DONGARA TO CAPE BURNEY COASTAL VEGETATION SURVEY

NORTHERN AGRICULTURAL CATCHMENT COUNCIL

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Table of Contents

Dongara to Cape Burney Coastal Vegetation Survey

Acknowledgments ..... **iv**

Summary ..... **v**

1.0 Introduction **1**

1.1 Project Overview 1

1.1.1 Study Area Location *2*

1.2 Project Objectives 3

1.3 Previous Botanical Investigations 3

2.0 Existing Environment **4**

2.1 Physical 4

2.1.1 Climate *4*

2.1.2 Geology, Landforms and Soils *5*

2.1.3 Hydrology *6*

2.2 Biological 6

2.2.1 Bioregional Context *6*

2.2.2 Vegetation *7*

2.2.3 Threatened Ecological Communities *9*

3.0 Methodology **10**

3.1 Approach 10

3.2 Desktop Assessment 10

3.3 Field Survey 11

3.3.1 Timing of Survey *11*

3.3.2 Vegetation *12*

3.3.3 Flora Survey *14*

3.3.4 Vegetation Mapping *15*

3.3.5 Vegetation Condition Assessment *15*

3.4 Analysis and Interpretation 15

3.5 Limitations of Survey 18

4.0 Results **20**

4.1 Vegetation 20

4.1.1 Plant Communities *20*

4.1.2 Condition *21*

4.2 Flora 23

4.2.1 Floristic Quadrats *23*

4.2.2 Flora Inventory *23*

4.2.3 Range Extensions *23*

4.2.4 Introduced Flora *23*

4.2.5 Environmental Weeds *24*

4.3 PATN Statistical Analysis 25

5.0 Discussion **30**

5.1 Dongara to Cape Burney Plant Communities 30

5.2 Regional Context of Vegetation 36

5.3 Vegetation Condition 39

5.4 Areas of Conservation Significance 40
5.4.1 Least Represented Vegetation 40
5.5 Threatening Processes....44
5.5.1 Impacts on Vegetation Communities and Flora 45
6.0 Conclusions 57
6.1 Summary of Dongara to Cape Burney Findings....57
6.2 Conservation Significance of Beard Vegetation Associations 58
6.2.1 Regionally Significant – Endangered....58
6.2.2 Regionally Significant – Vulnerable....59
6.2.3 Locally Significant....59
6.3 Conservation Significance of Dongara to Cape Burney Vegetation Communities....60
6.3.1 Plant Communities with Restricted Extent 60
6.3.2 Significant Plant Communities in Terms of Ecological Function 61
6.4 Vegetation Conservation Priorities....61
6.5 Plant Species Conservation....63
6.6 Vegetation Condition....63
6.7 Future Implementation of the Dongara to Cape Burney Coastal Vegetation Survey ..63
References 64
Appendix One: Soil Summary 68
Appendix Two: Definitions and Criteria 69
Appendix Three: Flora Inventory 75
Appendix Four: Quadrat Details 79
Appendix Five: Maps 110

LIST OF TABLES

Table 1: Representation of Beard Vegetation Associations 8
Table 2: NVIS information hierarchy....13
Table 3: NVIS height classes....13
Table 4: Extents of each plant community in the study area 21
Table 5: Extent of each Keighery Vegetation Condition Score 22
Table 6: Keighery Vegetation Condition Score for each floristic quadrat....22
Table 7: Weed ratings 24
Table 8: Summary of DAFWA soil-landscape subsystems and phases occurring within the proposed corridor alignment (Rogers 1996) 68
Table 9: Definitions and criteria for Threatened Ecological Communities and Priority Ecological Communities (DEC 2007b)....69
Table 10: DEC conservation codes and definitions for flora 72
Table 11: EPBC Act categories....73
Table 12: Keighery (1994) Bushland Condition Scale....74
Table 13: Occurrence of flora taxa within floristic quadrats 75

LIST OF FIGURES

Figure 1: Location of Study Area 2

Figure 2: Monthly rainfall and daily maxima and minima averages for Geraldton Airport BoM recording station 4

Figure 3: 2009 monthly rainfall totals for Geraldton Town BoM recording station compared with long term average (1941 – 2009). 12

Figure 4: PATN dendrogram of Dongara to Cape Burney floristic quadrat data 25

Figure 5: PATN Dendrogram of Dongara to Cape Burney floristic data, without agricultural weed species. 27

Figure 6: Hierarchical arrangement of Dongara to Cape Burney Plant Communities 28

LIST OF PLATES

Plate 1: Mosaic of low coastal vegetation with a patch of Melaleuca cardiophylla / M. huegelii shrubland on the dune slope. 20

Plate 2: Subdivision showing clearing and fragmentation of bushland 45

Plate 3: Paddock with Acacia rostellifera and Anthocercis intricata (P3). 47

Plate 4: African Boxthorn (Lycium ferocissimum) 48

Plate 5: African Boxthorn clump near Cape Burney 48

Plate 6: Castor Oil Plant 49

Plate 7: Wild Oats and Saffron Thistle (greyish plants in foreground) 49

Plate 8: Iceplant 49

Plate 9: Giant Reed 50

Plate 10: Century Plant. 50

Plate 11: Sand blowout 51

Plate 12: Waterbirds on the Greenough River 53

Plate 13: Osprey fishing in the Greenough River 53

Plate 14: Erosion damage to foredunes by unrestricted walking access 54

Plate 15: New track becoming established beside existing track, where the existing track has become too boggy over the dune crest 55

Plate 16: Rubbish from recreation use 55

Plate 17: Erosion under access ramp 56

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Dongara to Cape Burney Coastal Vegetation Survey

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- Department of Environment and Conservation, including Catherine Page
- City of Geraldton-Greenough
- Shire of Irwin
- landholders of the Dongara to Cape Burney project area, who were happy to permit access to their properties.

Summary

Dongara to Cape Burney Coastal Vegetation Survey

A coastal planning project has been initiated by the Department of Planning, the City of Geraldton-Greenough and the Shire of Irwin to develop a strategy to provide planning guidance for future land development in the Dongara to Cape Burney coastal area.

A vegetation survey of 6394.45 hectares of native vegetation in the coastal strip identified and mapped vegetation communities using a combination of statistic analysis of floristic quadrats and visual assessment, mapped vegetation condition, and identified areas of conservation significance.

A total of 21 floristic quadrats were sampled during the field survey, which was conducted in early December 2009. A further four floristic quadrats from within the study area were sampled in spring 2008, during the Geraldton Regional Flora and Vegetation Survey, and included in the analysis.

A total of 122 taxa (including subspecies and varieties) from 43 families and 86 genera were recorded from these 25 quadrats, of which 30 (or 21%) were introduced species. One, *Anthocercis intricata*, was a Priority 3 species.

Following statistical analysis, using the floristic data collected, and interpretation nine plant communities were identified in the Dongara to Cape Burney study area. These included vegetation in riparian, estuarine, foredune and primary dunes (two plant communities), two dunal plant communities (one from close to the coast and the other from taller dunes to the east), and *Melaleuca* and mallee plant communities from the dune swales and Greenough Alluvial Flats.

The riparian *Eucalyptus camaldulensis* low woodland (plant community 1) may formerly have corresponded with the *critically endangered* TEC 42 Greenough River Flats: *Acacia rostellifera* low forest with scattered *Eucalyptus camaldulensis* on Greenough Alluvial Flats. However, as this vegetation was assessed to be in *completely degraded* to *degraded* condition in the Dongara to Cape Burney study area, it cannot be considered an extant community. Therefore, the TEC does not occur in the Dongara to Cape Burney study area.

Beard Vegetation Association 371 (Low forest; *Acacia rostellifera*) is considered to be regionally significant (endangered) and Beard Vegetation Association 352 (York gum woodland) regionally significant (vulnerable), whilst Beard Vegetation Association 433 (Mosaic: shrubland *Acacia rostellifera* and *Melaleuca cardiophylla* thicket / sparse low woodland; Illyarrie) is considered to be locally significant.

Seven of the nine plant communities are considered to have local significance due to their restricted extent in the Dongara to Cape Burney study area: plant community 1: riparian *Eucalyptus camaldulensis* low woodland, plant community 2: estuarine *Casuarina obesa* open woodland, plant community 3: foredune and primary dune *Atriplex* / *Scaevola* shrubland, plant community 4: *Nitraria billardierei* open shrubland, plant community 6: *Thryptomene baeckeacea* heathland, plant community 8: *Melaleuca* spp. forest or tall shrubland and plant community 8: mallee *Eucalyptus* spp. However, as the extents of plant communities 8 and 9 could not be accurately determined and were included in areas mapped as mosaics, their local significance was not accurately assessed.

Plant communities 2: estuarine *Casuarina obesa* open woodland, 3: foredune and primary dune *Atriplex* / *Scaevola* shrubland and 4: *Nitraria billardierei* open shrubland also have significance as they perform important ecological functions, including preventing soil erosion and providing important habitat.

Areas of vegetation in *very good* condition should also be regarded as having conservation significance.

Setting preliminary priorities for areas of conservation significance by intersecting the above areas have identified some areas along the Greenough River as having the highest significance for preservation or management in the Dongara to Cape Burney study area. Other areas that should be considered as having conservation priority include estuarine and foredune vegetation, plant community 6: *Thryptomene baeckeacea* heathland and some areas of plant community 8: *Melaleuca* spp. forest or tall shrubland.

1.0 Introduction

Dongara to Cape Burney Coastal Vegetation Survey

1.1 Project Overview

Due to increasing pressure to develop land adjacent to the high water mark between Dongara and Cape Burney, the Department of Planning (DP), the City of Geraldton-Greenough and the Shire of Irwin have initiated a coastal planning project to develop a strategy to provide planning guidance for future sustainable development in the area. The result will be the development of a strategic coastal management plan for use by planners, developers and the community.

The objectives of the Dongara to Cape Burney Coastal Strategy are to:

- assemble essential background information through research and consultation
- identify broad coastal processes and foreshore areas at risk from coastal processes
- address conservation values and landscape significance and provide mechanisms for their protection
- address existing coastal management issues, recreational needs including access, and provide broad strategies for management
- provide planning guidance, principles and targets for the appropriate location, type and purpose of sustainable development, for example coastal living and tourism
- consult and engage with stakeholders, including land owners, coastal and indigenous groups and the general community.

It has been identified that very little is known about the conservation significance of the existing vegetation, and that little floristic work has been completed within the area. Therefore, a vegetation survey of the coastal strip between Dongara and Cape Burney (the 'study area') is required to:

- identify and map the vegetation communities
- map the vegetation condition
- identify areas of conservation significance.

The information from this survey would then assist in identifying areas of conservation significance and provide a regional context for decision making in relation to development proposals within the study area that may impact on native vegetation.

Ecoscape was commissioned by the Northern Agricultural Catchments Council to undertake the vegetation survey in November/December 2009.

1.1.1 Study Area Location

Figure 1 outlines the extent of the vegetation surveyed for this project. The study area occupied the area between Cape Burney and Dongara, from the high water mark to Company Road and Brand Highway.

Figure 1: Location of Study Area

1.2 Project Objectives

The project objectives are to:

- assemble background environmental information
- identify and map vegetation communities
- refine the plant communities based on PATN statistical analysis
- discuss the vegetation in a regional context, especially in relation to the area immediately to the north
- assess and map vegetation condition
- identify areas of conservation significance
- identify threats and threatening processes.

The Dongara to Cape Burney study area overlapped with the 2008 Geraldton Regional Flora and Vegetation Survey (GRFVS) study area (Department of Planning & Ecoscape (Australia) Pty Ltd 2010; Ecoscape 2009), with part of the area south of the Greenough River being common to both surveys. This is known as the 'overlap' survey area: four floristic quadrats were recorded from area are included in the analysis for this survey.

1.3 Previous Botanical Investigations

Ecoscape has undertaken previous relevant botanical studies in the area including:

- Geraldton Regional Flora and Vegetation Survey (Department of Planning & Ecoscape (Australia) Pty Ltd 2010; Ecoscape 2009)
- Oakajee – Narngulu Infrastructure Corridor Flora and Vegetation Survey (Ecoscape 2010)
- Environmental Services for Karloo, Geraldton (Ecoscape 2007).

2.1 Physical

2.1.1 Climate

The South-West of Western Australia experiences a Mediterranean climate of mild, wet winters and warm to hot, dry summers. The climate of the region is strongly influenced by the position of a band of high pressure known as the sub-tropical ridge. For much of the year the ridge is located to the south allowing the east or south easterly winds to prevail. During the cooler months the ridge periodically moves to the north allowing cold fronts to pass over the west coast and deliver much of the annual rainfall (BoM 2009).

The nearest active Bureau of Meteorology (BoM) weather station to the study area is located at Geraldton Airport. The site has an average annual rainfall of nearly 460 mm over, on average, approximately 80 days annually. February is the hottest month, with the long-term maximum temperature averaging 32.5. July is the coldest month, with an average maximum temperature of 19.5°, although the average minimum temperature is colder in August, at approximately 9°. There is an annual average of 8-9 hours of sunshine per day, ranging from approximately 11 hours in January to 5-6 hours in July. Offshore land breezes are common in the morning, and sea breezes common in the afternoons, particularly in the summer months (BoM 2009). Rainfall and temperature data for Geraldton Airport is shown in **Figure 2**

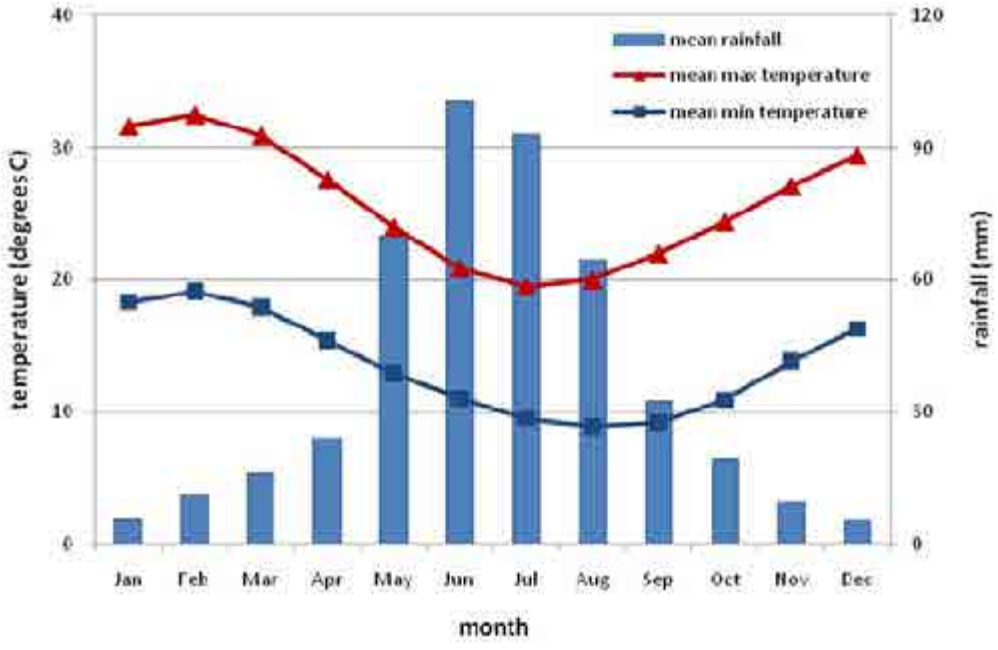

Figure 2: Monthly rainfall and daily maxima and minima averages for Geraldton Airport BoM recording station

2.1.2 Geology, Landforms and Soils

Geological mapping of the Geraldton and Dongara regions (Geological Survey of Western Australia 1973; Mory & Iasky 1995; Playford, Cockbain & Low 1976) outline that the study area is dominated by aeolian dunes composed of calcareous and quartz sand (equivalent of the Holocene Safety Bay Sands) near the coast, which are either mobile or fixed by vegetation. Tamala Limestone occurs to the east of the coastal dunes, as well as areas of alluvium associated with the Greenough River and related floodplain in the northern half of the study area.

Land system mapping encompassing the study area was first undertaken by Rogers (1996) of the Department of Agriculture and Food Western Australia (DAFWA) as part of a regional soil-landscape survey. Langford (2000) of the Geological Survey of Western Australia (GSWA), later broadly applied and refined the systems adopted by Rogers (1996), with an emphasis on regolith material at depth, together with its relationship to the underlying bedrock, as part of regolith-landform mapping of the Geraldton area (approximately encompassing the northern half of the study area). The naming of land systems typically followed that of Rogers (1996) with the exception of the Tamala South System which Langford (2000) renamed the Spearwood system to avoid confusion with the Tamala Limestone geological unit. Summaries of the land systems occurring within the study area according to Rogers (1996)/Langford (2000) are provided below:

- Quindalup Central/Quindalup System: Coastal dune system, including foredunes, beach ridge plains, parabolic dunes, deflation basins and flats. Aeolian processes dominant, with wave action important for erosion and deposition in the narrow coastal zone. Dunes and swales formed by southerly winds and eroded by coastal processes to form a westerly facing shoreline. Actively eroding to form blowouts in areas of vegetation loss. Calcareous deep and shallow sands.
- Tamala South/Spearwood System: Rises and low hills with relict dunes and some limestone outcrop. Originally calcareous dune sand, weathered by surface leaching and groundwater precipitation to form yellow and red residual quartz sand over white to light brown calcrete surface to the underlying calcarenite (Tamala Limestone).
- Greenough Alluvium System: Level alluvial plain with areas of minor terracing formed by fluvial deposition from the Greenough and Chapman Rivers on flood plains between dunes of the Spearwood and Quindalup Systems, and the inland plateau of the Moresby System. Red sandy and loamy earths, hard cracking and self-mulching clays.

Due to the hierarchical nature of soil-landscape mapping these systems can be further divided into firstly subsystems, and then phases (Schoknecht, Tille & Purdie 2004). At this higher level of detail, mapping units cover smaller areas with usually only minor soil

variation. A summary of sub-systems and phases occurring within the study area according to Rogers (1996) are provided in **Appendix One**.

Map 1 in **Appendix Five** indicates the soil landform systems in a regional context.

2.1.3 Hydrology

The study area is in the Greenough Drainage Basin, which is drained by the Chapman, Greenough and Irwin Rivers.

The Greenough River is 211 km long and drains 13 200 square kilometres. It originates north-east of Mullewa and flows mostly through agricultural lands. The sandbar at the river mouth, at Cape Burney, is only open after significant flows.

The salinity of the Greenough River is considered to be moderate (3 700 mg/L mean salinity, 1993-2002), and sedimentation as a result of agricultural clearing is regarded as problematic. The estuary has high nutrient levels and experiences a consistent algal bloom: the nutrient level is considered to be a result of animal wastes and fertilizers from agricultural activities.

Major floods have occurred sporadically since settlement, affecting floodplains, with the most recent occurring in 1999 (Stuart-Street *et al* 2005).

The superficial groundwater is generally fresh-brackish, commonly <2 000 mg/L TDS, except near the Greenough River where it is brackish (1 000 – 2 000 mg/L TDS), with small to moderate bore yields (<250 kL/day) in the coastal Spearwood Dunes. The groundwater of the Greenough Alluvial Flats, in the Cattamarra Aquifer is generally brackish with moderate bore yields (<500 kl/day) (Department of Water 2009).

2.2 Biological

2.2.1 Bioregional Context

The study area is located in the IBRA (Australian Government 2009; Australian Natural Resources Atlas 2009) Geraldton Sandplains bioregion, GS2 – Geraldton Hills subregion. The Geraldton Sandplains bioregion comprises mainly proteaceous scrub-heaths on the sandy earths of an extensive, undulating sandplain.

The Geraldton Hills subregion (GS2) incorporates the southern portion of the Carnarvon Basin and northern end of the Perth Basin, with exposed areas of Permian/Silurian siltstone and Jurassic sandstones mostly overlain by sandplains, alluvial plains, and coastal limestones. The vegetation is predominantly heathland with emergent *Banksia* and *Actinostrobus* on sandy soil, York gum woodlands on alluvial plains, proteaceous heath and

Acacia scrubs on limestones, low closed forest of *Acacia rostellifera* (now largely cleared) on alluvial plains of the Greenough and Irwin Rivers behind the beach dune system, south of Geraldton. The subregion also includes the Pinjarra Orogen (Northampton system) which is an area of hill country with a Proterozoic basement, and comprises extensive, undulating, lateritic uplands mantled in sandplain supporting proteaceous shrublands and mallees, while valleys support York Gum and Jam (Australian Natural Resources Atlas 2009).

2.2.2 Vegetation

Beard Vegetation Associations

Beard (1976b) considers the vegetation within the study area to form part of the Greenough and Ilyarrie Systems of the Irwin Botanical District. The Greenough System is associated with coastal limestone, with *Acacia rostellifera* and *Melaleuca cardiophylla* thickets on rocky ridges, *Acacia-Banksia* scrub on sand covered limestone and *Acacia rostellifera* low forest on the alluvial flats. The Ilyarrie System is also associated with coastal limestone and occurs on undulating country of lithified calcarenite overlain by variable depths of sand. North of the Arrowsmith River vegetation is predominantly thickets of *Acacia*, *Melaleuca* and mallee (Beard 1976a). Specific Beard Vegetations Associations mapped within the study area are outlined below:

- 125 - Bare areas; salt lakes
- 129 - Bare areas; drift sand
- 371 - Low forest; *Acacia rostellifera*
- 431 - Shrublands; *Acacia rostellifera* open scrub
- 433 - Mosaic: Shrublands; *Acacia rostellifera* & *Melaleuca cardiophylla* thicket / Sparse low woodland; illyarrie
- 352 – Medium woodland; York gum

Beard Vegetation Association Representation

DEC's 'Comprehensive and Adequate Reserve Analysis' data ('CAR' data 2007a) was used to determine the representation of Beard Vegetation Associations within Western Australia (**Table 1**). The Geraldton Regional Flora and Vegetation Survey (GRFVS) (Ecoscape 2009) identified limitations with the descriptions and the scale of mapping of these vegetation associations. This needs to be considered when using Beard Vegetation Associations to identify vegetation in the region.

Table 1: Representation of Beard Vegetation Associations

Region	Beard Vegetation Association	Extent (ha)		% Remaining
		Original	Current	
	125	3,489,858.39	3,246,667.14	93.03
	129	95,286.16	60,570.54	63.57
	371	32,816.04	3,315.20	10.10
	431	6,046.50	4,459.73	73.76
	433	32,460.48	14,226.10	43.83
Western Australia	352	724,272.93	120435.58	16.63
	125	8,651.09	5,901.84	68.22
	129	6,468.99	2,671.70	41.30
	371	32,807.61	3,315.20	10.10
	431	5,959.37	4,459.40	74.83
	433	32,460.48	14,226.10	43.83
Geraldton Sandplains Biogeographic Region	352	19,711.45	3,799.43	19.28
	125	2,904.53	341.60	11.76
	129	4,605.43	1,501.12	32.59
	371	32,807.61	3,315.20	10.10
	431	5,958.16	4,459.11	74.84
	433	14,363.76	3,233.44	22.51
Geraldton Hills Biogeographic Sub-region (GS1)	352	5,121.98	1,854.40	36.20
	125	126.00	108.77	86.33
	129	1,211.30	620.44	51.22
	371	26,215.58	961.88	3.67
	431	2,611.30	1,741.22	66.68
	433	319.45	102.37	32.05
Shire of Greenough	352	-	-	-
	125	-	-	-
	129	1,060.16	369.32	34.84
	371	521.48	148.14	28.41
	431	3,434.74	2,718.51	79.15
	433	32,141.04	14,123.73	43.94
Shire of Irwin	352	10,139.71	1,554.30	15.33
	125	119.1	101.7	85.41
	129	820.3	552.5	67.35
	371	1,714.3	77.4	4.51
	431	5,448.5	4,114.5	75.52
	433	1,389.8	406.2	29.23
Within Study Area	352	6.4	1.0	14.84

Coloured cells in **Table 1** indicate less than 10% of the vegetation association remaining (red) and 10-30% remaining (orange). Less than 10% remaining (red) indicates that the vegetation community is regarded by the EPA as *endangered* (EPA 2000) at a bioregional

scale[1]. Less than 30% remaining (orange) indicates a presumption against clearing (EPA 2000; EPA 2008).

Map 2 in **Appendix Five** shows the Beard Vegetation Associations in a regional context.

2.2.3 Threatened Ecological Communities

The *critically endangered* Threatened Ecological Community (TEC) 42 Greenough River Flats: *Acacia rostellifera* low forest with scattered *Eucalyptus camaldulensis* on Greenough Alluvial Flats (DEC 2010) occurs (or formerly occurred) in or close to the study area. The 1999 Interim Recovery Plan documents only 1.2 hectare of this community on the 'front flats' of the Greenough Alluvial Plain (Hamilton-Brown & Blyth 1999) however the actual location of the TEC is not disclosed.

The DEC now consider this community to be *presumed extinct*. This change in status is awaiting endorsement from the Minister for the Environment (C Page, DEC, *pers comm*).

There are no Priority Ecological Communities listed for the Dongara to Cape Burney area (DEC 2009).

Definitions and criteria for TECs and PECs are indicated in **Appendix Two**.

[1] Although bioregional scale is used by the EPA (2000) to define conservation significance, the colours are retained in the table at smaller scales to indicate concern.

3.0 Methodology

Dongara to Cape Burney Coastal Vegetation Survey

3.1 Approach

The flora and vegetation assessment methodology used was developed to comply with Ecoscape's interpretation of the EPA's *Guidance for the Assessment of Environmental Factors No 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (Environmental Protection Authority 2004) and *Terrestrial Biological Surveys as an Element of Biodiversity Protection Position Statement No. 3* (2002).

In order to determine the overall value of the vegetation and flora of the study area, data collected during the field survey was used to assess two different botanical attributes:

- vegetation types were described using the NVIS methodology (National Heritage Trust 2003) and mapped, indicating the distribution and relative abundance of each vegetation
- the overall flora was determined through the sampling of floristic quadrats. Data collected provided a measure of the overall floristic richness of the area, and identified the individual species present. It also identified species of particular conservation significance and introduced plant species.

The vegetation and flora surveys were carried out concurrently. The vegetation and floristic data was collected and described from 21 sampled quadrats with the floristic, biological and physical data from each of these quadrats recorded in detail. The flora records provided the names for use in the vegetation descriptions, and contributed to the flora species inventory. Several parameters relating to the individual quadrats were used to assist in both the description of vegetation types and the determination of flora.

3.2 Desktop Assessment

Prior to the field survey a desktop assessment was undertaken to identify possible quadrat locations within representative areas of different vegetation and soil types. The following were assessed using Geographic Information Systems (GIS):

- changes in vegetation pattern using 2006 aerial imagery supplied by DoP
- previous vegetation mapping from the Geraldton Regional Flora Survey (Ecoscape 2009)
- Beard vegetation association boundaries (DAFWA 2009)
- soil subsystems (DAFWA 2007)
- 2WD and 4WD access tracks.

The Beard native vegetation extent dataset was determined to be of sufficient accuracy this dataset has recently been updated by DAFWA (2009) using aerial imagery acquired from 1996 to 2006 and mapped at a scale from 1:10,000 to 1:20,000. Some coastal areas of the south west have been mapped at a scale of 1:5,000 to 1:15,000. The Beard extent boundaries matched closely with aerial photography supplied by the DoP and therefore no changes were made to this dataset.

The Beard vegetation pre-European dataset and current extent dataset were clipped to the study boundary using ArcGIS 9. Area calculations were done for both datasets to determine the area of each vegetation type remaining within the study boundary as presented in **Table 1**.

3.3 Field Survey

3.3.1 Timing of Survey

The field survey of the study area was conducted by Lyn Atkins (Senior Botanist) and Sonya Bateman (Environmental Scientist) over 5 days between 30th of November and the 4th of December 2009.

Seasonal conditions were considered to be favourable for the flora species reproduction, given the region had experienced above average rainfall for June and July of 2009. **Figure 3** outlines monthly rainfall totals for Geraldton during 2009, compared with long term averages. However, as the survey was conducted after the main flowering period for the region, many flora species had ceased flowering and annuals had desiccated and dropped their seeds. Therefore, many flora species could not be identified with certainty due to the lack of reproductive material required for identification.

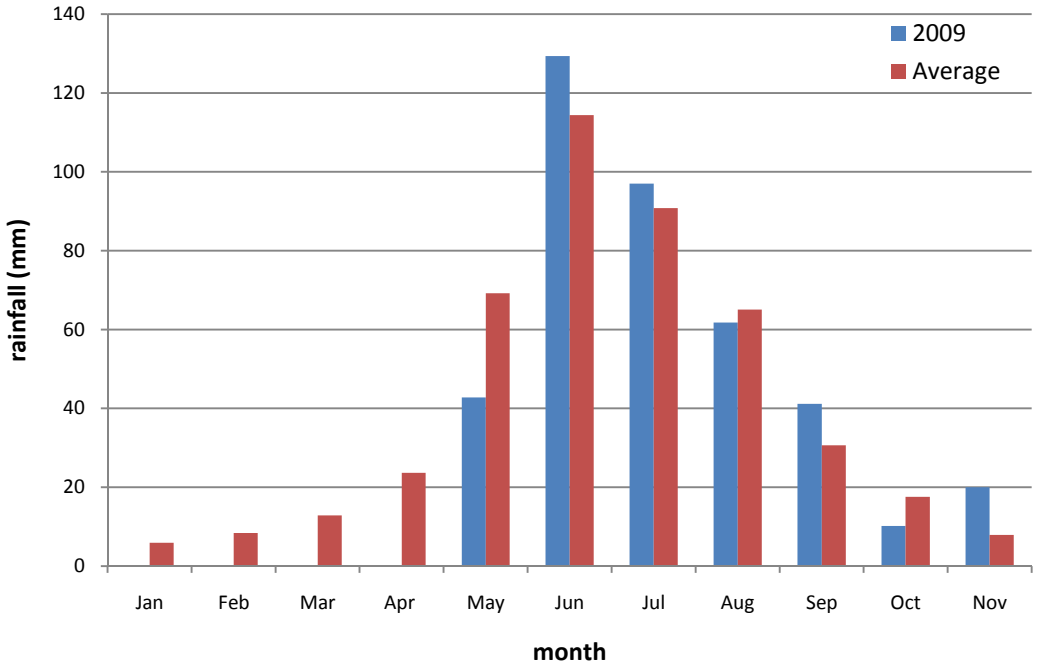

Figure 3: 2009 monthly rainfall totals for Geraldton Town BoM recording station compared with long term average (1941 – 2009).

3.3.2 Vegetation

A standard vegetation classification and description system was utilised during the vegetation survey. Descriptions were defined using the height and estimated cover of dominant species of each stratum using the National Vegetation Inventory System (NVIS) framework. The National Vegetation Information System (NVIS) (National Heritage Trust 2003) is a standardised nationally-consistent method of recording vegetation, and was used during the Geraldton Regional Flora and Vegetation Survey. It provides a comprehensive means of describing and representing vegetation information based on establishing relationships between structural and floristic data, and can be directly related to precise spatial areas as a vegetation map. A range of management and planning practices, including biodiversity conservation, salinity control, water quality control and fire management, can use the information collected by this system.

NVIS data is collected at various hierarchies, which equate to the level of detail and complexity of the information collected, shown below in **Table 2**. Levels V and VI are those recommended for data compilation.

Table 2: NVIS information hierarchy

Hierarchical Level	Description	NVIS Structural/Floristic Components Required
I	Class	Dominant growth form for the ecologically or structurally dominant stratum
II	Structural Formation	Dominant growth form, cover and height for the ecologically or structurally dominant stratum
III	Broad Floristic Formation	Dominant growth form, cover, height and dominant land cover genus for the upper most or the ecologically or structurally dominant stratum
IV	Sub-Formation	Dominant growth form, cover, height and dominant genus for each of the three traditional strata (i.e. Upper, Mid and Ground)
V	Association	Dominant growth form, height, cover and species (3 species) for the three traditional strata (i.e. Upper, Mid and Ground)
VI	Sub-Association	Dominant growth form, height, cover and species (5 species) for all layers/sub-strata

(National Heritage Trust 2003)

The GRFVS is recorded at Level V (Association level). At this level, information is collected in the field using the traditional three strata (Upper, Mid and Ground), recording the three dominant or characteristic species in each. There is a strict hierarchy assigned to how vegetation is recorded, with all species assigned to growth forms, strata confined to set height classes, and growth forms assigned to set strata (**Table 3** below). The result is a complex vegetation description, shown in floristic quadrat descriptions in **Appendix Four**).

Table 3: NVIS height classes

Height		**Growth Form**				
Height Class	**Height Range (m)**	tree, vine (M & U), palm (single-stemmed)	shrub*, fern, cycad, tree-fern, grass-tree, palm (multi-stemmed)	tree mallee, mallee shrub	grass**, sedge, rush, forb, vine (G)	moss, lichen, seagrass, aquatic
8	**>30**	tall	n/a	n/a	n/a	n/a
7	**10-30**	mid	n/a	tall	n/a	n/a
6	**<10**	low	n/a	mid	n/a	n/a
5	**<3**	n/a	n/a	low	n/a	n/a
4	**>2**	n/a	tall	n/a	tall	n/a
3	**1-2**	n/a	mid	n/a	tall	n/a
2	**0.5-1**	n/a	low	n/a	mid	tall
1	**<0.5**	n/a	low	n/a	low	low

(National Heritage Trust 2003)

* Shrubs can be divided into 'shrubs', 'heath shrubs', 'chenopod shrubs' and 'samphire shrubs'.

** Grasses can be divided into 'tussock grass', 'hummock grass', and 'other grass'.

Descriptions were made for each vegetation unit encountered during the survey. These vegetation descriptions were then grouped to arrive at vegetation units that were defined on the basis of shared structural, disturbance and floristic (species, abundance, cover) data. These units were also linked to the main landform/habitat types from which they were found to occur.

Vegetation condition was assessed using a rating scale that was developed based on a rating scale of Keighery (1994) detailed in **Appendix Two**.

3.3.3 Flora Survey

The flora survey involved the systematic sampling of floristic quadrats. Quadrats were typically 10 m x 10 m in dimension, as this size gives a good sample of flora presence in the Southwest Botanical Province and is in line with the DEC's Draft Botanical Survey Requirements for the Southwest Region (Department of Conservation and Land Management 2003) and EPA Guidance Statement *No. 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004). Where the vegetation extent was less than 10 m wide or oddly shaped (ie drainage systems), quadrat dimensions were altered as appropriate while maintaining an area of 100 m^2.

Quadrat locations were determined on the basis of topography/landform, interpretation and ground truthing of aerial photography, and field observations of vegetation structure and composition. In total 21 floristic quadrats were sampled, with at least two quadrats recorded from each native plant community identified. Each quadrat was given a unique identifying number (DCB09xx), and the following parameters were recorded:

- AMG coordinates recorded in GDA 94 datum using a hand-held Global Positioning System (GPS), to an accuracy usually within 5 m
- broad vegetation description based on the height and estimated cover of dominant species
- inventory of all species
- description of landform and habitat
- broad description of surface soil type
- percentage of litter cover and depth
- percentage of bare ground
- evidence of grazing, weed invasion, fires, rubbish dumping etc.

Colour photographs of the vegetation at each site were taken from the northwest corner of each quadrat.

Common species that were well known to the survey botanists were identified in the field. Voucher specimens of potentially significant flora species and other dominant species were

collected, assigned a unique number to facilitate tracking of data, and pressed in the field. Specimens collected than were dried and treated in accordance with the requirements of the West Australian Herbarium. These voucher specimens were identified with reference to appropriate publications, and/or comparison with pressed specimens housed at the West Australian Herbarium.

Nomenclature was checked against the current listing of scientific names recognised by the Western Australian Herbarium (WA Herbarium & DEC 2010) and updated as necessary .

All raw site data was entered into an Access (Site Species) database, with species names entered following formal identification of the collected specimens.

3.3.4 Vegetation Mapping

Plant communities were interpreted and mapped during the field assessment using visual assessment to identify plant communities and delineate the boundaries.

Ideally, floristic quadrat data is first collected and interpreted using PATN statistical analysis (detailed in **Section 3.4**), and the vegetation is then mapped, based on the plant communities interpreted from the floristic quadrat analysis. However, for the Dongara Cape Burney survey, time constraints did not permit separate surveys and the vegetation was mapped using the plant communities developed from the Geraldton Regional Vegetation and Flora Survey (Department of Planning & Ecoscape (Australia) Pty Ltd 2010; Ecoscape 2009), and adapted as necessary to account for the differences between the two areas.

3.3.5 Vegetation Condition Assessment

The vegetation condition of the project was assessed using the rating scale of Keighery (1994) detailed in **Appendix Two**. The vegetation condition of each floristic quadrat and the entire study area were assessed using this scale.

3.4 Analysis and Interpretation

PATN Analysis

PATN© statistical analysis (Belbin & Collins 2006), or earlier versions, have been used for several local floristic analyses including Gibson *et al* (1994) for the Swan Coastal Plain, Markey (1997) for the northern Darling Scarp, initially by Craig *et al* (2008) for the Ravensthorpe Ranges, the Geraldton Regional Flora and Vegetation Survey (Ecoscape 2009), and was the statistical analysis method specified in the project brief.

PATN© is a multivariate analysis tool that generates estimates of association (resemblance, affinity, distance) between sets of objects described by a suite of variables (attributes), and classifies the objects into groups and condenses the information and displays the patterns in the data graphically.

Presence / absence data recorded from the 25 floristic quadrats was used, with all species included in the analysis.

The fusion type used on the data was UPGMA (Unweighted Pair Group Mean Average also known as average link method) and is a simple agglomerative or bottom-up data clustering method. While the association measure used was the Kulczynski coefficient. Calculating association, resemblance, differences, correlation or affinity between objects or variables of the data table is one of the most important steps in pattern analysis. All classification, ordination and network techniques in pattern analysis use estimates of association (Belbin & Collins 2006). Stated previously in the report, the Bray Curtis Association is one of the best proven association measures in the field of ecology and is set as the default measure in PATN©. However, in this instance the Kulczynski coefficient was used as it was originally formulated for presence / absence data and it doesn't place the assumption on the data that differences between high data values are considered more significant than the same difference between low data values, as it does with the Bray Curtis Association (Clarke & Warwick 2001).

The results were displayed using a dendrogram (eg **Figure 4**). The number of hierarchical groups (in this case floristic groups) is not predetermined, but is chosen to best represent the pattens in the data emerging from the analysis. For the Dongara to Cape Burney data, it was considered that 8 floristic groups may be an appropriate number, thus **Figure 6** displays this number.

Generally, when interpreting a dendrogram, the earlier (further to the right) that a quadrat separates (splits) from the others, the more distinctive it is, and the later (further to the left), the greater the number of elements (in this case, species) in common. For the Dongara to Cape Burney quadrat data, the first separates quadrat DCB0916 from the rest, however this split may be an artefact because this quadrat only had two native species (when the analysis was run without agricultural weeds). Therefore, the second split, which separates the riparian floristic group from the others should be considered as the starting point of the interpretation, and subsequent splits further divided the quadrats into their separate floristic groups. The position of the splits (to the right) indicates that these groups have little similarity.

Vegetation Community Interpretation

PATN creates groups based on the data used in the analysis: in this case floristic (presence of plant species). There are no other factors used in the analysis, and therefore the resulting groups can be misleading, based purely on floristic associations, and require further interpretation.

Vegetation communities are generally described in terms of vegetation structure, dominant species and plant density (cover) values, none of which are used in PATN analysis. These factors are taken into account when determining vegetation communities and their names for this report.

3.5 Limitations of Survey

Possible Limitations	Constraints (Yes/No): Significant, Moderate or Negligible	Comment
Competency/experience of the consultant conducting the survey	No	The senior surveyor has over 20 years experience surveying Western Australian flora, and has recent experience working in the area.
Proportion of the flora identified	Negligible	122 species were recorded from the floristic quadrats. Despite the survey timing being not optimal (early summer rather than spring), only two species could not be identified to family level, 10 to genus level and two to species level.
Proportion of the task achieved and further work that may need to be undertaken	Negligible	25 floristic quadrats were recorded during the surveys, and are considered to adequately describe the vegetation of the area. Plant community mapping was conducted at a broad scale, and could not be conducted at a scale suitable for environmental surveys for development proposals.
Timing/weather/season/cycle	Negligible	The 2009 survey was conducted in early summer, which is not ideal for plant identification due to the lack of reproductive material and the desiccated nature of some annual species. Weather conditions were fine and clear during the survey. Seasonal rainfall was above average and most species had flowered well during spring. Four quadrats were recorded during spring 2008, when conditions were optimal with above average rainfall.
Intensity of survey (e.g. In retrospect was the intensity adequate?)	Moderate	25 floristic quadrats were recorded during the surveys, and are considered to adequately describe the vegetation of the area. Access to much of the area was impeded due to lack of tracks to the coast and locked private property, and plant community mapping was often achieved by interpreting aerial imagery rather than on-ground visual interpretation. Where not accessible, communities were often mapped as mosaics as the extent of the component communities could not be accurately determined.
Completeness (e.g. Was relevant area fully surveyed?)	Moderate	The vegetation community survey and floristic quadrats are considered sufficient to accurately describe the vegetation of the area, however lack of access meant plant community mapping was often achieved by aerial photograph interpretation and areas that could not accurately mapped may have been included as mosaics. Therefore, the full extent of plant communities mapped within mosaic areas and the areas included as plant community 4 (*Nitraria billardierei* open shrubland) are not accurately known.
Resources (e.g. Degree of expertise available for plant identification)	No	The senior botanists identifying the plants have sufficient experience to accurately identify the species in the field and herbarium.

Possible Limitations	Constraints (Yes/No): Significant, Moderate or Negligible	Comment
Remoteness and/or access problems	Moderate	Much of the area was inaccessible due to lack of access tracks between Brand Highway and the coast, through the coastal dunes.
Availability of contextual (e.g. bioregional) information for the survey area	Negligible	Descriptions of significant (Beard) vegetation associations are not adequate and have proven difficult to make accurate distinctions. However, none of these are likely to be Threatened Ecological Communities thus the limitations are descriptive rather than legislative. All other contextual information is adequate, however the extent of all communities is not known.

4.0 Results

4.1 Vegetation

4.1.1 Plant Communities

Vegetation was mapped using visual assessment during the field survey to detect variations in dominant species and vegetation structure, thereby identifying preliminary plant communities. As a result of floristic analysis, several of these communities were combined, and the plant community mapping reflects this analysis.

The nine different native plant communities identified as occurring in the study area are shown on **Maps 3a**-**3l** in **Appendix Five**. Due to the scale of the survey, small-scale changes in plant communities could not be individually mapped. The result is that much of the area has been mapped as mosaics of the various plant communities. **Plate 1** shows an example of a mosaic of vegetation types, where patches of *Melaleuca cardiophylla / M. huegelii* shrubland (plant community 8) occurred in the swales and occasionally on the dune slopes within low coastal shrubland (plant community 5), but at a scale too small to be mapped as an individual unit (<1 ha).

Plate 1: Mosaic of low coastal vegetation with a patch of Melaleuca cardiophylla / M. huegelii shrubland on the dune slope.

They are described in **Appendix Four** using NVIS (National Heritage Trust 2003) descriptions.

The extent of each plant community is indicated in **Table 4**. In many cases the vegetation occurred as a mosaic of two or more plant communities. The proportions of each of the

mosaic constituents were not constant, thus could not be calculated or estimated in any reasonable manner.

Table 4: Extents of each plant community in the study area

Plant Community		Area (hectares)	Percentage	Hectares included in mosaics
1	Riparian *Eucalyptus camaldulensis* low woodland	14.58	0.23	
2	Estuarine *Casuarina obesa* open woodland	8.22	0.13	
3	Foredune and primary dune *Atriplex* / *Scaevola* shrubland	134.25	2.10	
4	Foredune *Nitraria billardierei* open shrubland	*	*	
5	Low coastal *Scaevola* / *Rhagodia* / *Templetonia* / *Alyxia* shrubland	887.25	13.88	710.97
6	Coastal *Thryptomene baeckeacea* heathland	11.10	0.17	
7	Taller dune slope *Acacia rostellifera* / *Alyxia* / *Melaleuca depressa* / *Templetonia* shrubland	3312.19	51.80	1794.41
8	*Melaleuca* forest or tall shrubland	173.91	2.72	1785.68
9	Mallee *Eucalyptus obtusiflora* / *E. oraria*	33.37	0.52	50.83
5 & 8	Mosaic of low coastal / Taller dune slope	16.00	0.25	
5, 7 & 8	Mosaic of low coastal / Taller dune slope / *Melaleuca*	694.97	10.87	
7 & 8	Mosaic of Taller dune slope / *Melaleuca*	1057.78	16.54	
7 & 9	Mosaic of Taller dune slope / Mallee	17.90	0.28	
7, 8 & 9	Mosaic of Taller dune slope / *Melaleuca* / Mallee	7.76	0.12	
8 & 9	Mosaic of *Melaleuca* / Mallee	25.17	0.39	
Total Extent of Native Vegetation		**6394.45**	**100.00**	

*Plant community 4 was not mapped as a separate unit during the field survey. It appears on **Map 3k** as a token area to indicate its approximate location.

4.1.2 Condition

The area of each of the Keighery (1994) Vegetation Condition score for the entire area are indicated in **Table 5**, with the condition score for each floristic quadrat indicated in **Table 6**.

No vegetation assessed as being in *pristine* or *excellent* condition was observed during the field assessment. Due to the weedy nature of the area, by definition these condition scores could not be attributed.

Table 5: Extent of each Keighery Vegetation Condition Score

Condition Rating	Extent (ha)	Percent
Pristine	0	0
Excellent	0	0
Very Good	3376.17	52.80
Good	2325.72	36.37
Degraded	687.49	10.75
Completely Degraded	5.06	0.08
Total	**6394.45**	**100.00**

Table 6: Keighery Vegetation Condition Score for each floristic quadrat

Quadrat No.	Native Species	Introduced Species	% Introduced Species	Condition
DCB0901	7	2	22.22	*Good*
DCB0902	11	6	35.29	*Very good*
DCB0903	12	9	42.86	*Good*
DCB0904	17	15	46.88	*Good*
DCB0905	20	2	9.09	*Very good*
DCB0906	7	6	46.15	*Good*
DCB0907	2	10	83.33	*Degraded*
DCB0908	7	4	36.36	*Good*
DCB0909	12	3	20.00	*Good*
DCB0910	6	9	60.00	*Degraded*
DCB0911	8	3	27.27	*Good*
DCB0912	24	6	20.00	*Very good*
DCB0913	9	6	40.00	*Good*
DCB0914	4	2	33.33	*Good*
DCB0915	5	7	58.33	*Good*
DCB0916	2	4	66.67	*Degraded*
DCB0917	5	1	16.67	*Very good*
DCB0918	26	5	16.13	*Very good*
DCB0919	18	4	18.18	*Very good*
DCB0920	7	7	50.00	*Good*
DCB0921	8	8	50.00	*Degraded*
GRV0846	13	6	31.59	*Very good*
GRV0847	15	3	16.67	*Very good*
GRV0848	11	11	50.00	*Very good*
GRV0849	13	7	35.00	*Very good*

4.2 Flora

4.2.1 Floristic Quadrats

A total of 21 floristic quadrats were recorded during the 2009 survey, with an additional four quadrats included from the Geraldton Regional Flora and Vegetation Survey. Locations of the quadrats are shown on **Maps 4a**-**4l** and **Map 5,** and the flora species inventory from the quadrats is included in **Appendix Three**. Detailed descriptions of each floristic quadrat, including a photograph, are included in **Appendix Four**.

The vegetation of the floristic quadrats, using NVIS descriptions (National Heritage Trust 2003), are summarised in **Appendix Four**, and the plant community in which they occurred (as identified from PATN analysis) included.

4.2.2 Flora Inventory

A total of 122 taxa (species, subspecies and varieties) from 43 families and 86 genera were recorded within the survey area. Due to the lack of reproductive material, two specimens were only identified to family level, ten only to genus, and two were unable to be identified.

The families with greatest representation in the study area were the Poaceae (grass) family (19 taxa, 12 non-native), the Asteraceae (daisy) family (13 taxa, six non-native), the Chenopodiaceae (chenopod) family (13 taxa, one non-native) and the Myrtaceae (eucalypt) family (10 taxa). The most taxa rich genera were *Melaleuca* (7 taxa) followed by *Austrostipa*, *Atriplex*, *Eucalyptus*, *Pimelea, Rhagodia,* and *Tecticornia* all represented by 3 taxa. Twenty-one families and 65 genera were represented by a single taxon (species, subspecies or variety); ie there were no close relatives of these taxa identified during the survey.

A flora list, including a summary of occurrence within floristic quadrats, is provided in **Appendix Three**.

4.2.3 Range Extensions

No species identified during the floristic survey are considered to be range extensions.

4.2.4 Introduced Flora

There were 30 introduced flora species identified during the floristic quadrat survey, representing 21% of all species. These are listed below in **Table 7.**

4.2.5 Environmental Weeds

Environmental weeds include those listed as *Declared Plants* under the *Agriculture and Related Resources Protection Act 1976* (Government of Western Australia 1976). *Declared Plants* require a degree of control, depending on their rating in the district they are encountered (Government of Western Australia 2009).

Environmental weeds also include those listed as *Weeds of National Significance (WONS)* (Weeds Australia 2008). .

Another method of ranking weeds is the *Environmental Weed Strategy of Western Australia* (EWSWA) (Department of Conservation and Land Management 1999). Weeds identified as *high risk*, which are those weeds that have the ability to invade bushland in *good* to *excellent* condition, have a wide current or potential distribution, and have the ability to change the structure, composition and function of an ecosystem, in particular to form a monoculture.

Table 7: Weed ratings

Scientific Name	Common Name	EWSWA	WONS	APPRA
Anagallis arvensis	Pimpernel	Moderate	-	-
Arctotheca calendula	Cape Weed	Moderate	-	-
Avena barbata	Bearded Oat	Moderate	-	-
Brassica tournefortii	Mediterranean Turnip, Wild Turnip	High	-	-
Bromus diandrus	Great Brome	High	-	-
Bromus rubens	Red Brome	Moderate	-	-
Carpobrotus edulis	Hottentot Fig, Pigface	Moderate	-	-
Carthamus lanatus	Saffron Thistle	Low	-	P1, P3, P4
Chenopodium murale	Nettleleaf Goosefoot or Green Fat Hen	Low	-	-
Cynodon dactylon	Couch	Moderate	-	-
Ehrharta spp.	Veldt Grass	Low - High	-	-
Euphorbia terracina	Geraldton Carnation Weed	High	-	-
Hordeum leporinum	Barley Grass	Moderate	-	-
Hypochaeris glabra	Smooth Cat's Ear, Flat Weed	Moderate	-	-
Lolium sp.	Ryegrass	Low - Moderate	-	-
Lycium ferocissimum	African Boxthorn	High	-	-
Mesembryanthemum crystallinum	Common Ice Plant	Moderate	-	-
Parapholis incurva	Coast Barbgrass	Mild	-	-
Petrorhagia dubia	Velvet Pink	Mild	-	-
Polypogon monspeliensis	Annual Beardgrass	Moderate	-	-
Reichardia tingitana		Unrated	-	-
Silene gallica	French Catchfly	Low	-	-
Sonchus oleraceus	Common Sowthistle	Moderate	-	-
Tetragonia decumbens	Sea Spinach	Moderate	-	-

Scientific Name	Common Name	EWSWA	WONS	APPRA
Trachyandra divaricata	Onion Weed, Dune Onion Weed	Mild	-	-
Trifolium campestre	Hop Clover	Moderate	-	-
Urospermum picroides	False Hawkbit	Moderate	-	-
Vulpia bromoides	Squirrels Tail Fescue, Vulpia	Moderate	-	-
Vulpia myuros	Rat's Tail Fescue	Unrated	-	-

4.3 PATN Statistical Analysis

The floristic quadrat data was analysed using PATN analysis.

PATN analysis performed on the presence / absence floristic data for the study area did not, after interpretation, indicate logical floristic groupings. **Figure 4** shows this dendrogram: **Appendix Four** has a description of the vegetation of each quadrat.

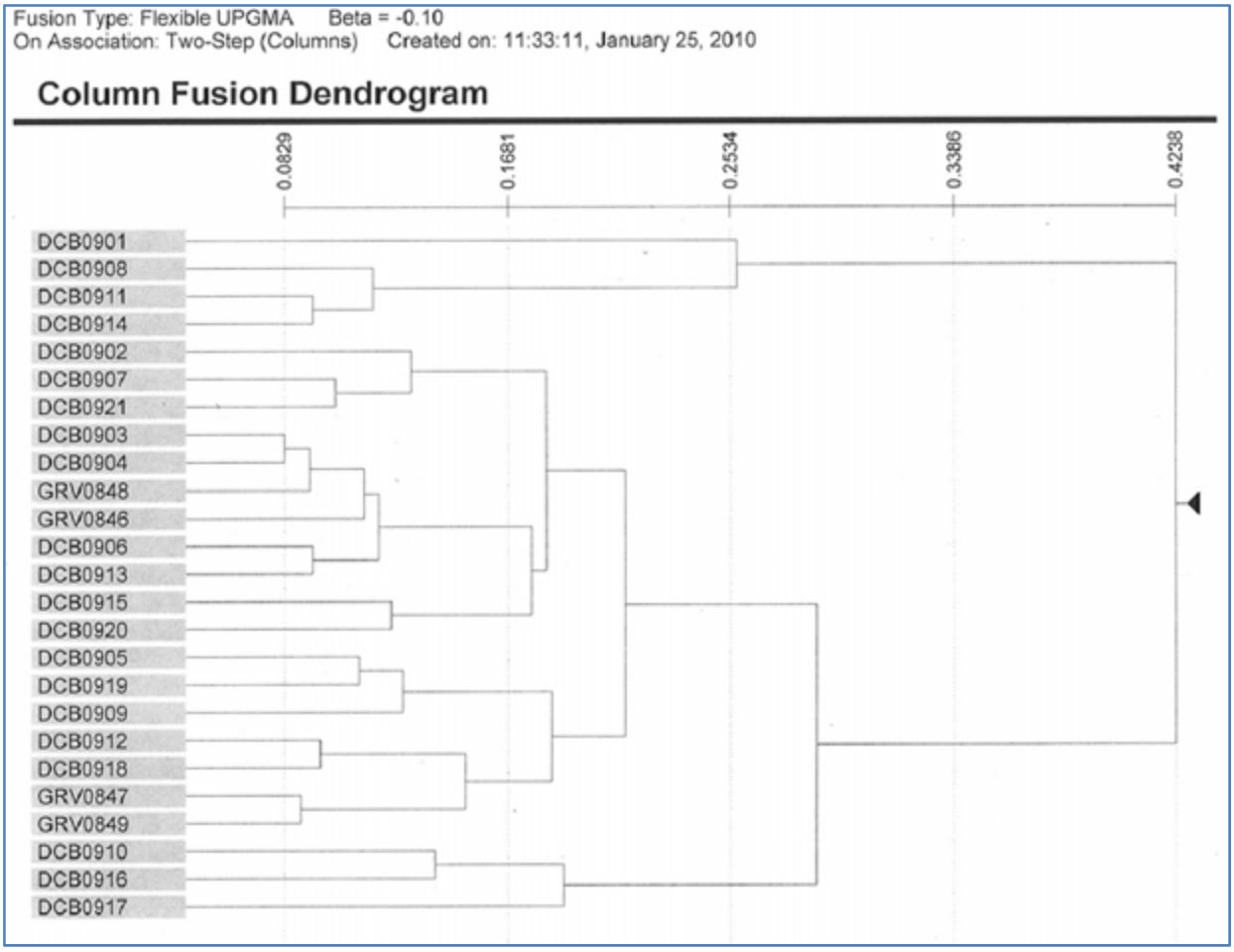

Figure 4: PATN dendrogram of Dongara to Cape Burney floristic quadrat data

As a result, PATN analysis was then performed on the same data, but removing agricultural weeds as it appeared likely that these may have influenced the groupings due to the high proportion of weeds in some quadrats (eg DCB0907 and DCB0916, see **Table 6**). *Lycium*

ferocissimum and *Tetragonia decumbens* were not regarded as agricultural weeds and thus remained in the dataset.

Removing the agricultural weeds resulted in a dendrogram (**Figure 5**) indicating floristic groupings that often correlated with groups recognised from the visual vegetation community survey. Some reinterpretation was required, including separating groupings on vegetation structure, which is not a factor included in PATN analysis using species. Factors used in interpretation include:

- Quadrat DCB0916, which is indicated as a unique grouping in **Figure 5**, is not actually unique but represents a *degraded* vegetation type with only two native species. Thus it is included in other groups.
- DCB0901 is a unique group (Estuarine, plant community 2)
- DBC0902, 21, 15 and 17, grouped closely in the dendrogram, are a unique group dominated by various *Melaleuca* species (plant community 8). DCB0904 and GRV0847 have been added to this group as they are also dominated by *Melaleuca* species.
- DCB0908, 11 and 14 are a unique group occurring on foredunes and close to the ocean on primary dunes (plant community 3)
- the central portion of the **Figure 5** dendrogram, including the section annotated as 'mostly TDS' (Taller dune slope) and 'low coastal', requires interpretation to form the various plant communities described below. This indicates that they are floristically closely related.

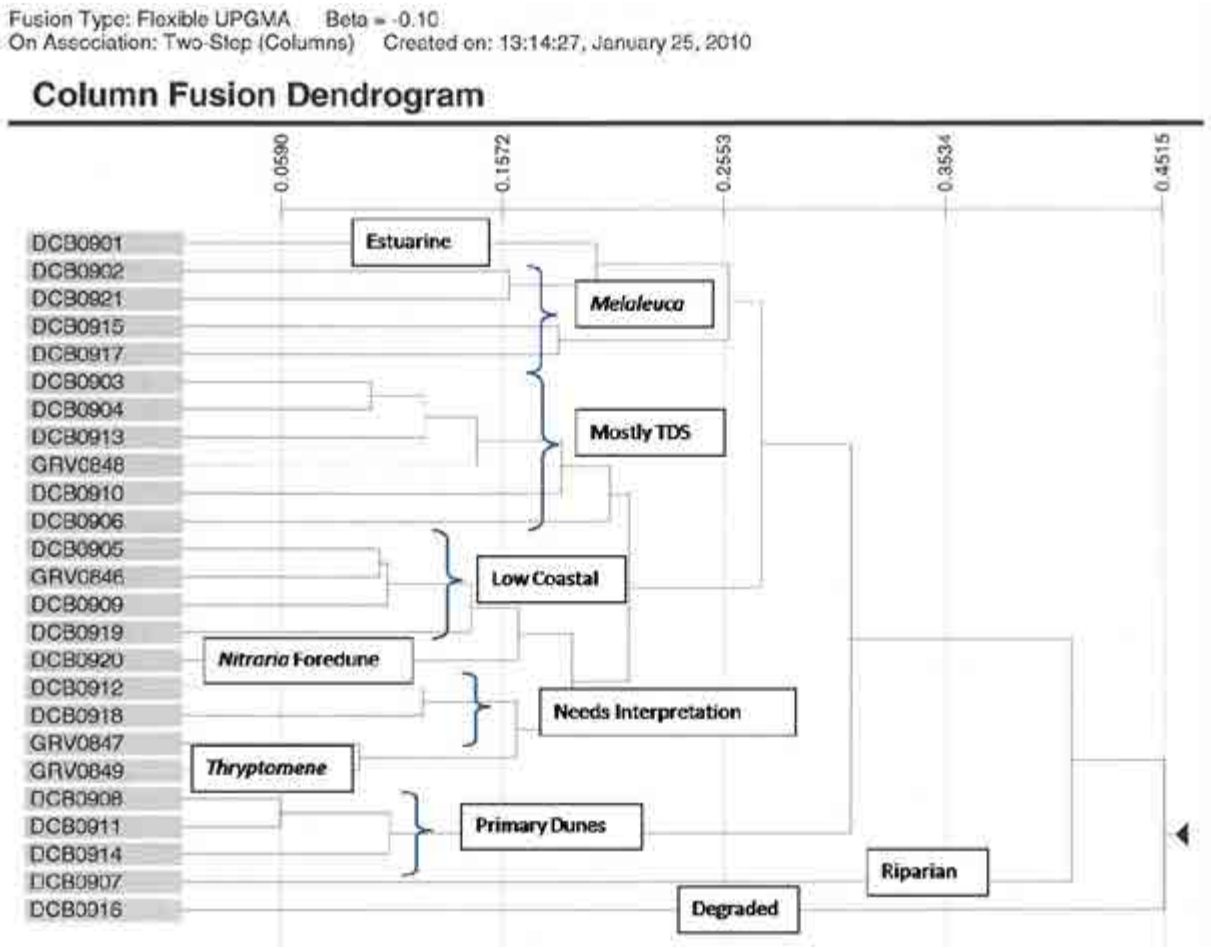

Figure 5: PATN Dendrogram of Dongara to Cape Burney floristic data, without agricultural weed species.

Analysis of the PATN dendrogram and interpretation (using floristics and vegetation structure) resulted in a hierarchy of nine different plant communities. These are indicated in green in **Figure 6**, with their relationships.

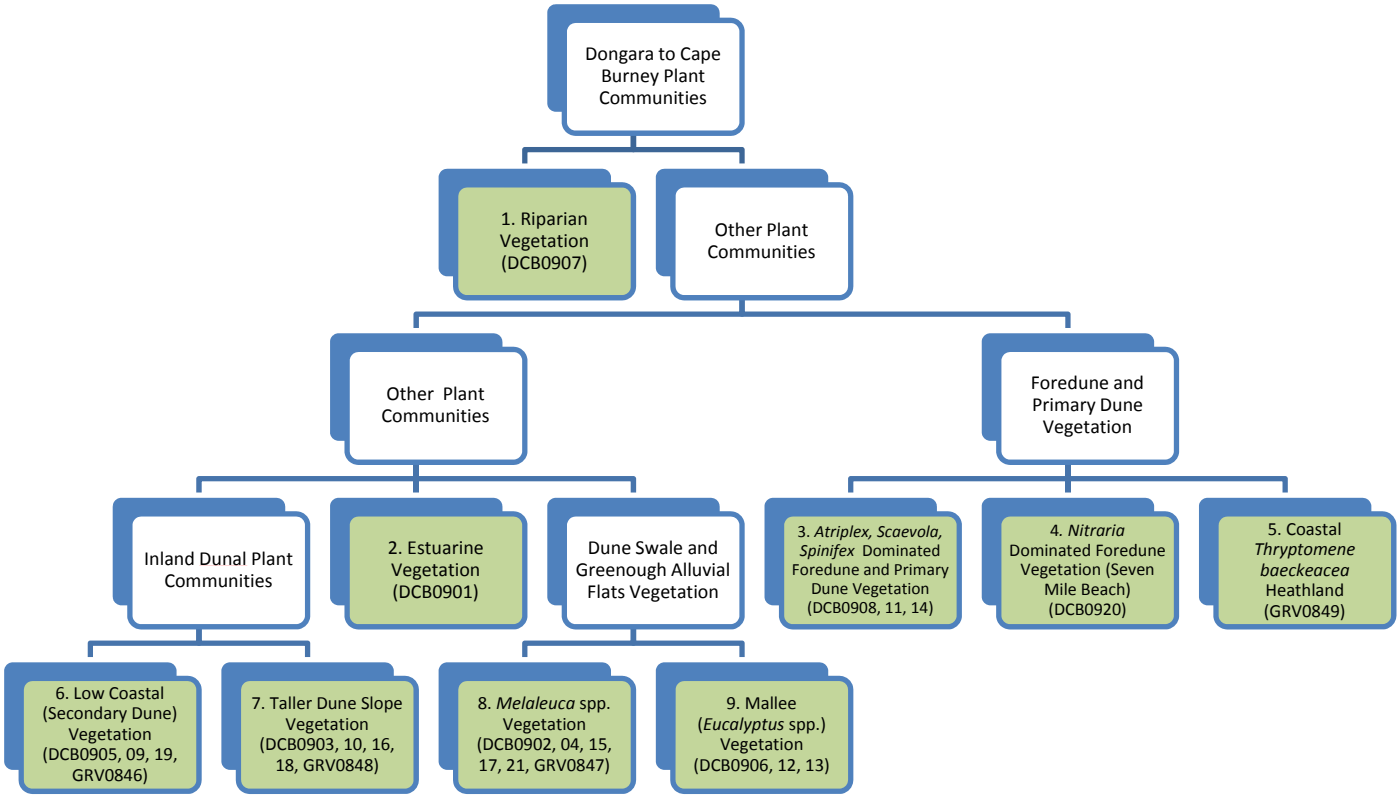

Figure 6: Hierarchical arrangement of Dongara to Cape Burney Plant Communities

Descriptions of these plant communities are:

1. **Riparian**: *Eucalyptus camaldulensis* low woodland or forest over introduced species (DCB0907), which occurred along the Greenough River on the western side of the Greenough Alluvial Plain, upstream from the estuarine area. The positioning of DCB0907 as an early 'split' in the dendrogram (**Figure 5**) indicates that this is the most unique plant community in the study area, in terms of floristics.
2. **Estuarine**: *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland (DCB0901), which occurred in the estuary of the Greenough River
3. **Foredune and primary dune**: *Atriplex isatidea, Scaevola crassifolia, Threlkeldia diffusa, Angianthus cunninghamii, Olearia axillaris* shrubland over *Spinifex longifolius* tussock grassland over *Tetragonia decumbens* forbland (DCB0908, DCB0911, DCB0914), abbreviated to *Atriplex / Scaevola* shrubland. This was the dominant vegetation on the foredunes (where they occurred) and primary dunes immediately behind the foredunes, and merged into plant community 5.
4. **Foredune**: *Nitraria billardierei* open shrubland over *Atriplex amnicola* and *Threlkeldia diffusa* shrubland and *Spinifex longifolius* tussock grassland (DCB0920), found only at Seven Mile Beach where there were no actual dune formation and the area immediately behind the beach was flat. This plant community was not identified as unique during the field survey, thus has not been mapped as a separate unit. Further surveys would be required to determine if it occurs in other areas. It is floristically most closely related to Plant community 5.

5. **Low coastal (secondary dune)**: *Scaevola crassifolia, Rhagodia preissii, Templetonia retusa* and *Alyxia buxifolia* open shrubland (DCB0905, 09, 19, GRV0846), occurring on the stable secondary dunes.
6. **Coastal:** *Thryptomene baeckeacea* Heathland (GRV0849). Quadrat GRV0849 was identified as being a unique floristic group during the GRFVS PATN analysis and has been retained in the Dongara to Cape Burney area due to its unique structure and dominant species. It was only observed at Cape Burney, which was included in both survey areas.
7. **Taller dune slope**: *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland (DCB0903, 10, 16, 18, GRV0848). This plant community occurred on the dune slopes and crests, and often in the swales, inland of plant community 5. It often merged with plant community 5, occurring as either a subtle merge, or as a mosaic in pockets of taller vegetation in the swales. Occasionally it occurred in a more degraded form, generally dominated by *Acacia rostellifera*.
8. **Dune swale and Greenough Alluvial Flats Melaleuca**: *Melaleuca lanceolata* Forest or *Melaleuca cardiophylla* and *Melaleuca huegelii* tall shrubland (DCB0902, 04, 15, 17, 21, GRV0847). It was anticipated that the *Melaleuca lanceolata* plant community would be floristically unique from the other *Melaleuca* communities, however PATN analysis grouped the various *Melaleuca* communities together or scattered in no apparent pattern throughout other apparent groupings, from which they were separated on structural characteristics. This plant community occurred in the northern part of the study area, not far from the Greenough River, or in the dune swales further south (and becoming more frequent and more coastal towards the south), and on the Greenough Alluvial Flats. Occasionally there were mallee *(Eucalyptus*) species scattered amongst the *Melaleuca*, however mostly the mallee were unique communities. Where the *Melaleuca* communities occurred in dune swales, the lack of access, available survey time and scale of their occurrence often resulted in this plant community being mapped as a mosaic rather than a separate unit.
9. **Mallee**: *Eucalyptus obtusiflora* and *Eucalyptus oraria* (DCB0906, 12, 13). This plant community generally occurred in swales and associated dune slopes, generally towards the southern portion of the study area. Occasionally the mallee species occurred within the *Melaleuca* communities, but were not the dominant life form. Like the *Melaleuca* communities, the lack of access, available survey time and scale of their occurrence often resulted in this plant community being mapped as a mosaic rather than a separate unit.

5.0 Discussion

5.1 Dongara to Cape Burney Plant Communities

Nine different plant communities were identified in the Dongara to Cape Burney area by a combination of field survey and statistical analysis. Of these, one was not mapped as it was not identified as a unique community during the field survey and further survey is suggested to map the extent and search for additional occurrences.

These plant communities are discussed in terms of their extents, where they were found, catenary sequence and geographical location within the study area and region.

As detailed in **Section 4.1.1**, due to constraints not all areas could be accessed for ground truthing. It was apparent that plant communities 3 – 8 largely merged from one into another, and therefore in most cases boundary mapping is approximate.

Boundaries were distinct for plant communities 1 and 2 (riparian and estuarine communities), which were confined to their appropriate landform.

In most cases, boundaries were also distinct for plant communities 8 (*Melaleuca* communities) and 9 (mallee community), but these often occurred at a scale too small to map at the scale used. These areas were mapped as a mosaic of the different component plant communities. Additionally, they also occurred in areas that were not accessible and boundaries were not distinctive on the aerial imagery supplied. These areas were also mapped as mosaics of the different communities, after considerable effort was made to determine where these mosaics occurred and their likely components.

Plant community 1: Riparian Eucalyptus camaldulensis low woodland

This plant community was identified from the Greenough River, in the small riparian area south of Phillips Road on the Greenough Alluvial Flats. One quadrat was recorded in this vegetation type. The riparian area was highly disturbed and had almost no native species except the dominant and characteristic species *Eucalyptus camaldulensis*.

This plant community is the remains of the *critically endangered* Threatened Ecological Community 42 '*Acacia rostellifera* low forest with scattered *Eucalyptus camaldulensis* on the Greenough Alluvial Flats' (DEC 2010). According to the 1999 Interim Recovery Plan for this community (Hamilton-Brown & Blyth 1999), there is only 1.2 hectares of this community remaining on the front flats, although it now regarded as *presumed extinct* (C Page, DEC, *pers comm*.). Although the vegetation mapped as this plant community in the

Dongara to Cape Burney survey occupied approximately 14 hectares, the *degraded* and *completely degraded* condition of the vegetation means that it cannot be considered as an extant community.

This plant community is restricted to riparian (riverine) landforms, and is therefore restricted in extent. In the Dongara to Cape Burney study area this is 14.58 ha, 0.23% of the total area included in the vegetation extent mapping. This small proportion is unsurprising as the study area is confined to the coastal strip, where there are no minor streams and only a small area of the non-estuarine Greenough River channel. Regionally, the equivalent GRFVS plant community (2 Riparian *Eucalyptus camaldulensis / Casuarina obesa /Melaleuca rhaphiophylla*) was similarly confined to non-estuarine riparian areas associated with the major drainage lines.

The main threats to the community are clearing, weed invasion (although it is already very weedy), hydrological change including salinity changes and to period of inundation, grazing, soil erosion caused by livestock grazing and flood events, and fire.

Plant community 2: Estuarine Casuarina obesa open woodland over Tecticornia spp. samphire shrubland

This plant community was identified from the bank of the Greenough River, on the northern and north-eastern edge of the study area. One quadrat was recorded in the study area, however one of the GRFVS estuarine sites was in Rudds Gully, approximately 500 m from study area boundary. This quadrat had similar floristic composition to the Dongara to Cape Burney quadrat.

Plant community 2 is confined to estuarine areas subject to periodic tidal inundation on the banks of the Greenough River, and is therefore geographically restricted in extent. It occupies 8.22 ha (0.13% of the vegetation extent) in the Dongara to Cape Burney study area. Regionally, the equivalent GRFVS plant community (1 *Casuarina obesa / Tecticornia / Sarcocornia*) was also recorded from estuarine areas of the major rivers and also in Rum Jungle (Glenfield), in a saline area that terminated a drainage system that no longer linked with the ocean.

Threats include hydrological change, including changes to salinity and period of inundation, and weed invasion.

Plant community 3: Foredune and Primary Dune Atriplex / Scaevola shrubland

This plant community occurred along the coast immediately adjacent to the beach where there were foredunes or mobile primary dunes. In areas without foredunes or mobile

primary dunes the low coastal shrubland (plant community 5) was the closest to coast, but usually included *Spinifex longifolius.* This foredune and primary dune plant community generally merged with low coastal shrubland.

In total there was 134.25 hectares (2.1% of the native vegetation extent) of this plant community mapped in the Dongara to Cape Burney study area, however this is a broad estimate as only limited areas of the coast could be accessed in the time available for field assessment. It is likely there is actually less of this vegetation than estimated, and detailed vegetation surveys to map the local extent of this plant community would be required for any development proposals.

This plant community is threatened by erosion caused by vehicles and people accessing the beach, and changes to coastal processes. Many of the species found in this plant community are effective colonisers of disturbed areas and are able to persist in the harsh dry, salty and windy conditions found on the immediate shoreline. This plant community, or vegetation with very similar floristic components, is found along much of the Western Australian coastline, including within the GRFVS study area (the equivalent plant community is 3: Foredune *Atriplex isatidea / Spinifex longifolius*). Due to the extent of this vegetation type it is unlikely to become threatened over its entire range.

Plant community 4: Foredune Nitraria billardierei open shrubland

This plant community was recorded in quadrat DCB0920, at Seven Mile Beach. During the field survey it was identified as being a variant of the usual foredune and primary dune vegetation, but was identified as a distinct vegetation unit during the PATN analysis. Therefore the extent of this vegetation was not mapped, and further survey is required to locate other occurrences. It was not observed elsewhere in the survey area, however the Seven Mile Beach was also the only beach area accessed that did not have distinctive foredune or primary dunes. In this area, there was a small berm along the beach, which was vegetated by this plant community and the more usual plant community 3 vegetation (dominated by *Scaevola crassifolia*), before it merged with low coastal shrubland.

This plant community is likely to be the most threatened in the Dongara to Cape Burney area due to its localised occurrence, however a more detailed survey along the shoreline would be required to confirm its distribution both within the study area and over a wider area.

Plant community 5: Low Coastal Scaevola / Rhagodia / Templetonia / Alyxia shrubland

This plant community was recorded along the coast, from close to the shoreline behind the foredunes (where they were present) on the primary dunes, and into the secondary stable

dunes. It merged with the foredune vegetation, and included *Spinifex longifolius* close to the coast and in areas where there is eroding soil, and with taller dune slope shrublands further from the coast on the taller dunes. Towards the southern portion of the study area it was more difficult to interpret the changes in the vegetation and more difficult to map boundaries between plant communities. In this area, the vegetation in the swales was often dominated by *Melaleuca* spp. that at a smaller mapping scale would have been mapped as plant community 8 *Melaleuca* forest or tall shrubland, or *Acacia rostellifera* dominated versions of the taller dune slope vegetation (plant community 7). Therefore it was often mapped as a mosaic of vegetation types.

There was 887.25 hectares, or 13.88% of the native vegetation extent, mapped as this plant community, and an additional 711 hectares mapped as a mosaic including this plant community. Regionally it is floristically and structurally similar to GRFVS plant community 8 (Coastal *Acacia rostellifera* Low Shrublands), although *Acacia rostellifera* was common as a dominant component in the GRFVS study area.

The threatening processes likely to impact on this plant community are soil erosion caused by human access, clearing, fire, feral animals and weed invasion.

Plant community 6: Coastal Thryptomene baeckeacea Heathland

Plant community 6, Coastal *Thryptomene baeckeacea* Heathland was recorded from one area near Cape Burney in the overlap area with the GRFVS survey. It occupied 11.1 hectares, or 0.17% of the area, on gently sloping stable dunes and was also not found elsewhere in the GRFVS study area.

The threatening processes likely to impact on this community are soil erosion caused by human access, clearing, fire, feral animals and weed invasion.

Plant community 7: Taller Dune Slope Acacia rostellifera / Alyxia / Melaleuca depressa /Templetonia

This plant community was recorded from the taller (stable secondary) dunes east of the primary dunes. In this area the dunes tended to be taller, with distinct bare or sparsely vegetated ridgetops, and the vegetation of the swales was often either dominated by *Acacia rostellifera* or *Melaleuca cardiophylla* / *M. huegelii* tall shrubland (plant community 8).

Plant community 7 occupied the largest proportion of the Dongara to Cape Burney study area, with 3312.19 hectares, or 51.8% of the native vegetation extent, mapped as this unit, although is an estimate as the community merged with plant community 5 Low coastal *Scaevola / Rhagodia / Templetonia / Alyxia* shrubland. Sixteen hectares was mapped as a

mosaic of these communities. Regionally, Dongara to Cape Burney plant community 7 is most floristically most similar to the widespread GRFVS plant community 10 (Near coastal *Acacia rostellifera* shrubland) and shares some similarities with GRFVS plant community 9 (Coastal *Acacia rostellifera / Eucalyptus* spp).

Dongara to Cape Burney plant community 7 also occurred in mosaics with plant community 8 *Melaleuca cardiophylla / M. huegelii* tall shrubland and plant community 9 Mallee *Eucalyptus obtusiflora* / *E. oraria*, where these generally occurred in the swales and occasionally on dune slopes. Mosaics of these plant communities occupied 1083.44 ha (16.94%) of the study area. Mosaics were generally more common and closer to the coast towards the southern portion of the study area.

An additional 694.57 hectares (or 10.86% of the native vegetation extent) was mapped as a mosaic of plant community 5 Low coastal *Scaevola / Rhagodia / Templetonia / Alyxia* shrubland, this plant community, and plant community 8 *Melaleuca* woodlands and tall shrublands. This mosaic was identified from the far southern portion of the study area, where the *Melaleuca* tall shrublands occupied most swales and sometimes dune slopes, but the scale of the mosaic was too fine to differentiate individual components.

The threatening processes likely to impact on this plant community are soil erosion caused by human access, clearing, fire, feral animals and weed invasion.

Plant community 8: Dune Swale and Greenough Alluvial Flats

Melaleuca lanceolata Forest or M. cardiophylla and M. huegelii tall shrubland

This plant community was identified by PATN analysis as being one community, although the two quadrats near the Greenough River (GRV0847 and DCB0904) showed floristic similarities with the Estuarine community and Taller dune slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* community.

Initial field assessment suggested that the *Melaleuca lanceolata* forest would be a separate community to the *M. cardiophylla* and *M. huegelii* tall shrubland. *Melaleuca lanceolata* forest was identified from the area close to Greenough River, as far south as African Reef Road, and on the Greenough Alluvial Flats and dunes immediately adjacent, southwards to the southern edge of the study area. It was most common towards the north of the study area, around African Reef Road and Phillips Road, but occurred sporadically throughout. Additional floristic quadrats would be required to determine if *Melaleuca lanceolata* forest should be considered a separate floristic community to the areas with *Melaleuca cardiophylla* or *Melaleuca huegelii*.

Review of historical records indicated that *Melaleuca lanceolata* dominated vegetation was formerly known from the GRFVS survey area (eg O'Connor 2001) however, despite extensive searching, only small areas (too small to map as a discrete vegetation unit) were located in the Geraldton Region. *Melaleuca lanceolata* forest occurred more commonly, but still rarely, in the Dongara to Cape Burney study area, but was not recorded as a separate floristic group to vegetation dominated by *Melaleuca cardiophylla* or *Melaleuca huegelii*. There was no equivalent GRFVS plant community.

Plant community 8 occurred in dune swales and at times on dune slopes, and on the Greenough Alluvial Flat. Further floristic quadrats would be required to determine if the community in the dune swales should have been considered a separate plant community to where it occurs on the Greenough Alluvial Flat.

Occasionally mallee species *Eucalyptus obtusiflora* and *E. oraria* occur in the *Melaleuca* plant community, but usually the *Melaleuca* and mallee vegetation was discrete although they often merge. Except in the areas where they merge, *Melaleuca* was generally not observed in the mallee plant community.

Where it occurred as a discreet mappable unit, plant community 8 *Melaleuca* forest or tall shrubland was mapped as occupying 173.91 hectares, or 2.72% of the native vegetation extent. It also occupied considerable proportions of mosaics with other communities, occurring in 1785.68 hectares or 27.93% of the native vegetation extent. It is not possible to estimate the actual proportion plant community 8 occupies within the mosaics, however it was observed to occupy a greater extent towards the southern portion of the study area than where it occurred in mosaics towards the north.

The threatening processes likely to impact on this plant community are soil erosion caused by human access, clearing, fire, feral animals and weed invasion. Tracks located through the swales, which have less erosion than the dune slopes and ridges, are a particular threat to this plant community.

Plant community 9: Mallee Eucalyptus obtusiflora and Eucalyptus oraria

This plant community occupied 33.37 hectares, or 0.52% of the native vegetation extent. It also occurred in a mosaic with plant community 8 *Melaleuca* woodland or tall shrubland (25.17 hectares), with plant community 7 Taller dune slope vegetation (17.9 hectares), or as a combination of these three (7.76 hectares). Except for the riparian and estuarine plant communities which are limited to uncommon landforms, plant community 9 mallee is the least common plant community in the Dongara to Cape Burney study area[2].

[2] The extent of plant community 4 has not been determined.

Plant community 9 occurred in the dune swales, especially towards the southern portion of the study area, and to a lesser extent on the Greenough Alluvial Flat. It was not floristically related to any community in the GRFVS survey, although the dominant mallee species were found in both areas. In the GRFVS area, *Eucalyptus obtusiflora* and *E. oraria* largely co-occurred with *Melaleuca cardiophylla* on limestone ridges, and occupied only approximately 20 hectares (in the approximate total of 6 041 hectares of native vegetation extent in the GRFVS area).

The floristic quadrats in the Dongara to Cape Burney study area were not closely associated in the PATN analysis, and showed a high degree of affinity with plant community 7 Taller dune slope *Acacia rostellifera* / *Alyxia* / *Melaleuca depressa* /*Templetonia*. They were separated largely due to the structural difference between the mallee and shrubland vegetation, rather than floristic differences, as was the case with the GRFVS quadrats.

The threats to this plant community are largely the same as for other communities, however the small extent renders it more likely to be lost.

5.2 Regional Context of Vegetation

The vegetation of the Dongara to Cape Burney study area was mostly considered to be floristically similar to that found in the coastal areas of the Geraldton Regional Flora and Vegetation Survey area immediately northwards. These similarities are discussed in **Section 5.1** above, but are not surprising given the geographic proximity and equivalent landscape position.

There are three soil units in the Dongara to Cape Burney study area (**Map 1**) (DAFWA 2007). The Quindalup and Tamala systems are coastal systems, with the Greenough Alluvial System formed by fluvial deposition.

The 221Qu Quindalup Central System occupies the largest proportion in the Dongara to Cape Burney study area. It occurs from Horrocks, south to Jurien Bay. Its most extensive development is southwards from Dongara, where it extends approximately 6.6 km inland from the coast. The maximum width of this system is approximately 2.4 km in the Dongara to Cape Burney study area, where it does not extend east of Brand Highway.

The dunes of the Quindalup system are formed by deposition from wave action in the narrow coastal zone (foredunes), and wind (aeolian) action for the remaining areas, and include actively eroding blowout areas. The vegetation of the Quindalup system is suited to changing conditions, and include colonising species (eg *Spinifex longifolius* and *Atriplex isatidea*) on the foredunes. In the Dongara to Cape Burney area, the vegetation consists of:

- two foredune and primary dune (where there are no active foredunes) plant communities
- low coastal vegetation (plant community 5 dominated by *Scaevola crassifolia*, *Rhagodia* spp., *Templetonia retusa* and *Alyxia buxifolia*, and commonly including *Acacia rostellifera, Acanthocarpus preissii, Threlkeldia diffusa* and *Olearia axillaris* and plant community 6 *Thryptomene baeckeacea* heathland)
- taller dune slope vegetation on the taller and more stable eastern dunes (plant community 7 dominated by *Acacia rostellifera*, *Alyxia buxifolia*, *Melaleuca depressa* and *Templetonia retusa*, and commonly including *Ptilotus divaricatus*, *Acanthocarpus preissii*, *Austrostipa elegantissima* and *Threlkeldia diffusa*)
- *Melaleuca* or, less commonly, mallee in the swales.

The 221Ta Tamala South System is the most regionally extensive of the three soil systems in the Dongara to Cape Burney study area. It occurs from Kalbarri south to Jurien Bay, where it is either immediately adjacent to the coast, or more usually east of the Quindalup System. Although it only occupies small areas within the Dongara to Cape Burney study area, it extends for up to 9 km eastwards, and is the soil system that forms the limestone ridge east of the study area, separating the 'front' and 'back' Greenough Alluvial Flats. Within the study area, the landscape of the Tamala South System is flat to gently undulating, consisting of shallow sand overlying Tamala Limestone that is occasionally exposed.

The Tamala South System in the Dongara to Cape Burney study area is largely cleared, but where it does occur it is generally grazed and consists of degraded versions of plant community 7 Taller dune slope shrublands dominated by *Acacia rostellifera, Melaleuca* forest or tall shrubland, or mallee *Eucalyptus obtusiflora / E. oraria*.

The 221Ga Greenough Alluvial System is confined to the areas close to and associated with the floodplains of the Greenough, Chapman and Irwin Rivers. In the Dongara to Cape Burney study area it consists of the areas described as the 'front flats' immediately east of the coastal dunes. East of this, but not included in the study area, are the 'back flats' behind the separating limestone ridge, which are connected to the 'front flats' by the Greenough River channel. The 'back flats' extend as far north as the northern bank of the Chapman River, and include the river channel to the ocean exit. There is also another extent of the Greenough Alluvial System associated with the Irwin River.

There is almost no native vegetation remaining on the Greenough Alluvial System within the Dongara to Cape Burney study area. Where it does occur, it is grazed *Eucalyptus camaldulensis* associated with the river channel, or *Acacia rostellifera* tall shrublands.

There are six Beard Vegetation Associations identified from the Dongara to Cape Burney study area (Department of Agriculture 2005), discussed below.

Beard Vegetation Association 125, described as bare areas/salt lakes, with samphire shrubs. The only area mapped as this Beard unit in the Dongara to Cape Burney study area occurs west of Henry Road, which was not accessible during the field assessment, and has not been groundtruthed to determine actual vegetation. However, viewing the topographic data indicates this area has a similar range of elevations to nearby areas, and is not flat as would be required for saline areas, thus suggesting that the application of this Beard unit may be incorrect. Regionally, this Beard unit occurs north of the study area near Port Gregory, associated with the Hutt Lagoon and south near Leeman associated with a salt lake. It is widespread throughout inland Western Australia, associated with saline lakes and drainage systems, from the Northern Territory border to near Eucla in the south-east, and as far west as the Wilson Inlet at Denmark.

Beard Vegetation Association 129, described as bare areas of draft sand. It occurs in the study area in the northern portion, close to the coast and consists of areas of bare drift sand that are not included in the vegetation extent mapping, and mostly low coastal shrubland (plant community 5). The *Melaleuca* and mallee plant communities did not occur in the swales in this area. Regionally, this Beard unit occurs sporadically to the north as far as Bluff Point (south of Kalbarri, where the orientation of the coast becomes more north-easterly), and includes the Southgate Dunes, south of Geraldton, and dune sheets in the Buller and Oakajee areas, and also occurs to the south of the study area.

Beard Vegetation Association 352, described as Medium woodland; York gum, or in more detail as *Eucalyptus loxophleba* woodland over mixed *Acacia* shrubland, with the constituent species listed as *Acacia acuminata* and *A. cyanophylla* (now *A. saligna*). Although one hectare of this vegetation association has been mapped as occurring in the study area, no vegetation matching this description was observed, although there were a few isolated *Eucalyptus loxophleba* trees along the road verges. Regionally it occurs along the Irwin River, but is more widespread through the Wheatbelt of Western Australia, and also occurs in the Esperance Plains, Mallee, Coolgardie, Murchison and Yalgoo IBRA regions.

Beard Vegetation Association 371, described as Low Forest: *Acacia rostellifera*, or in more detail, *Eucalyptus camaldulensis* trees over *Acacia rostellifera* shrubs. Within the Dongara to Cape Burney study area this Beard unit occurs on the Greenough Alluvial soil System, but there is very little native vegetation remaining, as described above. Regionally, this Beard unit only occurs in the Geraldton Sandplains bioregion, and occurs on much of the area mapped as the Greenough Alluvial soil System associated with the Greenough and Chapman Rivers east and north of the study area, and to the north near Bluff Point.

However at state, regional and local scales (**Table 1**) this vegetation association is considered to be *endangered*.

Beard Vegetation Association 431, described as Shrublands; *Acacia rostellifera* open scrub, or in more detail, a mosaic of *Spinifex* tussock grassland with *Acacia* open shrubland/*Acanthocarpus* open forbland. Common species include *Acacia rostellifera, A. xanthina, Spinifex longifolius, Atriplex isatidea, Melaleuca acerosa* (now *M. systena*), *M. huegelii, Acanthocarpus preissii, Carpobrotus aequilaterus* and *Olearia axillaris*. It occupies the central and south-western portions of the study area, as far south as Dongara, and only occurs in the Geraldton Sandplains bioregion.

Beard Vegetation Association 433, described as Mosaic: Shrublands; *Acacia rostellifera* & *Melaleuca cardiophylla* thicket / Sparse low woodland; Illyarrie. It occurs near Wakeford Road, and along the eastern margin of the southern portion of the study area, east of the dunes. Regionally it occurs on the Tamala South soil system, to the east and south of the study area, however few of the other characteristic species (*Eucalyptus erythrocorys*, *Acacia blakelyi*, *Acacia pulchella*, *Acacia spathulata*, *Dryandra sessilis* (now *Banksia sessilis*) and *Hakea costata*) described from this vegetation association were identified from the study area. It only occurs in the Geraldton Sandplain bioregion.

5.3 Vegetation Condition

There was no vegetation recorded as *excellent* or *pristine* (Keighery 1994) condition in the Dongara to Cape Burney study area (**Table 5**, **Maps 4a**-**l**). The main reason is the general weediness of the area.

By definition, vegetation with aggressive weeds cannot be assessed as *excellent* or *pristine* (undisturbed) condition (**Table 12**). Weeds rated as *high risk* in the Environmental Weed Strategy for Western Australia (Department of Conservation and Land Management 1999) are considered to be aggressive: 18 of the 25 floristic quadrats (72%) had weeds in this category (*Brassica tournefortii, Bromus diandrus* and *Lycium ferocissimum*), thus these quadrats could not be assessed as being in better than *very good* condition. Floristic quadrats are recorded in vegetation considered to be in the best condition available within the representative vegetation, thus if there are aggressive weeds in floristic quadrats, they are also likely to be present in the rest of the vegetation.

Weeds can also influence vegetation condition when they have significant cover: more than half of the floristic quadrats had 10% or more weed cover, indicating the generally weediness of the area.

Much of the area is grazed by livestock, or has been historically grazed. Grazing increases weed cover due to soil disturbance and nutrient addition that encourages weed germination and growth, and spread of weed seeds in animal droppings. Selective grazing by livestock can also affect species composition, favouring unpalatable species that may be prickly, hard or contain unpalatable chemicals, or are favoured by disturbance. Rabbits were also observed to be common and, like livestock, can also affect species composition by selectively grazing low palatable species, especially seedlings.

Over half of the area (52.8%) was assessed as being in *very good* condition. **Maps 4a-l** show that *very good* condition vegetation was mostly found close to the coast, with little occurring immediately adjacent to cleared, grazed lands. *Very good* condition vegetation, in comparison to vegetation in *good* or lesser condition, should be considered a higher priority for conservation.

Only 0.08% of the study area was assessed as having native vegetation in *completely degraded* condition (**Table 5**). *Completely degraded* vegetation contains virtually no native species. There was also 10.75% of the vegetation assessed as being in *degraded* condition. *Degraded* condition vegetation usually has high weed cover and fewer than expected native species, or the species composition has been altered by disturbance. Areas dominated by *Acacia rostellifera* are often *degraded* if they have few other native species within them, and are often a result of grazing, clearing or frequent fire. Although these areas are included in the vegetation extent mapping (DAFWA 2006) and their condition assessed as part of this project, the vegetation within them is in poor condition.

5.4 Areas of Conservation Significance

Areas of conservation significance include:

- threatened communities (TECs), although the TEC listed as occurring in the Dongara to Cape Burney study area no longer exists
- plant communities occupying less than 10% of the study area that are considered to be the least represented communities
- Beard Vegetation Associations occupying less than 30% of the study area that can be considered to have regional significance
- areas under threat
- other areas.

5.4.1 Least Represented Vegetation

Threatened Ecological Communities

The Threatened Ecological Community 42 Greenough River Flats: *Acacia rostellifera* low forest with scattered *Eucalyptus camaldulensis* on Greenough Alluvial Flats is known to

occur in or close to the study area (DEC 2010). Although vegetation matching the description of this community was recorded during the field survey (plant community 1 Riparian *Eucalyptus camaldulensis* low woodland), it was in *degraded* and *completely degraded* condition, containing few native species, and could not be considered to be an existing community in the Dongara to Cape Burney study area.

Least Represented Plant Communities

Table 4 shows the representation of each plant community.

Plant community 2 Estuarine *Casuarina obesa* open woodland is restricted by landform, thus there is only a small area (14.5 hectares, **Table 4**). Whilst this plant community is significant in terms of extent, it is not currently threatened. This community provides fauna habitat and protects the river banks from erosion and is therefore considered to be conservation significant.

Plant community 5 *Thryptomene baeckeacea* heathland is locally significant as it was only recorded from 11.1 hectares (0.17%) of the study area near Cape Burney. It has not been identified from any other areas during the Dongara to Cape Burney or GRFVS surveys, but is expected to be more common further north, although additional survey would be required to confirm this (Ecoscape 2009). It should be considered to be of local conservation significance.

Plant community 1 Riparian *Eucalyptus camaldulensis* low woodland occupies only 14.58 hectares (0.23%) of the study area, however it was in *degraded* and *completely degraded* condition. Due to its poor condition it is not considered to have conservation significance.

Plant communities 3 and 4 occur on the foredunes and primary dunes immediately adjacent to the coast, and are geographically restricted to this landform. They are threatened by natural processes (wind and wave erosion) and human impacts (soil erosion) but are geographically widespread. Therefore they could be considered of conservation significance, but are not likely to become rare and are significant in terms of dune stabilisation.

Plant community 8 *Melaleuca* forest or tall shrubland is locally significant, and was recorded from 173.91 hectares (2.72% of the area) as a discrete mappable unit. It is also included as a proportion of an additional 1785.68 hectares included in mosaics with other plant communities. Whilst it is included as a significant proportion of the area when considered as a mosaic, the proportion within the mosaic is often small, and it is generally restricted to swales and to the Greenough Alluvial Flats. Therefore this plant community should be considered to be of local conservation significance.

Plant community 8 was comprised of three dominant *Melaleuca* species: *M. cardiophylla, M. huegelii* and *M. lanceolata*. In most cases, only one of these species could be considered to be dominant and therefore characteristic in any given location, however floristic analysis combined them into one plant community as it was not uncommon for two or more *Melaleuca* species to co-occur. Additional survey may separate the *Melaleuca* forest or tall shrubland into different plant communities occupying smaller extents and increase their conservation significance.

Plant community 9 *Mallee Eucalyptus obtusiflora / E. oraria* was significant in that it only occupies 33.37 hectares (0.52% of the area), when considered as a separate mappable unit. Its inclusion in mosaics adds a proportion of an additional 50.83 hectares, however it is one of the least represented of the plant communities of the Dongara to Cape Burney study area, and has local conservation significance for that reason.

Regionally Significant Vegetation Associations

EPA Position Statement 2 (2000) discusses criteria at which vegetation types (as defined by (Beard 1990)) are considered to become significant in terms of biodiversity conservation. The threshold level of 30% of the pre-clearing extent of a vegetation type (at bioregion scale) is the level at which species loss appears to accelerate exponentially at an ecosystem level. There is a presumption against clearing at less than 10% of the original extent of the vegetation type, at which level it is considered to be *endangered.*

Beard Vegetation Associations 371, Low Forest: *Acacia rostellifera* is the equivalent of TEC 42, discussed above. Vegetation extent mapping (DAFWA 2006) records 77 hectares of this vegetation association in the study area, which is 4.51% of the pre-European extent (**Table 1**). It is considered to be *endangered* according to EPA Position Statement 2 (2000) as 10% of the previous extent remains in the bioregion. It is the most cleared vegetation association from the study area, and therefore has conservation significance. However, the 14.58 hectares of vegetation that matched the description of the TEC (plant community 1 Riparian *Eucalyptus camaldulensis* low woodland) was in *degraded* or *completely degraded* condition and is not considered to be an extant community, and is unlikely to be able to be restored to a condition resembling the original vegetation.

Beard Vegetation Association 352 (York Gum woodland) is mapped as having only one hectare remaining in the study area, however no vegetation matching this description was recorded. There is 16.63% of the pre-European extent remaining elsewhere in Western Australia, and it is therefore is considered to have biodiversity conservation significance according to EPA Position Statement 2 (2000) as there is less than 30% of the previous extent remaining. At this level there is a presumption against clearing.

Beard Vegetation Association 433 (Mosaic: Shrublands; *Acacia rostellifera* & *Melaleuca cardiophylla* thicket / Sparse low woodland; Illyarrie) is also considered to be *endangered* both within the Dongara to Cape Burney study area and within the Geraldton Hills Biogeographic Sub-region (GS1), although more than 30% of the pre-European extent remains in Western Australia and at other scales (**Table 1**). This vegetation association is mapped as occurring near Wakeford Road, and along the eastern margin of the southern portion of the study area, east of the dunes. Vegetation matching this description, but divided between two plant communities (7 Taller dune slope vegetation and 8 *Melaleuca* woodlands and shrublands), occurs in the area mapped as this Beard Vegetation Association (although Illyarrie *Eucalyptus erythrocorys* was not observed), and should be considered to have local conservation significance.

Areas Under Threat

Threatening processes are discussed in **Section 5.5**.

Some plant communities are under threat from specific processes, including changes to salinity and hydrology that may impact on plant community 2 Estuarine *Casuarina obesa* open woodland, and changes to coastal processes that may impact on plant communities 3 Foredune and primary dune *Atriplex* / *Scaevola* shrubland and 4 Foredune *Nitraria billardierei* open shrubland. These areas should be considered to have conservation significance, not only because they are threatened by natural processes (including natural processes exacerbated by human impacts) but because they perform crucial roles in preventing further degradation of surrounding areas by stabilising the soil and preventing soil movement caused by wind erosion. The estuarine area is also important because it provides important habitat for fauna species, thereby performing an important ecological function.

Most of the other threatening processes discussed in **Section 5.5** are more general in nature, impacting on all vegetation types (vegetation associations and plant communities).

Other Areas of Conservation Significance

The field assessment did not include a search for conservation significant flora species, therefore no DEC database searches were requested for the area. A search for conservation significant flora species using NatureMap (DEC 2007-) on an area approximating the study area returned a result of three conservation significant flora species having been collected: *Anthocercis intricata* (P3), *Homalocalyx chapmanii* (P2) and *Wurmbea tubulosa*(R). Of these, *Anthocercis intricata* was observed in the area close to Butcher Road, including from floristic quadrat DCB0918 and close to Dongara. The other species were not observed, and targeted searches were not conducted, however *Homalocalyx chapmanii* was collected in 1932 and *Wurmbea tubulosa* was last collected in

1983, and may therefore no longer be present. *Wurmbea tubulosa* is a characteristic understorey species of the Greenough TEC 42, but it would have been unlikely to have been observed during the field survey, even if it had been present, as *Wurmbea* species are cormous and have ephemeral leaves that would not have be present during the survey time.

Therefore the native vegetation in the area adjacent to Butcher Road may be considered to have conservation significance. A more detailed search for conservation significant flora species should be conducted to accurately define areas defined as significant for this reason.

5.5 Threatening Processes

In order to develop a management strategy, there needs to be an understanding of the threatening processes of the area. A summary of the main threats and threatening processes identified from the Dongara to Cape Burney study area are discussed below.

The threatening processes within the Geraldton Sandplains 2 subregion are documented in Desmond and Chant (2001), and include:

- historical broad-scale vegetation clearing
- increasing fragmentation, loss of remnants and lack of vegetation recruitment
- grazing pressure
- feral animals, including foxes, cats, rabbits and goats
- exotic weeds, including box thorn, castor oil, wild oats, lupins, iceplant and saffron thistle
- changed fire regimes
- changed salinity
- changed hydrology, including altered flow regimes affecting riparian vegetation and sand occlusion
- pollution
- human influences including urbanisation, recreation (including access on horses and off road motor vehicles) and tourism.

Whilst the survey did not investigate issues affecting fauna, all other threatening processes listed above were observed in the Dongara Cape Burney area.

Other threatening processes that may impact on the study area include soil disease and climate change affecting rainfall, hydrology, coastal processes and fire frequency.

Threats to fauna species are discussed in relation to how they are impacted by changes to vegetation.

Of the threatening processes listed, clearing and grazing have the greatest impact in the Dongara to Cape Burney area.

5.5.1 Impacts on Vegetation Communities and Flora

Clearing and Fragmentation

Clearing and fragmentation were not investigated as part of this project.

The effects of clearing are obvious, being the removal of native vegetation and loss of individual plants and animals, and potentially communities and ecosystems.

Fragmentation has the effect of increasing edge effects on remnant vegetation, including weed invasion due to increased input of propagules (seeds) from cleared lands and nutrient input from wind-blown farm fertilizers and rainfall runoff. Fragmentation can also interrupt genetic flow through the landscape, most obviously for animals that do no cross open land and are restricted to remnant bush areas, but also for plants where cross pollination from a smaller selection of individuals may be detrimental to the population.

Plate 2 shows clearing and fragmentation in a subdivision in the Dongara to Cape Burney study area.

Plate 2: Subdivision showing clearing and fragmentation of bushland

Clearing is not allowed unless a valid exemption applies, including:

- the area has already been assessed and clearing approved by the EPA
- the clearing area is not within an environmentally sensitive area (including riparian areas), is less than 1 hectare per financial year and is for approved buildings, to maintain existing cleared areas, remove isolated trees, or for new fence lines, firebreaks, vehicle and walking tracks or water supply

- for approved subdivisions
- within approved building envelopes.

Clearing from future developments has potential to substantially impact on the native vegetation of the area, although the planning process is expected to identify potential environmental issues.

Grazing Pressure

This project only surveyed the remnant native vegetation of the Dongara Cape Burney area, and therefore there is no assessment of the grazing pressure on agricultural lands.

Many areas of native vegetation in the dunes and the Greenough Alluvial Flats to the east of the dunes are currently grazed by livestock (sheep, cattle and horses), and it is likely that most of the area has been historically grazed as it was amongst the first areas of agricultural settlement in Western Australia. Rabbits were observed to be common, and the effect of rabbit grazing is likely to be severe, especially following fire as new growth is particularly palatable and the only food source available.

Grazing pressure by domestic livestock and feral animals is likely to result in lack of recruitment of some native plant species as palatable species are more susceptible to grazing, allowing unpalatable and often prickly species (eg *Lycium ferocissimum*) to survive and become dominant. African Boxthorn *Lycium ferocissimum* was observed throughout the study area, but was more common towards the northern areas than southern. Of interest, *Anthocercis intricata*, a Priority Three species with rigid thorns and tangling branches that appeared to be superficially similar to African Boxthorn, was observed in one area where it was preferentially not grazed and was a dominant species (with *Acacia rostellifera*) in an otherwise bare paddock (**Plate 3**).

Definitions of DEC conservation codes are included in **Appendix Two**.

Plate 3: Paddock with Acacia rostellifera and Anthocercis intricata (P3).

Grazing pressure may also impact on native animal species, with competition for preferred food sources, or aggression or belligerence of livestock keeping native species away from particular areas.

Feral Animals

The effects of feral animals on native fauna were not assessed during this survey.

Goats were not observed during the field survey but rabbits, rabbit warrens and dung mounds were frequently seen and were often associated with elevated weed cover.

Rabbit grazing is also likely to have a severe impact on native plant regeneration, especially following fire as new growth is particularly palatable and the only food source available.

Predation by feral animals is also likely to impact on native animal species, particularly small sized species. Fauna was not assessed during this survey, however several lizard and bird species, particularly smaller honeyeater-sized birds and waterbirds were observed during the survey.

Exotic Weeds

Desmond and Chant (2001) list, in order of significance, African Boxthorn (*Lycium ferocissimum*, **Plates 4**-**5**), Castor Oil (*Ricinus communis*, **Plate 6**), Wild Oats (*Avena* spp., **Plate 7**), Lupins (*Lupinus cosentinii*), Iceplant (*Mesembryanthemum crystallinum*, **Plate 8**) and Saffron Thistle (*Carthamus lanatus*, **Plate 7**) as the most serious weed species in the Geraldton Sandplains 2 subregion. All of these were observed in the Dongara to Cape Burney study area.

Other species that may become serious weeds include Giant Reed (*Arundo donax*, **Plate 9**), Century Plant (*Agave americana*, **Plate 10**), Wild Turnip (*Brassica tournefortii*) and Tamarisk (*Tamarix aphylla*). Giant Reed, sometime incorrectly called Bamboo, has been planted on the eastern (downwind) side of mobile dunes for sand stabilisation, however once established it may spread into remnant bushland. Wild Turnip is a common serious weed in remnant bushland throughout much of the agricultural areas of Western Australia, where the dead plant is often seen as a 'tumbleweed' piled onto fences. Tamarix has been planted for soil stabilisation and as a windbreak. It occurs in patches throughout the dunes and on the Greenough Alluvial Flats. It has the potential to become a serious weed, and is listed as a 'weed of national significance' (Weeds Australia 2008).

Plate 4: African Boxthorn (Lycium ferocissimum)

Plate 5: African Boxthorn clump near Cape Burney

Plate 6: Castor Oil Plant

Plate 7: Wild Oats and Saffron Thistle (greyish plants in foreground)

Plate 8: Iceplant

Plate 9: Giant Reed

Plate 9 was taken from the northern bank of the Greenough River, just outside the study area.

Plate 10: Century Plant.

Plate 10 was taken from just outside the study area, however there were isolated areas (eg north of Wakeford Road) within the Dongara to Cape Burney study area where Century Plant was likely to become a problem.

Changed Fire Regimes

Changed fire regimes can significantly alter the vegetation of an area by favouring different plant groups, depending on fire frequency (Bell 2001).

Although no recently burnt areas or evidence of changes in fire frequency were observed in the Dongara to Cape Burney study area, future changes may impact on vegetation.

Annuals, or short-lived perennial species that grow rapidly and set significant quantities of seed after only a short period (eg *Acacia rostellifera*), are favoured by frequent fires. These species may be disadvantaged by long fire intervals, as their lifespan may be short and they may require fire to germinate seed. Soil seed stores may become depleted as seeds are eaten by insects or attacked by micro-organisms.

Perennial species that resprout from an underground lignotubers may be disadvantaged by frequent fires, as their energy stores may become depleted. These species, which include several *Melaleuca* species, may take several years to flower and set seed after a fire.

In addition to different plant groups having life cycles suited to different fire frequencies and seasons, changes to soil nutrients induced by fires also tend to favour weeds, as these have the ability to germinate quickly and utilise soil nutrients for rapid growth.

Grazing by livestock, rabbits or kangaroos following fire may also affect native vegetation as they may selectively graze palatable species. *Melaleuca lanceolata* has been documented as having declined in extent on Rottnest and Garden Islands: this is at least in part attributed to overgrazing by native marsupials (McArthur 1998; Pen & Green 1983), and it is highly likely that the same situation is possible in the Dongara to Cape Burney area.

Changed fire regimes may also impact on native fauna, with animals killed as a result of fire or loss of shelter, including additional prospects of predation, or food resources following fire. Habitat fragmentation may limit the opportunities for fauna species to escape from fire, or limit opportunities for recolonisation of an area following fire.

Soil erosion following fire may also have a severe impact on the environment, with the strong winds associated with sand blowouts already a feature of the landscape (**Plate 11**).

Plate 11: Sand blowout

Changed Salinity

The most obvious effect of changed salinity is on rivers and streams. The only watercourse in the Dongara to Cape Burney study area is the Greenough River, which has a large catchment through agricultural lands. As elevated salinity is a well known effect of land clearing for agriculture in Western Australia, it is anticipated that the salinity of the Greenough River has probably changed since settlement, although the projections are not for salinity to increase (Short & McConnell 2001).

Changes to plant species and vegetation structure as a result of salinity changes may also impact on fauna species that depend on fringing and aquatic vegetation for food resources and shelter. Some aquatic species may also be affected by salinity changes.

Changes to groundwater salinity may also impact on native vegetation, by directly effecting plant species with their roots in shallow groundwater. Salinity changes to areas of surface expression (eg seeps and soaks) may directly impact on native vegetation.

Changed Hydrology

Desmond and Chant (2001) list altered flow affecting riparian vegetation and sand occlusion as threatening processes within the Geraldton Sandplains 2 subregion.

The Greenough River is only open to the ocean during major flow events, and sedimentation and algal blooms due to high nutrient levels are considered to be problematic (Stuart-Street *et al* 2005). Sedimentation may impede the breaching of the sand bar across the river mouth, reducing the opportunities to flush excessive nutrients from the estuary. Sediments may also be a source of nutrients.

Despite these problems, the Greenough River supports a population of water birds (**Plate 12**), including osprey (**Plate 13**), that are at least partly dependent on the fish found in the estuary. The fringing and aquatic vegetation ('waterweeds' and beneficial algae) are critical to the survival of fish and smaller aquatic animals, including crustacea, insects and worms. Any changes to water quality affecting aquatic animals will have a detrimental flow-on impact on the waterbirds of the estuary.

Plate 12: Waterbirds on the Greenough River

Plate 13: Osprey fishing in the Greenough River

Pollution

Pollution has been identified as a threatening process by Desmond and Chant (2001). Except for elevated nutrient levels in the Greenough River, no other evidence of pollution was observed in the Dongara to Cape Burney study area.

Potential sources of pollution include:

- septic tanks from household and tourist developments
- human effluent from camp sites
- animal waste from intensive feedlots
- rubbish dumping from camp sites, fishing boats and households
- petroleum spills from offshore and vehicle accidents
- leaking fuel from fuel suppliers (eg roadhouses) and farm fuel supplies, including leaching into the soil and watertable

- chemical container dumping from farming activities
- chemical overspray or wash from agricultural activities.

Human Influences

Human-induced threatening processes include urbanisation, tourism and recreational uses.

Urbanisation is a threatening process as it often includes land clearing, vegetation fragmentation as a result of clearing, grazing by domestic livestock (even at small hobby-farm scale) and potential pollution.

Tourist developments have the same potential for land clearing and fragmentation as urbanisation, and higher likelihood for pollution due to the development density and transient nature of the clients.

Uncontrolled tourism (recreation), including camping, surfing and fishing, has high potential to cause damage to the environment, including

- soil erosion due to uncontrolled horse and offroad vehicle use and unrestricted track access through foredunes (eg **Plate 14**)
- damage to vegetation by vehicle use (eg **Plate 15**) and clearing for campsites
- fire from camp fires, discarded cigarettes and deliberate arson
- rubbish dumping from campsites and fishing parties (eg **Plate 16**), including discarded fishing lines
- feral animals attracted to discarded rubbish, fish offal and campsites
- fauna deaths due to vehicle impact
- weed invasion due to soil disturbance and spread of seed (eg Doublegee or Caltrop on car tyres).

Plate 14: Erosion damage to foredunes by unrestricted walking access

Plate 15: New track becoming established beside existing track, where the existing track has become too boggy over the dune crest

Plate 16: Rubbish from recreation use

Changes to Coastal Processes

Whilst coastal processes were not investigated as part of this assessment, changes to coastal processes have the potential to impact on the onshore environment.

Changes to the coastline, resulting in beach erosion may be a result of human impact (eg where marina and port developments alter ocean currents along shorelines) or climate change, where altered wind direction, strength or seasonal changes affect sand deposition and erosion.

Small-scale changes to coastal processes were observed in the Dongara to Cape Burney study area, where erosion under access ramps and stairs were noted (**Plate 17**).

Plate 17: Erosion under access ramp

Soil Disease

Soil disease is not usually considered to be a threatening process in the coastal environment, where the soil is generally considered to be too dry to support disease causing organisms like *Phytophthora cinnamomi.*

However, research has indicated that there are soil diseases that have potential to impact on native vegetation species in the coastal environment. Shearer *et al* (1997) investigated the role of *Armillaria luteobubalina* (Australian Honey Fungus – a native collar rot fungus) as far north as Cervantes, and determined that it was a threat to coastal vegetation throughout their study area (Cervantes to Cape Arid). It is well established throughout the south-west of Western Australia (eg English 1999; Hamilton-Brown 2002), however its occurrence in the Dongara to Cape Burney area has not been assessed, and there is no evidence to suggest it occurs in the area.

Despite there being no evidence of its occurrence, the potential for it to be present now or in the future cannot be ignored and it is considered to be a potential threatening process.

6.0 Conclusions

Dongara to Cape Burney Coastal Vegetation Survey

6.1 Summary of Dongara to Cape Burney Findings

The Dongara to Cape Burney vegetation survey resulted in nine plant communities being recognised and mapped in the study area, which consisted of 6394.45 hectares of native vegetation. These plant communities were based on those identified during the 2008 Geraldton Regional Flora and Vegetation Survey and were refined to better represent the vegetation in the Dongara to Cape Burney area by a combination of visual assessment and PATN statistical analysis.

The plant communities identified from the Dongara to Cape Burney study area were:

- associated with riparian areas (plant community 1, *Eucalyptus camaldulensis* low woodland), on the edges of the ephemeral drainage channel of the Greenough River
- estuarine (plant community 2, *Casuarina obesa* open woodland from the saline tidal area near the Greenough River mouth
- two communities identified from immediately adjacent to the beach (plant community 3, Foredune and primary dune *Atriplex* / *Scaevola* shrubland and plant community 4 Foredune *Nitraria billardierei* open shrubland)
- low coastal shrubland (plant community 5, *Scaevola* / *Rhagodia* / *Templetonia* / *Alyxia*) from behind the foredunes, until it merged with plant community 7
- coastal *Thryptomene baeckeacea* heathland (plant community 6), from near Cape Burney
- taller dune slope shrubland (plant community 7 *Acacia rostellifera* / *Alyxia* / *Melaleuca depressa* / *Templetonia*), which occurred on the taller dunes and steeper slopes
- *Melaleuca* forest or tall shrubland (plant community 8), which was dominated by *Melaleuca lanceolata* (the forest community) or *M. cardiophylla* / *M. huegelii* (tall shrubland), mostly in the dune swales but also on the Greenough Alluvial Flats
- Mallee *Eucalyptus obtusiflora / E. oraria* (plant community 9), mostly in the dune swales.

Much of the area could only be mapped as a mosaic of plant communities 5 and 7 – 9 due to a combination of the scale of the vegetation components, and time and access constraints that limited ground truthing of many areas.

The vegetation condition was assessed using the Keighery (1994) Bushland Condition Scale. No areas of *excellent* or *pristine* vegetation were recorded during the survey, largely as a

result of weed invasion and grazing. *Very good* condition vegetation occurred on 52.8% of the study area, and *good* condition vegetation on 36.37%. *Degraded* and *completely degraded* condition vegetation was associated with housing developments and grazed lands, mostly towards the eastern side of the coastal dunes and on the Greenough Alluvial Flats.

Twenty one floristic quadrats were recorded to describe the vegetation of the Dongara to Cape Burney study area. An additional four quadrats from the 2008 Geraldton Regional Flora and Vegetation Survey were included in the assessment. From these 25 quadrats, 122 taxa (including subspecies and varieties) from 43 families and 86 genera were recorded, however not all could be identified due to the lack of reproductive material, which was largely a result of the survey being conducted in early summer. Of these taxa, 30 (or 21%) were introduced species.

Although the results of PATN statistical analysis undertaken using combined Geraldton Regional Flora and Vegetation Survey and Dongara to Cape Burney floristic data is not included in the report, the analysis confirmed that the riparian, estuarine and coastal vegetation was floristically similar in both areas, but there was less similarity with the *Melaleuca* and mallee communities. The combined analysis also confirmed that the Geraldton Regional Flora and Vegetation Survey thickets and woodlands on the Northampton and Moresby soil systems, and the shrublands on the deeper sands of the Greenough and Tamala systems had little floristic similarity with the coastal vegetation of the Dongara to Cape Burney study area.

The desktop assessment and vegetation community mapping also identified areas that should be considered as having conservation significance but it is not possible, within the scope of the project, to objectively rank conservation significance of different areas.

6.2 Conservation Significance of Beard Vegetation Associations

Beard Vegetation Associations are mapped and described using broad scale vegetation units (associations). They are not intended to provide detailed and accurate descriptions of specific areas but describe the general range of vegetation types found within the association. Therefore, conservation significance should be considered in terms of both the broad scale Beard Vegetation Associations and the local plant communities.

6.2.1 Regionally Significant – Endangered

Vegetation associations are considered to be *endangered* when there is only 10% of their pre-European extent remaining in the bioregion (EPA 2000).

Beard Vegetation Association 371 Low forest; *Acacia rostellifera* has 10.1% of its pre-European extent remaining in the Geraldton Sandplains Biogeographical Region. The more detailed description of this association is *Eucalyptus camaldulensis* trees over *Acacia rostellifera* shrubs, which corresponds with Dongara to Cape Burney plant community 1: Riparian *Eucalyptus camaldulensis* low woodland, which only occupied 14.58 hectares, all of which was in *degraded* or *completely degraded* condition.

The *critically endangered* Threatened Ecological Community 42 Greenough River Flats: *Acacia rostellifera* low forest with scattered *Eucalyptus camaldulensis* on Greenough Alluvial Flats is the equivalent of Beard Vegetation Association 371. Whilst vegetation matching this description, included in plant community 1, is still considered to be native vegetation, it could not be considered as an *extant* part of the TEC. This vegetation should be considered to have conservation significance, however due to the poor condition of the vegetation it is unlikely that the area can be rehabilitated to anything approaching its natural condition.

6.2.2 Regionally Significant – Vulnerable

Vegetation associations with between 10 and 30% of their pre-European extent remaining within the bioregion are considered to be *vulnerable*.

Beard Vegetation Association 352 Medium woodland; York gum has 19.28% of its pre-European extent remaining in the Geraldton Sandplains Biogeographical Region. However no vegetation matching this description was located during the survey (although individual York Gum *Eucalyptus loxophleba* trees were observed on road verges and may have occurred in a very small area in an inaccessible paddock) and only 1 hectare is mapped as occurring in the study area. Therefore, although this vegetation association is considered to be *vulnerable*, it is unlikely to still occur in the Dongara to Cape Burney study area.

6.2.3 Locally Significant

Beard Vegetation Associations with less than 30% of their pre-European extent remaining at a local scale can be considered to have local conservation significance. Beard Vegetation Associations 371 and 352, discussed above, have local as well as regional conservation significance.

Beard Vegetation Association 433 has less than 30% of its pre-European extent remaining in the Dongara to Cape Burney study area. Vegetation association 433 *Acacia rostellifera* & *Melaleuca cardiophylla* thicket / Sparse low woodland is represented by the vegetation occurring on the Greenough Alluvial Flats and was mapped largely as plant community 7 Taller dune slope shrubland, dominated by *Acacia rostellifera*. It also included areas mapped as plant community 8 *Melaleuca* Forest or Tall Shrubland, dominated by *M.*

cardiophylla and *M. huegelii* and a small area of plant community 9 Mallee, dominated by *Eucalyptus obtusiflora*.

6.3 Conservation Significance of Dongara to Cape Burney Vegetation Communities

Several vegetation communities identified from the Dongara to Cape Burney study area are geographically restricted in extent or restricted to specific landforms. It is not possible to estimate the pre-clearing (pre-European) extent of vegetation communities to determine the remaining proportions, as is possible using Beard Vegetation Associations.

6.3.1 Plant Communities with Restricted Extent

Plant community 4 Foredune *Nitraria billardierei* open shrubland was not mapped during the field survey and was only recorded from Seven Mile Beach. It is likely to be the most restricted plant community of the study area, however further survey is required to determine its full extent. It is likely to be threatened by human disturbance and coastal processes.

Plant community 2 Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland occupied only 8.22 hectares or 0.13% of the study area. Whilst it is not currently threatened, its small extent, importance as fauna habitat and roll in preventing river bank soil erosion also gives it conservation significance. The main threats to this plant community are hydrological change, including changes to salinity and period of inundation, and weed invasion.

Plant community 6 Coastal *Thryptomene baeckeacea* heathland occupied 11.1 hectares, or 0.17% of the study area. It was restricted to stable dunes near Cape Burney, and was also not recorded elsewhere during the GRFVS survey. Its restricted extent gives it local conservation significance. It is threatened by soil erosion caused by human access, fire, feral animals and weed invasion.

Plant community 1 Riparian *Eucalyptus camaldulensis* low woodland or forest, with 14.58 hectares in the Dongara to Cape Burney study area (occupying 0.23%), is also restricted in extent. However, it's *degraded* and *completely degraded* condition means it is unlikely to be able to be restored to anything near its original condition, even with intensive management.

Plant community 9 Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria* occupied 33.37 hectares, or 0.52% of the study area, however it also occurred within mosaics with other plant communities. It occurred on hills with exposed limestone, on dune slopes, in dune swales and on the Greenough Alluvial Flats but was only recorded at least 500 m from the

coast. It appears to be naturally restricted in extent but, aside from not occurring adjacent to the coast, is not restricted to any particular landform. The main threats are clearing and weed invasion.

Plant community 3 Foredune and primary dune *Atriplex* / *Scaevola* shrubland occupied 134.25 hectares, or 2.1% of the study area. It was restricted to foredunes and primary dunes immediately behind the foredunes. The main threats to this plant community are erosion caused by human access and changes to coastal processes, however as the characteristic species are effective colonisers of disturbed areas and the vegetation is likely to be widespread along the coastline, it is unlikely that this plant community is threatened at a larger scale.

Plant community 8 *Melaleuca* forest or tall shrubland occupied 173.91 hectares or 2.72% of the study area. It also occurred in mosaics with other communities, and is therefore considered to occupy a greater extent. However, additional surveys are likely to separate this plant community into *M. lanceolata* forest and *M. cardiophylla / M. huegelii* tall shrubland, further adding to its, or their, conservation significance. Plant community 8 occurred on dune slopes and swales and on the Greenough Alluvial Flats, and is threatened by soil erosion caused by human access, clearing, fire, feral animals and weed invasion. On the Greenough Alluvial Flat, which is largely cleared, this plant community has particular conservation significance.

6.3.2 Significant Plant Communities in Terms of Ecological Function

Plant communities that have specific ecological function are particularly important in terms of conservation significance.

The vegetation associated with estuarine areas, plant community 2, has a role in protecting the river banks from soil erosion, and provides fauna habitat.

Vegetation associated with foredunes and primary dunes, plant communities 3 and 4, have a vital role in preventing soil erosion that can result in large blowouts that are a common feature along the coastline. However, any vegetation associated with sand dunes has a vital role in preventing soil erosion.

6.4 Vegetation Conservation Priorities

It is important that land managers have priorities set for conservation of native vegetation, however it is often difficult to decided which areas are more important to preserve or manage than others.

In order to assist with setting conservation priorities, a preliminary hierarchy of conservation priorities has been assessed. The areas included as having conservation significance are discussed above, being the:

1. significant Beard Vegetation Associations (regionally and locally significant)
2. plant communities with restricted extent
3. plant communities with significant ecological function (although all vegetation performs important ecological functions)
4. areas of vegetation in the best (*very good*) condition.

Priority areas have been set by intersecting these areas using GIS software, with the results shown in **Maps 6a-c**. However this is only a preliminary hierarchy because:

- Plant community 4 Foredune *Nitraria billardierei* open shrubland has not been accurately mapped
- Plant community 3 Foredune and primary dune *Atriplex* / *Scaevola* shrubland have been mapped as indicative areas only
- Plant communities 8 *Melaleuca* forest or tall shrubland and 9 Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria* have significant representation within mosaic units, which are not included as being of restricted extent
- there is no inclusion of areas with conservation significant flora species (DRF or Priority Listed flora species), which were not assessed as part of this project
- there is no inclusion of any threats in the priority setting process
- Plant community 1 is not included due to the *degraded* or *completely degraded* condition.

Review of the resulting intersected areas indicate that there are only two areas where all four categories of conservation significance intersect (indicated by arrows in the inset of **Map 6a**), along the Greenough River opposite Devlin Pool Road in plant community 2 Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland. This should be considered as the area having the highest conservation priority in the Dongara to Cape Burney study area.

Areas where three categories of conservation significance intersect include:

- areas adjacent to the area of highest conservation significance near the Greenough River in plant communities 2 Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland and 8 *Melaleuca* forest or tall shrubland
- near Cape Burney in plant communities 3 Foredune and primary dune *Atriplex* / *Scaevola* shrubland and 6 Coastal *Thryptomene baeckeacea* heathland
- areas with primary dune vegetation.

These areas should be considered as having the next highest priority for conservation, however more accurate mapping of plant communities 8 *Melaleuca* forest or tall shrubland

and 9 Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria* in areas currently included within mosaics would probably also be included in this area.

6.5 Plant Species Conservation

The only conservation significant flora species recorded during the Dongara to Cape Burney survey was Priority 3 *Anthocercis intricata*. No specific search for conservation significant species was included in the survey, however this species was observed near Bookara Beach and Dongara, which is near the southern extent of its population. Priority 3 species are considered to be poorly known but have some populations that are not considered under immediate threat (Smith 2010).

6.6 Vegetation Condition

There was no *pristine* or *excellent* condition vegetation recorded in the Dongara to Cape Burney study area. By definition (Keighery 1994), only areas without aggressive weeds can be classed as *pristine* or *excellent*, and some of the more common weeds found throughout the study area can be considered to be 'aggressive', including *Lycium ferocissimum, Brassica tournefortii, Bromus diandrus* and *Euphorbia terracina*.

Over half (52.8%) of the study area was rated as being in *very good* condition: these areas should be considered as having higher conservation significance than areas of lesser condition. Most of the *very good* condition areas are on the western side of the study area in the dunes, with the eastern side probably more affected by grazing and as a consequence have more weeds.

6.7 Future Implementation of the Dongara to Cape Burney Coastal Vegetation Survey

The purpose of the Dongara to Cape Burney coastal vegetation survey is to provide background information on the existing vegetation and identify areas of conservation significance. The Dongara to Cape Burney survey results, especially when combined with the Geraldton Regional Vegetation and Flora Survey, provide a regional context for decision making for development proposals impacting on native vegetation.

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Appendix One:
Soil Summary

Dongara to Cape Burney Coastal Vegetation Survey

Table 8: Summary of DAFWA soil-landscape subsystems and phases occurring within the proposed corridor alignment (Rogers 1996)

Mapping Unit	Name	Level	Description
221Ga_1	Greenough Alluvium 1 Subsystem	subsystem	Level alluvial plain with areas of low river terraces.
221Ga_1Dr	Greenough Alluvium 1 Drainage line Phase	phase	Drainage lines in the alluvial plain. Red sandy earth with cracking clay and Semi-wet soils
221Ga_1G1	Greenough Alluvium 1 Plain Phase	phase	Level to very gently undulating alluvial plain. Hard setting, cracking uniform clayey soils with an alkaline soil reaction trend.
221Ga_2	Greenough Alluvium 2 Subsystem	subsystem	Level alluvial plain with areas of low river terraces.
221Ga_3	Greenough Alluvium 3 Subsystem	subsystem	Alluvial plain.
221GaIR1	Greenough Alluvium Irwin Phase 1	phase	Level alluvial flats with loamy duplex soils and alkaline grey clays.
221Qu_1	Quindalup Central 1 Subsystem	subsystem	Coastal dune system, no fixed drainage.
221Qu_1Dr	Quindalup Central 1 Drainage Line Phase	phase	Drainage lines which cut through the Quindalup dunes. Calcareous deep sand with wet and Semi wet soils
221Qu_1Qm	Quindalup Central mobile parabolic dune Phase	phase	Active parabolic dunes and blowouts. Calcareous deep sand
221Qu_1Qp1	Quindalup Central stable parabolic dune Phase1	phase	Low stable parabolic dunes with relief 5-15 m. Calcareous deep sand
221Qu_1Qp2	Quindalup Central stable parabolic dune Phase2	phase	Large scale parabolic dunes with relief 20-40 m. Calcareous deep sand
221Qu_1Qs1	Quindalup Central 1 frontal plain Phase	phase	Low lying plain adjoining foredune or beach. Calcareous deep sand
221Qu_1Qs2	Quindalup Central 1 swale Phase	phase	Gently undulating plains surrounded by parabolic dunes. Calcareous deep sand
221QuX_BEACH	Quindalup Central beach Phase	phase	Beach. Calcareous deep sand
221Ta_5	Tamala South 5 Subsystem	subsystem	Low hills with relict dunes and some limestone outcrop; Calcareous shallow and deep sands
221Ta_5Dr	Tamala South 5 Drainage line Phase	phase	Drainage lines dissecting the dunes and hills. Calcareous deep sand with Wet and Semi-wet soils

Appendix Two: Definitions and Criteria

Dongara to Cape Burney Coastal Vegetation Survey

Table 9: Definitions and criteria for Threatened Ecological Communities and Priority Ecological Communities (DEC 2007b)

Criteria	Definition
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B) All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Criteria	Definition
Threatened Ecological Communities	
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Criteria	Definition
Priority Ecological Communities	
Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, state forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; ii. Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. a. ***Rare***. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change These communities are usually represented on conservation lands. b. ***Near Threatened***. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table 10: DEC conservation codes and definitions for flora

Conservation Code		Definition
X	**Declared Rare Flora - Presumed Extinct**	Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee
R	**Declared Rare Flora - Extant**	Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee. (= Threatened Flora = Endangered + Vulnerable)
P1	**Priority One - Poorly Known**	Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey
P2	**Priority Two - Poorly Known**	Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey
P3	**Priority Three - Poorly Known**	Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey
P4	**Priority Four - Rare**	Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years

Table 11: EPBC Act categories

EPBC Act Category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 12: Keighery (1994) Bushland Condition Scale.

Condition	Description
Pristine	No obvious signs of disturbance
Excellent	Vegetation structure intact, disturbance only affecting individual species and weeds are non-aggressive species
Very Good	Vegetation structure altered, obvious signs of disturbance eg repeated fires, aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure altered, obvious signs of disturbance. Retains basic vegetation structure or ability to regenerate it. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Requires intensive management. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Completely Degraded	Vegetation structure is no longer intact and the area is completely or almost completely without native flora. 'Parkland Cleared'.

Appendix Three:
Flora Inventory

Dongara to Cape Burney Coastal Vegetation Survey

Table 13: Occurrence of flora taxa within floristic quadrats

Family	Int.	Species	DCB0901	DCB0902	DCB0903	DCB0904	DCB0905	DCB0906	DCB0907	DCB0908	DCB0909	DCB0910	DCB0911	DCB0912	DCB0913	DCB0914	DCB0915	DCB0916	DCB0917	DCB0918	DCB0919	DCB0920	DCB0921	GRFVS46	GRFVS47	GRFVS48	GRFVS49	Total
Adiantaceae		*Cheilanthes sieberi*		+											+													**2**
	*	*Carpobrotus edulis*								+	+		+			+	+				+	+						**7**
		Carpobrotus virescens					+																				+	**2**
	*	*Mesembryanthemum crystallinum*																				+						**1**
	*	*Tetragonia decumbens*								+			+			+												**3**
Aizoaceae		*Tetragonia implexicoma*																			+						+	**2**
Amaranthaceae		*Ptilotus divaricatus*			+	+	+					+							+	+					+	+	**8**
Anthericaceae		*Thysanotus manglesianus*												+										+	+			**3**
		Daucus glochidiatus																						+				**1**
		Trachymene ornata		+																				+				**2**
Apiaceae		*Trachymene pilosa*												+						+								**2**
Apocynaceae		*Alyxia buxifolia*		+	+	+	+					+													+	+		**7**
Asphodelaceae	*	*Trachyandra divaricata*							+																			**1**
		Angianthus cunninghamii								+			+															**2**
	*	*Arctotheca calendula*				+																						**1**
		Asteraceae spD																							+			**1**
	*	*Carthamus lanatus*							+																			**1**
	*	*Hypochaeris glabra*				+						+		+			+						+					**5**
		Olearia ? dampieri																		+								**1**
		Olearia axillaris				+	+				+		+			+					+							**6**
		Podolepis lessonii																		+								**1**
		Podotheca angustifolia												+														**1**
	*	*Reichardia tingitana*		+	+	+		+	+	+		+								+	+	+	+	+		+		**13**
		Senecio hispidulus					+				+			+			+			+	+							**6**
		Senecio pinnatifolius																									+	**1**
		Senecio sp.																				+						**1**
	*	*Sonchus oleraceus*		+	+	+						+		+				+						+	+	+	+	**10**
Asteraceae	*	*Urospermum picroides*			+						+		+															**3**
Boraginaceae		*Echium plantagineum*																								+		**1**
Brassicaceae	*	*Brassica tournefortii*			+	+								+			+			+				+		+		**7**
Caryophyllaceae	*	*Petrorhagia dubia*				+																	+					**2**

Family	Int.	Species	DCB0901	DCB0902	DCB0903	DCB0904	DCB0905	DCB0906	DCB0907	DCB0908	DCB0909	DCB0910	DCB0911	DCB0912	DCB0913	DCB0914	DCB0915	DCB0916	DCB0917	DCB0918	DCB0919	DCB0920	DCB0921	GRFVS46	GRFVS47	GRFVS48	GRFVS49	Total
	*	*Silene gallica*			+															+								**2**
Caryophyllaceae		*Spergularia marina*	+																									**1**
Casuarinaceae		*Casuarina obesa*	+																									**1**
		Atriplex amnicola																				+						**1**
		Atriplex cinerea											+															**1**
		Atriplex isatidea								+						+												**2**
		Chenopodium gaudichaudianum																							+			**1**
	*	*Chenopodium murale*							+																			**1**
		Enchylaena tomentosa			+	+						+																**3**
		Rhagodia baccata			+		+	+							+													**4**
		Rhagodia latifolia subsp. *recta*				+	+	+		+	+		+	+										+	+		+	**10**
		Rhagodia preissii		+		+						+					+	+	+		+		+					**8**
		Salsola tragus			+																							**1**
		Tecticornia indica subsp. *bidens*	+																									**1**
		Tecticornia pergranulata	+																									**1**
		Tecticornia sp.	+																									**1**
Chenopodiaceae		*Threlkeldia diffusa*	+	+	+	+	+			+	+	+	+	+	+	+	+				+	+		+	+	+	+	**19**
Crassulaceae		*Crassula colorata*				+								+											+			**3**
Cunoniaceae		*Aphanopetalum clematideum*		+																								**1**
Cyperaceae		*Ficinia nodosa*									+																	**1**
		Acanthocarpus preissii			+	+	+	+			+			+						+	+	+		+		+		**11**
Dasypogonaceae		*Lomandra maritima*																			+							**1**
Dilleniaceae		*Hibbertia subvaginata*																		+	+							**2**
		Euphorbia peplus																								+	+	**2**
		Euphorbia tannensis			+																							**1**
	*	*Euphorbia terracina*			+	+						+			+							+	+	+		+	+	**9**
Euphorbiaceae		*Phyllanthus scaber*												+	+					+								**3**
		Scaevola crassifolia								+	+		+								+			+				**5**
Goodeniaceae		*Scaevola tomentosa*			+	+																				+		**3**
Haemodoraceae		*Conostylis candicans* subsp. *calcicola*												+						+	+							**3**
		Lamiaceae sp.																		+								**1**
Lamiaceae		*Westringia dampieri*												+														**1**
		Cassytha flava																									+	**1**
		Cassytha racemosa																						+				**1**
Lauraceae		*Cassytha* sp.					+																+					**2**
Lobeliaceae		*Lobelia heterophylla*																		+								**1**
		Acacia rostellifera					+				+	+		+				+		+	+			+		+		**9**
Mimosaceae		*Acacia saligna*																			+							**1**
Myoporaceae		*Myoporum insulare*																						+				**1**

Family	Int.	Species	DCB0901	DCB0902	DCB0903	DCB0904	DCB0905	DCB0906	DCB0907	DCB0908	DCB0909	DCB0910	DCB0911	DCB0912	DCB0913	DCB0914	DCB0915	DCB0916	DCB0917	DCB0918	DCB0919	DCB0920	DCB0921	GRFVS46	GRFVS47	GRFVS48	GRFVS49	Total
		Eucalyptus camaldulensis							+																			1
		Eucalyptus obtusiflora						+						+									+					3
		Eucalyptus oraria						+							+													2
		Melaleuca ? *viminea*																					+					1
		Melaleuca cardiophylla															+		+						+			3
		Melaleuca depressa					+													+								2
		Melaleuca huegelii		+															+		+		+					4
		Melaleuca lanceolata		+		+																						2
		Melaleuca leuropoma												+														1
		Melaleuca systena																			+							1
Myrtaceae		*Thryptomene baeckeacea*																									+	1
Nyctaginaceae		*Boerhavia schomburgkiana*					+																					1
Orchidaceae		*Eriochilus dilatatus* subsp. *undulatus*																							+			1
Oxalidaceae		*Oxalis perennans*																								+		1
		Lotus australis								+	+		+															3
		Templetonia retusa					+				+									+	+							4
Papilionaceae	*	*Trifolium campestre*																					+					1
Phormiaceae		*Dianella revoluta*												+														1
		Pittosporum ligustrifolium												+												+	+	3
Pittosporaceae		*Pittosporum phylliraeoides*						+												+								2
Plantaginaceae		*Misopates orontium*																								+		1
		Austrodanthonia sp.				+															+							2
		Austrostipa compressa				+	+							+	+					+	+							6
		Austrostipa elegantissima			+	+	+							+						+		+	+	+	+	+		10
		Austrostipa sp.		+																								1
	*	*Avena barbata*		+		+		+	+			+			+		+	+		+		+	+		+	+	+	14
	*	*Bromus diandrus*		+		+	+		+			+					+	+			+	+	+			+		11
	*	*Bromus rubens*				+		+																				2
	*	*Cynodon dactylon*							+																			1
	*	*Ehrharta longiflora*			+	+	+	+	+		+	+		+	+		+	+	+	+	+	+	+	+				+	18
	*	*Ehrharta* sp.															+											1
	*	*Hordeum leporinum*							+					+														2
		Lolium rigidum																							+			1
	*	*Lolium* sp.													+													1
	*	*Parapholis incurva*	+																									1
		Poa porphyroclados					+																					1
		Poaceae sp.				+																						1
	*	*Polypogon monspeliensis*	+			+								+														3
Poaceae		*Schismus barbatus*																									+	1

Family	Int.	Species	DCB0901	DCB0902	DCB0903	DCB0904	DCB0905	DCB0906	DCB0907	DCB0908	DCB0909	DCB0910	DCB0911	DCB0912	DCB0913	DCB0914	DCB0915	DCB0916	DCB0917	DCB0918	DCB0919	DCB0920	DCB0921	GRFVS46	GRFVS47	GRFVS48	GRFVS49	Total
		Spinifex longifolius								+			+			+						+						4
	*	*Vulpia bromoides*				+																						1
Poaceae	*	*Vulpia myuros*		+																						+		2
		Comesperma integerrimum				+								+	+								+					4
Polygalaceae		*Comesperma* sp.		+																								1
Polygonaceae		*Muehlenbeckia adpressa*												+														1
		Calandrinia brevipedata																							+		+	2
Portulacaceae		*Calandrinia liniflora*																							+	+		2
	*	*Anagallis arvensis*		+	+	+		+				+			+									+			+	8
Primulaceae		*Samolus repens* var. *floribundus*	+																									1
Proteaceae		*Grevillea argyrophylla*																					+					1
Ranunculaceae		*Clematis linearifolia*					+							+										+				3
Rubiaceae		*Galium murale*																								+		1
		Diplolaena eneabbensis																		+								1
Rutaceae		*Diplolaena* sp.												+														1
		Anthobolus foveolatus																		+								1
Santalaceae		*Exocarpos sparteus*									+																	1
Sapindaceae		*Dodonaea aptera*																		+								1
		Anthocercis intricata																		+								1
	*	*Lycium ferocissimum*			+	+		+	+	+		+			+													7
Solanaceae		*Nicotiana occidentalis* subsp. *hesperis*																									+	1
		Guichenotia ledifolia																		+								1
		Lasiopetalum angustifolium		+																+								2
Sterculiaceae		*Rulingia borealis*																		+								1
Surianaceae		*Stylobasium spathulatum*			+									+												+		3
		Pimelea gilgiana																		+					+			2
		Pimelea microcephala			+										+													2
Thymelaeaceae		*Pimelea* sp.				+			+																			2
Urticaceae		*Parietaria cardiostegia*																							+		+	2
		Nitraria billardierei																				+						1
Zygophyllaceae		*Zygophyllum fruticulosum*					+				+				+				+	+				+	+		+	8
		INDET sp 1					+										+				+							3
INDET		INDET sp 2						+						+														2
			9	**17**	**21**	**32**	**22**	**13**	**12**	**11**	**15**	**15**	**11**	**30**	**15**	**6**	**12**	**6**	**6**	**31**	**22**	**14**	**16**	**19**	**18**	**22**	**20**	

Appendix Four:
Quadrat Details

Dongara to Cape Burney Coastal Vegetation Survey

Quadrat Descriptions:

DCB0901

U^*Casuarina obesa*\^tree\6\r; G+^*Tecticornia indica* subsp*. bidens,*^*Tecticornia* sp., *Threlkeldia diffusa*\^samphire shrub\2\c

Description: *Casuarina obesa* low open woodland over *Tecticornia indica* subsp*. bidens, Tecticornia* sp., *Threlkeldia diffusa* low samphire shrubland

Plant community 2: Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland

DCB0902

U+^*Melaleuca lanceolata, Melaleuca huegelii*\^tree\6\d; G^*Threlkeldia diffusa*\chenopod shrub\1\r

Description: *Melaleuca lanceolata, M. huegelii* low closed forest over *Threlkeldia diffusa* sparse low chenopod shrubland

Plant community 8: Dune swale and Greenough Alluvial Flats *Melaleuca lanceolata* Forest or *Melaleuca cardiophylla* and *Melaleuca huegelii* tall shrubland

DCB0903

M+^*Alyxia buxifolia,* ^*Rhagodia baccata, Ptilotus divaricatus*\^shrub, ^chenopod shrub\3\c; G^ *Reichardia tingitana, Ehrharta longiflora, Euphorbia terracina*\^forb, other grass\1\c

Description: *Alyxia buxifolia, Rhagodia baccata, Ptilotus divaricatus* mid shrubland/chenopod shrubland over *Reichardia tingitana, Ehrharta longiflora, Euphorbia terracina* low forbland/grassland

Plant community 7: Taller dune slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

DCB0904

U+^*Melaleuca lanceolata*\^tree\6\c; M^*Lycium ferocissimum, Alyxia buxifolia*\^shrub\3\c; G^*Rhagodia latifolia* subsp*. recta, Threlkeldia diffusa, Reichardia tingitana*\^chenopod shrubland, forb\1\c

Description: *Melaleuca lanceolata* low open forest over *Lycium ferocissimum, Alyxia buxifolia* mid shrubland over *Rhagodia latifolia* subsp*. recta, Threlkeldia diffusa, Reichardia tingitana* low chenopod shrubland/forbland

Plant community 8: Dune swale and Greenough Alluvial Flats *Melaleuca lanceolata* Forest or *Melaleuca cardiophylla* and *Melaleuca huegelii* tall shrubland

DCB0905

M^*Alyxia buxifolia, Rhagodia baccata*\^shrub, chenopod shrub\3\i; G+^*Melaleuca depressa, Templetonia retusa, Zygophyllum fruticulosum*\^shrub\2\i

Description: *Alyxia buxifolia, Rhagodia baccata* open mid shrubland/chenopod shrubland over *Melaleuca depressa, Templetonia retusa, Zygophyllum fruticulosum* low shrubland

Plant community 5: Low coastal (secondary dune) *Scaevola crassifolia, Rhagodia preissii, Templetonia retusa* and *Alyxia buxifolia* open shrubland

DCB0906

U+^*Eucalyptus oraria, Eucalyptus obtusiflora*\^tree mallee\6\i; G^ *Rhagodia latifolia* subsp*. recta, Ehrharta longiflora*\^chenopod shrub, other grass\1\r

Description: *Eucalyptus oraria, Eucalyptus obtusiflora* mid mallee woodland over *Rhagodia latifolia* subsp*. recta, Ehrharta longiflora* sparse low chenopod shrubland\sparse low grassland

Plant community 9: Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria* mallee

DCB0907

U+^*Eucalyptus camaldulensis*\^tree\6\d; G^*Ehrharta longiflora, Bromus diandrus, Avena barbata*\^other grass\1\i

Description: *Eucalyptus camaldulensis* low closed forest over *Ehrharta longiflora, Bromus diandrus, Avena barbata* low grassland

Plant community 1: Riparian *Eucalyptus camaldulensis* low woodland or forest over introduced species

DCB0908

G+^*Threlkeldia diffusa,* ^*Spinifex longifolius, Tetragonia decumbens*\^chenopod shrub, ^tussock grass, forb\1\c

Description: *Threlkeldia diffusa, Spinifex longifolius, Tetragonia decumbens* low chenopod shrubland/low tussock grassland\low forbland

Plant community 3: Foredune and primary dune *Atriplex, Scaevola* shrubland and *Spinifex* tussock grassland

DCB0909

G+^*Scaevola crassifolia, Olearia axillaris, Rhagodia latifolia* subsp*. recta*\^shrub, chenopod shrub\2\c

Description: *Scaevola crassifolia, Olearia axillaris, Rhagodia latifolia* subsp*. recta* low shrubland\low chenopod shrubland

Plant community 5: Low coastal (secondary dune) *Scaevola crassifolia, Rhagodia preissii, Templetonia retusa* and *Alyxia buxifolia* open shrubland

DCB0910

M+^*Acacia rostellifera*\^shrub\4\i; ^*Bromus diandrus, Avena barbata, Ehrharta longiflora*\^other grass\1\d

Description: *Acacia rostellifera* open tall shrubland over *Bromus diandrus, Avena barbata, Ehrharta longiflora* closed low grassland

Plant community 7: Taller dune slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

DCB0911

G+^*Scaevola crassifolia, Angianthus cunninghamii, Olearia axillaris*\^shrub\1\c

Description: *Scaevola crassifolia, Angianthus cunninghamii, Olearia axillaris* low shrubland

Plant community 3: Foredune and primary dune *Atriplex, Scaevola* shrubland and *Spinifex* tussock grassland

DCB0912

M+^*Eucalyptus obtusiflora*\mallee shrub\6\c; G^*Acanthocarpus preissii, Westringia dampieri, Rhagodia latifolia* subsp*. recta*\^forb, shrub, chenopod shrub\2\c

Description: *Eucalyptus obtusiflora* mid mallee shrubland over *Acanthocarpus preissii, Westringia dampieri, Rhagodia latifolia* subsp*. recta* mid forbland\low shrubland\low chenopod shrubland

Plant community 9: Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria* mallee

DCB0913

U+^*Eucalyptus oraria*\^tree mallee\6\c; M^*Rhagodia baccata*\^chenopod shrub\3\i; G^*Ehrharta longiflora, Avena barbata*\^other grass\1\d

Description: *Eucalyptus oraria* open mid mallee forest over *Rhagodia baccata* open mid chenopod shrubland over *Ehrharta longiflora, Avena barbata* closed low grassland

Plant community 9: Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria* mallee

DCB0914

M^*Atriplex isatidea*\^chenopod shrub\3\r\G+^*Tetragonia decumbens, Olearia axillaris, Spinifex longifolius*\^forb, shrub, tussock grass\1\c

Description: *Atriplex isatidea* sparse mid chenopod shrubland over *Tetragonia decumbens, Olearia axillaris, Spinifex longifolius* low forbland\low shrubland\low tussock grassland

Plant community 3: Foredune and primary dune *Atriplex, Scaevola* shrubland and *Spinifex* tussock grassland

DCB0915

M+^*Melaleuca cardiophylla*\^shrub\4\c; G^*Ehrharta* sp., *Threlkeldia diffusa*\^other grass, chenopod shrub\1\d

Description: *Melaleuca cardiophylla* tall shrubland over *Ehrharta* sp., *Threlkeldia diffusa* closed grassland\closed chenopod shrubland

Plant community 8: Dune swale and Greenough Alluvial Flats *Melaleuca lanceolata* Forest or *Melaleuca cardiophylla* and *Melaleuca huegelii* tall shrubland

DCB0916

U+^*Acacia rostellifera*\^tree\6\c; G^*Bromus diandrus, Ehrharta longiflora*\^other grass\1\d

Description: *Acacia rostellifera* low woodland over *Bromus diandrus, Ehrharta longiflora* closed low grassland

Plant community 7: Taller dune slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

DCB0917

M+^*Melaleuca huegelii, Melaleuca cardiophylla*\^shrub\4\d; G^*Rhagodia preissii, Threlkeldia diffusa, Ptilotus divaricatus*\^chenopod shrub, shrub\2\i

Description: *Melaleuca huegelii, Melaleuca cardiophylla* tall closed shrubland over *Rhagodia preissii, Threlkeldia diffusa, Ptilotus divaricatus* low open chenopod shrubland\low open shrub

Plant community 9: Dune swale and Greenough Alluvial Flats *Melaleuca lanceolata* Forest or *Melaleuca cardiophylla* and *Melaleuca huegelii* tall shrubland

DCB0918

M+^ *Melaleuca depressa, Templetonia retusa*\^shrub\3\i; G^*Olearia ?dampieri, Anthocercis intricata, Acanthocarpus preissii*\^shrub\2\i

Description: *Melaleuca depressa, Templetonia retusa* open mid shrubland over open low shrubland

Plant community 7: Taller dune slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

DCB0919

M+^*Scaevola crassifolia, Rhagodia preissii, Templetonia retusa*\^shrub, chenopod shrub\3\i; G^*Lomandra maritima, Bromus diandrus, Carpobrotus edulis*\^forb, other grass\1\i

Description: *Scaevola crassifolia, Rhagodia preissii, Templetonia retusa* open mid shrubland\open mid chenopod shrubland over *Lomandra maritima, Bromus diandrus, Carpobrotus edulis* open low forbland\open low grassland

Plant community 5: Low coastal (secondary dune) *Scaevola crassifolia, Rhagodia preissii, Templetonia retusa* and *Alyxia buxifolia* open shrubland

DCB0920

M+^*Nitraria billardierei*\^shrub\3\i; G^*Atriplex amnicola, Spinifex longifolius, Threlkeldia diffusa*\^chenopod shrub, tussock grass\2\i

Description: *Nitraria billardierei* mid open shrubland over *Atriplex amnicola, Spinifex longifolius, Threlkeldia diffusa* low open chenopod shrubland\mid open tussock grassland

Plant community 4: Foredune *Nitraria billardierei* open shrubland over *Atriplex amnicola and Threlkeldia diffusa* shrubland and *Spinifex longifolius* tussock grassland

DCB0921

M+^*Melaleuca huegelii, Eucalyptus obtusiflora, Rhagodia preissii*\^shrub, mallee shrub, chenopod shrub\4\c; G^*Ehrharta longiflora, Bromus diandrus*\^other grass\1\d

Description: *Melaleuca huegelii, Eucalyptus obtusiflora, Rhagodia preissii* tall shrubland\low mallee shrubland\tall chenopod shrubland over *Ehrharta longiflora, Bromus diandrus* low closed grassland

Plant community 8: Dune swale and Greenough Alluvial Flats *Melaleuca lanceolata* Forest or *Melaleuca cardiophylla* and *Melaleuca huegelii* tall shrubland

GRV0846

M+^*Scaevola crassifolia, Acacia rostellifera, Zygophyllum fruticulosum*\^shrub\3\i; G^*Ehrharta longiflora, Reichardia tingitana*\^other grass, forb\1\r

Description: *Scaevola crassifolia, Acacia rostellifera, Zygophyllum fruticulosum* mid open shrubland over *Ehrharta longiflora, Reichardia tingitana* sparse low grassland\sparse low forbland

Plant community 5: Low coastal (secondary dune) *Scaevola crassifolia, Rhagodia preissii, Templetonia retusa* and *Alyxia buxifolia* open shrubland

GRV0847

M+^*Melaleuca cardiophylla*\^shrub\4\c; G^*Calandrinia brevipedata, Crassula colorata*\^forb\1\r

Description: *Melaleuca cardiophylla* tall shrubland over *Calandrinia brevipedata, Crassula colorata* low sparse forbland

Plant community 8: Dune swale and Greenough Alluvial Flats *Melaleuca lanceolata* Forest or *Melaleuca cardiophylla* and *Melaleuca huegelii* tall shrubland

GRV0848

M+^*Alyxia buxifolia, Pittosporum ligustrifolium*\^shrub\4\i; G^*Euphorbia peplus, Bromus diandrus, Euphorbia terracina*\^forb, other grass\1\c

Description: *Alyxia buxifolia, Pittosporum ligustrifolium* tall open shrubland over *Euphorbia peplus, Bromus diandrus, Euphorbia terracina* low forbland\low grassland

Plant community 7: Taller dune slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

GRV0849

M+^*Thryptomene baeckeacea*\^heath shrub\3\c; G^*Anagallis arvensis, Euphorbia peplus, Sonchus oleraceus*\^forb\1\r

Description: *Thryptomene baeckeacea* mid Heathland over *Anagallis arvensis, Euphorbia peplus, Sonchus oleraceus* low sparse forbland

Plant community 6: Coastal *Thryptomene baeckeacea* Heathland

Quadrat/Site:	DCB0901		**Date:**	30/11/2009	
Field Staff:	LA/SB				
Waypoint:	1	**MGA (Zone 50)**	6803118 **mN**	0271423 **mE**	
Photo No:	8	**Direction:**	SE		
Aspect:	n/a	**Slope:**	Flat	**Topography:**	Riverbank
Surface Soil:	Clay	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	10%	**Litter depth:**	<1 cm	**Bare ground:**	15%
Condition:	Good	**Weed cover:**	10%		
Disturbance:	*Type*	Tracks	*Extent*	edge	
Community Description		U^*Casuarina obesa*\^tree\6\r; G+^ *Tecticornia indica* subsp. *bidens,*^*Tecticornia* sp., *Threlkeldia diffusa*\^samphire shrub\2\c			

Species

Casuarina obesa

**Parapholis incurva*

**Polypogon monspeliensis*

Samolus repens var. *floribundus*

Spergularia marina

Tecticornia indica subsp. *bidens*

Tecticornia pergranulata

Tecticornia sp.

Threlkeldia diffusa

Quadrat/Site:	DCB0902		**Date:**	30/11/2009	
Field Staff:	LA/SB				
Wpt.	2	**MGA (Zone 50)**	6801882 **mN**	0272492 **mE**	
Photo No:	9	**Direction:**	SE		
Aspect:	n/a	**Slope:**	Flat	**Topography:**	Riverbank
Surface Soil:	Clay loam	**Colour:**	Brown		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	80%	**Litter depth:**	<1 cm	**Bare ground:**	10%
Condition:	Very good	**Weed cover:**	2%		
Disturbance:	*Type*	Weeds	*Extent*	2%	
Community Description		U+^*Melaleuca lanceolata, Melaleuca huegelii*\^tree\6\d; U^*Threlkeldia diffusa*\chenopod shrub\1\r			

Species

Alyxia buxifolia
**Anagallis arvensis*
Aphanopetalum clematideum
Austrostipa sp.
**Avena barbata*
**Bromus diandrus*
Cheilanthes sieberi
Comesperma sp.
Lasiopetalum angustifolium
Melaleuca huegelii
Melaleuca lanceolata
**Reichardia tingitana*
Rhagodia preissii
**Sonchus oleraceus*
Threlkeldia diffusa
Trachymene ornata
**Vulpia myuros*

Quadrat/Site:	DCB0903		**Date:**	30/11/2009	
Field Staff:	LA/SB				
Waypoint:	4	**MGA (Zone 50)**	6801242 **mN**	0273030 **mE**	
Photo No:	14	**Direction:**	SE		
Aspect:	E	**Slope:**	Steep	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	Light grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	30%	**Litter depth:**	2 – 3 cm	**Bare ground:**	10%
Condition:	Good	**Weed cover:**	60%		
Disturbance:	*Type*	Grazed	*Extent*	Whole site	
	Type	Weeds	*Extent*	Whole site	
	Type	Rabbits	*Extent*	Whole site	
Community Description		M+^*Alyxia buxifolia, ^Rhagodia baccata, Ptilotus divaricatus*\^shrub, ^chenopod shrub\3\c; G^ *Reichardia tingitana, Ehrharta longiflora, Euphorbia terracina*\^forb, other grass\1\c			

Species

Acanthocarpus preissii
Alyxia buxifolia
**Anagallis arvensis*
Austrostipa elegantissima
**Brassica tournefortii*
**Ehrharta longiflora*
Enchylaena tomentosa
Euphorbia tannensis
**Euphorbia terracina*
**Lycium ferocissimum*
Pimelea microcephala
Ptilotus divaricatus
**Reichardia tingitana*
Rhagodia baccata
Salsola tragus
Scaevola tomentosa
**Silene gallica*
**Sonchus oleraceus*
Stylobasium spathulatum
Threlkeldia diffusa
**Urospermum picroides*

Quadrat/Site:	DCB0904		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	5	**MGA (Zone 50)**	6799419 **mN**	0274332 **mE**	
Photo No:	15	**Direction:**	SE		
Aspect:	W	**Slope:**	Gentle	**Topography:**	Valley/dune
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	20%	**Litter depth:**	<1 cm	**Bare ground:**	25%
Condition:	Good	**Weed cover:**	15%		
Disturbance:	*Type*	Weeds	*Extent*	Whole site	
Community Description		U+^*Melaleuca lanceolata*\^tree\6\c; M^*Lycium ferocissimum, Alyxia buxifolia*\^shrub\3\c; G^*Rhagodia latifolia* subsp*. recta, Threlkeldia diffusa, Reichardia tingitana*\^chenopod shrubland, forb\1\c			

Species

Acanthocarpus preissii
Alyxia buxifolia
**Anagallis arvensis*
**Arctotheca calendula*
Austrodanthonia sp.
Austrostipa compressa
Austrostipa elegantissima
**Avena barbata*
**Brassica tournefortii*
**Bromus diandrus*
**Bromus rubens*
Comesperma integerrimum
Crassula colorata
**Ehrharta longiflora*
Enchylaena tomentosa
**Euphorbia terracina*
**Hypochaeris glabra*
**Lycium ferocissimum*
Melaleuca lanceolata
Olearia axillaris
**Petrorhagia dubia*
Pimelea sp.
Poaceae sp.
**Polypogon monspeliensis*
Ptilotus divaricatus
**Reichardia tingitana*
Rhagodia latifolia subsp*. recta*
Rhagodia preissii
Scaevola tomentosa
**Sonchus oleraceus*
Threlkeldia diffusa
**Vulpia bromoides*

Quadrat/Site:	DCB0905		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	7	**MGA (Zone 50)**	6797551 **mN**	0275069 **mE**	
Photo No:	18	**Direction:**	SE		
Aspect:	W	**Slope:**	Gentle	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	20%	**Litter depth:**	<1 cm	**Bare ground:**	10%
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Rabbits	*Extent*	Whole site	
Community Description		M^*Alyxia buxifolia, Rhagodia baccata*\^shrub, chenopod shrub\3\i; G+^*Melaleuca depressa, Templetonia retusa, Zygophyllum fruticulosum*\^shrub\2\i			

Species

Acacia rostellifera
Acanthocarpus preissii
Alyxia buxifolia
Austrostipa compressa
Austrostipa elegantissima
Boerhavia schomburgkiana
**Bromus diandrus*
Carpobrotus virescens
Cassytha sp.
Clematis linearifolia
**Ehrharta longiflora*
INDET sp 1
Melaleuca depressa
Olearia axillaris
Poa porphyroclados
Ptilotus divaricatus
Rhagodia baccata
Rhagodia latifolia subsp. *recta*
Senecio hispidulus
Templetonia retusa
Threlkeldia diffusa
Zygophyllum fruticulosum

Quadrat/Site:	DCB0906		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	8	**MGA (Zone 50)**	6798348 **mN**	0275876 **mE**	
Photo No:	19	**Direction:**	SE		
Aspect:	NW	**Slope:**	Gentle	**Topography:**	
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	Limestone	**% Surface Rock:**	2%	**Fragment size**	10 – 15 cm
Litter cover:	70%	**Litter depth:**	1 – 2 cm	**Bare ground:**	20%
Condition:	Good	**Weed cover:**	5%		
Disturbance:	*Type*	Grazed	*Extent*	Whole site	
Community Description		U+^*Eucalyptus oraria, Eucalyptus obtusiflora*\^tree mallee\6\i; G^ *Rhagodia latifolia* subsp. *recta, Ehrharta longiflora*\^chenopod shrub, other grass\1\r			

Species

Acanthocarpus preissii
**Anagallis arvensis*
**Avena barbata*
**Bromus rubens*
**Ehrharta longiflora*
Eucalyptus obtusiflora
Eucalyptus oraria
INDET sp 2
**Lycium ferocissimum*
Pittosporum phylliraeoides
**Reichardia tingitana*
Rhagodia baccata
Rhagodia latifolia subsp. *recta*

Quadrat/Site:	DCB0907		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	9	**MGA (Zone 50)**	6797696 **mN**	0276651 **mE**	
Photo No:	20	**Direction:**	SE		
Aspect:	n/a	**Slope:**	Flat	**Topography:**	Riverbank
Surface Soil:	Clayey loam	**Colour:**	Red brown		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	80%	**Litter depth:**	1 – 40 cm	**Bare ground:**	5%
Condition:	Degraded	**Weed cover:**	30%		
Disturbance:	*Type*	Grazed	*Extent*	Whole site	
Community Description		U+^*Eucalyptus camaldulensis*\^tree\6\d; G^*Ehrharta longiflora, Bromus diandrus, Avena barbata*\^other grass\1\i			

Species

**Avena barbata*

**Bromus diandrus*

**Carthamus lanatus*

**Chenopodium murale*

**Cynodon dactylon*

**Ehrharta longiflora*

Eucalyptus camaldulensis

**Hordeum leporinum*

**Lycium ferocissimum*

Pimelea sp.

**Reichardia tingitana*

**Trachyandra divaricata*

Quadrat/Site:	DCB0908		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	10	**MGA (Zone 50)**	6793805 **mN**	0278442 **mE**	
Photo No:	24	**Direction:**	SE		
Aspect:	n/a	**Slope:**	Flat	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	White		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	2%	**Litter depth:**	<1 cm	**Bare ground:**	40%
Condition:	Good	**Weed cover:**	15%		
Disturbance:	*Type*	Weeds	*Extent*	15%	
Community Description		G+^*Threlkeldia diffusa, ^Spinifex longifolius, Tetragonia decumbens*\^chenopod shrub, ^tussock grass, forb\1\c			

Species

Angianthus cunninghamii

Atriplex isatidea

**Carpobrotus edulis*

Lotus australis

**Lycium ferocissimum*

**Reichardia tingitana*

Rhagodia latifolia subsp. *recta*

Scaevola crassifolia

Spinifex longifolius

**Tetragonia decumbens*

Threlkeldia diffusa

Quadrat/Site:	DCB0909		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	11	**MGA (Zone 50)**	6793845 **mN**	0278507 **mE**	
Photo No:	28	**Direction:**	SE		
Aspect:	W	**Slope:**	Gentle	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	Cream		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	10%	**Litter depth:**	<1 cm	**Bare ground:**	15%
Condition:	Good	**Weed cover:**	2%		
Disturbance:	*Type*	Drought	*Extent*	Whole site	
Community Description		G+^*Scaevola crassifolia, Olearia axillaris, Rhagodia latifolia* subsp. *recta*\^shrub, chenopod shrub\2\c			

Species

Acacia rostellifera
Acanthocarpus preissii
**Carpobrotus edulis*
**Ehrharta longiflora*
Exocarpos sparteus
Ficinia nodosa
Lotus australis
Olearia axillaris
Rhagodia latifolia subsp. *recta*
Scaevola crassifolia
Senecio hispidulus
Templetonia retusa
Threlkeldia diffusa
**Urospermum picroides*
Zygophyllum fruticulosum

Quadrat/Site:	DCB0910		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	12	**MGA (Zone 50)**	6789511 **mN**	0283826 **mE**	
Photo No:	29	**Direction:**	SE		
Aspect:	E	**Slope:**	Gentle	**Topography:**	Dune/ridge
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	20%	**Litter depth:**	<1 cm	**Bare ground:**	1%
Condition:	Degraded	**Weed cover:**	90%		
Disturbance:	*Type*	Weeds	*Extent*	Whole site	
	Type	Fire?	*Extent*	Whole site	
Community Description		M+^*Acacia rostellifera*\^shrub\4\i; ^*Bromus diandrus, Avena barbata, Ehrharta longiflora*\^other grass\1\d			

Species

Acacia rostellifera
Alyxia buxifolia
**Anagallis arvensis*
**Avena barbata*
**Bromus diandrus*
**Ehrharta longiflora*
Enchylaena tomentosa
**Euphorbia terracina*
**Hypochaeris glabra*
**Lycium ferocissimum*
Ptilotus divaricatus
**Reichardia tingitana*
Rhagodia preissii
**Sonchus oleraceus*
Threlkeldia diffusa

Quadrat/Site:	DCB0911		**Date:**	1/12/2009	
Field Staff:	LA/SB				
Waypoint:	13	**MGA (Zone 50)**	6788635 **mN**	0283559 **mE**	
Photo No:	30	**Direction:**	SE		
Aspect:	W	**Slope:**	Moderate	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	1%	**Litter depth:**	<1 cm	**Bare ground:**	45%
Condition:	Good	**Weed cover:**	2%		
Disturbance:	*Type*	Rubbish	*Extent*	small	
Community Description		G+^*Scaevola crassifolia, Angianthus cunninghamii, Olearia axillaris*\^shrub\1\c			

Species

Angianthus cunninghamii
Atriplex cinerea
**Carpobrotus edulis*
Lotus australis
Olearia axillaris
Rhagodia latifolia subsp. *recta*
Scaevola crassifolia
Spinifex longifolius
**Tetragonia decumbens*
Threlkeldia diffusa
**Urospermum picroides*

Quadrat/Site:	DCB0912		**Date:**	2/12/2009	
Field Staff:	LA/SB				
Waypoint:	15	**MGA (Zone 50)**	6783983 **mN**	0289360 **mE**	
Photo No:	37	**Direction:**	SE		
Aspect:	SE	**Slope:**	Gentle	**Topography:**	Dune/valley
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	80%	**Litter depth:**	1 -2 cm	**Bare ground:**	5%
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Weeds	*Extent*	Whole site	
Community Description		M+^*Eucalyptus obtusiflora*\mallee shrub\6\c; G^*Acanthocarpus preissii, Westringia dampieri, Rhagodia latifolia* subsp. *recta*\^forb, shrub, chenopod shrub\2\c			

Species

Acacia rostellifera
Acanthocarpus preissii
Austrostipa compressa
Austrostipa elegantissima
**Brassica tournefortii*
Clematis linearifolia
Comesperma integerrimum
Conostylis candicans subsp. *calcicola*
Crassula colorata
Dianella revoluta
Diplolaena sp.
**Ehrharta longiflora*
Eucalyptus obtusiflora
**Hordeum leporinum*
**Hypochaeris glabra*
INDET sp 2
Melaleuca leuropoma
Muehlenbeckia adpressa
Phyllanthus scaber
Pittosporum ligustrifolium
Podotheca angustifolia
**Polypogon monspeliensis*
Rhagodia latifolia subsp. *recta*
Senecio hispidulus
**Sonchus oleraceus*
Stylobasium spathulatum
Threlkeldia diffusa
Thysanotus manglesianus
Trachymene pilosa
Westringia dampieri

Quadrat/Site:	DCB0913		**Date:**	2/12/2009	
Field Staff:	LA/SB				
Waypoint:	16	**MGA (Zone 50)**	6784545 **mN**	0289726 **mE**	
Photo No:	38	**Direction:**	SE		
Aspect:	n/a	**Slope:**	flat	**Topography:**	Plain
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	80%	**Litter depth:**	2 – 3 cm	**Bare ground:**	<1 cm
Condition:	Good	**Weed cover:**	90%		
Disturbance:	*Type*	Grazed	*Extent*	Whole site	
	Type	Rabbits	*Extent*	Whole site	
Community Description		U+^*Eucalyptus oraria*\^tree mallee\6\c; M^*Rhagodia baccata*\^chenopod shrub\3\i; G^*Ehrharta longiflora, Avena barbata*\^other grass\1\d			

Species

**Anagallis arvensis*
Austrostipa compressa
**Avena barbata*
Cheilanthes sieberi
Comesperma integerrimum
**Ehrharta longiflora*
Eucalyptus oraria
**Euphorbia terracina*
**Lolium* sp.
**Lycium ferocissimum*
Phyllanthus scaber
Pimelea microcephala
Rhagodia baccata
Threlkeldia diffusa
Zygophyllum fruticulosum

Quadrat/Site:	DCB0914		**Date:**	2/12/2009	
Field Staff:	LA/SB				
Waypoint:	17	**MGA (Zone 50)**	6780513 **mN**	0290703 **mE**	
Photo No:	39, 40	**Direction:**	SE		
Aspect:	W	**Slope:**	Steep	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	Cream		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	5%	**Litter depth:**	<1 cm	**Bare ground:**	30%
Condition:	Good	**Weed cover:**	30%		
Disturbance:	*Type*	Weeds	*Extent*	30%	
	Type	Wind	*Extent*	Whole site	
Community Description		M^*Atriplex isatidea*\^chenopod shrub\3\r\G+^*Tetragonia decumbens, Olearia axillaris, Spinifex longifolius*\^forb, shrub, tussock grass\1\c			

Species

Atriplex isatidea

**Carpobrotus edulis*

Olearia axillaris

Spinifex longifolius

**Tetragonia decumbens*

Threlkeldia diffusa

Quadrat/Site:	DCB0915		**Date:**	2/12/2009	
Field Staff:	LA/SB				
Waypoint:	19	**MGA (Zone 50)**	6780431 **mN**	0291886 **mE**	
Photo No:	47, 48	**Direction:**	SE		
Aspect:	N	**Slope:**	Gentle	**Topography:**	Dune/slope
Surface Soil:	Sand	**Colour:**	Pale grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	80%	**Litter depth:**	<1 cm	**Bare ground:**	10%
Condition:	Good	**Weed cover:**	75%		
Disturbance:	*Type*	Grazing	*Extent*	Whole site	
	Type	Weeds	*Extent*	Whole site	
Community Description		M+^*Melaleuca cardiophylla*\^shrub\4\c; G^*Ehrharta* sp., *Threlkeldia diffusa*\^other grass, chenopod shrub\1\d			

Species

**Avena barbata*

**Brassica tournefortii*

**Bromus diandrus*

**Carpobrotus edulis*

**Ehrharta longiflora*

**Ehrharta* sp.

**Hypochaeris glabra*

INDET sp 1

Melaleuca cardiophylla

Rhagodia preissii

Senecio hispidulus

Threlkeldia diffusa

Quadrat/Site:	DCB0916		**Date:**	2/12/2009	
Field Staff:	LA/SB				
Waypoint:	21	**MGA (Zone 50)**	6777301 **mN**	0295088 **mE**	
Photo No:	54, 55	**Direction:**	SE		
Aspect:	n/a	**Slope:**	Flat	**Topography:**	Plain
Surface Soil:	Sandy loam	**Colour:**	Grey-brown		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	90%	**Litter depth:**	1 – 2 cm	**Bare ground:**	nil
Condition:	Degraded	**Weed cover:**	95%		
Disturbance:	*Type*	Grazing	*Extent*	Whole site	
	Type	Weeds	*Extent*	Whole site	
Community Description		U+^*Acacia rostellifera*\^tree\6\c; G^*Bromus diandrus, Ehrharta longiflora*\^other grass\1\d			

Species

Acacia rostellifera

**Avena barbata*

**Bromus diandrus*

**Ehrharta longiflora*

Rhagodia preissii

**Sonchus oleraceus*

Quadrat/Site:	DCB0917		**Date:**	3/12/2009	
Field Staff:	LA/SB				
Waypoint:	23	**MGA (Zone 50)**	6777030 **mN**	0293182 **mE**	
Photo No:	60	**Direction:**	SE		
Aspect:	SE	**Slope:**	Gentle	**Topography:**	Dune/valley
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	90%	**Litter depth:**	2 – 3 cm	**Bare ground:**	nil
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Weeds	*Extent*	Minor	
Community Description		M+^*Melaleuca huegelii, Melaleuca cardiophylla*\^shrub\4\d; G^*Rhagodia preissii, Threlkeldia diffusa, Ptilotus divaricatus*\^chenopod shrub, shrub\2\i			

Species

**Ehrharta longiflora*

Melaleuca cardiophylla

Melaleuca huegelii

Ptilotus divaricatus

Rhagodia preissii

Zygophyllum fruticulosum

Quadrat/Site:	DCB0918		**Date:**	3/12/2009	
Field Staff:	LA/SB				
Waypoint:	24	**MGA (Zone 50)**	6776633 **mN**	0294635 **mE**	
Photo No:	64	**Direction:**	SE		
Aspect:	-	**Slope:**	-	**Topography:**	Dune/slope
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	20%	**Litter depth:**	1-5 cm	**Bare ground:**	10%
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Grazing	*Extent*	Whole site	
	Type	Rabbits	*Extent*	Whole site	
Community Description		M+^ *Melaleuca depressa, Templetonia retusa*\^shrub\3\i; G^*Olearia ?dampieri, Anthocercis intricata, Acanthocarpus preissii*\^shrub\2\i			

Species

Acacia rostellifera
Acanthocarpus preissii
Anthobolus foveolatus
Anthocercis intricata
Austrostipa compressa
Austrostipa elegantissima
**Avena barbata*
**Brassica tournefortii*
Conostylis candicans subsp. *calcicola*
Diplolaena eneabbensis
Dodonaea aptera
**Ehrharta longiflora*
Guichenotia ledifolia
Hibbertia subvaginata
Lamiaceae sp.
Lasiopetalum angustifolium
Lobelia heterophylla
Melaleuca depressa
Olearia ? *dampieri*
Phyllanthus scaber
Pimelea gilgiana
Pittosporum phylliraeoides
Podolepis lessonii
Ptilotus divaricatus
**Reichardia tingitana*
Rulingia borealis
Senecio hispidulus
**Silene gallica*
Templetonia retusa
Trachymene pilosa
Zygophyllum fruticulosum

Quadrat/Site:	DCB0919		**Date:**	4/12/2009	
Field Staff:	LA/SB				
Waypoint:	32	**MGA (Zone 50)**	6772666 **mN**	0294635 **mE**	
Photo No:	87	**Direction:**	SE		
Aspect:	W	**Slope:**	Gentle	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	White		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	20%	**Litter depth:**	<1 cm	**Bare ground:**	10%
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Rabbits	*Extent*	Whole site	
Community Description		M+^*Scaevola crassifolia, Rhagodia preissii, Templetonia retusa*\^shrub, chenopod shrub\3\i; G^*Lomandra maritima, Bromus diandrus, Carpobrotus edulis*\^forb, other grass\1\i			

Species

Acacia rostellifera
Acacia saligna
Acanthocarpus preissii
Austrodanthonia sp.
Austrostipa compressa
**Bromus diandrus*
**Carpobrotus edulis*
Conostylis candicans subsp. *calcicola*
**Ehrharta longiflora*
Hibbertia subvaginata
INDET sp 1
Lomandra maritima
Melaleuca huegelii
Melaleuca systena
Olearia axillaris
**Reichardia tingitana*
Rhagodia preissii
Scaevola crassifolia
Senecio hispidulus
Templetonia retusa
Tetragonia implexicoma
Threlkeldia diffusa

Quadrat/Site:	DCB0920		**Date:**	4/12/2009	
Field Staff:	LA/SB				
Waypoint:	33	**MGA (Zone 50)**	6771440 **mN**	0294680 **mE**	
Photo No:	99	**Direction:**	SE		
Aspect:	W	**Slope:**	Gentle	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	White		
Exposed Rock:	-	**% Surface Rock:**	-	**Fragment size**	-
Litter cover:	20%	**Litter depth:**	<1 cm	**Bare ground:**	30%
Condition:	Good	**Weed cover:**	30%		
Disturbance:	*Type*	Human	*Extent*	Whole site	
	Type	Trampling	*Extent*	Whole site	
	Type	Weeds	*Extent*	Whole site	

Community Description M+^*Nitraria billardierei*\^shrub\3\i; G^*Atriplex amnicola, Spinifex longifolius, Threlkeldia diffusa*\^chenopod shrub, tussock grass\2\i

Species

Acanthocarpus preissii
Atriplex amnicola
Austrostipa elegantissima
**Avena barbata*
**Bromus diandrus*
**Carpobrotus edulis*
**Ehrharta longiflora*
**Euphorbia terracina*
**Mesembryanthemum crystallinum*
Nitraria billardierei
**Reichardia tingitana*
Senecio sp.
Spinifex longifolius
Threlkeldia diffusa

Quadrat/Site:	DCB0921		**Date:**	4/12/2009	
Field Staff:	LA/SB				
Waypoint:	34	**MGA (Zone 50)**	6778974 **mN**	0294010 **mE**	
Photo No:	100	**Direction:**	SE		
Aspect:	n/a	**Slope:**	Flat	**Topography:**	Plain
Surface Soil:	Sand	**Colour:**	Black		
Exposed Rock:	Limestone	**% Surface Rock:**	10%	**Fragment size**	Consolidated
Litter cover:	90%	**Litter depth:**	1 – 2 cm	**Bare ground:**	2%
Condition:	Degraded	**Weed cover:**	80%		
Disturbance:	*Type*	Grazing	*Extent*	Whole site	
	Type	Weeds	*Extent*	Whole site	

Community Description M+^*Melaleuca huegelii, Eucalyptus obtusiflora, Rhagodia preissii*\^shrub, mallee shrub, chenopod shrub\4\c; G^*Ehrharta longiflora, Bromus diandrus*\^other grass\1\d

Species

Austrostipa elegantissima
**Avena barbata*
**Bromus diandrus*
Cassytha sp.
Comesperma integerrimum
**Ehrharta longiflora*
Eucalyptus obtusiflora
**Euphorbia terracina*
Grevillea argyrophylla
**Hypochaeris glabra*
Melaleuca ? *viminea*
Melaleuca huegelii
**Petrorhagia dubia*
**Reichardia tingitana*
Rhagodia preissii
**Trifolium campestre*

Quadrat/Site	GRV0846		**Date**	18/08/2008	
Field Staff	LA/CK				
Wpt	46	**Lat.**	28°53'02.2"	**Long.**	114°38'49.7"
Photo No:	46	**Direction:**	SE		
Aspect	W	**Slope:**	Gentle	**Topography:**	Slope/dune
Surface Soil:	Sand	**Colour:**	White		
Exposed Rock:	n/a	**% Surface Rock:**	n/a	**Fragment size:**	n/a
Litter cover:	80%	**Litter depth:**	1 cm	**Bare ground:**	2%
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Drought	*Extent*	Whole site	
	Type	Rabbits	*Extent*	Whole site	

Community Description: M+^*Scaevola crassifolia, Acacia rostellifera, Zygophyllum fruticulosum*\^shrub\3\i;G^*Ehrharta longiflora, Reichardia tingitana*\^other grass,forb\1\r

Species

Acacia rostellifera
Acanthocarpus preissii
**Anagallis arvensis*
Austrostipa elegantissima
**Brassica tournefortii*
Cassytha racemosa
Clematis linearifolia
Daucus glochidiatus
**Ehrharta longiflora*
**Euphorbia terracina*
Myoporum insulare
**Reichardia tingitana*
Rhagodia latifolia subsp. *recta*
Scaevola crassifolia
**Sonchus oleraceus*
Threlkeldia diffusa
Thysanotus manglesianus
Trachymene ornata
Zygophyllum fruticulosum

Quadrat/Site	GRV0847		**Date**	18/08/2008	
Field Staff	LA/CK				
Wpt	47	**Lat.**	28°53’01.1”	**Long.**	114°39’49.0”
Photo No:	47	**Direction:**	SE		
Aspect	n/a	**Slope:**	Flat	**Topography:**	Dune
Surface Soil:	Loamy sand	**Colour:**	Grey		
Exposed Rock:	n/a	**% Surface Rock:**	n/a	**Fragment size:**	n/a
Litter cover:	50%	**Litter depth:**	1 cm	**Bare ground:**	15%
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Drought	*Extent*	Whole site	
Community Description:		M+^*Melaleuca cardiophylla*\^shrub\4\c; G^*Calandrinia brevipedata, Crassula colorata*\^forb\1\r			

Species

Alyxia buxifolia

Asteraceae spD

Austrostipa elegantissima

**Avena barbata*

Calandrinia brevipedata

Calandrinia liniflora

Chenopodium gaudichaudianum

Crassula colorata

Eriochilus dilatatus subsp. *undulatus*

**Lolium rigidum*

Melaleuca cardiophylla

Parietaria cardiostegia

Pimelea gilgiana

Rhagodia latifolia subsp. *recta*

**Sonchus oleraceus*

Threlkeldia diffusa

Thysanotus manglesianus

Zygophyllum fruticulosum

Quadrat/Site	GRV0848		**Date**	18/08/2008	
Field Staff	LA/CK				
Wpt	48	**Lat.**	28°52'06.0"	**Long.**	114°38'56.5"
Photo No:	48	**Direction:**	SE		
Aspect	N	**Slope:**	Gentle	**Topography:**	Slope
Surface Soil:	Sand	**Colour:**	Grey		
Exposed Rock:	n/a	**% Surface Rock:**	n/a	**Fragment size:**	n/a
Litter cover:	20%	**Litter depth:**	1-2 cm	**Bare ground:**	15%
Condition:	Very good	**Weed cover:**	35%		
Disturbance:	*Type*	Drought	*Extent*	Whole site	
Notes:	Soil surface covered in snail shells				
Community Description:	M+^*Alyxia buxifolia, Pittosporum ligustrifolium*\^shrub\4\i;G^*Euphorbia peplus, Bromus diandrus, Euphorbia terracina*\^forb, other grass\1\c				

Species

Acacia rostellifera
Acanthocarpus preissii
Alyxia buxifolia
Austrostipa elegantissima
**Avena barbata*
**Brassica tournefortii*
**Bromus diandrus*
Calandrinia liniflora
**Echium plantagineum*
**Euphorbia peplus*
**Euphorbia terracina*
**Galium murale*
**Misopates orontium*
Oxalis perennans
Pittosporum ligustrifolium
Ptilotus divaricatus
**Reichardia tingitana*
Scaevola tomentosa
**Sonchus oleraceus*
Stylobasium spathulatum
Threlkeldia diffusa
**Vulpia myuros*

Quadrat/Site	GRV0849		**Date**	18/08/2008	
Field Staff	LA/CK				
Wpt	49	**Lat.**	28°52'12.5"	**Long.**	114°38'08.2"
Photo No:	49	**Direction:**	SE		
Aspect	SE	**Slope:**	Gentle	**Topography:**	Dune
Surface Soil:	Sand	**Colour:**	White		
Exposed Rock:	n/a	**% Surface Rock:**	n/a	**Fragment size:**	n/a
Litter cover:	40%	**Litter depth:**	1-2 cm	**Bare ground:**	25%
Condition:	Very good	**Weed cover:**	5%		
Disturbance:	*Type*	Drought	*Extent*	Whole site	
	Type	Rabbits	*Extent*	5%	

Notes: Quadrat sited on eastern slope of dune – vegetation the same as western (seaward) side.

Community Description: M+^*Thryptomene baeckeacea*\^heath shrub\3\c; G^*Anagallis arvensis, Euphorbia peplus, Sonchus oleraceus*\^forb\1\r

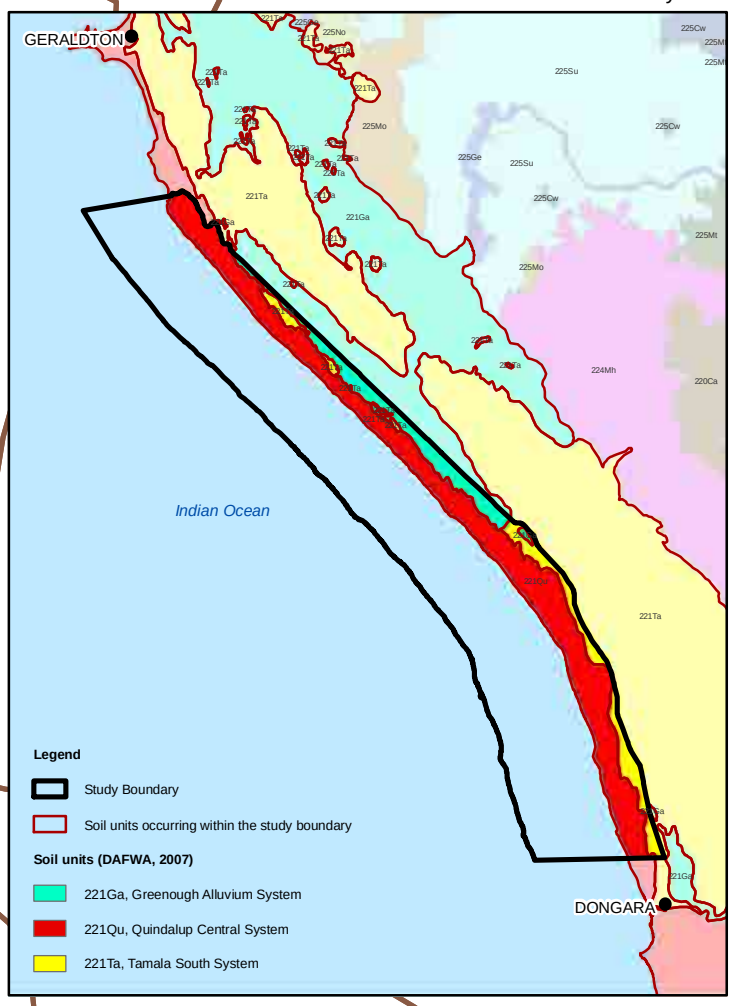
Species

**Anagallis arvensis*
**Avena barbata*
Calandrinia brevipedata
Carpobrotus virescens
Cassytha flava
**Ehrharta longiflora*
**Euphorbia peplus*
**Euphorbia terracina*
Nicotiana occidentalis subsp. *hesperis*
Parietaria cardiostegia
Pittosporum ligustrifolium
Ptilotus divaricatus
Rhagodia latifolia subsp. *recta*
**Schismus barbatus*
Senecio pinnatifolius
**Sonchus oleraceus*
Tetragonia implexicoma
Threlkeldia diffusa
Thryptomene baeckeacea
Zygophyllum fruticulosum

Appendix Five:
Maps

Dongara to Cape Burney Coastal Vegetation Survey

Soil landform of the Study Area



Legend

Study Boundary

IBRA regions

Soil units (DAFWA, 2007)

212Bs, Bassendean System
220Ca, Casuarina System
220Er, Eradu System
221Cy, Correy System
221Ea, Eatha System
221En, Eneabba Plain System
221Ga, Greenough Alluvium System
221In, Indoon System
221Qu, Quindalup Central System
221Ta, Tamala South System
222Ag, Agaton System
222Co, Coalara System
222Da, Dandaragan System
222La, Launer System
222Mr, Mooladara Hill System
223Bn, Binnu North System
223Dn, Dartmoor North System
224Bh, Boothendarra System
224Ir, Irwin System
224Ma, Mount Adams System
224Mh, Mount Horner System
224Ms, Mount Lesueur System
224Mt, Mintaja Hills System
224Ny, Nylagarda System
224Ot, Otorowiri System
224Ye, Yerramullah System
225Aj, Ajana System
225Bi, Binnu System
225Cw, Casuarina West System
225Dw, Dartmoor West System
225Ge, Greenough System
225Mo, Moresby System
225Mt, Mt Horner North System
225No, Northampton System
225Og, Ogilvie System
225Su, Sugarloaf System
226Dd, Dudewa System
226Mg, Mullingarra System
226Ne, Nebru System
226Nt, Nangetty System
226Yn, Yandanooka System
227Be, Binnu East System
227Da, Dartmoor System
227En, 227En
227Gu, 227Gu
227Jo, Joseph System
231Gy, Grey System
231Qu, Quindalup North System
231Ta, Tamala North System
232Ba, Balline System
232Bw, Binnu West System
232Ch, Christmas Hill System
232Mr, Murchison System
232Ur, Urina System
232Wi, Wittecarra System
232Ya, Yallabatharra System
234Eu, Eurardy Land System
234Hi, Highway Land System
234Na, Nanga System
234Yd, Yandi System
256Bg, Burabidge Hill System
256Ra, Ranfurly System
258Bb, Balgerbine System
258Bd, Ballidu System
258Cw, Coorow System
258Ih, Inering Hill System
258Ud, Upsan Downs System
258Wa, Wallambin System
271Cw, 271Cw
271Wh, 271Wh

Soil units occurring within the study boundary

Note: Soil dataset only available for the south west agricultural region

Map 1

Dongara to Cape Burney Coastal Vegetation Survey

Regional Context - Soil Landform of the Geraldton Sandplains

Feb 2010

N

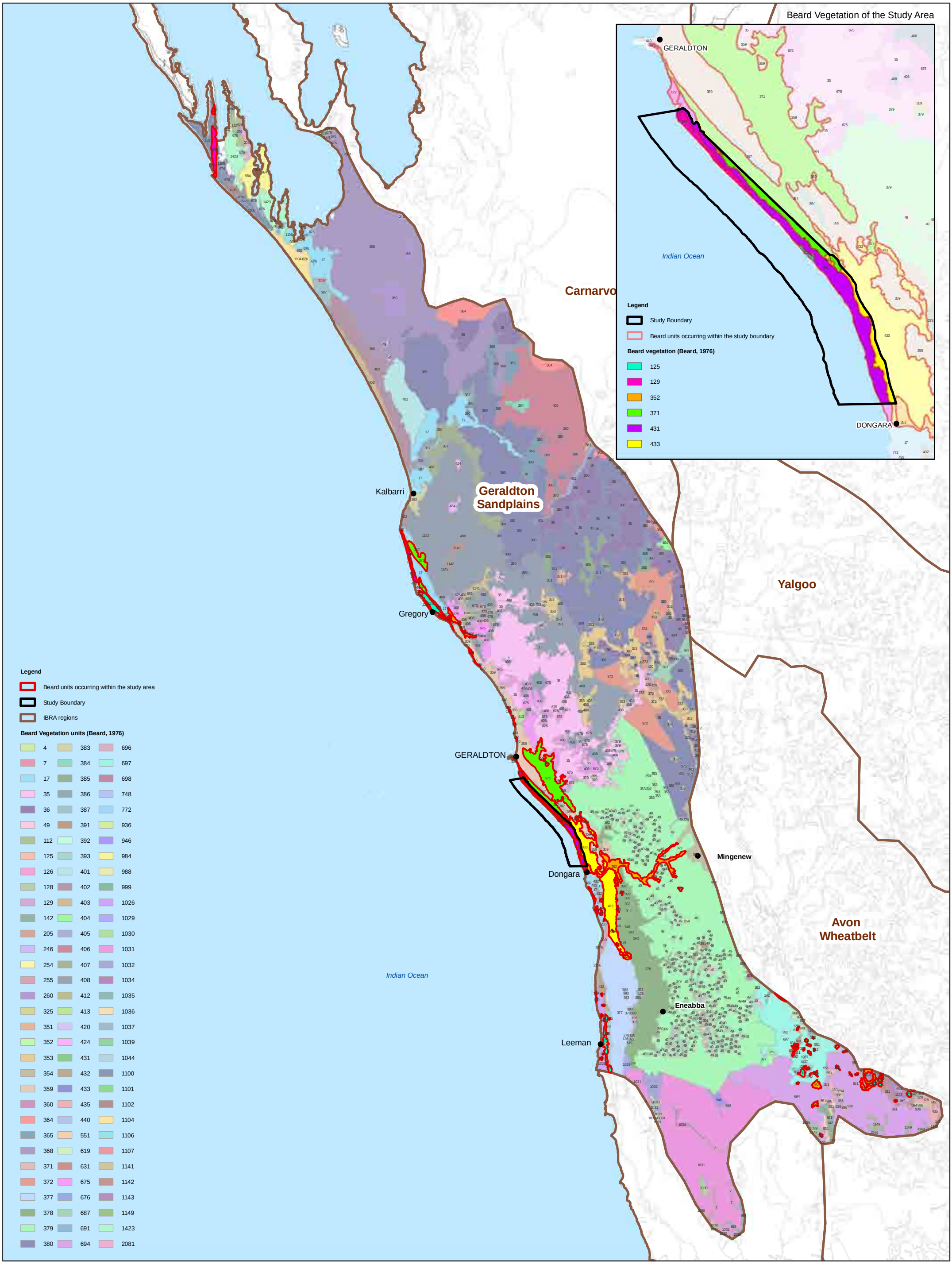
prepared for Northern Agricultural Catchments Council

0 10 20 30 40 50 kms

1:1,500,000 @ A3

Project No. 2382-09

ecoscape



Map 2

Dongara to Cape Burney Coastal Vegetation Survey

Regional Context - Beard Vegetation of the Geraldton Sandplains

Feb 2010

N

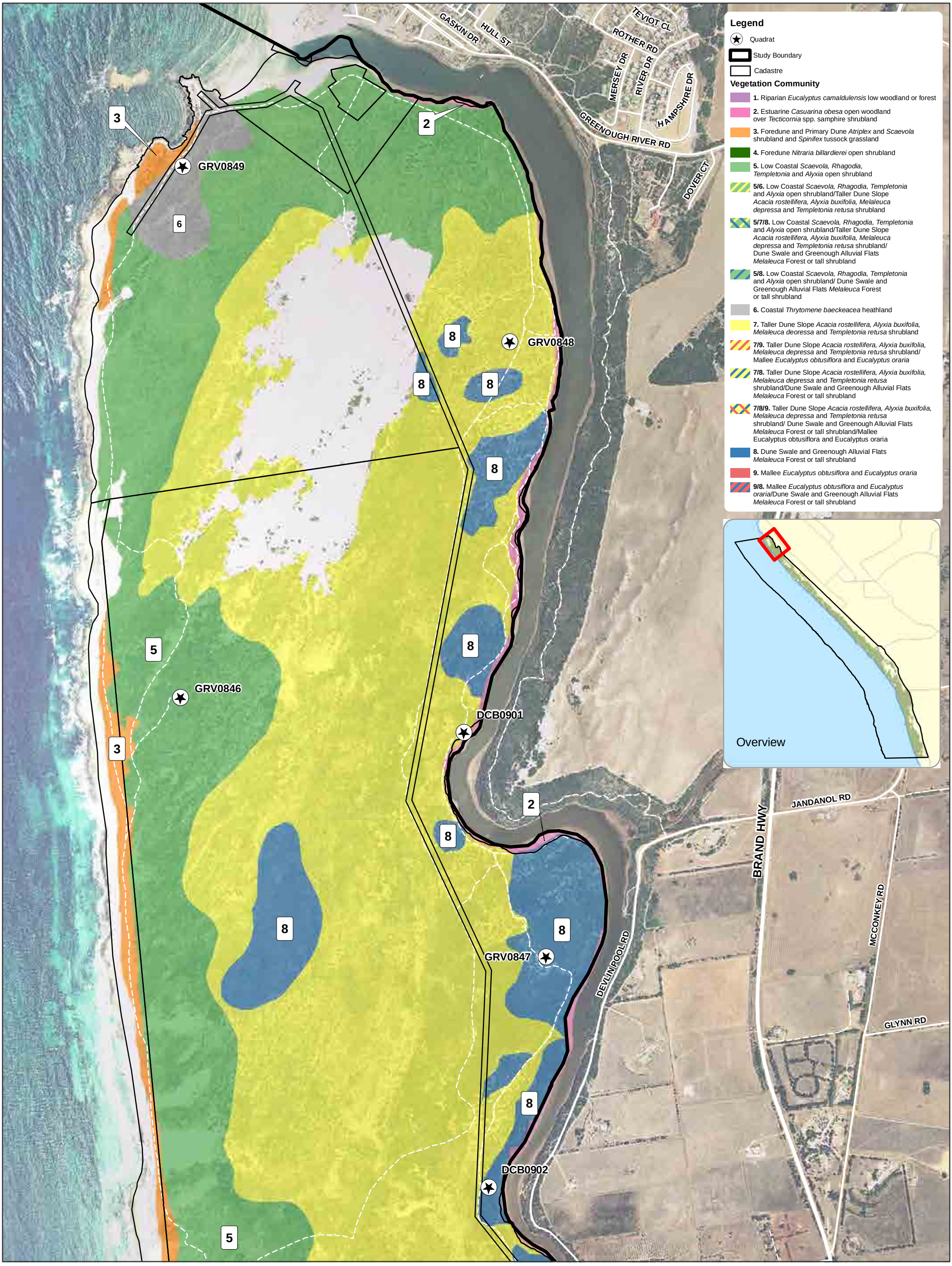
prepared for Northern Agricultural Catchments Council

0 10 20 30 40 50 kms

1:1,500,000 @ A3

Project No. 2382-09

ecoscape



Map 3a

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

July 2010

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

Legend

Quadrat

Study Boundary

Cadastre

Vegetation Community

1. Riparian *Eucalyptus camaldulensis* low woodland or forest

2. Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland

3. Foredune and Primary Dune *Atriplex* and *Scaevola* shrubland and *Spinifex* tussock grassland

4. Foredune *Nitraria billardierei* open shrubland

5. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland

5/6. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

5/7/8. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

5/8. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

6. Coastal *Thrytomene baeckeacea* heathland

7. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca deoressa* and *Templetonia retusa* shrubland

7/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

7/8. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

7/8/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland/Mallee Eucalyptus obtusiflora and Eucalyptus oraria

8. Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

9. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

9/8. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

Overview

DCB0902

DCB0903

DCB0904

DEVLIN POOL RD

WEST BANK RD

COMPANY RD

CROWTHER RD

TURTLEDOVE RISE

NORTH ISLAND LOOP

AFRICAN REEF BVD

ABROLHOS CL

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

Map 3b

July 2010

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Community

- **1.** Riparian *Eucalyptus camaldulensis* low woodland or forest
- **2.** Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland
- **3.** Foredune and Primary Dune *Atriplex* and *Scaevola* shrubland and *Spinifex* tussock grassland
- **4.** Foredune *Nitraria billardierei* open shrubland
- **5.** Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland
- **5/6.** Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland
- **5/7/8.** Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland
- **5/8.** Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland
- **6.** Coastal *Thrytomene baeckeacea* heathland
- **7.** Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca deoressa* and *Templetonia retusa* shrubland
- **7/9.** Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*
- **7/8.** Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland
- **7/8/9.** Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland/Mallee Eucalyptus obtusiflora and Eucalyptus oraria
- **8.** Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland
- **9.** Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*
- **9/8.** Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

Map 3c

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

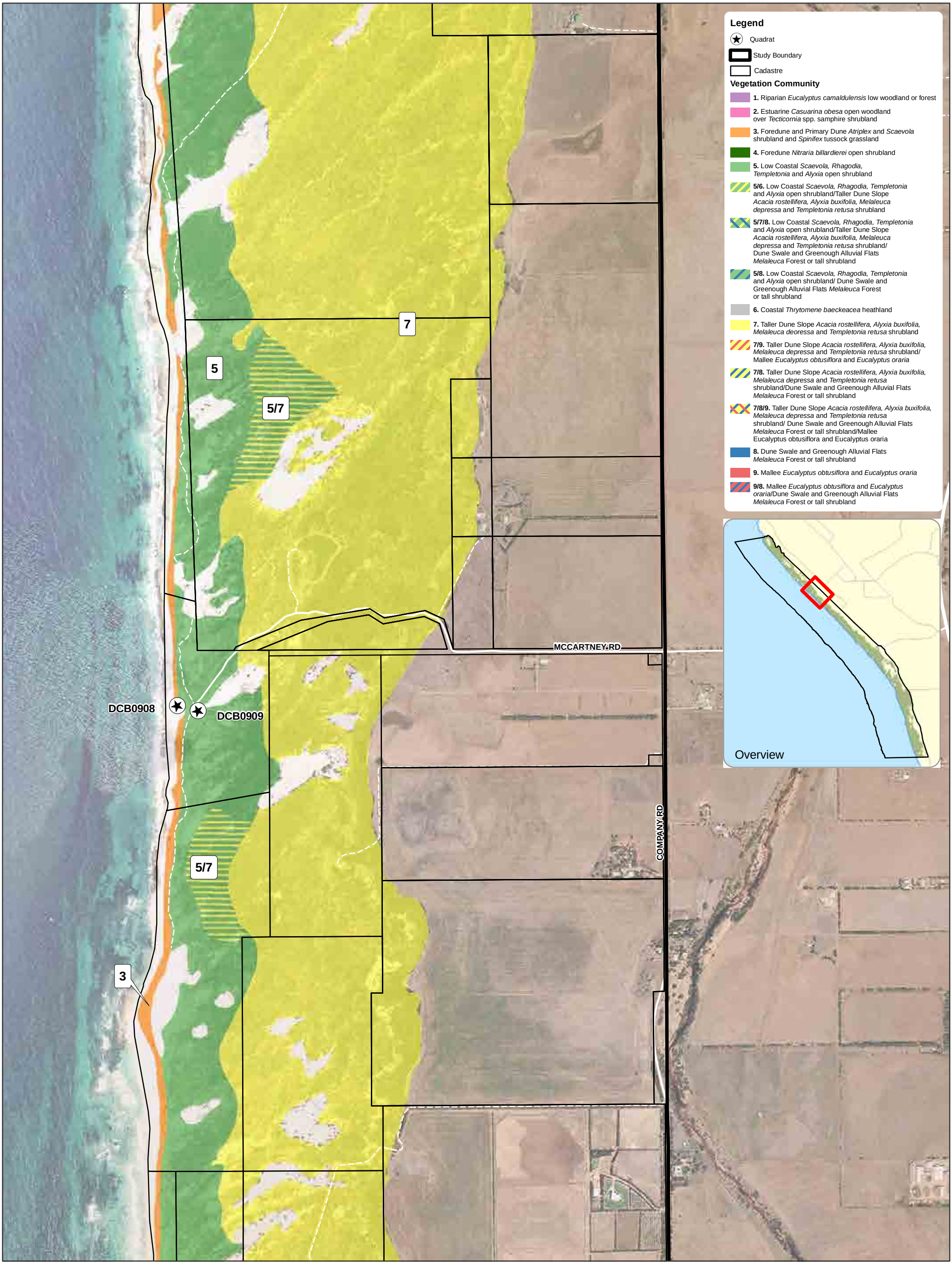
July 2010

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09



Map 3d

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

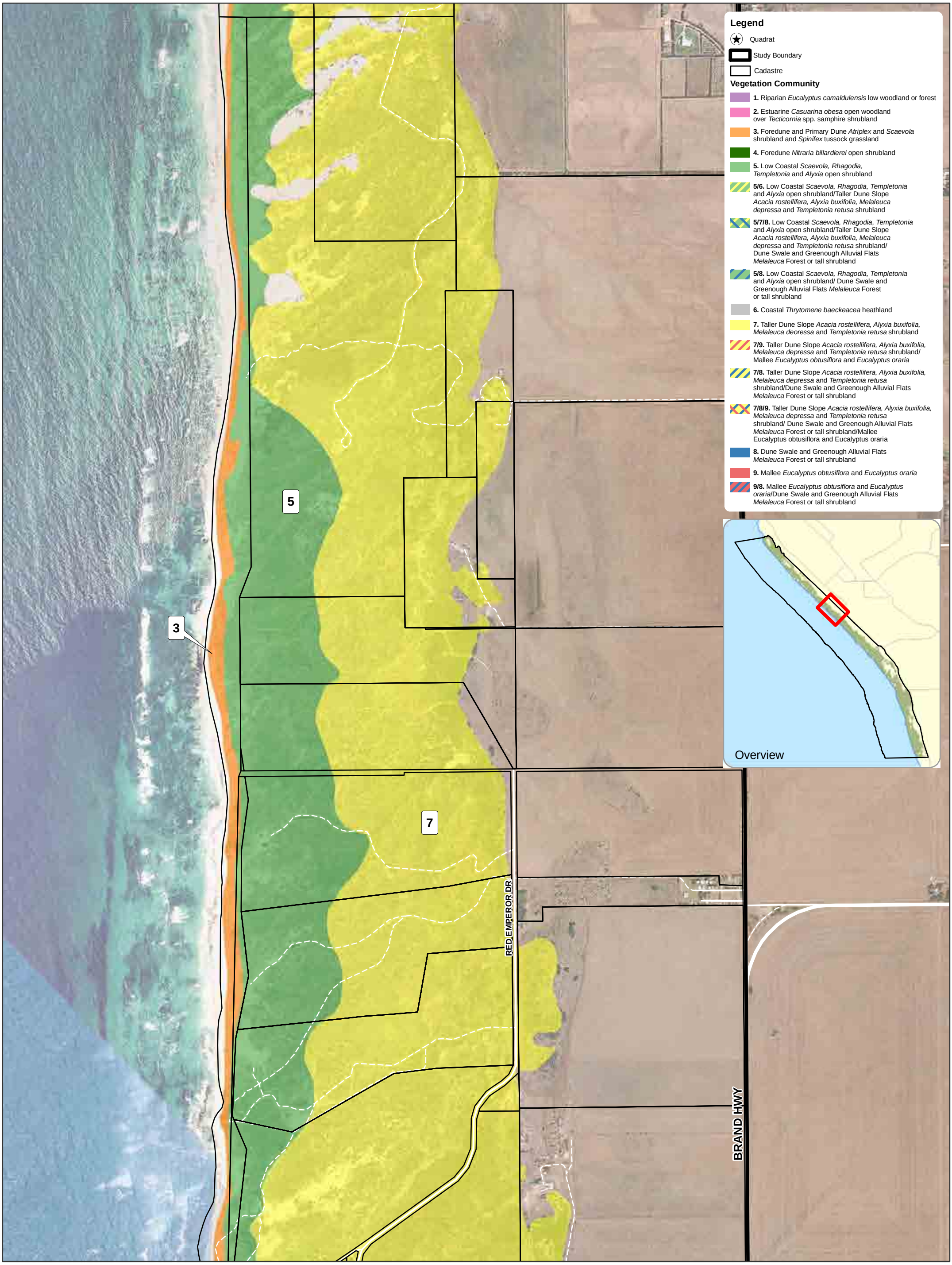
Plant Communities

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09



Dongara to Cape Burney Coastal Vegetation Survey

Map 3e

Plant Communities

July 2010

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

MULLOWAY PL

RED EMPEROR DR

FLAT ROCKS RD

BRAND HWY

KNAPPS RD

DCB0910

DCB0911

3

5

7

Legend

Quadrat

Study Boundary

Cadastre

Vegetation Community

1. Riparian *Eucalyptus camaldulensis* low woodland or forest

2. Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland

3. Foredune and Primary Dune *Atriplex* and *Scaevola* shrubland and *Spinifex* tussock grassland

4. Foredune *Nitraria billardierei* open shrubland

5. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland

5/6. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

5/7/8. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

5/8. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

6. Coastal *Thrytomene baeckeacea* heathland

7. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca deoressa* and *Templetonia retusa* shrubland

7/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

7/8. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

7/8/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland/Mallee Eucalyptus obtusiflora and Eucalyptus oraria

8. Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

9. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

9/8. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

Map 3f

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

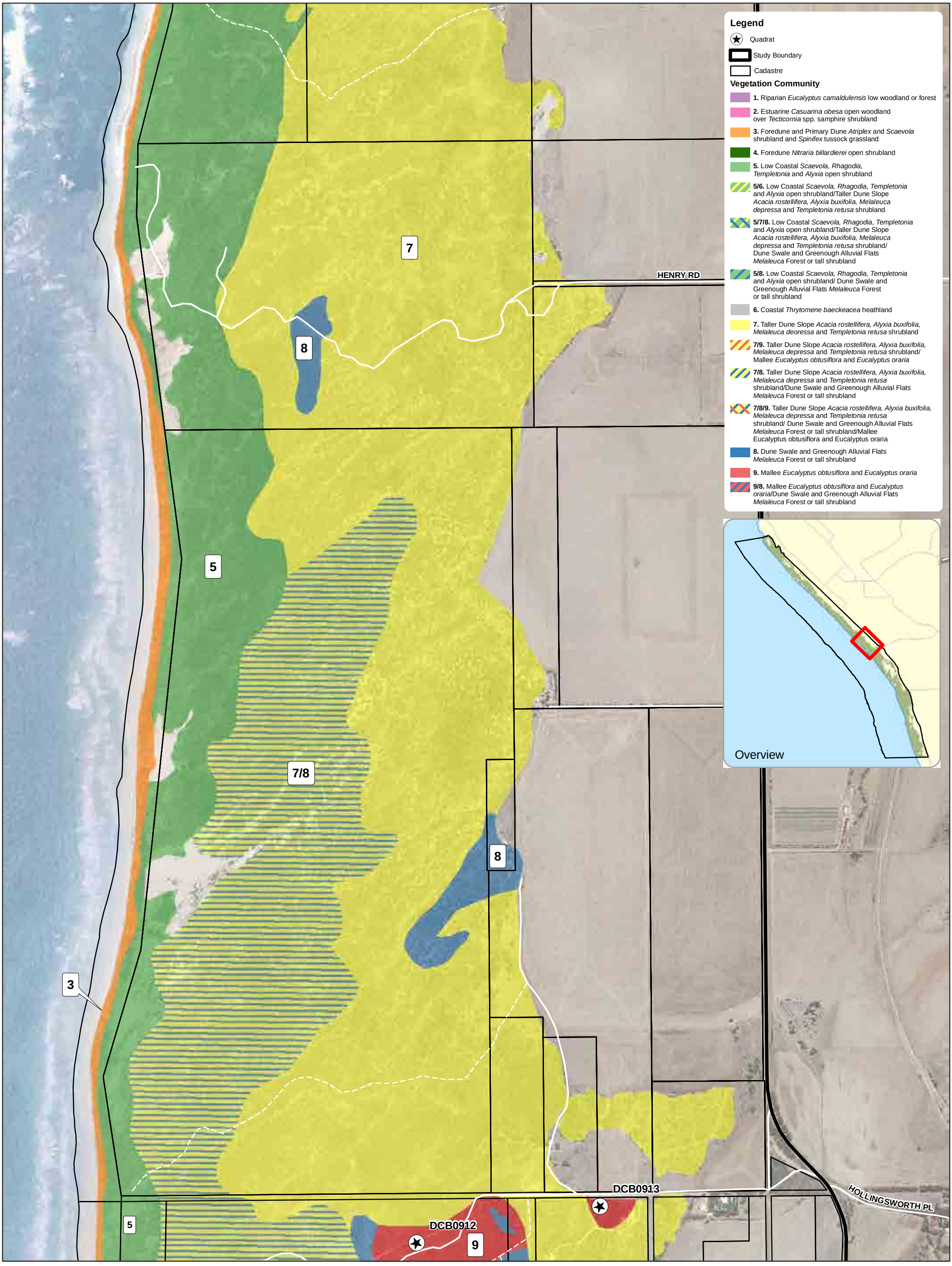
prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape



Map 3g

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

July 2010

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

DCB0913
DCB0912
DCB0914
BUTCHER RD
5
9
8
8/9
7/8
3
7
5/7/8
9

Overview

Legend

Quadrat
Study Boundary
Cadastre

Vegetation Community

1. Riparian *Eucalyptus camaldulensis* low woodland or forest

2. Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland

3. Foredune and Primary Dune *Atriplex* and *Scaevola* shrubland and *Spinifex* tussock grassland

4. Foredune *Nitraria billardierei* open shrubland

5. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland

5/6. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland

5/7/8. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

5/8. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

6. Coastal *Thrytomene baeckeacea* heathland

7. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca deoressa* and *Templetonia retusa* shrubland

7/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

7/8. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

7/8/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland/Mallee Eucalyptus obtusiflora and Eucalyptus oraria

8. Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

9. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

9/8. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

Map 3h

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

July 2010

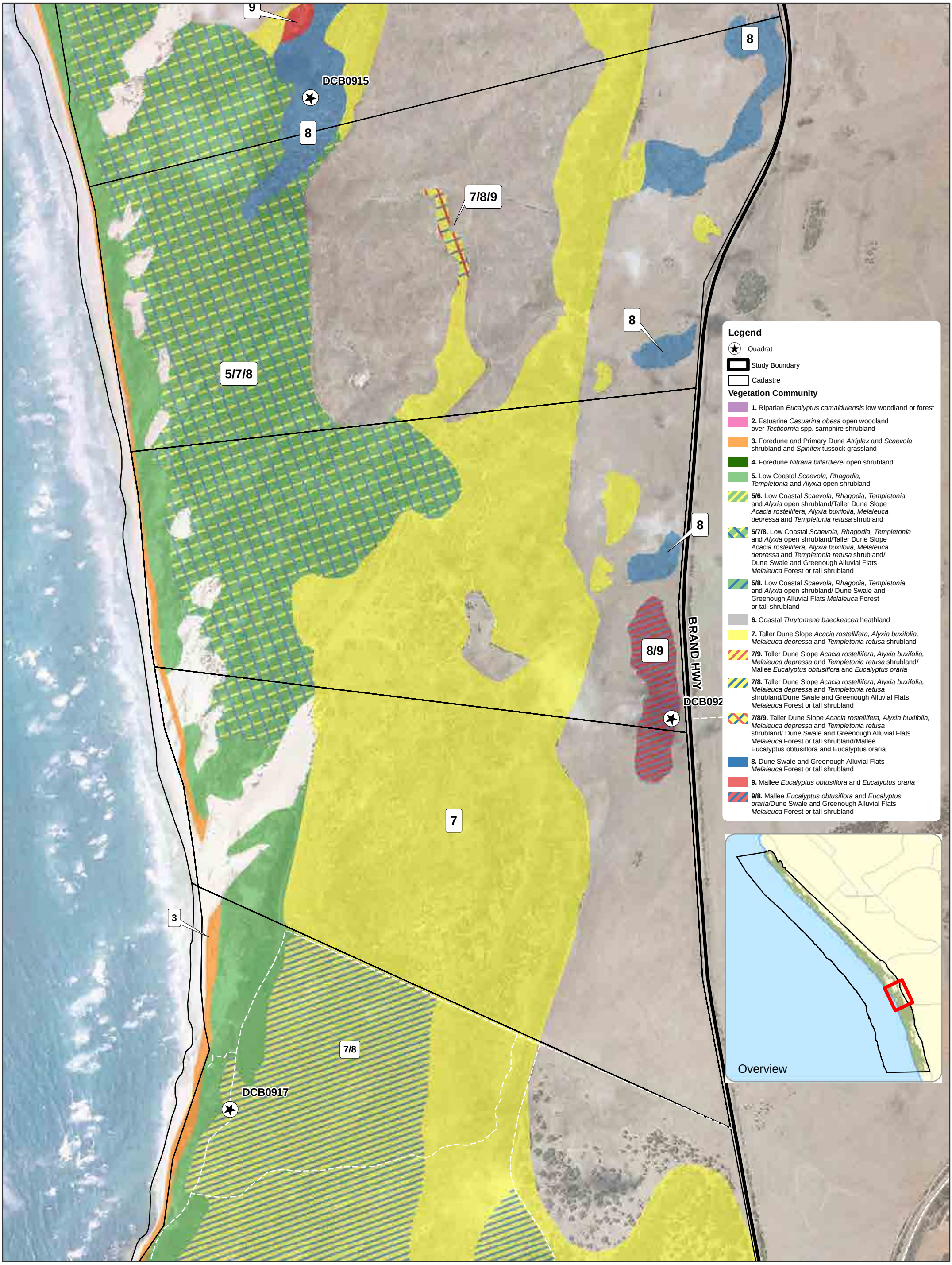
prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape



Map 3i

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

DCB0917

DCB0916

DCB0918

9

7/8

8

5/7/8

3

5

7

7/8/9

7/8

8

9

7/9

7

MATSEN RD

BRAND HWY

Overview

Legend

Quadrat

Study Boundary

Cadastre

Vegetation Community

1. Riparian *Eucalyptus camaldulensis* low woodland or forest

2. Estuarine *Casuarina obesa* open woodland over *Tecticornia* spp. samphire shrubland

3. Foredune and Primary Dune *Atriplex* and *Scaevola* shrubland and *Spinifex* tussock grassland

4. Foredune *Nitraria billardierei* open shrubland

5. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland

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5/7/8. Low Coastal *Scaevola, Rhagodia, Templetonia* and *Alyxia* open shrubland/Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

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6. Coastal *Thrytomene baeckeacea* heathland

7. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca deoressa* and *Templetonia retusa* shrubland

7/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

7/8. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

7/8/9. Taller Dune Slope *Acacia rostellifera, Alyxia buxifolia, Melaleuca depressa* and *Templetonia retusa* shrubland/ Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland/Mallee Eucalyptus obtusiflora and Eucalyptus oraria

8. Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

9. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*

9/8. Mallee *Eucalyptus obtusiflora* and *Eucalyptus oraria*/Dune Swale and Greenough Alluvial Flats *Melaleuca* Forest or tall shrubland

Dongara to Cape Burney Coastal Vegetation Survey

Map 3j Plant Communities

July 2010

prepared for Northern Agricultural Catchments Council

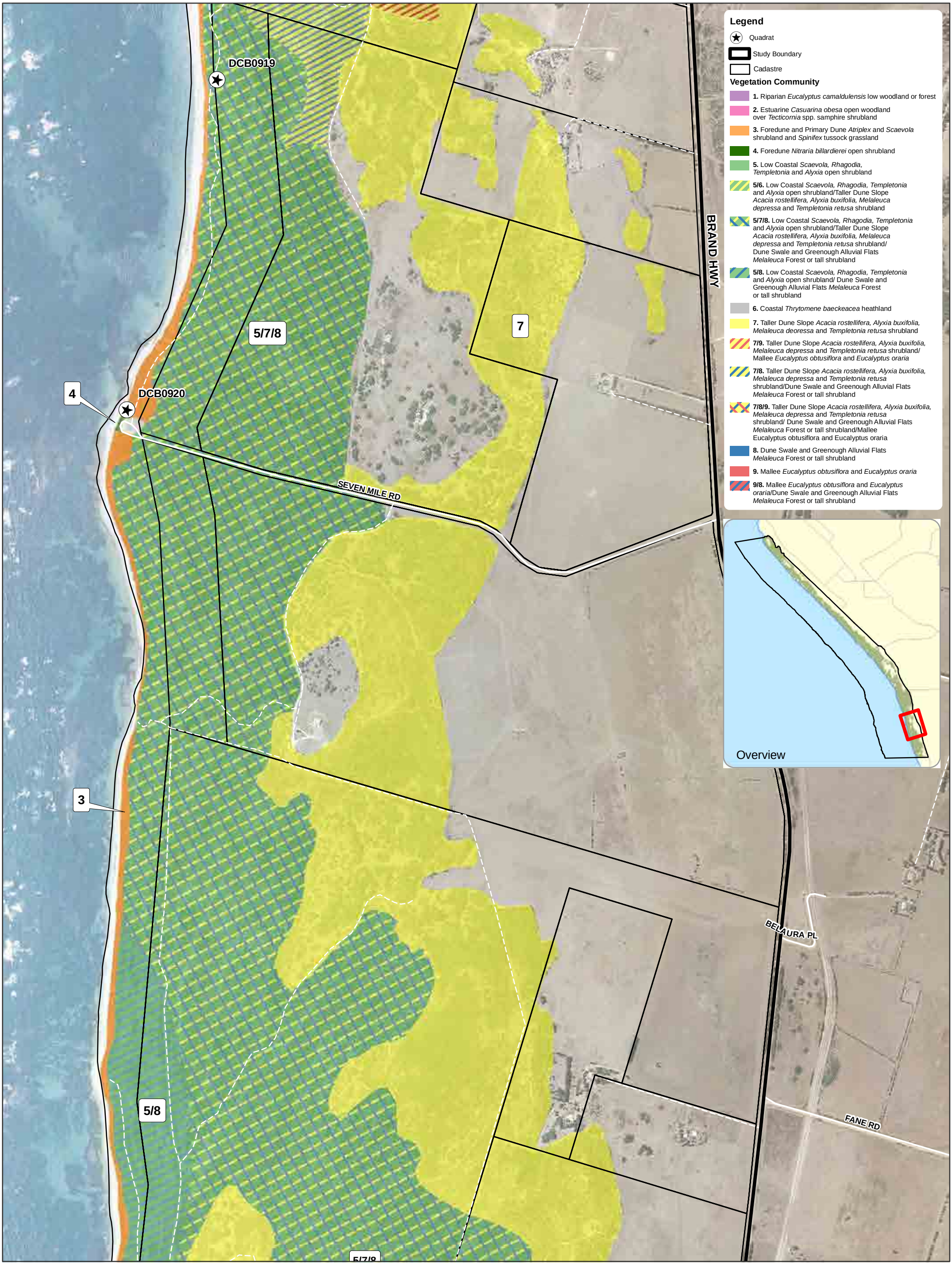
N

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape



Map 3k

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

July 2010

prepared for Northern Agricultural Catchments Council

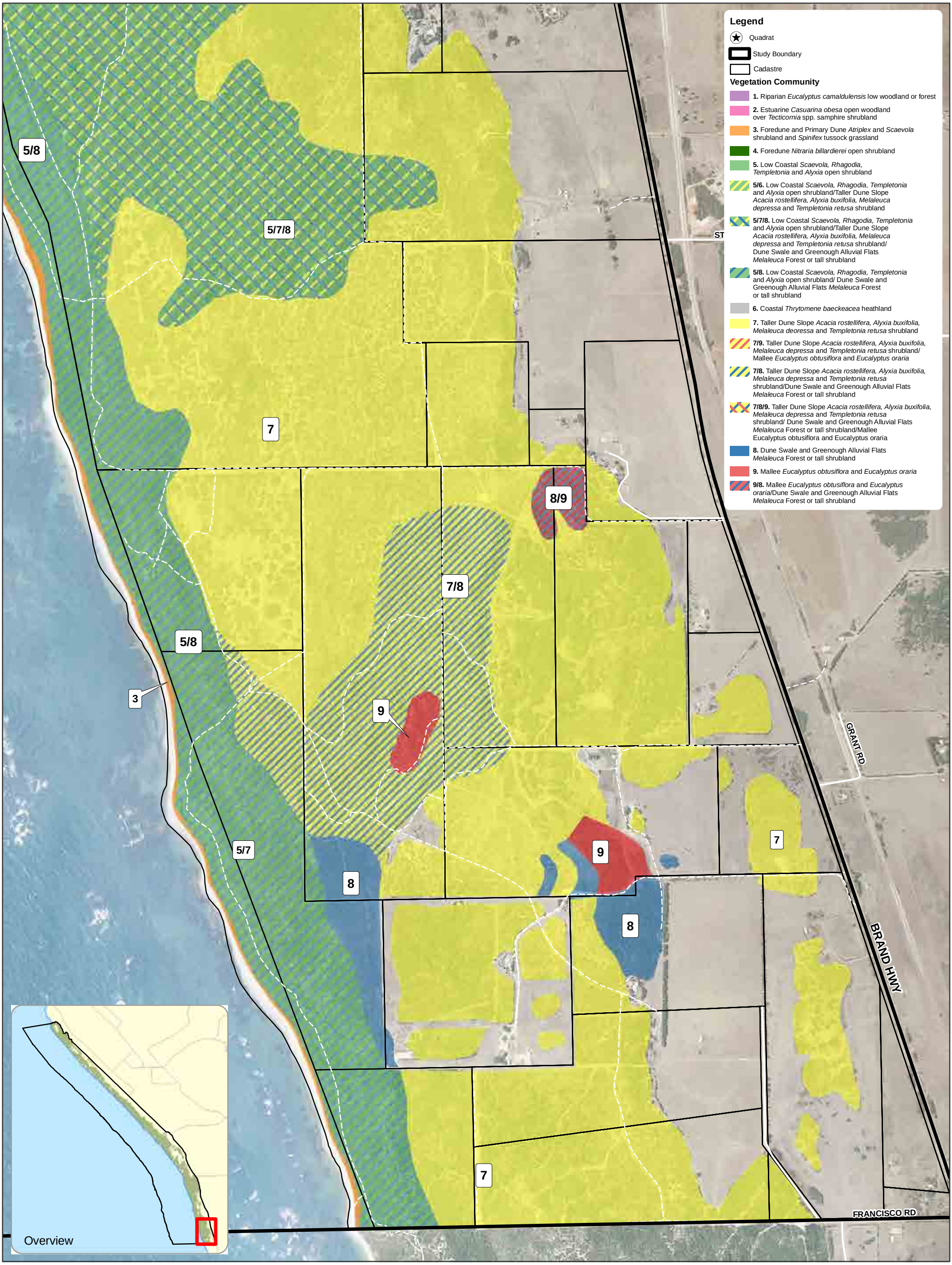
0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

N

ecoscape



Map 3l

July 2010

N

Dongara to Cape Burney Coastal Vegetation Survey

Plant Communities

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

MURRAY RD
GASKIN DR
HULL ST
THAMES DR
ROTHER RD
MERSEY DR
RIVER DR
HAMPSHIRE DR
GREENOUGH RIVER RD
DOVE

Overview

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

DCB0901

DCB0902

BRAND HWY

JANDANOL RD

DEVLIN POOL RD

MCCONKEY RD

GLYNN RD

Map 4a

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

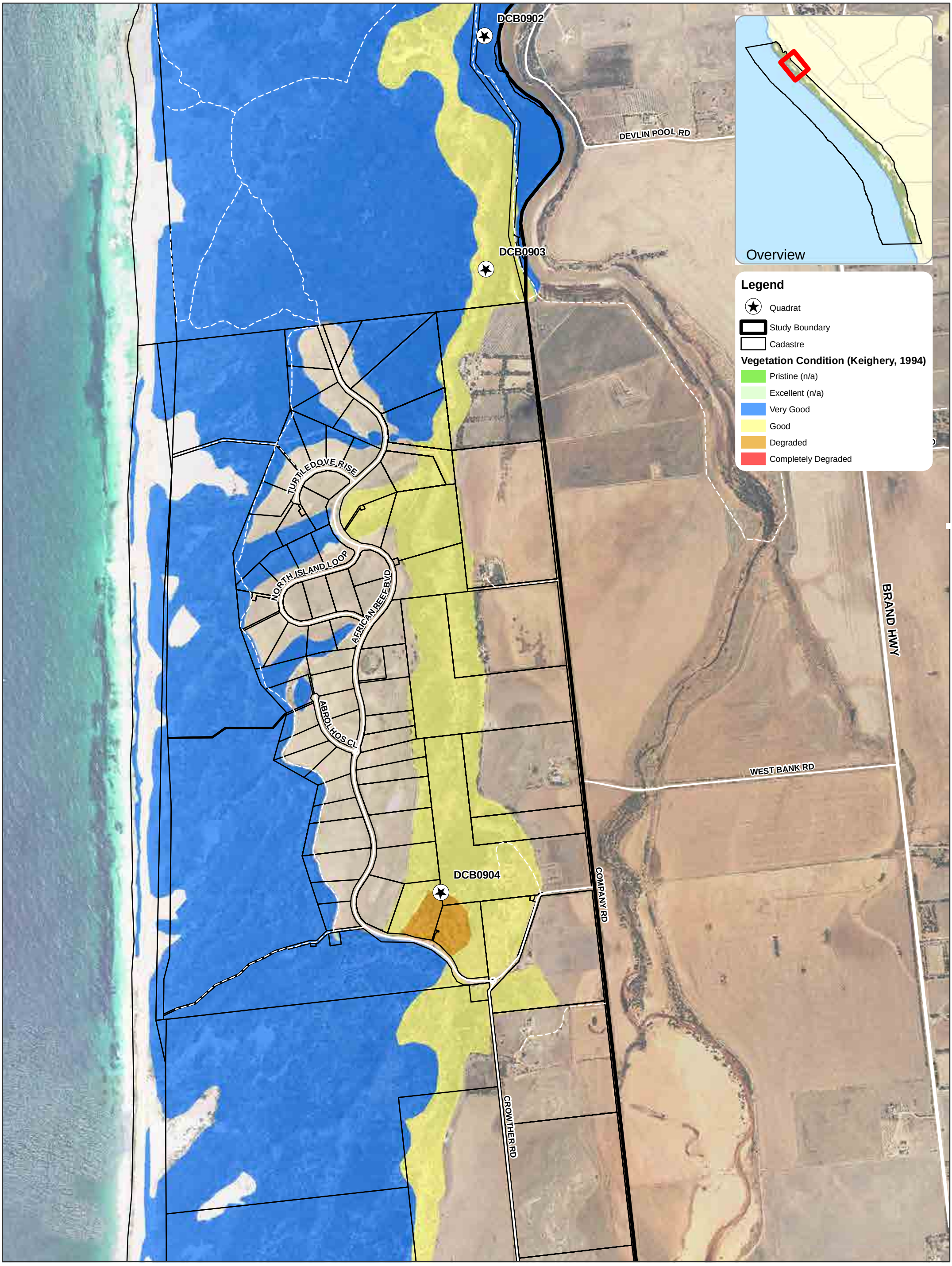
prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape



Map 4b

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

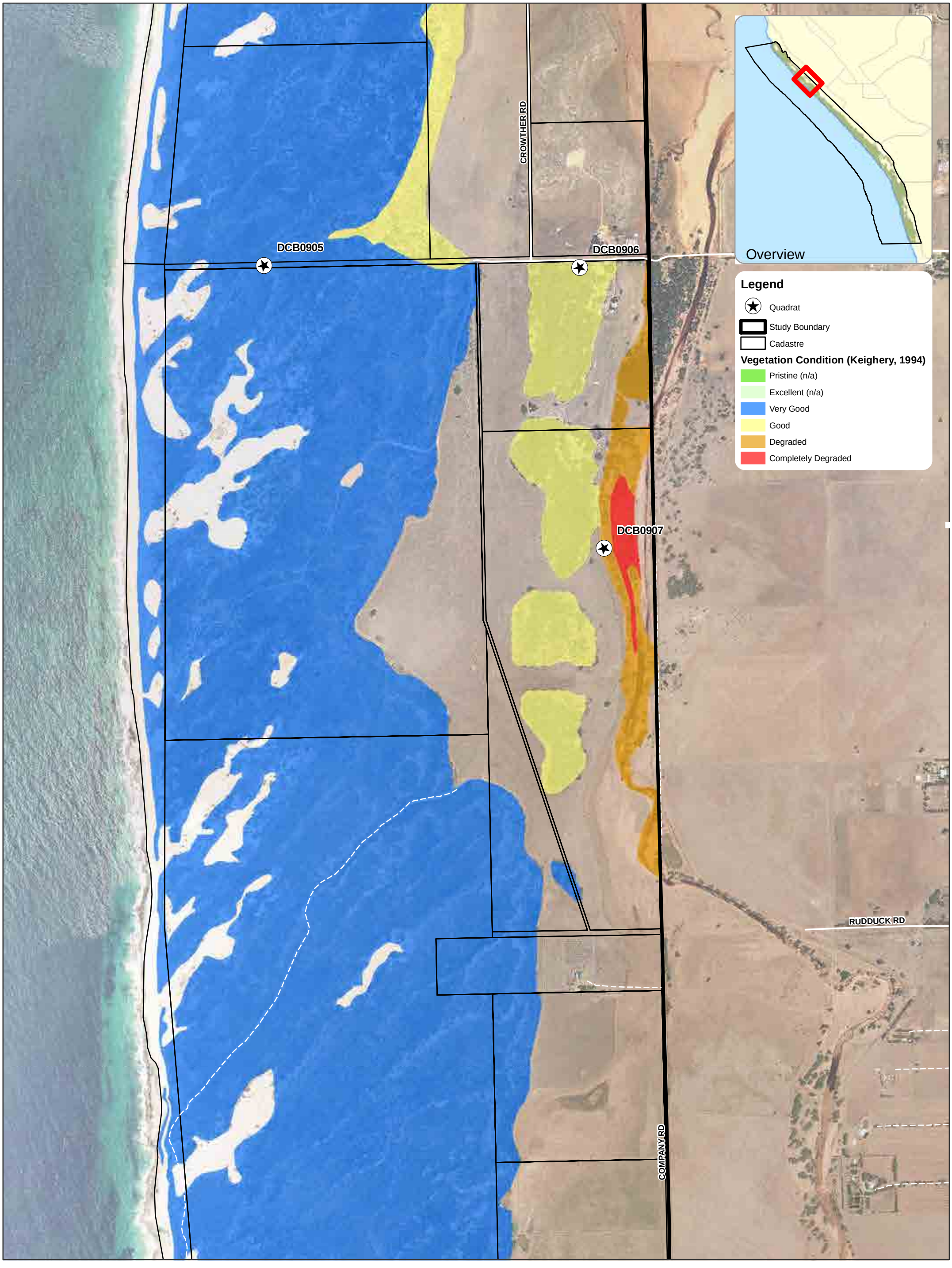
Vegetation Condition

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09



Map 4c

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

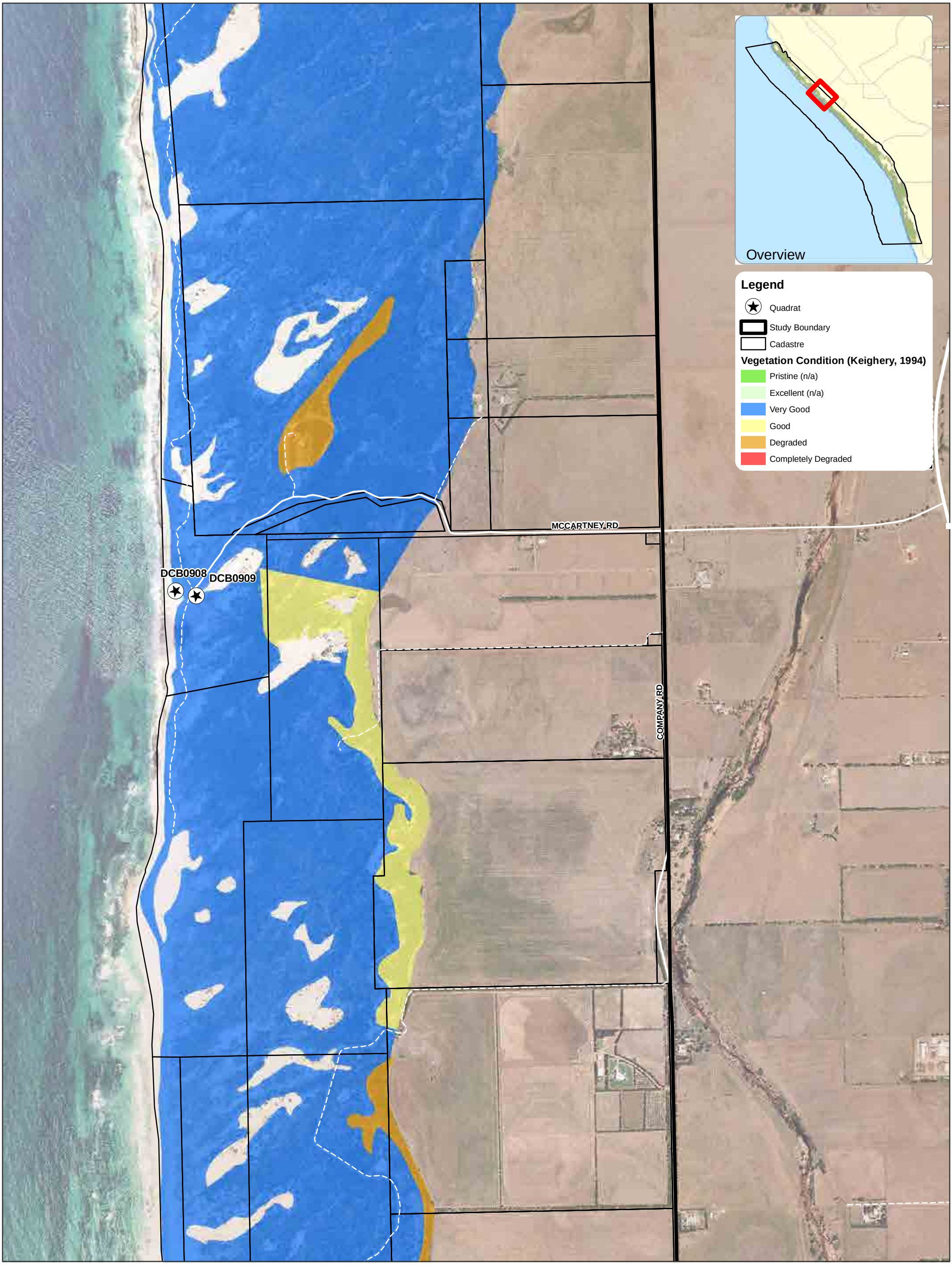
prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape



Map 4d

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

COMPANY RD

RED EMPEROR DR

MULLOWAY PL

BRAND HWY

Overview

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

Map 4e

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape

DCB0910
DCB0911
RED EMPEROR DR
FLAT ROCKS RD
DUNCAN RD
BRAND HWY
KNAPPS RD

Overview

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

Map 4f

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape

HENRY RD

Overview

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

DCB0913

DCB0912

HOLLINGSWORTH PL

Map 4g

July 2010

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape

DCB0913

DCB0912

HOLLINGSWORTH PL

BOOKARA RD E

DCB0914

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

Overview

Map 4h

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

July 2010

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

DCB0915

DCB0921

DCB0917

BRAND HWY

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

Overview

Map 4i

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

July 2010

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

N

DCB0916

DCB0918

DCB0919

MOUNT HORNER RD W

MATSEN RD

BRAND HWY

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

Overview

Map 4j

July 2010

N

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

DCB0919

DCB0920

SEVEN MILE RD

BRAND HWY

MELALEUCA RD

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

Overview

Map 4k

July 2010

N

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

prepared for Northern Agricultural Catchments Council

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape

Overview

Legend

- Quadrat
- Study Boundary
- Cadastre

Vegetation Condition (Keighery, 1994)

- Pristine (n/a)
- Excellent (n/a)
- Very Good
- Good
- Degraded
- Completely Degraded

GRANT RD

BRAND HWY

FRANCISCO RD

Map 4l

Dongara to Cape Burney Coastal Vegetation Survey

Vegetation Condition

July 2010

prepared for Northern Agricultural Catchments Council

N

0 100 200 300 400 500 Meters

1:12,000 @ A3

Project No. 2382-09

ecoscape

Map 5

June 2010

N

Dongara to Cape Burney Coastal Vegetation Survey

Quadrat Locations

prepared for Northern Agricultural Catchments Council

0 1 2 3 4 5 kms

1:125,000 @ A3

Project No. 2382-09

INSET - Significant vegetation

0 125 250 500 Meters

RUDDS GULLY RD
GREENOUGH RIVER RD
MEADOWCROFT ST
JANDANOL RD
HAMPTON RD
GLYNN RD
MCCONKEY RD
DEVLIN POOL RD
BOOTENAL RD
SEE INSET
WEST BANK RD
COMPANY RD
AFRICAN REEFBVD
CROWTHER RD
PHILLIPS RD
HWY
GILBERT RD
RUDDUCK RD
MCCARTNEY RD
GREGORY RD
COMPANY RD
MCCARTNEY RD

BRAND HWY
EDWARD RD
Overview

Legend

- Study Area Boundary
- Regionally or Locally Significant Beard Vegetation Associations
- Significant Plant Communities with restricted extent
- Significant Plant Communities with Significant Ecological Function
- Very Good Condition Vegetation

Dongara to Cape Burney Coastal Vegetation Survey

Map 6a Significant Vegetation

July 2010

prepared for Northern Agricultural Catchments Council

0 0.5 1 1.5 2 2.5 Kilometres

1:45,000 @ A3

Project No. 2382-09

N

ecoscape

REYNOLDS RD
COMPANY RD
CRAMPTON RD
WALTER RD
FRASER RD
ALLANOOKA SPRINGS RD
RED EMPEROR DR
DUNCAN RD
MULLOWAY PL
FLAT ROCKS RD
BRAND HWY
KNAPPS RD
HENRY RD
BOOKARA RD E
HOLLINGSWORTH PL
BUTCHER RD

EDWARD RD
BRAND HWY
Overview

Legend

- Study Area Boundary
- Regionally or Locally Significant Beard Vegetation Associations
- Significant Plant Communities with restricted extent
- Significant Plant Communities with Significant Ecological Function
- Very Good Condition Vegetation

Map 6b

Dongara to Cape Burney Coastal Vegetation Survey

Significant Vegetation

July 2010

prepared for Northern Agricultural Catchments Council

N

0 0.5 1 1.5 2 2.5 Kilometres

1:45,000 @ A3

Project No. 2382-09

ecoscape

MOUNT HORNER RD W
MATSEN RD
PADBURY RD
MELALEUCA RD
SEVEN MILE RD
BEAGLE RD
FANE RD
BRAND HWY
STEELE RD
FRANCISCO RD
BONNIEFIELD RD E
BRENNAND RD
PHILBEY RD

Overview
EDWARD RD
BRAND HWY

Legend

- Study Area Boundary
- Regionally or Locally Significant Beard Vegetation Associations
- Significant Plant Communities with restricted extent
- Significant Plant Communities with Significant Ecological Function
- Very Good Condition Vegetation

Dongara to Cape Burney Coastal Vegetation Survey

Map 6c Significant Vegetation

July 2010

prepared for Northern Agricultural Catchments Council

N

0 0.5 1 1.5 2 2.5 Kilometres

1:45,000 @ A3

Project No. 2382-09