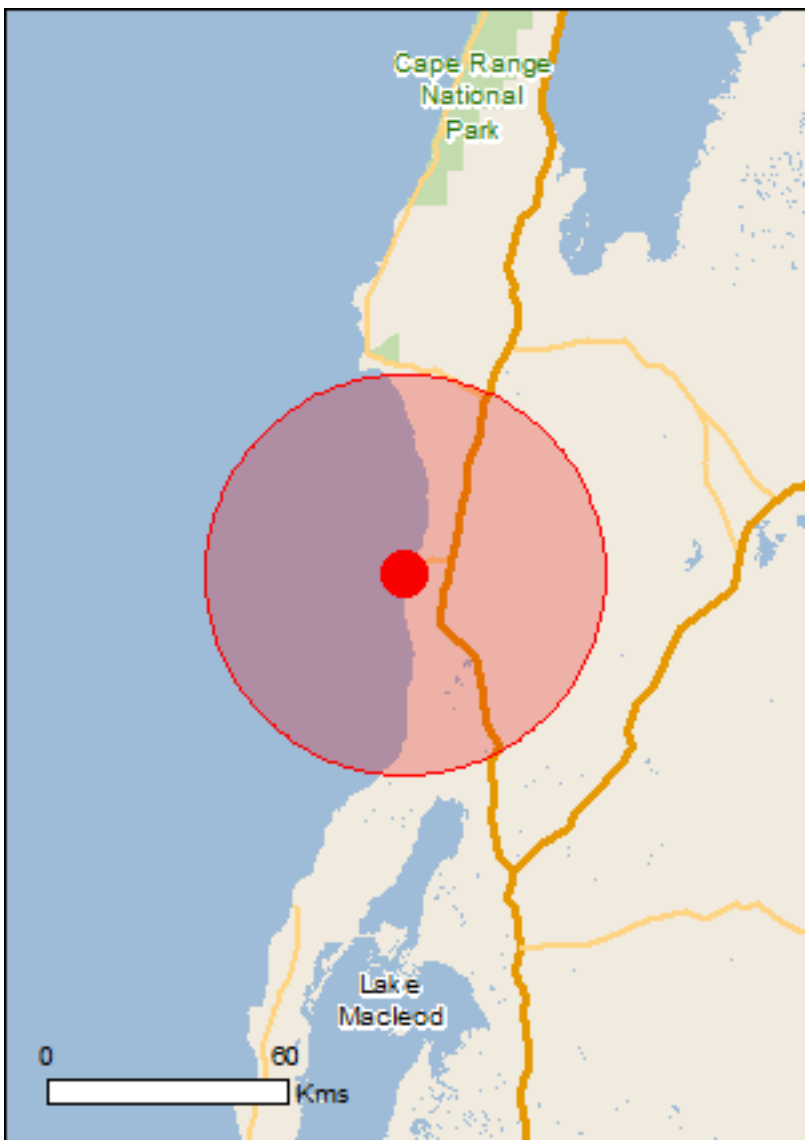
EPBC Act Protected Matters Report

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

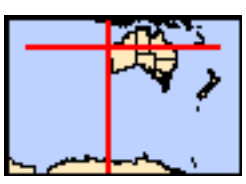
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 05/09/19 17:13:16



Coordinates
Buffer: 50.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	30
Listed Migratory Species:	44

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	1
Listed Marine Species:	61
Whales and Other Cetaceans:	26
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	3

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	9
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area [Resource Information]

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

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat may occur within area
Plants		
Pityrodia augustensis Mt Augustus Foxglove [4962]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area

Name	Status	Type of Presence
[Natator depressus](#)		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
[Carcharias taurus (west coast population)](#)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
[Carcharodon carcharias](#)		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
[Pristis zijsron](#)		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
[Rhincodon typus](#)		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Anous stolidus](#)		
Common Noddy [825]		Species or species habitat likely to occur within area
[Apus pacificus](#)		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardenna carneipes](#)		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
[Fregata ariel](#)		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
[Macronectes giganteus](#)		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
[Sterna dougallii](#)		
Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
[Thalassarche impavida](#)		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
[Balaena glacialis australis](#)		
Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
[Balaenoptera borealis](#)		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Balaenoptera edeni](#)		
Bryde's Whale [35]		Species or species habitat likely to occur within area
[Balaenoptera musculus](#)		
Blue Whale [36]	Endangered	Migration route known to occur within area
[Balaenoptera physalus](#)		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
[Motacilla cinerea](#)		
Grey Wagtail [642]		Species or species habitat may occur within area
[Motacilla flava](#)		
Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
[Actitis hypoleucos](#)		
Common Sandpiper [59309]		Species or species habitat known to occur within area
[Calidris acuminata](#)		
Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
[Calidris canutus](#)		
Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
[Calidris ferruginea](#)		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
[Calidris melanotos](#)		
Pectoral Sandpiper [858]		Species or species habitat known to occur within area
[Charadrius veredus](#)		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
[Glareola maldivarum](#)		
Oriental Pratincole [840]		Species or species habitat may occur within area
[Limosa lapponica](#)		
Bar-tailed Godwit [844]		Species or species habitat may occur within area
[Numenius madagascariensis](#)		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
[Pandion haliaetus](#)		
Osprey [952]		Breeding known to occur within area
[Tringa nebularia](#)		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places		[Resource Information]
Name	State	Status
Natural		
[Ningaloo Marine Area - Commonwealth Waters](#)	WA	Listed place

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
[Actitis hypoleucos](#)		
Common Sandpiper [59309]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Breeding known to occur within area
[Pterodroma mollis](#) Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
[Puffinus carneipes](#) Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
[Sterna dougallii](#) Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
[Thalassarche impavida](#) Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
[Bulbonaricus brauni](#) Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
[Choeroichthys brachysoma](#) Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
[Choeroichthys suillus](#) Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
[Doryrhamphus negrosensis](#) Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
[Festucalex scalaris](#) Ladder Pipefish [66216]		Species or species habitat may occur within area
[Filicampus tigris](#) Tiger Pipefish [66217]		Species or species habitat may occur within area
[Halicampus brocki](#) Brock's Pipefish [66219]		Species or species habitat may occur within area
[Halicampus spinirostris](#) Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
[Haliichthys taeniophorus](#) Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Ephalophis greyi](#) North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
[Hydrophis elegans](#) Elegant Seasnake [1104]		Species or species habitat may occur within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
[Pelamis platurus](#) Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
[Balaenoptera acutorostrata](#) Minke Whale [33]		Species or species habitat may occur within area
[Balaenoptera borealis](#) Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Balaenoptera edeni](#) Bryde's Whale [35]		Species or species habitat likely to occur within area
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Migration route known to occur within area
[Balaenoptera physalus](#) Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Delphinus delphis](#) Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
[Eubalaena australis](#) Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
[Feresa attenuata](#) Pygmy Killer Whale [61]		Species or species habitat may occur within area
[Globicephala macrorhynchus](#) Short-finned Pilot Whale [62]		Species or species habitat may occur within area
[Grampus griseus](#) Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
[Kogia breviceps](#) Pygmy Sperm Whale [57]		Species or species habitat may occur within area
[Kogia simus](#) Dwarf Sperm Whale [58]		Species or species habitat may occur within area
[Megaptera novaeangliae](#) Humpback Whale [38]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks	[Resource Information]
Name	Label
Gascoyne	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Unnamed WA37500	WA

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Commonwealth waters adjacent to Ningaloo Reef	North-west

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-23.1425 113.77333

Acknowledgements

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

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

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

Please feel free to provide feedback via the Contact Us page.

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Appendix 2 Department of Biodiversity Conservation and Attractions Threatened and Priority Flora Categories

Threatened Flora (*Biodiversity Conservation Act 2016*) and Department of Biodiversity Conservation and Attractions Priority Flora Categories (DBCA website, 2019)

Threatened Flora

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

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

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

Priority Flora

Priority One - Poorly Known Species.

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

Priority Two - Poorly Known Species.

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

Priority Three - Poorly Known Species.

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes

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

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

Appendix 3 Vegetation Structural Classes

Life form and height of tallest stratum	Projective foliage cover of tallest stratum as %	Description
Trees over 30 metres	70 -100	High closed forest
	30 -70	High open forest
	10 - 30	high woodland
	2 -10	high open woodland
	under 2	Scattered tall trees
Trees 10 - 30 metres	70 -100	Closed forest
	30 -70	Open forest
	10-30	Woodland
	2 -10	Open woodland
	under 2	Scattered trees
Trees under 10 metres	70 -100	Low closed forest
	30 - 70	Low open forest
	10 - 30	Low woodland
	2 -10	Low open woodland
	under 2	Scattered low trees
Shrubs over 2 metres	70 - 100	Closed scrub
	30 - 70	Open scrub
	10 - 30	High shrubland
	2 -10	High open shrubland
	under 2	Scattered tall shrubs
Shrubs 1 - 2 metres	70 - 100	Closed heath
	30 - 70	Open heath
	10 - 30	Shrubland

	2 -10	Open shrubland
	under 2	Scattered shrubs
Shrubs under 1 metre	70 - 100	Low closed heath
	30 - 70	Low open heath
	10 - 30	Low shrubland
	2 -10	Low open shrubland
	under 2	Low scattered shrubs
Herbs/Sedges/Grasses	70 - 100	Closed herb, sedge, grassland
	30 - 70	Herb, sedge, grassland
	10 - 30	Open herb, sedge, grassland
	2 -10	Very open herb, sedge, grassland
	under 2	Scattered herbs sedges, grasses

Grasslands then divided into:

- Tussock grasslands (perennial tussock species, e.g. *Eragrostis* species);
- Hummock grasslands (*Triodia* and *Plectrachne* species that form hummocks)
- Curly spinifex grassland (*Plectrachne pungens*, which does not form hummocks) (follows J.S. Beard).
- Annual tussock grassland (e.g. annual *Sorghum* species).

Appendix 4 Vegetation Condition Scale and Descriptions

Vegetation condition scale

(EPA, 2016 (adapted from Trudgen, 1988)).

E = Excellent. Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.

VG = Very good. Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.

G = Good. More obvious signs of damage caused by human activities since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.

P = Poor. Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.

D = Degraded. Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but, not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.

CD = Completely degraded. Areas that are completely or almost completely without native species in the structure of their vegetation; ie. areas that are cleared or "parkland cleared" with their flora comprising weed or crop species with isolated native trees or shrubs.

Appendix 5 List of flora recorded in the Coral Bay survey area

List of flora recorded in the Coral Bay survey area

Notes:
1. Plant families are listed in alphabetical order within the main classification groups.
2. An asterisk (*) beside the taxon name indicates an introduced species exotic to Western Australia (weed).
3. The 'status' column shows the conservation status of significant flora species on the list. T = Threatened Flora; P1 to P4 = Priority 1 to Priority 4 (see definitions in Appendix B); RS = other regionally significant flora

FAMILY/TAXA	COMMON NAMES	STATUS
ANGIOSPERMAE (flowering plants)		
ACANTHACEAE		
Dipteracanthus australasicus subsp. *corynothecus*		
AIZOACEAE		
Carpobrotus sp. Thevenard Island (M. White 050)		P3
* *Mesembryanthemum crystallinum*		
AMARANTHACEAE		
* *Aerva javanica*		
Amaranthus undulatus		
Ptilotus obovatus var. obovatus		
Ptilotus villosiflorus		
APOCYNACEAE		
Cynanchum viminale subsp. *austral*	(formerly *Sarcostemma viminale* subsp. *austral*)	
ASPARAGACEAE		
Acanthocarpus preissii		
Acanthocarpus robustus		
ASTERACEAE		
* *Flaveria trinervia*		
Gnephosis tenuissima		
Olearia axillaris		
Olearia sp. Kennedy Range (G. Byrne 66)		
Rhodanthe psammophila		
Senecio pinnatifolius		
BORAGINACEAE		
Heliotropium crispatum		
Trichodesma zeylanicum var. *zeylanicum*		
CELASTRACEAE		
Stackhousia muricata		

FAMILY/TAXA	COMMON NAMES	STATUS
CHENOPODIACEAE		
Atriplex semilunaris		
Enchylaena tomentosa		
Rhagodia preissii subsp. *obovata*		
Salsola australis		
Sclerolaena uniflora		
Threlkeldia diffusa		
CONVOLVULACEAE		
Ipomoea costata		
EUPHORBIACEAE		
Euphorbia sharkoensis		
FABACEAE		
Acacia coriacea subsp. *coriacea*		
Acacia pyrifolia var. *pyrifolia*		
Acacia ryaniana		P2
Acacia sclerosperma subsp. *sclerosperma*		
Acacia tetragonophylla		
Lotus australis		
Senna glutinosa subsp. *chatelainiana*		
GOODENIACEAE		
Dampiera incana var. *incana*		
Scaevola spinescens		
Scaevola tomentosa		
HEMEROCALLIDACEAE		
Dianella revoluta var. *divaricata*		
LAURACEAE		
Cassytha aurea var. *aurea*		
MALVACEAE		
Abutilon cunninghamii		
Sida calyxhymenia		
Sida fibulifera		
MYRTACEAE		
Pileanthus limacis		
Thryptomene dampieri		
NYCTAGINACEAE		
Commicarpus australis		

FAMILY/TAXA	COMMON NAMES	STATUS
POACEAE		
* *Cenchrus ciliaris*		
Eragrostis aff. eriopoda		
* *Eragrostis barrelieri*		
Paractaenum novae-hollandiae subsp. *novae-hollandiae*		
Spinifex longifolius		
Sporobolus virginicus		
Triodia ?epactia (one sterile plant)		
PORTULACACEAE		
Portulaca oleracea		
PROTEACEAE		
Banksia ashbyi (just outside western boundary of Site 2)		
SANTALACEAE		
Exocarpos aphyllus		
Santalum spicatum		
SAPINDACEAE		
Alectryon oleifolius subsp. *oleifolius*		
SCROPHULARIACEAE		
Myoporum montanum		
SOLANACEAE		
Nicotiana occidentalis		
Solanum cleistogamum		
Solanum lasiophyllum		
SURIANACEAE		
Stylobasium spathulatum		
ZYGOPHYLLACEAE		
Roepera fruticulosa	formerly *Zygophyllum fruticulosum*	
Roepera similis	formerly *Zygophyllum simile*	

Appendix 6 List of rare flora recorded in the Coral Bay survey area

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List of rare flora recorded in the Coral Bay survey area

Taxon	Cons. Status	Survey Area Location	Easting	Northing	Number of Plants	Comments
Acacia ryaniana	P2	Site 1	783472	7437672	1	60cm high; on crest of white sand dune
Carpobrotus sp. Thevenard Island (M. White 050)	P3	Site 1	783421	7437710	0.5% cover	Quadrat CBQ01
Carpobrotus sp. Thevenard Island (M. White 050)	P3	Site 3	784190	7438624	several	Releve CBR01

Appendix 7 Quadrat descriptions for the Coral Bay survey area

Quadrat descriptions for the Coral Bay survey area

Coral Bay **Site** CBQ01
Described by BRM **Date** 3/08/2019 **Type** Q 30x30
Season **Uniformity**
Location
MGA Zone 50 783421 **mE** 7437710 **mN** 119.767801 **E** -23.145159 **S**
Habitat Dune crest and slopes
Soil White calcareous sand
Rock Type na
Vegetation *Acacia coriacea* subsp. *coriacea* open shrubland over *Rhagodia preissii* subsp. *obovata*, *Santalum spicatum*, *Pileanthus limacis*, *Roepera aurantiaca* low open shrubland over *Threlkeldia diffusa*, *Carpobrotus* sp. Thevenard Island (M. White 050), *Ptilotus villosiflorus* scattered herbs with **Cenchrus ciliaris* very open grassland.
Veg Condition Good
Fire Age More than 10 years since fire

SPECIES LIST:

Name	Cover	C Class	Height	Specimen	Notes
Acacia coriacea subsp. *coriacea*	3		110	CBQ01-10	Acacia long lves
Acanthocarpus preissii	+		30	CBQ01-12	Acanthocarpos glaucous lf
Carpobrotus sp. Thevenard Island (M. White 050)	0.5		15	(=CBR01-09	Carpobrotus wte flr
Cassytha aurea var. *aurea*	+		60	CBQ01-05	Cassytha
Cenchrus ciliaris	5-6		35	CBQ01-06	Cenchrus ciliaris
Commicarpus australis	+		30	(=CBG33)	Pink flr stragler
Dampiera incana var. *incana*	+		30	CBQ01-09	Dampiera pple flr
Eragrostis barrelieri	+		20	CBQ01-11	Annual Eragrostis
Flavaria trinerva	+		20	(=CBG30)	Flavaria x 50
Euphorbia sharkoensis	+		5	(=CBG44)	Euphorbia small
Heliotropium crispatum	+		20	(=CBG35)	Wte flr helio
Lotus australis	+		12	(=CBG34)	Swainsona
Olearia axillaris	+		30	CBQ01-08	
Paractaenum novae-hollandiae subsp. *novae-hollandiae*	+		30	CBQ01-07	grass
Pileanthus limacis	3-4		35	CBQ01-01	Myrt in bud
Portulaca oleracea	+		10	(=CBG56)	Prtulaca
Ptilotus villosiflorus	0.5		12	CBQ01-02	Ptilotus wte flr
Rhagodia preissii subsp. *obovata*	1		80	CBQ01-03	Rhagodia succulent grn lf
Roepera fruticulosa	0.2		70	(=CBR01-04	Tribulus
Roepera similis	+		10	(=CBR01-16	Zygophyllum
Salsola australis	0.5		35		Salsola
Santalum spicatum	0.5		40	(=CBG39)	Santalum spicatum with fruit
Senecio pinnatifolius	+		30	(=CBG31)	Senecio lge ylw flr
Spinifex longifolius	0.2		50		Spinifex long
Threlkeldia diffusa	0.5		20	(=CBR01-07	Chenopod torpedo lves grn
Trichodesma zeylanicum var. *zeylanicum*	+		45	(=CBR01-12	Trichodesma

Appendix 8 Releve descriptions for the Coral Bay survey area

Releve descriptions for the Coral Bay survey area

Note: these site descriptions do not have a complete species list, but list representative species under 'Associated species'.

Coral Bay (Site 3) **Site:** CBR01
Described by BM **Date** 2/8/2019
Location: Site 3
Photo: 725-727 looking south from near northern boundary. Also 730, 731 from nearby.
AMG: Zone 49K; 784190mE, 7438624mN (GDA94)
Habitat: Dune crest and slopes.
Soil: Pale brown sand.
Rock Type: na
Vegetation: *Acacia coriacea* subsp. *coriacea* (150cm, 2%), *Alectryon oleifolius* subsp. *oleifolius* (120cm, 1%), *Rhagodia preissii* subsp. *obovata* (130cm, 0.5%) open shrubland over *Roepera fruticulosa*, *Senna glutinosa* subsp. *chatelainiana*, *Scaevola tomentosa* , *Threlkeldia diffusa* (40cm) scattered low shrubs over **Cenchrus ciliaris* (30-40%) grassland.
Assoc. species: *Nicotiana occidentalis*, *Carpobrotus* sp. Thevenard Island (M. White 050), *Salsola australis*, *Solanum cleistogamum* (20cm), *Exocarpos aphyllus* (160cm), *Trichodesma zeylanicum* var. *zeylanicum*, *Lotus australis*, *Gnephosis tenuissima*, *Heliotropium crispatum* (30cm), *Roepera similis*, *Ptilotus villosiflorus*, *Commicarpus australis* (80-100 cm), *Sclerolaena uniflora* (25cm), *Acacia tetragonophylla* (mostly in swales), *Enchylaena tomentosa* (70cm), *Eragrostis* aff. *eriopoda*, *Rhagodia preissii* subsp. *obovata*
Veg Condition (MET): Poor to Degraded. Very high **Cenchrus ciliaris* cover (30 to 40%). Scattered native species present.
Fire Age: More than 8 years since fire.

Coral Bay –(Site 1)- **Site** CBR02
Described by BM **Date** 31/08/2019
Location: Site 1
Photo: 735-737
AMG: Zone49K 783490 mE, 7437926mN (WGS84)
Habitat: low rise near beach.
Soil: white to pale yellow-brown sand.
Rock Type: limestone
Vegetation: *Acacia sclerosperma* subsp. *sclerosperma* (3m; 60%), *Myoporum montanum* (210cm; 3-4%) open to closed scrub over *Rhagodia preissii* subsp. *obovata* scattered shrubs over **Cenchrus ciliaris* (20%) open grassland (forms a grassland around the scrub).
Assoc. species: *Acacia coriacea* subsp. *coriacea*; *Stylobasium spathulatum*; *Abutilon cunninghamii*; *Threlkeldia diffusa*.
Veg Condition (MET): Good to Poor. High buffle cover. (Area of remnant vegetation only small, disturbed. ?Partly cleared.)

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