

# ALBANY REGIONAL VEGETATION SURVEY

## Extent, Type and Status

E.M. Sandiford & S. Barrett

2010





## Cover Photos

Front cover-  
Background,

*Gahnia trifida* Sedgeland/Wet Shrubland and *Melaleuca raphiophylla* Woodland/Low Forest Complex, Millbrook Nature Reserve

Insets

*Hakea* spp Shrubland/Woodland Complex, Angove Water Reserve.  
Karri Forest, Limeburners Creek

*Melaleuca striata/Banksia* spp Coastal Heath, Gull Rock National Park

Back cover  
Insets

Limestone Heath, Wind Farm

*Eucalyptus goniantha* Mallee, Bettys Beach/Two Peoples Bay

*Evandra aristata* Sedgeland, Bornholm.



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A project funded by Western Australian Planning Commission (EnviroPlanning “Integrating NRM into Land Use Planning” and State NRM Program), South Coast Natural Resource Management Inc. and City of Albany for the Department of Environment and Conservation.





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## SUMMARY

The Albany Regional Vegetation Survey (ARVS) provides a local and regional overview of the native vegetation of the area to assist land use and conservation planning in the region by describing, mapping and assessing the conservation status of the vegetation within the ARVS area. This report provides detailed descriptions and maps of the vegetation types and the condition status of remnants within the ARVS area in written and digital formats. Assessments of the extent, rarity, diversity and reservation status of vegetation units, their status as wetland/streamline/estuarine or coastal dune vegetation and threats to vegetation units are provided to assist in determining the local and regional conservation significance of the vegetation.

The ARVS area encompasses 124,415 ha that extends some 30 km east and west of Albany and 20 km north. It is situated at the junction of three IBRA biogeographic regions - the Warren, Jarrah Forest and Esperance Plains Regions - and includes a variety of landforms from coastal dunes, granitic hills, gently undulating plains, lowland flats, rivers and drainage lines to estuarine fringes and lakes.

The ARVS determined that 35% (44,093 ha) of remnant vegetation remains within the ARVS area of which 19% occurs within formal conservation reserves (IUCN I-IV) and 39% in other Crown reserves. Two thirds (67%) of the vegetation is in residual condition (excellent-very good) with 21% in modified and 12% in transformed states.

The ARVS found the flora and vegetation to be very diverse. The survey involved a review of existing vegetation information, extensive field work including the recording of 785 floristic relevés and statistical analysis of data that were used along with field observations to define 67 native vegetation units. Extensive field work was essential in defining and mapping the vegetation due to high vegetation and landform diversity, low aerial photography interpretability and the absence of other data sets at a fine enough scale to reflect the vegetation patterning.

The vegetation units defined through the ARVS include 32 upland units, 22 wetland units and 13 dampland or transitional units. Within these there are nine Jarrah / Marri / Sheoak / *Eucalyptus staeri* woodland or forest units, seven coastal dune units, seven granite outcrop units, and three tidal or estuarine units. Nineteen units do not appear to have been described previously, and comparisons with Beard (1979) vegetation units and units described in other surveys within the region are provided.

The vegetation units are not evenly distributed throughout the survey area but are linked to distinctive broad landforms. The most common unit is Jarrah/Marri/Sheoak Laterite Forest (unit 12) representing 29.8% of remnant vegetation, with the next most common unit, Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland (13), representing 11.7%. The most restricted units, *Lepidosperma longitudinale* Sedgeland (42) and *Leucophyta brownii* Coastal Shrubland/Grassland (7), occur on less than 1ha.

Many units occur in small patches, with 49 units each occurring on less than 1% of the remnant vegetation within the ARVS area. The importance of these small units in terms of biodiversity is highlighted by the finding that 20% of all species recorded in the ARVS are restricted to these 49 units, and 78% of all species recorded in the ARVS occur within this group.

Over 800 species were recorded during the survey including six Declared Rare Flora, 43 Priority listed species and 19 species occurring beyond their previously known distribution. Due to the methodology this list under represents the number of species in the area, particularly annuals and geophytes, and many species are known to occur at their range limits within the survey area.

The conservation status of the vegetation units was assessed on a local and regional scale and the botanical significance of the ARVS area is highlighted by the occurrence of over a half of the units at their range limit and over a quarter of units are likely to be restricted to the survey area and its 10 km buffer based on species distribution maps. Further survey outside the ARVS area is required to verify the entire extent of these units. However, at least one unit, *Banksia occidentalis*/*Kunzea clavata* Shrubland (34), is restricted to the survey area and another, *Banksia coccinea* Shrubland/*Eucalyptus*

*staeri*/Sheoak Open Woodland (14), is largely restricted to the survey area and currently listed as a Priority 1 Ecological Community. Nine units were restricted to the eastern edge of the ARVS area, near the boundary of the wetter Jarrah Forest biogeographic region and the drier Esperance Plains biogeographic region.

At least four units appear to have less than 30% of their total pre-clearing extent remaining in Western Australia including *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Woodland (14), Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland (13), *Pericalymma spongiocaule* Shrubland (39) and *Astartea scoparia* Swamp Thicket (56). A further 17 units are likely to have less than 30% of their pre-clearing extent remaining within the ARVS area.

The local reservation status of the vegetation units varies and needs to take into account areas of conservation reserve within the ARVS 'context area' i.e. within a 35 km radius of Albany, as well as the ARVS area. Taking these areas into account, over one quarter of units are poorly reserved having less than 10% of their local extent within conservation reserves (IUCN I-IV). The importance of other Crown reserves (non IUCN I-IV) is highlighted by 15 units being either restricted to or having greater than 70 % of their ARVS occurrence within these reserves.

Major threats observed through the ARVS include Phytophthora dieback, hydrological change, weed invasion (particularly by *\*Acacia longifolia*), fire, land clearing and grazing. Given the high number of units that occur at their range limit and the high number of wetland/dampland units, the potential for climate change to impact on the vegetation within the survey area is very high.

Recommendations include: further survey and assessment to determine the regional significance of units thought to be largely restricted to the ARVS area; further assessment of threats and the condition status of units to determine their regional significance; prioritisation of the conservation significance of units to assist in land use planning; extension of mapping to non surveyed areas within the ARVS context area; modelling of pre-clearing vegetation extent, updating vegetation map as required, reassessment of conservation species and assessment of units against threatened ecological community criteria.

The ARVS report, associated maps and data will assist land use planning by State and local government agencies, community groups, land owners and developers; but does not preclude the requirement for site based ecological assessment in areas likely to be impacted by development.





# 1 INTRODUCTION

## 1.1 Background

In 2007, in response to increasing demand for land for urban and peri-urban development in the Albany area, State and local government planners and land managers (under the umbrella of the Government Officers Technical Advisory Group (GOTAG)) identified that there was a lack of information available to assess the regional significance of remnant vegetation. GOTAG put forward a proposal to survey the vegetation of the greater Albany area in order to assist the identification and assessment of regional biodiversity values.

The Lower Great Southern Strategy (WAPC 2007) also recommended a regional vegetation assessment be undertaken to provide strategic direction for achieving conservation priorities in land use planning at a local level. The Strategy sets out the strategic direction for regional land use planning and infrastructure requirements for the coming decades and recognised the conservation importance of remnant vegetation given its limited extent, high biodiversity and landscape, recreation and cultural heritage significance.

Similarly, the Albany Local Planning Strategy (ALPS) (CoA 2007) recognised the City's biodiversity as one of its most important assets, creating a sense of the area's identity. The Strategy established the encouragement of biodiversity preservation and the conservation of remnant vegetation as planning principles and recognised the need to identify and protect areas of high biodiversity.

At this time, the Environmental Protection Authority (EPA) made it a requirement that the conservation significance of native vegetation in three peri-urban areas (Yakamia, Bayonet Head and Emu Point) that were undergoing structure planning to facilitate residential development be assessed by the developers within a regional context. The EPA also indicated a reluctance to assess developments proposals in the greater Albany area that had the potential to impact on areas of potentially significant vegetation in the absence of this information.

As a result of the need for improved information on regional vegetation for land use planners, the City of Albany (CoA) partnered with the Western Australian Planning Commission (through the EnviroPlanning Project), South Coast Natural Resource Management Inc (South Coast NRM) and the Department of Environment and Conservation (DEC) to implement an Albany Regional Flora and Vegetation Survey (ARVS) project. Funding for the ARVS project was provided by EnviroPlanning "Integrating NRM into Land Use Planning" project and State NRM Program, CoA and South Coast NRM with the project based at and supported by DEC Albany. A steering committee was established with additional representatives from the Department of Water (DoW), Department of Agriculture and Food Western Australia (DAFWA) and the Office of the EPA (OEPA). Funding for the first 12 months became available in spring 2007, with two botanists employed to undertake a desk-top assessment, field survey, vegetation classification, mapping and report writing. Further funding from CoA, EnviroPlanning and South Coast NRM was committed to the project as the size of the task was fully realised, extending the project to July 2010.

The ARVS project was to be completed in three phases, described below.

### Phase 1: Initial flora and vegetation survey

- Regional vegetation association mapping, establishment of vegetation plots covering typical and rare vegetation associations and floristic plot analysis,
- Preparation of a report defining the representation, condition and significance of vegetation associations,
- Extrapolation from native vegetation extent, soil and landform and rainfall maps to estimate the pre-clearing extent of vegetation associations,\*

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\* The steering committee agreed at the beginning of the survey to remove this objective due to the complexity of the vegetation and low correlation between vegetation units and landform, soil data sets and aerial patterns.



- Provide a methodology to the EnviroPlanning project for mapping native vegetation in order to inform decision making in relation to development.

#### Phase 2: Conservation and regional planning

- Identify priority areas for conservation including consideration of threatening processes and the maintenance of ecological linkages,
- Interpret and utilise vegetation information to inform priority conservation areas for fauna,
- Identify critical areas requiring restoration,
- Utilise this information for strategic regional land use planning.

#### Phase 3: Further regional flora and vegetation surveys

- Extension of methodology from the Greater Albany region to areas such as Ravensthorpe and Esperance.

This report is a result of Phase 1, with Phase 2 and 3 subject to further funding.

The results of this project do not preclude the requirement for individual developers or land owners to undertake detailed biological assessment of natural areas likely to be impacted by development.

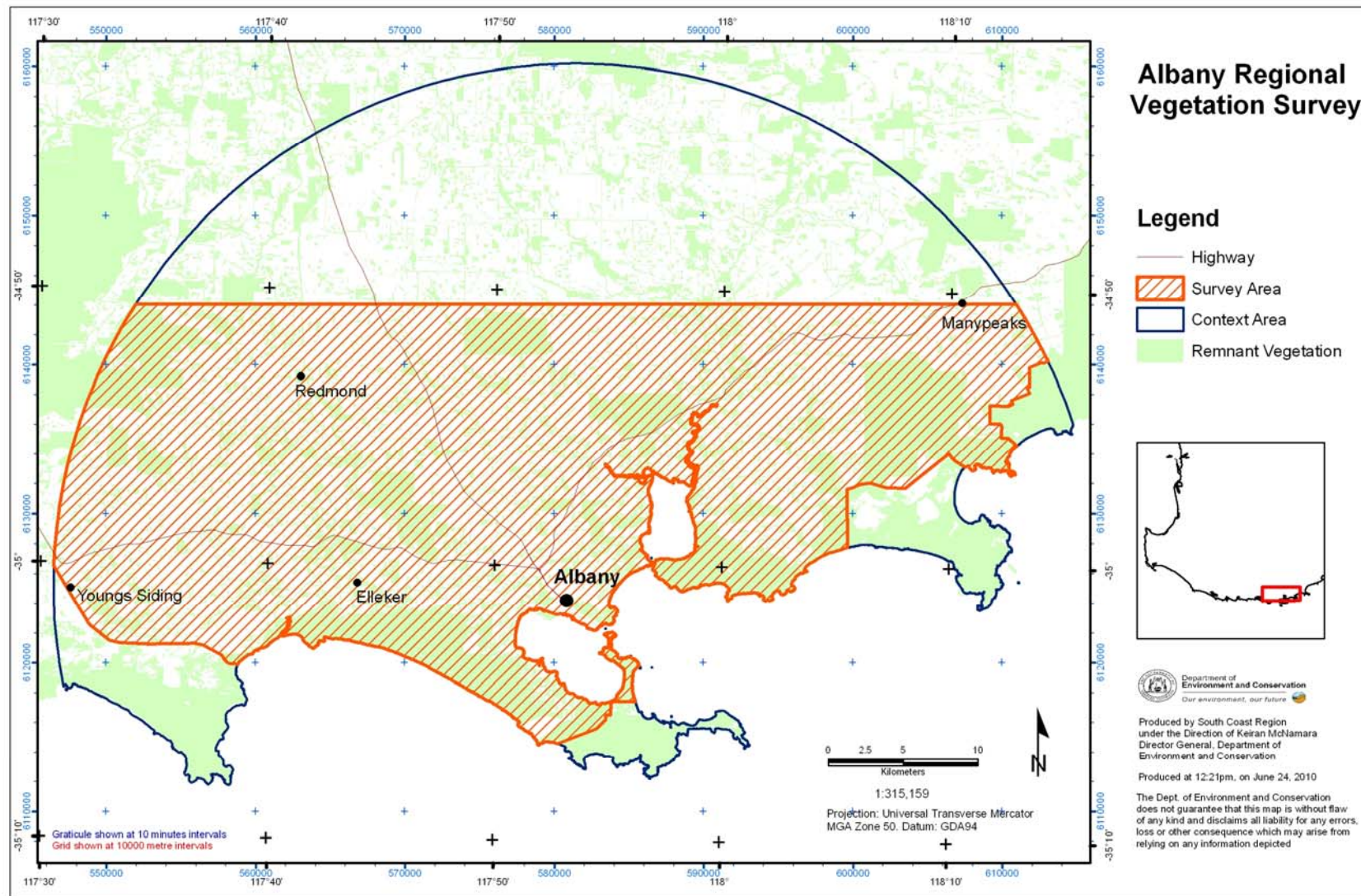
## **1.2 Context Area**

### **1.2.1 Location**

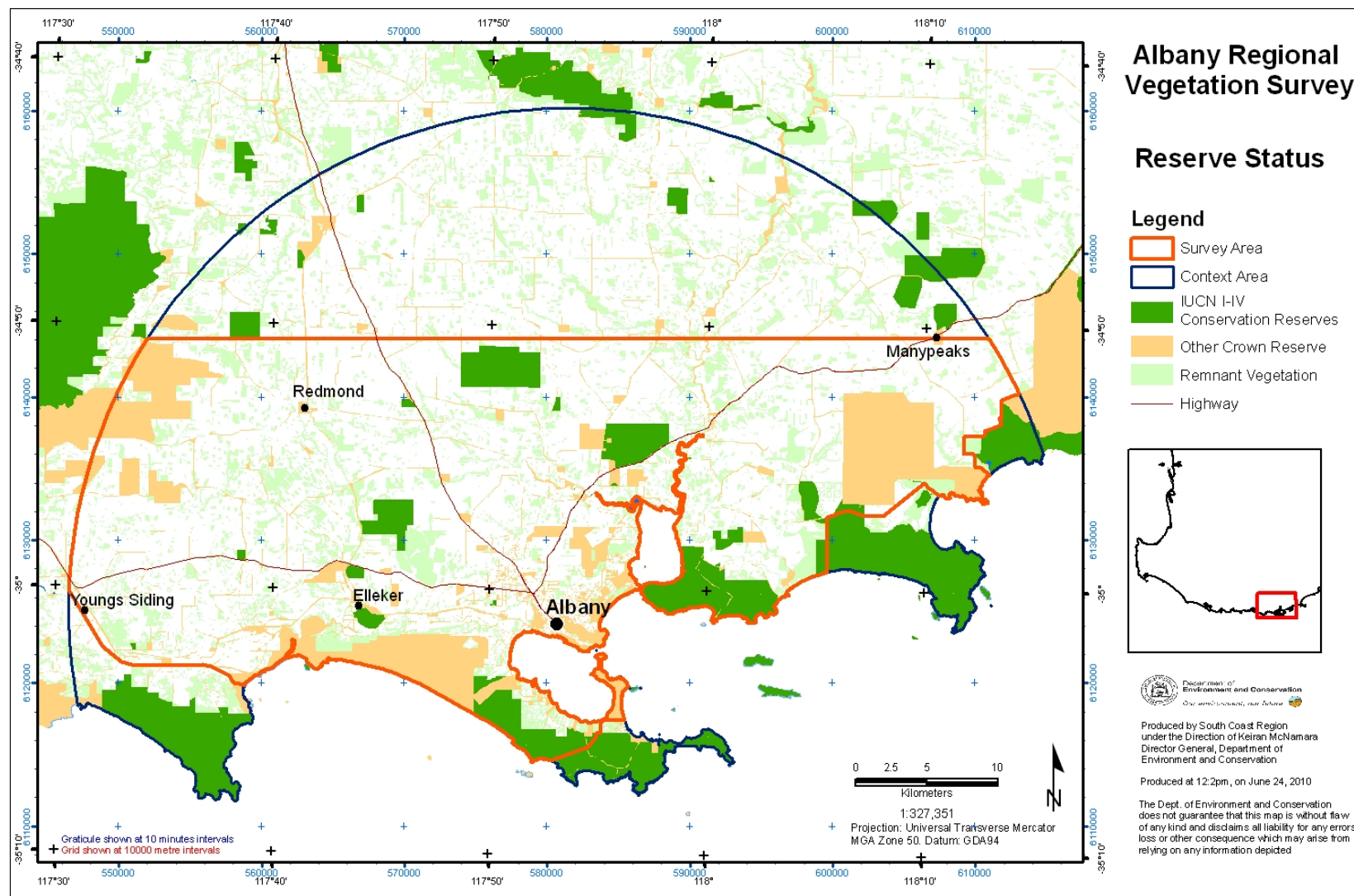
The original proposed survey area, referred to hereafter as the context area, encompassed an area of 209,060 ha within a 35 km radius of Albany with the eastern boundary at Bettys Beach, the northern boundary just south of the Porongurup Range and the western boundary near Youngs Siding (Figure 1.1). Most of the coastal fringe within this area is reserved within National Park, Nature Reserve or City of Albany Reserves while the hinterland supports a variety of rural land uses including agriculture, timber, horticulture, viticulture and scattered reserves (Figure 1.2). The area ultimately surveyed and mapped, hereafter referred to as the survey area, encompassed an area of 125,415ha, bounded on the north by an east-west line running close to the northern edge of Mill Brook Nature Reserve with West Cape Howe National Park (NP), eastern areas of Torndirrup NP, and most of Two Peoples Bay Nature Reserve (NR) excluded (Figure 1.1). Albany is the only large population centre within the area. Due to time constraints, the vegetation of the remainder of the context area was not mapped.

### **1.2.2 Land use history**

The Albany region has been home to indigenous people for at least 19,000 years with the oldest evidence, a campsite at the Kalgan Hall (Piggott 1992). Within the City of Albany, woodland, coastal river and estuarine areas were used for hunting, gathering and ceremonial purposes. This use continued into the late 19<sup>th</sup> century when European expansion commenced and clearing for agriculture disrupted traditional life. European settlement began in 1827 when the Frederickstown military outpost was established at the current Albany town site, preceding settlement in Perth and Fremantle by two years. Through the 19<sup>th</sup> century Albany became the gateway to the southern hinterland and the Eastern Goldfields beyond. Agriculture expanded slowly from the early 19<sup>th</sup> century (Piggott 1992). By the late 19<sup>th</sup> century, drainage schemes and subdivisions had commenced west of Albany in Gledhow, Torbay and Grasmere Swamp



**Figure 1.1 Albany Regional Vegetation Survey area**



**Figure 1.2: Extent of remnant vegetation and reservation status**



extending to the Robinson Estate area in the early 20<sup>th</sup> century (N. Ashford, Albany History Collection, pers. comm.). Albany's significance as a port declined after completion of Fremantle Harbour in 1893 and throughout the 20<sup>th</sup> century the economic base turned primarily to agriculture, timber and whaling. By 1945, less than 5% of land managed by the Albany Roads Board (the authority preceding the Albany Shire Council and in turn the City of Albany), had been developed (Johnson 1982). With the advent of modern fertilisers, mechanical clearing methods, soldier settlement and conditional purchase schemes, major clearing commenced in the 1950's and continued through the 1960's. By the beginning of the 21<sup>st</sup> century, 63% of the vegetation within the City of Albany local government area had been cleared for agriculture and urban growth (CoA 2007).

Today, Albany has a population approaching 32,000 people and is one of fastest growing cities in south-western Western Australia. The region is recognised for its natural beauty and cultural heritage values and is a popular tourist destination and base from which to explore the forests, coast and mountains of the hinterland.

### **1.2.3 Geology, landforms and soils**

The topography of most of the context area is dominated by a gently undulating plain sloping to the coast and incised by the King and Kalgan Rivers and numerous smaller drainage lines. The coastal fringe is dominated by coastal dune systems, limestone headlands and cliffs or granite/gneiss headlands and hills, with several lakes, Torbay Inlet and low lying flats occurring behind the dune systems (Churchward *et al.* 1988).

Geologically the area is underlain by Proterozoic rocks including granites and metamorphic gneiss of the Albany Fraser Province which are exposed as hills to 360 meters high along the coastal and near coastal fringe (Muhling and Brakel 1985). Eocene marine sediments including the Werrilup Formation and Pallinup Siltstone lie above much of this basement rock with the Pallinup Siltstone occasionally exposed in central and eastern regions and the highly fossilized Werrilup Formation exposed near Nanarup. Along the coastal fringe the Quaternary sediments of the Tamala Limestone may be present over either the granite and gneiss or the Tertiary sediments and are overlain by dunes systems.

A long history of weathering of these parent rocks has resulted in a complex variety of soils and landforms with 50 soil/ landform units (Figure 1.3) identified within the context area by Churchward *et al.* (1988). Broadly these landform units can be divided into five groups: a low relief undulating plain of the hinterland, valleys and associated drainage lines dissecting the plain, taller coastal and near coastal granite/gneiss hills, coastal limestone and dune systems and low lying poorly drained flats in the south-west. Common soil types include lateritic duricrust, yellow duplex soils, deep sands and podzols (Churchward *et al.* 1988).

### **1.2.4 Climate**

The context area lies between the 1,100 mm isohyet in the south west and 750 mm isohyet in the north east and has a mild climate with cool wet winters and mild summers. Average rainfall recorded for Albany is 930 mm per year, with the wettest months between May and September. Average winter rainfall is 134 mm per month and average summer rainfall 25 mm per month. Temperatures are generally mild with average minimum and maximum summer temperatures of 15 °C and 23°C respectively, and average minimum and maximum winter temperatures of 9°C and 16°C, respectively (Bureau of Meteorology 2010). Frosts may occur in the deep interdunal swales along the coast and inland.

### **1.2.5 Biogeography and Vegetation**

The botanical diversity of the area has been acknowledged since the first European explorers visited in the late 1700's and subsequent studies have highlighted this diversity (Beard 1979; Hopper and Gioia 2004). The survey area lies within the Southwest Australian Biodiversity Hotspot, one of 34 internationally recognised biodiversity hotspots which corresponds to the Southwest Botanical Province (Myers *et al.* 2000; Conservation International 2004). It occurs at the eastern limit of two national Interim Bio-geographic Regional Areas (IBRA), the Jarrah Forest (Southern Jarrah Forest

Region sub region) and Warren Regions and near the western limit of the Esperance Plains Region (Fitzgerald sub-region) (Thackway and Creswell 1995) (Figure 1.4). The eastern limit of the former bio-geographic regions marks the transition zone from the more mesic forested south west of Western Australia to the drier interior and eastern coastal areas that are vegetated by mallee, woodland and shrubland associations. Many plants reach their eastern limit within the area and a few their western or south-western limit (DEC 2009).

The vegetation of the area has been mapped on a broad landscape scale by Beard (1979) and Connell and ATA Environmental (2001). Beard's mapping was undertaken in the 1970's, when he devised a state wide mapping and vegetation classification system based on geographic, geological, soil, climate, structure, life form and vegetation characteristics. Vegetation units were regarded as associations and were grouped into Vegetation Systems representing a particular pattern of association distribution within a given area. Within Beard's classification most of the survey area lies within either the Menzies or Warren Sub-Districts of the Darling Botanical District with the extreme eastern edge of the survey area occurring in the Eyre Botanical District (Figure 1.4).

Beard (1979) recognised seven vegetation systems within the survey area: the Torndirrup, Denmark, Hay, Narrikup, Albany, East Kalgan and Manypeaks systems, and 12 vegetation associations (Figure 3). Common associations were Heath, Scrub-heath and *Agonis flexuosa* Low Woodland mapped on coastal dunes; four Jarrah dominated woodland or forest associations that occurred on other upland areas including most of the hinterland, and Reed Swamp along drainage lines and low lying flats.

Sixty two (62) vegetation units were recorded within the survey area by Connell and ATA Environmental (2001) including 39 Jarrah/Marri/Casuarina woodland or forest units, three Karri, seven Coastal Heath, seven Sedgeland, three Wet heath, two *Melaleuca/Casuarina* Woodland and one *Melaleuca* scrub unit.

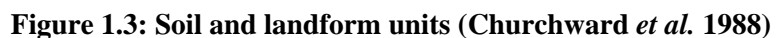
Several areas within the study area have been mapped at smaller scales from 1:25,000 to 1:10,000, including Bakers Junction and Mill Brook Nature Reserve (Griffin 1985), Mt. Martin (Sandiford 2000), the Wind Farm area (Halpern Glick Maunsell 2000) and Princess Royal and Oyster Harbour fringes (Pen 1995). The vegetation of Two Peoples Bay Nature Reserve has also been mapped, but only vegetation descriptions are available (Hopkins *et al.* unpublished).

### **1.2.6 Wetlands**

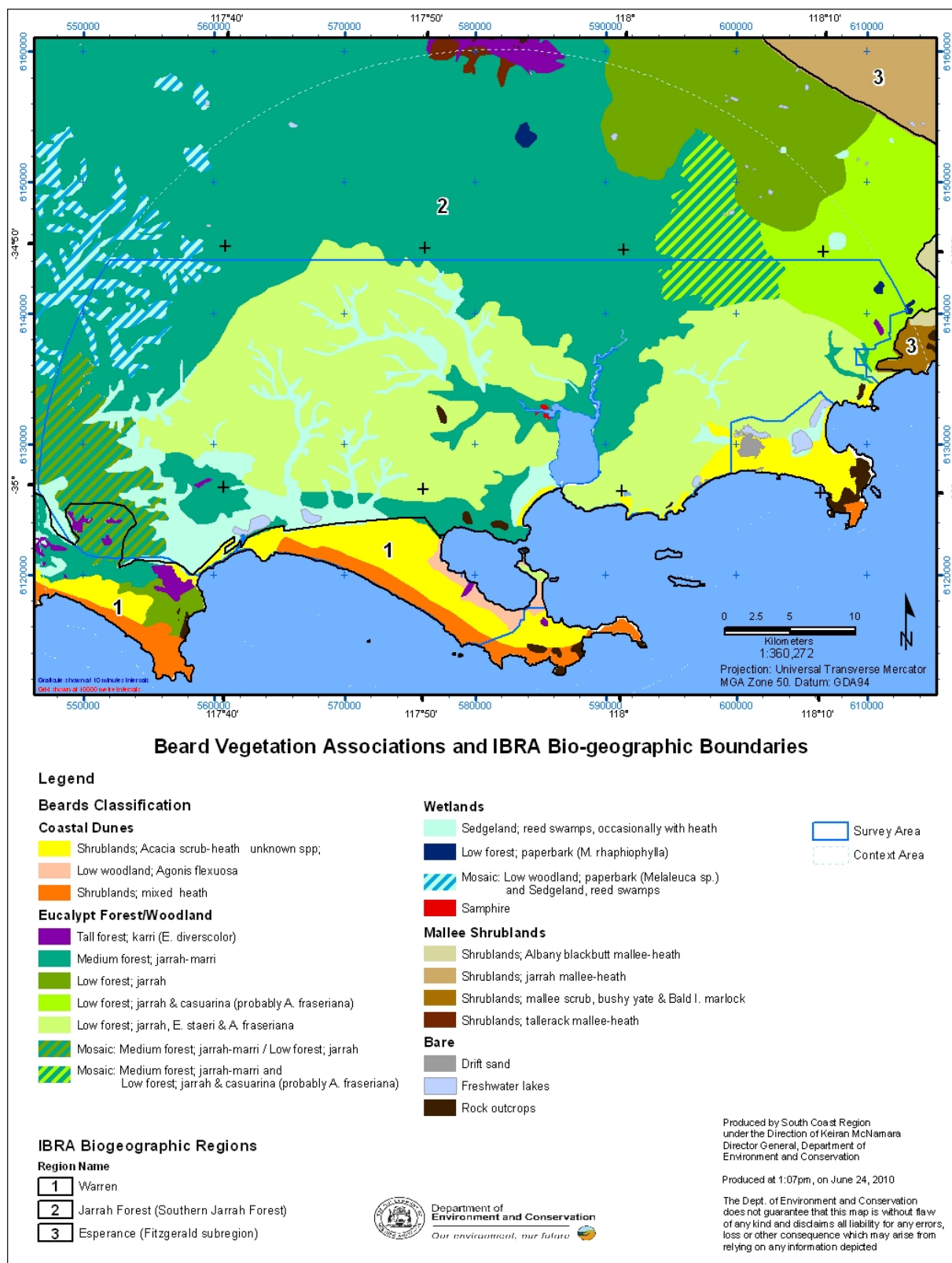
A variety of wetlands occur within the context area including freshwater lakes, rivers and seasonally inundated swamps. Major drainage lines include the Kalgan, King and Goodga Rivers, Mill Brook and Marbellup Brook. Three wetland suites within the context area are included in the Australian Directory of Important Wetlands (DEWHA 2010): the Moates Lake System which includes Lake Gardner, Moates Lake, Angove Lake and tributaries, the Lake Pleasant View System including South Sister Lake and Lake Pleasant, and Oyster Harbour and associated tidal vegetation.

Thirty five other wetlands within the context area have been recognised as "conservation category wetlands" based on representation, scarcity, presence of conservation flora and/or fauna and social/cultural values (Dept. of Water 2007).

Many wetlands have been cleared, filled or drained. Other significant changes to wetlands include nutrient enrichment, sedimentation, weed invasion, and changing hydrological status. The latter includes increased salinity and increased runoff and water levels due to vegetation clearing as well as lowered water levels attributed to extraction of water for supply purposes (Dept. of Water 2007).







**Figure 1.4. Beard vegetation map (1979) and IBRA biogeographic regions (Thackway and Creswell 1995).**

## 2 METHODS

### 2.1 Existing data

Existing vegetation reports within the survey area were reviewed from published sources, botanical consultancies and DEC (Albany) archives and files to provide a guide to possible vegetation types and distribution.

Existing quadrat data in the ARVS context area, comprising over 200 quadrats surveyed by consultants and DEC staff, were assessed for their suitability to complement data collected by this project.

The following map data sets were used:

- Beard Vegetation (Beard 1979), digitised (DAFWA 2005)
- Vegetation extent (DAFWA 2006)
- South Coast Landforms and Soils (Churchward *et al.* 1988)
- Updated landform and soil mapping (DAFWA Albany)
- Contour (DEC corporate data)
- Geophysics, partial coverage
- Cadastre maps (City of Albany, DEC corporate data)
- Orthophotography (Landgate 1990s-1997)
- Stereo pairs aerial photography, 1:25,000 (Project 92045 Mt Barker DOLA 1993)

### 2.2 Quadrats

Twenty permanently marked 10 m x 10 m quadrats were established in wetland vegetation with the aim of quantitatively describing vegetation communities. The following data was recorded:

- All vascular species. Each species was assigned a visually assessed cover abundance according to a six point Braun Blanquet scale: 1 = few <5% cover, 2 = common <5%, 3 = >5<25%, 4 = >25<50%, 5 = >50<75% and 6 = >75%.
- Vegetation structure. Estimates of structure using standardised National Vegetation Information System (NVIS) (ESCAVI 2003) height and cover classes were made, with the exception of an additional emergent cover class used for the upper stratum (E = <5%, emergent) and some growth form rationalisations (Appendix 1). Dominant or co-dominant species within each stratum were recorded with structural data for the upper shrub and all tree strata recorded over a 20 m x 20 m area. Species that could not be identified in the field were collected and identified later. Selected voucher specimens were collected for lodgment in the Perth and Albany Regional Herbaria.
- Physical attributes. Visual assessments included soil colour and type, geology, percentage surface rock, landform hydrology and drainage status.
- Condition rating according to Keighery (1994).
- Location. The location of quadrats were recorded and tagged at the north west corner using a hand held Global Positioning System (GPS) unit (datum: GDA 1994) and descriptions of location recorded.

### 2.3 Relevé field survey

#### 2.3.1 Pre survey

Prior to field work, digital orthophotos were viewed to plan traverses that would cover the apparent vegetation diversity and range of landforms present. Draft vegetation maps were made for some areas based on aerial patterns. Draft vegetation codes, collated from a review of existing vegetation reports within the context area and supplemented with new codes during the survey, were assigned where possible to provide an indication of aerial photograph interpretability (API). Field traverses were planned to cover the apparent vegetation diversity as well as the range of landforms present within each remnant.

### 2.3.2 Survey and relevé data collection

Most field work was conducted between November 2007 and June 2009. Additional sampling of estuarine vegetation occurred from February to March 2010. Field work initially targeted areas closest to Albany and subsequently radiated outwards. Vegetation boundaries were marked as waypoints using a hand held Global Positioning System (GPS) unit (datum: GDA 1994). Representative vegetation was sampled using relevés, with the methods adapted from a mapping project in the Ravensthorpe Range (Craig *et. al.* 2007). Relevé locations were chosen to sample the range of vegetation types and variation within vegetation types.

Each relevé consisted of an unmarked 10 m x 10 m area centered on a GPS marked location. Where vegetation occurred in narrow bands an equivalent area of 5 m x 20 m was sampled. Floristic and structural data, species dominance, physical data, notes and condition were recorded as per quadrats (Section 2.2) with the exception that vascular plants were only recorded where a minimum of three individuals were present or species cover was greater than 5%, and individual species were not assigned a cover abundance category (Appendix 2 Relevé Recording Sheet). Each relevé was given a unique number and assigned, where possible, a draft vegetation code. On completion of all field work, draft vegetation codes were reassessed on the basis of patterns observed throughout the survey area and where relevant, updated.

Locations of conservation-listed species, additional notes on the structural and floristic composition of vegetation and disturbance factors, such as weed invasion and *Phytophthora* dieback caused by the root pathogen *Phytophthora cinnamomi*, were recorded and marked as waypoints using a GPS.

Vegetation type and condition (see 2.7.1) were also assessed by vehicular survey of all public roads and most tracks within DEC managed reserves, CoA Reserves and water reserves.

The extent of native remnant vegetation within the ARVS context area was updated from an existing digital map by ground truthing or by API from 2007 digital photos. Where vegetation occurred over pasture or introduced plants, it was determined to constitute remnant vegetation only if the upper stratum retained at least 50% of its natural cover.

### 2.4 Plant identifications

Plants that could not be identified in the field were identified using the Albany Regional Herbarium, Perth Herbarium and taxonomic experts. Nomenclature followed current WA Herbarium usage (DEC 2010), with the following five exceptions:

- *Schoenus efoliatus* incorporated *Schoenus rodwayanus*, a species that was reinstated during the time of this survey;
- *Lysinema ciliatum* incorporated the re-instated *Lysinema pentapetalum* and all recognised forms of *L. ciliatum*,
- Identification of *Lepidosperma* was assisted by Russell Barrett with new phrase names applied to a number of taxa,
- Supplementary names were applied to taxa that varied from type or that represented identifiable forms,
- Taxa that could not be identified to species level due to insufficient material were given the epithet “unident”.

### 2.5 Data storage

All waypoint data and relevé data were entered in three separate databases linked by the unique relevé code. Species data, including names, dominance, growth form and collection numbers, for all sites were entered using the WA Herbarium designed Max database (DEC 2005) which enables taxonomic changes to be updated. Site data were entered into a database using a form with predetermined classes to minimise error. Waypoint data were entered into the third database. All relevé data were checked against original recording sheets.

## 2.6 Data analysis

Following all field work, all relevés were reviewed. Obvious ecotonal and modified sites (recognised *in situ* or on subsequent evaluation) were removed from the dataset. Also removed were all annuals (including annual geophytes), introduced species and species that could not be identified due to lack of suitable material. Forms, varieties, subspecies and selected species that could not be consistently distinguished were amalgamated prior to the analysis (Appendix 3).

Compositional analysis of the refined data set (using presence and absence data only) was undertaken using standard routines in Primer® statistical software using a Bray Curtis coefficient association matrix.

An analysis of similarity test (ANOSIM) was used to test the consistency of the draft vegetation units in terms of species composition and to determine whether further investigation was required. ANOSIM tests whether there are significant differences in composition between groups based on the association matrix using permutation tests ( $P < 0.05$ ) (Clarke 1993). The test statistic (R value) reflects the degree of differences between groups. An R value of 0 indicates there are no differences in species composition between groups. An R value of 1 indicates complete separation of groups with all samples within a group more similar to each other than to any other sample from another group. ANOSIM enables comparison of groups of different sample size although comparisons between single sampled groups could not be made.

Non-metric multi-dimensional scaling (nMDS) ordinations were conducted between units to assist in defining final vegetation units that best represented the patterns observed in the field. These nMDS ordinations construct a map in a specified number of dimensions with sample sites (relevés) closer together more similar to those further apart. Species dominance, vegetation structure, landform and soil preferences as recorded in relevé data and field notes, were taken into account in finalising the units.

A comparative cluster analysis classification of all data, excluding modified and ecotonal relevés using Primer® was subsequently run to provide a diagrammatic representation of all unit affinities. However, there are limitations in using cluster analysis to define groups as it assumes discrete boundaries between groups whereas boundaries between vegetation types vary from discrete to continuous with the latter frequent within the survey area (James and McCulloch 1990; Austin and Cunningham 1981).

## 2.7 Mapping

### 2.7.1 Vegetation mapping

Mapping was undertaken using ArcGIS™ V9.2 software. Waypoints were downloaded and printed on maps at a scale of 1:5,000 or 1:10,000. Site data, field notes, aerial photographic patterns on digital orthophotos and 1:25,000 colour stereo pairs viewed under a stereoscope were used to draw or redraw vegetation boundaries with draft vegetation codes assigned to each map polygon. For larger remnants and reserves, boundaries were drawn on clear plastic overlays, scanned, geo-referenced and traced. For smaller areas, boundaries were transferred by eye using underlying orthophotos, contours and gridlines as a guide. Following data analysis vegetation codes were updated. Vegetation type, percentage of mosaic (maximum of three vegetation types per polygon) and a reliability code (Table 2.1) were recorded. Printed maps were checked against hardcopy draft maps. Low resolution orthophoto (circa 1990s) were used as base maps for mapping prior to July 2008. Subsequent mapping used high resolution 2007 orthophotos.

The percentage area of units within formal conservation reserves (International Union for Conservation of Nature (IUCN) I-IV), other Crown reserves and non reserve remnants was calculated using available DEC data sets.

**Table 2.1 Vegetation map reliability code**

Code	Rating	Criteria
1	Very High	Polygon visited +/- site sampled. Uniform aerial pattern (AP) and landform within polygon or AP very distinctive.
2	High	Polygon visited +/-site sampled but polygon large and >1 vegetation type with similar pattern in similar landform or polygon viewed from distance, dominant species observed. Area not visited but AP/landform the same as nearby visited polygons.
3	Moderate	Site visited but difficult to interpret due to disturbance or site not visited, AP consistent with a trend observed in area, Landform include >1 vegetation type with similar AP
4	Low	Site not visited, AP not clear.

### 2.7.2 Condition mapping

The condition of remnants was mapped using the national standard Vegetation Assets States and Transition (VAST) framework (Thackway and Lesslie 2006). For native vegetation three categories were used: 'residual', 'modified', and 'transformed' with their criteria and corresponding Keighery (1994) categories listed in Appendix 4. A fourth category, 'replaced adventive', was used for larger non native invasions e.g. *Typha orientalis* Sedgeland. Non native vegetation was only mapped where this occurred as small areas within native vegetation. Due to the complexity of mapping condition within larger reserves, particularly in relation to Phytophthora dieback, areas of residual, modified or transformed vegetation were not individually mapped. Instead, an overall reserve condition rating for each condition category was estimated for each reserve based on field observation and consultation with DEC staff. Condition status for most other remnants was interpreted from aerial photography and thus results must be treated with caution.

## 2.8 CONSERVATION STATUS

The regional significance of all vegetation units could not be assessed quantitatively against thresholds set by the Commonwealth (Environment Australia 2001a) and adopted by the Environmental Protection Authority (EPA 2000; 2008) due to the absence of comparative pre-clearing vegetation extent data within and outside the survey area. Conservation status was assessed incorporating relevant criteria used to assess the conservation status of vegetation types as outlined in EPA Guidance Statement 33 (EPA 2008) and adapted in the *Local Government Biodiversity Planning Guidelines: Addendum to the South West Biodiversity Project Area* (Molloy *et al.* 2007). The distribution of key dominant species, known to be restricted to or reach the limit of their range either in the survey area or up to 10 km outside, was used as a guide to regional distribution. In lieu of pre-clearing thresholds, an area of less than 1500 ha was used to indicate rarity (Molloy *et al.* 2007).

The criteria assessed were:

- Rarity based on total extent of unit (<1,500 ha significant),
- Distribution (unit restricted to or at limit of range in ARVS area and 10 km buffer),
- The presence of Threatened or Priority Ecological Communities, Declared Rare Flora and Priority species,
- Specific habitat types of significance in terms of supporting important ecological functions, namely wetlands, riparian, riparian buffer, estuarine or coastal dune (aeolian foredune) vegetation and wetlands of national significance,
- Current threats to vegetation units: Phytophthora dieback, fire, hydrological change,
- Representation in conservation (IUCN I-IV) reserves (<10% significant).



## 3 RESULTS

### 3.1 EXISTING DATA REVIEW

Over 200 quadrats surveyed by consultants within the ARVS context area were found to have taxonomic errors that could not be reconciled, thus this data could not supplement quadrat data collected during this project.

### 3.2 FIELD SURVEY

#### 3.2.1 Quadrats

Twenty quadrats were established in eleven wetland vegetation types. This took two weeks which meant that if this methodology were to be continued there would be insufficient time and resources to:

- adequately sample the floristically diverse and complex vegetation
- sample the variety of landforms
- map the vegetation.

Thus, the Steering Committee agreed that assessment of vegetation types by quadrat should cease in favour of survey by relevés.

#### 3.2.2 Relevés

Seven hundred and eighty five (785) relevés were recorded across the survey area with their distribution reflecting clearing patterns and accessibility, and the condition, abundance, distribution and heterogeneity of vegetation types (Figure 3.1). Relevé reports are provided in digital format. All major reserves within the survey area were surveyed on foot and remnants on 20 private properties were visited with other properties observed from the roadside.

Seventy three (73) relevés (9%) were recognised, either *in situ* or subsequently, as being ecotonal or modified and were not used in statistical analyses. Some relevés were deliberately located in modified areas to provide some baseline data for monitoring, e.g. in *Banksia littoralis*/*Melaleuca raphiophylla* Low Woodland (58) and in regenerating *Eucalyptus goniantha* Mallee (20) and Karri Forest (9) on private property.

### 3.3 FLORA

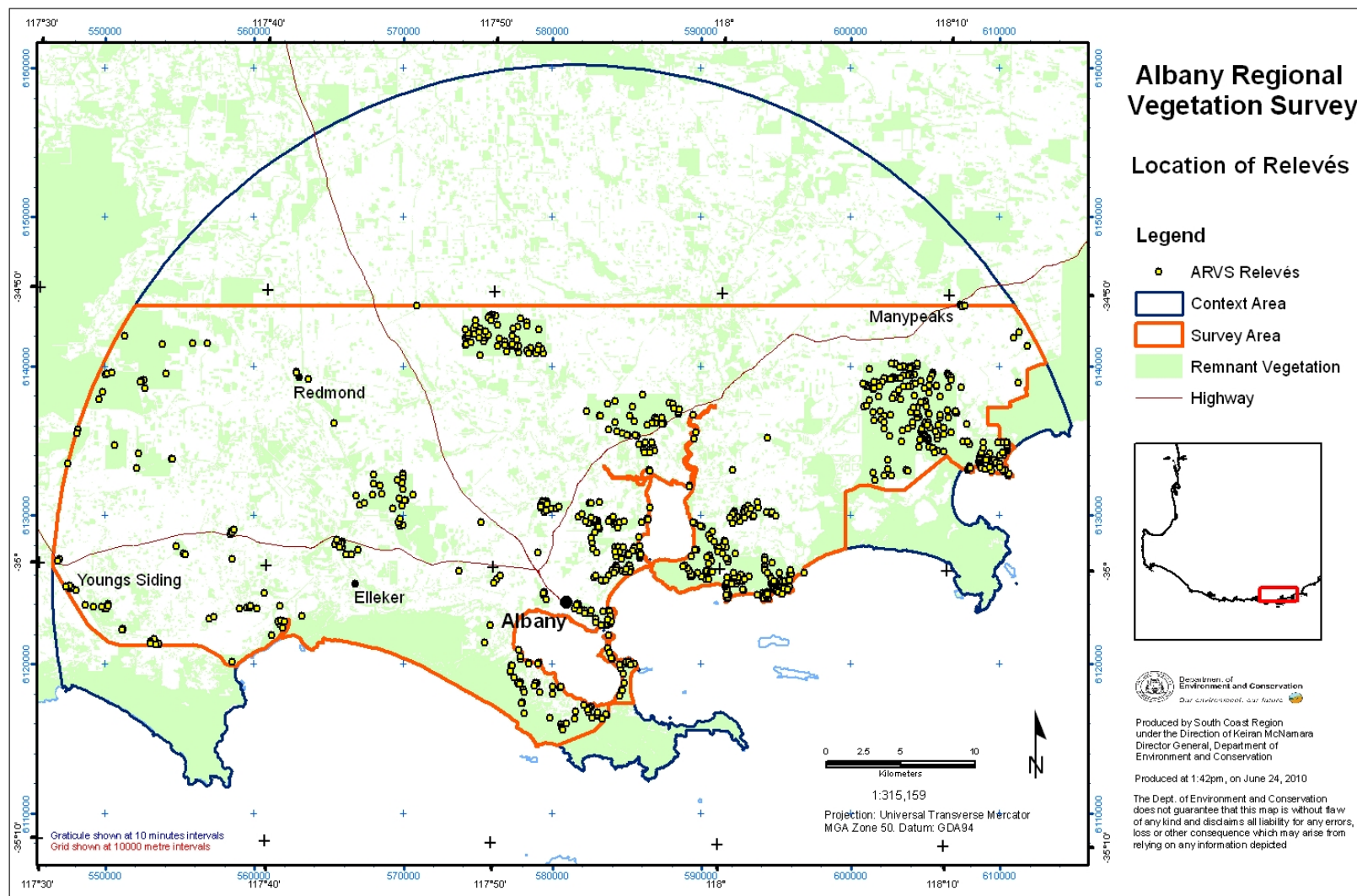
Seven hundred and ninety six (796) species were recorded within the 785 relevés (Appendix 5). Due to the methodology the number of species recorded under represents the number of species in the area, particularly annuals and geophytes. The most diverse families were Fabaceae (100) species including 21 from the genus *Acacia* which was previously classified in the Mimosaceae, Myrtaceae (86), Proteaceae (86), Cyperaceae (76) and Ericaceae (56). The most common genera were *Stylidium* (34), *Leucopogon* (29), *Schoenus* (27\*), *Banksia* (26), *Lepidosperma* (22\*), *Acacia* (21), *Hakea* (19) and *Melaleuca* (18\*). Less than 1% of records were unidentifiable to species level due to insufficient flowering material. Most of these records were sterile or immature *Lepidosperma*, *Astartea*, *Sphaerolobium*, *Schoenus* and Poaceae. Two hundred and ninety five (295) species were collected for lodgment in the WA Herbarium with duplicates in the Albany Regional Herbarium.

#### 3.3.1 Conservation species

Forty three (43) species of conservation significance were recorded during the survey. Appendix 6 lists priority codes and categories. Many records represent new populations and 19 represent significant range extensions (Appendices 7 and 8).

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\* These figures do not include forms and affinities which may be discrete species based on floristic and habitat differences. This is particularly so for the genus *Lepidosperma* which is currently undergoing revision. It is not clear if all forms identified here will eventually be described as species as currently proposed (R. Barrett pers. comm.)



**Figure 3.1 Location of floristic relevés**

### 3.3.2 Declared Rare plants

Six Declared Rare Flora (DRF) were recorded including a significant range extension for *Chordifex abortivus*. This record is the fourth population known to exist with all occurrences of this species occurring in different vegetation associations. New populations of *Banksia goodii*, *Banksia brownii*, *Isopogon uncinatus* and *Andersonia pinaster* were recorded. *Banksia verticillata* was observed in a known population.

### 3.3.3 Priority species

New populations of priority species found were:

- Three Priority 1 species (*Andersonia jamesii*, *Schoenus* sp. Grey Rhizome and *Stylidium falcatum*)
- Four Priority 2 species (*Thomasia quercifolia*, *Stylidium articulatum*, *Stylidium daphne* and *Spyridium spadiceum*)
- 21 Priority 3 species (Appendix 7)
- 15 Priority 4 species (Appendix 7)

Four priority species - *Gonocarpus simplex* P3, *Sphaerolobium rostratum* P3, *Xanthosia eichleri* P3 and *Lasiopetalum* sp Denmark P3 - had previously only been recorded west of the survey area. Other easterly range extensions were recorded for *Stylidium falcatum* P1 while *Gonocarpus simplex* was located east of its main population centre, with an outlier previously recorded at Esperance (DEC 2010). *Stylidium gloeophyllum* P3, *Stylidium daphne* P3 and *Verticordia harveyi* P3 were recorded further south west than their previously known distributions.

### 3.3.4 Unusual species

Three taxa recorded may represent new species as they do not appear to fit current taxon. These are *Cassytha* aff *flava*, *Hibbertia* sp. L 543 and *Melaleuca* aff *densa*. Collections of these taxa have been made and further taxonomic work is required to determine their status.

#### *Cassytha* aff *flava*

This taxon is a small semi-prostrate plant with reddish stems and few, relatively large maroon flowers with large hairs on the outside of the ovary and fruit. It was found several times along drainage lines under dense shrubs. It appears to be related to *Cassytha flava* in floral features but differs in its much larger flowers and fruits, colour and habitat with the latter species typically growing on well drained soils.

#### *Hibbertia* sp. L 543

This low growing shrub was found in the western margin of the study area in Redmond State Forest. It has lanceolate leaves with revolute margins, a glabrous textured upper leaf surface and a dense silky lower leaf surface with a tuft protruding beyond the leaf tip. Its taxonomic affinities are unclear as it does match or appear similar to any specimens in the Perth Herbarium.

#### *Melaleuca* aff *densa*

This taxon was observed along Mill Brook within Mill Brook Nature Reserve. It has very small semi appressed leaves arranged in threes, small yellow flowers and has affinities with *M. densa*. The latter species is known for its variability in form; however, *M. aff densa* does not fall within the known range of variability.

### 3.3.5 Range extensions

Range extensions were recorded for 19 species and are summarised in Appendix 8. *Hemichroa pentandra*, a species common to saltmarshes in southern Australia, is included on this list although Pen (1995; Pen unpublished) recorded this species in the King River and around Princess Royal Harbour. This species had previously only been collected in Western Australia from Rottnest Island (DEC 2010).

### 3.4 Vegetation units and data analysis

#### 3.4.1 Vegetation units

Quantitative analysis and field observations were used to identify 67 native vegetation units which are described in Appendix 9 and represented diagrammatically according to broad land form or geographical relationships in Figure 3.2. However, not all units fall discretely within land forms or divisions within land forms e.g. units 1, 22 and 53 (Figure 3.2). Vegetation descriptions include floristic and structural characteristics and common variations, habitat characteristics, unit affiliations, key identifying features, notes on condition and threats as observed in the field, likely distribution, a representative photo and a distribution map within the survey area.

The 67 vegetation units were based primarily on species composition, with species dominance taken into account where this was observed to have a strong link to particular landform or environmental variables, and best fit the description of NVIS level 5 associations (ESCAVI 2003) (Appendix 10).

Thirty two (32) units are upland units, 22 are wetland (including three tidal or estuarine units) and 13 dampland or transitional units that occur between wetlands and uplands.

Two units are mapping units, Miscellaneous Granite Shrublands (28) and Miscellaneous Drainage Woodland/Shrubland (50), covering areas that were not interpretable and vegetation that did not clearly fall within any other unit.

Three units: *Hakea* spp Transitional shrubland (22), *Adenanthos cuneatus/Banksia quercifolia* Transitional Heathland (34) and *Gahnia trifida* Sedgeland/Wet Shrubland (51) appear ecotonal and do not clearly fall within other units. Further survey is required to determine their status, floristic variation and affinities with other units.

Sub-units have been described within 19 units representing commonly observed floristic variations (Appendix 9). These sub-units typically reflect differences in some environmental variables within units e.g. *Cyathochaeta equitans* Sedgeland (3a) represents a frost hollow sub-unit within Coastal Heath (3). Some sub-units represent distributional changes in a dominant species across the survey area, e.g. *Beaufortia sparsa* Open Heath/*Evandra aristata* Sedgeland (46a) is dominant within unit 46 in the western and central areas of the survey area but is absent in the eastern areas where *Kunzea ericifolia* (46b) or *Pericalymma spongiocaula* (46c) are dominant. A few sub-units may represent distinct units but further survey is required to determine their floristic composition, e.g. Karri Tall Open Forest (9b).

#### 3.4.2 Data analysis

Initially, 75 draft units were investigated with three units not included in analysis as they represented either: a highly modified unit (*Melaleuca raphiophylla/Banksia littoralis* Woodland 58), were composed primarily of introduced species (Beach Herbland/Grassland 8) or were inadvertently not sampled (Mixed Sedgeland 63). Several of five closely related *Hakea* spp Woodland/Shrubland draft units, some of which occurred as mosaics, were not supported by ANOSIM tests. As ordination of these draft units did not reveal clear patterns in species composition or distribution, they were amalgamated into a complex. Similarly, some coastal shrubland draft units were united into a complex, and Jarrah/Marri, granite shrubland and *Agonis flexuosa* draft units were amalgamated with other units. Appendix 11 list the statistical significance of ANOSIM tests between the final vegetation units excluding modified, unsampled, miscellaneous or single sampled units while Appendix 12 lists the R values for these units.

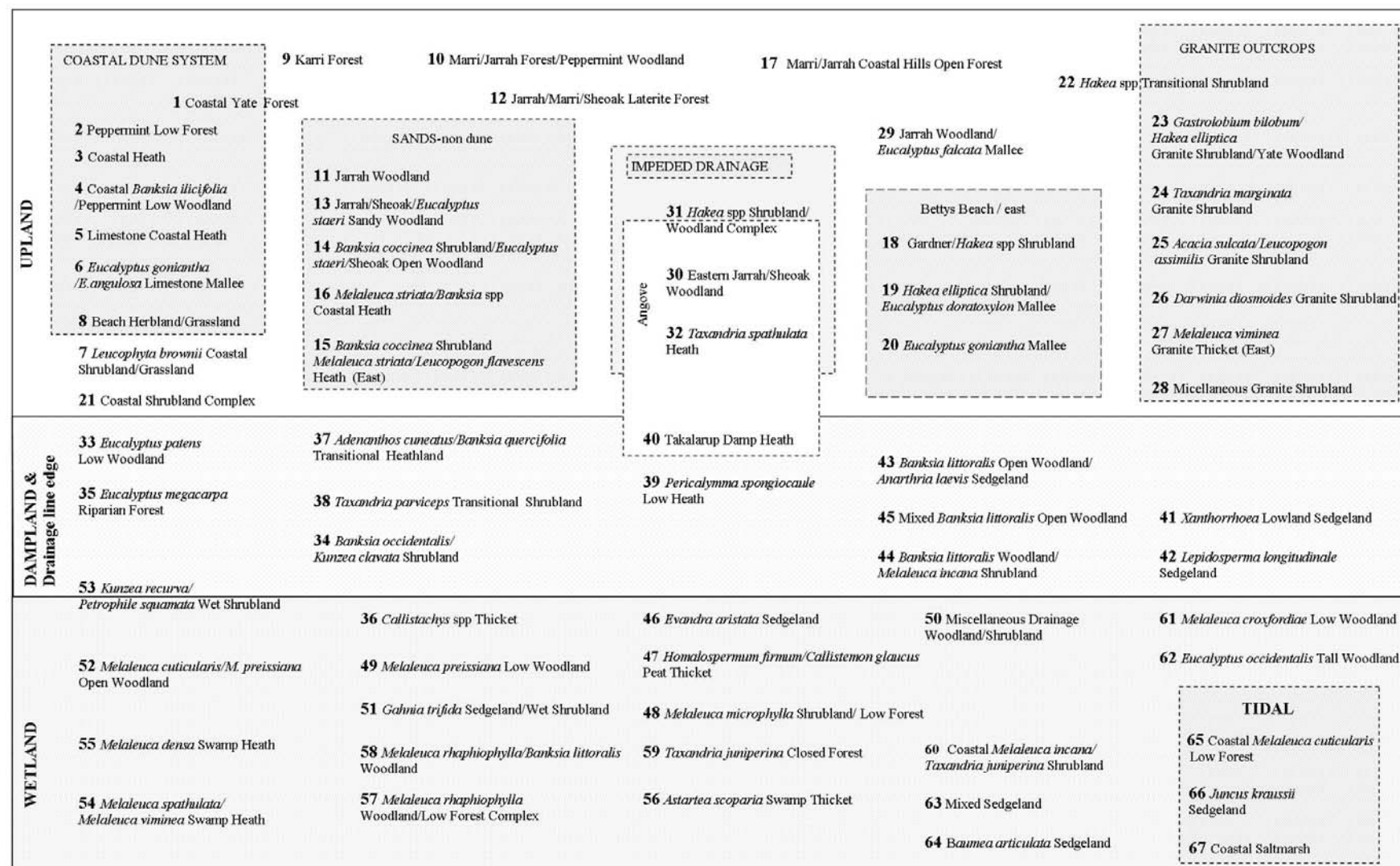
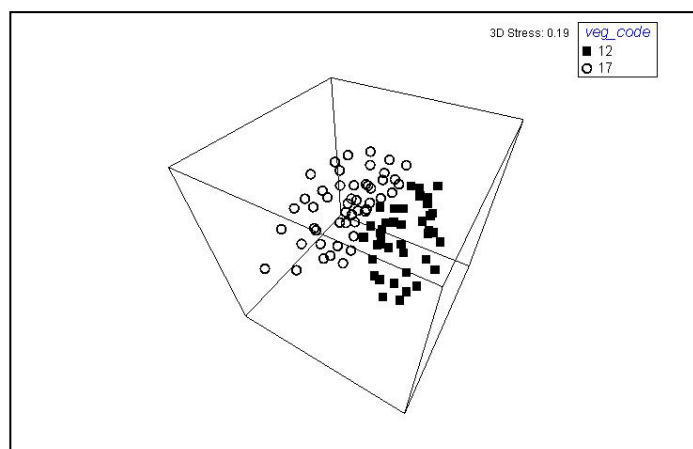


Figure 3.2 Diagrammatical representation of vegetation units according to broad land form and geographic distribution.



Figure 3.3 provides an example of a three dimensional ordination plot of relevés in two floristically similar units: Jarrah/Marri/Sheoak Laterite Forest (12) and Coastal Hills Jarrah/Marri Forest (17) ( $R = 0.35$ ,  $P < 0.01$ ). This plot demonstrates both the species similarities and dissimilarities. These units share canopy species and some understorey species but have marked differences in understorey species dominance and differences in habitat and distribution (Appendix 9, Vegetation descriptions).



**Figure 3.3 Three dimensional ordination plot of relevés within units 12 and 17**  
( $R = 0.35$ ,  $P < 0.01$ )

Most ANOSIM tests with low  $R$  values were highly significant and most non significant results were attributed to low sampling effort or low species diversity within one unit. *Juncus kraussii* Sedgeland (75) and Coastal Saltmarsh (76) ( $R = 0.15$ ,  $P =$  not significant) were separated on differences in structure and spatial distribution to best reflect their structural status at NVIS level 5. Coastal Saltmarsh (76) and *Leucophyta brownii* Coastal Shrubland/Grassland (7), ( $R=0.21$ ,  $P=$  not significant) were separated on species diversity, structure and habitat differences (Appendix 9, Vegetation descriptions).

Units that were only sampled once or had low replication were only recognised if they exhibited marked differences in species composition, dominance and habitat, if they were repeatedly observed in similar habitats e.g. *Callistachys* spp Thicket (36) and *Eucalyptus megacarpa* Riparian Forest (35) or had previously been documented e.g. *Baumea articulata* Sedgeland (64), *Eucalyptus occidentalis* Tall Woodland (62) (Appendix 9 Vegetation descriptions). Most units with low levels of replication could not have been sampled more due to their rarity or disturbance. A graph of the proportion of sampling effort per unit compared with the proportion of total remnant vegetation area occupied by the unit is provided in Appendix 13.

A comparative simplified classification dendrogram of all relevés included in analysis is presented in Appendix 14. Within this classification, units were grouped into very broad landform categories - wetlands, damplands/transitional zones and uplands. There were some trends in soil preferences and correlation of units with Churchward soil/landform units (Churchward *et al.* 1988), but these were not consistent or clearly delineated. For example, two of the units (units 3 and 4) which were largely restricted to the Meerup landform unit, were split in this classification from other units also predominantly restricted to this landform unit (units 1, 2, 5 and 6).

Whilst some vegetation units classified discretely with all relevés occurring together, other vegetation units clustered with closely related units e.g. vegetation units 12 and 17. Within a few vegetation units, relevés were more or less evenly split between two clusters with this trend most evident in transitional units and seral stages within units. For example, long unburnt relevés within *Taxandria spathulata* Heath (32) were widely separated from relevés burnt 10 years ago.

Relevés of some units classified in a distant cluster and, represented atypical sites e.g. species poor sites or those containing an atypical species. Odd clusterings also occurred within this classification e.g. the relevé within Jarrah Woodland / *Eucalyptus falcata* Mallee (29) clustered with one *Acacia*

*sulcata/Leucopogon assimilis* Granite Shrubland (25) relevé. These relevés, containing 28 and 25 species respectively, shared only a third of their species and did not share any common shrubs or tree species. Most of the shared species were sedges and herbs that were common to many units.

Two way tables of related vegetation units are provided on the CD accompanying this report. These tables only display species used in the data analysis. For units where there were large levels of replication, tables are represented by a random selection of units.

### 3.4.3 Species diversity

Mean species diversity within units varied from 2 to 31.2 (Table 3.3). Lower species diversity occurred in units associated with permanently or seasonally inundated wetlands or tidal areas (Table 3.3). High species diversity was recorded in upland shrubland and woodland units with the highest mean species richness of 31.2 recorded in *Hakea* spp Shrubland/Woodland Complex (31).

### 3.4.4 Comparison with other surveys

Appendix 15 lists Beard (1979) vegetation associations and the equivalent ARVS units based on his descriptions. Only one Beard association, Karri Forest, corresponds directly to an ARVS unit (Unit 9 Karri Forest). Beard's "Samphire" is equivalent to ARVS units *Juncus kraussii* Sedgeland (66) and Coastal Saltmarsh (67). Beard's "Peppermint Low Woodland", "Heath" and "Scrub-heath" are combined as one group, equivalent floristically and spatially to ARVS units 1-5 (Yate Coastal Forest (1), Peppermint Low Forest (2), Coastal Heath (3), Coastal *Banksia ilicifolia*/Peppermint Low Woodland (4) and Limestone Coastal Heath (5)).

Beard (1979) mapped major drainage lines and swampy areas as either "Reed Swamps" or "Paperbark Forest", recognising but not differentiating several associations which appear to be equivalent to ARVS units: *Callistachys* spp Thicket (36), *Pericalymma spongiocaule* Low Heath (39), *Evandra aristata* Sedgeland (46), *Homalospermum firmum/Callistemon glaucus* Peat Thicket (47), *Melaleuca cuticularis/M. preissiana* Open Woodland (52) and *Taxandria juniperina* Closed Forest (59).

Beard's four Jarrah Marri Forest units correspond to six ARVS units (Marri/Jarrah Forest/Peppermint Woodland (10), Jarrah/Marri/Sheoak Laterite Forest (12), Jarrah/Sheoak/*E. staeri* Sandy Woodland (13), *Banksia coccinea* Shrubland/*E. staeri*/Sheoak Open Woodland (14), Marri/Jarrah Coastal Hills Forest (17), *Hakea* spp Shrubland/Woodland Complex (31)). However, comparison with individual units is difficult as Beard descriptions for "Jarrah Low Forests and Woodlands" list understorey species of different associations together and he recognised that different associations occurred as mosaics. Numerous wetlands and damplands within the extent of Beard's woodlands and forests were not mapped due to the scale of Beard mapping. Errors noted in the digitised format of Beard mapping (DAFWA 2005) are outlined in Appendix 15.

Due to the paucity of floristic information within Connell vegetation units, it is not possible to compare units recorded by Connell and ATA Environmental (2001) with ARVS units.

Forty three of the ARVS units have been previously mapped and described in smaller projects within the ARVS context area (Appendix 16). Some units described in these local studies were split on structural grounds and upper canopy dominance and thus multiple units correspond to one ARVS unit. For example, Griffin (1985) listed four units corresponding to ARVS unit 12 and noted that these were differentiated primarily on the dominance of Jarrah and/or Sheoak or Marri in the canopy and were otherwise floristically similar. Pen (1995; unpublished) recorded three Coastal *Melaleuca cuticularis* units, split on structure and sedge dominance, and numerous *Juncus kraussii* sedgelands and saltmarsh units. Conversely, some units in these mapping projects represent several ARVS units.

Five other units: *Leucophyta brownii* Coastal Shrubland/Grassland (7), Karri Forest (9), *Eucalyptus patens* Low Woodland (33), *Lepidosperma longitudinale* Sedgeland (42) and *Eucalyptus occidentalis* Tall Woodland (62) are known to occur or have very similar floristic composition to units outside the survey area. The remaining 19 units do not appear to be described before (Units 6, 15, 16, 18, 19, 20, 21, 26, 27, 32, 30, 32, 34, 40, 41, 53, 54, 58 and 63).

### **3.5 MAPPING**

This report is accompanied by a CD with vegetation and condition status layers in digital format (shapefiles compatible with ArcMap) and five vegetation maps as pdf files. Not all mosaics are shown on these vegetation maps and some smaller units are not clearly visible. A simplified vegetation map is shown in Figure 3.4. Due to scale this map does not identify the vegetation types but provides an indication of the vegetation patterning across the survey area.

All mapping and data derived from the mapping needs to be viewed with the limitations of the methodology taken into account as not all remnants were visited. When viewing vegetation units, users must take into consideration the confidence levels associated with the mapped polygons. Sixty seven percent (67%) of vegetation was mapped with a high or very high confidence, 31 % moderate confidence and 2% low confidence. Most moderate to low confidence ratings occurred on private property and within Jarrah dominated units or wetland units. Confidence levels were not applied to condition status.

#### **3.5.1 Remnant vegetation mapping**

Within the survey area 44,093 ha were mapped as remnant vegetation, representing 35% of the 125,415 ha survey area.

Within the context area, 71,686 ha were mapped as remnant vegetation, representing 34% of the context area. Prior to this survey the extent of remnant vegetation within the context area was estimated to be 37%. The reduction in the extent of remnant vegetation in the context area is attributed to both the loss of vegetation in recent years (e.g. through clearing), and the greater accuracy of the revised mapping layer (e.g. roads and planted windbreaks were removed from the layer).

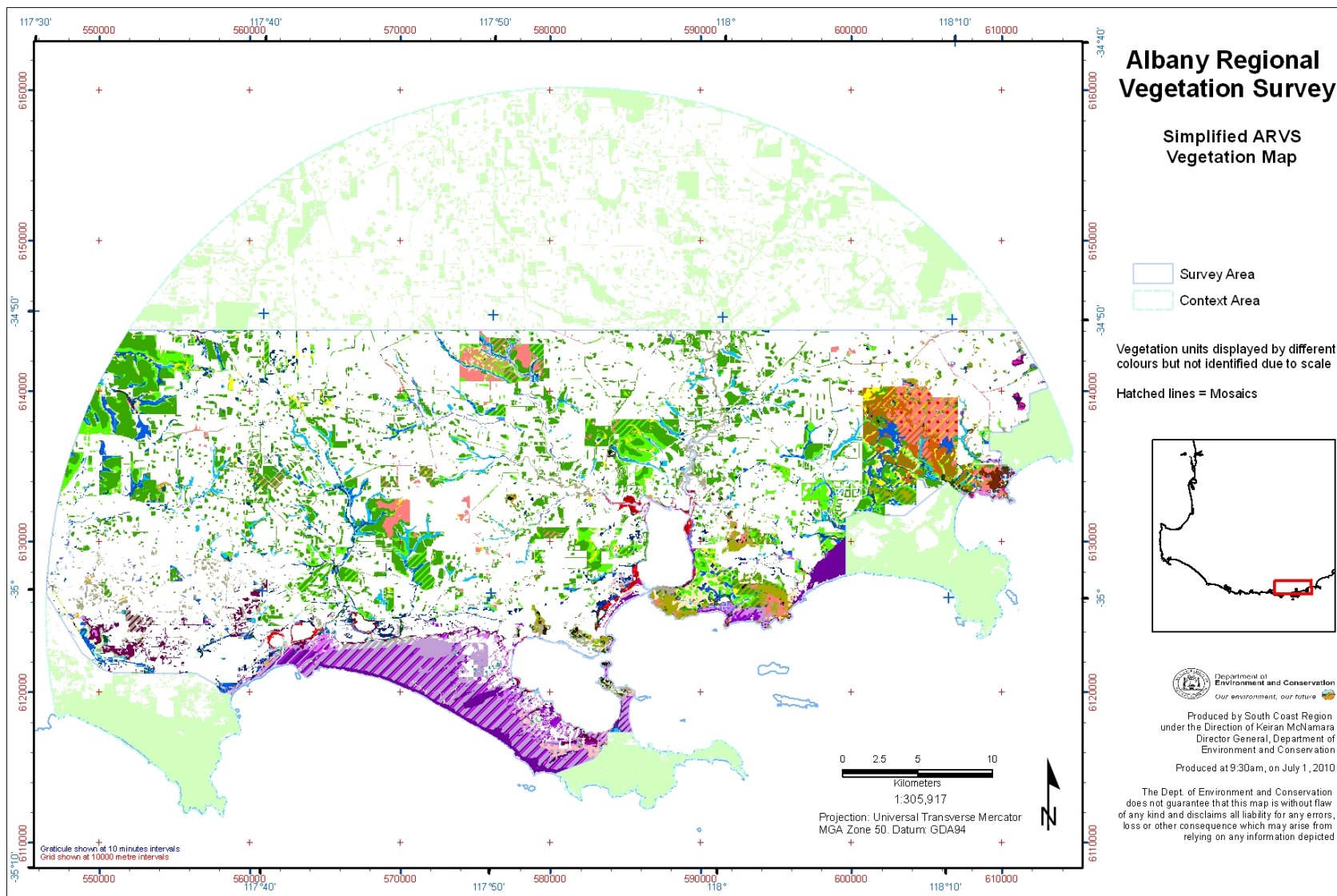
As the natural canopy of different units varies considerably in density, some highly disturbed areas of wetland woodland units with a naturally sparse tree cover were rated as remnant vegetation (e.g. unit 52), whilst areas with similar canopy densities in Jarrah dominated units were deemed non-remnant. However, it is very important to recognise the ecological and habitat values of these 'non-remnant' areas for wildlife.

Within the survey area, 19% of remnant vegetation occurs within formal conservation reserves (IUCN I-IV) and 39 % in other Crown reserves (Table 3.2).

#### **3.5.2 Vegetation unit mapping**

Table 3.2 provides a summary of the total extent (hectares and percentage) and reservation status (IUCN I-IV and other Crown reserves) for each vegetation unit within the survey area.

The size of units ranged from <1ha (Units 7 and 42) to 13,036 ha (Unit 12). Eighteen units each occurred on >1% of the remnant vegetation, accounting collectively for 92% of the total remnant vegetation. Within this group 82% of all species were recorded, with 22% of species restricted to this group. In comparison, 49 units each occurred on <1% of remnant vegetation and collectively represented 8% of remnant vegetation. Within this group 78% of all species were recorded, with 20% of species restricted to this group. Nine native species (1%) were only recorded in the two smallest units (units 7 and 42) that together represented 0.0005% of the remnant vegetation.



**Figure 3.4 Simplified vegetation map of ARVS survey area**



Thirty-two (32) units had <10% of their ARVS extent reserved within IUCN I-IV reserves including the most common unit Jarrah/Marri/Sheoak Laterite Forest (12), with 15 units not occurring on conservation reserves. Of these units, five had >70% area on non reserved land: Karri Forest (9), *Eucalyptus goniantha* Mallee (20), *Eucalyptus megacarpa* Riparian Forest (35), *Melaleuca preissiana* Low Woodland (52) and *Eucalyptus occidentalis* Tall Woodland (62). However, care needs to be taken in interpreting the conservation reservation status on a local scale as significant areas of conservation reserve occur within or adjacent to the ARVS context area, but outside the ARVS survey area, i.e. within West Cape Howe NP, Torndirrup NP, Waychinnicup NP and Two Peoples Bay NR (Figure 1.2 and discussion). A further three units had >70% occurrence on non reserved land: Coastal Yate Forest (1), *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (47), and *Melaleuca raphiophylla* Woodland/Low Forest Complex (57).

### 3.5.3 Condition status mapping

Table 3.1 summarises the condition status of remnant vegetation within the survey area. Values for “replaced adventive” used for areas of non native vegetation are not included as these areas were negligible.

A simplified condition map is displayed in Figure 3.5 showing the predominant condition status of each remnant but does not indicate mosaics. The greatest proportion of modified and transformed remnant vegetation occurred on non-reserve land.

**Table 3.1: Percentage of remnant vegetation in ARVS area within each condition category and percentage reservation status by category.**

Condition category	Total survey area (%)	Area in IUCN I-IV reserves (%)	Area in Other Crown reserves (%)	Area in Non reserve (%)
Residual	67	83	86	41
Modified	21	13	11	34
Transformed	12	4	3	25

The condition status of individual vegetation units has not been calculated, partly due to the complexity of the task and time constraints and partly because inaccurate assessments will arise as reserves were assigned an overall condition status. For example, over 50% of *Banksia coccinea* Shrubland *Melaleuca striata*/*Leucopogon flavescens* Heath (14) within the Bettys Beach Reserve is estimated to be affected by Phytophthora dieback, but an assessment based on the overall reserve condition status would indicate that only 15% was modified. However, using areas that were only mapped as one unit, i.e. excluding mosaics, an analysis of three units thought to have a high percentage in a modified or transformed condition state, indicates that at least 46% of the most common unit Jarrah/Marri/Sheoak Laterite Forest (12), 69% of *Melaleuca raphiophylla* Woodland Low Forest Complex (57) and 41% of *Melaleuca cuticularis*/*Melaleuca preissiana* Open Woodland Complex (52) are either modified or transformed.

Major factors influencing the condition status of remnants included clearing of understorey, grazing, the presence of weeds and Phytophthora dieback.

Units which are considered fire sensitive on the basis of criteria outlined identified by Barrett *et al.* (2009) and those that were observed to be affected by Phytophthora dieback or hydrological change during this survey are identified in Table 3.3.

**Table 3.2: Extent and reservation status of ARVS vegetation units**

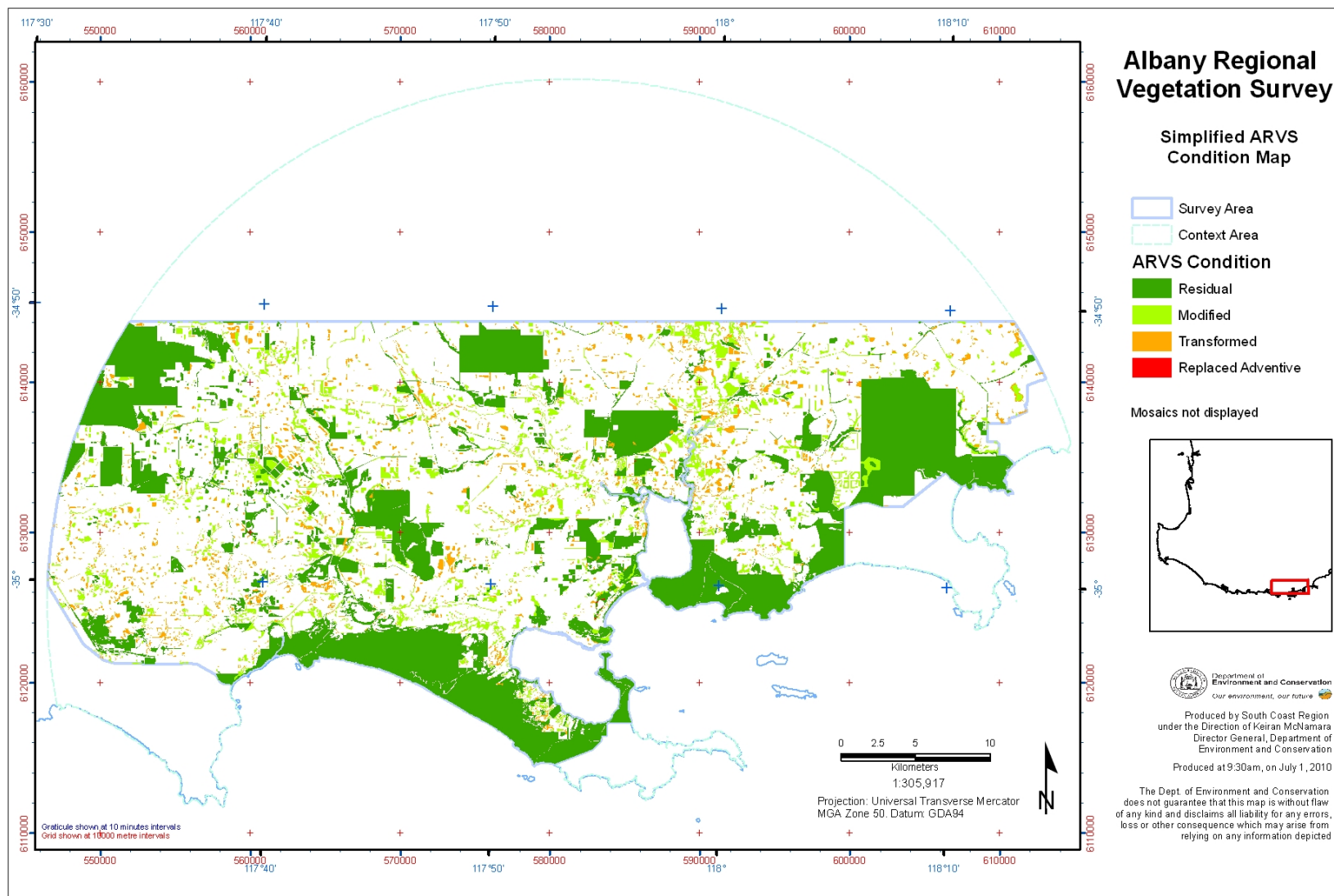
Veg code	Area and Vegetation unit	Current Extent Remnant vegetation		IUCN I-IV Reserves			Other Crown Reserves			Non Reserve		
		Hectares	%	Hectares	%	summary %	Hectares	%	summary %	Hectares	%	summary %
	Total remnant vegetation within ARVS Context area	71686	34.0									
	Total remnant vegetation within ARVS Survey area	44093	35.0	8574	19.0		17054	39.0		18464	42.0	
12	Jarrah/Marri/Sheoak Laterite Forest	13144	29.8	1273	9.8	<10	3991.6	30.4		7879	59.9	
13	Jarrah/Sheoak/ <i>Eucalyptus staeri</i> Sandy Woodland	5148	11.7	1334	25.9		1878	36.5		1936	37.6	
3	Coastal Heath	3737	8.5	830	22.2		2391	64.0		517	13.8	
31	<i>Hakea</i> spp Shrubland/Woodland Complex	2366	5.4	1073	45.4		948	40.1		345	14.6	
47	<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket	2083	4.7	263	12.6		214	10.3		1606	77.1	>70
5	Limestone Coastal Heath	1849	4.2	740	40.0		782	42.3		326	17.6	
46	<i>Evandra aristata</i> Sedgeland	1747	4.0	219	12.5		1046	59.9		482	27.6	
10	Marri/Jarrah Forest/Peppermint Woodland	1597	3.6	107	6.7	<10	409	25.6		1081	67.7	
14	<i>B. coccinea</i> Shrubland/ <i>E. staeri</i> /Sheoak Open Woodland	1330	3.0	674	50.7		468	35.2		188	14.1	
17	Marri/Jarrah Coastal Hills Open Forest	1238	2.8	625	50.5		365	29.5		247	20.0	
2	Peppermint Low Forest	1232	2.8	281	22.8		619	50.2		332	26.9	
30	Eastern Jarrah/Sheoak Woodland	1042	2.4	<0.1	<1	<10	993	95.4	>70	48	4.6	<10
9	Karri Forest	885	2.0	14	1.6	<10	143	16.2		728	82.3	>70
39	<i>Pericalymma spongiocaula</i> Low Heath	880	2.0	202	22.9		506	57.5		172	19.5	
59	<i>Taxandria juniperina</i> Closed Forest	779	1.8	77	9.9	<10	201	25.8		501	64.3	
49	<i>Melaleuca preissiana</i> Low Woodland	679	1.5	53	7.7	<10	150	22.1		476	70.2	>70
4	Coastal <i>B. ilicifolia</i> /Peppermint Low Woodland	506	1.1	202	39.9		209	41.3		96	18.9	
57	<i>M. raphiophylla</i> Woodland/Low Forest Complex	495	1.1	60	12.2		50	10.0		385	77.8	>70
1	Coastal Yate Forest	419	0.9	90	21.4		36	8.7		293	70.0	>70
32	<i>Taxandria spathulata</i> Heath	304	0.7	0	0.0	0	304	100.0	100	0	0.0	0
52	<i>Melaleuca cuticularis</i> / <i>M. preissiana</i> Open Woodland	263	0.6	97	36.9		83	31.6		83	31.5	
50	Miscellaneous Drainage Woodland/Shrubland	259	0.6	21	8.0	<10	77	29.9		161	62.1	
65	Coastal <i>Melaleuca cuticularis</i> Low Forest	208	0.5	10	4.8	<10	132	63.6		66	31.6	

**Table 3.2 cont. Extent and reservation status of ARVS vegetation units**

Veg code	Area and Vegetation unit	Current Extent Remnant vegetation		IUCN I-IV Reserves			Other Crown Reserves			Non Reserve		
		Hectares	%	Hectares	%	summary %	Hectares	%	summary %	Hectares	%	summary %
11	Jarrah Woodland	171	0.4	1	0.8	<10	87	51.1		82	48.1	
40	Takalarup Damp Heath	165	0.4	0	0.0	0	165	100.0	100	0	0.0	0
23	<i>G. bilobum/H elliptica</i> Granite Shrubland/Yate Woodland	163	0.4	2	1.3	<10	95	58.1		66	40.5	
15	<i>Banksia coccinea</i> Shrubland <i>M. striata/L. flavescens</i> Heath	162	0.4	21	13.1		127	78.4	>70	14	8.5	<10
18	Gardner/ <i>Hakea</i> spp Shrubland	138	0.3	0	0.0	0	138	99.6	>70	1	0.4	<10
38	<i>Taxandria parviceps</i> Transitional Shrubland	109	0.2	45	41.1		32	29.4		32	29.5	
24	<i>Taxandria marginata</i> Granite Shrubland	109	0.2	21	19.1		67	61.5		21	19.4	
33	<i>Eucalyptus patens</i> Low Woodland	102	0.2	2	1.8	<10	38	37.1		62	61.1	
67	Coastal Saltmarsh	79	0.2	0	0.0	0	35	44.4		44	55.6	
66	<i>Juncus kraussii</i> Sedgeland	70	0.2	2	2.4	<10	49	69.6		20	28.0	
64	<i>Baumea articulata</i> Sedgeland	56	0.1	21	37.8		6	11.5		28	50.7	
35	<i>Eucalyptus megacarpa</i> Riparian Forest	43	0.1	3	6.7	<10	6	15.0		34	78.3	>70
28	Miscellaneous Granite Shrubland	39	0.1	14	36.5		18	45.3		7	18.2	
36	<i>Callistachys</i> spp Thicket	36	0.1	4	10.9		8	23.7		23	65.5	
20	<i>Eucalyptus goniantha</i> Mallee	34	0.1	0	0.0	0	8	23.6		26	76.4	>70
21	Coastal Shrubland Complex	33	0.1	22	65.4		11	33.1		1	1.6	<10
22	<i>Hakea</i> spp Transitional Shrubland	33	0.1	31	92.0	>70	2	6.6	<10	<1	1.4	<10
16	<i>Melaleuca striata/Banksia</i> Coastal Heath	30	0.1	30	100.0	100	0	0.0	0	0	0.0	0
6	<i>Eucalyptus goniantha/E. angulosa</i> Limestone Mallee	29	0.1	29	100.0	100	0	0.0	0	0	0.0	0
45	Mixed <i>Banksia littoralis</i> Open Woodland	26	0.1	3	12.3		16	61.6		7	26.1	
19	<i>Hakea elliptica</i> Shrubland/ <i>E. doratoxylon</i> Mallee	25	0.1	0	0.0	0	24	97.9	>70	1	2.1	<10
58	<i>Melaleuca raphiophylla/B. littoralis</i> Woodland	25	0.1	25	100.0	100	0	0.0	0	0	0.0	0
48	<i>Melaleuca microphylla</i> Shrubland/ Low Forest	24	0.1	3	12.8		5	20.0		16	67.2	
8	Beach Herbland/Grassland	22	0.1	5	23.1		14	61.1		4	15.8	
55	<i>Melaleuca densa</i> Swamp Heath	22	0.1	1	5.7	<10	20	90.8	>70	1	3.5	<10
51	<i>Gahnia trifida</i> Sedgeland/Wet Shrubland	21	<0.1	21	100.0	100	0	0.0		0	0.0	0

**Table 3.2 cont Extent and reservation status of ARVS vegetation units**

Veg code	Area and Vegetation unit	Current Extent Remnant vegetation		IUCN I-IV Reserves			Other Crown Reserves			Non Reserve		
		Hectares	%	Hectares	%	summary %	Hectares	%	summary %	Hectares	%	summary %
53	<i>Kunzea recurva</i> / <i>Petrophile squamata</i> Wet Shrubland	19	<0.1	<1	1.8	<10	18	93.9	>70	1	4.3	<10
25	<i>Acacia sulcata</i> / <i>Leucopogon assimilis</i> Granite Shrubland	17	<0.1	8	50.0		7	41.1		1	8.9	<10
56	<i>Astartea scoparia</i> Swamp Thicket	15	<0.1	<1	3.0	<10	9	58.2		6	38.9	
63	Mixed Sedgeland	12	<0.1	0	0.0	0	10	82.3	>70	2	17.7	
34	<i>Banksia occidentalis</i> / <i>Kunzea clavata</i> Shrubland	12	<0.1	<1	0.4	<10	11	93.3	>70	1	6.2	<10
27	<i>Melaleuca viminea</i> Granite Thicket	11	<0.1	0	0.0	0	11	100.0	100	0	0.0	0
54	<i>Melaleuca spathulata</i> / <i>Melaleuca viminea</i> Swamp Heath	10	<0.1	0	0.0	0	4	40.8		6	59.2	
60	Coastal <i>Melaleuca incana</i> / <i>T. juniperina</i> Shrubland	8	<0.1	0	0.0	0	5	54.4		4	45.6	
41	<i>Xanthorrhoea</i> Lowland Sedgeland	8	<0.1	0	0.0	0	3	40.5		5	59.5	
29	Jarrah Woodland/ <i>Eucalyptus falcata</i> Mallee	6	<0.1	6	100.0	100	0	0.0	0	0	0.0	0
37	<i>Adenanthos cuneatus</i> / <i>B. quercifolia</i> Transitional Heathland	6	<0.1	6	100.0	100	0	0.0	0	0	0.0	0
62	<i>Eucalyptus occidentalis</i> Tall Woodland	4	<0.1	0	0.0	0	1	26.1		3	73.9	>70
44	<i>Banksia littoralis</i> Woodland/ <i>Melaleuca incana</i> Shrubland	4	<0.1	1	23.4		3	71.9	>70	<1	4.6	<10
26	<i>Darwinia diosmoides</i> Granite Shrubland	3	<0.1	1	40.9		1	37.2		1	21.9	
61	<i>Melaleuca croxfordiae</i> Low Woodland	3	<0.1	0	0.0	0	3	100.0	100	0	0.0	0
43	<i>B. littoralis</i> Open Woodland/ <i>Anarthria laevis</i> Sedgeland	1	<0.1	1	69.3		<1	30.7		0	0.0	0
42	<i>Lepidosperma longitudinale</i> Sedgeland	<1	<0.1	0	0.0	0	<1	100.0	100	0	0.0	
7	<i>Leucophyta brownii</i> Coastal Shrubland/Grassland	<1	<0.1	0	0.0	0	<1	100.0	100	0	0.0	0



**Figure 3.5 Simplified map of condition status of remnants within ARVS survey area.**  
Note: Status is based on predominant condition status and mosaics within reserves are not shown.



### 3.6 Rare and geographically restricted units and conservations status

A summary of the conservation status of ARVS units, excluding mapping units 28 and 50, using the criteria outlined in Section 2.8 is provided in Table 3.3.

One unit, *Banksia occidentalis/Kunzea clavata* Shrubland (34), is entirely restricted to the survey area while the Priority 1 Ecological Community (PEC), *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) is almost restricted to this area. A further 17 units are potentially restricted to the survey area or to within 10 km of this area. Further survey and assessment is required to clarify their distribution.

Based on species distribution maps, 35 units appear to be at their range limit within the survey area and the 10 km buffer. Twenty three (23) units occur at their eastern, four at their southern, one at its south eastern, five at their south-western and two at their western limits. Nine of these units (15, 16, 18, 19, 21, 27, 30, 32 and 40) were only recorded near the eastern edge of the survey area. The distribution of 13 units outside the survey area could not be fully determined.

All but eight units each occur on less than 1,500 ha, a figure which represents 3.4% of the total remnant vegetation remaining in the survey area or 1.2% of the total survey area (including cleared land). Forty-nine units each occur on <1% (<440 ha) of the remnant vegetation and 12 units each occur on < 10 ha.

Declared Rare species were recorded in eight units and priority species were recorded in 34 units. An analysis of previously recorded distributions of DRF or priority species in relation to ARVS units has not been conducted.

Thirty four (34) units were wetland, dampland, buffer or estuarine units and three were coastal dune units.

**Table 3.3 Conservation assessment of vegetation units**

Regional and local representation criteria adapted from Molloy *et al.* (2007). **Key:** o = potentially/largely restricted, +/- = range limit within 10 km of survey area boundary, E = eastern, S = southern, W = western, U = unknown, † = observed during survey, \* = identified according to criteria in Barrett *et al.* (2009).

Vegetation unit code	ARVS Vegetation Unit		Regional and local representation criteria											<10% in IUCN Reserves	Threats		
	Vegetation unit name	No. of relevés	Restricted ARVS	Range limit in ARVS	Rarity <1500ha	Diversity (mean species/relève)	TEC/PEC	DRF	Priority	Wetland/Dampland/Riparian/buffer	Wetland National significance	Estuarine	Coastal dune		Phytophthora dieback <sup>†</sup>	Hydrological change <sup>†</sup>	Fire sensitive*
1	Yate Coastal Forest	7		+/-E	•	11.7											
2	Peppermint Low Forest	10		+/-E	•	10							•				
3	Coastal Heath	16		+/-E		21.1		•					•				
4	Coastal <i>Banksia ilicifolia</i> /Peppermint Low Woodland	17		E	•	21.9		•	•						•		
5	Limestone Coastal Heath	18				14.6			•				•				5c
6	<i>Eucalyptus goniantha</i> / <i>E.angulosa</i> Limestone Mallee	4	o		•	18.8			•								
7	<i>Leucophyta brownii</i> Coastal Shrubland/Grassland	1			•	18							•				
8	Beach Herbland/Grassland	2			•	5.2			•				•				
9	Karri Forest	11		+/-E	•	10.6			•				•				
10	Marri/Jarrah Forest/Peppermint Woodland	24		+/-E		18.5			•	•			•				10b
11	Jarrah Woodland	8		+/-E	•	20.3							•		•		
12	Jarrah/Marri/Sheoak Laterite Forest	40	o	+/-E		25.7			•				•		•		12b
13	Jarrah/Sheoak/ <i>E.staeri</i> Sandy Woodland	41	o	+/-E		28		•	•						•		•
14	<i>Banksia coccinea</i> Shrubland/ <i>Eucalyptus staeri</i> /Sheoak Open Woodland	41	o		•	27.6	•	•	•						•		•
15	<i>Banksia coccinea</i> Shrubland <i>Melaleuca striata</i> / <i>Leucopogon flavescens</i> Heath	6	o	SW	•	27.5		•							•		•
16	<i>Melaleuca striata</i> / <i>Banksia</i> spp Coastal Heath	4	o	U	•	24.8									•		•
17	Marri/Jarrah Coastal Hills Open Forest	49	o	+/-E	•	25.9			•								17 ab
18	Gardner/ <i>Hakea</i> spp Shrubland	8	o	W	•	24.3			•				•		•		•
19	<i>Hakea elliptica</i> Shrubland/ <i>Eucalyptus doratoxylon</i> Mallee	3	o	W	•	10			•				•				•
20	<i>Eucalyptus goniantha</i> Mallee	4		SW	•	9.5			•				•				
21	Coastal Shrubland Complex	15			•	21.4									•		•
22	<i>Hakea</i> spp Transitional Shrubland	4		U	•	27.8											•
23	<i>Gastrolobium bilobum</i> / <i>Hakea elliptica</i> Granite Shrubland/Yate Woodland	11	o	+/-E	•	10.8							•				•
24	<i>Taxandria marginata</i> Granite Shrubland	9			•	12.3		•	•						•		•
25	<i>Acacia sulcata</i> / <i>Leucopogon assimilis</i> Granite Shrubland.	9			•	15.8			•								
26	<i>Darwinia diosmoides</i> Granite Shrubland	1		U	•	14											
27	<i>Melaleuca viminea</i> Granite Thicket	3		U	•	5			•				•				•
29	Jarrah Woodland/ <i>Eucalyptus falcata</i> Mallee	1		S	•	28			•								
30	Eastern Jarrah/Sheoak Woodland	36	o	SW	•	27.4			•				•				•
31	<i>Hakea</i> spp Shrubland/Woodland Complex	72		SW		31.2		•	•						•		•
32	<i>Taxandria spathulata</i> Heath	6	o	SW	•	20			•				•				•
33	<i>Eucalyptus patens</i> Low Woodland	3		E	•	13				•			•				
34	<i>Banksia occidentalis</i> / <i>Kunzea clavata</i> Shrubland	3	•		•	13.7				•			•				•

**Table 3.3 cont. Conservation assessment of vegetation units**

Regional and local representation criteria adapted from Molloy *et al.* (2007). **Key:** o = potentially/largely restricted, +/- = range limit within 10 km of survey area boundary, E = eastern, S = southern, W = western, U = unknown, † = observed during survey, \* = identified according to criteria in Barrett *et al.* (2009).

ARVS Vegetation Unit			Regional and local representation criteria											<10% in IUCN Reserves	Threats		
Vegetation unit code	Vegetation unit name	No. of relevés	Restricted ARVS	Range limit in ARVS	Rarity <1500ha	Diversity (mean species / relevé)	TEC/PEC	DRF	Priority	Wetland/Dampland /Riparian/buffer	Wetland National significance	Estuarine	Coastal dune		Phytophthora dieback <sup>†</sup>	Hydrological change <sup>†</sup>	Fire sensitive*
35	<i>Eucalyptus megacarpa</i> Riparian Forest	1		+/-E	•	14			•	•	•			•			
36	<i>Callistachys</i> spp Thicket	1		U	•	6			•	•							
37	<i>Adenanthos cuneatus/Banksia quercifolia</i> Transitional Heathland	2	o		•	18		•		•					•		•
38	<i>Taxandria parviceps</i> Transitional Shrubland	10		+/-E	•	23.7				•					•		•
39	<i>Pericalymma spongiocaula</i> Low Heath	32	o	+/-E	•	25.3			•	•					•		•
40	Takalarup Damp Heath	8		S	•	27.3			•	•				•			•
41	<i>Xanthorrhoea</i> Lowland Sedgeland	1		U	•	19			•	•				•			
42	<i>Lepidosperma longitudinale</i> Sedgeland	1		SE	•	5				•				•			
43	<i>Banksia littoralis</i> Open Woodland/ <i>Anarthria laevis</i> Sedgeland	1		S	•	9				•							
44	<i>Banksia littoralis</i> Woodland/ <i>Melaleuca incana</i> Shrubland	3	o	E	•	13				•							
45	Mixed <i>Banksia littoralis</i> Open Woodland	5		U	•	19.6			•	•					•		
46	<i>Evandra aristata</i> Sedgeland	48		+/-E		18.6			•	•	•				•		•
47	<i>Homalospermum firmum/Callistemon glaucus</i> Peat Thicket	19				12.5				•	•				48 b		•
48	<i>Melaleuca microphylla</i> Shrubland/ Low Forest	9		E	•	8.2				•							•
49	<i>Melaleuca preissiana</i> Low Woodland	7		+/-E	•	15.7			•	•				•			•
51	<i>Gahnia trifida</i> Sedgeland/Wet Shrubland	3	o	U	•	13			•	•					•		•
52	<i>Melaleuca cuticularis/M. preissiana</i> Open Woodland	10		U	•	17.9			•	•							•
53	<i>Kunzea recurva/Petrophile squamata</i> Wet Shrubland	6		U	•	21.8			•	•				•			•
54	<i>Melaleuca spathulata/Melaleuca viminea</i> Swamp Heath	2		E	•	4.5				•				•			•
55	<i>Melaleuca densa</i> Swamp Heath	8		U	•	8.9				•				•			•
56	<i>Astartea scoparia</i> Swamp Thicket	9	o	E	•	6.9			•	•				•			•
57	<i>Melaleuca raphiophylla</i> Woodland/Low Forest Complex	10		U	•	6.5				•							•
58	<i>Melaleuca raphiophylla/Banksia littoralis</i> Woodland	2		U	•	10				•						•	•
59	<i>Taxandria juniperina</i> Closed Forest	5			•	6.8				•	•			•			•
60	Coastal <i>Melaleuca incana/Taxandria juniperina</i> Shrubland	3	o	E	•	9.7			•	•		•		•			•
61	<i>Melaleuca croxfordiae</i> Low Woodland	1		+/-E	•	13				•				•			•
62	<i>Eucalyptus occidentalis</i> Tall Woodland	1		S	•	4			•	•				•			
63	Mixed Sedgeland	0		U	•	n/a				•				•			•
64	<i>Baumea articulata</i> Sedgeland	1			•	2				•	•					•	•
65	Coastal <i>Melaleuca cuticularis</i> Low Forest	5			•	6				•	•	•		•			•
66	<i>Juncus kraussii</i> Sedgeland	4			•	3				•	•	•		•			
67	Coastal Saltmarsh	4			•	5.3				•	•	•		•			

## 4 DISCUSSION

### 4.1 Vegetation units and patterning

This project has identified, described and mapped 67 native vegetation units within a survey area of 125,415 ha surrounding Albany. This remnant vegetation covers 44,093 ha or 35% of the survey area, with 19% occurring in conservation reserves (IUCN I-IV reserves) and 39% in other Crown reserves.

The vegetation within the ARVS area is very diverse and reflects the variety of the landforms present. Over half of the vegetation units occur at the limit of their range within or near the survey area, reflecting the location of the ARVS area at the junction of three bio-geographic regions, the Warren, Jarrah Forest and Esperance Plains Regions.

Particularly high vegetation diversity was found in wetland habitats, on granite outcrops and along the coastal fringe overlying granite hills, relative to the extent of these areas. The occurrence of high vegetation diversity within wetland areas has previously been reported for the Walpole, Lake Muir and Swan Coastal Plain areas and attributed to rapidly changing edaphic and hydrological factors (Gibson *et al.* 1994; Wardell-Johnson and Williams 1996; Gibson and Keighery 2000). Similarly, high vegetation diversity associated with granite outcrops has been reported in the Walpole region and along the Darling Scarp and attributed to edaphic, hydrological and past climatic histories (Wardell-Johnson and William 1996; Smith and Sage 2006). The high vegetation diversity observed in this study along the coastal fringe overlying granitic hills and slopes is attributed to the underlying geology and associated soils which change over very small areas with granite, limestone, laterite and deep sands occurring in close proximity.

A simplified vegetation map of the survey area (Figure 3.4) shows that vegetation units are not distributed evenly throughout the survey area but occur in several distinct areas related to landform and geographical location. Strong vegetation patterning was observed in several areas with vegetation units either following a gradational sequence or occurring as mosaics across the landscape. These patterns are outlined in Appendix 17. This patterning of gradational sequences and mosaics has been reported elsewhere in the south west of Western Australia by Gibson and Keighery (2000), Griffin (1984) and Wardell-Johnson and Williams (1996).

Much of this patterning was detected by Beard (1979) through his vegetation systems mapping although his broad scale association mapping did not show the complexity inferred within his vegetation system descriptions. The distinctive vegetation patterning observed in this study supports three Beard (1979) vegetation systems: Torndirrup, Denmark and Manypeaks Systems. The transitional nature noted by Beard (1979) within the East Kalgan vegetation system is also evident in the north and eastern areas of this system within the survey area. Three units and two sub-units (Units 30, 32, and 40 and sub-units 31a and 17c) were restricted to this area, many of which contained species occurring at their south-western limit. However, within the survey area the vegetation pattern observed within the Albany System is similar to that in the Hay, Narrikup and western and central portions of the East Kalgan Systems. The distinctive patterning associated with the granite coastal hills was not delineated in Beard vegetation systems.

### 4.2 Conservation and reservation status of vegetation units

Preliminary assessments of the conservation significance of the vegetation units were made using criteria shown in Table (3.3). This data along with reservation status (Table 3.2) has been used to identify some of the locally and regionally significant vegetation units discussed below. However, caution needs to be used in interpreting the reservation status data provided as significant areas of conservation reserve occur within the ARVS context area but outside the survey area e.g. Two Peoples Bay NR. No prioritisation of significant units has been made as further survey of the extent of

vegetation units outside the ARVS area and further analysis of their condition status and the impact of threats are required for such prioritisation.

Units of both local and regional significance include those restricted to, or occurring at their range limits, within the ARVS survey area and its 10 km buffer and the high number of these units highlights the botanical importance of the area. Over one quarter of units appear to be restricted to this area based on species distribution maps, habitat and author observations. These include *Banksia occidentalis*/*Kunzea clavata* Shrubland (34) which is restricted to a small area around Torbay Inlet and *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) which is recognised as a Priority 1 Ecological Community due to the threat of *Phytophthora* dieback. A further 17 units including the two most common units (12 and 13) appear to be restricted or almost restricted to the ARVS area and buffer (Table 3.3) but further survey is required to verify their distributions. Thirty-five (35) vegetation units occur at their range limit within this area reflecting the location of the ARVS area at the junction of three biogeographic regions.

While results indicate that nearly half of the units have < 10% of their ARVS extent occurring in conservation reserves (IUCN I-IV), care needs to be used in interpreting the reservation status data provided as significant areas of conservation reserve occur within the ARVS context area but outside the survey area e.g. within West Cape Howe NP, Torndirrup NP, Waychinnicup NP and Two Peoples Bay NR. Taking known vegetation occurrences in these reserves into account, 18 units (units 20, 27, 30, 32, 33, 40, 41, 42, 53, 54, 55, 56, 60, 62, 63, 65, 66 and 67) have less than 10% of their area occurring in conservation reserves and thus would be considered poorly reserved on a local scale. The importance of other Crown reserves is highlighted by the restriction of six units (7, 27, 32, 40, 42 and 61) to non conservation reserves, with a further nine units (15, 18, 19, 30, 34, 44, 53, 55 and 63) having more than 70% of their extent occurring in non conservation reserves. Six of these units occurred in Angove Water Reserve and five in Bettys Beach Reserve.

Only eight units are common within the survey area using the criterion of >1,500 ha (an area which represents 1.2% of the total ARVS area or 3.4% of remnant vegetation). However, at least one other unit, Peppermint Low Forest (2), is also common on a local scale given its widespread distribution within West Cape Howe NP and areas of Torndirrup NP outside the survey area but within the ARVS context area. Forty-nine (49) units each occur on <1% (<440 ha) of the remnant vegetation (Table 3.3). Whilst many of these 49 units are naturally limited in distribution due to habitat and naturally occur in small patches, their importance in terms of biodiversity can be gauged by the restriction of 20% of all species recorded to this collective group and the occurrence of 78% of all species within this group (3.5.2).

#### 4.2.1 Pre-clearing extent of vegetation units

Two important criteria used in assessing the conservation status of native vegetation, particularly in relation to land clearing, are the current extent in relation to pre-clearing extent with important thresholds being:

- <30% of the pre-clearing extent of each vegetation type is regarded as the threshold level below which species loss appears to accelerate exponentially at an ecosystem level,
- <10% of the pre-clearing extent of each vegetation type is regarded as the level representing an 'endangered' vegetation type (Environment Australia 2001a).

A limitation of this survey is the absence of pre-clearing extent data for ARVS units. However, based on the predicted extent of units using areas mapped in this survey, habitat, species distribution maps and clearing patterns within the survey area and the 10 km buffer, it is likely that at least one ARVS unit: *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) has less than 30% of its pre-clearing extent remaining. A further three units (13, 39 and 56) which appear to be restricted to the survey area and buffer are also likely to have <30% of their extent remaining. Seven other units which appear restricted to the ARVS survey area and buffer (Units 6, 15, 16, 17, 18, 19 and 23) are



likely to have >30% of their pre-clearing extent present. The pre-clearing extent of other units thought to be restricted to the ARVS survey area including 12, 30, 32, 35, 37, 44, 45, 51 and 60 is unclear.

On a local scale, i.e. within the ARVS survey area and buffer, at least one quarter of ARVS units appear to occur at <30% of their pre-clearing extent based on the unit area mapped in this survey, habitat and clearing patterns. These units fall into two broad areas:

- (i) units occurring on the sands and drainage lines associated with inland undulating plains (13, 14, 38, 39, 46, 47, 49),
- (ii) units occurring on the lowland flats and adjacent rises (10, 33, 41, 45, 52, 53, 54, 55, 56, 57).

The status of other units in relation to pre-clearing extent is not clear and no attempt has been made to identify units falling under the 10% threshold.

#### 4.2.2 Occurrence of threatened and priority flora in vegetation units

Declared rare flora (DRF) were found in eight vegetation units with the two most significant vegetation units being *Banksia coccinea* Shrubland/*Melaleuca striata*/*Leucopogon flavescens* Heath (15) which contains nearly all known populations of *Andersonia pinaster* (DRF), all of which occur within the ARVS survey area and *Taxandria marginata* Granite Shrubland (24) which contains all known populations of *Banksia verticillata*, much of which are restricted to the ARVS context area. Two other DRF species that are restricted to the ARVS survey area include *Calectasia cyanea* which was recorded in Coastal Heath (3) and *Banksia ilicifolia*/Peppermint Low Woodland (4) and *Banksia goodii* which was recorded in Jarrah/Sheoak *Eucalyptus staeri* Sandy Woodland (13) and *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14). Other units containing DRF were *Hakea* spp Shrubland Woodland Complex (31) and *Adenanthos cuneatus*/*Banksia quercifolia* Transitional Heathland (34). Over half of the vegetation units contained priority species. A reassessment of the priority status of some species is recommended following the discovery of many new populations during this survey.

#### 4.3 Threats to vegetation units

Threats impacting on the vegetation units within the survey area include land clearing and grazing. Phytophthora dieback, aerial canker, hydrological change, weed invasion and fire. These threats need to be considered when assessing the conservation status of these vegetation units. Although threats within the survey area were not comprehensively surveyed or assessed, a summary of the major threats and units most affected by them is provided below based on field observations.

Land clearing has been identified as a key threatening process in Australia (Environment Protection and Biodiversity Conservation (EPBC) Act 1999, Environment Australia 2001b) and whilst current land clearing laws regulate clearing and require the assessment of vegetation prior to clearing, pressure for further clearing due to urban expansion will remain (CoA 2007) and incremental losses will occur. A comparison of 1990's aerial photography within the ARVS area with 2007 photography indicates that some remnants on private property have been cleared and that the boundaries of many remnants have shrunk with tree deaths, removal of vegetation, and the establishment of firebreaks and tracks. Similarly, the establishment of tracks and firebreaks within reserves, widening of roads and clearing for housing developments has also resulted in loss of remnant vegetation during this period. Grazing by stock has resulted in the removal of the understorey and its replacement by pasture or weed species in many remnants, particularly in three units: Jarrah/Marri/Sheoak Laterite Woodland (12), *Melaleuca cuticularis*/M. *preissiana* Open Woodland (52) and *Melaleuca raphiophylla* Woodland/Low Forest Complex (52) all of which have at least 40% of their ARVS extent in modified or transformed state.

The widespread occurrence of Phytophthora dieback caused by the introduced root pathogen *Phytophthora cinnamomi* Rands (Oomycetes) is of particular concern as infestations in susceptible vegetation results in significant reductions in floristic and structural diversity. Phytophthora dieback

has been well documented as a major threat to vegetation communities on the south coast (Grant and Barrett 2003, Shearer *et al.* 2007, Cahill *et al.* 2008) and has been identified as a key threatening process in Australia (EPBC Act 1999, Environment Australia 2001b). Within the ARVS area the impacts of this disease are most notable in units dominated by *Banksia* species occurring on either deep sands or in areas of impeded drainage or along the valley floor and edges. Dieback susceptible units include units 4, 12, 13, 14, 15, 16, 18, 21, 24 (sub-unit 24b), 31, 37, 38, 45, 46, 47 (sub-unit 47b) and 51. The impacts of this disease on these units are noted under the relevant vegetation description (Appendix 9). It was, however, beyond the scope of this project to map the occurrence and extent of Phytophthora dieback. Due to the long history of dieback in the Albany area, interpretation of disease impact in some units e.g. valley floor units, was hampered by the lack of indicator species. *Banksia coccinea* Shrublands/*E.staeri*/*Casuarina* Low Woodland (14) is currently nominated as a Priority 1 Ecological Community (TEC) due to the threat from Phytophthora dieback. Occurrences of *Banksia brownii* Thicket (sub unit 31d) and *Banksia coccinea* Shrubland/ *Melaleuca striata*/*Leucopogon flavescens* Heath (15) are currently being protected from this disease by regular aerial spraying of the fungicide phosphite by DEC. Further assessment of disease impact on susceptible units is required to determine their conservation status.

Aerial canker causing fungi were observed to cause limb death as well as plant mortality in *Banksia coccinea* in *Melaleuca striata*/*Banksia* spp Coastal heath (16), *B. verticillata* in *Taxandria marginata* Granite Shrubland (sub-unit 24b) and *Hakea trifurcata* in Coastal Shrubland Complex (21). The impact of this disease can be severe and rapid with the long term destruction of *B. coccinea* stands due to canker fungi documented between 1989 and 1992 at Cheyne Beach, just east of the survey area (Shearer and Fairman 1991; Shearer *et al.* 1995).

Two units, *Banksia littoralis* Woodland/*Melaleuca incana* Shrubland (44) and *Melaleuca raphiophylla*/*Banksia littoralis* Woodland (48), appear to be under threat from hydrological change with wetland species dying and upland species invading these units. Areas of unit 44 have disappeared in the Little Grove area and are now only evident as stumps of *Banksia littoralis* beneath thickets of *Agonis flexuosa* and by the very sporadic occurrence of species typical of winter wet areas including *Sphenotoma gracilis*, *Villarsia parnassifolia* and *Melaleuca incana*. *Banksia littoralis* is a deep rooted species requiring access to fresh water during summer and the changes observed suggest that the water table has lowered over the past decades. It is unclear if the changes observed in the Little Grove area are related to a natural decline in aquifer recharge associated with declining rainfall since the mid 1970s (Hennessey *et al.* 1999, CSIRO and BoM 2007), due to water extraction as the area lies over the Werrilup Borefield which supplies town water, or due to other causes such as changes in salinity. A similar decline in *B. littoralis* documented on the Gnangara Groundwater Mounds on the Swan Coastal Plain has been attributed to the cumulative effects of abstraction and below average rainfall (Groom *et al.* 2001).

A detailed assessment of the impact of weeds on the vegetation units recorded in this survey has not been undertaken however major environmental weeds within the ARVS area have been identified and assessed by CoA (2005) and Peltzer (2007). However, the widespread occurrence of *\*Acacia longifolia* (Sydney Golden Wattle) in otherwise undisturbed bushland is of concern as this species has proliferated in the survey area in the past two decades and may form dense stands out competing native species. This species is recognised as a major environmental weed in the Albany region as well as Victoria, South Africa and Portugal (Pieterse and Cairns 1988; Muyt 2001; Marchante *et al.* 2004; Peltzer 2007). Infestations observed during this survey ranged from single seedlings to dense monotypic stands and were recorded in many vegetation types with the exception of seasonally or permanently inundated wetlands. Given the rapid recent spread of this species and its ability to invade undisturbed bushland and displace native species, urgent action is required to limit its dispersal and establishment. This may require some legislative enforcement such as its formal recognition as a Declared Weed.

Fire sensitive vegetation units within the survey area have been identified (Table 3.3) as those dominated by serotinous obligate seeder species (i.e. plants that are killed by fire and only germinate from seed released from woody fruiting capsules), refugial habitat units e.g. granite outcrop units; wetland/riparian units and those restricted to peaty soils (Barrett *et al.* 2009). For serotinous obligate

seeder species sufficient time between fires is required to allow plants to mature and produce seed and suitable conditions are needed for seed germination and establishment. Units with serotinous seeders as dominant species include *Banksia coccinea* dominated units (units 14-16), *B. occidentalis* units (34, 46d and 51) and *Hakea* spp Shrubland Woodland complex (31). Within the survey area local extinctions of *Banksia occidentalis* (unit 46d) have been observed following fire (E. Hickman pers. comm.) and the absence of *Banksia coccinea* in otherwise healthy vegetation was attributed to past fire regimes. Wetland and riparian vegetation do not generally burn readily due to moisture content however they are vulnerable to very intense fires that can destroy the structure of peat soils and may kill resprouters (e.g. species that re-sprout from epicormic buds, lignotubers, underground tubers etc). Deaths of the lignotuberous species, *Homalospermum firmum* and *Callistemon glaucus*, following an intense fire in 2000 in Angove Water reserve, were observed during this survey while extensive fire damage to peat soils were observed in *Homalospermum firmum*/ *Callistemon glaucus* Swamp Thicket (47), *Taxandria juniperina* Closed Forest (49) and *Astartea scoparia* Thicket (56).

Predicted climate change is a future threat to the vegetation within the survey area and loss of terrestrial habitat as a result of climate change due to the anthropogenic emission of green house gases has been identified as a key threatening process in the Australian environment (EPBCn Act 1999, Environment Australia 2001b). In the south west of Western Australia there has been a significant decrease in autumn and winter rainfall since the mid 20<sup>th</sup> century and mean annual temperatures have increased during the 20<sup>th</sup> century (Hennessy *et al.* 1999; IOCI 2005). Global climate models predict that these trends will continue (CSIRO and BoM 2007). These changes are likely to result in reductions in water tables, increased evaporation and a prolonged dry season, with impacts on vegetation predicted to include changes in relative abundance, range contractions, changes in community composition, changes in flowering times and increased vulnerability to stress induced factors such as *Phytophthora* dieback (Hughes 2003). Given the high number of units occurring at their range limits within ARVS context area and the high number of wetland and dampland units, the potential for climate change to impact on the vegetation is high. South coast communities identified as most at risk to climate change include climate refugial communities such as Karri Forest (9) on the eastern boundary of the survey area; those with species dependent upon freshwater, wetlands and damplands and units containing geographically localised, fire sensitive or dieback susceptible species (Gilfillan *et al.* 2009).

#### 4.4 Methodology

The use of quadrats was found to be too time consuming to assess the vegetation within the survey area in the 12 months originally available. Relevé assessment permitted more rapid assessment while simultaneously combining mapping of the vegetation. This concurrent relevé and ground truth mapping was adapted from Craig *et al.* (2007). Assessment by relevés enabled more time for extensive field work which was vital in identifying many units. Most units could not be predicted to occur as they were not readily identifiable from aerial photography nor restricted to unique soil/landform and many had not been described prior to this survey. Extensive field work was also important in recognising the vegetation patterning within the survey area, particularly in units that occurred in very small patches and in determining the floristic variation within vegetation units.

A limitation of this relevé sampling method is the absence of full floristic descriptions which limits analytical comparisons with quadrat data collected elsewhere in Western Australia. A comparison of the data collected in this survey with some quadrat data from the survey area suggests that between 60% and 100 % of species were recorded in the relevés with the higher percentage occurring in species poor units, notably permanently and seasonally inundated wetlands. Many of the species recorded in these quadrats and absent in relevés were annuals. As these annuals were subsequently removed from the data set for analysis, their absence was not seen as a major drawback in defining vegetation units.

Vegetation classification aims to find patterns of species distribution that reflect those on the ground and the level to which units can be separated is subjective and dependent upon scale. The units identified in this study were guided by quantitative analysis and field observations and reflect the patterns observed in the field. However, it is recognised that these units are not a definitive list of

vegetation associations within the survey area and further survey may warrant the addition of new units and the amalgamation of others. This is particularly relevant to some units occurring on the margins of the survey area and to some sub-units as described under the relevant vegetation unit description (Appendix 9).

Due to rarity, disturbance and time constraints a high number (43%) of units were sampled less than four times which could pose problems in defining and comparing units. However nearly all these units were either highly distinctive (e.g. *Baumea articulata* Sedgeland 64), occurred in specific habitats (e.g. Beach Herbland/Grassland 8) or represented known vegetation types occurring at their range limits (e.g. *Eucalyptus patens* Low Woodland 33). The repeated occurrence of most of these units represents a distinctive element in the patterning of the vegetation within the survey area and the importance of these small units is highlighted by the disproportionate number of species restricted to the smaller sized units given their extent (section 3.5.2). A few of these poorly sampled units were not highly distinctive, but did not clearly fit other units, e.g. *Xanthorrhoea* Sedgeland (41) and *Gahnia trifida* Sedgeland/Wet Shrubland (51), as noted in their vegetation descriptions, and further survey is required to determine their affinities. Conversely, a number of units were over-sampled relative to their extent, either because they were initially thought to represent several units e.g. *Evandra aristata* Sedgeland (46), or because the complex patterns within the sub-units could not be determined e.g. *Hakea* spp Shrubland/Woodland Complex (31).

Mapping the vegetation was challenging, particularly in areas not visited, and the maps provided need to be viewed with the limitations of the methodology in mind. These limitations include: low aerial photographic interpretability, the lack of discrete boundaries between many units; the occurrence of many vegetation types over relatively small areas; and absence of other data sets, e.g. soil/land maps, at a scale that reflects the distribution of vegetation units.

Aerial photographic patterns were of limited value in identifying the ARVS vegetation units and often reflected only the structural status of vegetation and frequently correlated with burn boundaries. Highly distinctive aerial photography patterns were rare and tended to be restricted to units with uniform structure and monotypic canopies, e.g. Karri Forest (9), *Astartea scoparia* Swamp Thicket (56), *Baumea articulata* Sedgeland (64), and *Juncus kraussii* Sedgeland (66). Difficulties were encountered in interpreting the Jarrah/Casuarina/Marri dominated units which share canopy species (units 12, 13, 30 and 31) and in interpreting patterns in drainage lines where obvious boundaries on aerial photos did not always correspond to vegetation boundaries, and similar patterns in adjacent drainage lines frequently corresponded to different vegetation units.

The difficulties and limitations experienced in mapping the vegetation units in this survey highlight the need for extensive field work when mapping vegetation at an association level in areas of high vegetation diversity.

## 4.5 Recommendations for future work

In addition to proposals outlined in Section 1 under Phase 2 and 3 of the original project, recommendations for future work include:

- Determine the entire extent of units thought to be restricted or almost restricted to the survey or context area and assess against threatened ecological community criteria to verify their local and regional significance.
- Assess the condition status of the units using data collected during this survey to assist in identifying vegetation units of local and regional significance.
- Assess the impact of *Phytophthora* dieback on susceptible ARVS units to assist in identifying vegetation units of local and regional significance.
- Prioritise the vegetation units in terms of conservation status to assist in land use planning.
- Assess the impact of weeds, in particular *Acacia longifolia*, on ARVS units and investigate means of controlling or eradicating this species to help protect the vegetation of the area.
- Re-assess the status of conservation species within the survey area in light of findings during this survey.
- Investigate methods of using the data collected during this survey, along with other data sets (including 1944 aerial photography) to model the pre-clearing extent of units within the survey area.
- Map the unsurveyed areas within the ARVS context area.
- Update the vegetation map as new information becomes available.



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**APPENDIX 1: Life form definitions that differ from NVIS standards.**

Life form (layer code)	Plant family, or genus specific life form
Trees (T)	Includes multi- stemmed forms <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Eucalyptus staeri</i> and <i>Agonis flexuosa</i>
Mallee (M)	Lignotuberous <i>Eucalyptus</i> species
Shrubs (s)	<i>Xanthorrhoea</i> , <i>Kingia</i> , Cycads, “Chenopods Heath Shrub”
Sedges (V)	Cyperaceae, Restionaceae, Juncagaceae
Herbs (H)	Annuals, geophytes, climbers, aquatic herbs, ferns, forbs Xyridaceae, Liliaceae, Samphires, some chenopods
Grasses	Poaceae



## APPENDIX 2: Relevé Recording Sheet

<b>ALBANY REGIONAL VEGETATION SURVEY – Relevé</b>				<b>SITE_ID:</b>	
<b>Date:</b>		<b>Wp:</b>		<b>mE</b>	
<b>Recorder:</b>		<b>VegCode:</b>		<b>mN</b>	
<b>Location and Site Notes:</b>					
<b>Condition:</b> <i>Pristine Excellent Very Good Good Degraded --- RESIDUAL MODIFIED TRANSFORMED</i>					
<b>Aspect:</b> <i>N NE E SE S SW W NW</i>			<b>Slope:</b> <i>Flat Gentle Mod Steep</i>		
<b>Geology:</b> <i>Gnei Gran Lat Lime Silt</i>			<b>Rock:</b> <i>0 &lt;2 2-10 10-20 20-50 &gt;50</i>		
<b>Soil Colour:</b> <i>Brown Grey Dark Brown Dark Grey Light Grey Light Brown Orange/Brown White Yellow Yellow/Grey</i>			<b>Soil Type:</b> <i>C CL CLS CS L LS S SCL SL SP ZCL ZL ZS P GL GS</i>		
<b>Hydrology:</b> <i>Good drain Poor drain Perm wet Seasonal wet</i>		<b>Landform:</b> <i>Breakaway Cliff Consolidated Dune Drainage Depression Dune Gully Hill Crest Riparian Bank Rock Outcrop Slope Lower Slope Middle Slope Upper Swale Swamp Tidal Flat Tor Valley Flat Berm Flat Plain Ridge</i>			

Growth form	Ht	Cvr	NVIS/dominant	Others
T <sub>1</sub>	>30			
T <sub>2</sub>	10-30			
T <sub>3</sub>	<10			
M <sub>1</sub>	>8			
M <sub>2</sub>	<8			
S <sub>1</sub>	>2			
S <sub>2</sub>	1-2			
S <sub>3</sub>	0.5-1			
S <sub>4</sub>	<0.5			
V	NA			
H	NA			
G	NA			

Cover Codes: **D** >70%   **M** 30-70%   **S** 10-30%   **V** 2-10%   **E** <5% Emergent

<b>Other Species:</b>
-----------------------

Entered by..... Access [ ] / Max [ ]      Checked by ..... [ ]      Updated database [ ]

### APPENDIX 3: Taxa rationalisations for data analysis

Original taxon	Data Taxon
<i>Acacia pulchella</i>	<i>Acacia pulchella</i>
<i>Acacia pulchella</i> var. <i>goadbyi</i>	
<i>Acacia sulcata</i>	<i>Acacia sulcata</i>
<i>Acacia sulcata</i> var. <i>sulcata</i>	
<i>Anarthria prolifera</i>	<i>Anarthria prolifera</i>
<i>Anarthria prolifera</i> forma narrow	
<i>Boronia juncea</i>	<i>Boronia juncea</i>
<i>Boronia juncea</i> subsp. <i>micrantha</i>	
<i>Calytrix flavescens</i>	<i>Calytrix flavescens</i>
<i>Calytrix asperula</i>	
<i>Crowea angustifolia</i>	<i>Crowea angustifolia</i>
<i>Crowea angustifolia</i> var. <i>angustifolia</i>	
<i>Dampiera pedunculata</i>	<i>Dampiera pedunculata</i>
<i>Dampiera linearis</i>	
<i>Hibbertia pulchra</i>	<i>Hibbertia pulchra</i>
<i>Hibbertia pulchra</i> var. <i>crassinervis</i>	
<i>Lepidosperma densiflora</i>	<i>Lepidosperma densiflora</i>
<i>Lepidosperma densiflora</i> forma proliferous	
<i>Lepidosperma</i> aff <i>squamatum</i> forma broad leaf	
<i>Lepidosperma</i> aff <i>squamatum</i> forma narrow leaf	<i>Lepidosperma squamatum</i>
<i>Lepidosperma</i> aff <i>squamatum</i> forma proliferous	
<i>Lepidosperma</i> sp Down Rd	
<i>Lepidosperma</i> aff <i>pubisquameum</i>	<i>Lepidosperma</i> sp Down Rd
<i>Lepidosperma</i> aff Dunn Swamp	
<i>Lepidosperma gracile</i>	<i>Lepidosperma gracile</i>
<i>Lepidosperma gracile</i> forma large	
<i>Lepidosperma gracile</i> forma terete	
<i>Leucopogon obovatus</i>	<i>Leucopogon obovatus</i>
<i>Leucopogon obovatus</i> forma coastal	
<i>Lomandra micrantha</i>	<i>Lomandra micrantha</i>
<i>Lomandra micrantha</i> subsp. <i>micrantha</i>	
<i>Patersonia occidentalis</i>	<i>Patersonia occidentalis</i>
<i>Patersonia occidentalis</i> var. <i>angustifolia</i>	
<i>Patersonia occidentalis</i> var. <i>occidentalis</i>	
<i>Pimelea lehmanniana</i>	<i>Pimelea lehmanniana</i>
<i>Pimelea lehmanniana</i> subsp. <i>lehmanniana</i>	
<i>Rhadinothamnus rudis</i>	<i>Rhadinothamnus rudis</i>
<i>Rhadinothamnus rudis</i> subsp. <i>rudis</i>	
<i>Schoenus acuminatus</i>	<i>Schoenus acuminatus</i>
<i>Schoenus acuminatus</i> black base	
<i>Schoenus obtusifolia</i>	<i>Schoenus obtusifolia</i>
<i>Schoenus</i> aff <i>obtusifolia</i>	
<i>Schoenus efoliatus</i>	<i>Schoenus efoliatus</i>
<i>Schoenus rodwayanus</i>	
<i>Tetraria capillaris</i>	<i>Tetraria capillaris</i>
<i>Tetraria capillaris</i> forma large	
<i>Tetraria octandra</i>	<i>Tetraria octandra</i>
<i>Tetraria octandra</i> sp fine	

#### APPENDIX 4: Vegetation Condition Scale (Thackway and Lesslie 2006)

		Native Vegetation cover			Non-native vegetation cover		
Vegetation Cover Class Criteria	<b>Type 0 Naturally bare</b> Areas where native vegetation does not naturally persist	<b>Type I Residual</b> Native vegetation community structure, composition, and regenerative capacity intact – no significant perturbation from land use/land management practice	<b>Type II Modified</b> Native vegetation community structure, composition and regenerative capacity intact – perturbed by land use /land management practice	<b>Type III Transformed</b> Native vegetation community structure, composition and regenerative capacity significantly altered by land use/land management practice	<b>Type IV Replaced Adventive</b> Native vegetation replacement – species alien to the locality and spontaneous in occurrence	<b>Type V Replaced managed</b> Native vegetation replacement with cultivated vegetation	<b>Type VI Removed</b> Vegetation removal
Diagnostic criteria	Natural regenerative capacity unmodified	unmodified, structural and compositional integrity of native vegetation is very high	Natural regeneration tolerates/endures under past &/or present current land management practices. Structure is predominantly altered but intact e.g. a layer and/growth form and or age classes removed. Composition of vegetation is altered but intact	Natural regenerative capacity is limited/at risk under past &/or current land use or land management practices. Rehabilitation and restoration possible through modified land management practice Dominant structuring species of native vegetation community significantly altered e.g. a layer frequently and repeatedly removed	Regeneration of native vegetation community has been suppressed by ongoing disturbances of the natural regenerative capacity Limited potential for restoration. Dominant structuring species of native vegetation removed or predominantly cleared or extremely degraded.	Regeneration of native vegetation community lost or suppressed by intensive land management. Limited potential for restoration. Dominant structuring species of native vegetation community removed	Nil or minimal  Vegetation absent or ornamental
ARVS notes	<b>Not used</b> Areas mapped as part of remnant vegetation or not mapped				Only used where small areas surrounded by native vegetation	<b>Not used</b>	<b>Not used</b>
Example	Lakes not mapped as remnant vegetation		Light firewood harvesting, scattered weeds, Phytophthora dieback front	Understorey removed by grazing, severely affected by Phytophthora dieback.	* <i>Typha orientalis</i> Sedgeland &, * <i>Acacia longifolia</i> thickets surround by native vegetation.	Plantations, planted parklands, pastures,	Roads, gardens
Corresponding Keighery (1994) Condition Scale		Very good excellent, Pristine	Good to very good	Very degraded to degraded/good	Completely degraded	Completely degraded	

## APPENDIX 5: Species list

\* indicates introduced species

### **Aizoaceae**

*Carpobrotus* sp.  
*Disphyma crassifolium*  
*Tetragonia implexicoma*

### **Amaranthaceae**

*Hemichroa pentandra*

### **Anarthriaceae**

*Anarthria gracilis*  
*Anarthria laevis*  
*Anarthria prolifera*  
*Anarthria prolifera* forma narrow  
*Anarthria scabra*  
*Lyginia barbata*  
*Lyginia imberbis*

### **Apiaceae**

*Actinotus glomeratus*  
*Actinotus omnifertilis*  
*Apium prostratum* var. *prostratum*  
*Centella asiatica*  
*Pentapeltis silvatica*  
*Platysace compressa*  
*Platysace filiformis*  
*Platysace pendula*  
*Schoenolaena juncea*  
*Xanthosia candida*  
*Xanthosia eichleri*  
*Xanthosia huegelii*  
*Xanthosia rotundifolia*  
*Xanthosia singuliflora*  
*Xanthosia tasmanica*

### **Araliaceae**

*Hydrocotyle alata*  
*Hydrocotyle callicarpa*  
*Hydrocotyle hispidula*  
*Trachymene pilosa*

### **Asparagaceae**

*Chamaescilla corymbosa*  
*Laxmannia jamesii*  
*Laxmannia sessiliflora*  
*Laxmannia* sp. "unident"  
*Lomandra* ? *britannii*  
*Lomandra caespitosa*  
*Lomandra integra*  
*Lomandra micrantha*  
*Lomandra micrantha* subsp. *micrantha*  
*Lomandra nigricans*  
*Lomandra pauciflora*  
*Lomandra sericea*  
*Lomandra sonderi*  
*Lomandra* sp. "unident"

### **Asparagaceae**

*Lomandra suaveolens*  
*Thysanotus gracilis*  
*Thysanotus isantherus*  
*Thysanotus manglesianus*  
*Thysanotus multiflorus*  
*Thysanotus pauciflorus*  
*Thysanotus sparteus*

### **Asteraceae**

*Actites megalocarpus*  
\**Arctotheca populifolia*  
\**Conyza bonariensis*  
\**Conyza* sp "unident"  
*Gnaphalium indutum*  
*Gnephosis drummondii*  
\**Hypochaeris glabra*  
\**Hypochaeris radicata*  
*Lagenophora huegelii*  
\**Leontodon saxatilis*  
*Leucophyta brownii*  
*Millotia tenuifolia*  
*Olearia axillaris*  
*Olearia ciliata*  
*Olearia elaeophila*  
*Pithocarpa pulchella* var. *melanostigma*  
*Quinetia urvillei*  
*Senecio glomeratus*  
*Senecio minimus*  
*Senecio pinnatifolius*  
*Siloxerus filifolius*  
*Trichocline spathulata*  
*Vellereophyton dealbatum*

### **Boryaceae**

*Borya nitida*  
*Borya sphaerocephala*

### **Campanulaceae**

*Lobelia anceps*

### **Caryophyllaceae**

\**Sagina maritima*

### **Casuarinaceae**

*Allocasuarina decussata*  
*Allocasuarina fraseriana*  
*Allocasuarina humilis*  
*Allocasuarina lehmanniana*  
*Allocasuarina microstachya*  
*Allocasuarina thuyoides*

### **Centrolepidaceae**

*Aphelia* aff *cyperoides*  
*Aphelia cyperoides*  
*Centrolepis aristata*  
*Centrolepis strigosa*

## APPENDIX 5 cont. Species list

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### **Cephalotaceae**

*Cephalotus follicularis*

### **Chenopodiaceae**

*Atriplex hypoleuca*

\**Atriplex prostrata*

*Maireana oppositifolia*

*Rhagodia baccata* subsp. *baccata*

*Sarcocornia quinqueflora*

*Suaeda australis*

### **Colchicaceae**

*Burchardia congesta*

*Burchardia* sp. "unident"

### **Convolvulaceae**

*Dichondra repens*

*Wilsonia backhousei*

*Wilsonia humilis*

### **Crassulaceae**

*Crassula closiana*

*Crassula exserta*

*Crassula* sp. "unident"

### **Cyperaceae**

*Baumea acuta*

*Baumea arthropphylla*

*Baumea articulata*

*Baumea juncea*

*Baumea rubiginosa*

*Baumea vaginalis*

*Caustis dioica*

*Chorizandra enodis*

*Cyathochaeta avenacea*

*Cyathochaeta equitans*

*Evandra aristata*

*Evandra pauciflora*

*Ficinia nodosa*

*Gahnia decomposita*

*Gahnia sclerioides*

*Gahnia* sp. Headland (G.J. Keighery 8501)

*Gahnia trifida*

*Gymnoschoenus anceps*

*Isolepis cyperoides*

*Lepidosperma* aff *pubisquameum*

*Lepidosperma* aff *squamatum* forma broad leaf

*Lepidosperma* aff *squamatum* forma narrow leaf

*Lepidosperma* aff *squamatum* forma proliferous

*Lepidosperma* aff. *angustatum*

*Lepidosperma* aff. Dunn Swamp

*Lepidosperma angustatum*

*Lepidosperma carphoides*

*Lepidosperma densiflora*

*Lepidosperma densiflora* forma proliferous

### **Cyperaceae cont**

*Lepidosperma drummondii*

*Lepidosperma effusum*

*Lepidosperma effusum* forma small

*Lepidosperma gladiatum*

*Lepidosperma gracile*

*Lepidosperma gracile* forma large

*Lepidosperma gracile* forma terete

*Lepidosperma longitudinale*

*Lepidosperma persecans* forma narrow

*Lepidosperma* sp Manypeaks fine

*Lepidosperma* sp. "unident"

*Lepidosperma* sp. Bakers Junction

*Lepidosperma* sp. Carracarrup Creek (S. Kern,  
R. Jasper, D. Brassington LCH 16738)

*Lepidosperma* sp. Down Rd fan

*Lepidosperma* sp. Manypeaks large (R.L. Barrett  
RLB 2476)

*Lepidosperma* sp. Mt Burdett

*Lepidosperma* sp. Mt Taylor

*Lepidosperma* sp. Saltbush Hill (K.R. Newbey 4118)

*Lepidosperma squamatum*

*Lepidosperma striatum*

*Lepidosperma striatum* forma small

*Lepidosperma tetraquetrum*

*Mesomelaena graciliceps*

*Mesomelaena stygia* subsp. *stygia*

*Mesomelaena tetragona*

*Schoenus acuminatus*

*Schoenus acuminatus* black base

*Schoenus* aff *lanatus*

*Schoenus* aff *obtusifolia*

*Schoenus bifidus*

*Schoenus breviculmis*

*Schoenus brevisetis*

*Schoenus caespititius*

*Schoenus cruentus*

*Schoenus curvifolius*

*Schoenus efoliatus*

*Schoenus laevigatus*

*Schoenus lanatus*

*Schoenus multiglumis*

*Schoenus nitens*

*Schoenus obtusifolius*

*Schoenus odontocarpus*

*Schoenus pedicellatus*

*Schoenus pleiostemoneus*

*Schoenus rodwayanus*

*Schoenus* sp. "unident"

*Schoenus* sp. Cape Riche Cushion  
(G.J. Keighery 9922)

## APPENDIX 5 cont. Species list

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### **Cyperaceae** cont.

*Schoenus* sp. Grey Rhizome (K.L. Wilson 2922)

*Schoenus* sp. South Coast (R. Davis 10239)

*Schoenus subbarbatus*

*Schoenus subbulbosus*

*Schoenus subfascicularis*

*Schoenus sublateralis*

*Schoenus sublaxus*

*Schoenus submicrostachyus*

*Schoenus trachycarpus*

*Tetraria capillaris*

*Tetraria capillaris* forma large

*Tetraria capillaris* forma limestone

*Tetraria octandra*

*Tetraria octandra* forma "fine"

*Tricostularia compressa*

*Tricostularia neesii* var. *elator*

*Tricostularia neesii* var. *neesii*

*Tricostularia* sp. South Coast (R.T. Wills 1423)

### **Dasypogonaceae**

*Baxteria australis*

*Calectasia grandiflora*

*Dasypogon bromeliifolius*

*Kingia australis*

### **Dennstaedtiaceae**

*Pteridium esculentum*

### **Dilleniaceae**

*Hibbertia amplexicaulis*

*Hibbertia commutata*

*Hibbertia cuneiformis*

*Hibbertia cunninghamii*

*Hibbertia depressa*

*Hibbertia diamesogenos*

*Hibbertia furfuracea*

*Hibbertia grossulariifolia*

*Hibbertia inconspicua*

*Hibbertia lineata*

*Hibbertia microphylla*

*Hibbertia pulchra*

*Hibbertia pulchra* var. *crassinervia*

*Hibbertia racemosa*

*Hibbertia* sp L543

### **Droseraceae**

*Drosera dichrosepala*

*Drosera enodes*

*Drosera erythrorhiza*

*Drosera glanduligera*

*Drosera huegelii*

*Drosera menziesii*

*Drosera pallida*

*Drosera platypoda*

### **Droseraceae** cont.

*Drosera pulchella*

*Drosera pygmaea*

*Drosera red rosette*

*Drosera roseana*

*Drosera* sp. "unident"

*Drosera sulphurea*

### **Elaeocarpaceae**

*Tetratheca affinis*

*Tetratheca pubescens*

*Tetratheca setigera*

*Tremandra diffusa*

*Tremandra stelligera*

### **Ericaceae**

*Acrotriche cordata*

*Acrotriche ramiflora*

*Andersonia caerulea*

*Andersonia depressa*

*Andersonia jamesii* ms

*Andersonia micrantha*

*Andersonia parvifolia*

*Andersonia pinaster*

*Andersonia setifolia*

*Andersonia simplex*

*Andersonia sprengelioides*

*Andersonia sprengelioides* forma swamp

*Astroloma baxteri*

*Astroloma ciliatum*

*Astroloma pallidum*

*Astroloma prostratum*

*Astroloma tectum*

*Cosmelia rubra*

*Leucopogon alternifolius*

*Leucopogon altissimus*

*Leucopogon australis*

*Leucopogon concinnus*

*Leucopogon distans*

*Leucopogon elatior*

*Leucopogon elegans*

*Leucopogon flavescens*

*Leucopogon gibbosus*

*Leucopogon glabellus*

*Leucopogon gracilis*

*Leucopogon hirsutus*

*Leucopogon interstans*

*Leucopogon obovatus*

*Leucopogon obovatus* forma coastal

*Leucopogon ovalifolius*

*Leucopogon oxycedrus*

*Leucopogon parviflorus*

*Leucopogon pendulus*



## APPENDIX 5 cont. Species list

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### **Ericaceae cont.**

*Leucopogon polystachyus*  
*Leucopogon propinquus*  
*Leucopogon racemulosus*  
*Leucopogon reflexus*  
*Leucopogon rubricaulis*  
*Leucopogon* sp. "carinata group"  
*Leucopogon* sp. aff. *assimilis*  
*Leucopogon* sp. "unident"  
*Leucopogon* sp. Coujinup (M.A. Burgman 1085)  
*Leucopogon* sp. Walpole (R.J. Cranfield 10940)  
*Leucopogon unilateralis*  
*Leucopogon verticillatus*  
*Lysinema ciliatum*  
*Lysinema conspicuum*  
*Lysinema lasianthum*  
*Needhamiella pumilio*  
*Oligarrhena micrantha*  
*Sphenotoma capitata*  
*Sphenotoma dracophylloides*  
*Sphenotoma gracilis*  
*Sphenotoma parviflora*  
*Sphenotoma squarrosa*

### **Euphorbiaceae**

*Amperea ericoides*  
*Amperea protensa*  
*Amperea volubilis*  
\**Euphorbia paralias*  
*Ricinocarpus glaucus*  
*Stachystemon virgatus*

### **Fabaceae**

*Acacia alata*  
*Acacia applanata*  
*Acacia biflora*  
*Acacia browniana* var. *browniana*  
*Acacia cochlearis*  
*Acacia crispula*  
*Acacia cyclops*  
*Acacia divergens*  
*Acacia hastulata*  
*Acacia leioderma*  
*Acacia littorea*  
*Acacia luteola*  
*Acacia myrtifolia*  
*Acacia pentadenia*  
*Acacia pulchella*  
*Acacia pulchella* var. *goadbyi*  
*Acacia robiniae*  
*Acacia subcaerulea*  
*Acacia sulcata*  
*Acacia sulcata* var. *sulcata*

### **Fabaceae cont.**

*Acacia tetragonocarpa*  
*Acacia uliginosa*  
*Acacia willdenowiana*  
*Aotus intermedia*  
*Aotus passerinoides*  
*Bossiaea dentata*  
*Bossiaea linophylla*  
*Bossiaea ornata*  
*Bossiaea praetermissa*  
*Bossiaea rufa*  
*Callistachys lanceolata*  
*Callistachys* sp. south-coast variant  
(M. Carter 180)  
*Chorizema cytisoides*  
*Chorizema diversifolium*  
*Chorizema glycinifolium*  
*Chorizema ilicifolium*  
*Chorizema reticulatum*  
*Chorizema rhombeum*  
*Chorizema spathulatum*  
*Daviesia alternifolia*  
*Daviesia flexuosa*  
*Daviesia gracilis*  
*Daviesia horrida*  
*Daviesia incrassata*  
*Daviesia inflata*  
*Daviesia oppositifolia*  
*Daviesia preissii*  
*Daviesia spinosissima*  
*Euchilopsis linearis*  
*Eutaxia epacridoides*  
*Eutaxia myrtifolia*  
*Eutaxia parvifolia*  
*Eutaxia virgata*  
*Gastrolobium bilobum*  
*Gastrolobium bracteolosum*  
*Gastrolobium coriaceum*  
*Gastrolobium retusum*  
*Gastrolobium sericeum*  
*Gompholobium burtonioides*  
*Gompholobium capitatum*  
*Gompholobium confertum*  
*Gompholobium knightianum*  
*Gompholobium ovatum*  
*Gompholobium polymorphum*  
*Gompholobium preissii*  
*Gompholobium scabrum*  
*Gompholobium tomentosum*  
*Gompholobium venustum*  
*Gompholobium villosum*

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## APPENDIX 5 cont. Species list

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### **Fabaceae** cont.

*Hardenbergia comptoniana*  
*Hovea chorizemifolia*  
*Hovea elliptica*  
*Hovea trisperma*  
*Isotropis cuneifolia*  
*Jacksonia horrida*  
*Jacksonia spinosa*  
*Kennedia coccinea*  
*Kennedia microphylla*  
*Latrobea brunonis*  
*Latrobea diosmifolia*  
*Latrobea genistoides*  
*Latrobea glabrescens* ms  
*Latrobea tenella*  
*Paraserianthes lophantha*  
*Phyllota barbata*  
*Pultenaea aspalathoides*  
*Pultenaea heterochila*  
*Pultenaea reticulata*  
*Pultenaea tenuifolia*  
*Pultenaea verruculosa*  
*Sphaerolobium alatum*  
*Sphaerolobium drummondii*  
*Sphaerolobium fornicatum*  
*Sphaerolobium grandiflorum*  
*Sphaerolobium hygrophilum*  
*Sphaerolobium macranthum*  
*Sphaerolobium medium*  
*Sphaerolobium pubescens*  
*Sphaerolobium rostratum*  
*Sphaerolobium* sp. "unident"  
*Sphaerolobium vimineum*  
*Templetonia retusa*  
*Viminaria juncea*  
**Geraniaceae**  
\**Pelargonium capitatum*  
**Goodeniaceae**  
*Dampiera alata*  
*Dampiera leptoclada*  
*Dampiera linearis*  
*Dampiera pedunculata*  
*Dampiera* sp. "unident"  
*Diaspasis filifolia*  
*Goodenia coerulea*  
*Goodenia filiformis*  
*Goodenia leptoclada*  
*Lechenaultia expansa*  
*Lechenaultia tubiflora*  
*Scaevola nitida*  
*Scaevola striata* var. *striata*

### **Goodeniaceae** cont.

*Scaevola thesioides*  
*Velleia trinervis*  
**Gyrostemonaceae**  
*Gyrostemon sheathii*  
**Haemodoraceae**  
*Anigozanthos flavidus*  
*Conostylis aculeata* subsp. *aculeata*  
*Conostylis serrulata*  
*Conostylis setigera* subsp. *setigera*  
*Haemodorum laxum*  
*Haemodorum paniculatum*  
*Haemodorum sparsiflorum*  
*Haemodorum spicatum*  
*Phlebocarya ciliata*  
*Tribonanthes violacea*  
**Haloragaceae**  
*Gonocarpus diffusus*  
*Gonocarpus hexandrus*  
*Gonocarpus paniculatus*  
*Gonocarpus pusillus*  
*Gonocarpus trichostachyus*  
**Hemerocallidaceae**  
*Agrostocrinum hirsutum*  
*Dianella revoluta*  
*Johnsonia acaulis*  
*Johnsonia lupulina*  
*Johnsonia teretifolia*  
*Stypandra glauca*  
*Tricoryne elatior*  
*Tricoryne humilis*  
**Iridaceae**  
*Patersonia babianoides*  
*Patersonia juncea*  
*Patersonia limbata*  
*Patersonia maxwellii*  
*Patersonia occidentalis*  
*Patersonia occidentalis* var. *angustifolia*  
*Patersonia occidentalis* var. *occidentalis*  
*Patersonia pygmaea*  
*Patersonia* sp. "unident"  
*Patersonia umbrosa* var. *umbrosa*  
\**Watsonia meriana* var. *bulbillifera*  
**Juncaceae**  
*Juncus kraussii*  
*Juncus pallidus*  
**Juncaginaceae**  
*Triglochin huegelii*  
*Triglochin striata*  
*Triglochin trichophora*

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**APPENDIX 5 cont. Species list**

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**Lamiaceae**

*Hemigenia humilis*  
*Hemigenia podalyrina*  
*Microcorys barbata*  
*Microcorys virgata*  
*Westringia dampieri*

**Lauraceae**

*Cassytha* aff. *flava*  
*Cassytha flava*  
*Cassytha glabella*  
*Cassytha melantha*  
*Cassytha micrantha*  
*Cassytha racemosa*  
*Cassytha* sp. "unident"

**Lentibulariaceae**

*Utricularia menziesii*  
*Utricularia multifida*

**Lindsaeaceae**

*Lindsaea linearis*

**Loganiaceae**

*Logania campanulata*  
*Logania fasciculata*  
*Logania serpyllifolia*  
*Logania vaginalis*  
*Phyllangium paradoxum*

**Loranthaceae**

*Nuytsia floribunda*  
*Lycopodiaceae*  
*Lycopodiella serpentina*

**Malvaceae**

*Lasiopetalum cordifolium* subsp. *cordifolium*  
*Lasiopetalum floribundum*  
*Lasiopetalum indutum*  
*Lasiopetalum* sp. Denmark  
(B.G. Hammersley 2012)  
*Rulingia corylifolia*  
*Thomasia discolor*  
*Thomasia pauciflora*  
*Thomasia quercifolia*  
*Thomasia solanacea*

**Menyanthaceae**

*Villarsia lasiosperma*  
*Villarsia parnassiifolia*

**Myrtaceae**

*Actinodium calocephalum* ms  
*Actinodium cunninghamii*  
*Agonis flexuosa*  
*Agonis theiformis*  
*Astartea corniculata*  
*Astartea glomerulosa*  
*Astartea laricifolia*

**Myrtaceae cont.**

*Astartea scoparia*  
*Astartea* sp. "unident"  
*Astartea* sp. "small horns"  
*Baeckea pygmaea*  
*Beaufortia anisandra*  
*Beaufortia decussata*  
*Beaufortia sparsa*  
*Callistemon glaucus*  
*Calothamnus lateralis*  
*Calothamnus quadrifidus*  
*Calothamnus schaueri*  
*Calytrix asperula*  
*Calytrix flavescens*  
*Calytrix leschenaultii*  
*Calytrix* sp. Esperance (M.A. Burgman 4268A)  
*Conothamnus aureus*  
*Corymbia calophylla*  
*Corymbia ficifolia*  
*Darwinia citriodora*  
*Darwinia diosmoides*  
*Darwinia oederoides*  
*Darwinia vestita*  
*Eucalyptus acies*  
*Eucalyptus angulosa*  
*Eucalyptus buprestium*  
*Eucalyptus cornuta*  
*Eucalyptus decipiens*  
*Eucalyptus decurva*  
*Eucalyptus diversicolor*  
*Eucalyptus doratoxylon*  
*Eucalyptus falcata*  
*Eucalyptus goniantha* subsp. *goniantha*  
*Eucalyptus marginata* subsp. *marginata*  
*Eucalyptus megacarpa*  
*Eucalyptus occidentalis*  
*Eucalyptus patens*  
*Eucalyptus staeri*  
*Homalospermum firmum*  
*Hypocalymma angustifolium*  
*Hypocalymma cordifolium* subsp. *cordifolium*  
*Hypocalymma ericifolium*  
*Hypocalymma strictum*  
*Kunzea clavata*  
*Kunzea ericifolia* subsp. *ericifolia*  
*Kunzea recurva*  
*Melaleuca* aff *densa* "fine"  
*Melaleuca bracteosa*  
*Melaleuca croxfordiae*  
*Melaleuca cuticularis*  
*Melaleuca densa*

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*Melaleuca diosmifolia*  
*Melaleuca incana*  
*Melaleuca lateritia*  
*Melaleuca microphylla*  
*Melaleuca pauciflora*  
*Melaleuca pentagona*  
*Melaleuca preissiana*  
*Melaleuca raphiophylla*  
*Melaleuca spathulata*  
*Melaleuca striata*  
*Melaleuca suberosa*  
*Melaleuca thymoides*  
*Melaleuca viminea* subsp. *demissa*  
*Melaleuca viminea* subsp. *viminea*  
 forma broad leaf  
*Melaleuca violacea*  
*Pericalymma crassipes*  
*Pericalymma spongiocaule*  
*Rinzia schollerifolia*  
*Taxandria angustifolia*  
*Taxandria conspicua*  
*Taxandria fragrans*  
*Taxandria juniperina*  
*Taxandria linearifolia*  
*Taxandria marginata*  
*Taxandria parviceps*  
*Taxandria spathulata*  
*Verticordia endlicheriana* var. *endlicheriana*  
*Verticordia fastigiata*  
*Verticordia habrantha*  
*Verticordia plumosa* var. *grandiflora*  
*Verticordia plumosa* var. *plumosa*

**Olacaceae**

*Olax benthamiana*  
*Olax phyllanthi*

**Orchidaceae**

*Caladenia flava*  
*Corybas abditus*  
*Cryptostylis ovata*  
*Elythranchera brunonis*  
*Praecoxanthus aphyllus*  
*Prasophyllum parvifolium*  
*Pterostylis recurva*  
*Pterostylis* sp. "unident"  
*Pterostylis vittata*  
*Pyrorchis nigricans*  
*Thelymitra crinita*

**Philydraceae**

*Philydrella pygmaea* subsp. *pygmaea*

*Phyllanthus calycinus*  
*Poranthera huegelii*  
**Pittosporaceae**  
*Billardiera drummondii*  
*Billardiera fusiformis*  
*Billardiera laxiflora*  
*Billardiera* sp. "unident"  
*Billardiera variifolia*  
*\*Pittosporum undulatum*  
**Plantaginaceae**  
*Gratiola pubescens*  
**Poaceae**  
*\*Aira cupaniana*  
*\*Aira praecox*  
*Amphipogon amphipogonoides*  
*Amphipogon avenaceus*  
*Amphipogon debilis*  
*Amphipogon laguroides* subsp. *laguroides*  
*Amphipogon setaceus*  
*Amphipogon* sp. "unident"  
*Amphipogon turbinatus*  
*\*Anthoxanthum odoratum*  
*Austrodanthonia acerosa*  
*Austrodanthonia caespitosa*  
*Austrodanthonia setacea*  
*Austrodanthonia* sp. "unident"  
*Austrostipa juncifolia*  
*Austrostipa* sp. "unident"  
*\*Briza maxima*  
*\*Briza minor*  
*Deyeuxia quadriseta*  
*Eragrostis brownii*  
*Hemarthria uncinata*  
*\*Holcus lanatus*  
*\*Lagurus ovatus*  
*\*Lolium perenne*  
*Microlaena stipoides*  
*Neurachne alopecuroidea*  
*Poa poiformis*  
*Poa porphyroclados*  
*Poa* sp. "unident"  
*Spinifex hirsutus*  
*\*Spinifex sericeus*  
*Sporobolus virginicus*  
*Tetrarrhena laevis*  
**Podocarpaceae**  
*Podocarpus drouynianus*  
**Polygalaceae**  
*Comesperma calymega*  
*Comesperma flavum*

## APPENDIX 5 cont. Species list

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### **Polygalaceae cont.**

*Comesperma nudiusculum*

*Comesperma* sp. "unident"

*Comesperma virgatum*

### **Polygonaceae**

*Muehlenbeckia adpressa*

### **Portulacaceae**

*Calandrinia* sp. "unident"

### **Primulaceae**

*Samolus junceus*

*Samolus repens*

### **Proteaceae**

*Acidonia microcarpa*

*Adenanthos apiculatus*

*Adenanthos cuneatus*

*Adenanthos obovatus*

*Adenanthos sericeus*

*Banksia arctotidis*

*Banksia armata*

*Banksia attenuata*

*Banksia biterax*

*Banksia brownii*

*Banksia brunnea*

*Banksia coccinea*

*Banksia dallanneyi*

*Banksia dryandroides*

*Banksia formosa*

*Banksia gardneri* var. *gardneri*

*Banksia goodii*

*Banksia grandis*

*Banksia ilicifolia*

*Banksia littoralis*

*Banksia mucronulata* subsp. *mucronulata*

*Banksia nutans*

*Banksia occidentalis*

*Banksia pellaefolia*

*Banksia praemorsa*

*Banksia quercifolia*

*Banksia serra*

*Banksia sessilis*

*Banksia sphaerocarpa* var. *sphaerocarpa*

*Banksia squarrosa*

*Banksia tenuis* var. *tenuis*

*Conospermum caeruleum*

*Conospermum capitatum*

*Conospermum flexuosum*

*Conospermum petiolare*

*Conospermum teretifolium*

*Franklandia fucifolia*

*Grevillea depauperata*

*Grevillea fasciculata*

### **Proteaceae cont.**

*Grevillea occidentalis*

*Grevillea pulchella*

*Grevillea trifida*

*Hakea amplexicaulis*

*Hakea ceratophylla*

*Hakea corymbosa*

*Hakea cucullata*

*Hakea drupacea*

*Hakea elliptica*

*Hakea ferruginea*

*Hakea florida*

*Hakea lasiantha*

*Hakea linearis*

*Hakea lissocarpha*

*Hakea oleifolia*

*Hakea prostrata*

*Hakea ruscifolia*

*Hakea sulcata*

*Hakea trifurcata*

*Hakea tuberculata*

*Hakea undulata*

*Hakea varia*

*Isopogon attenuatus*

*Isopogon axillaris*

*Isopogon buxifolius*

*Isopogon cuneatus*

*Isopogon formosus*

*Isopogon longifolius*

*Lambertia echinata* subsp. *citrina*

*Lambertia uniflora*

*Persoonia elliptica*

*Persoonia graminea*

*Persoonia longifolia*

*Petrophile acicularis*

*Petrophile divaricata*

*Petrophile diversifolia*

*Petrophile media*

*Petrophile rigida*

*Petrophile squamata* subsp. *squamata*

*Petrophile teretifolia*

*Stirlingia latifolia*

*Stirlingia tenuifolia*

*Synaphea gracillima*

*Synaphea petiolaris*

*Synaphea polymorpha*

*Synaphea preissii*

*Synaphea reticulata*

### **Ranunculaceae**

*Clematis pubescens*

## APPENDIX 5 cont. Species list

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### Restionaceae

*Chaetanthus aristatus*  
*Chaetanthus leptocarpoides*  
*Chaetanthus tenellus*  
*Chordifex abortivus*  
*Chordifex isomorphus*  
*Chordifex laxus*  
*Chordifex sphacelatus*  
*Desmocladius fasciculatus*  
*Desmocladius flexuosus*  
*Empodisma gracillimum*  
*Harperia lateriflora*  
*Hypolaena exsulca*  
*Hypolaena fastigiata*  
*Hypolaena pubescens*  
*Leptocarpus laxus*  
*Leptocarpus tenax*  
*Lepyrodia drummondiana*  
*Lepyrodia hermaphrodita*  
*Lepyrodia monoica*  
*Lepyrodia muirii*  
*Loxocarya cinerea*  
*Meeboldina denmarkica*  
*Meeboldina roycei* ms  
*Meeboldina scariosa*  
*Meeboldina* sp. "unident"  
*Meeboldina tephрина* ms  
*Melanostachya ustulata*  
*Platychorda applanata*  
*Sporadanthus strictus*  
*Stenotalis ramosissima*  
*Tremulina tremula*

### Rhamnaceae

*Spyridium globulosum*  
*Spyridium majoranifolium*  
*Spyridium spadiceum*  
*Trymalium ledifolium*  
*Trymalium odoratissimum*

### Rubiaceae

*Opercularia apiciflora*  
*Opercularia hispidula*  
*Opercularia vaginata*  
*Opercularia volubilis*

### Rutaceae

*Boronia crassipes*  
*Boronia crenulata*  
*Boronia denticulata*  
*Boronia heterophylla*  
*Boronia juncea*  
*Boronia juncea* subsp. *micrantha*  
*Boronia megastigma*

### Rutaceae cont.

*Boronia spathulata*  
*Boronia stricta*  
*Boronia subsessilis*  
*Chorilaena quercifolia*  
*Crowea angustifolia*  
*Crowea angustifolia* var. *angustifolia*  
*Crowea angustifolia* var. *platyphylla*  
*Rhadinothamnus anceps*  
*Rhadinothamnus rudis*  
*Rhadinothamnus rudis* subsp. *rudis*

### Santalaceae

*Exocarpos sparteus*  
*Leptomeria ericoides*  
*Leptomeria scrobiculata*  
*Leptomeria squarrulosa*

### Sapindaceae

*Dodonaea ceratocarpa*

### Schizaeaceae

*Schizaea fistulosa*

### Selaginellaceae

*Selaginella gracillima*

### Solanaceae

*Anthocercis littorea*  
*Anthocercis viscosa*

### Stylidiaceae

*Levenhookia pusilla*  
*Stylidium adnatum*  
*Stylidium amoenum*  
*Stylidium articulatum*  
*Stylidium assimile*  
*Stylidium caespitosum*  
*Stylidium calcaratum*  
*Stylidium crassifolium*  
*Stylidium daphne*  
*Stylidium despectum*  
*Stylidium diademum*  
*Stylidium diversifolium*  
*Stylidium falcatum*  
*Stylidium fasciculatum*  
*Stylidium glaucifolium* ms  
*Stylidium glaucum*  
*Stylidium gloeophyllum*  
*Stylidium guttatum*  
*Stylidium hirsutum*  
*Stylidium imbricatum*  
*Stylidium junceum*  
*Stylidium luteum*  
*Stylidium nymphaeum* ms  
*Stylidium perpusillum*  
*Stylidium petiolare*



## APPENDIX 5 cont. Species list

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### **Stylidiaceae** cont.

*Stylidium piliferum*

*Stylidium plantagineum*

*Stylidium repens*

*Stylidium scandens*

*Stylidium schoenoides*

*Stylidium* sp. Mt Barker (E.J. Croxford 1906)

*Stylidium spathulatum*

*Stylidium spinulosum*

*Stylidium squamosotuberosum*

*Stylidium violaceum*

### **Thymelaeaceae**

*Pimelea angustifolia*

*Pimelea clavata*

*Pimelea drummondii*

*Pimelea ferruginea*

*Pimelea hispida*

*Pimelea imbricata* var. *imbricata*

*Pimelea imbricata* var. *piligera*

*Pimelea lanata*

*Pimelea lehmanniana*

*Pimelea lehmanniana* subsp. *lehmanniana*

*Pimelea longiflora* subsp. *longiflora*

*Pimelea rosea* subsp. *rosea*

*Pimelea* sp. "unident"

*Pimelea suaveolens*

*Pimelea tinctoria*

### **Violaceae**

*Hybanthus floribundus*

### **Xanthorrhoeaceae**

*Xanthorrhoea gracilis*

*Xanthorrhoea platyphylla*

*Xanthorrhoea preissii*

*Xanthorrhoea* sp. "unident"

### **Xyridaceae**

*Xyris lacera*

*Xyris lanata*

### **Zamiaceae**

*Macrozamia riedlei*

## **APPENDIX 6: Conservation Codes For Western Australia**

(DEC 2010b)

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### **R: Declared Rare Flora - Extant Taxa (= Threatened Flora = Endangered + Vulnerable).**

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

### **X: Declared Rare Flora -Presumed Extinct Taxa.**

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

### **I: Priority One-Poorly Known Taxa**

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

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

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

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

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

### **4: Priority Four – Rare Taxa**

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

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## APPENDIX 7: Conservation species

Conservation species	Cons. Code	New to Albany district	New Pop.	Range extension
<i>Andersonia pinaster</i>	DRF		+	
<i>Banksia brownii</i>	DRF		+	
<i>Banksia goodii</i>	DRF		+	
<i>Banksia verticillata</i>	DRF			
<i>Chordifex abortivus</i>	DRF		+	+
<i>Isopogon uncinatus</i>	DRF		+	
<i>Andersonia jamesii</i>	P1		+	
<i>Schoenus</i> sp Grey Rhizome	P1			
<i>Stylidium falcatum</i>	P1		+	+
<i>Thomasia quercifolia</i>	P2		+	
<i>Stylidium articulatum</i>	P2		+	
<i>Spyridium spadiceum</i>	P2		+	
<i>Stylidium daphne</i>	P2		+	+
<i>Amperea protensa</i>	P3		+	
<i>Andersonia depressa</i>	P3		+	
<i>Andersonia setifolia</i>	P3		+	
<i>Boronia crassipes</i>	P3		+	
<i>Chorizema reticulatum</i>	P3		+	
<i>Gahnia sclerioides</i>	P3		+	
<i>Gonocarpus trichostachyus</i>	P3		+	
<i>Gonocarpus simplex</i>	P3	+	+	+
<i>Hakea tuberculata</i>	P3		+	
<i>Lasiopetalum</i> sp Denmark	P3	+	+	+
<i>Leucopogon alternifolius</i>	P3		+	
<i>Leucopogon altissimus</i>	P3		+	
<i>Lysinema lasianthum</i>	P3		+	
<i>Melaleuca diosmifolia</i>	P3		+	
<i>Sphaerolobium pubescens</i>	P3		+	
<i>Sphaerolobium rostratum</i>	P3	+	+	+
<i>Stylidium gloeophyllum</i>	P3		+	+
<i>Synaphea incurva</i>	P3		+	
<i>Thomasia discolor</i>	P3		+	
<i>Thomasia solanacea</i>	P3		+	
<i>Xanthosia eichleri</i>	P3	+	+	
<i>Astartea arbuscula</i>	P4			
<i>Asplenium aethiopicum</i>	P4		+	
<i>Adenanthos cunninghamii</i>	P4		+	
<i>Billardiera drummondii</i>	P4		+	
<i>Banksia serra</i>	P4		+	
<i>Centrolepis caespitosa</i>	P4		+	
<i>Chordifex isomorphus</i>	P4		+	
<i>Drosera fimbriata</i>	P4		+	
<i>Eucalyptus acies</i>	P4		+	
<i>Eucalyptus goniantha</i> subsp <i>goniantha</i>	P4		+	
<i>Goodenia filiformis</i>	P4		+	
<i>Thysanotus isantherus</i>	P4		+	
<i>Laxmannia jamesii</i>	P4		+	
<i>Stylidium plantagineum</i>	P4		+	
<i>Verticordia harveyi</i>	P4		+	+

## APPENDIX 8: Taxon range extensions

Species	Range extension	New record for survey area
<i>Hemichroa pentandra</i>	SE	<input type="checkbox"/>
<i>Eucalyptus patens</i>	E	
<i>Gonocarpus simplex</i> P3	E	
<i>Lasiopetalum</i> sp. Denmark P3	E	<input type="checkbox"/>
<i>Latrobea tenella</i>	E	<input type="checkbox"/>
<i>Lepidosperma tetraquetrum</i>	E	
<i>Melaleuca lateritia</i>	E	
<i>Sphaerolobium rostratum</i> P3	E	<input type="checkbox"/>
<i>Stylidium falcatum</i> P1	E	
<i>Lepidosperma</i> sp. Carracarrup Creek	SW	<input type="checkbox"/>
<i>Schoenus</i> sp Cape Riche Cushion	SW	<input type="checkbox"/>
<i>Stylidium gloeophyllum</i> P3	SW	
<i>Petrophile phyllicoides</i>	SW	<input type="checkbox"/>
<i>Verticordia harveyi</i> P4	SW	<input type="checkbox"/>
<i>Chordifex sphacelatus</i>	S	<input type="checkbox"/>
<i>Opercularia apiciflora</i>	S	<input type="checkbox"/>
<i>Stylidium daphne</i> P2	S	<input type="checkbox"/>
<i>Tricostularia</i> sp South Coast	S	
<i>Chordifex abortivus</i> DRF	W	

## APPENDIX 9: Vegetation Descriptions

The vegetation descriptions following are based on both relevé data and field observations and include:

**Unit code and name:** Name descriptors are simple and aim to be indicative of the habitat or landform the unit occupies. Where landform units were utilized in naming this implies that the majority, but not necessarily all occurrences are restricted to the landform. Common names are used for some tree species.

**Statistics:** Number of relevés sampled, mean species richness, total area of unit (ha), percentage area of remnant vegetation within survey area (%), and percentage area of unit in IUCN Reserves I-IV (%).

**Unit description:** Outlines soils, landscape, structure, (using structural classification according to Keighery (1994), Table 9.1). Dominant and common species are listed and sub-units described where applicable. Commonly occurring adjacent units and floristically similar units are noted.

**Comments:** Outlines major threats observed, likely distribution and some comparable vegetation recorded in areas outside the survey area.

**Floristic Summary:** Table documenting typical unit structure and common species.

Cover values :      E = emergent,  
                              D = > 70%  
                              M = >30 & <70 %  
                              S = >10 & < 30%  
                              V = <10 %

**Key identifying features:** A quick summary of dominant or characteristic species and habitat

**Photo:** Typical example of unit

**Map:** Graphic representation of unit distribution within survey area. Grey shading and symbols indicate areas where unit mapped as mosaic with other unit(s).

**Table 9.1 Structural Classification (Keighery 1994)**

Life form / height class	Canopy cover			
	100-70%	70-30%	30-10%	10-2%
Trees over 30 Trees 10-30m Trees under 10 m	Tall Closed Forest Closed Forest Low Closed Forest	Open Forest Open Forest Low Open forest	Tall woodland Woodland Low Woodland	Tall Open Woodland Open Woodland Low Open Woodland
Tree Mallee Shrub Mallee	Closed Tree Mallee Closed Shrub Mallee	Tree mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee
Shrubs over 2m Shrubs 1-2m Shrubs under 1m	Closed Tall Scrub Closed Heath Closed Low Heath	Tall Open Scrub Open Heath Open Low Heath	Tall Shrubland Shrubland Low Shrubland	Tall Open Shrubland Open Shrubland Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

## 1 Coastal Yate Woodland.

No. of relevés 7 Mean spp. richness 11.7 Area 419 ha % of Rem. Veg. 0.9 % in IUCN Reserve 1-IV 21.4

### Description

Coastal Yate Woodland is found along the coastal fringe in protected swales, slopes, crests and flats on grey sand. It is dominated by an upper canopy of *Eucalyptus cornuta* over a sparse secondary tree stratum of *Agonis flexuosa*. There is usually one shrub layer, a tall open scrub or open heath and common dominant shrubs include *Hibbertia furfuracea*, *Bossiaea linophylla* and *Spyridium globulosum*. Ground cover is frequently sparse and there is a high degree of variability in sedge dominance with *Desmocladius flexuosus* most common.

This unit is one of four units that equate to "Scrub heath on dunes" as mapped by Beard (1979), and described as "Peppermint Low Woodland and Scrub-heath". The other units are Peppermint Low Forest (2), Coastal Heath (3) and Limestone Coastal Heath (4). This unit shares many species with Peppermint Low Forest (2), with which it merges, but differs in the absence of *Adenanthos sericeus* and presence of *Hibbertia furfuracea*. It is usually found in more protected and damper sites. In some areas this unit merges with Karri Forest (9).

### Comments

Infestations of *\*Dipogon lignosus* (Dolichos Pea) and *\*Zantedeschia aethiopicum* (Arum Lily) were observed within this unit in the Little Grove and Robinson areas. This unit is largely restricted to coastal and near coastal consolidated dunes with occasional occurrences along near coastal drainage lines, though one site near Bornholm was recorded on a hill top. The distribution of dominant understorey species suggest that this unit reaches its eastern limit just east of the survey area (the eastern limit of *Hibbertia furfuracea* and *Hardenbergia comptoniana*) and it probably extends to the west along the coastal fringe of the Warren Botanical District. Direct comparison with units described in the Walpole region by Wardell-Johnson and Williams (1996) is difficult, though it is likely that this unit falls within their community group A4.

This unit is naturally restricted to the coastal fringe. The only other *Eucalyptus cornuta* dominated unit within the survey area, Unit 24, is restricted to granite outcrops.

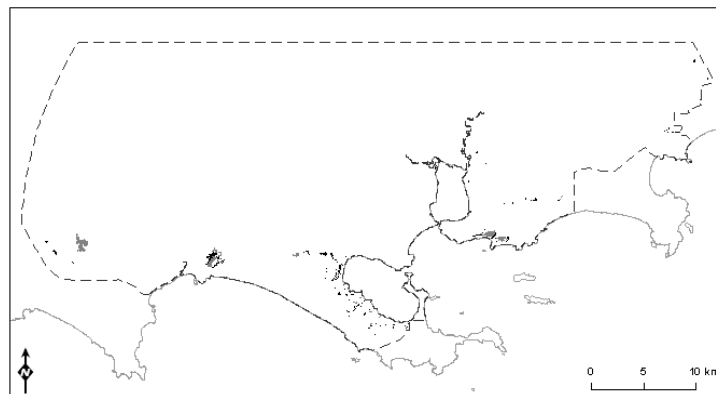
### Floristic Summary

Lifeform	%cover	Species
Trees 10-30m	S-M	<i>Eucalyptus cornuta</i>
Trees <10m	V	<i>Agonis flexuosa</i>
Shrubs >2m	M	<i>Hibbertia furfuracea</i> , <i>Bossiaea linophylla</i> , <i>Spyridium globulosum</i>
Shrubs 1-2m		<i>Leucopogon obovatus</i> , <i>Hibbertia cuneiformis</i> , <i>Pimelea clavata</i>
Shrubs <1m		<i>Tremandra stelligera</i> , <i>Rhagodia baccata</i>
Sedges/rushes	Nil -V	<i>Desmocladius flexuosus</i> , <i>Lepidosperma densiflora</i> , <i>Lepidosperma densiflora</i> forma proliferous, <i>Lepidosperma effusum</i> , <i>Lepidosperma effusum</i> forma small, <i>Lepidosperma gladiatum</i> , <i>Ficinia nodosa</i>
Herbs		<i>Billardiera fusiformis</i> , <i>Clematis pubescens</i> , <i>Stylidium adnatum</i> , <i>Opercularia hispidula</i> , <i>Hardenbergia comptoniana</i>
Grasses		<i>Tetrarrhena laevis</i>

### Key identifying Features

- Canopy of *Eucalyptus cornuta* above *Agonis flexuosa* and shrubland dominated by *Hibbertia furfuracea*, *Bossiaea linophylla* and *Spyridium globulosum*.
- Coastal distribution on sand.

**Conservation species** None recorded



**Unit 1 Coastal Yate Woodland**



## 2 Peppermint Low Forest

No. of relevés 10 Mean spp. richness 10 Area 1232 ha % of Rem. Veg. 2.8 % in IUCN Reserve 1-IV 23.0

### Description

Peppermint Low Forest is restricted to the coastal dune system where it commonly occurs in swales and flats. A dense canopy of *Agonis flexuosa* (Peppermint) is characteristic of this unit with the structure varying from a closed heath on exposed coastal slopes to a low closed forest in swales with shrub species often sub or co-dominant in exposed areas. A tall shrubland of *Spyridium globulosum*, *Adenanthos sericeus*, *Bossiaea linophylla* and *Leucopogon obovatus* is usually present over an open or closed sedgeland with *Rhagodia baccata*, *Hardenbergia comptoniana* and *Clematis pubescens* common.

This unit forms a mosaic with Coastal Heath (3), Limestone Coastal Heath (5), Coastal *Banksia ilicifolia*/Peppermint Low Woodland (4) and Coastal Yate Woodland (1) and appears to be the climax of Coastal Heath (Beard 1979).

Three sub-units are described:

**2a Peppermint Low Forest** occurs on coastal dunes and swales and is described above.

**2b Peppermint/*Eucalyptus megacarpa* Low Forest** occurs along minor drainage lines on lower slopes of the coastal dunes. *Eucalyptus megacarpa* is co-dominant in the upper strata and *Lepidosperma effusum* and *Pteridium esculentum* are common.

**2c Peppermint Low Forest/*Lepidosperma gladiatum* Sedgeland** occurs in the swale behind the fore dune and occasionally in deep valleys on the inland dunes. *Lepidosperma gladiatum*, *Desmocladius flexuosus*, *Rhagodia baccata* and *Hardenbergia comptoniana* are prominent understorey species with *Hibbertia cuneiformis* and *Pimelea clavata* common shrubs.

### Comments

This unit also includes *Agonis flexuosa* thickets that have invaded other units. In the Little Grove and Big Grove area, *A. flexuosa* is invading what was once *Banksia littoralis*/Woodland *Melaleuca incana* Shrubland (44) as indicated by the dead and dying *Banksia littoralis* and the presence of scattered species indicative of winter wet areas such as *Villarsia parnassiifolia*, *Sphenotoma gracilis* and *Melaleuca incana* under dense canopies of *A. flexuosa*. This invasion suggests that a significant and prolonged lowering of the water table may have occurred. Anecdotal evidence indicates that large areas of Little Grove and Big Grove were more swampy forty to fifty years ago (T. Allen, pers. comm.).

Many infestations of *\*Acacia longifolia* were observed within this unit, particularly in the Little Grove area. *Agonis flexuosa* occurs as a lower tree stratum or as a co-dominant in a number units (1, 4, 9 and 10) and where this species occurs as stands over pasture, identification of the unit has been based on the nearest intact vegetation.

Peppermint Low Forest is common along the south west coastline though those with *Adenanthos sericeus* in the understorey (2a) are restricted to areas around Albany as this species only occurs from the Nullaki Peninsula to Waychinnicup with an outlying population at Warriup. *Eucalyptus megacarpa* and *Hardenbergia comptoniana* reach their eastern limit near Mt Manypeaks and Cheyne Beach respectively (DEC 2009).

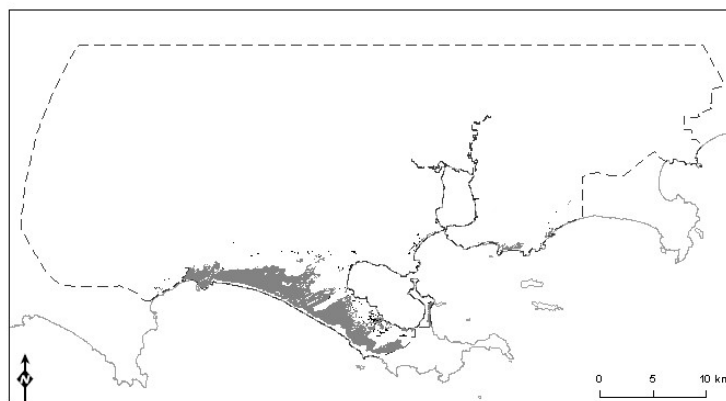
### Floristic Summary

Lifeform	%cover	Species
Mallee/Tree <8m	M-D	<i>Agonis flexuosa</i> +/- <i>Eucalyptus megacarpa</i> , +/- <i>Hakea oleifolia</i>
Shrubs 1m to >2m	S	<i>Spyridium globulosum</i> , <i>Adenanthos sericeus</i> , <i>Bossiaea linophylla</i> , <i>Leucopogon obovatus</i> , <i>Hibbertia cuneiformis</i>
Shrubs 0.5-1m	V	<i>Rhagodia baccata</i>
Sedges/rushes	V-D	<i>Desmocladius flexuosus</i> , <i>Lepidosperma densiflora</i> forma proliferous, <i>Lepidosperma gladiatum</i> , <i>Lepidosperma effusum</i>
Herbs	V	<i>Hardenbergia comptoniana</i> , <i>Clematis pubescens</i> , <i>Opercularia hispidula</i> , <i>Billardiera fusiformis</i>

### Key identifying Features

- Thickets with *Agonis flexuosa* dominant or co-dominant.
- Occurs on sand in coastal areas

**Conservation species** None recorded



**Unit 2 Peppermint Low Forest**

### 3 Coastal Heath

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No. of relevés 16 Mean spp. richness 21.1 Area 3737 ha % of Rem. Veg. 8.5 % in IUCN Res. 1-IV 22.2

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#### Description

Coastal Heath is restricted to light grey sand on the coastal dunes system with extensive areas present from Torndirrup National Park west to Torbay Inlet. The mixed open heath is very diverse, occurring above a low open heath and a mixed sedgeland with *Cyathochaeta equitans* prominent and clumps of *Agonis flexuosa* common. Common larger shrubs include those typical of range of soils including *Bossiaea linophylla*, *Banksia grandis*, *Hakea florida*, *Hibbertia furfuracea* (typical of lateritic and granitic soils), *Jacksonia horrida*, *Adenanthos cuneatus*, *Leucopogon obovatus*, (acidic sand) and *Acacia cochlearis*, *Spyridium globulosum* and less frequently *Adenanthos sericeus* and *Banksia praemorsa* (alkaline soils). *Banksia grandis* and *Hakea prostrata* are present as prostrate forms. Other typical species include *Hibbertia racemosa*, *Pimelea rosea* subsp. *rosea*, *Amperea ericoides*, *Logania serpyllifolia*, *Allocasuarina humilis*, *Platysace compressa*, *Loxocarya cinerea*, *Lepidosperma densiflora*, *Anarthria prolifera* and *Lyginia* spp.

This unit forms a mosaic with Coastal Limestone Heath (5) and Peppermint Thicket (2) and in Torndirrup NP often occurs upslope of Coastal *Banksia ilicifolia*/Peppermint Low Woodland (4).

Four sub-units are described:

#### 3a Coastal heath

This is the most widespread of the sub-units and is described above.

#### 3b *Cyathochaeta equitans* Sedgeland

This sub-unit is restricted to deep swales and low flats in and abutting the coastal hills, where occasional frosts limit the growth of trees and shrubs. A diverse sedgeland dominated by *Cyathochaeta equitans* is the prominent feature of this sub-unit and a relatively open shrubland and/or open low heath may be present. Common species include *Melaleuca thymoides*, *Pultenaea reticulata*, *Jacksonia horrida*, *Leucopogon reflexus*, *Olearia axillaris*, *Hibbertia racemosa*, *Lepidosperma densiflora*, *Schoenus caespititius*, *Desmocladius flexuosus*, *Hypolaena exsulca*, *Anarthria prolifera* and *Lyginia imberbis*.

#### 3c *Darwinia diosmoides* Coastal heath

This sub-unit is found on the isthmus north of Quaranup and on the lower slopes of Mt Adelaide and is distinguished by the dominance of *Darwinia diosmoides* in the understorey. These coastal rims were not well surveyed during this survey and vary in species and structural composition with affinities to several units including Coastal *Banksia ilicifolia*/Peppermint Low Woodland (4) and some granitic and coastal shrubland units.

#### 3d *Allocasuarina fraseriana* Woodland/Coastal Heath.

A large area of this sub-unit is found on the protected northern slopes of the coastal hills west of the prison. This sub-unit was not sampled but the common understorey species appear the same as those in the coastal heath sub-unit (3a).

#### Comments

\**Acacia longifolia* infestations were observed within this unit, particularly around the Albany Prison area.

This unit falls within the Mixed Heath and Peppermint Low Woodland and Scrub Heath mosaic mapped by Beard (1979) as part of the Torndirrup System. An extensive area of this unit has been described as common between Lake Gardner and Mt Gardner in Two Peoples Bay (Hopkins *et al.* unpublished) though some of this has reverted to Peppermint Low Forest in the absence of fire for over 30 years. This unit was mapped in the wind farm area, and described under "Inland Heath, Sedgelands and Woodlands" (Halpern Glick Maunsell 2000). The large areas of this unit between Mutton Bird and Sharp Point were not extensively sampled due to the unit being well represented in coastal conservation reserves and some of the sampled relevés on lower slopes are atypical.

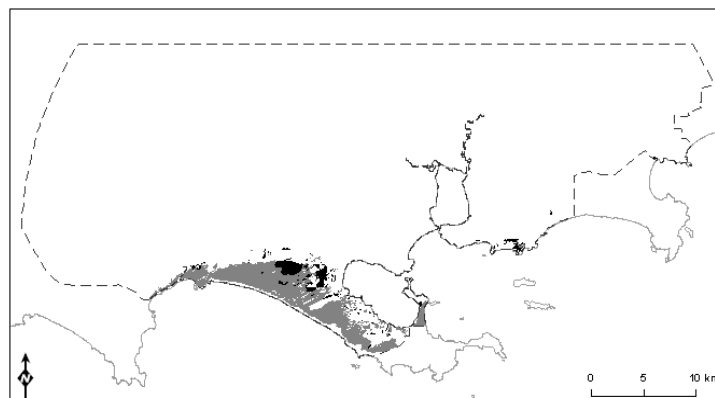
#### Key identifying Features

- Occurs on coastal dunes on acidic sand.
- Diverse mixed heaths with *Cyathochaeta equitans* a dominant sedge and interspersed with *Agonis flexuosa* clumps.

**Conservation species** *Calectasia cyanea* DRF, *Adenanthos cunninghamii* P4

### Floristic Summary (sub-unit 3a)

Lifeform	%cover	Species
Trees<10m	E-V	<i>Agonis flexuosa</i>
Shrubs >2m	V	<i>Adenanthos sericeus</i> , , +/- <i>Banksia praemorsa</i> ,
Shrubs 1-2m	M	<i>Bossiaea linophylla</i> , <i>Banksia grandis</i> , <i>Hakea florida</i> , <i>Hakea ruscifolia</i> , <i>Hibbertia furfuracea</i> , <i>Jacksonia horrida</i> , <i>Adenanthos cuneatus</i> , <i>Spyridium globulosum</i> , <i>Leucopogon obovatus</i> , <i>Isopogon formosus</i> , <i>Acacia littorea</i> , <i>Melaleuca thymoides</i>
Shrubs 0.5-1m	S	<i>Allocasuarina humilis</i> , <i>Lysinema ciliatum</i> , <i>Gompholobium confertum</i> , <i>Chorizema glycinifolium</i> , <i>Olax phyllanthi</i> , <i>Olearia axillaris</i> , <i>Gyrostemon sheathii</i>
Shrubs <0.5m	V-S	<i>Hibbertia racemosa</i> , <i>Pimelea rosea</i> subsp <i>rosea</i> , <i>Amperea ericoides</i> , <i>Olearia ciliata</i> , <i>Platysace compressa</i> , <i>Hakea prostrata</i> , <i>Hibbertia amplexicaulis</i> , <i>Banksia dallanneyi</i> , <i>Isopogon attenuatus</i> , <i>Lechenaultia expansa</i>
Sedges/rushes	S-M	<i>Cyathochaeta equitans</i> , <i>Desmocladius flexuosus</i> , <i>Anarthria prolifera</i> , <i>Schoenus caespitius</i> , <i>Lepidosperm densiflora</i> , <i>Lyginia imberbis</i> , <i>Lyginia barbata</i> , <i>Loxocarya cinerea</i>
Herbs	V	<i>Logania serpyllifolia</i> , <i>Conostylis aculeata</i> subsp <i>aculeata</i> , <i>Opercularia hispidula</i> , <i>Billardiera fusiformis</i> , <i>Cassytha racemosa</i> , <i>Cassytha glabella</i> , <i>Kennedia coccinea</i> , <i>Velleia trinervis</i> , <i>Stylidium hirsutum</i>



**Unit 3 Coastal Heath**

## 4 Coastal *Banksia ilicifolia*/Peppermint Low Woodland

No. of relevés 17 Mean spp. richness 21.9 Area 506 ha % of Rem. Veg. 1.1 % in IUCN Reserve 1-IV 39.9

### Description

Coastal *Banksia ilicifolia*/Peppermint Low Woodland is restricted to coastal areas where it is found on deep acidic sand, typically on lower slopes. It is common on the Torndirrup Peninsula, where it usually occurs down slope of the Coastal Heath (3), Limestone Heath (5) and Peppermint Low Forest (2) mosaic.

A canopy of *Banksia ilicifolia* and *Agonis flexuosa* is characteristic of this unit with *Banksia attenuata* and *Allocasuarina fraseriana* co-dominant in some areas. The understorey is usually an open heath over a low shrubland and sedgeland. Common understorey species include *Jacksonia horrida*, *Pultenaea reticulata*, *Melaleuca thymoides*, *Adenanthos cuneatus*, *Leucopogon obovatus*, *Leucopogon reflexus*, *Acacia pulchella*, *Astroloma baxteri*, *Bossiaea praetermissa*, *Hibbertia racemosa*, *Anarthria scabra*, *Anarthria prolifera*, *Schoenus caespititius*, *Lyginia barbata*, *Mesomelaena gracilipes*, *Cyathochaeta equitans*, *Dasyopogon bromeliifolius* and *Amperea ericoides*.

Two sub-units are described:

**4a Coastal *Banksia ilicifolia*/Peppermint Low Woodland** is common along the coastal fringe from Quaranup to the west of Torbay Inlet with isolated pockets in other coastal areas. This sub-unit lacks *Anarthria scabra*, *Allocasuarina fraseriana* and *Leucopogon rubricaulis*. Some areas on the Vancouver Peninsula appear to be intermediate between the two sub-units and it is not clear if the absence of *Allocasuarina fraseriana* is natural or a result of previous harvesting.

**4b Coastal *Banksia ilicifolia*/Peppermint/Sheoak Low Woodland** is common around the Emu Point and Yakamia Creek areas. Sheoak (*Allocasuarina fraseriana*) is co-dominant in the overstorey with *Anarthria scabra* the dominant sedge. Other common species include *Desmocladius flexuosus*, *Acacia pulchella*, *Leucopogon rubricaulis* and *Stylidium repens*.

### Comments

Phytophthora dieback infestations were observed within this unit resulting in the deaths of *Banksia ilicifolia* and *Banksia attenuata* and reducing the floristic and structural diversity of the understorey. Infestations were noted in this unit in Torndirrup NP and in the Emu Point and Yakamia Creek areas. \**Acacia longifolia* seedlings, saplings and mature shrubs were observed scattered within this unit throughout its range.

This unit shares a large number of more resilient species with Jarrah Woodland (11) and *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) and along the coastal fringe these units can be difficult to distinguish, particularly if modified.

This unit is naturally restricted to the coastal fringe and is likely to occur at its eastern limit within the survey area. Key species including *Allocasuarina fraseriana*, *Leucopogon rubricaulis* and *Pultenaea reticulata* reach their eastern limit just east of the survey area where suitable habitat is not known (DEC 2009). Similar vegetation has been reported in the William Bay area (Beard 1979).

### Floristic Summary

Lifeform	%cover	Species
Trees<10m	V-S	<i>Banksia ilicifolia</i> , <i>Banksia attenuata</i> , <i>Allocasuarina fraseriana</i> , <i>Agonis flexuosa</i> , <i>Nuytsia floribunda</i>
Shrubs 1-2m	S-M	<i>Jacksonia horrida</i> , <i>Pultenaea reticulata</i> , <i>Melaleuca thymoides</i> , <i>Leucopogon obovatus</i> , <i>Adenanthos cuneatus</i> , <i>Leucopogon obovatus</i> , <i>Banksia grandis</i>
Shrubs 0.5-1m	S	<i>Leucopogon reflexus</i> , <i>Acacia pulchella</i> , <i>Lysinema ciliatum</i> , <i>Leucopogon rubricaulis</i>
Shrubs <0.5m	V	<i>Astroloma baxteri</i> , <i>Bossiaea praetermissa</i> , <i>Hibbertia racemosa</i> , <i>Petrophile rigida</i> , <i>Andersonia caerulea</i> , <i>Amperea ericoides</i>
Sedges/rushes	V-M	<i>Lepidosperma densiflora</i> , <i>Anarthria scabra</i> , <i>Anarthria prolifera</i> , <i>Schoenus caespititius</i> , <i>Lyginia barbata</i> , <i>Cyathochaeta equitans</i> , <i>Hypolaena exsulca</i> , <i>Mesomelaena gracilipes</i> , <i>Loxocarya cinerea</i> , <i>Desmocladius flexuosus</i>
Herbs	V	<i>Dasyopogon bromeliifolius</i> , <i>Amperea ericoides</i> , <i>Cassytha racemosa</i> , <i>Opercularia hispidula</i> , <i>Cassytha glabella</i>



### Key identifying Features

- Canopy dominated by *Banksia ilicifolia* and *Agonis flexuosa*, often in association with *Banksia attenuata* and *Allocasuarina fraseriana*. *Eucalyptus* species absent.
- Heathland dominated by *Jacksonia horrida*, *Pultenaea reticulata* and *Melaleuca thymoides*.
- Coastal distribution on deep acidic sand.

**Conservation species** *Calectasia cyanea* DRF and *Conospermum quadripetalum* P2 have been recorded in areas mapped as this unit.



### Unit 4 Coastal *Banksia ilicifolia*/Peppermint Low Woodland

## 5 Coastal Limestone Heath

No. of relevés 18 Mean spp. richness 14.6 Area 1849 ha % of Rem. Veg. 4.2 % in IUCN Res.1-IV 40.1

### Description

Coastal Limestone Heath is a heterogeneous group that is restricted to yellow-grey and light grey alkaline sands and limestone soils of the coastal fringe. Several sub units are described with exposure, soil depth, rock cover and time since fire factors influencing the structure and floristic composition of these sub-units. *Scaevola striata* and *Acacia littorea* are often very prominent in the first few years after fire.

This unit forms a mosaic with Coastal Heath (3), *Eucalyptus goniantha*/*Eucalyptus angulosa* Limestone Mallee (6) and Peppermint Low Forest (2).

### 5a Coastal Limestone Tall Shrubland

This sub-unit is common on deeper sand and, in more protected areas, may be overtopped by a sparse canopy of *Agonis flexuosa* with *Hakea oleifolia* occasionally present. Patches dominated by *Adenanthos sericeus* may occur along the coastal fringe and *Scaevola nitida* frequently dominates post-fire. Other common shrubs include *Banksia sessilis*, *Acacia littoralis*, *Allocasuarina lehmanniana*, *Leucopogon parviflorus*, *Spyridium globulosum*, *Acrotriche cordata*, *Platysace compressa* and *Pimelea ferruginea*. The sedgeland is dominated by *Desmocladius flexuosus* and *Lepidosperma densiflora* forma proliferous. Common herbs and grasses include *Opercularia vaginata*, *Conostylis aculeata* subsp *aculeata*, *Haloragis acutangula* and *Poa poiformis*.

### 5b Coastal Limestone Heath

This sub-unit occurs on shallower and more exposed areas than the former sub-unit and is lower in stature. Floristically this sub-unit is transitional between sub-unit 5a and unit 6, lacking many of the taller shrubs of sub-unit 5a and mallees of unit 6 and containing a greater variety of lower shrubs than either. Common shrubs include *Thomasia quercifolia* P2, *Acacia cochlearis*, *Acacia littorea*, *Lysinema ciliatum*, *Acrotriche cordata*, *Pultenaea heteroclila*, *Pultenaea tenuifolia*, *Chorizema ilicifolia*, *Pimelea ferruginea*, *Phyllanthus calycinus*, *Scaevola nitida*, *Spyridium majoranifolium* and *Acacia littorea*. The sedgeland is more diverse and more open than sub-unit 5a with *Gahnia* sp Headland, *Schoenus lanatus*, *Tetraria capillaris* forma limestone, *Desmocladius flexuosus* and *Lepidosperma densiflora* forma proliferous common. Common herbs include *Conostylis aculeata*, *Opercularia vaginata* and *Stylidium fasciculatum*.

### 5c *Banksia praemorsa* Tall Open Scrub.

This sub-unit is most frequent on the seaward slopes and is distinguished by the presence of a *Banksia praemorsa* Tall Open/Closed Scrub strata. *B. praemorsa* may also form a tall shrub stratum over Coastal Heath (3).

### Comments

This unit was mapped as both Heath and Scrub Heath by Beard (1979) and described as part of Peppermint Low Woodland and Scrub Heath mosaic in the Torndirrup System. An extensive area of this unit has been described as common in the consolidated sand dunes in the south western part of Two Peoples Bay (Hopkins *et al.* unpublished), and it was mapped along the coastal fringe of the wind farm area where it was described under "Coastal Heath" and "Inland Heath" (Halpern Glick Maunsell 2000).

This unit is naturally restricted to the coastal fringe with most occurrences on the Meerup landform unit (Churchward *et al* 1988). Heaths occurring on coastal limestone and alkaline sands are common along the southern Western Australian coast however two species sometimes dominant in this unit: *Adenanthos sericeus* and *Banksia praemorsa* are largely restricted to the ARVS context area (DEC 2009).

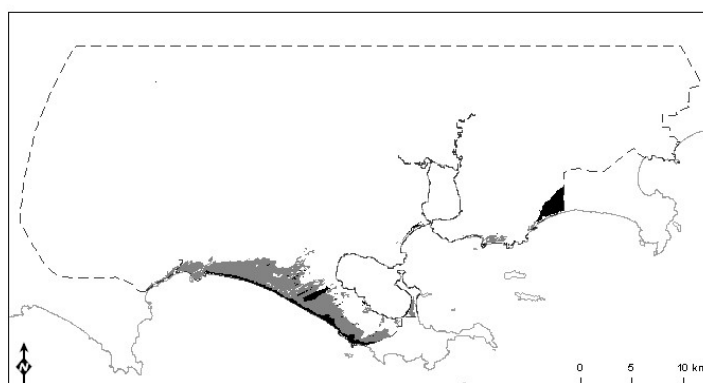
### Key identifying Features

- Mixed tall shrub layer with *Adenanthos sericeus*, *Spyridium globulosum*, *Banksia praemorsa*, *Banksia sessilis*, *Leucopogon parviflorus*, *Acacia littorea*, *Allocasuarina lehmanniana* and *Scaevola nitida* dominant.
- Occurs on coastal sand dunes and adjacent flats with alkaline soils.

**Conservation species** *Thomasia quercifolia* P2, *Adenanthos cunninghamii* P4

## Floristic Summary

Lifeform	%cover	Species
Tree<10m	E	<i>Agonis flexuosa</i> , <i>Hakea oleifolia</i>
Shrubs >2m	V-M	<i>Adenanthos sericeus</i> , <i>Spyridium globulosum</i> , <i>Banksia praemorsa</i> , <i>Banksia sessilis</i> , <i>Templetonia retusa</i>
Shrubs 1-2m	M	<i>Leucopogon parviflorus</i> , <i>Acacia littorea</i> , <i>Allocasuarina lehmanniana</i> , <i>Scaevola nitida</i> , <i>Exocarpos sparteus</i> , <i>Anthocercis viscosa</i> , <i>Melaleuca pentagona</i>
Shrubs 0.5-1m		<i>Acacia cochlearis</i> , <i>Spyridium majoranifolium</i> , <i>Lysinema ciliatum</i> , <i>Westringia dampieri</i>
Shrubs <0.5m	V	<i>Platysace compressa</i> , <i>Acrotriche cordata</i> , <i>Chorizema ilicifolia</i> , <i>Pimelea ferruginea</i> , <i>Scaevola thesioides</i> , <i>Pultenaea heterochila</i> , <i>Thomasia quercifolia</i> , <i>Hibbertia grossulariifolia</i> , <i>Thomasia triphylla</i>
Sedges/rushes	V-D	<i>Lepidosperma densiflora</i> forma proliferous, <i>Desmocladius flexuosus</i> , <i>Gahnia</i> sp Headland, <i>Tetraria capillaris</i> forma limestone, <i>Schoenus lanatus</i> , <i>Lepidosperma gladiatum</i> , <i>Schoenus submicrostachyus</i>
Herbs	V	<i>Conostylis aculeata</i> , <i>Phyllanthus calycinus</i> , <i>Opercularia vaginata</i> , <i>Haloragis acutangula</i> , <i>Stylidium fasciculatum</i> , <i>Senecio pinnatifolius</i>
Grasses	-	<i>Poa poiformis</i>





## 6 *Eucalyptus goniantha/Eucalyptus angulosa* Limestone Mallee

No. of relevés 4 Mean spp. richness 18.8 Area 29 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 100

### Description

*Eucalyptus goniantha/Eucalyptus angulosa* Limestone Mallee is found on moderate to steep limestone outcrops along the coastal dune system. It is distinguished by an open to moderately dense canopy of *Eucalyptus goniantha* subsp *goniantha* and *Eucalyptus angulosa* above two relatively open shrub strata and a very open sedgeland dominated by *Gahnia* sp Headland and *Desmocladius flexuosus* with *Tetraria capillaris* forma limestone and *Schoenus lanatus* common. *Melaleuca pentagona* is the dominant shrub with *Templetonia retusa*, *Adenanthos sericeus* and *Acacia littorea* common. Other typical species include *Acrotriche cordata*, *Spyridium majoranifolium*, *Chorizema ilicifolium*, *Pultenaea heterochila*, *Logania fasciculata*, *Lysinema ciliatum*, *Opercularia vaginata* and *Stylidium fasciculatum*.

This unit occurs as a mosaic with Coastal Limestone Heath (5) and Coastal Heath (3) and it shares many species with Coastal Limestone Heath, particularly sub-unit 5b, differing in the presence of a mallee canopy and *Melaleuca pentagona* and lacking many tall shrub species. This unit differs from another *E. goniantha* subsp *goniantha/E. angulosa* dominated unit *Eucalyptus goniantha* Mallee (20) by its much greater floristic and structural diversity and its occurrence on limestone.

### Comments

This unit is likely to have a limited distribution based on the rarity of the landform and geology, and it is possibly restricted to the survey area. The area of overlap of key species including *Eucalyptus goniantha* subsp *goniantha*, *Eucalyptus angulosa*, *Melaleuca pentagona*, *Stylidium fasciculatum* and *Gahnia* sp Headland and less frequent species such as *Adenanthos sericeus* and *Banksia praemorsa* is limited to the survey area and east to Cheyne Bay.

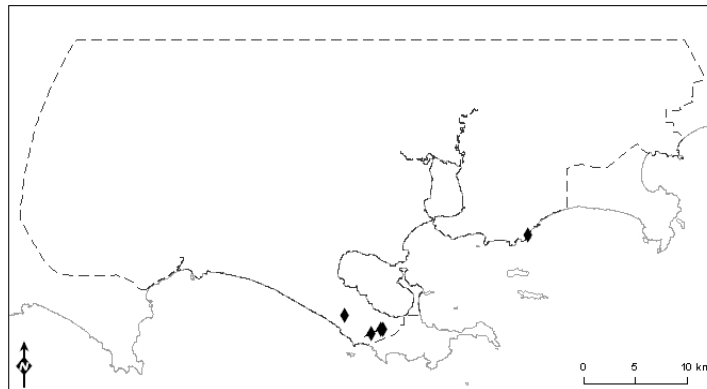
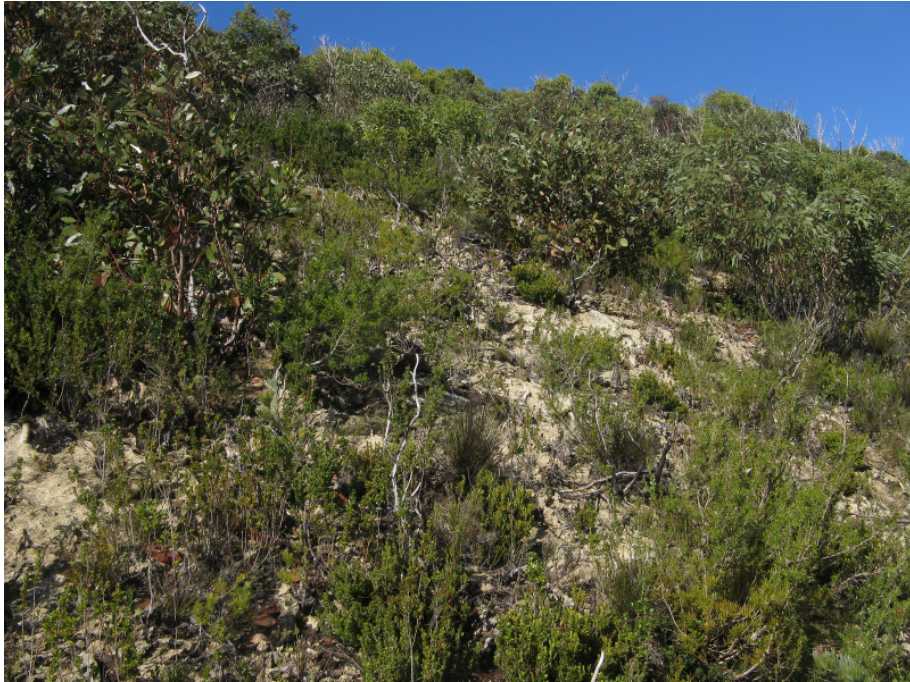
### Floristic Summary

Lifeform	%cover	Species
Mallee <8m	V-M	<i>Eucalyptus goniantha</i> subsp <i>goniantha</i> , <i>Eucalyptus angulosa</i>
Shrubs 1m - >2m	S	<i>Melaleuca pentagona</i> , <i>Templetonia retusa</i> , <i>Acacia littorea</i> , <i>Adenanthos sericeus</i> , <i>Spyridium globulosum</i> , <i>Exocarpos sparteus</i> , <i>Scaevola nitida</i> , <i>Banksia praemorsa</i> , <i>Banksia sessilis</i>
Shrubs 0.5-1m	S	<i>Acrotriche cordata</i> , <i>Spyridium majoranifolium</i> , <i>Chorizema ilicifolium</i> , <i>Pultenaea heterochila</i> , <i>Logania fasciculata</i> , <i>Lysinema ciliatum</i> , <i>Platysace compressa</i>
Sedges/rushes	V	<i>Gahnia</i> sp Headland, <i>Schoenus lanatus</i> , <i>Tetraria capillaris</i> forma limestone, <i>Desmocladius flexuosus</i> , <i>Lepidosperma</i> sp Mt Burdett, <i>Lepidosperma densiflora</i> forma proliferous, <i>Lepidosperma carphoides</i>
Herbs	V	<i>Stylidium fasciculatum</i> , <i>Opercularia vaginata</i> , <i>Cassytha racemosa</i>

### Key identifying Features

- Canopy of *Eucalyptus goniantha* subsp *goniantha* and *Eucalyptus angulosa* over well developed shrub layers with *Melaleuca pentagona*.
- Sparse sedge layer including *Gahnia* sp Headland, *Desmocladius flexuosus*, *Tetraria capillaris* forma "limestone", *Lepidosperma* sp Mt Burdett and *Schoenus lanatus*.
- Occurs on skeletal soils on steep to moderate coastal limestone outcrops.

**Conservation species** *Eucalyptus goniantha* subsp *goniantha* P4



**Unit 6 *Eucalyptus goniantha*/*Eucalyptus angulosa* Limestone Mallee**

## 7 *Leucophyta brownii* Coastal Shrubland/Grassland

No. of relevés 1 Mean spp. richness 18 Area <1 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

*Leucophyta brownii* Coastal Shrubland /Grassland was recorded near Nanarup occurring on gravelly calcareous sand on a granite headland. A low open shrubland dominated by *Leucophyta brownii* occurs above *Austrostipa juncifolia*/*Poa poiformis* Closed Grassland with scattered taller shrubs including *Leucopogon parviflorus*, *Maireana oppositifolia*, and *Westringia dampieri* present. Other species present are salt tolerant.

### Comments

This unit was only encountered once and further survey of similar habitat would be required to fully describe this unit. Small areas of *Leucophyta brownii* dominated low shrublands have been observed along the windswept fringe of Torndirrup NP and similar low shrublands were recorded on Michaelmas, Breaksea and Eclipse Islands but appear to lack *A. juncifolia* (Abbott 1981).

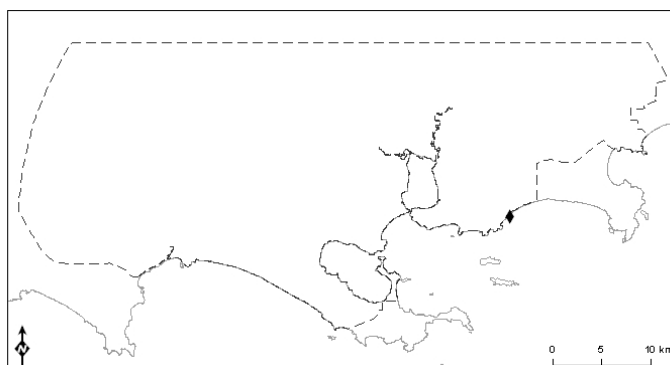
### Floristic Summary

Lifeform	%cover	Species
Shrubs <0.5m	V	<i>Leucophyta brownii</i> , <i>Leucopogon parviflorus</i> , <i>Maireana oppositifolia</i> , <i>Westringia dampieri</i> , <i>Tetragonia implexicoma</i>
Sedges/rushes		<i>Ficinia nodosa</i> , <i>Desmocladus flexuosus</i>
Herbs		<i>Disphyma crassifolia</i> , <i>Sarcocornia quinqueflora</i> , <i>Samolus repens</i> , <i>Senecio pinnatifida</i> , <i>Gnaphalium indutum</i> , <i>Triglochin trichophora</i> , <i>Crassula</i> sp, <i>*Sagina maritima</i>
Grasses	D	<i>Austrostipa juncifolia</i> , <i>Poa poiformis</i> , <i>Sporobolus virginicus</i>

### Key identifying Features

- Dominance of *Austrostipa juncifolia*, *Poa poiformis* and *Leucophyta brownii*
- Occurs on calcareous sands on rocky coastal slopes exposed to salt spray.

Conservation species None recorded





## 8 Beach Herbland/Grassland

No. of relevés 2 Mean spp. richness 5.2 Area 22 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 23.1

### Description

Beach Herbland/Grassland is a colonizing unit that occurs on beaches above the high water mark and on some fore dunes. This unit is transitional, subject to erosion by storm wave action or invasion by secondary successional species and changing to Coastal Limestone Heath (4). The unit varies from an open herbland to a closed grassland with most species present introduced. Common species include *Spinifex hirsutus*, *Lepidosperma gladiatum*, *\*Spinifex sericeus*, *\*Ammophila arenaria*, *\*Lagurus ovatus*, *Ficinia nodosa*, *\*Cakile maritima*, *\*Arctotheca calendula*, *Carpobrotus* sp, *\*Pelargonium capitatum* and *\*Euphorbia paralias*. Occasional shrubs may be present. Species present are salt tolerant and many were only recorded in this unit.

### Comments

This unit is vulnerable to destruction by vehicle movement. Due to the high number of introduced species, sites within this unit were not included in any analysis. It is naturally restricted to the upper beach margin and is widespread along beaches in south west WA.

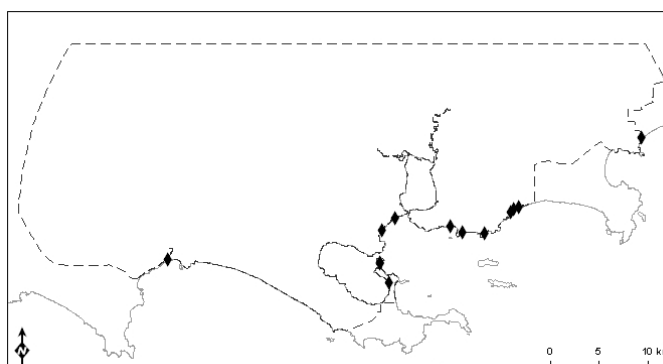
### Floristic Summary

Lifeform	%cover	Species
Shrubs <0.5m		+/- <i>Spyridium globulosum</i> , <i>Acacia littoralis</i> , <i>Scaevola nitida</i> , <i>Leucopogon parviflorus</i>
Sedges/rushes	V-M	<i>Spinifex hirsutus</i> , <i>Lepidosperma gladiatum</i> , <i>*Spinifex sericeus</i> , <i>*Ammophila arenaria</i> , <i>*Lagurus ovatus</i> , <i>Ficinia nodosa</i>
Herbs	S	<i>*Cakile maritima</i> , <i>*Arctotheca calendula</i> , <i>*Carpobrotus</i> sp <i>*Pelargonium capitatum</i> , <i>*Crassula glomerata</i> and <i>*Euphorbia paralias</i>

### Key identifying Features

- Presence of *Spinifex hirsutus*, *\*Spinifex sericeus*, *\*Ammophila arenaria*, *\*Cakile maritima*, *\*Arctotheca calendula* and *\*Euphorbia paralias*.
- Confined to upper limits of beaches and fore dunes.

**Conservation species** *Poa billardiarei* P1 (ex *Austrofestuca littoralis*) has previously been recorded within this unit



## 9 Karri Forest

No. of relevés 11 Mean spp. richness 10.6 Area 885 ha % of Rem. Veg. 2.0 % in IUCN Reserve 1-IV 1.6

### Description

Karri Forest is found in the southern and south western areas of the survey area with isolated pockets along the north-west boundary. It is distinguished by the dominance of *Eucalyptus diversicolor* (Karri) trees in the canopy. Three sub-units are described, differing in floristic composition, landform and soil type and distribution. However, two of these sub-units were poorly sampled and further survey is required to clarify floristic differences.

#### Sub-units:

**9a Coastal Karri Forest** is found in a scattered band on the flats and lower slopes north of the coastal hills from Goode Beach to Torbay Townsite, with isolated pockets occurring south of Manypeaks. It often occurs on grey sand often overlying limestone and typically it is an open forest, occasionally reaching > 30 m in height. *Eucalyptus cornuta* is often a sub-dominant canopy species and *Agonis flexuosa* forms an open secondary tree stratum. The understorey shrubs vary from a closed tall scrub on very moist sites to a tall open scrub or open heath over open sedgeland. Common species include *Chorilaena quercifolia*, *Trymalium odoratissimum*, *Thomasia solanacea*, *Hibbertia furfuracea*, *Bossiaea linophylla*, *Tremandra stelligera*, *Lepidosperma effusum*, *Ficinia nodosa*, *Gahnia sclerioides* and *Desmocladius flexuosus*. The climbers *Hardenbergia comptoniana*, *Clematis pubescens* and *Billardiera variifolia* are frequently prominent. This sub-unit often grades into *Eucalyptus cornuta* Open Forest on drier sites.

### 9b Karri Tall Open Forest

This sub-unit is found on the deep red Karri loams on the hills around Torbay, Bornholm and Torbay townsite. This unit was poorly sampled (1 relevé) and is differentiated from the Coastal Karri sub-unit by the presence and/or dominance of *Allocasuarina decussata* and/or *Acacia pentadenia* in the lower tree/upper shrub strata and the absence of *Thomasia solanacea* and *Templetonia retusa*. This sub-unit occasionally merges with sub-unit 9a on the lower slopes/flats of hills near Bornholm and Torbay townsite where colluvial sands occur. An unsurveyed pocket in the Goode Beach area also appears transitional with subunit 9a with *Acacia pentadenia* present (WA Herbarium records). Other common species include *Agonis flexuosa*, *Hibbertia furfuracea*, *Trymalium odoratissimum* and *Bossiaea linophylla*. This unit often occurs upslope of Marri/Jarrah Forest/Peppermint Woodland (10) and appears to have close floristic affinities with Karri forests in the Denmark Walpole/Manjimup area with *Allocasuarina decussata* and *Acacia pentadenia* in the understorey.

### 9c Redmond Karri Forest

This sub-unit was recorded on the north west boundary of the survey area along a broad valley on skeletal soils overlying a very dark exposed lateritic rock. All areas had been recently burnt (2002) and post fire opportunistic species including *Rulingia corylifolia*, *Acacia pulchella* and *Opercularia hispidula* were dominant beneath a *Bossiaea linophylla* Tall Open Scrub. Other species present were *Leucopogon obovatus*, *Cyathochaeta avenacea*, *Ficinia nodosa*, *Opercularia hispidula*, *Pteridium esculentum*, *Xanthosia candida* and *Tetrarrhena laevis*.

### Comments

The Karri forests observed on several previously cleared remnants on the plains south of Manypeaks have regenerated well following fencing and the presence of *Chorilaena quercifolia* and *Templetonia retusa* suggest they belong to sub-unit 9a.

Karri forests are common throughout the Warren Botanical District with the eastern limit occurring on the slopes of Mt Manypeaks just east of the survey area. An outlying population occurs in the Porongurup Range north of the context area. The floristic similarity of Karri forests outside the study area to the sub-units recorded here has not been assessed. The occurrence of sub-unit 9c on skeletal dark lateritic soil may be unusual as Karri forests are typically found on deep loam or sand.

## Floristic Summary

Lifeform	%cover	Species
Trees 10-30m	M	<i>Eucalyptus diversicolor</i> , <i>Eucalyptus cornuta</i>
Trees <10 m	V	<i>Agonis flexuosa</i> , <i>Allocasuarina decussata</i> , <i>Hakea oleifolia</i>
Shrubs >2m	S-M	<i>Trymalium odoratissimum</i> , <i>Chorilaena quercifolia</i> , <i>Thomasia solanacea</i> , <i>Hibbertia furfuracea</i> , <i>Bossiaea linophylla</i> , <i>Templetonia retusa</i> , <i>Acacia pentadenia</i> , <i>Rulingia corylifolia</i>
Shrubs <2m	V	<i>Acacia alata</i> , <i>Tremandra stelligera</i>
Sedges/rushes	V	<i>Lepidosperma effusum</i> , <i>Ficinia nodosa</i> , <i>Desmocladus flexuosus</i> , <i>Lepidosperma squamatum</i> , <i>Lepidosperma densiflora</i>
Herbs	V	<i>Opercularia hispidula</i> , <i>Hardenbergia comptoniana</i> , <i>Clematis pubescens</i> , <i>Billardiera variifolia</i> , <i>Lagenophora huegelii</i> , <i>Pteridium esculentum</i>
Grasses		<i>Tetrarrhena laevis</i> , <i>Poa porphyroclados</i> , <i>Microlaena stipoides</i>

## Key identifying Features

- Canopy of *Eucalyptus diversicolor* (Karri).

**Conservation species** *Thomasia solanacea* P3, *Gahnia sclerioides* P3



## Unit 9 Karri Forest

## 10 Marri/Jarrah Forest/Peppermint Woodland

No. of relevés 24 Mean spp. richness 18.5 Area 1597 ha % of Rem. Veg. 3.6 % in IUCN Reserve 1-IV 6.7

### Description

Marri/Jarrah Forest/Peppermint Woodland is found scattered in the southern half of the survey area occurring on well drained sand and sandy loam on hill slopes and adjacent to larger creeks and rivers. The structure varies from a low open forest on exposed coastal slopes to open forest in protected gullies. *Eucalyptus marginata* may be a sub-dominant canopy species with *Agonis flexuosa* usually forming a sparse secondary tree stratum. The understorey is not very diverse and often dominated by a *Hibbertia furfuracea* Open Heath over *Tremandra stelligera* Low Open Shrubland, Mixed Open Sedgeland and *Pteridium esculentum* Herbland. A tall shrubland of *Bossiaea linophylla* is sometimes present with *Gastrolobium bilobum* present near granite outcrops and *Trymalium odoratissimum* and *Lasiopetalum floribundum* present on wetter sites. Sedges include those typical of both sandy and granitic soils and the grasses *Tetrarrhena laevis* and *Microlaena stipoides* frequently occur on damper sites. Along the coastal hills this unit usually merges with Marri/Jarrah Coastal Hills Forest (17) which occurs on drier shallow soils and with *Gastrolobium bilobum*/*Hakea elliptica* Granite Shrubland/Yate Woodland around granite outcrops. Along creek lines this unit often merges upslope with Jarrah/Marri/Sheoak Laterite Forest (12) and on the western hills occurs downslope of Karri Forest (9).

Three sub-units are described:

**10a Marri/Jarrah Forest/Peppermint Woodland** - described above.

### 10b Western Marri/Jarrah Forest/Peppermint Woodland

This sub-unit was only recorded in the south western corner of the survey area occurring on lower hill slopes. *Agonis flexuosa* is less prominent in this sub-unit which is usually an open forest, and *Hakea oleifolia* and *Macrozamia riedlei* are common. Other common species include *Bossiaea linophylla*, *Hibbertia furfuracea*, *Hibbertia cuneiformis*, *Leucopogon obovatus*, *Tremandra stelligera*, *Lepidosperma* aff *squamatum*, *Anarthria scabra*, *Tremandra stelligera*, *Pteridium esculentum* and *Patersonia umbrosa*. Much of this sub-unit has been parkland cleared and thus is difficult to distinguish from parkland cleared areas of unit 12.

### 10c Damp Marri/Jarrah Forest/Peppermint Woodland

This sub-unit was only recorded in gullies or on southern hill slopes with the presence of *Lasiopetalum floribundum* and/or *Trymalium odoratissimum* indicative of the damper nature of this sub-unit. Other distinctive species include *Stylidium falcatum* and *Lepidosperma* sp Mt Taylor with *Agonis flexuosa* uncommon.

### Comments

Many *Acacia longifolia* saplings and seedlings were observed within this unit.

Similar vegetation has been observed west of the survey area and it is likely to be common in the wetter south west forest region and it possibly extends east of the survey area to the slopes of Mt Manypeaks. In the south western parts of the survey area where only a canopy of Marri and Jarrah occurs over pasture it is difficult to distinguish this unit from unit 12, and the extent of this unit may have been over or under mapped.

### Floristic Summary

Lifeform	%cover	Species
Trees <10-<30m	M	<i>Corymbia calophylla</i> , <i>Eucalyptus marginata</i>
Trees<10m	V	<i>Agonis flexuosa</i>
Shrubs >2m	V-D	<i>Bossiaea linophylla</i> , <i>Hovea elliptica</i> , <i>Hakea florida</i> , <i>Leucopogon verticillatus</i> , <i>Hibbertia cuneiformis</i> , <i>Hakea oleifolia</i> , <i>Lasiopetalum floribundum</i> , <i>Trymalium odoratissimum</i> , <i>Gastrolobium bilobum</i>
Shrubs 1-2m	V-	<i>Leucopogon obovatus</i> , <i>Logania vaginalis</i> , <i>Hovea elliptica</i>
Shrubs 0.5-1m	V	<i>Tremandra stelligera</i> , <i>Crowea angustifolia</i> subsp <i>angustifolia</i> , <i>Xanthosia rotundifolia</i> , <i>Macrozamia riedlei</i>
		<i>Hibbertia amplexicaulis</i>
Sedges/rushes	V-M	<i>Cyathochaeta avenacea</i> , <i>Lepidosperma gracile</i> , <i>Tetrandra octandra</i> , <i>Tetraria capillaris</i> , <i>Lepidosperma</i> aff <i>angustatum</i> , <i>Lepidosperma densiflora</i> , <i>Anarthria scabra</i> , <i>Desmocladus flexuosus</i> , <i>Anarthria prolifera</i> , <i>Loxocarya cinerea</i>
Herbs	V	<i>Pteridium esculentum</i> , <i>Lomandra pauciflora</i> , <i>Opercularia hispidula</i> , <i>Billardiera variifolia</i> , <i>Patersonia umbrosa</i>
Grasses	—	<i>Tetrarrhena laevis</i> , <i>Microlaena stipoides</i>



### Key identifying Features

- Canopy dominated by *Corymbia calophylla* with a lower tree stratum of *Agonis flexuosa* usually present.
- *Hibbertia furfuracea*, *Bossiaea linophylla*, *Hakea oleifolia* and *Tremandra stelligera* dominant in the understorey with *Pteridium esculentum* common in the ground stratum.
- Occurs on well drained sandy loam and sand on hill slopes and adjacent creeks and rivers.

**Conservation species** *Stylidium falcatum* P2, *Gahnia sclerioides* P3



### Unit 10 Marri/Jarrah Forest/Peppermint Woodland



## 11 Jarrah Woodland

No. of relevés 8 Mean spp. richness 20.3 Area 171 ha % of Rem. Veg. 0.4 % in IUCN Reserve 1-IV 0.8

### Description

Jarrah Woodland is found on grey sand on lower to middle slopes in coastal and near coastal hills from near Young Siding to Mt Clarence and the Vancouver Peninsula. It is not as diverse floristically as other Jarrah dominated units and has an understorey dominated by species typical of deep well-drained sandy soils. The canopy is relatively open with *Banksia ilicifolia* and *Corymbia calophylla* occasionally present. The understorey is often a *Taxandria parviceps* tall shrubland above one or two lower open shrub layers, an *Anarthria scabra*/*Hypolaena exsulca* Sedgeland and mixed open herbland dominated by *Dasypogon bromeliifolius*, and/or *Patersonia umbrosa* and *Pteridium esculentum*. Common understorey shrubs include *Pultenaea reticulata*, *Melaleuca thymoides*, *Acacia pulchella*, *Bossiaea praetermissa*, *Leucopogon rubricaulis*, *Xanthosia rotundifolia* and *Boronia crenulata*.

In western areas, Jarrah Woodland often occurs down slope from Marri/Jarrah Forest/Peppermint Woodland (10) and upslope of *Eucalyptus patens* Low Woodland (33).

This unit has floristic affinities with Coastal *Banksia ilicifolia*/Peppermint Low Woodland (4) but differs in the presence and dominance of *Eucalyptus marginata*, *Taxandria parviceps*, *Pteridium esculentum* and *Patersonia umbrosa* and the absence of *Agonis flexuosa*, *Adenanthos cuneatus*, *Astroloma baxteri*, *Amperea ericoides* and *Hibbertia racemosa*. Around Quaranup and the lower slopes of Mt Adelaide these two units appear to intergrade.

### Comments

The extent of this unit outside of the survey area is not known, however, it is likely to be at or near its eastern limit within the survey area given the distribution of common species. This unit has some floristic affinities with the super community group A, recorded by Wardell-Johnson and Williams (1996) in the Walpole/Nornalup area.

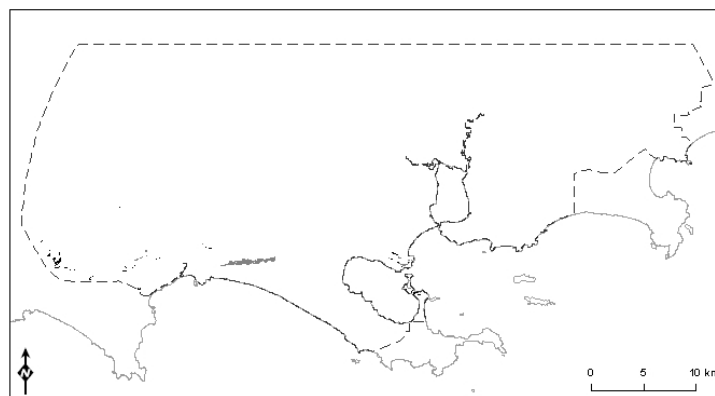
### Floristic Summary

Lifeform	%cover	Species
Trees<10m	V-S	<i>Eucalyptus marginata</i> , <i>Banksia ilicifolia</i> , +/- <i>Corymbia calophylla</i>
Shrubs >2m	V-M	<i>Taxandria parviceps</i>
Shrubs 1-2m	V-M	<i>Pultenaea reticulata</i> , <i>Leucopogon obovatus</i> , <i>Melaleuca thymoides</i> , <i>Acacia pulchella</i> , <i>Bossiaea praetermissa</i> , <i>Leucopogon rubricaulis</i> , <i>Hibbertia cuneiformis</i>
Shrubs <1m	V-S	<i>Xanthosia rotundifolia</i> , <i>Bossiaea praetermissa</i> , <i>Boronia crenulata</i> , <i>Hypocalymma strictum</i> , <i>Tremandra diffusa</i>
Sedges/rushes		<i>Anarthria scabra</i> , <i>Hypolaena exsulca</i> , <i>Anarthria prolifera</i> , <i>Loxocarya cinerea</i> , <i>Lepidosperma densiflora</i> forma <i>densiflora</i>
Herbs	V	<i>Dasypogon bromeliifolius</i> , <i>Patersonia umbrosa</i> , <i>Pteridium esculentum</i> , <i>Platysace filiformis</i> , <i>Cassytha racemosa</i> , <i>Phlebocarya ciliata</i> , <i>Billardiera laxiflora</i> , <i>Lindsaea linearis</i>

### Key identifying Features

- Low open canopy of *Eucalyptus marginata* +/- *Banksia ilicifolia* over a relatively open understorey with species typical of well drained sandy soils including *Taxandria parviceps*, *Pultenaea reticulata*, *Pteridium esculentum*, *Dasypogon bromeliifolius* and *Patersonia umbrosa*.
- Occurrence on grey sand on lower-mid slopes in coastal and near coastal areas.

**Conservation species** None recorded



### **Unit 11 Jarrah Woodland**

## 12 Jarrah/Marri/Sheoak Laterite Forest

No. of relevés 40 Mean spp. richness 25.7 Area 13144 ha % of Rem. Veg. 29.8 % in IUCN Res. 1-IV 9.8

### Description

Jarrah/Marri/Sheoak Laterite Forest is found on well drained shallow loamy/sandy soil, with outcropping laterite, usually occurring on the crests and middle slopes of low relief hills and plateaus with occasional occurrences on lower slopes. It has a strong affinity with the Dempster landform unit (Churchward *et al* 1988).

Canopy structure varies from a low woodland to an open forest and both *Eucalyptus marginata* and *Allocasuarina fraseriana* may be present as sole canopy species. *Banksia grandis* is often present as a secondary tree strata or a tall shrub layer. The understorey is often relatively open though structurally diverse with shrub, sedge and herb layers well developed. Common shrub species include *Bossiaea linophylla*, *Beaufortia decussata*, *Hakea florida*, *Hakea amplexicaulis*, *Agonis theiformis*, *Leucopogon verticillatus*, *Isopogon longifolius*, *Xanthorrhoea platyphylla*, *Acacia browniana* subsp *browniana*, *Xanthosia rotundifolia*, *Tetratheca setigera*, *Sphaerolobium alatum*, *Hovea chorizemifolia*, *Hibbertia amplexicaulis* and in western areas *Bossiaea ornata*. The sedge layer is typified by the co-dominance of four sedges *Anarthria prolifera*, *Tetraria octandra*, *Tetraria capillaris* and *Desmocladius fasciculatus* with *Cyathochaeta avenacea* and *Lepidosperma gracile* occasionally present. Common herbs include *Stylidium amoenum*, *Conostylis setigera*, *Logania serpyllifolia*, *Patersonia umbrosa*, *Opercularia hispidula*, *Lomandra pauciflora*, *Lindsaea linearis* and *Lomandra sericea*.

This unit typically occurs upslope of Jarrah/Sheoak/E. *staeri* Sandy Woodland (13) with the boundary usually marked by a distinct change in sedge species with *Anarthria scabra* and/or *Cyathochaeta equitans* dominant in the latter unit. Where drainage is impeded over laterite soils, this unit often abuts *Hakea* spp Shrubland/Woodland Complex (31). It is floristically most similar to Marri/Jarrah Coastal Hills Forest (17) and differs in its more open structure, the absence of *Hibbertia furfuracea*, *Crowea angustifolia*, *Hovea elliptica*, *Hakea elliptica*, *Gastrolobium coriaceum*, *Chorizema rhombeum*, and *Stylidium spathulatum* and rarity of *Banksia formosa* and *Hakea trifurcata*.

4 sub-units are described

**12a Jarrah/Marri/Sheoak Laterite Forest** Described above. It is the most common of the sub-units.

**12b Jarrah/Marri/Sheoak Forest over *Banksia serra* Tall Shrubland.** The presence of a *Banksia serra* Tall Shrubland distinguishes this sub-unit. *Banksia squarrulosa* may also be present. Large areas of this sub-unit were recorded in and near Mill Brook Nature Reserve and in parts of Redmond State Forest. *Banksia serra* P4 and *Banksia squarrulosa* are highly susceptible to *Phytophthora dieback*.

**12c Jarrah/Sheoak Woodland/*Daviesia preissii*/*Banksia dallanneyi* Low Shrubland.**

This sub-unit was restricted to gritty colluvial soils overlying laterite in the Redmond State Forest area and is distinguished by a more open understorey with *Daviesia alternifolia*, *Daviesia preissii*, *Banksia dallanneyi*, *Hakea lissocarpha*, *Hibbertia* sp. L543 and *Mesomelaena stygia* present. This sub-unit may occur to the west of the survey area and further survey is required to determine its floristic composition and affinities.

**12d Jarrah/Sheoak Forest/*Podocarpus drouynianus* Low Shrubland**

This sub-unit was only recorded on the far western edge the survey area in Redmond State Forest and is distinguished by the presence of *Podocarpus drouynianus* and *Grevillea quercifolia* which are more common to the west suggesting that this sub-unit may have greater affinities with Jarrah/Casuarina open forest/woodlands to the west and may mark the western limit of Jarrah/Marri/Sheoak Laterite Forest (12).

### Comments

As this unit shares the same canopy species with a number of other units, it has a very similar or identical aerial photographic pattern, making interpretation from aerial photography difficult. Existing landform and soil data sets within the survey area were not on a fine enough scale to accurately determine boundaries from the desktop and it is probable that this unit has been over mapped particularly in transformed or modified areas on private property where soil type, hydrology and understorey species were unknown.

Dieback infestations were observed within this unit throughout the survey area and are marked by reduced floristic diversity and a more open understorey. The most obvious changes are the removal of taller shrub species including *Banksia grandis*, *B. serra* and *Petrophile diversifolia*. The absence of serotinous obligate re-seeders such as *B. serra* and *B. squarrulosa* may also reflect multiple fires over a short time span.

Many infestations of *\*Acacia longifolia* were observed within this unit including along the northern and north-western parts of the survey area.

Areas modified by grazing and/or frequent fire were usually reduced to an understorey of *Agonis theiformis* over very scattered low shrubs and an open sedgeland with weed invasion apparently limited by the skeletal nature of the soil.

Harvesting of *Allocasuarina fraseriana* for barrel making and other purposes occurred in the first half the 20<sup>th</sup> century. This practice appears extensive as the 1954 Albany Shire minutes record a motion to investigate a reforestation program due to the lack of good trees, (M. Traill, Albany History Collection, pers. comm.). It is not known if harvesting has permanently removed *Allocasuarina fraseriana* from some areas or altered the dominance of this species in the canopy. Stumps and barrel lengths are still evident and some were observed remote from tracks in Bakers Junction, Down Road and Goodga River Nature Reserves.

This unit is the most widespread of the Jarrah/Casuarina and/or Marri dominated woodland/forest units within the survey area and may be restricted to the ARVS context area. Its floristic similarity with other Jarrah units to the west of the study has not been fully assessed, however, the paucity or absence of species such as *Bossiaea ornata*, *Acacia extensa*, *Podocarpus drouynianus*, *Hakea lissocarpha* and *Grevillea quercifolia* suggest that there may be significant floristic differences between these areas.

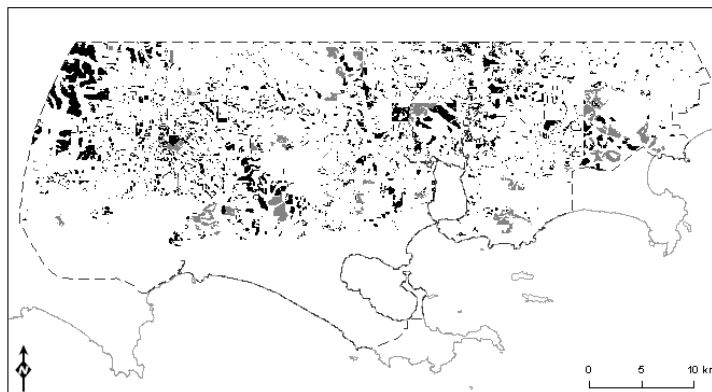
#### Floristic Summary (sub-unit 12a)

Lifeform	%cover	Species
Trees	S-M	<i>Eucalyptus marginata</i> , <i>Allocasuarina fraseriana</i> , +/- <i>Corymbia calophylla</i>
Trees<10m	V	<i>Banksia grandis</i>
Shrubs >2m	S	<i>Bossiaea linophylla</i> , <i>Beaufortia decussata</i> , <i>Hakea florida</i> , <i>Hakea amplexicaulis</i> , <i>Persoonia longifolia</i> , <i>Taxandria parviceps</i> , <i>Petrophile diversifolia</i> , <i>Banksia serra</i> , <i>Banksia squarrulosa</i> , +/- <i>Hakea trifurcata</i>
Shrubs 1-2m	S	<i>Agonis theiformis</i> , <i>Leucopogon verticillatus</i> , <i>Grevillea occidentalis</i> , <i>Isopogon longifolius</i> , <i>Xanthorrhoea platyphylla</i> , <i>Acacia browniana</i> subsp <i>browniana</i> , <i>Bossiaea dentata</i> , <i>Leptomeria squarrulosa</i> , <i>Hakea ruscifolia</i>
Shrubs 0.5-1m	V-S	<i>Xanthosia rotundifolia</i> , <i>Bossiaea ornata</i> , <i>Tetratheca setigera</i> , <i>Sphaerolobium alatum</i> , <i>Boronia spathulata</i> , <i>Gompholobium polymorphum</i> , <i>Gompholobium confertum</i> , <i>Tetratheca affinis</i> , <i>Boronia crenulata</i> , <i>Sphaerolobium medium</i> , <i>Grevillea fasciculata</i>
Shrubs <0.5m	V	<i>Hovea chorizemifolia</i> , <i>Hibbertia amplexicaulis</i> , <i>Pimelea hispida</i> , <i>Astroloma pallidum</i> , <i>Grevillea pulchella</i> , <i>Hovea trisperma</i> , <i>Gompholobium knightianum</i>
Sedges/rushes	V-S	<i>Anarthria prolifera</i> , <i>Tetraria octandra</i> , <i>Tetraria capillaris</i> , <i>Desmocladus fasciculatus</i> , +/- <i>Lepidosperma densiflora</i> , <i>Lepidosperma gracile</i> , <i>Cyathochaeta avenacea</i> , <i>Mesomelaena gracilipes</i>
Herbs	V	<i>Stylidium amoenum</i> , <i>Stylidium plantagineum</i> , <i>Conostylis setigera</i> , <i>Logania serpyllifolia</i> , <i>Patersonia umbrosa</i> , <i>Opercularia hispidula</i> , <i>Lomandra pauciflora</i> , <i>Lindsaea linearis</i> , <i>Billardiera variifolia</i> , <i>Conospermum caeruleum</i> , <i>Lomandra sericea</i> , <i>Cassytha racemosa</i>
Grasses		<i>Amphipogon amphipogonoides</i>

#### Key identifying Features

- Canopy of *Eucalyptus marginata* and *Allocasuarina fraseriana* over a relatively open though diverse understorey dominated by *Bossiaea linophylla*, *Agonis theiformis* and *Xanthosia rotundifolia* with *Banksia grandis* often present as a tall shrub strata. Open sedgeland of *Tetraria octandra*, *Tetraria capillaris*, *Desmocladus fasciculatus* and *Anarthria prolifera*.
- Occurs on well-drained lateritic soil.

**Conservation species** *Stylidium plantagineum* P4, *Banksia serra* P4, *Chorizema reticulatum* P4, *Andersonia depressa* P4



**Unit 12 Jarrah/Marri/Sheoak Laterite Forest**

### 13 Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland

No. of relevés 41 Mean spp. richness 28 Area 5148 ha % of Rem. Veg. 11.7 % in IUCN Res. 1-IV 25.8

#### Description

Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland is usually found on gentle middle to lower slopes on sandy soil overlying laterite. This unit usually occurs between Jarrah/Marri/Sheoak Laterite Forest (12) and *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) and shares many species with these units. The understorey is typically very diverse though species and structural diversity decreases with age. A low open woodland of *Banksia attenuata* and less frequently *Banksia ilicifolia* is often present as a secondary tree strata over a tall open scrub, open heath, low shrubland, sedgeland and herbland. Dominant understorey species include *Banksia grandis*, *Beaufortia decussata*, *Persoonia longifolia*, *Melaleuca thymoides*, *Adenanthos cuneatus*, *Agonis theiformis*, *Isopogon longifolius*, *Leucopogon glabellus*, *Gompholobium scabrum*, *Daviesia flexuosa*, *Daviesia incrassata*, *Xanthosia rotundifolia*, *Beaufortia anisandra*, *Astroloma baxteri*, *Cyathochaeta equitans*, *Anarthria scabra*, *Tricostularia elatior* subsp. *elatior*, *Anarthria prolifera* and *Dasypogon bromeliifolius*. On lower slopes *Eucalyptus marginata* is usually absent and *Taxandria parviceps* is often the dominant shrub over a less diverse lower shrub layer and dense *Anarthria scabra*, *Dasypogon bromeliifolius* sedgeland/herbland.

This unit often occurs upslope of *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) with the boundary marked by a more open tree strata, the dominance of *Banksia coccinea* and *Jacksonia spinosa* in the latter unit and absence of species typical of laterite soil including *Eucalyptus marginata*, *Banksia grandis*, *Agonis theiformis*, *Persoonia longifolia* and *Isopogon longifolius*. Upslope it abuts Jarrah/Marri/Sheoak Laterite Forest (12) from which it differs in the presence of many species typical of sandy soil including *Banksia attenuata*, *Adenanthos cuneatus*, *Melaleuca thymoides*, *Cyathochaeta equitans* and *Anarthria scabra*.

#### Comments

Key structural components of this unit are highly susceptible to Phytophthora dieback including *Banksia attenuata*, *B. grandis*, *B. ilicifolia*, *Gompholobium* spp. and *Daviesia* spp. and occurrences with dieback infestations were structurally and floristically depauperate.

Numerous *Acacia longifolia* seedlings and shrubs were observed in this unit, with older infestations forming dense thickets over very sparse lower shrub/sedge strata.

Within the survey area, most of the predicted habitat for this unit (well drained sandy soil) has been cleared. Based on the distribution of many common species, this unit reaches its eastern limit within or near the survey area and it may be restricted to the study area. It has floristic affinity with Community group A1, consisting of three units, described by Wardell-Johnson and Williams (1996) as “forest/sandplain ecotone” in the Walpole Nornalup area. Direct comparison with this group is difficult in the absence of unit descriptions, however, several common species in unit 13 are absent in Community group A1 including *Gompholobium scabrum*, *G. villosum*, *Beaufortia anisandra*, *Hakea ruscifolia* and *Conostylis serrulata*. Several frequently recorded species in Community group A1 were absent in this unit including *Leucopogon capitellatus*, *Leptocarpus tenax*, *Chaetanthes aristatus*, *Jacksonia furcellata* and *Agonis flexuosa*. Further survey in the intervening areas would be required to determine if these differences are significant.

#### Key identifying Features

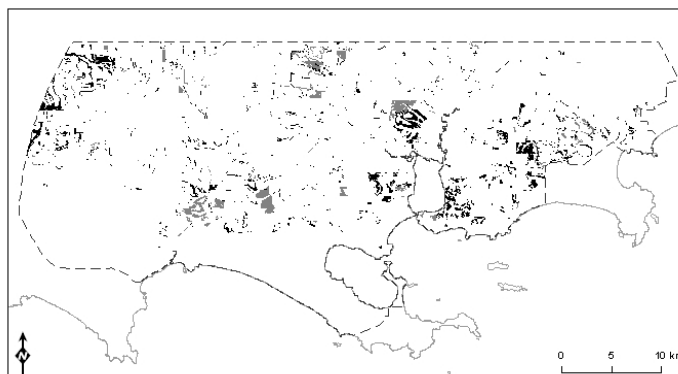
- Canopy of *Eucalyptus marginata*, *E. staeri* and *Allocasuarina fraseriana* over secondary low tree stratum containing *Banksia attenuata*, *B. grandis* and *B. ilicifolia*.
- Very diverse understorey with species typical of both lateritic and deep sandy soils.
- Sedgeland dominated by *Anarthria scabra* and *Cyathochaeta equitans* with *Tricostularia elatior* subsp. *elatior* often present.
- Occurs on sandy soil overlying laterite.

**Conservation species** *Banksia goodii* DRF, *Andersonia depressa* P4



## Floristic Summary

Lifeform	%cover	Species
Trees<10m	S	<i>Allocasuarina fraseriana</i> , <i>Eucalyptus marginata</i> , <i>Eucalyptus staeri</i> , <i>Banksia attenuata</i> , <i>Banksia ilicifolia</i>
Shrubs >2m	V	<i>Banksia grandis</i> , <i>Taxandria parviceps</i> , <i>Hakea ruscifolia</i> , <i>Persoonia longifolia</i> , <i>Beaufortia decussata</i>
Shrubs 1-2m	V-M	<i>Isopogon longifolia</i> , <i>Melaleuca thymoides</i> , <i>Agonis theiformis</i> , <i>Gompholobium scabrum</i> , <i>Isopogon formosus</i> , <i>Acacia myrtifolia</i>
Shrubs 0.5-1m	V-M	<i>Adenanthos cuneatus</i> , <i>Xanthosia rotundifolia</i> , <i>Leucopogon glabellus</i> , <i>Allocasuarina humilis</i> , <i>Daviesia flexuosa</i> , <i>Daviesia incrassata</i> , <i>Tetratheca setigera</i> , <i>Hypocalymma strictum</i> , <i>Beaufortia anisandra</i> , <i>Leptomeria squarrosa</i> , <i>Gompholobium knightianum</i> , <i>Gompholobium venustum</i> , <i>Acacia browniana</i> , <i>Acacia luteola</i> , <i>Acacia robiniae</i> , <i>Xanthorrhoea preissii</i> , <i>Adenanthos obovatus</i>
Shrubs <0.5m	V	<i>Astroloma baxteri</i> , <i>Petrophile rigida</i> , <i>Boronia spathulata</i> , <i>Boronia crenulata</i> , <i>Dampiera pedunculata</i> , <i>Synaphea polymorpha</i> , <i>Hibbertia depressa</i> , <i>Dampiera leptoclada</i> , <i>Rinzia schollerifolia</i> , +/- <i>Banksia goodii</i>
Sedges/rushes	M	<i>Anarthria scabra</i> , <i>Cyathochaeta equitans</i> , <i>Tricostularia neesii</i> var <i>elatior</i> , <i>Lepidosperma densiflora</i> , <i>Hypolaena exsulca</i> , <i>Desmocladius fasciculatus</i> , <i>Anarthria prolifera</i> , <i>Mesomelaena gracilipes</i> , <i>Schoenus sublateralis</i> , <i>Schoenus caespititius</i> , <i>Mesomelaena tetragona</i>
Herbs	V	<i>Dasyopogon bromeliifolius</i> , <i>Conostylis setigera</i> , <i>Conostylis serrulata</i> , <i>Conospermum caeruleum</i> , <i>Stylidium scandens</i> , <i>Logania serpyllifolia</i> , <i>Scaevola striata</i> , <i>Lindsaea linearis</i> , <i>Patersonia umbrosa</i>



**Unit 13 Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland**



## 14 *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland

No. of relevés 41 Mean spp. richness 27.6 Area 1330 ha % of Rem. Veg. 3.0 % in IUCN Res. 1-IV 50.7

### Description

*Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland is found on deep white/light grey sand on the lower slopes and valleys, usually occurring just upslope of seasonally wet drainage lines. With the exception of occurrences on the lower slopes of Mt. Martin and Mt. Adelaide, it is absent from the coastal fringe.

This unit is floristically very diverse and structurally quite variable. Typically *Allocasuarina fraseriana*, *Eucalyptus staeri*, *Banksia attenuata* and *Banksia ilicifolia* are present as emergents or as a low open woodland above a *Banksia coccinea* tall open scrub, mixed open/closed heath, mixed low open heath, mixed sedgeland and open herbland. *Jacksonia spinosa* often forms a distinct stratum above the heathland, dominant heath species are *Melaleuca thymoides*, *Adenanthos cuneatus*, *Leucopogon rubricaulis*, *Phyllota barbata*, *Hypocalymma strictum* and *Leucopogon glabellus*. Common sedges and herbs include *Anarthria scabra*, *Lyginia barbata*, *Schoenus caespitius*, *Anarthria prolifera*, *Anarthria gracilis* and *Cyathochaeta equitans*. *Banksia coccinea* sometimes forms dense thickets over a sparse understorey and dense sedgeland.

Along the lower slopes adjacent to Angove Creek, this unit forms a broad ecotone with *Evandra aristata* Sedgeland (46) with *Kunzea ericifolia* dominant in the understorey. *Banksia coccinea* is a serotinous obligate re-seeder and the absence of this species from otherwise healthy and diverse vegetation suggests that past fire regimes may be responsible.

This unit usually occurs down slope of Jarrah/Sheoak/*E. staeri* Sandy Woodland (13) and the boundary is usually marked by a sparser canopy, dominance of *Banksia coccinea* and presence of *Jacksonia spinosa* and *Leucopogon rubricaulis*.

This unit has strong floristic affinities with *Melaleuca striata*/*Banksia* spp Coastal Heath (16) and *Banksia coccinea* Shrubland /*Melaleuca striata*/*Leucopogon flavescens* Heath (15) which occurs in the eastern part of the survey area and contains species typical of the Eyre Botanical District including *Melaleuca striata*, *Leucopogon flavescens* and *Oligarrhena micrantha*.

Two sub-units are described

### 14a *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland

Described above. This sub-unit has been nominated as a Threatened Ecological Community and is currently a Priority 1 ecological community as it is highly susceptible to Phytophthora dieback with infestations resulting in greatly reduced floristic and structural diversity. This sub-unit appears to be restricted to the Albany region.

### 14b Redmond *Banksia attenuata*/*Banksia ilicifolia* Low Open Woodland

This sub-unit was observed around Redmond State Forest and lacks *Banksia coccinea* which has never been recorded from this area. *Eucalyptus marginata* is often co-dominant in the canopy and the understorey appears to be much less diverse than that of sub-unit 14a. However, this unit was poorly sampled and may have greater floristic affinities with *Banksia attenuata*/*B. ilicifolia*/*A. fraseriana*/*E. marginata*/*E. staeri* dominated low open woodlands that occur to the west of the survey area.

### Comments

Based on soil and landform, most of the suitable habitat within the survey area has been cleared. This unit is highly susceptible to Phytophthora dieback that results in the loss of *Banksia* species, *Jacksonia spinosa* and many other heathland shrub species, thus reducing the vegetation to a canopy of emergent *E. staeri*/*A. fraseriana* over a very open shrubland and sedgeland. The majority of areas surveyed exhibited some evidence of dieback infestation however this is not reflected in the condition statistics as the condition rating within Gull Rock NP and larger DEC reserves was based on a general overall assessment for these reserves.

This unit is fire sensitive, with many shrub species being obligate seeders and the dominant *Banksia coccinea*, a serotinous obligate seeder (Barrett *et al* 2009). Aerial canker infestations were also noted and *\*Acacia longifolia* saplings and seedlings were observed within this unit.

It is likely that this unit is restricted to the survey area. *Banksia coccinea* does not occur to the west of the survey area but extends north to the Stirling Range and east to Stokes Inlet, whilst *Allocasuarina fraseriana* reaches its eastern limit just outside the survey area. The occasional presence of *Melaleuca striata* and *Verticordia harveyi* in the northern areas of Mill Brook NR suggest that this area may be transitional with other *B. coccinea* dominated units that occur to the north and north east which include *Banksia baxteri*, *Melaleuca striata*, *Beaufortia empetrifolia*, *Banksia repens* and *Harperia confertospicata* (Sandiford 2003-2006).

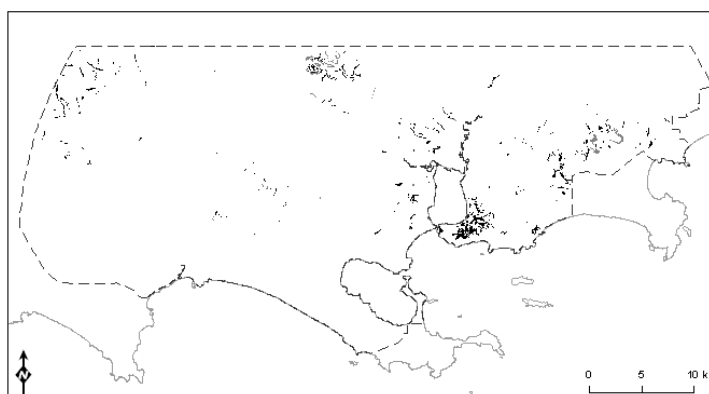
## Floristic Summary

Lifeform	%cover	Species
Trees<10m	V	<i>Eucalyptus staeri</i> , <i>Allocasuarina fraseriana</i> , <i>Banksia attenuata</i> , <i>Banksia ilicifolia</i> , +/- <i>Eucalyptus marginata</i> , <i>Nuytsia floribunda</i>
Shrubs >2m	S-D	<i>Banksia coccinea</i> , <i>Taxandria parviceps</i>
Shrubs 1-2m	M	<i>Jacksonia spinosa</i> , <i>Melaleuca thymoides</i> , <i>Adenanthos cuneatus</i> , <i>Adenanthos obovatus</i> , <i>Daviesia incrassata</i> , <i>Daviesia flexuosa</i> , <i>Gompholobium scabrum</i> , <i>Phyllota barbata</i> , <i>Leucopogon rubricaulis</i> , <i>Kingia australis</i> , <i>Latrobea glabrescens</i>
Shrubs 0.5-1m	S-M	<i>Xanthosia rotundifolia</i> , <i>Leucopogon gracilis</i> , <i>Pimelea longifolia</i> , <i>Hypocalymma strictum</i> , <i>Franklandia fucifolia</i> , <i>Acacia robiniae</i> , <i>Leucopogon glabellus</i> , <i>Banksia nutans</i> , <i>Synaphea polymorpha</i> , <i>Isopogon longifolius</i> , <i>Hibbertia depressa</i> , <i>Beaufortia anisandra</i> , <i>Darwinia vestita</i> , <i>Lysinema ciliatum</i> , <i>Tetratheca setigera</i> , <i>Latrobea brunonis</i> , <i>Bossiaea praetermissa</i> , <i>Gompholobium capitatum</i> , <i>Andersonia caerulea</i>
Shrubs <0.5m		<i>Andersonia micranthera</i> , <i>Needhamiella pumilio</i> , <i>Petrophile rigida</i> , <i>Petrophile acicularis</i> , <i>Astroloma baxteri</i> , <i>Hibbertia pulchra</i> subsp <i>crassifolia</i> , <i>Dampiera leptoclada</i> , <i>Boronia spathulata</i> , <i>Dampiera pedunculata</i>
Sedges/rushes	S-M	<i>Lyginia barbata</i> , <i>Anarthria scabra</i> , <i>Anarthria prolifera</i> , <i>Hypolaena exsulca</i> , <i>Hypolaena fastigiata</i> , <i>Schoenus caespititius</i> , <i>Mesomelaena gracilipes</i> , <i>Anarthria gracilis</i> , <i>Cyathochaeta equitans</i>
Herbs	V	<i>Dasypogon bromeliifolius</i> , <i>Phlebocarya ciliata</i> , <i>Cassytha racemosa</i> , <i>Conostylis serrulata</i> , <i>Stylidium repens</i> , <i>Johnsonia lupulina</i> , <i>Johnsonia teretifolia</i> , <i>Drosera erythrorhiza</i> , <i>Drosera menziesii</i> , <i>Drosera pallida</i> , <i>Conospermum caeruleum</i> , <i>Actinotus glomeratus</i> , <i>Stylidium scandens</i> , <i>Stylidium violaceum</i> , <i>Phlebocarya ciliata</i> , <i>Xanthosia huegelii</i> , <i>Lomandra nigricans</i> , <i>Patersonia umbrosa</i>

## Key identifying Features

- Presence of *Banksia coccinea* tall shrub layer (except sub-unit 14b) over a diverse heath dominated by *Melaleuca thymoides* and *Jacksonia spinosa*.
- An open upper tree layer including *Allocasuarina fraseriana* and/or *Eucalyptus staeri*, *Banksia attenuata* and *B. ilicifolia*.
- Occurs on deep white sand on lower slopes and valleys.

**Conservation species** *Banksia goodii* DRF, *Andersonia depressa* P4, *Verticordia harveyi* P4, *Laxmannia jamesii* P4, (*Drakaea micrantha* DRF has previously been recorded in this unit).





**Unit 14 *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland**



**Unit 15 *Banksia coccinea* Shrubland /*Melaleuca striata*/*Leucopogon flavescens* Heath**

## 15 *Banksia coccinea* Shrubland /*Melaleuca striata*/*Leucopogon flavescens* Heath

No. of relevés 6 Mean spp. richness 27.5 Area 162 ha % of Rem. Veg. 0.4 % in IUCN Reserve 1-IV 13.1

### Description

*Banksia coccinea* Shrubland /*Melaleuca striata*/*Leucopogon flavescens* Heath occurs on deep sand on lower slopes and valleys in the southern parts of Angove Water Reserve, northern parts of Two Peoples Bay Nature Reserve and around Bettys Beach. It has close floristic affinities with *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) which may occur in the same general vicinity but differs in the presence and dominance of *Melaleuca striata* and *Leucopogon flavescens* in the heath strata, the scattered presence of *Taxandria angustifolia* and *Andersonia pinaster* and the absence of *Phyllota barbata*, *Leucopogon rubricaulis*, *Gompholobium scabrum* and *Stylidium repens*. Structurally this unit is a diverse heathland over a diverse sedgeland dominated by *Anarthria scabra* and a very open herbland dominated by *Dasypogon bromeliifolius*. Emergent trees may be present.

### Comments

*Banksia coccinea* and *Andersonia pinaster* are highly susceptible to Phytophthora dieback and many infestations were observed. This unit may be restricted to the survey area or occur at its south western limit. It has floristic similarities with *Melaleuca striata*//*Banksia* spp Coastal Heath (16), *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) and with *Banksia coccinea* units occurring to the north of the survey area which contain *Banksia baxteri*, *Melaleuca striata*, *Beaufortia empetrifolia*, *Banksia repens* and *Harperia confertospicata* (Sandiford 2003-2006), and may represent a transitional unit between different biogeographic regions. Further survey to the north east of the survey area is required to determine its floristic affinities and extent.

*Andersonia pinaster* DRF is largely restricted to this unit

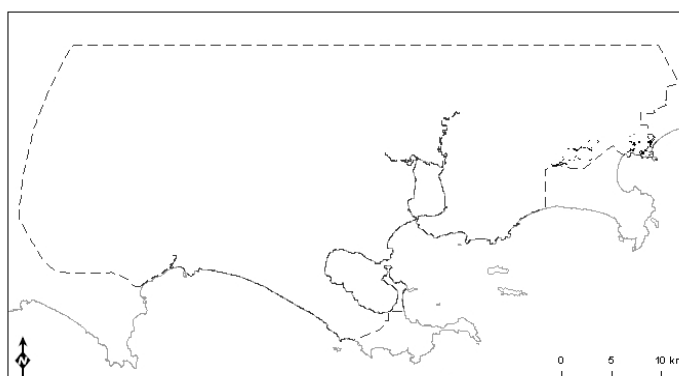
### Floristic Summary

Lifeform	%cover	Species
Trees<10m	E	<i>Allocasuarina fraseriana</i> , <i>Eucalyptus staeri</i> , <i>Eucalyptus marginata</i>
Shrubs >1m	V	<i>Banksia coccinea</i> , <i>Taxandria angustifolia</i> , +/- <i>Banksia attenuata</i> , <i>Banksia ilicifolia</i>
Shrubs 0.5-1m	M	<i>Melaleuca striata</i> , <i>Leucopogon flavescens</i> , <i>Banksia nutans</i> , <i>Melaleuca thymoides</i> , <i>Leucopogon elegans</i> , <i>Lysinema ciliatum</i> , <i>Petrophile rigida</i> , <i>Leucopogon glabellus</i> , <i>Adenanthos obovatus</i> , <i>Xanthosia rotundifolia</i> , <i>Hypocalymma strictum</i> , <i>Jacksonia spinosa</i> , <i>Adenanthos cuneatus</i> , <i>Agonis theiformis</i> , <i>Pimelea longifolia</i> , <i>Calytrix flavescens</i>
Shrubs< 0.5	V	<i>Andersonia pinaster</i> , <i>Andersonia micrantha</i> , <i>Xanthosia rotundifolia</i>
Sedges/rushes	M	<i>Anarthria scabra</i> , <i>Lyginia barbata</i> , <i>Schoenus caespititius</i> , <i>Hypolaena exsulca</i> , <i>Anarthria gracilis</i> , <i>Anarthria prolifera</i> , <i>Tricostularia</i> sp South Coast, <i>Schoenus sublateralis</i> , <i>Schoenus curvifolius</i>
Herbs	V	<i>Dasypogon bromeliifolius</i> , <i>Stylidium scandens</i> , <i>Conospermum caeruleum</i> , <i>Platysace pendula</i> , <i>Phlebocarya ciliata</i> , <i>Conostylis serrulata</i>

### Key identifying Features

- Presence of open *Banksia coccinea* shrubland over *Melaleuca striata*/*Leucopogon flavescens* heathland.
- Occurs on light grey or grey deep sand on lower slopes and valleys.

**Conservation species** *Andersonia pinaster* DRF



## 16 *Melaleuca striata/Banksia* spp Coastal Heath

No. of relevés 4 Mean spp. richness 24.8 Area 30 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 100

### Description

*Melaleuca striata/Banksia* spp Coastal Heath is found on light grey sand on the mid to lower slopes of Mt Taylor (Gull Rock NP). *Melaleuca striata*, *Banksia attenuata* and *Banksia coccinea* dominate the closed to open heath/low heath with exposure to salt laden winds restricting the growth of the latter two species. This unit is typically dense being a closed to open heath/low heath over a dense sedgeland dominated by *Anarthria scabra*. Other common species include *Isopogon cuneatus*, *Adenanthos cuneatus*, *Astroloma baxteri*, *Hypocalymma strictum*, *Petrophile rigida*, *Melaleuca thymoides*, *Lyginia barbata* and *Hypolaena exsulca*.

This unit is less diverse, both floristically and structurally than the two other *Banksia coccinea* dominated units (14 & 15) and its separation is based on structure, species dominance and distribution. It differs from *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14) by the presence and/or dominance of *Melaleuca striata* and *Isopogon cuneatus* and the absence of trees and many shrub species including *Adenanthos obovatus*, *Taxandria parviceps*, *Daviesia flexuosa*, *Johnsonia lupulina*, *Phlebocarya ciliata* and *Stylidium repens*. It differs from *Banksia coccinea* Shrubland/*Melaleuca striata/Leucopogon flavescens* Heath (15) in its structure and the co-dominance of *Banksia attenuata*, the presence of *Isopogon cuneatus* and the absence of *Leucopogon flavescens*, *Taxandria angustifolia*, *Andersonia pinaster*, *Andersonia micrantha*, *Leucopogon elegans*, *Johnsonia teretifolia* and *Platysace pendula*.

### Comments

Areas within this unit have been modified by Phytophthora dieback with *Banksia attenuata*, *B. coccinea* and *Isopogon cuneatus* either absent or dying. Aerial canker fungi have caused extensive limb death and plant mortality within this unit (S. Barrett, C. Crane, pers. comm.).

Transformed areas of this unit, dominated by *Melaleuca striata*, appear to be similar to a coastal heath unit described as "Headland Mixed Dense Low Heath" that occurs on the slopes of Mt Gardner, Two Peoples Bay (Hopkins *et al* unpublished). The description of this latter vegetation does not mention Proteaceous species.

Based on habitat it is likely that this unit is restricted to the survey area.

### Floristic Summary

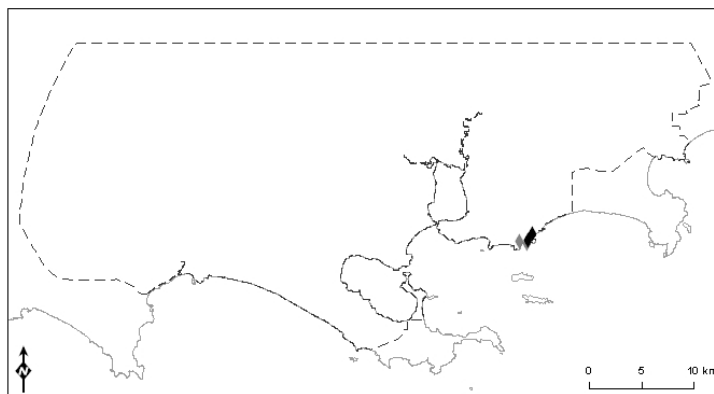
Lifeform	%cover	Species
Shrubs 0.5-1m	M_D	<i>Banksia attenuata</i> , <i>Melaleuca striata</i> , <i>Banksia coccinea</i> , <i>Isopogon cuneatus</i> , <i>Adenanthos cuneatus</i> , <i>Agonis theiformis</i> , <i>Phyllota barbata</i>
Shrubs <0.5m	V	<i>Xanthosia rotundifolia</i> , <i>Astroloma baxteri</i> , <i>Petrophile rigida</i>
Sedges/rushes	M-D	<i>Anarthria scabra</i> , <i>Lyginia barbata</i> , <i>Hypolaena exsulca</i> , <i>Anarthria prolifera</i> , <i>Cyathochaeta equitans</i>
Herbs		<i>Dasypogon bromeliifolius</i> , <i>Conospermum caeruleum</i>

### Key identifying Features

- Dense coastal heath dominated by *Melaleuca striata*, *Banksia attenuata* and/or *Banksia coccinea*

Conservation species None recorded





**Unit 16**      ***Melaleuca striata/Banksia* spp Coastal Heath**

## 17 Marri/Jarrah Coastal Hills Forest

No. of relevés 49 Mean spp. richness 25.9 Area 1238 ha % of Rem. Veg. 2.8 % in IUCN Res. 1-IV 50.5

### Description

Marri/Jarrah Coastal Hills Forest is a diverse unit associated with the granitic coastal hills. It occurs on a variety of soils from gravelly loam, gravelly sand to sandy loam and sand, with granite and lateritic exposures frequently present. One sub-unit, Marri Forest over *Acacia leioderma* Tall Scrub (17c) is typically found around drainage depressions in the north east of the survey area and may represent a separate unit.

The structure of this unit is highly variable with both Marri and Jarrah occurring as shrubs or low mallees on the windswept exposed coastal slopes and occurring as an open forest on the deeper soil of more protected slopes and gullies. High floristic diversity, dense tall shrub layers and a sedgeland frequently dominated by *Lepidosperma gracile* and *Cyathochaeta avenacea* are typical of this unit as is the dominance or co-dominance of *Corymbia calophylla* in the overstorey. A wide variety of tall to medium shrubs may dominate or co-dominate the understorey including *Gastrolobium coriaceum*, *Hakea trifurcata*, *Hibbertia furfuracea*, *Banksia formosa*, *Taxandria angustifolia*, *Beaufortia decussata*, *Hakea elliptica*, *Bossiaea linophylla*, *Hovea elliptica*, *Acacia leioderma* and *Agonis theiformis*. Common lower shrubs include *Sphaerolobium alatum*, *Acacia browniana* subsp. *browniana*, *Grevillea pulchella* and *Chorizema rhombeum*.

This unit often merges with Marri/Jarrah Forest/Peppermint Woodland which occurs on deeper moister soil. Less frequently it merges with Jarrah/Marri/Sheoak Laterite Forest (12), which occurs down slope and on shallower more lateritic soil; with Gardner/*Hakea* spp Shrubland (18) which occurs upslope in more exposed areas on the eastern edge of the survey area and with *Hakea* spp Transitional Shrubland (22) which is associated with very shallow soil around granite slabs.

Three sub-units are described, with landform, soil depth, hydrology and exposure factors that differentiate the floristic differences of these sub-units.

### 17a Coastal Marri/Jarrah Mixed Mallee/Open Scrub

This sub-unit occurs on shallower often laterized soils of the lower coastal hills of Mt Martin and Mt Taylor and is often a stunted closed tall scrub or tall open scrub. Common species include *Corymbia calophylla*, *Eucalyptus marginata*, *Hakea elliptica*, *Hakea trifurcata*, *Agonis theiformis*, *Gastrolobium coriaceum*, *Acacia browniana* subsp. *browniana*, *Kingia australis*, *Anarthria prolifera* and *Tetraria octandra*.

### 17b Marri/Jarrah Open Forest

This sub-unit occurs on mid to upper slopes of the coastal hills on deeper soil than sub-unit 17a. Common species include *Agonis theiformis*, *Gastrolobium coriaceum*, *Hakea trifurcata*, *Hakea elliptica*, *Bossiaea linophylla*, *Leucopogon verticillatus*, *Hovea elliptica*, *Hibbertia furfuracea*, *Hakea florida*, *Banksia formosa*, *Acacia browniana* subsp. *browniana*, *Xanthosia rotundifolia*, *Chorizema rhombeum*, *Xanthorrhoea preissii*, *Xanthorrhoea platyphylla*, *Crowea angustifolia* subsp. *angustifolia*, *Sphaerolobium alatum*, *Lepidosperma gracile*, *Cyathochaeta avenacea*, *Tetraria octandra*, *Stylidium spathulatum*, *Lomandra pauciflora* and *Tetrarrhena laevis*.

Around Mt Mason, *Taxandria angustifolia*, *Beaufortia decussata*, *Hibbertia furfuracea*, *Hovea elliptica*, *Crowea angustifolia* subsp. *angustifolia* and *Spyridium spadiceum* are often dominant.

### 17c Marri Forest over *Acacia leioderma* Tall scrub.

This sub-unit is restricted to the eastern edge of the survey area where it is largely restricted to bands around small winter filled depressions and along drainage lines. *Corymbia calophylla* dominates the open to low open forest with *E. marginata* occasionally co-dominant. The understorey is distinctive with *Acacia leioderma* forming dense stands and it is not clear if this dominance is due to a fire in 2000., however, other species are present at very low frequencies. This unit is much less diverse than other sub-units. A sparse to moderately dense sedgeland dominated by *Lepidosperma gracile* and *Cyathochaeta avenacea* is common with a very open herbland dominated by *Patersonia umbrosa*.

### Comments

\**Acacia longifolia* was observed occasionally in this unit.

The distribution of this unit outside the survey area is not known but it is likely that all sub-units bar sub-unit 17c, reach their eastern limit near the survey area and may be restricted to the survey area. Whilst many of the species are common in the Warren Botanical District, *Acacia leioderma* is absent west of Walpole and *Hakea elliptica* only occurs along the coastal fringe of the study area and east to near Cheyne Beach (DEC 2010). Similar vegetation to sub-unit 17c has been recorded north east of the survey area, occurring around small seasonal swamps and on the north eastern slopes of Mt Manypeaks. Sub-unit 17c may warrant unit status based on the dominance of the understorey, landform and distribution (Sandiford 2003-2006; Hickman 2008).



It can be difficult to distinguish this unit from *Hakea* spp Transitional Shrubland (22) where the latter is dominated by *Hakea trifurcata* as there is often a broad ecotonal region. However, a very sparse or absent tree cover and the dominance of the sedges *Mesomelaena tetragona* and *Mesomelaena stygia* and the presence of species associated with skeletal soils overlying granite, including *Banksia armata*, *Allocasuarina humilis* and *Neurachne alopecuroides*, distinguish unit 22.

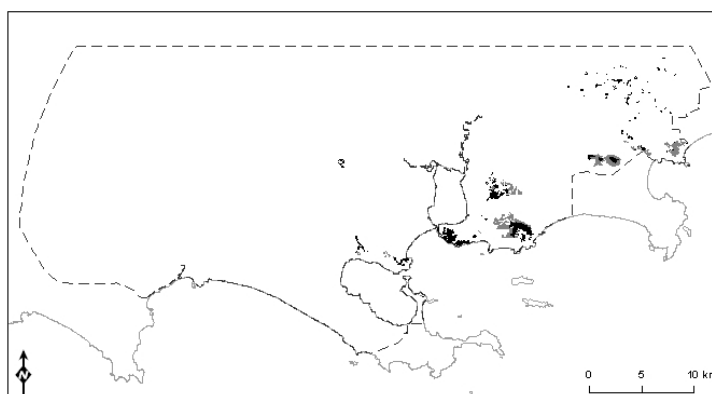
#### Floristic Summary

Lifeform	%cover	Species
Trees<10m to 10-30	V-M	<i>Corymbia calophylla</i> , <i>Eucalyptus marginata</i> , <i>Allocasuarina fraseriana</i>
Shrubs >2m	V-D	<i>Taxandria angustifolia</i> , <i>Hakea trifurcata</i> , <i>Beaufortia decussata</i> , <i>Hakea elliptica</i> , <i>Hibbertia furfuracea</i> , <i>Gastrolobium coriaceum</i> , <i>Hakea florida</i> , <i>Bossiaea linophylla</i> , <i>Acacia leioderma</i> , +/- <i>Taxandria parviceps</i> , <i>Petrophile diversifolia</i>
Shrubs 1-2m	V-M	<i>Hovea elliptica</i> , <i>Agonis theiformis</i> , <i>Crowea angustifolia</i> subsp <i>angustifolia</i> , <i>Eutaxia parvifolia</i> , <i>Leucopogon obovatus</i> , <i>Acacia myrtifolia</i> , <i>Xanthorrhoea preissii</i> , <i>Xanthorrhoea platyphylla</i> , <i>Leucopogon verticillatus</i>
Shrubs 0.5-1m	V-M	<i>Acacia alata</i> , <i>Sphaerolobium alatum</i> , <i>Xanthosia rotundifolia</i> , <i>Acacia browniana</i> subsp. <i>browniana</i> , <i>Dampiera leptoclada</i> , <i>Boronia spathulata</i>
Shrubs <0.5		<i>Grevillea pulchella</i> , <i>Hibbertia amplexicaulis</i> , <i>Chorizema rhombeum</i>
Sedges/rushes	S	<i>Lepidosperma gracile</i> , <i>Cyathochaeta avenacea</i> , <i>Tetraria octandra</i> , <i>Anarthria prolifera</i> forma narrow, <i>Mesomelaena gracilipes</i> , <i>Tetraria capillaris</i> , <i>Anarthria prolifera</i> , <i>Desmocladius fasciculatus</i>
Herbs	V	<i>Stylidium spathulatum</i> , <i>Patersonia umbrosa</i> , <i>Lomandra pauciflora</i> , <i>Opercularia hispidula</i> , <i>Logania serpyllifolia</i> , <i>Lindsaea linearis</i> , <i>Conostylis setigera</i> subsp <i>setigera</i> , <i>Lomandra sericea</i> , <i>Platysace filiformis</i> , <i>Scaevola striata</i>
Grasses	V	<i>Tetrarrhena laevis</i> , <i>Amphipogon amphipogonoides</i>

#### Key identifying Features

- Canopy dominated by *Corymbia calophylla* and *Eucalyptus marginata*, diverse understorey with dense tall shrub layers and a sedgeland usually dominated by *Lepidosperma gracile* and *Cyathochaeta avenacea*.
- Understorey is a mixed tall shrubland with co-dominants including *Hakea elliptica*, *Hakea trifurcata*, *Hibbertia furfuracea*, *Gastrolobium coriaceum*, *Bossiaea linophylla*, *Acacia leioderma*, *Hovea elliptica*, over a lower shrub stratum co-dominated by *Crowea angustifolia*, *Sphaerolobium alatum*, *Xanthosia rotundifolia* and *Acacia browniana*.
- Occurs on coastal hills on gravelly loam/sand overlying granite.

**Conservation species** *Stylidium falcatum* P1, *Spyridium spadiceum* P2, *Stylidium plantagineum* P4, *Andersonia setifolia* P3, *Stylidium plantagineum* P4





**Sub-unit 17a**



**Sub-unit 17b**

**Unit 17 Marri/Jarrah Coastal Hills Forest**

## 18 Gardner/*Hakea* spp Shrubland

No. of relevés 8 Mean spp. richness 24.3 Area 138 ha % of Rem. Veg. 0.3 % in IUCN Reserve 1-IV 0

### Description

Gardner/*Hakea* spp Shrubland is restricted to the mid to upper slopes of the granite hills around Bettys Beach and occurs on sandy/loamy soil with exposed granite boulders. This unit is transitional in floristic composition between Marri/Jarrah Coastal Hills Forest (17) and *Hakea* spp Shrubland/ Woodland Complex (31) and it contains several species absent or very uncommon in either of those units including *Leucopogon altissimus*, *Crocea angustifolia* subsp *platyphylla* and *Petrophile divaricata*. Structurally this unit is a mixed closed tall scrub or closed heath over a mixed very open sedgeland with *Eucalyptus marginata* present as a mallee/shrub. Dominant species include *Hakea elliptica*, *Gastrolobium coriaceum*, *Eucalyptus marginata*, *Banksia formosa*, *Bossiaea dentata*, *Melaleuca striata*, *Hakea lasiantha*, *Acacia leioderma*, *Beaufortia decussata*, *Lepidosperma* sp Bakers Junction, *Tetraria capillaris*, *Lepidosperma* aff *angustatum* and *Anarthria prolifera* forma narrow.

This unit often abuts Marri/Jarrah Coastal Hills Forest (17), with the latter unit confined to gullies and protected sites.

### Comments

Some of the common species, particularly the Proteaceous species are susceptible to *Phytophthora* dieback and many dominant species are fire sensitive, being serotinous obligate re-seeders and thus vulnerable to inappropriate fire regimes.

This unit grades into both Marri/Jarrah Coastal Hills Forest (17) and *Hakea* spp Shrubland/ Woodland Complex (31) and the boundaries are not always clear.

Given the distribution of common species within this unit including *Hakea elliptica*, *Banksia formosa*, *Melaleuca striata*, *Banksia mucronulata* and *Hakea lasiantha*, this unit is likely to be restricted a small area from Bettys Beach to Mt Manypeaks. Hickman (2008) recorded similar vegetation on the lower south western slopes of Mt Manypeaks. Thus it has its western limit within the survey area.

### Floristic Summary

Lifeform	%cover	Species
Trees<10m	E	<i>Eucalyptus marginata</i>
Shrubs 1->2m	M-D	<i>Hakea elliptica</i> , <i>Banksia formosa</i> , <i>Gastrolobium coriaceum</i> , <i>Bossiaea dentata</i> , <i>Beaufortia decussata</i> , <i>Banksia mucronulata</i> , <i>Petrophile divaricata</i> , <i>Acacia leioderma</i> , <i>Hakea lasiantha</i> , <i>Kingia australis</i> , +/- <i>Hibbertia furfuracea</i> , <i>Hakea florida</i> , <i>Hakea trifurcata</i>
Shrubs 0.5-1m	V	<i>Leucopogon altissimus</i> , <i>Crocea angustifolia</i> subsp <i>platyphylla</i> , <i>Acacia browniana</i> subsp <i>browniana</i> , <i>Leucopogon</i> sp Walpole, <i>Sphenotoma dracophylloides</i> , <i>Leucopogon obovatus</i> , <i>Xanthosia rotundifolia</i> , +/- <i>Hakea ceratophylla</i>
Sedges/rushes	V-S	<i>Lepidosperma</i> sp Bakers Junction, <i>Lepidosperma</i> aff <i>angustatum</i> , <i>Tetraria capillaris</i> , <i>Mesomelaena tetragona</i> , <i>Lepidosperma gracile</i> , <i>Cyathochaeta avenacea</i> , <i>Tetraria octandra</i> , <i>Anarthria scabra</i> , <i>Mesomelaena stygia</i> subsp <i>stygia</i> , <i>Schoenus brevisetis</i> , <i>Desmocladius fasciculatus</i> .
Herbs	-	<i>Conostylis setigera</i> subsp <i>setigera</i> , <i>Thysanotus multiflorus</i> , <i>Lomandra pauciflora</i> , <i>Cassytha racemosa</i>
Grasses	-	+/- <i>Amphipogon amphipogonoides</i> , <i>Tetrarrhena laevis</i>

### Key identifying Features

- Dense shrubland transitional in species composition between units 17 and 31 and dominated by Proteaceous, Papilionaceous and Myrtaceous species.
- Occurs on sandy/loam soil on hills with granite boulders in the Bettys Beach area.

**Conservation species** *Stylidium articulatum* P2, *Leucopogon altissimus* P3, *Stylidium plantagineum* P4





**Unit 18 Gardner/*Hakea* spp Shrubland**

## 19 *Hakea elliptica* Shrubland/*Eucalyptus doratoxylon* Mallee

No. of relevés 3 Mean spp. richness 10 Area 25 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 0

### Description

*Hakea elliptica* Shrubland/*Eucalyptus doratoxylon* Mallee occurs on grey brown sandy loam with occasional outcropping granite on lower southern slopes in the Bettys Beach area. This unit is not floristically diverse and is characterized by a canopy of *Eucalyptus doratoxylon* over a *Hakea elliptica* dominated tall shrubland or tall open scrub over mixed open heath and a very sparse or absent sedge strata. *Gastrolobium bilobum*, *Trymalium odoratissimum* and *Taxandria angustifolia* may be co-dominant in the upper shrub layer, with *Thomasia discolor*, *Calothamnus quadrifidus* and *Melaleuca diosmifolia* dominant in the middle shrub layer. In some areas the canopy is dominated by *Hakea elliptica*.

### Comments

This unit is fire sensitive with common species including *Hakea elliptica*, *Calothamnus quadrifidus* and *Melaleuca diosmifolia* being serotinous obligate seeders.

The area of overlap of dominant species including *Eucalyptus doratoxylon*, *Hakea elliptica*, *Thomasia discolor* and *Melaleuca diosmifolia* indicate that this unit is likely to be restricted to the coastal slopes of Mt Manypeaks and around Bettys Beach. It's presence on Mt Manypeaks needs verification.

Vegetation co-dominated by *Eucalyptus doratoxylon* and *Hakea elliptica* previously recorded west of Cheyne Beach differs in the co-dominance of *Eucalyptus acies* and *E. goniantha* subsp *goniantha* in the canopy and the presence of *Banksia serra*, *Acacia leioderma*, *Rhadinotheramnus rudis* and *Desmocladius flexuosus* in the understorey (Sandiford 2003-2006).

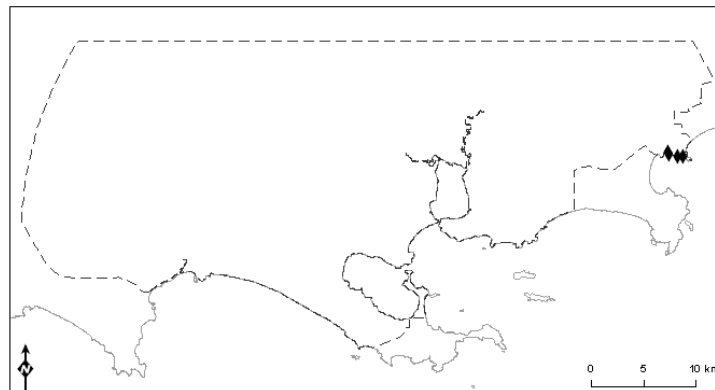
### Floristic Summary

Lifeform	%cover	Species
Mallee<10m		<i>Eucalyptus doratoxylon</i>
Shrubs >2m		<i>Hakea elliptica</i> , <i>Taxandria angustifolia</i> , <i>Gastrolobium bilobum</i> , <i>Trymalium odoratissimum</i>
Shrubs 1-2m	S-M	<i>Thomasia discolor</i> , <i>Calothamnus quadrifidus</i> , <i>Melaleuca diosmifolia</i> , <i>Ricinocarpos glaucus</i> , <i>Leucopogon obovatus</i> , <i>Chorilaena quercifolia</i> , <i>Acacia leioderma</i> , <i>Banksia formosa</i>
Shrubs 0.5-1m		<i>Crocea angustifolia</i> subsp. <i>angustifolia</i> , <i>Agonis theiformis</i>
Sedges/rushes	V	<i>Tetraria capillaris</i> , <i>Tetraria octandra</i> , <i>Lepidosperma</i> sp Manypeaks
Herbs		<i>Billardiera fusiformis</i>

### Key identifying Features

- *Eucalyptus doratoxylon* and *Hakea elliptica* dominant in canopy and/or upper shrub stratum.
- *Thomasia discolor*, *Calothamnus quadrifidus*, *Melaleuca diosmifolia* dominant in middle shrub stratum
- Occurrence on sandy loam on lower coastal slopes overlying granite.

**Conservation species** *Thomasia discolor* P3, *Melaleuca diosmifolia* P3



**Unit 19 *Hakea elliptica* Shrubland/*Eucalyptus doratoxylon* Mallee**



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No. of relevés 4   Mean spp. richness 9.5   Area 34 ha   % of Rem. Veg. 0.1   % in IUCN Reserve 1-IV 0

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**Description**

*Eucalyptus goniantha* Mallee is restricted to the eastern fringe of the survey area where it occurs on orange brown loam or grey to brown loamy sand on the coast and inland plain. One sub-unit (20b) is restricted to yellow grey sand over limestone. This unit is floristically and structurally depauperate, usually consisting of *Eucalyptus goniantha* subsp *goniantha* over a *Templetonia retusa* tall open scrub with bare ground prominent. *Trymalium odoratissimum* may be a co-dominant species in the upper shrub layer with a low open shrubland of *Spyridium majoranifolium* present near the coast. A very open sedgeland is sometimes present with *Lepidosperma densiflora* forma proliferous, *Desmocladius flexuosus* and *Lepidosperma* sp Saltbush Hill characteristic. The latter species occurs here well outside its previously known range but commonly occurs in mallee associations (R Barrett pers. comm.).

An area dominated by *Eucalyptus angulosa* is included here as a sub-unit, however this may warrant unit status based on soil type and geology.

Sub-units:

**20a *Eucalyptus goniantha* Mallee/*Templetonia retusa* Tall Open Scrub** Described above and possibly limited to orange brown loam/sand overlying spongelite.

**20b *Eucalyptus angulosa* Mallee/*Rhadinotheramnus rudis*/*Templetonia retusa* Tall Shrubland**

This sub-unit was only observed above Bettys Beach campsite occurring on yellow-grey sand overlying limestone. *Eucalyptus goniantha* subsp *goniantha* was present in the canopy and *Rhadinotheramnus rudis* co-dominated the understorey with *Templetonia retusa*. This sub-unit lacked most of the other shrub species recorded in 20a but had the same very open sedge stratum.

On two remnants on private property along the eastern edge of the survey area, unit 20 occurred adjacent to and within stands of Karri. Although these areas were previously grazed, subsequent regeneration following fencing has been good and weed presence is minimal. These areas differed slightly in understorey composition with a *Templetonia retusa*/*Trymalium odoratissimum* tall open scrub occurring above a very open grassland and herbland with *Microlaena stipoides*, *Lagenophora huegelii* and *Clematis pubescens* common. Relevés within these areas were excluded from the floristic analysis due to the history of disturbance.

Unit 20 differs from the other *E. goniantha* subsp *goniantha*/*E. angulosa* dominated unit (6) in its lower floristic diversity, the dominance of *Templetonia retusa*, the absence of many understorey species typical of limestone soils and its occurrence on different soils.

**Comments**

Sub-unit 20a appears to be restricted in distribution and occurs at its south western limit within the survey area with possible scattered occurrences north east towards Green Range. *E. goniantha* subsp *goniantha* occurs along the coastal fringe from Albany to the Pallinup River with a westerly intrusion towards the Stirling Range. Its range overlaps with the more widespread *Templetonia retusa*, however, herbarium records indicate that these species have not been recorded together except in the Bettys Beach area (DEC 2009). Similar vegetation with a depauperate understorey, but dominated by *Acacia leioderma* has been recorded south of Green Range (Sandiford 2003-2006). Other *E. goniantha* dominated vegetation occurs on the plains west and north west of Cheyne Beach, usually in association with *E. lehmannii* and/or *E. acies* and with different understorey species (Sandiford 2003-2006; WLCDC (1997).

Sub-unit 20b appears similar to *E. angulosa*/*T. retusa* dominated vegetation recorded from Bremer Bay (WA Herbarium records, DEC 2009) and it has affinities with coastal *E. angulosa* Mallee recorded around Hopetoun, though it differs in the absence of *Acacia rostellifera* and *Melaleuca nesophila* (G. Craig pers comm.). *E. angulosa* dominated vegetation appears to be restricted to dunes with alkaline sands and further survey in areas between Albany and Hopetoun would be required to ascertain the status and affinities of sub-unit 20b.

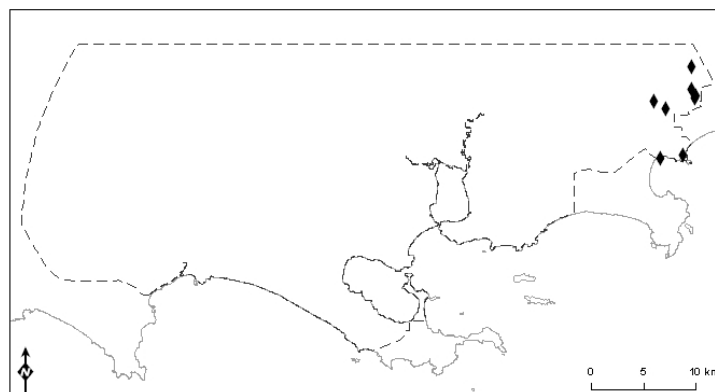
**Key identifying Features**

- Canopy of *Eucalyptus goniantha* subsp *goniantha* (and less commonly *E. angulosa*) over tall open shrubland dominated by *Templetonia retusa*.
- Absence or scarcity of low shrub, sedge and herb layers.

**Conservation species** *Thomasia solanacea* P3, *Melaleuca diosmifolia* P3, *Eucalyptus goniantha* subs sp *goniantha* P4

### Floristic Summary

Lifeform	%cover	Species
Mallee > 8	M	<i>Eucalyptus goniantha</i> subsp <i>goniantha</i> , <i>Eucalyptus angulosa</i>
Shrubs >2m	M	<i>Templetonia retusa</i> , <i>Trymalium odoratissimum</i> , <i>Gastrolobium bilobum</i> , <i>Rhadinothamnus rudis</i> , <i>Westringia dampieri</i> , <i>Leucopogon obovatus</i>
Shrubs 1-2m		<i>Chorilaena quercifolia</i>
Shrubs <0.5m		<i>Spyridium majoranifolium</i>
Sedges/rushes	VV	<i>Lepidosperma densiflora</i> forma <i>proliferous</i> , <i>Lepidosperma</i> sp Saltbush Hill, <i>Desmocladius flexuosus</i>
Herbs		<i>Billardiera fusiformis</i>



### Unit 20 *Eucalyptus goniantha* Mallee

## 21 Coastal Shrubland Complex

No. of relevés 15 Mean spp. richness 21.4 Area 33 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 65.4

### Description

Coastal Shrubland Complex is a heterogonous unit which includes a variety of shrublands restricted to gentle to steep slopes or breakaways on the coastal fringe around Bettys Beach, Gull Rock NP, Quararup and Oyster Harbour. These shrublands generally occur on shallow sandy soil often in association with lateritic exposures and are typically dense and low in stature, being exposed to strong salt laden winds. Unusual combinations of dominant species are common reflecting the complexity of soil mosaics present e.g. *Banksia formosa*/*Banksia coccinea* open heath and *Hakea elliptica*/*Melaleuca striata* heath. Along the lower slopes of Mt Taylor, where most of this unit was recorded, species turnover is high over relatively small distances with species typical of deep sand, granite, laterite and limestone soils present. A relatively high number of species were restricted to or largely restricted to this unit including *Pimelea drummondii*, *Microcorys virgata*, *Microcorys barbata*, *Lambertia echinata* subsp *citrina*, *Banksia pellaefolia*, *Isopogon cuneatus* and *Daviesia gracilis*.

Further work is required to determine floristic patterns within this unit though it appears that *Banksia formosa* open low heath over *Andersonia sprengelioides* low open heath and *Lepidosperma* aff *angustatum* very open sedgeland is common on crest edges.

### Comments

Many of the common species in this unit are serotinous obligate reseeder thus sensitive to inappropriate fire regimes and some dominant species are highly susceptible to Phytophthora dieback including *Banksia coccinea*, *Banksia biterax* and *Isopogon cuneatus*. Dieback infestations were observed within this unit in the eastern end of GRNP, and populations of *Hakea trifurcata* in this area have been reduced by aerial canker (S. Barrett, C. Crane pers. comm.). Similarly, extensive deaths of *H. trifurcata* in this unit in the Bettys Beach area were attributed to an aerial canker species (*Cytospora* sp).

It is likely that similar vegetation occurs along parts of the coastal fringe of Torndirrup NP.

*Banksia mucronulata*, *Banksia pellaefolia*, *Hakea elliptica*, *Microcorys barbata* and *Banksia biterax* occur at or near their eastern, southern or south western range limits within the survey area. This unit appears to be restricted to the coastal fringe and its distribution outside the survey area has not been assessed.

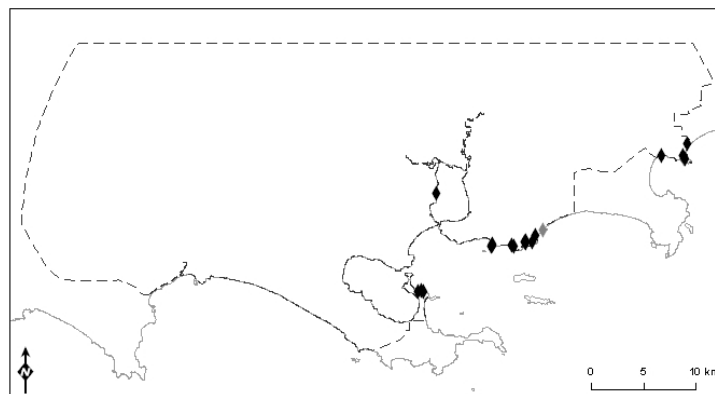
### Floristic Summary

Lifeform	%cover	Species
Shrubs >1m	M	<i>Hakea elliptica</i> , <i>Banksia formosa</i> , <i>Melaleuca striata</i> , <i>Darwinia diosmoides</i> , <i>Lambertia uniflora</i> , <i>Lambertia echinata</i> subsp <i>citrina</i> , <i>Acacia leioderma</i> , <i>Adenanthos sericeus</i> , <i>Banksia mucronulata</i> , <i>Isopogon cuneatus</i> , <i>Agonis theiformis</i> , <i>Melaleuca pentagona</i> , <i>Leucopogon obovatus</i> , <i>Banksia biterax</i> , <i>Hakea trifurcata</i> , <i>Hakea ruscifolia</i> , <i>Xanthorrhoea platyphylla</i>
Shrubs <1m	S	<i>Andersonia sprengelioides</i> , <i>Grevillea pulchella</i> , <i>Allocasuarina humilis</i> , <i>Spyridium majoranifolium</i> , <i>Hibbertia amplexicaulis</i> , <i>Hovea chorizemifolia</i> , <i>Acacia browniana</i> subsp <i>browniana</i> , <i>Lysinema ciliatum</i>
Sedges/rushes	V	<i>Anarthria prolifera</i> , <i>Lepidosperma</i> aff <i>angustatum</i> , <i>Anarthria scabra</i> , <i>Desmocladius fasciculatus</i> , <i>Tetraria octandra</i> , <i>Desmocladius flexuosus</i> , <i>Loxocarya cinerea</i> , <i>Cyathochaeta equitans</i>
Herbs		<i>Lomandra pauciflora</i> , <i>Xanthosia huegelii</i> , <i>Conostylis setigera</i> subsp <i>setigera</i>

### Key identifying Features

- Restricted to the coastal fringe.
- Closed to open heath with species typical of granitic, lateritic and deep sandy soils present e.g. *Banksia formosa*, *Melaleuca striata*, *Hakea elliptica*, *Darwinia diosmoides*, *Banksia coccinea*, *Isopogon cuneatus*, *Andersonia sprengelioides*, *Lambertia uniflora*, *Grevillea pulchella*.

**Conservation species** None recorded



**Unit 21 Coastal Shrubland Complex**

## 22 *Hakea* spp Transitional Shrubland

No. of relevés 4 Mean spp. richness 27.8 Area 33 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 92

### Description

*Hakea* spp Transitional Shrubland is a restricted to colluvial gravelly/sandy soil overlying or around granitic pans and exposures. A tall shrub layer dominated by one of three *Hakea* species - *Hakea trifurcata*, *H. prostrata* or *H. undulata*, often in association with *Agonis theiformis*, is characteristic of this unit which may have an emergent or very open canopy of *Eucalyptus marginata* and *Corymbia calophylla*. The structure of this unit varies with areas dominated by *Hakea trifurcata* tending to be denser than those dominated by either *Hakea prostrata* or *Hakea undulata*. Lower shrub strata are open, typically an open low shrubland occurs over an open to very open sedgeland. Understorey species are often those indicative of gravelly soils including *Agonis theiformis*, *Bossiaea ornata*, *Banksia dallanneyi*, *Hovea trisperma*, *Astroloma pallidum*, *Calectasia grandiflora*, *Mesomelaena tetragona* and *Mesomelaena stygia* subsp. *stygia*.

This unit often grades into adjacent vegetation, usually Marri/Jarrah Coastal Hills Forest (17) or Marri/Jarrah Forest/Peppermint Woodland (10) and compared to other granitic shrublands appears restricted to deeper sandier soil overlying or surrounding granitic pans.

### Comments

This unit was not well surveyed and it appears to be a transitional unit between true granitic outcrop units and adjacent woodland/forest units particularly Units 10 and 17 with which it merges. The boundaries between these units are not always clear, especially where *Hakea trifurcata* dominates. Further work is required to clearly define this unit and other shrublands associated with granite which, in south Western Australia, are known for their floristic variability (Wardell-Johnson and Williams 1996; Smith and Sage 2006).

The distribution of this unit outside the survey area is not known however the overlap of common species within this unit suggest it may be restricted to the southern areas of the Darling Botanical District.

### Floristic Summary

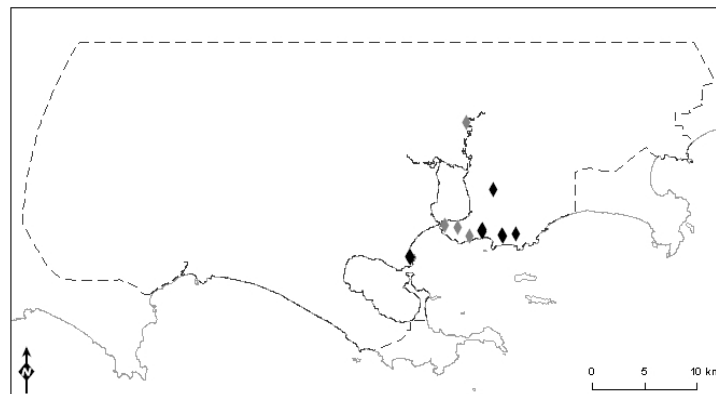
Lifeform	%cover	Species
Trees<10m	nil-V	<i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i>
Shrubs >2m	V-M	<i>Hakea trifurcata</i> , <i>Hakea prostrata</i> , <i>Hakea undulata</i>
Shrubs 1-2m	V	<i>Agonis theiformis</i> , <i>Allocasuarina humilis</i> , <i>Xanthorrhoea preissii</i> , <i>Xanthorrhoea platyphylla</i>
Shrubs 0.5-1m		<i>Bossiaea ornata</i>
Shrubs <0.5m	V	<i>Hibbertia microphylla</i> , <i>Hovea trisperma</i> , <i>Astroloma pallidum</i> , <i>Gompholobium knightianum</i> , <i>Hovea chorizemifolia</i> , <i>Banksia armata</i> , <i>Hibbertia diamesogenos</i> , <i>Banksia dallanneyi</i>
Sedges/rushes	V-S	<i>Mesomelaena tetragona</i> , <i>Mesomelaena stygia</i> subsp <i>stygia</i> , <i>Tetrandra octandra</i> , <i>Cyathochaeta avenacea</i>
Herbs	V	<i>Conostylis setigera</i> , <i>Lomandra sericea</i> , <i>Stylidium spathulatum</i>
Grasses	V	<i>Amphipogon avenacea</i> , <i>Neurachne alopecuroides</i>

### Key identifying Features

- Shrub layer dominated by *Hakea* species including *H. trifurcata* and/or *H. prostrata*, *H. undulata*, often in association with *Agonis theiformis* and *Allocasuarina humilis*.
- Tall shrubland occurring on gravelly sand overlying or around granitic pans and exposures

**Conservation species** None recorded





**Unit 22 *Hakea* spp Transitional Shrubland**



## 23 *Gastrolobium bilobum/Hakea elliptica* Granite Shrubland/Yate Woodland

No. of relevés 11 Mean spp. richness 10.8 Area 163 ha % of Rem. Veg. 0.4 % in IUCN Reserve 1-IV 1.3

### Description

*Gastrolobium bilobum/Hakea elliptica* Granite Shrubland/Yate Woodland is found scattered throughout the survey area fringing granite outcrops with most occurrences on upper slopes and hill crests. Soils are typically well drained orange brown or brown sandy loams. Dense stands of *Gastrolobium bilobum* are the distinctive feature of this unit with a sparse overstorey of *Eucalyptus cornuta* often present. In eastern areas, *Corymbia calophylla* is often the dominant tree species. This unit is not very diverse with the understorey often reduced to a very open sedgeland with *Lepidosperma gracile* and *Cyathochaeta avenacea* usually the dominant species. In some areas *Hakea elliptica* is the dominant shrub forming thickets (23b). These areas often grade into Marri/Jarrah Coastal Hills Forest (17) and Marri/Jarrah Forest/Peppermint Woodland (10) units that occur down slope.

### Sub-units

**23a *Gastrolobium bilobum* Closed Tall Scrub/*Eucalyptus cornuta* Low Woodland** Described above.

### 23b *Hakea elliptica* Thicket

In this sub-unit *Hakea elliptica* is dominant or co-dominant with *Gastrolobium bilobum*. This sub-unit also includes a couple of *Hakea elliptica* patches that occurred on lower slopes or drainage lines and were not obviously associated with granite outcrops.

### Comments

*Hakea elliptica* is a serotinous obligate re-seeder and inappropriate fire regimes may have an adverse impact on this species. \**Acacia longifolia* plants were observed occasionally in this unit.

The distribution of this unit outside the survey area is not known however one common species, *Hibbertia furfuracea*, reaches its eastern limit just east of the survey area and *Hakea elliptica* extends from the survey area near Cheyne Beach with an outlier in Walpole/Nornalup National Park (DEC 2009). The distribution of the common species suggests that subunit 23a may occur on suitable habitat throughout the Warren and southern Darling Botanical Districts. This unit has floristic affinities with *E. cornuta*/*G. bilobum* dominated units around Esperance and the Recherche Archipelago though there are differences in understorey composition (DEC 2009).

Sub-unit 23b is limited by the distribution of *Hakea elliptica* which is restricted to granitic coastal areas from Torndirrup NP to just west of Cheyne Beach, with one outlying record near Nornalup (WA Herbarium records). Thus it is largely confined to the survey area. *Hakea elliptica* thickets have been observed outside the survey area but within the ARVS context south-east of Stony Hill in Torndirrup NP.

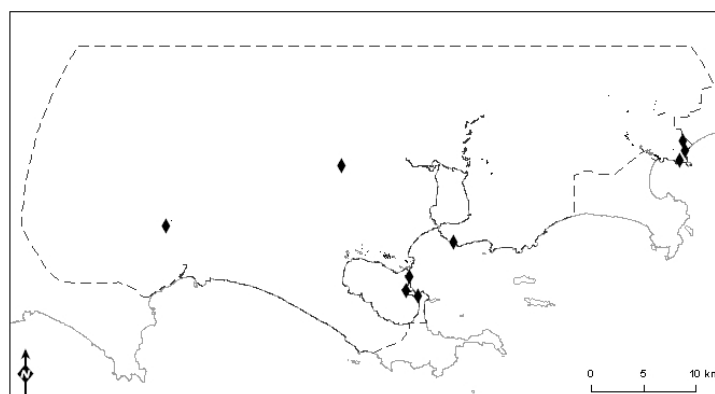
### Floristic Summary

Lifeform	%cover	Species
Trees<10m	E-M	<i>Eucalyptus cornuta</i> , <i>Corymbia calophylla</i>
Shrubs >2m	M-D	<i>Gastrolobium bilobum</i> , <i>Hakea elliptica</i> , +/- <i>Trymalium odoratissimum</i>
Shrubs 1-2m	Nil-V	<i>Hibbertia furfuracea</i> , <i>Ricinocarpos glaucus</i> , <i>Acacia leioderma</i> , <i>Xanthorrhoea platyphylla</i> , +/- <i>Spyridium globulosum</i>
Shrubs 0.5-1m	Nil-V	<i>Tremandra stelligera</i> .
Sedges/rushes	V	<i>Lepidosperma gracile</i> , <i>Cyathochaeta avenacea</i> , <i>Lepidosperma</i> aff <i>angustatum</i> , <i>Tetraria capillaris</i> , <i>Tetraria octandra</i>
Herbs	Nil-V	<i>Lomandra pauciflora</i> , <i>Billardiera fusiformis</i>
Grasses		<i>Tetrarrhena laevis</i>

### Key identifying Features

- Thickets of *Gastrolobium bilobum* +/- *Hakea elliptica*, often with a canopy of *Eucalyptus cornuta* and/or *Corymbia calophylla*. Usually lacking well developed ground stratum.
- Occurs on orange brown to grey brown well drained sandy loam around granite outcrops.

**Conservation species** None recorded



**Unit 23 *Gastrolobium bilobum*/*Hakea elliptica* Granite Shrubland/Yate Woodland**

## 24 *Taxandria marginata* Granite Shrubland

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No. of relevés 9 Mean spp. richness 12.3 Area 110 ha % of Rem. Veg. 0.2 % in IUCN Reserve 1-IV 19.1

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### Description

*Taxandria marginata* Granite Shrubland is restricted to granite outcrops where it occurs on skeletal grey/brown or dark brown gravelly loam. *Taxandria marginata* is the dominant shrub with *Hakea drupacea* and/or *Anthocercis viscosa* sometimes forming a taller shrub stratum. *Lepidosperma angustatum* is the dominant sedge with *L. drummondii* co-dominant in some areas and a very open shrubland or low shrubland including *Dodonaea ceratocarpa*, *Eutaxia myrtifolia* *Verticordia plumosa*, *Andersonia sprengelioides* and *Pimelea imbricata* subsp. *imbricata* is often present. *Borya nitida*, *Borya sphaerocephala*, *Stypandra glauca* and *Cheilanthes austrotenuifolia* are the dominant perennial herbs. Moss beds may occur on the broad granite sheets between the shrublands, supporting a very diverse geophyte and annual flora.

This unit is frequently surrounded by *Gastrolobium bilobum*/*Hakea elliptica* Granite Shrubland/Yate Woodland (23).

Sub-units:

**24a *Taxandria marginata* Granite Shrubland** Described above.

### 24b *Banksia verticillata* Tall Open Scrub

This sub-unit was not sampled during this survey. Most populations occur in Torndirrup NP with isolated occurrences in Gull Rock NP and outside the survey area at Cheyne Beach and near Walpole. It differs from sub-unit 24a in the dominance of *Banksia verticillata*. It is not clear if this unit was once more widespread within the ARVS area. *Banksia verticillata* Low Open Woodland mapped in the Jerramungup/Fitzgerald area by Newbey and later digitized for the Gnowangerup Land Conservation Council, were erroneously named and represent a *Banksia littoralis* Low Open Woodland (Newbey 1979).

### Comments

Granite exposures between the shrublands were included when mapping this unit as these frequently contained moss swards. Degradation of moss beds by weed invasion, rabbit grazing, foot and vehicle traffic was observed during the survey. Grazing by rabbits resulted in the loss of moss beds, increased weed presence and decreased density and diversity of geophytes. Common weeds observed included members of the Iridaceae with infestations of *\*Watsonia* spp., *\*Gladiolus undulatus* and *\*Romulea rosea* common on outcrops on Mt Melville, Mt Clarence, Mt Adelaide and around Quaranup. *\*Aira* species and *\*Pelargonium capitatum* were also observed in moderate numbers and *\*Acacia longifolia* was occasionally present.

*Banksia verticillata* (24b) is a serotinous obligate seeder, as is *Hakea drupacea* which is present in both sub-units. *B. verticillata* has a long juvenile period, requiring 8-10 years to commence flowering after fire, and is therefore very sensitive to frequent fire (Barrett *et al.* 2009). *B. verticillata* is highly susceptible to *Phytophthora* dieback as well as aerial canker (C Crane pers. comm.) Population extinctions of this species are known to have occurred at Two-Peoples Bay NR and on Mt Manypeaks and populations in Gull Rock NP are very close to extinction (S. Barrett pers. comm.).

*Taxandria marginata* dominated shrublands occur in two disjunct areas, from Walpole to Albany, and from Esperance to Point Malcolm. Several key species including *Taxandria marginata*, *Hakea drupacea*, *Borya nitida* and *Dodonaea ceratocarpa* are common in both areas, however, *Pimelea imbricata* subsp. *imbricata* and *Verticordia plumosa* subsp. *plumosa* are absent from eastern areas and *Lepidosperma angustatum* and *L. drummondii* may be restricted to the Albany region (R. Barrett pers. comm). Thus this unit may occur from Walpole to Cheyne Beach.

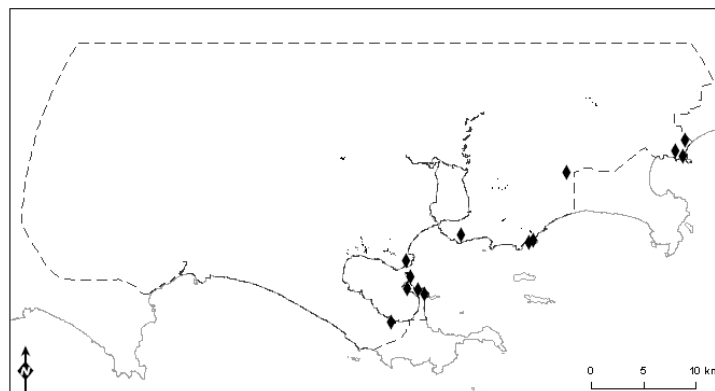
### Key identifying Features

- Tall scrub/open heath dominated by *Taxandria marginata*.
- Restricted to granite outcrops.

**Conservation species** *Banksia verticillata* DRF, *Thysanotus isantherus* P4, *Centrolepis caespitosa*, P4, *Asplenium aethiopicum* P4

## Floristic Summary

Lifeform	%cover	Species
Shrubs >2m	M	<i>Taxandria marginata</i> , <i>Hakea drupacea</i> , <i>Anthocercis viscosa</i> +/- <i>Banksia verticillata</i>
Shrubs 1-2m	V	<i>Dodonaea ceratocarpa</i> , <i>Eutaxia myrtifolia</i>
Shrubs 0.5-1m	V	<i>Verticordia plumosa</i>
Shrubs <0.5m	V	<i>Andersonia sprengelioides</i> , <i>Pimelea imbricata</i> subsp <i>imbricata</i>
Sedges/rushes	V-M	<i>Lepidosperma angustatum</i> , <i>Lepidosperma drummondii</i>
Herbs		<i>Borya nitida</i> , <i>Borya sphaerocephala</i> , <i>Stypandra glauca</i> , <i>Quinetia urvillei</i> , <i>Chamaescilla corymbosa</i> , <i>Thysanotus isantherus</i> , <i>Drosera menziesii</i> , <i>Aphelia cyperoides</i> , <i>Gnephosis drummondiana</i> , <i>Stylidium calcaratum</i> , <i>Centrolepis strigosa</i> , <i>Centrolepis aristata</i> , <i>Hydrocotyle alata</i> , <i>Philydrella pygmaea</i> , <i>Mitrasacme paradoxa</i> , <i>Levenhookia pusilla</i> , <i>Stylidium despectum</i> <i>Siloxerus filifolia</i> , <i>Trachymene pilosa</i> , <i>Millotia tenuifolia</i> , <i>Microtis</i> sp., <i>Thelymitra antennifera</i>



### Unit 24 *Taxandria marginata* Granite Shrubland

## 25 *Acacia sulcata/Leucopogon assimilis* Granite Shrubland.

No. of relevés 9 Mean spp. richness 15.8 Area 17 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 50.0

### Description

*Acacia sulcata/Leucopogon assimilis* Granite Shrubland is found on and around broken granite exposures on skeletal loam or gravelly loam soil which appear to have some clay content. The structure is usually an open shrubland over low shrubland over an open sedgeland and very open grassland of *Neurachne alopecuroidea*. Common species include those typical of either granite outcrops or gravelly clay soil including *Acacia sulcata* subsp *sulcata*, *Leucopogon* aff *assimilis*, *Hemigenia podalyrina*, *Dodonaea ceratocarpa*, *Leucopogon pendulus*, *Allocasuarina humilis*, *Leucopogon* sp. Coujinup, *Andersonia sprengelioides*, *Hibbertia microphylla*, , *Boronia subsessilis*, *Calytrix* sp Esperance, *Anarthria gracilis*, *Mesomelaena stygia*, *Desmocladius fasciculatus*, *Lepidosperma angustatum*, *Conostylis setigera* subsp *setigera* and *Goodenia caerulea*. Shrublands dominated by *Calytrix* sp Esperance are described as a sub-unit but may represent a separate unit.

Sub-units:

**25a *Acacia sulcata/Leucopogon assimilis* Shrubland** Described above

**25b *Calytrix* sp Esperance Shrubland** This sub-unit is dominated by stands of *Calytrix* sp Esperance and appears to be restricted to small patches on sandy gravelly soil on and around the edges of granite exposures. The structure varies from a shrubland to open heath, a low open shrubland and very open sedgeland and / or grassland may be present. Species recorded in this sub-unit include *Hakea undulata*, *Acacia sulcata*, *Andersonia sprengelioides*, *Grevillea pulchella*, *Boronia subsessilis*, *Stirlingia tenuifolia*, *Olex phyllanthi*, *Lepidosperma angustatum* and *Neurachne alopecuroidea*.

### Comments

This unit is naturally limited in distribution to shallow soil around granite outcrops and its distribution outside the survey area is not known. Further survey is required to fully describe sub-unit 25b and to determine its floristic affinities.

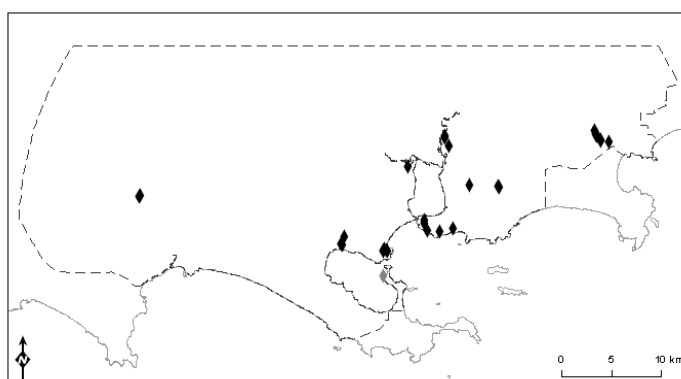
### Floristic Summary (\*sub-unit 25a)

Lifeform	%cover	Species
Shrubs >2m		<i>Agonis theiformis</i> , <i>Gastrolobium bilobum</i> +/- <i>Hakea undulata</i>
Shrubs 1-2m	S-M	<i>Acacia sulcata</i> subsp <i>sulcata</i> , <i>Calytrix</i> sp Esperance, <i>Hemigenia podalyrina</i> , <i>Dodonaea ceratocarpa</i>
Shrubs <1m	V-S	<i>Leucopogon</i> aff <i>assimilis</i> , <i>Leucopogon pendulus</i> , <i>Allocasuarina humilis</i> , <i>Leucopogon</i> sp Coujinup, <i>Andersonia sprengelioides</i> , <i>Hibbertia microphylla</i> , <i>Lasiopetalum cordifolium</i> , <i>Boronia subsessilis</i>
Sedges/rushes	V	<i>Anarthria gracilis</i> , <i>Mesomelaena stygia</i> , <i>Desmocladius fasciculatus</i> , <i>Lepidosperma angustatum</i> , <i>Lepidosperma gracile</i> , <i>Cyathochaeta avenacea</i> , <i>Tetraria octandra</i>
Herbs		<i>Conostylis setigera</i> subsp <i>setigera</i> , <i>Goodenia caerulea</i>
Grasses		<i>Neurachne alopecuroidea</i>

### Key identifying Features

- Shrubland dominated by *Acacia sulcata* subsp *sulcata* and/or *Leucopogon* aff *assimilis*.
- Occurs on shallow gravelly soil with some clay content, around broken granite exposures.

**Conservation species** *Xanthosia eichleri* P3, *Thysanotus isantherus* P4







**Unit 25 *Acacia sulcata*/*Leucopogon assimilis* Granite Shrubland**



**Unit 26 *Darwinia diosmoides* Granite Shrubland**



## 26 *Darwinia diosmoides* Granite Shrubland

No. of relevés 1 Mean spp. richness 14.0 Area 3 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 40.9

### Description

*Darwinia diosmoides* Granite Shrubland occurs in small patches on granite outcrops and shallow sand surrounding outcrops in coastal areas. Typically stands of *Darwinia diosmoides* occur over a very sparse understorey. Very narrow bands occur just above the granite shoreline around Quaranup and Torndirrup NP but these were not well assessed and further survey is required to understand the floristic variation and environmental characteristics of this unit.

### Comments

This unit differs from *Darwinia diosmoides* Coastal Heath (3c) in the absence of other shrub species typical of deep sand, its lower species diversity and its occurrence on shallow soil overlying granite. A few small patches had a similar understorey to *Taxandria marginata* Granite Shrubland areas (24) and further survey is required to determine the floristic affinities between these units.

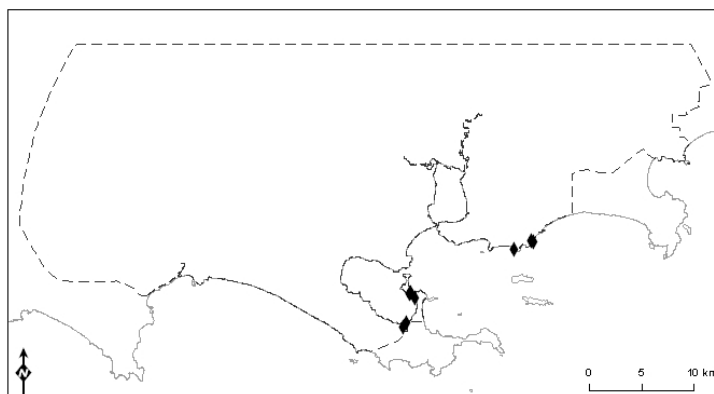
### Floristic Summary

Lifeform	%cover	Species
Shrubs 1-2m	M	<i>Darwinia diosmoides</i>
Shrubs <0.5m	V	<i>Andersonia sprengelioides</i> , <i>Leucopogon</i> sp Coujinup, <i>Gompholobium tomentosum</i> , <i>Pimelea imbricata</i> subsp <i>imbricata</i>
Sedges/rushes	V	<i>Lepidosperma angustatum</i> , <i>Lyginia imberbis</i> , <i>Cyathochaeta equitans</i> , <i>Schoenus curvifolius</i> , <i>Desmocladius flexuosus</i>
Herbs		<i>Drosera erythrorhiza</i> , <i>Velleia trinervis</i> , <i>Opercularia vaginata</i>

### Key identifying Features

- *Darwinia diosmoides* dominated shrubland.
- Occurrence restricted, or adjacent, to granite exposures.

**Conservation species** None recorded



## 27 *Melaleuca viminea* Granite Thicket

No. of relevés 3 Mean spp. richness 5 Area 11 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

*Melaleuca viminea* Granite Thicket is restricted to the littoral fringe occurring on loam and loamy sand overlying granite in the Bettys Beach area. This unit is not very diverse, sometimes reduced to a dense canopy of *Melaleuca viminea* subsp *viminea*, over bare ground and litter. The structure varies from a closed shrubland in the most exposed areas to a low closed forest or low open woodland in more protected areas, it usually lacks a distinct sedgeland or herbland.

Areas of mixed closed scrub co-dominated by *Leucopogon obovatus*, *Acacia leioderma*, *Westringia dampieri*, *Calothamnus quadrifidus* and *Gastrolobium bilobum* are included in this unit as they appear to represent an early seral stage.

Very thin patches of *Melaleuca viminea* subsp *demissa* are known to occur on the mainland littoral fringe near Mistaken Island, but lack many of the understorey species typical of unit 27 and have not been mapped due to their size.

### Comments

*Melaleuca viminea* subsp *demissa* is found scattered along the south coast from Walpole to the Recherche Archipelago. Shrublands dominated by this species have been recorded on Bald and Eclipse Islands (Abbott, 1981) and are known to occur near Cheyne Beach with isolated stands occurring near Cable Beach and Peak Head in Torndirrup NP. It is not clear if these shrublands have a similar floristic composition to those within the ARVS area. Vegetation dominated by this species would appear to be the ecological equivalent of some *Melaleuca lanceolata* dominated vegetation which is found in similar habitats in the Cape Leeuwin-Naturaliste area. These two species are similar and *Melaleuca viminea* subsp *demissa* has been mis-identified as *M. lanceolata* in the past.

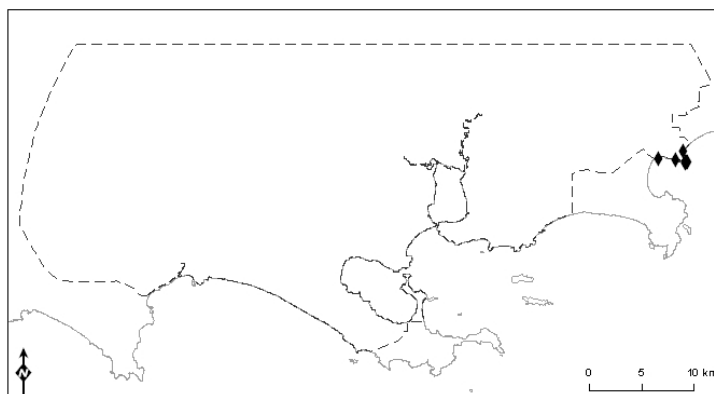
### Floristic Summary

Lifeform	%cover	Species
Trees<10m	S-D	<i>Melaleuca viminea</i> subsp <i>demissa</i>
Shrubs >2m	V	<i>Calothamnus quadrifidus</i> , <i>Gastrolobium bilobum</i>
Shrubs 1-2m	V	<i>Leucopogon obovatus</i> , <i>Acacia leioderma</i> , <i>Westringia dampieri</i> , <i>Olearia axillaris</i> , <i>Darwinia diosmoides</i> , <i>Thomasia solanacea</i> , <i>Thomasia discolor</i>
Sedges/rushes	-	<i>Lepidosperma angustatum</i>

### Key identifying Features

- Canopy of *Melaleuca viminea* subsp *demissa*.
- Coastal fringe distribution on loam/ loamy sand overlying granite.

**Conservation species** *Thomasia solanacea* P3, *Thomasia discolor* P3



**Unit 27 *Melaleuca viminea* Granite Thicket**

## 28 Miscellaneous Granite Shrubland

No. of relevés 1 Mean spp. richness n/a Area 39 % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 36.5

### Description

Miscellaneous Granite Shrubland is essentially a mapping unit to describe outcrop areas where vegetation type has not been identified. It includes one relevé recorded in the Angove Water Reserve that did not have close affinities with other granite shrubland units. This site was very open with a *Taxandria spathulata* Shrubland occurring over *Verticordia endlicheriana* subsp *endlicheriana* Low Open Shrubland and a mixed very open sedgeland. Common species include *Pultenaea verruculosa*, *Chorizema cytisoides*, *Leucopogon pendulus*, *Leucopogon gibbosus*, *Lepidosperma angustatum*, *Lepidosperma* sp Carracarrup Creek, *Mesomelaena stygia*, *Schoenus breviculmis*, *Gonocarpus trichostachyus*, *Stylidium gloeophyllum*, *Stylidium repens*, *Laxmannia sessiliflora* and *Conostylis setigera*.

### Comments

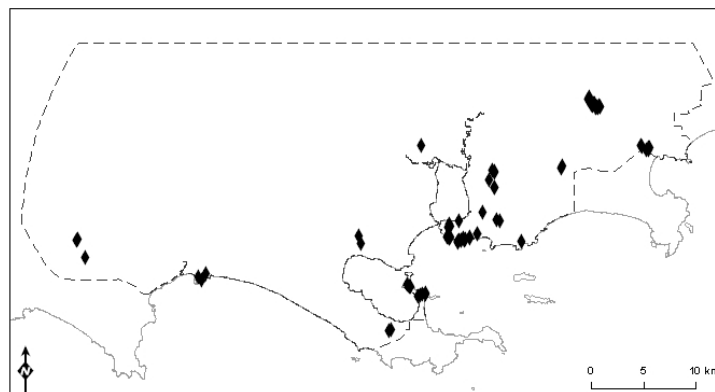
Many of the common species recorded in the one relevé in this unit occur near their southern or south western limit in the ARVS area and further survey is required to determine if similar vegetation occurs to the north or east. Low shrublands dominated by *Verticordia endlicheriana* subsp *endlicheriana* have been observed on small shallow pans to the north and north east of survey area but usually in association with low growing *Melaleuca* species typical of areas of impeded drainage and not in association with exposed granite.

**Floristic Summary-** Not applicable

### Key identifying Features

- Mapping unit (Includes a shrubland dominated by *Taxandria spathulata* and *Verticordia endlicheriana* subsp *endlicheriana*).
- Occurs around granite exposures.

**Conservation species** *Gonocarpus trichostachyus* P3, *Stylidium gloeophyllum* P3



## 29 Jarrah Woodland/*Eucalyptus falcata* Mallee

No. of relevés 1 Mean spp. richness 28 Area 6 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 100

### Description

Jarrah Woodland/*Eucalyptus falcata* Mallee is restricted to the northern boundary of Mill Brook NR where it occurs on gentle slopes with gravelly sands interspersed with laterite. This unit was only encountered once but was also recorded by Griffin (1985) and all occurrences were burnt in a hot fire in 2004. *Eucalyptus falcata* forms a distinctive sub-canopy beneath *Eucalyptus marginata*. The understorey is relatively open and includes species typical of sandy, gravelly and lateritic soil. Common shrubs include *Xanthorrhoea platyphylla*, *Acacia subcaerulea*, *Leucopogon glabellus*, *Acacia browniana*, *Grevillea fasciculata*, *Hakea corymbosa*, *Pultenaea verruculosa*, *Grevillea pulchella*, *Banksia dallanneyi*, *Isopogon attenuatus* and *Chorizema rhombeum*. Ground cover appears sparse and common species include *Desmocladius fasciculatus*, *Tetraria octandra*, *Harperia lateriflora*, *Cyathochaeta avenacea*, *Lepyrodia hermaphrodita*, *Tetraria capillaris*, *Xanthosia singuliflora*, *Gompholobium knightianum*, *Conostylis setigera*, *Lomandra micrantha* and *Neurachne alopecuroidea*.

### Comments

This unit was mapped by Griffin (1985) who noted *Hakea trifurcata*, *Agonis theiformis* and *Acacia myrtifolia* as common species. *Eucalyptus falcata* occurs at its southern limit within the survey area and it is not known if this unit occurs elsewhere. *Eucalyptus falcata* dominated units have been just recorded north of study area but lack a *Eucalyptus marginata* overstorey and differ in understorey floristics (Sandiford 2003-2006).

### Floristic Summary

Lifeform	%cover	Species
Trees <10m	S	<i>Eucalyptus marginata</i>
Mallee <10m	S-V	<i>Eucalyptus falcata</i>
Shrubs 1-2m	V	<i>Xanthorrhoea platyphylla</i>
Shrubs 0.5-1m	V	<i>Acacia subcaerulea</i> , <i>Leucopogon glabellus</i> , <i>Acacia browniana</i> subsp. <i>browniana</i> , <i>fasciculatus</i> , <i>Hakea corymbosa</i>
Shrubs <0.5m	S	<i>Pultenaea verruculosa</i> , <i>Banksia dallanneyi</i> , <i>Xanthosia eichleri</i> , <i>Grevillea pulchella</i> , <i>Isopogon attenuatus</i> , <i>Chorizema rhombeum</i> , <i>Hibbertia amplexicaulis</i>
Sedges/rushes	V	<i>Desmocladius fasciculatus</i> , <i>Tetraria octandra</i> , <i>Lepyrodia hermaphrodita</i> , <i>Tetraria capillaris</i> , <i>Harperia lateriflora</i> , <i>Cyathochaeta avenacea</i>
Herbs	V	<i>Xanthosia singuliflora</i> , <i>Gompholobium knightianum</i> , <i>Gompholobium venustum</i> , <i>Pithocarpa melanostigma</i> , <i>Trichocline spathulata</i>
Grasses		<i>Neurachne alopecuroidea</i>

### Key identifying Features

- A sub-canopy of *Eucalyptus falcata* beneath *Eucalyptus marginata* Low Woodland.
- Occurrence on gravelly sand interspersed with laterite.

**Conservation species** *Xanthosia eichleri* P3



**Unit 29 Jarrah Woodland/*Eucalyptus falcata* Mallee**



## 30 Eastern Jarrah/Sheoak Woodland

No. of relevés 36 Mean spp. richness 27.4 Area 1042 ha % of Rem. Veg. 2.4 % in IUCN Reserve 1-IV 0

### Description

Eastern Jarrah/Sheoak Woodland is restricted to gentle slopes and rises in central and northern areas of Angove Water Reserve and occurs on a variety of soils often overlying siltstone/spongelite. This area overlies the boundary of the Dempster/ Minor Valley and Takalarup landform units (Churchward *et al* 1988).

This unit grades into *Hakea* spp. Shrubland/Woodland Complex (31) on the lower slopes and plains overlying siltstone/spongelite, and it grades into Jarrah/Marri/Sheoak Laterite Forest (12) on the more laterized upland slopes. Species composition is transitional in nature and additional species may include *Eucalyptus doratoxylon*, *Lasiopetalum* sp Denmark, *Sphaerolobium drummondii*, *Sphaerolobium macranthum*, *Chorizema spathulatum*, *Taxandria angustifolia*, *Goodenia leptoclada*, *Lepidosperma striatum*, *Mesomelaena tetragona* and *Anarthria scabra*.

The understorey is usually quite open, typically being a *Taxandria parviceps* tall open shrubland over a mixed open low heath, low open shrubland, open sedgeland and very open herbland. Occasionally *Hakea tuberculata*, *Hakea cucullata*, or *Taxandria spathulata* may be sub-dominant in the upper stratum. Dominant lower shrubs include *Acacia browniana* subsp *browniana*, *Grevillea fasciculata*, *Xanthosia rotundifolia*, *Leucopogon glabellus*, *Leucopogon pendulus*, *Hibbertia microphylla*, *Pultenaea verruculosa*, *Leptomeria squarrulosa* and *Agonis theiformis*. The sedgeland is mixed and contains species typical of a variety of soils, with *Cyathochaeta avenacea*, *Lepidosperma striatum*, *Anarthria scabra* and *Anarthria prolifera* often dominant. A wide array of herbs were recorded with *Stylidium gloeophyllum*, *Lindsaea linearis*, *Patersonia umbrosa*, *Lomandra sericea*, *Conostylis setigera*, *Stylidium amoenum* and *Logania serpyllifolia* most frequent. Where spongelite is exposed, *Eucalyptus doratoxylon* may be sub-dominant in the canopy.

### Comments

This unit forms part of a very complex mosaic of units in the Angove Water Reserve and boundaries between units are seldom sharp. This unit appears to be limited to rises on the siltstone/spongelite plain and may be restricted to the survey area. *Allocasuarina fraseriana* reaches its eastern limit just east of the survey area.

Phytophthora dieback infestations were observed in this unit as well structural damage to the canopy trees from an intense bushfire in 2000.

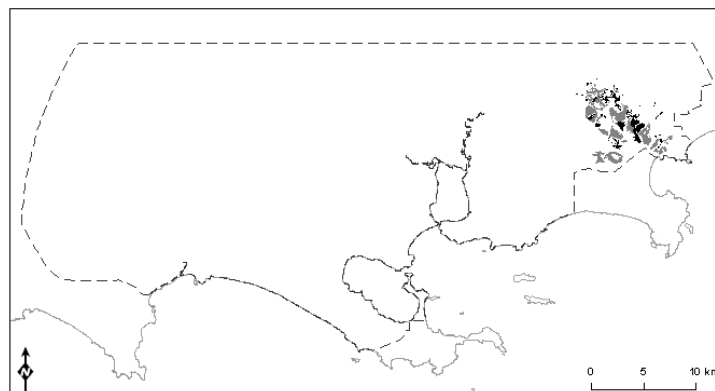
### Floristic Summary

Lifeform	%cover	Species
Trees<10m	S-V	<i>Allocasuarina fraseriana</i> , <i>Eucalyptus marginata</i> , <i>Eucalyptus doratoxylon</i>
Shrubs >2m	V	<i>Taxandria parviceps</i> , +/- <i>Beaufortia decussata</i> , <i>Hakea tuberculata</i> , <i>Hakea cucullata</i> , <i>Taxandria angustifolia</i> , <i>Gastrolobium coriaceum</i>
Shrubs 1-2m		<i>Acacia browniana</i> , <i>Sphaerolobium grandiflorum</i> , <i>Xanthorrhoea preissii</i> , <i>Xanthorrhoea platyphylla</i> , <i>Acacia myrtifolia</i> , <i>Eutaxia parvifolia</i> , <i>Hakea ceratophylla</i> , <i>Agonis theiformis</i>
Shrubs 0.5-1m	S	<i>Grevillea fasciculata</i> , <i>Lasiopetalum</i> sp Denmark, <i>Sphaerolobium alatum</i> , <i>Leucopogon glabellus</i> , <i>Leptomeria squarrulosa</i> , <i>Gastrolobium bracteolosum</i>
Shrubs< 0.5	S	<i>Hibbertia microphylla</i> , <i>Darwinia vestita</i> , <i>Sphaerolobium alatum</i> , <i>Sphaerolobium drummondii</i> , <i>Sphaerolobium macranthum</i> , <i>Leucopogon pendulus</i> , <i>Chorizema spathulatum</i> , <i>Xanthosia rotundifolia</i> , <i>Boronia spathulata</i> , <i>Dampiera alata</i> , <i>Pimelea hispida</i> , <i>Sphenotoma dracophylloides</i>
Sedges/rushes	S	<i>Cyathochaeta avenacea</i> , <i>Anarthria scabra</i> , <i>Anarthria prolifera</i> , <i>Lepidosperma gracile</i> , <i>Mesomelaena tetragona</i> , <i>Lepidosperma striatum</i> , <i>Mesomelaena stygia</i> , <i>Lepidosperma</i> sp Down Rd Fan, <i>Desmocladius fasciculatus</i> , <i>Tetraria capillaris</i> , <i>Schoenus obtusifolia</i>
Herbs	V	<i>Stylidium gloeophyllum</i> , <i>Patersonia umbrosa</i> , <i>Dasypogon bromeliifolius</i> , <i>Goodenia leptoclada</i> , <i>Lomandra sericea</i> , <i>Conostylis setigera</i> , <i>Lomandra sericea</i> , <i>Stylidium plantagineum</i> , <i>Lindsaea linearis</i> , <i>Scaevola striata</i> , <i>Thysanotus multiflorus</i> , <i>Stylidium amoenum</i> , <i>Patersonia limbata</i> , <i>Logania serpyllifolia</i> , <i>Xanthosia singuliflora</i>
Grasses		<i>Amphipogon amphipogonoides</i>

### Key identifying Features

- Woodland canopy of Jarrah and Casuarina over a diverse and relatively open understorey with *Taxandria parviceps* and *Lepidosperma striatum* often prominent. *Acacia browniana*, *Grevillea fasciculata*, *Xanthosia rotundifolia*, *Sphaerolobium drummondii*, *Sphaerolobium macranthum*, *Leucopogon glabellus*, *Leucopogon pendulus*, *Hibbertia microphylla*, *Chorizema spathulata*, *Stylidium gloeophyllum* are common.
- Occurs on gentle slopes overlying spongelite

**Conservation species** *Hakea tuberculata* P3, *Stylidium gloeophyllum* P3, *Stylidium plantagineum* P4, *Chorizema reticulatum* P3



### Unit 30 Eastern Jarrah/Sheoak Woodland

## 31 *Hakea* spp Shrubland/ Woodland Complex

No. of relevés 72 Mean spp. richness 31.2 Area 2366 ha % of Rem. Veg. 5.4 % in IUCN Res.1-IV 45.4

### Description

*Hakea* spp Shrubland/ Woodland Complex is a floristically diverse and very complex group that occurs in areas of impeded drainage on a variety of soils overlying laterite or spongelite. A tall shrubland dominated or co-dominated by one to four *Hakea* species: *Hakea cucullata*, *H. lasiantha*, *H. trifurcata* and *H. ferruginea*, and a sedgeland, usually co-dominated by *Lepidosperma* sp Bakers Junction along with species typical of impeded drainage and lateritic soil including *Mesomelaena tetragona*, *Lepidosperma* sp Down Rd Fan, *Anarthria gracilis*, *Anarthria prolifera*, *Schoenus obtusifolia* and *Desmocladius fasciculatus*, is indicative of this unit. It varies in structure from a tall open scrub over heath/shrubland on shallow soil on crests and plains to low woodland on gentle slopes.

Six sub-units are described below. Some of these sub-units occur adjacent to one another and some may warrant unit status. However, further work is required to elucidate the complex patterns which were obscured by recent fires and Phytophthora dieback. There appears to be a strong floristic fidelity to location though this may reflect past disturbance. The two most extensive areas of this unit in Angove Water Reserve and Mill Brook NR were subject to intense fires in 2000 and 2004, respectively. Extensive areas of this unit in Mill Brook NR and the southern slopes of Mt Taylor in Gull Rock NP have been affected by Phytophthora dieback with aerial canker also affecting the latter area.

Sub-units:

### 31a Spongelite Plain *Hakea* spp Tall Open Scrub

This sub-unit is restricted to the plains in the north-east of the survey area. It occurs on a variety of poorly drained soils overlying spongelite which may contain some clay or have some surface laterization. It forms a mosaic on flat to gently sloping plains with *Taxandria spathulata* Heath (31) and Tackalarup Damp Heath (40). It often abuts Eastern Jarrah/Sheoak Woodland (30) and sub-unit 31b on the rises and hills scattered on or adjacent to the plain. It is distinguished by a tall shrub layer dominated by *Hakea cucullata*, *H. lasiantha* and *H. trifurcata* over an open heath including *Taxandria spathulata* and *Banksia mucronulata*. *Kingia australis* and, less frequently, *H. tuberculata*, may be present in the upper shrub stratum and an emergent tree stratum including *Eucalyptus marginata*, *E. staeri*, *E. doratoxylon* and *Allocasuarina fraseriana* may be present. This sub-unit is distinguished from others by the presence of *Taxandria spathulata*, *Leucopogon gibbosus*, *Andersonia sprengelioides*, *Banksia brunnea*, *Stylidium gloeophyllum* and the absence of *Hakea ferruginea*, *Chordifex laxis*, *Gastrolobium coriaceum*, *Xanthosia rotundifolia* and *Hovea trisperma* and the scarcity of *Lepidosperma* sp Bakers Junction.

### 31b *Hakea* spp Tall Open Scrub +/- *Eucalyptus marginata*/ *Allocasuarina fraseriana* Low Woodland.

This sub-unit occurs on lateritic soil with impeded drainage throughout the range of the complex. In the Betty's Beach area this unit occurs on gentle slopes with an understorey dominated by *Melaleuca striata* and *Banksia mucronulata* and contains several species typical of granite substrates including *Gastrolobium coriaceum* and *Leucopogon* sp Walpole. Elsewhere, the structure of this unit is dictated by landform and hydrology with flat impeded areas being tall open scrub and the better drained gentle slopes having an open woodland overstorey.

### 31c *Hakea ferruginea*/ *Banksia biterax* Open Heath +/- Low Woodland

This sub-unit is distinguished by the dominance of *Hakea ferruginea* and *Banksia biterax* in the understorey though this sub-unit frequently forms a mosaic with subunit 31b and 31d. The most extensive areas were recorded in Mill Brook NR where large areas have been modified by Phytophthora dieback. Other areas occur in the western outskirts of Albany and west of Bakers Junction NR.

### 31d *Banksia brownii* Thickets

This sub-unit was only recorded in Mill Brook NR and is distinguished by the dominance of *Banksia brownii* in the upper shrub strata with *Hakea lasiantha* and, *H. ferruginea* sub-dominant. Extensive areas are modified by Phytophthora dieback.

### 31e *Taxandria angustifolia*/ *Hakea ceratophylla*/ *Gastrolobium coriaceum* Shrubland

This sub-unit is restricted to the coastal slopes and crest of Mt Taylor and the crest of Mt Mason and is distinguished by the dominance of *Taxandria angustifolia*, *Hakea ceratophylla*, *Gastrolobium coriaceum*, *Kingia australis* and *Beaufortia decussata* in the upper stratum and the presence of *Pentapeltis silvatica* in the understorey as well as a scarcity of typical dominant *Hakea* species. *Hakea trifurcata* is occasionally dominant in the upper strata with *Hakea elliptica* forming an overstorey on the mid to upper slopes of Mt Taylor. This sub-unit is relatively open which may be the result of disease. Phytophthora dieback is present on the mid slopes

of Mt Taylor and aerial canker has affected *Hakea trifurcata* populations in the same area (S. Barrett pers. comm.).

### 31f *Hakea ferruginea* and/or *H. trifurcata*/ *Xanthorrhoea platyphylla* Shrubland

Small patches of this sub-unit were recorded in the central and north western areas of the survey area. This sub-unit is very open and usually lacks a lower shrub stratum. Further work is required to determine the status and relationship of this unit with *Pericalymma spongiocaule* units co-dominated by *Hakea ferruginea* observed around the Narrikup area, which is within the ARVS context area but outside the survey area.

#### Comments

This unit is vulnerable to Phytophthora dieback with many species being highly susceptible including *Banksia brownii* DRF, *B. mucronulata*, *B. seneciifolia*, *B. biterax*, *Xanthorrhoea platyphylla*, *Andersonia jamesii* and *Pultenaea verruculosa*. Extensive dieback infestations within this complex were observed in Mill Brook NR and in Gull Rock NP resulting in reduced floristic and structural diversity. Occurrences of the *Banksia brownii* Thicket (31d) are currently being maintained by DEC by regular aerial phosphate application.

Plant deaths associated with aerial canker were observed in *Hakea trifurcata* plants within this unit in coastal areas of Gull Rock NP and Betty's Beach, with *Cytospora* species isolated from dead specimens (C. Crane pers. comm.). This disease has caused decline of *H. trifurcata* in the past decade on the lower slopes of Mt Taylor (Gull Rock NP) (S. Barrett pers. comm.).

This complex is also fire-sensitive with dominant species almost all dominant *Hakea* and *Banksia* species being serotinous obligate seeders and typically requiring six or more years to first flower and seed set (Barrett *et al.* 2009).

The extent of this complex outside the survey area is not known though sub-units 31a to 31e are likely to be at their south western limit within the survey area. Many of the dominant species reach their western and south western limit within the ARVS survey area including *Hakea lasiantha*, *H. cucullata*, *Banksia brownii*, *B. mucronulata*, *B. biterax*, *Taxandria spathulata* and *Melaleuca striata*. This complex has floristic affinities with vegetation recorded on poorly drained lateritic soils on the marine plain north and north east of the ARVS context area. However, *Allocasuarina fraseriana* is absent from this northern vegetation and *Lambertia inermis* frequently present

#### Floristic Summary (all sub-units)

Lifeform	%cover	Species
Trees<10m	E-S	<i>Eucalyptus marginata</i> , <i>Eucalyptus staeri</i> , <i>Allocasuarina fraseriana</i> , <i>Eucalyptus doratoxylon</i>
Shrubs >2m	E-D	<i>Hakea cucullata</i> , <i>Hakea lasiantha</i> , <i>Hakea trifurcata</i> , <i>Hakea ferruginea</i> , <i>Kingia australis</i> , <i>Taxandria parviceps</i> , +/- <i>Hakea elliptica</i> , <i>Banksia brownii</i> , <i>Hakea tuberculata</i> , <i>Beaufortia decussata</i> , <i>Gastrolobium coriaceum</i>
Shrubs 1-2m	S-M	<i>Hakea ferruginea</i> , <i>Agonis theiformis</i> , <i>Melaleuca striata</i> , <i>Hakea ceratophylla</i> , <i>Isopogon formosus</i> , <i>Petrophile squamata</i> , <i>Allocasuarina humilis</i> , <i>Taxandria spathulata</i> , <i>Xanthorrhoea platyphylla</i> , <i>Xanthorrhoea preissii</i> , <i>Banksia mucronulata</i> , <i>Banksia biterax</i> , <i>Daviesia alternifolia</i>
Shrubs 0.5-1m	V-S	<i>Beaufortia anisandra</i> , <i>Leucopogon pendulus</i> , <i>Acacia browniana</i> , <i>Grevillea fasciculata</i> , <i>Pimelea tinctoria</i>
Shrubs <0.5 m	V-S	<i>Hibbertia microphylla</i> , <i>Pultenaea verruculosa</i> , <i>Adenanthos apiculatus</i> , <i>Leucopogon concinnus</i> , <i>Leucopogon gibbosus</i> , <i>Pimelea hispida</i> , <i>Pericalymma spongiocaule</i> , <i>Andersonia sprengelioides</i> , <i>Andersonia jamesii</i> , <i>Banksia brunnea</i>
Sedges/rushes	V-M	<i>Lepidosperma</i> sp Bakers Junction, <i>Mesomelaena tetragona</i> , <i>Lepidosperma</i> sp Down Rd Fan, <i>Lepidosperma</i> aff <i>pubisquameum</i> , <i>Anarthria gracilis</i> , <i>Anarthria prolifera</i> , <i>Chordifex laxus</i>
Herbs	V	<i>Stylidium gloeophyllum</i> , <i>Patersonia limbata</i> , <i>Gonocarpus trichostachyus</i> , <i>Stylidium imbricatum</i> , <i>Pentapeltis silvatica</i>
Grasses		<i>Amphipogon amphipogonoides</i>



### Key identifying Features

- Tall shrub strata dominated by *Hakea* species including *Hakea lasiantha*, *H. cucullata*, *H. trifurcata* and *H. ferruginea*.
- Presence of *Lepidosperma* sp Bakers Junction in a diverse sedgeland including *Lepidosperma* sp Down Rd Fan, *Schoenus obtusifolia*, *Mesomelaena tetragona*, *Anarthria gracilis* along with *Anarthria prolifera* and *Desmocladus fasciculatus*.
- Occurs on poorly drained shallow soils overlying laterite or spongelite/siltstone.

**Conservation species** *Schoenus* sp Grey rhizome P1, *Stylidium gloeophyllum* P3, *Stylidium daphne* P3, *Hakea tuberculata* P3, *Chorizema reticulatum* P3, *Andersonia jamesii* P3



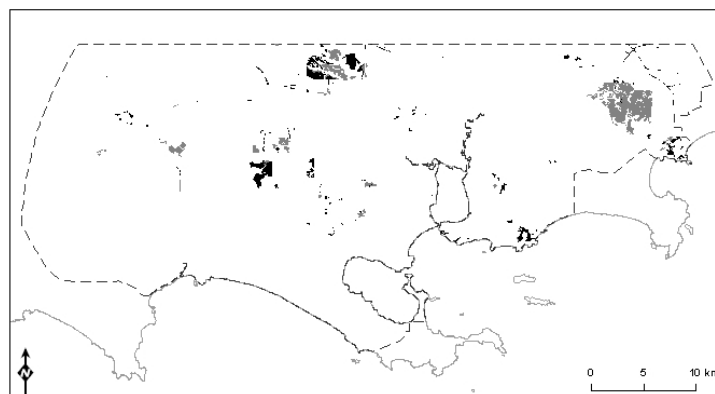
***Hakea* spp Shrubland/ Woodland Complex sub-unit 31a**



***Hakea* spp Shrubland/ Woodland Complex sub-unit 31b**



**Sub-unit 31d**



**Unit 31 *Hakea* spp Shrubland/ Woodland Complex**



## 32 *Taxandria spathulata* Heath

No. of relevés 6 Mean spp. richness 20 Area 304 ha % of Rem. Veg. 0.7 % in IUCN Reserve 1-IV 0

### Description

*Taxandria spathulata* Heath is restricted to the plains in the north of Angove Water Reserve where it occurs on shallow brown clay loam overlying spongelite. This unit is characterized by stands of *Taxandria spathulata* occurring over a depauperate shrubland and open sedgeland dominated by *Schoenus* sp Cape Riche Cushion, *Mesomelaena stygia*, *Mesomelaena tetragona* and *Cyathochaeta avenacea*. *Hakea cucullata* and *Allocasuarina thuyoides* may be present as emergents in an upper tall shrub stratum. An annual herb layer was recorded in several locations, reflecting the clay nature of soils, and in a few areas a distinct low shrubland of *Verticordia plumosa* subsp *grandiflora* was present.

After fire this unit has a more diverse lower shrub stratum and identification of boundaries between this unit and sub-unit 31a, with which it usually forms a mosaic, can be difficult. This unit also forms a mosaic with Takalarup Damp Heath (40) which occurs in wetter areas in very shallow depressions on spongelite plains.

### Comments

Many areas of this unit were burnt in an intense fire in 2000 and it has been mapped as a mosaic with *Hakea* spp Shrubland/Woodland Complex (31) and Takalarup Damp Heath (40) though it does form extensive bands.

This unit appears to be restricted to the siltstone/spongelite soils on the Takalarup and Boulongup landform units (Churchward *et al.* 1988) within the survey area and may be limited to the ARVS context area. *Taxandria spathulata* is a common species across the Eyre and eastern areas of the Stirling Botanical Districts, reaching its south western limit within the survey area. Similar vegetation was not found during surveys on remnants on ITC properties on the plains north and north east of the survey area nor is it known to occur in the Ravensthorpe, Fitzgerald or Esperance areas (Sandiford 2003-2006; G. Craig pers. comm.).

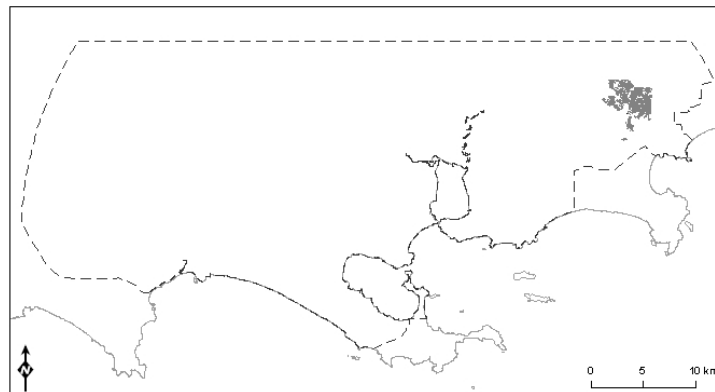
### Floristic Summary

Lifeform	%cover	Species
Shrubs >2m	E	<i>Hakea cucullata</i> , <i>Allocasuarina thuyoides</i>
Shrubs 1-2m	M	<i>Taxandria spathulata</i> , <i>Petrophile squamata</i> , <i>Eutaxia parvifolia</i>
Shrubs <1m	V	<i>Grevillea fasciculata</i> , <i>Verticordia plumosa</i> subsp <i>grandiflora</i> , <i>Acacia sulcata</i> subsp <i>sulcata</i> , <i>Leucopogon pendulus</i> , <i>Andersonia sprengelioides</i> , <i>Leucopogon gibbosa</i> , <i>Pultenaea verruculosa</i> , <i>Hibbertia microphylla</i>
Sedges/rushes	S	<i>Mesomelaena stygia</i> , <i>Mesomelaena tetragona</i> , <i>Schoenus</i> sp Cape Riche Cushion, <i>Schoenus</i> sp Grey Rhizome, <i>Cyathochaeta avenacea</i> , <i>Schoenus obtusifolia</i> , <i>Lepidosperma</i> sp Down Rd Fan
Herbs	V	<i>Patersonia pygmaea</i> , <i>Stylidium gloeophyllum</i> , <i>Philydrella pygmaea</i> , <i>Aphelia cyperoides</i> , <i>Stylidium perpusillum</i> , <i>Levenhookia pusilla</i> , <i>Stylidium despectum</i>
Grasses		<i>Neurachne alopecuroidea</i>

### Key identifying Features

- Open Heath dominated by *Taxandria spathulata*, with a sedgeland that includes *Schoenus* sp Cape Riche Cushion and *Mesomelaena stygia*.
- Occurrence on clay loam over lying spongelite plains.

**Conservation species** *Schoenus* sp “Grey Rhizome P1, *Hakea tuberculata* P3, *Centrolepis caespitosa* P4  
*Andersonia jamesii* P3, *Stylidium gloeophyllum* P3



**Unit 32 *Taxandria spathulata* Heath**

### 33 *Eucalyptus patens* Low Woodland

No. of relevés 3 Mean spp. richness 13 Area 102 ha % of Rem. Veg. 0.2 % in IUCN Reserve 1-IV 1.8

#### Description

*Eucalyptus patens* Low Woodland is found scattered in the western section of the survey area where it is found on grey to dark grey sand and sandy loams low in the landscape where moisture retention is high. This unit forms narrow bands along valley edges and drainage lines between upland and wetland units and has a relatively open understorey with low species diversity dominated by a *Taxandria parviceps* Tall Shrubland, *Pultenaea reticulata*/ *Leucopogon unilateralis* Mixed Shrubland over a *Leptocarpus tenax*/ *Anarthria scabra* Open Sedgeland and *Pteridium esculentum*/ *Patersonia umbrosa* Open Herbland with *Stylidium nymphaeum* in the latter. In southern areas, *Kunzea clavata* may be present in the upper understorey stratum.

#### Comments

Much of the suitable habitat for this unit within the survey area has been cleared and it is likely this unit was once more common. \**Pittosporum undulatum* was noted in low numbers in this unit in Barrett Meadows NR and it is likely this unit is vulnerable to weed invasion following disturbances such as fire or grazing due to the high moisture content of the soil.

This is an uncommon unit within the survey area and occurs at its eastern limit, with *E. patens* reaching its eastern limit within the survey area. This unit has been observed to the north west of the ARVS area between Mt Barker and Rocky Gully (Sandiford 2003-2006). *E. patens* is common in the Warren and parts of the Darling Botanical Districts and *E. patens* low woodlands observed from Denmark to Northcliffe occur on similar landforms to those observed within the survey area (author observations).

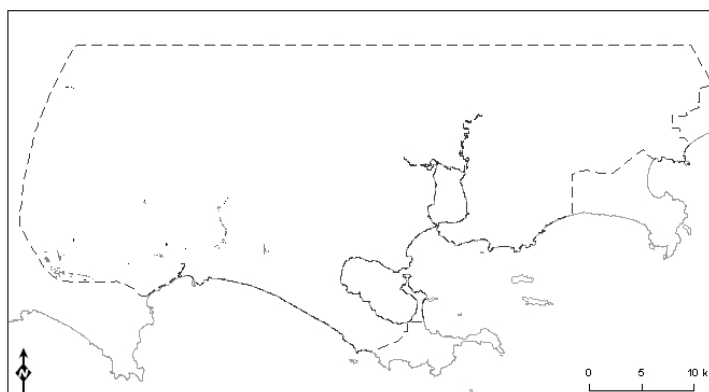
#### Floristic Summary

Lifeform	%cover	Species
Trees	S-M	<i>Eucalyptus patens</i>
Shrubs >2m	S	<i>Taxandria parviceps</i> +/- <i>Astartea laricifolia</i> , +/- <i>Kunzea clavata</i>
Shrubs 1-2m	S	<i>Pultenaea reticulata</i> , <i>Leucopogon unilateralis</i> , <i>Aotus intermedia</i> , <i>Latrobea glabrescens</i> , <i>Leucopogon obovatus</i>
Shrubs <1		<i>Bossiaea praetermissa</i> , <i>Boronia crenulata</i> , <i>Adenanthos cuneatus</i>
Sedges/rushes	S	<i>Leptocarpus tenax</i> , <i>Anarthria scabra</i> , <i>Hypolaena exsulca</i> , <i>Anarthria prolifera</i> , <i>Lepidosperma</i> aff <i>squamatum</i> forma narrow
Herbs	S-V	<i>Stylidium nymphaeum</i> , <i>Patersonia umbrosa</i> , <i>Pteridium esculentum</i> , <i>Opercularia hispidula</i>

#### Key identifying Features

- Dominance of *Eucalyptus patens* and *Taxandria parviceps* in upper two strata in association with *Pultenaea reticulata*, *Leucopogon unilateralis*, *Pteridium esculentum*, *Patersonia umbrosa* and *Stylidium nymphaeum*
- Occurrence adjacent to creek lines and drainage lines.

**Conservation species** None recorded







**Unit 33 *Eucalyptus patens* Low Woodland**



**Unit 34 *Banksia occidentalis*/*Kunzea clavata* Shrubland**

### 34 *Banksia occidentalis/Kunzea clavata* Shrubland

No. of relevés 3 Mean spp. richness 13.7 Area 12 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0.4

#### Description

*Banksia occidentalis/Kunzea clavata* Shrubland is restricted to grey sandy soil on poorly drained flats around Torbay Inlet and the western end of Lake Powell. It is distinguished by a *Banksia occidentalis* and *Kunzea clavata* dominated close tall scrub to shrubland occurring over an *Anarthria laevis* dominated sedgeland with the structure thinning with age. This unit is often bordered by *Taxandria juniperina* Closed Forest (59) which occurs in lower wetter areas and by Coastal *Banksia ilicifolia*/Peppermint Low Woodland (4) on drier sites.

#### Comments

\**Acacia longifolia* was observed within this unit north of Torbay Inlet.

*Kunzea clavata*, a key floristic and structural component of this unit, has a limited distribution, and has been recorded from West Cape Howe, Grasmere, Torbay and Kronkup. Thus this unit is restricted to the context area and appears confined to a small area around Lake Powell and Torbay Inlet. *Banksia occidentalis* is highly susceptible to *Phytophthora* dieback, though no infestations were observed within this unit. It is also vulnerable to inappropriate fire regimes as it is a serotinous obligate seeder.

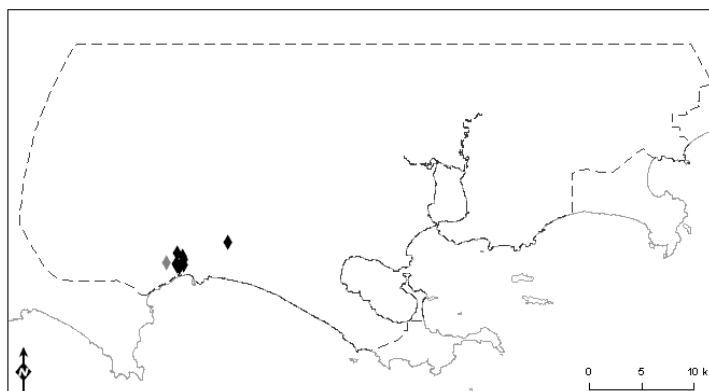
#### Floristic Summary

Lifeform	%cover	Species
Shrubs >2m	S-D	<i>Banksia occidentalis</i> , <i>Kunzea clavata</i> , +/- <i>Taxandria juniperina</i> , <i>Astartea scoparia</i> ,
Shrubs 1-2m	V	<i>Aotus intermedia</i> , <i>Adenanthos obovatus</i> , <i>Pericalymma spongiocaula</i> , <i>Acacia hastulata</i>
Shrubs <0.5m		<i>Andersonia caerulea</i>
Sedges/rushes	M	<i>Anarthria laevis</i> , <i>Lepidosperma striatum</i> , <i>Anarthria laevis</i> , <i>Schoenus efoliatus</i> , <i>Schoenus rodwayanus</i> , <i>Hypolaena exsulca</i> , <i>Leptocarpus tenax</i>
Herbs		<i>Dasyogon bromeliifolius</i> , <i>Drosera</i> spp.

#### Key identifying Features

- Dominance of *Banksia occidentalis*, *Kunzea clavata* in upper shrub stratum and *Anarthria laevis* in the sedgeland.
- Occurrence on sandy low lying flats.

Conservation species None recorded



### 35 *Eucalyptus megacarpa* Riparian Forest

No. of relevés 1 Mean spp. richness 14 Area 43 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 6.7

#### Description

*Eucalyptus megacarpa* Riparian Forest is found along flat creek banks and drainage lines in the eastern section of the survey area, and along drains and flats around Grasmere. This unit was poorly sampled due to disturbance (fire and grazing). In eastern areas the understorey is typically a *Taxandria parviceps* tall open shrubland over *Hypocalymma cordatum* open heath, *Cyathochaeta avenacea* open sedgeland and *Tetrarrhena laevis* very open grassland with *Trymalium odoratissimum*, *Acacia leioderma*, *Xanthorrhoea platyphylla*, *Taxandria linearifolia*, *Pteridium esculentum*, *Lomandra pauciflora*, and *Lepidosperma striatum* common.

This unit differs from *E. megacarpa*/*Agonis flexuosa* Tree Mallee (2b) in its species composition and landform, with the latter occurring on dune systems.

#### Comments

Occurrences of this unit within Goodga River Nature Reserve were observed after a severe fire (2008) and the understorey species composition was not determined. The eastern limit of this unit is likely to be just east of the survey area at the range limit of *E. megacarpa*. Hickman (2008) recorded this unit with *Agonis flexuosa* in the understorey on the western margins of Waychinnicup NP, and it has been recorded along the Goodga River in the western area of Two Peoples Bay Nature Reserve (Hopkins *et al.* unpublished). Similar vegetation has been observed along creek lines from Denmark to Northcliffe and may extend further west, though the understorey species composition in this region is not known (author observations).

#### Floristic Summary

Lifeform	%cover	Species
Trees	M	<i>Eucalyptus megacarpa</i> +/- <i>Corymbia calophylla</i>
Shrubs >2m	S	<i>Taxandria parviceps</i> <i>Trymalium odoratissimum</i> <i>Acacia leioderma</i> , <i>Xanthorrhoea platyphylla</i> , <i>Taxandria linearifolia</i> +/- <i>Melaleuca microphylla</i>
Shrubs 1-2m	M	<i>Hibbertia furfuracea</i>
Shrubs <0.5m		<i>Thomasia pauciflora</i>
Sedges/rushes	S	<i>Cyathochaeta avenacea</i> , <i>Lepidosperma gracile</i> , <i>Lepidosperma striatum</i>
Herbs	V	<i>Pteridium esculentum</i> , <i>Billardiera drummondii</i>
Grasses	V	<i>Tetrarrhena laevis</i>

#### Key identifying Features

- Canopy of *Eucalyptus megacarpa* and dominance of *Taxandria parviceps*, *Hypocalymma cordatum* and *Cyathochaeta avenacea*
- Occurrence along flat creek banks and drainage lines

**Conservation species** *Billardiera drummondii* P4, *Hakea tuberculata* P3







**Unit 35 *Eucalyptus megacarpa* Riparian Forest**



**Unit 36 *Callistachys* spp Thicket**

## 36 *Callistachys* spp Thicket

No. of relevés 1 Mean spp. Richness 6 Area 36 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 10.9

### Description

*Callistachys* spp Thicket was not well sampled as patches were usually very small and often disturbed. It occurs where local soaks or seepages occur on minor drainage lines, flats, gullies and slopes, on sandy to peaty soil. This unit is dominated by a canopy of *Callistachys lanceolata*, either as shrubs or trees. The understorey is heterogeneous reflecting both small patch size and soil moisture. Species diversity and density appears to thin as the canopy closes over. Commonly recorded species include *Pteridium esculentum*, *Leptocarpus tenax*, *Baumea juncea*, *Lepidosperma striatum*, *Leucopogon obovatus*, *Hibbertia cuneiformis*, *Homalospermum firmum*, *Aotus intermedia*, *Gahnia decomposita* and *Anarthria prolifera*.

*Callistachys lanceolata* appears to intergrade with *Callistachys* sp South Coast which has a coastal distribution and it is often difficult to differentiate between the two. Small *Callistachys* sp South Coast thickets are restricted to the coastal fringe, near coastal gullies and seepages and are mapped as *Callistachys lanceolata* thickets as none were sampled.

### Comments

This unit is vulnerable to weed invasion and *\*Acacia longifolia* and *\*Psoralea pinnata* were commonly observed within it.

The unit naturally occurs in small patches but is relatively widespread in the survey area.

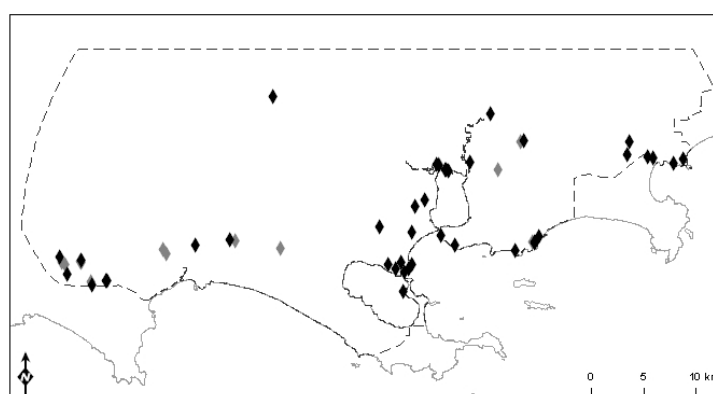
### Floristic Summary

Lifeform	%cover	Species
Shrubs-Tree >2m	M-D	<i>Callistachys lanceolata</i> , <i>Callistachys</i> sp South Coast
Shrubs 1-2m	M	<i>Homalospermum firmum</i> , <i>Leucopogon obovatus</i> , <i>Hibbertia cuneiformis</i> , <i>Aotus intermedia</i> , <i>Hypocalymma cordifolium</i>
Shrubs 0.5-1m	S	<i>Adenanthos obovatus</i>
Sedges/rushes	V-M	<i>Lepidosperma striatum</i> , <i>Leptocarpus tenax</i> , <i>Gahnia decomposita</i> , <i>Anarthria prolifera</i>
Herbs	S	<i>Pteridium esculentum</i> , <i>Lomandra pauciflora</i>

### Key identifying Features

- Dominance of *Callistachys lanceolata* or *Callistachys* sp South Coast.
- Occurrence around seepages and soaks.

Conservation species *Billardiera drummondii* P4



## 37 *Adenanthos cuneatus/Banksia quercifolia* Transitional Heathland

No. of relevés 2    Mean spp. richness 18    Area 6 ha    % of Rem. Veg. <0.1    % in IUCN Reserve 1-IV 100

### Description

*Adenanthos cuneatus/Banksia quercifolia* Transitional Heathland was only recorded within Mill Brook NR and occurred on dark grey loamy sand in shallow depressions along broad hill crests and valleys. This unit appears ecotonal in floristic composition with affinities to *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (14), *Taxandria parviceps* Transitional Shrubland (38), *Pericalymma spongiocaule* Low Heath (39) and *Evandra aristata* Sedgeland (47). It lacks key floristic elements of these units including *Banksia coccinea* and *Jacksonia spinosa*; *Pericalymma spongiocaule*, *Beaufortia anisandra* and *Tremulina tremula*; *Taxandria parviceps* and *Evandra aristata*, respectively. It contains *Latrobea tenella*, *Euchilopsis linearis* and *Chordifex abortivus* and is dominated by *Banksia quercifolia*, *Adenanthos cuneatus* and *Latrobea tenella*. Further survey is required to determine its floristic affinities, extent and ecotonal nature.

### Notes

Very little of this unit was observed and all areas were recovering from a fire in 2004. This unit was described in Mill Brook Nature Reserve as *Banksia quercifolia* Heath (Griffin 1985).

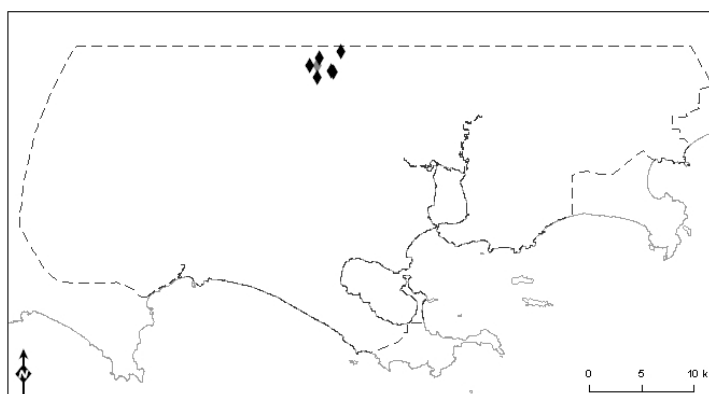
### Floristic Summary

	%cover	Species
Trees		+/- <i>Eucalyptus staeri</i>
Shrubs 1-2m	M	<i>Adenanthos cuneatus</i> , <i>Banksia quercifolia</i> , <i>Daviesia flexuosa</i> , <i>Phyllota barbata</i>
Shrubs <1m		<i>Latrobea tenella</i> , <i>Leucopogon distans</i> , <i>Leucopogon gracilis</i> , <i>Lysinema conspicuum</i> , <i>Hypocalymma strictum</i> , <i>Adenanthos obovatus</i> , <i>Euchilopsis linearis</i>
Sedges/rushes	S	<i>Anarthria scabra</i> , <i>Anarthria gracilis</i> , <i>Hypolaena fastigiata</i> , <i>Lyginia barbata</i> , <i>Chordifex abortivus</i> , <i>Hypolaena exsulca</i>
Herbs		<i>Stylidium scandens</i> , <i>Dasyopogon bromeliifolius</i>

### Key identifying Features

- Transitional open heath occurring on sandy soil.
- Dominance of *Adenanthos cuneatus*, *Banksia quercifolia* and *Latrobea tenella*,

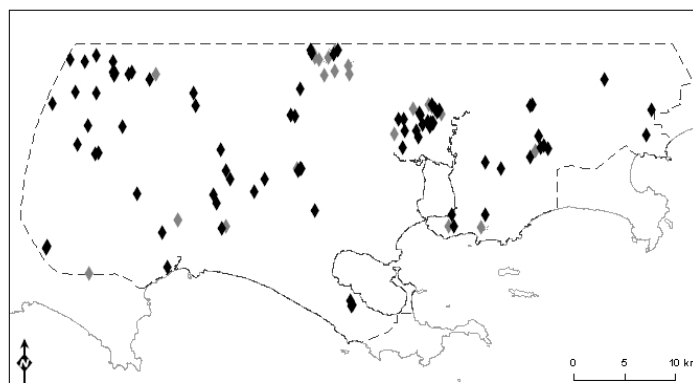
**Conservation species** *Chordifex abortivus* DRF







**Unit 37 *Adenanthos cuneatus/Banksia quercifolia* Transitional Heathland**



**Unit 38 *Taxandria parviceps* Transitional Shrubland**

## 38 *Taxandria parviceps* Transitional Shrubland

No. of relevés 10 Mean spp. richness 23.7 Area 109 ha % of Rem. Veg. 0.2 % in IUCN Reserve 1-IV 41.1

### Description

*Taxandria parviceps* Transitional Shrubland is found throughout the survey area on grey sand along the edge of drainage depressions, or in pockets of poorly drained sand over laterite. This unit often exists as narrow bands along valleys between the uplands and wetlands and shares species with units typical of these areas. The upper stratum is a *Taxandria parviceps* tall open or closed tall scrub with understorey strata decreasing in both structural and floristic diversity with increasing canopy cover. *Banksia quercifolia* may be co-dominant in the upper stratum. Emergent trees are occasionally present. Common species include *Melaleuca thymoides*, *Adenanthos obovatus*, *Leucopogon glabellus*, *Boronia spathulata*, *Dampiera leptoclada*, *Conospermum caeruleum*, *Anarthria scabra*, *Anarthria prolifera*, *Mesomelaena gracilipes*, *Hypolaena exsulca*, *Schoenus efoliatius*, *Evandra aristata* and *Dasypogon bromeliifolius*.

### Comments

Most remnants along drainage lines on private property have been cleared to, or just below, the upper margin of winter wet soils. As this unit usually occurs just above this margin, it is likely that much of it has been cleared.

*Banksia quercifolia*, a co-dominant species within this unit, is highly susceptible to *Phytophthora* dieback and in many areas unhealthy or dead specimens were observed. *Taxandria parviceps* is a species resilient to dieback, fire and grazing and stands of this species were frequently observed in highly disturbed areas along roadsides and in the vicinities of drainage lines on private land. A similar proliferation of *Taxandria parviceps* combined with deaths of *Banksia quercifolia* associated with *Phytophthora* dieback has been noted in the Walpole area (J. Young pers. comm.).

The dominant and common species of this unit are found throughout the Warren and southern areas of the Darling Botanical Districts. The eastern limit of *Taxandria parviceps* and *Banksia quercifolia* occurs around Cheyne Bay. Thus, similar vegetation is likely to be widespread to the west and extending just east of the survey area. This unit shares many species with communities within the super Community group A recorded by Wardell-Johnson and Williams (1996) in the Walpole -Nornalup area. However, this community group also contained common species which were not observed in unit 38 in the ARVS area. This unit also appears to be floristically similar to Community Type 2 listed as occurring in the Walpole Nornalup National Park (Wardell-Johnson *et al.* 1989).

### Floristic Summary

Lifeform	%cover	Species
Trees		<i>Eucalyptus marginata</i> , <i>Allocasuarina fraseriana</i> , <i>Eucalyptus staeri</i> <i>Melaleuca preissiana</i>
Shrubs >2m	M-S	<i>Taxandria parviceps</i> , <i>Beaufortia decussata</i>
Shrubs 1-2m	M	<i>Banksia quercifolia</i> , <i>Beaufortia sparsa</i> , <i>Sphaerolobium grandiflorum</i>
Shrubs <1m	V	<i>Adenanthos obovatus</i> , <i>Leucopogon glabellus</i> , <i>Sphenotoma gracilis</i> , <i>Boronia crenulata</i> , <i>Conospermum caeruleum</i> , <i>Dampiera leptoclada</i> , <i>Xanthosia rotundifolia</i> , <i>Pimelea longiflora</i> , <i>Hypocalymma strictum</i> , <i>Dampiera leptoclada</i>
Sedges/rushes	M	<i>Anarthria scabra</i> , <i>Anarthria prolifera</i> , <i>Mesomelaena gracilipes</i> , <i>Hypolaena exsulca</i> , <i>Schoenus efoliatius</i> , <i>Schoenus acuminatus</i> , <i>Evandra aristata</i> , <i>Lyginia barbatus</i> , <i>Lepidosperma striatum</i> , <i>Leptocarpus tenax</i> , <i>Chordifex laxus</i>
Herbs	V	<i>Dasypogon bromeliifolius</i> , <i>Johnsonia lupulina</i> , <i>Stylidium scandens</i> , <i>Phlebocarya ciliata</i> , <i>Stylidium violaceum</i> , <i>Cassytha glabellus</i>

### Key identifying Features

- Dominance of *Taxandria parviceps* in upper stratum, often in association with *Banksia quercifolia*.
- A transitional unit often occurring between the well drained sandy soil of lower valley slopes and winter wet soil of drainage depressions.

**Conservation species** None recorded

### 39 *Pericalymma spongiocaule* Low Heath

No. of relevés 32 Mean spp. richness 25.3 Area 880 ha % of Rem. Veg. 2.0 % in IUCN Reserve 1-IV 22.9

#### Description

*Pericalymma spongiocaule* Low Heath is typically found at the edges of drainage depressions on grey sandy soil where drainage is impeded by an impervious subsurface layer (T. Griffin pers. comm.). It also occurs mid slope or on crests where there is localized impeded drainage. Within the survey area it appears to have a strong affinity with Minor Valley and Dempster landform units (Churchward *et al.* 1988). Many patches are very small with the dominance of *Pericalymma spongiocaule* the distinctive feature of this unit along with a very diverse sedgeland usually dominated by *Tremulina tremula*. *Beaufortia anisandra* is often co-dominant with other common shrub species that include *Adenanthos obovatus*, *Calothamnus schaueri*, *Actinodium cunninghamii*, *Andersonia caerulea*, *Hypocalymma ericifolium*, *Leucopogon pendulus* and *Lysinema conspicuum*. Co-dominant sedges include *Mesomelaena tetragona*, *Anarthria gracilis* and *Hypolaena fastigiata*, with *M. tetragona* occasionally the dominant sedge. The herb layer is typically very sparse with *Dasypogon bromeliifolius* the most prominent herb. The grasses *Amphipogon debilis* and *Amphipogon laguroides* are often present.

An emergent or very sparse tree stratum and taller shrub species may be present particularly on undulating ground where the trees and taller shrubs form open clumps on slightly higher ground. In these areas additional common species include *Eucalyptus staeri*, *E. marginata*, *Allocasuarina fraseriana*, *Kingia australis*, *Beaufortia decussata*, *Hakea ceratophylla*, *Sphaerolobium grandiflorum* and *Taxandria parviceps*. On slightly drier or sandier sites *Melaleuca thymoides*, *Dasypogon bromeliifolius* and *Lyginia barbata* may be present.

Along drainage lines this unit is often present just upslope of *Evandra aristata* Sedgeland (46).

Two sub-units are described

**39a *Pericalymma spongiocaule* Low Open Heath** described above.

**39b *Hakea sulcata*/Petrophile squamata Shrubland/ *Pericalymma spongiocaule* Low Open Heath**

This sub-unit is less diverse than 39a and has a distinctive upper shrub stratum of *Hakea sulcata*, *Petrophile squamata*, and occasionally *Hakea ferruginea* occurring above the *Pericalymma spongiocaule* Low Open Heath, with *Stirlingia tenuifolia* often present.

#### Comments

*Pericalymma spongiocaule* was previously included in *P. ellipticum*, but separated on its soft swollen stems and floral characteristics. In a number of areas the entire strata of *Pericalymma spongiocaule* was dead or dying of unknown causes.

This unit shares many species with Takalarup Damp Heath (40) and is differentiated by the absence of *Banksia dryandroides*, *Taxandria spathulata*, *Melaleuca suberosa* and *Eutaxia parvifolia*, rarity of *Hakea tuberculata* and dominance of *Tremulina tremula*. These units merge in Angove Water Reserve and the latter unit may represent a transitional unit between different biogeographic regions.

Much of the potential habitat for this unit has been cleared within the ARVS area. The distribution of this unit outside the survey area is not known. Many of the common species are widespread in the Warren Botanical district, particularly in the Scott River area, and from Walpole to Albany. However, one common and often dominant species, *Beaufortia anisandra*, is only recorded east of Denmark and the unit may have a limited distribution centered on the ARVS context area.

#### Key identifying Features

- *Pericalymma spongiocaule* dominated low open heath over very diverse sedgeland dominated or co-dominated by *Tremulina tremula*
- Occurrence on sands with impeded drainage.

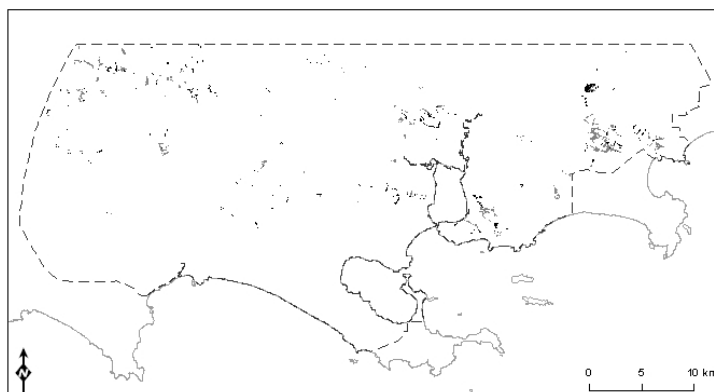
**Conservation species** *Hakea tuberculata* P3, *Goodenia filiformis* P4



## Floristic Summary

Lifeform	%cover	Species
Trees<10m	E	<i>Eucalyptus staeri</i> , <i>Eucalyptus marginata</i> , <i>Allocasuarina fraseriana</i>
Shrubs >2m	E-V	<i>Taxandria parviceps</i> , <i>Beaufortia decussata</i> , <i>Kingia australis</i>
Shrubs 1-2m	V	<i>Xanthorrhoea platyphylla</i> , <i>Sphaerolobium grandifolium</i> , +/- <i>Melaleuca thymoides</i> , <i>Hakea ceratophylla</i> , <i>Petrophile squamata</i> *
Shrubs 0.5-1m	V-M	<i>Pericalymma spongiocaule</i> , <i>Beaufortia anisandra</i> , <i>Leucopogon glabellus</i> , <i>Adenanthos obovatus</i> , <i>Sphenotoma gracilis</i> , <i>Petrophile squamata</i> , <i>Leucopogon pendulus</i> , <i>Hakea sulcata</i> *
Shrubs < 0.5m	V-S	<i>Pericalymma crassipes</i> , <i>Dampiera leptoclada</i> , <i>Boronia spathulata</i> , <i>Lysinema conspicuum</i> , <i>Hibbertia microphylla</i> , <i>Darwinia oederoides</i> , <i>Darwinia vestita</i> , <i>Andersonia caerulea</i> , <i>Calothamnus schaueri</i> , <i>Conostylis caeruleum</i> , <i>Actinodium cunninghamii</i> , <i>Stirlingia tenuifolia</i> *, +/- <i>Hypocalymma ericifolium</i> , <i>Euchilopsis linearis</i> , <i>Andersonia sprengelioides</i> forma swamp
Sedges/rushes	V-M	<i>Tremulina tremula</i> , <i>Leptocarpus tenax</i> , <i>Mesomelaena tetragona</i> , <i>Anarthria gracilipes</i> , <i>Lyginia barbata</i> , <i>Chordifex laxus</i> , <i>Anarthria scabra</i> , <i>Anarthria prolifera</i> , <i>Hypolaena fastigiata</i> , <i>Hypolaena exsulca</i> , <i>Mesomelaena gracilipes</i> , <i>Schoenus acuminatus</i> , <i>Lepyrodia drummondiana</i> , <i>Chaetanthus tenellus</i> , <i>Schoenus efoliatus</i> , <i>Tricostularia neesii</i> var <i>elatior</i> . +/- <i>Anarthria laevis</i>
Herbs	Nil-V	<i>Dasyopogon bromeliifolius</i> , <i>Johnsonia lupulina</i> , <i>Baxteria australis</i> , <i>Stylidium luteum</i> , <i>Stylidium scandens</i> , <i>Conostylis setigera</i> subsp <i>setigera</i> , <i>Conospermum caeruleum</i> ,
Grasses	Nil-V	<i>Amphipogon debilis</i> , <i>Amphipogon laguroides</i>

\*Sub-unit 39b





**Unit 39 *Pericalymma spongiocaula* Low Heath**

## 40 Takalarup Damp Heath

No. of relevés 8 Mean spp. richness 27.3 Area 165 ha % of Rem. Veg. 0.4 % in IUCN Reserve 1-IV 0

### Description

Damp Spongelite Open Low Heath is a heterogeneous unit only recorded in the northern area of Angove Water Reserve where it occurs in low-lying, seasonally damp/wet areas, on clay loams/sands overlying siltstone/spongelite on the Takalarup and Boulongup Landform Unit (Churchward *et al.* 1988). A large number of species were recorded in all sites though many were limited to one or two sites and further survey is required to fully describe this unit.

An open low heath is characteristic of this unit with a *Hakea tuberculata* Shrubland often present. Common shrub species include *Pericalymma spongiocaula*, *Eutaxia parvifolia*, *Taxandria spathulata*, *Synaphea polymorpha*, *Hibbertia microphylla*, *Leucopogon reflexus*, *Melaleuca violacea*, *Xanthorrhoea platyphylla*; *Andersonia sprengelioides* form swamp and *Taxandria spathulata*. The sedgeland is typically very open and often dominated by *Mesomelaena tetragona*. Other emergent shrubs and trees include *Hakea cucullata*, *Kingia australis*, *Hakea ceratophylla*, *Viminea juncea*, *Taxandria parviceps*, *Eucalyptus staeri* and *Melaleuca preissiana*.

This unit has close floristic affinities with *Pericalymma spongiocaula* Low Heath (39) (see comments unit 39). It also shares species with *Hakea* spp Shrubland/ Woodland Complex (31) and *Taxandria spathulata* Heath (32) with which it forms a mosaic on gently undulating plains. It differs from these in the presence of species indicative of seasonally damp/wet flats with clay soils including *Melaleuca violacea*, *Melaleuca densa*, *Hakea tuberculata* and less frequently *Banksia dryandroides*, *Banksia arctotidis*, *Banksia brunnea*, *Melaleuca spathulata*, *M. suberosa*, *Astartea glomerosa*, *Astartea* sp. small horns and *Viminea juncea*. It also differs in its more open and less diverse sedgeland. Many of these species reach their south western limit in the vicinity of Angove Water Reserve.

### Comments

The distribution of this unit outside the survey area is not known and it may be limited to siltstone/spongelite soils.

The unit contains a range of species susceptible to *Phytophthora dieback*.

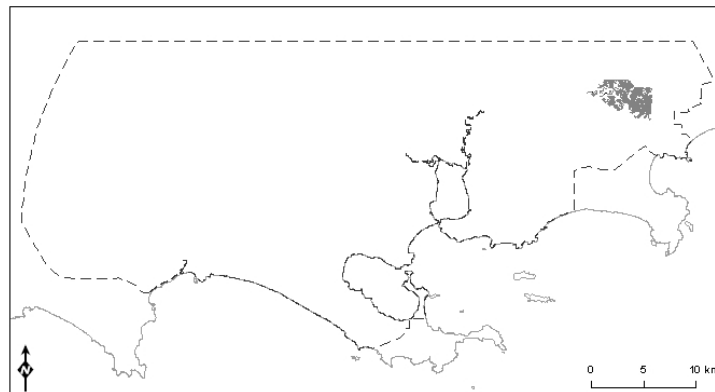
### Floristic Summary

Lifeform	%cover	Species
Trees/Mallees <10m	E	<i>Eucalyptus staeri</i> , <i>Melaleuca preissiana</i>
Shrubs >2m	E	<i>Hakea tuberculata</i> , <i>Hakea cucullata</i> , <i>Viminea juncea</i> , <i>Kingia australis</i> , <i>Hakea ceratophylla</i> , <i>Taxandria parviceps</i>
Shrubs 0.5-1m	S-M	<i>Pericalymma spongiocaula</i> , <i>Taxandria spathulata</i> , <i>Allocasuarina humilis</i> , <i>Melaleuca spathulata</i> , <i>Grevillea fasciculata</i> , <i>Petrophile squamata</i> , <i>Hakea ceratophylla</i> , <i>Eutaxia parvifolia</i> , <i>Melaleuca densa</i> , <i>Beaufortia anisandra</i> , <i>Andersonia sprengelioides</i> forma swamp, <i>Synaphea polymorpha</i> , <i>Gompholobium capitatum</i> , <i>Eutaxia virgata</i> , <i>Melaleuca violacea</i> , <i>Pultenaea aspalathoides</i> , <i>Leucopogon pendulus</i> , <i>Pultenaea verruculosa</i> , <i>Leucopogon reflexus</i> , <i>Chorizema cytisoides</i> , <i>Hibbertia microphylla</i> , <i>Melaleuca suberosa</i> , <i>Banksia dallanneyi</i> , <i>Calothamnus schaueri</i> , <i>Banksia brunnea</i> , <i>Banksia dryandroides</i>
Sedges/rushes	V-S	<i>Mesomelaena tetragona</i> , <i>Lepidosperma</i> sp Down Rd Fan, <i>Cyathochaeta avenacea</i> , <i>Desmocladus fasciculatus</i> , <i>Schoenus obtusifolius</i> , <i>Anarthria gracilis</i> .
Herbs	nil- V	<i>Conostylis setigera</i> subsp <i>setigera</i> , <i>Stylidium gloeophyllum</i> , <i>Thysanotus multiflorus</i>
Grasses		<i>Amphipogon debilis</i>

### Key identifying Features

- Open Low Heaths dominated by a variety Myrtaceous, Proteaceous and Papilionaceous species.
- Occurrence on clay loam soil in low lying winter damp to wet areas overlying spongelite.

**Conservation species** *Hakea tuberculata* P3, *Stylidium gloeophyllum* P3



**Unit 40 Takalarup Damp Heath**

## 41 *Xanthorrhoea* Lowland Sedgeland

No. of relevés 1 Mean spp. richness 19 Area 8 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

*Xanthorrhoea* Lowland Sedgeland is a dense and diverse sedgeland with a canopy of *Xanthorrhoea* species that occurs on low lying flats at the edge of rises along the western fringe of the survey area. Common sedges include *Leptocarpus tenax*, *Mesomelaena tetragona*, *Baumea acuta*, *Lyginia imberbis*, *Schoenus bifidus*, *Chordifex laxus*, *Hypolaena fastigiata* and *Schoenus curvifolius*. *Melaleuca preissiana* may be present as an emergent.

This unit was only sampled once. “*Xanthorrhoea* flats” are recalled as being relatively common in western areas prior to clearing (C. Hortin pers. comm.) and a few bands of *Xanthorrhoea* were observed on flats on a number of private properties occurring below *Corymbia calophylla* / *Agonis flexuosa* Low Open Forest (10).

It is unclear if both *Xanthorrhoea preissii* and *X. platyphylla* are typical of this unit. These species appear to intergrade in the Albany area and identification to species level is often difficult

### Comments

Further survey work is required to determine the floristic composition of this unit and clarify its affinities, particularly to Mixed *Banksia littoralis* Open Woodland (45) which can have a *Xanthorrhoea preissii* stratum. Most of the low lying flats on which this unit was recorded have been cleared.

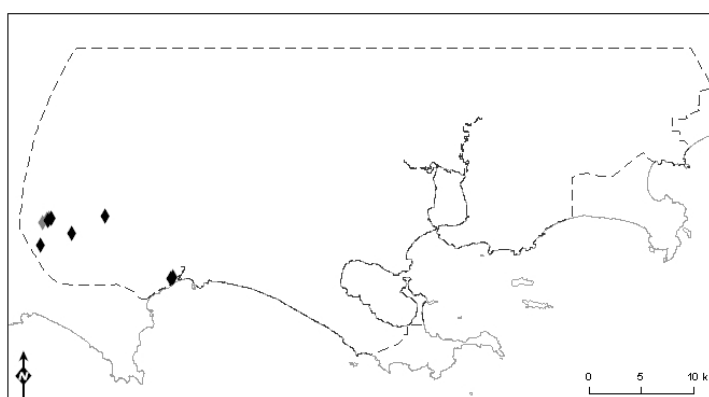
### Floristic Summary

Lifeform	%cover	Species
Trees		<i>Melaleuca preissiana</i>
Shrubs 1-2m	V	<i>Xanthorrhoea preissii</i> , ? <i>X. platyphylla</i>
Shrubs 0.5-1m		<i>Hakea ceratophylla</i>
Sedges/rushes	D	<i>Leptocarpus tenax</i> , <i>Mesomelaena tetragona</i> , <i>Baumea acuta</i> , <i>Lyginia imberbis</i> , <i>Schoenus bifidus</i> , <i>Chordifex laxus</i> , <i>Hypolaena fastigiata</i> , <i>Schoenus curvifolius</i>
Herbs		<i>Dasypogon bromeliifolius</i> , <i>Schoenolaena juncea</i>
Grasses		<i>Amphipogon laguroides</i>

### Key identifying Features

- Shrubland of *Xanthorrhoea* spp. over a diverse sedgeland.
- Occurrence on low lying flats.

**Conservation species** None recorded







**Unit 41 *Xanthorrhoea* Lowland Sedgeland**



**Unit 42 *Lepidosperma longitudinale* Sedgeland**



## 42 *Lepidosperma longitudinale* Sedgeland

No. of relevés 1 Mean spp. richness 5 Area <1 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

*Lepidosperma longitudinale* Sedgeland was recorded only once near Redmond, occurring on a flat of grey sand. This unit is dominated by an open sedgeland of *Lepidosperma longitudinale* over an open grassland of *Eragrostis brownii* and *Deyeuxia quadriseta*. Another common species is *Lepidosperma* aff *pubisquameum*.

This unit was surrounded by *Pericalymma spongiocaule* Low Heath (39).

### Comments

Although only a very small area of this unit was recorded within the survey area, similar sedgelands have been recorded in the Lake Muir area (Gibson and Keighery. 2000). Within the ARVS survey area, this unit occurs at its south eastern limit.

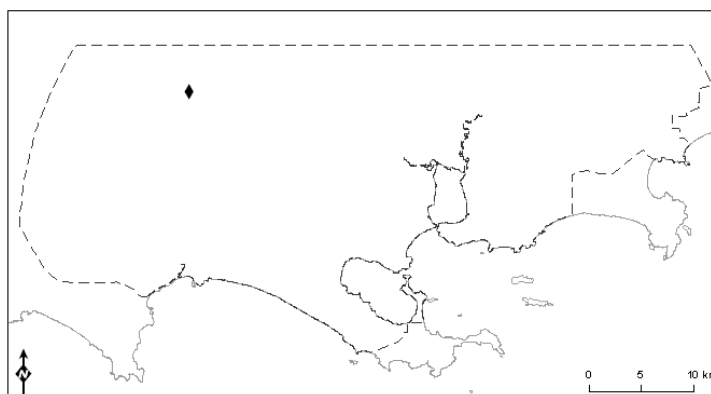
### Floristic Summary

Lifeform	%cover	Species
Shrubs< 0.5m		+/- <i>Eutaxia virgata</i> , <i>Pericalymma spongiocaule</i>
Sedges/rushes	D	<i>Lepidosperma longitudinale</i> , <i>L. aff pubisquameum</i>
Herbs		* <i>Leontodon saxatilis</i>
Grasses	V	<i>Eragrostis brownii</i> , <i>Deyeuxia quadriseta</i>

### Key identifying Features

- Dominance of *Lepidosperma longitudinale* and presence of a very open grassland of *Eragrostis brownii* and *Deyeuxia quadriseta*

**Conservation species** None recorded



### 43 *Banksia littoralis* Open Woodland/*Anarthria laevis* Sedgeland

No. of relevés 1 Mean spp. richness 9 Area 1 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 69.3

#### Description

*Banksia littoralis* Open Woodland/*Anarthria laevis* Sedgeland is restricted to small, often circular depressions, on sandy or sandy peat soil. It is very open in structure with *Banksia littoralis* occurring as an emergent or low open woodland over a low open shrubland and *Anarthria laevis* sedgeland. Common species include *Daviesia flexuosa*, *Daviesia incrassata*, *Adenanthos cuneatus*, *Pericalymma spongiocaule*, *Lepidosperma striatum*, *Chordifex laxus* and *Tricostularia neesii* subsp. *neesii*. Some zonation of sedges may occur with *Lepidosperma striatum* dominating in lower wetter areas.

#### Comments

This unit was only observed twice, on the northern boundary of Baker Junction NR and west of Dempster Rd and it is probably at its south western limit within the survey area. This vegetation has previously been recorded on remnants to the north east of the study area on the plains east of the Porongurup Range where it is naturally uncommon being limited to small depressions (Sandiford 2003- 2006). These occurrences share the same dominant and common species but also have several species more typical of eastern areas including *Beaufortia empetrifolia* and *Verticordia plumosa* subsp. *grandiflora*. Thus, the occurrences within the survey area are likely to represent the south western limit of this unit.

The dominant species, *B. littoralis*, is highly susceptible to *Phytophthora* dieback.

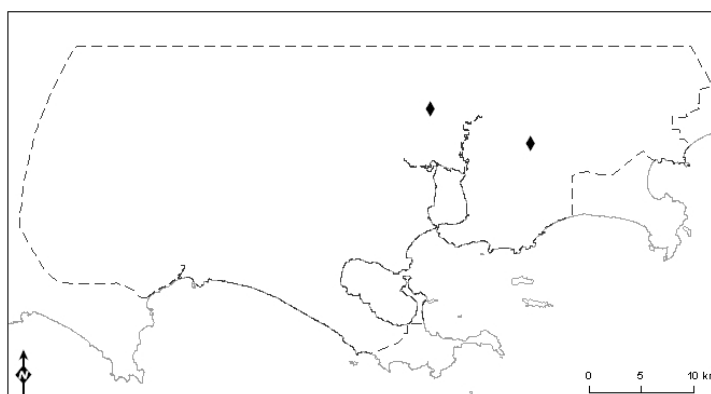
#### Floristic Summary

Lifeform	%cover	Species
Trees	V	<i>Banksia littoralis</i>
Shrubs 1-2m	V	<i>Daviesia flexuosa</i> , <i>Daviesia incrassata</i>
Shrubs 0.5-1m		<i>Adenanthos cuneatus</i> , <i>Pericalymma spongiocaule</i>
Shrubs <0.5m		<i>Adenanthos apiculatus</i>
Sedges/rushes	M-D	<i>Anarthria laevis</i> , <i>Lepidosperma striatum</i> , <i>Chordifex laxus</i> , <i>Tricostularia neesii</i> subsp. <i>neesii</i>

#### Key identifying Features

- Very open canopy of *Banksia littoralis* over an *Anarthria laevis* sedgeland.

Conservation species None recorded





**Unit 43 *Banksia littoralis* Open Woodland /*Anarthria laevis* Sedgeland**



**Unit 44 *Banksia littoralis* Woodland/*Melaleuca incana* Shrubland**

#### 44 *Banksia littoralis* Woodland/*Melaleuca incana* Shrubland

No. of relevés 3 Mean spp. richness 13 Area 4 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 23.4

##### Description

*Banksia littoralis* Woodland/*Melaleuca incana* Shrubland was recorded in the Little Grove to Goode Beach area where it occurs along drainage lines and in winter wet depressions on dark grey sand or sandy loam overlying limestone. This unit is dominated by a *Banksia littoralis*/*Agonis flexuosa* low woodland/low open forest of over a mixed tall open scrub, *Melaleuca incana*/*Hakea varia* open heath/shrubland and mixed sedgeland co-dominated by *Platychorda applanata*, *Gahnia trifida*, *Baumea juncea*, *Chaetanthus aristatus* and several closely related *Lepidosperma* species. *Platychorda applanata* was only observed in this unit during this survey.

##### Comments

The co-occurrence the dryland species *Agonis flexuosa*, *Spyridium globulosum* and *Acacia cyclops* with wetland species appears indicative of hydrological change in this unit. At several locations around Little Grove, dead and dying *Banksia littoralis* trees are evident beneath thickets of *Agonis flexuosa*. These areas have shallow soils overlying a pavement of limestone that are no longer winter wet and support very sporadic occurrences of species typical of winter wet areas including *Melaleuca incana*, *Hakea varia*, *Villarsia parnassiifolia* and *Sphenotoma gracilis*. This suggests that a lowering of the water table has occurred in recent years. Anecdotal observations of a long time Albany resident indicate that the vegetation of the Little Grove area has changed over the past 50 years and that swampy vegetation was once more common (T. Allen pers. comm.).

*Banksia littoralis* Woodland/*Melaleuca incana* Shrubland has previously been recorded in the same vicinity (Pen 1995). This unit reaches its eastern limit within the survey area based on the distribution of distribution of *Melaleuca incana*, *Platychorda applanata* and *Chaetanthus aristatus* and may be restricted to the survey area (DEC 2009).

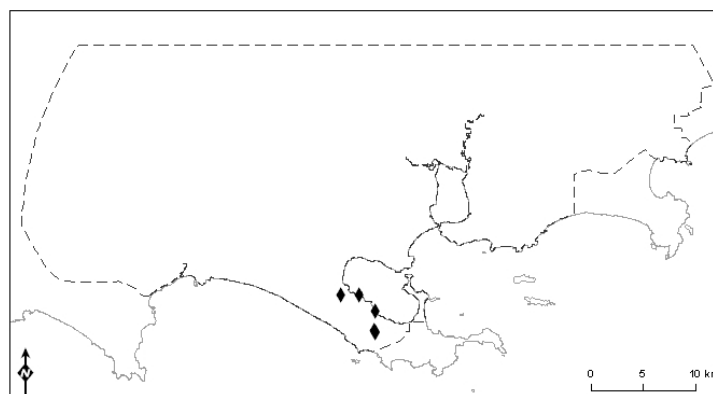
##### Floristic Summary

Lifeform	%cover	Species
Trees	S-M	<i>Banksia littoralis</i> , <i>Agonis flexuosa</i>
Shrubs >2m	V-M	<i>Rhadinanthus anceps</i> , <i>Spyridium globulosum</i> , <i>Acacia cyclops</i>
Shrubs 1-2m	S-M	<i>Melaleuca incana</i> , <i>Hakea varia</i> , <i>Acacia littorea</i> , <i>Leucopogon obovatus</i>
Shrubs 0.5-1m		<i>Leucopogon parviflorus</i> , <i>Oxalys phyllanthi</i> , <i>Spyridium majoranifolium</i> .
Shrubs <0.5m		<i>Rhagodia baccata</i>
Sedges/rushes	M	<i>Platychorda applanata</i> , <i>Gahnia trifida</i> , <i>Baumea juncea</i> , <i>Chaetanthus aristatus</i> , <i>Lepidosperma effusum</i> , <i>Lepidosperma persecans</i> forma narrow, <i>Lepidosperma effusum</i> forma narrow
Herbs		<i>Amperea protensa</i> , <i>Opercularia hispidula</i> , <i>Villarsia parnassiifolia</i>

##### Key identifying Features

- Canopy of *Banksia littoralis* +/- *Agonis flexuosa* over a shrub layer including *Melaleuca incana* and *Hakea varia*.
- Occurrence on sand overlying limestone along drainage lines and depressions.

Conservation species *Amperea protensa* P3



## 45 Mixed *Banksia littoralis* Open Woodland

No. of relevés 5 Mean spp. richness 19.6 Area 26 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 12.3

### Description

Mixed *Banksia littoralis* Open Woodland is essentially a mapping unit encompassing *Banksia littoralis* low open woodlands that occur in small seasonal swamps but do not show uniformity in understorey species nor fit other *B. littoralis* dominated woodlands (43, 44). Most occurrences were on the flats inland of the coastal dune systems and due to disturbance were not well sampled. Few floristic patterns were discerned other than the dominance of *B. littoralis* and its occurrence on sand in small depressions or along minor drainage lines. The understorey is either a shrubland or open heath over a sedgeland. Dominant shrub species, recorded at different sites included *Astartea laricifolia*, *Taxandria parviceps*, *Taxandria fragrans* and *Xanthorrhoea preissii*. *Lepidosperma effusum* was a dominant in some modified sites. The presence of species more typical of well drained sandy sites including *Melaleuca thymoides*, *Dasypogon bromeliifolius* and *Patersonia umbrosa* suggest that some sites are reasonably free draining.

*Banksia littoralis* trees were also observed occasionally as emergents in *Melaleuca preissiana* Low Woodland (49) and *Homalospermum firmum*/*Callistemon glaucus* Swamp Thicket (48) but these units differed in the presence of species tolerant of long periods of water logging such as *Homalospermum firmum* and *Schoenus multiglumis*. Whether some occurrences of this unit are similar to *Xanthorrhoea* Lowland Sedgeland is unclear (see notes Unit 41).

### Comments

All areas of this unit were small in size and unhealthy *Banksia littoralis* trees were frequently observed, possibly reflecting changing hydrology or the presence of *Phytophthora* dieback. On private property this unit was frequently reduced to a canopy of trees above pasture. The dominant species, *B. littoralis* is highly susceptible to *Phytophthora* dieback.

*Banksia littoralis* is common throughout the Darling and Warren Botanical District, however the floristic affinities of this unit with other *B. littoralis* dominated units is not known.

### Floristic Summary

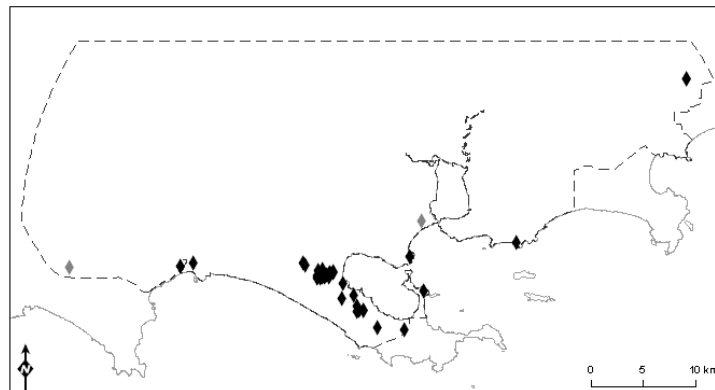
Lifeform	%cover	Species
Trees	E-V	<i>Banksia littoralis</i>
Shrubs 1-2m	nil-M	<i>Astartea laricifolia</i> , <i>Taxandria parviceps</i> , <i>Taxandria fragrans</i> , <i>Xanthorrhoea preissii</i>
Shrubs 0.5-1m	V	<i>Adenanthos obovatus</i> , <i>Hakea ceratophylla</i> , <i>Pultenaea reticulata</i> , <i>Melaleuca thymoides</i> , <i>Sphenotoma gracilis</i>
Sedges/rushes	M-D	<i>Lepidosperma striatum</i> , <i>Baumea juncea</i> , <i>Mesomelaena gracilipes</i> , <i>Schoenus efoliatus</i> , <i>Hypolaena</i> spp., <i>Leptocarpus tenax</i> , <i>Lyginia imberbis</i>
Herbs	V	<i>Dasypogon bromeliifolius</i> , <i>Patersonia umbrosa</i> , <i>Lindsaea linearis</i>

### Key identifying Features

- Low Open Woodland of *Banksia littoralis* lacking both a *Melaleuca incana* tall shrubland and *Anarthria laevis* sedgeland.
- Occurrence in low-lying areas with sandy/loamy soil.

Conservation species *Amperea protensa* P3





**Unit 45 Mixed *Banksia littoralis* Open Woodland**

No. of relevés 48 Mean spp. richness 18.6 Area 1747 ha % of Rem. Veg. 4.0 % in IUCN Reserve 1-IV 12.5

### Description

*Evandra aristata* Sedgeland is widespread on the upper margins of drainage depressions, often forming distinct bands on gentle slopes above the seepage zone. They also occur on some poorly drained flats. Soil types vary from sand through to sandy loam and sandy peat and are seasonally wet. This unit is floristically diverse, especially in the sedge stratum and the structure varies with soil, hydrology, landscape and fire history. The dominance of *Evandra aristata* appears to decline following fire. This trend is most notable where medium to tall shrubs are present with the structure changing over time from a sedgeland over an open low heath to an open or closed heath.

Common sedges include *Evandra aristata*, *Leptocarpus tenax*, *Schoenus efolius*, *Schoenus multiglumis*, *Anarthria prolifera*, *Anarthria scabra*, *Mesomelaena gracilipes*, *Gymnoschoenus anceps*, *Lepidosperma* sp Down Road Fan, *Anarthria gracilis* and *Hypolaena fastigiata*. Dominant larger shrubs include *Beaufortia sparsa*, *Kunzea ericifolia*, *Taxandria fragrans*, *Taxandria parviceps*, *Banksia quercifolia* and *Sphaerolobium grandifolium*. Common lower shrubs include *Astartea corniculata*, *Sphenotoma gracilis*, *Pericalymma spongiocaula*, *Boronia spathulata*, *Adenanthos obovatus*, *Lysinema conspicuum*, *Pericalymma crassipes*, *Calothamnus schaueri*, *Pimelea longifolia*, *Hypocalymma strictum*, *Leucopogon distans* and *Dampiera leptoclada*. Common herbs include *Xyris lanata*, *Stylidium luteum* and *Dasypogon bromeliifolius*.

This unit often occurs up slope of *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (47) along drainage depressions with the seepage zone boundary often marked by the occurrence of sub-unit 47b.

Four sub-units were described, distinguished by the dominance of the shrub species and to lesser extent by distribution.

### 46a *Beaufortia sparsa* Heath/*Evandra aristata* Sedgeland

This sub-unit is distinguished by the dominance of *Beaufortia sparsa* in the upper shrub layer, with *Homalospermum firmum* often a co-dominant. *Schoenus multiglumis*, *Astartea corniculata* and *Dampiera leptoclada* are also common but rarely recorded in the other sub-units. This sub-unit is more common in the western part of the survey area with the most eastern record in Gull Rock NP. It appears to occur on damper sites with more loam or peat in the soil than the other sub-units.

### 46b *Kunzea ericifolia* Heath/ *Evandra aristata* Sedgeland

This unit is distinguished by the dominance of *Kunzea ericifolia* subsp. *ericifolia* and was recorded across the northern and eastern parts of the survey area. Over time this unit becomes a closed tall scrub of *Kunzea ericifolia* with little underneath and in some areas *Melaleuca preissiana* is present as an emergent. Like the former sub-unit, it is often present as a distinct band at the upper margins of drainage depressions.

### 46c *Evandra aristata* Sedgeland/*Pericalymma spongiocaula* Low Shrubland.

This sub-unit occurs on flats or broad gentle slopes at the head of minor drainage depressions on sandy soil and lacks medium to tall shrubs. *Pericalymma spongiocaula* is usually dominant with *Lysinema conspicuum* often sub-dominant. *Banksia quercifolia* may have been common in this sub unit with scattered plants recorded within Angove Water Reserve (see comments).

### 46d *Banksia occidentalis* Thicket

Dense stands of *Banksia occidentalis* occurring over *Evandra aristata* Sedgeland were observed in some drainage depressions. It is unclear if these stands were once more widespread as *Banksia occidentalis* is highly susceptible to Phytophthora dieback and as a serotinous obligate seeder is fire sensitive. These thickets also extended less frequently over adjacent vegetation, *Homalospermum firmum*/*Callistemon glaucus* Swamp thicket (47) and *Pericalymma spongiocaula* Low Heath (39) but have been included in this sub-unit due to the greater floristic similarities to this unit in most areas.

### Comments

*Evandra aristata* Sedgeland is widespread along the larger drainage lines and valleys throughout the survey area though much of this habitat has been cleared. In a few locations, *Banksia quercifolia* was a co-dominant species. *B. quercifolia* is highly susceptible to Phytophthora dieback and the numerous dead and dying specimens observed throughout the survey area, suggest that it was once a more common feature of this unit. Similarly, many dead and dying *B. occidentalis* were observed, particularly in Mill Brook NR, and it probable that these thickets were once more widespread. This species is a serotinous obligate seeder and population extinction has been observed following fire (E. Hickman pers. comm.). In several areas numerous *Xanthorrhoea* sp. bases were observed underfoot, though this species was rarely observed live, it is likely that it was once a common

element of this unit. Its demise along with that of *Banksia quercifolia* and *B occidentalis* indicate that some significant floristic and structural changes have already occurred within this unit with *Phytophthora dieback* and fire implicated.

The eastern limit of this vegetation, determined by range limit of *Evandra aristata*, is just east of the survey area on the lower slopes and flats around Mt Manypeaks (DEC 2009). This unit appears to be common to the west of the survey area, extending at least as far as Walpole with key species within this group described within the vegetation community group B2 in the Walpole region (Wardell-Johnson and Williams 1996). Both *Kunzea ericifolia* and *Beaufortia sparsa* dominated *Evandra aristata* sedgeland have been observed near Mt Lindsay though floristic comparison with these western areas has not been conducted (author observations).

#### Floristic Summary

Lifeform	%cover	Species
Trees		+/- <i>Melaleuca preissiana</i>
Shrubs >2m	S-D	<i>Kunzea ericifolia</i> sub sp. <i>ericifolia</i> )
Shrubs 1-2m	M	<i>Beaufortia sparsa</i> , <i>Homalospermum firmum</i> , <i>Taxandria fragrans</i> , <i>Taxandria parviceps</i> , <i>Banksia quercifolia</i> , <i>Sphaerolobium grandifolium</i> , <i>Banksia occidentalis</i>
Shrubs <1m	S	<i>Astartea corniculata</i> , <i>Sphenotoma gracilis</i> , <i>Pericalymma spongiocaula</i> , <i>Boronia spathulata</i> , <i>Adenanthos obovatus</i> , <i>Lysinema conspicuum</i> , <i>Pericalymma crassipes</i> , <i>Calothamnus schaueri</i> , <i>Pimelea longifolia</i> , <i>Hypocalymma strictum</i> , <i>Leucopogon distans</i> , <i>Dampiera leptoclada</i>
Sedges/rushes	M-D	<i>Evandra aristata</i> , <i>Leptocarpus tenax</i> , <i>Schoenus efoliatus</i> , <i>Schoenus multiglumis</i> , <i>Anarthria prolifera</i> , <i>Anarthria scabra</i> , <i>Mesomelaena gracilipes</i> , <i>Gymnoschoenus anceps</i> , <i>Lepidosperma</i> sp Down Rd Fan, <i>Anarthria gracilipes</i> , <i>Hypolaena fastigiata</i> , <i>Hypolaena exsulca</i> , <i>Schoenus acuminatus</i> , <i>Schoenus rodwayanus</i>
Herbs	Nil-V	<i>Xyris lanata</i> , <i>Stylidium luteum</i> , <i>Dasypogon bromeliifolius</i> , <i>Cassytha aff flava</i>

#### Key identifying Features

- Diverse sedgeland dominated by *Evandra aristata*.
- Dominance of *Beaufortia sparsa* or *Kunzea ericifolia* subsp. *ericifolia* or *Pericalymma spongiocaula* in the upper shrub stratum
- Occurrence on margins of drainage depressions and on low lying flats on sandy or loamy soil.

**Conservation species.** *Gonocarpus simplex* P3, *Sphaerolobium pubescens* P3







***Evandra aristata* Sedgeland sub-unit 46a**



***Banksia occidentalis* Thicket sub-unit 46d**



## 47 *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket

No. of relevés 19 Mean spp. richness 12.5 Area 2082 ha % of Rem. Veg. 4.7 % in IUCN Reserve 1-IV 12.6

### Description

*Homalospermum firmum*/*Callistemon glaucus* Peat Thicket occurs in drainage depressions below the seepage zone on dark brown peat or sandy peat that is waterlogged in winter and moist in summer.

This unit has a distinctive dense sedgeland characterized by the presence and dominance of *Empodisma gracillimum*. Other co- or sub-dominant sedges include *Lepidosperma striatum*, *Leptocarpus tenax*, *Schoenus multiglumis*, *Gymnoschoenus anceps*, *Gahnia decomposita* and *Baumea rubiginosa*. The upper stratum is dominated by tall shrubs and varies from a closed tall scrub or closed heathland to a shrubland, a lower secondary shrub stratum may be present. Common shrub species include *Callistemon glaucus*, *Homalospermum firmum*, *Hakea linearis*, *Aotus intermedia*, *Acacia hastulata*, *Sphaerolobium fornicatum* and *Dampiera leptoclada*. The drainage channel is often marked by a line of *Taxandria linearifolia* and *Gahnia decomposita* with *Rhadinanthus anceps* and *Callistachys lanceolata* also occasionally present.

This unit typically lacks a tree layer though *Eucalyptus megacarpa* is a frequent overstorey species in some areas of Angove Water Reserve where *Boronia stricta* and *Hypocalymma cordatum* are common in the understorey. Elsewhere emergent *Taxandria juniperina* and *Melaleuca preissiana* are occasionally present.

Along valleys, this unit often occurs down slope from *Evandra aristata* Sedgeland (46) with the boundary between the units marked by a seepage zone and sub-unit 47b. On broader flats, this unit frequently borders *Taxandria juniperina* Closed Forest (59) and it may grade into *Melaleuca preissiana* Low Woodland (49) which occurs on better drained sandier soil.

Six sub-units are described:

### 47a *Homalospermum firmum*/*Callistemon glaucus* Swamp Thicket (described above)

### 47b Seepage Shrubland

This unit usually occurs in very narrow bands along the seepage zone marking the upper limit of this unit (47) and the lower limit of *Evandra aristata* Sedgeland (46). This sub-unit is more open than other sub-units and is distinguished by the presence of *Cosmelia rubra* and *Cephalotus follicularis*. Common species sedges are *Leptocarpus tenax*, *Gymnoschoenus anceps*, *Evandra aristata*, *Schoenus multiglumis* and *Schoenus efolius*. Other common species include *Callistemon glaucus*, *Xyris lanata*, *Diaspasis filifolia*, *Lycopodiella serpentina* and *Stylidium assimile*.

### 47c *Eucalyptus megacarpa* Low Open Woodland/*Aotus intermedia* Swamp Thicket

This sub-unit appears to be restricted to Angove Water Reserve where *E. megacarpa* formed a distinct tree stratum above a closed heath dominated by *Aotus intermedia*. *Homalospermum firmum* and *Callistemon glaucus* are less prominent than in sub-unit 47a and *Boronia stricta* and *Hypocalymma cordifolium* are common.

### 47d Mixed Sedgeland

In Bakers Junction NR and Down Rd NR several large areas of closed sedgeland lacking a defined shrub layer were observed. These areas are dominated by *Baumea acuta*, *Leptocarpus tenax*, *Gymnoschoenus anceps*, *Lepidosperma striatum*, *Empodisma gracillimum* and *Schoenus multiglumis*. *Homalospermum firmum*, *Sphaerolobium fornicatum*, *Amphipogon laguroides* subsp. *laguroides*, *Xyris lanata*, *Lycopodium serpentinum* and *Cephalotus follicularis* may also be present.

### 47e *Leptocarpus tenax* Sedgeland

Very small pockets of *Leptocarpus tenax* Sedgeland are present occasionally within this unit.

### 47f *Taxandria linearis* Shrubland

This sub-unit represents a modified form of the unit, evident in areas heavily grazed or previously cleared.

### Comments

This unit would once have been widespread along drainage lines at the bottom of valleys. Remnants that remain on private land, but are open to grazing appear vulnerable to weed invasion, particularly by *Psoralea pinnata* and introduced grasses, and are often reduced to depauperate stands of *Taxandria linearifolia* (47f). The Seepage Shrubland (47b) is vulnerable to Phytophthora dieback as dead *Cosmelia rubra* samples taken during this survey tested positive for *Phytophthora cinnamomi*. Removal of *Cephalotus follicularis* plants by spade were also observed in several areas. *Banksia occidentalis* is occasionally co-dominant in the upper stratum of sub-unit 47a and it is not clear if this species was once more widespread or if its current absence is linked to both dieback and fire (see Comments unit 46). This unit is vulnerable to high fire intensity that may remove the peat



content of the soil and kill lignotuberous re-sprouters including *Homalospermum firmum* and *Callistemon glaucus*, as observed in Angove Water Reserve.

Many of the key species including *Empodisma gracillimum*, *Callistemon glaucus*, *Homalospermum firmum*, *Gahnia decomposita*, *Schoenus multiglumis* and *Acacia hastulata* are common throughout the Warren District suggesting this unit occurs west of the survey area. This unit has been recorded just west of Cheyne Beach (Sandiford 2003-2006) with a very small area of similar vegetation, but lacking *Callistemon glaucus* and *Homalospermum firmum*, recorded on Wongerup Creek, south of Green Range (Sandiford 2003-2006).

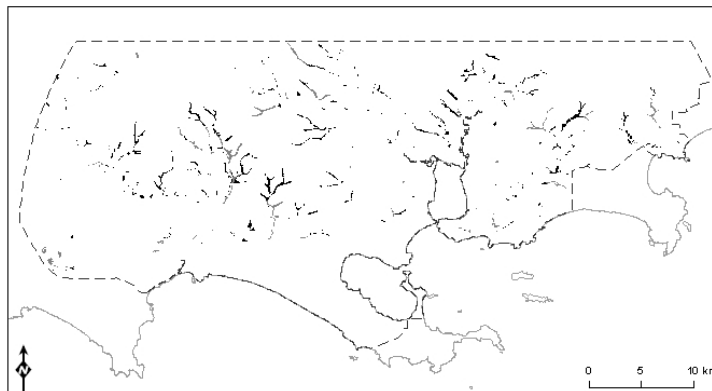
#### Floristic Summary

Lifeform	%cover	Species
Trees	Nil-E	<i>Melaleuca preissiana</i> , <i>Eucalyptus megacarpa</i>
Shrubs >2m	S-D	<i>Homalospermum firmum</i> , <i>Callistemon glaucus</i> , <i>Hakea linearis</i> , <i>Taxandria linearifolia</i> , <i>Taxandria parviceps</i> +/- <i>Callistachys lanceolata</i> , <i>Rhadinothamnus anceps</i>
Shrubs 1-2m	S-M	<i>Acacia hastulata</i> , <i>Hypocalymma cordatum</i> , <i>Boronia crassipes</i> , <i>Sphaerolobium rosulatum</i> , <i>Boronia stricta</i> , <i>Sphaerolobium fornicatum</i>
Shrubs <0.5m		<i>Dampiera leptoclada</i> , <i>Sphenotoma gracilis</i> , <i>Astartea corniculata</i>
Sedges/rushes	D	<i>Empodisma gracillimum</i> , <i>Gymnoschoenus anceps</i> , <i>Schoenus multiglumis</i> , <i>Leptocarpus tenax</i> , <i>Gahnia decomposita</i> , <i>Lepidosperma striatum</i> , <i>Baumea rubiginosa</i> , <i>Schoenus sublaxus</i> , <i>Baumea acuta</i>
Herbs	V	<i>Xyris lanata</i> , <i>Xyris lacera</i> , <i>Cephalotus follicularis</i> , <i>Lycopodium serpentinum</i> , <i>Diaspasis filifolia</i> , <i>Stylidium assimile</i>

#### Key identifying Features

- Occurrence on peaty soil in low lying drainage depressions and swamps.
- Presence of a dense sedge layer dominated or co-dominated by *Empodisma gracillimum* beneath a shrub stratum dominated by *Homalospermum firmum*, *Callistemon glaucus*, *Hakea linearis* and *Taxandria linearis*.

**Conservation species** *Boronia crassipes* P3, *Sphaerolobium rostratum* P3, *Amperea protensa* P3, *Leucopogon alternifolius* P3, *Gonocarpus simplex* P3.



#### Unit 47 *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket



***Homalospermum firmum*/Callistemon glaucus** Peat Thicket sub-unit 47a



**Seepage Shrubland** sub-unit 47b

## 48 *Melaleuca microphylla* Shrubland/Low Forest

No. of relevés 9 Mean spp. Richness 8.2 Area 24 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 12.8

### Description

*Melaleuca microphylla* Shrubland/Low Forest was only observed in very small pockets in permanently wet creeks, soaks or gullies on dark brown/grey sandy loam or sandy peat soil. In long unburnt areas this unit is usually a low closed forest of *Melaleuca microphylla* over *Lepidosperma tetraquetrum* sedgeland. More typically it is a tall open scrub or closed tall scrub, dominated by *Taxandria linearifolia* and *Melaleuca microphylla* over a closed sedgeland dominated by *Empodisma gracillima*, *Lepidosperma tetraquetrum* and *Gahnia decomposita*. Other common species include *Callistachys lanceolata* which is occasionally a co-dominant, *Lepidosperma striatum*, *Hypocalymma cordatum* and *Trymalium odoratissimum*. *Acacia divergens* was a co-dominant species in one gully.

This unit is often surrounded by *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (47)

### Comments

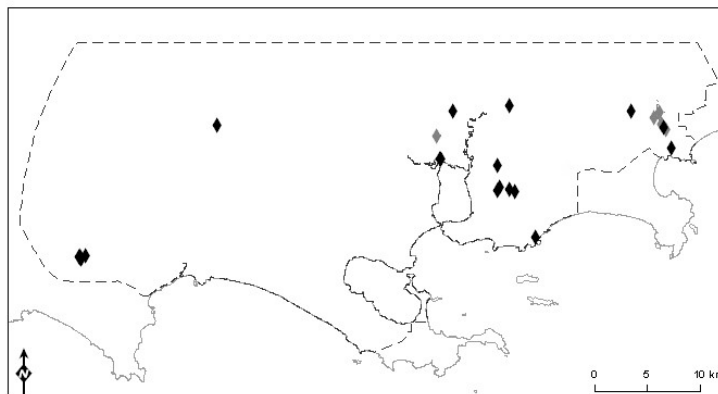
The eastern limit of this unit is likely to be within the survey area as this corresponds to the eastern limit of *Lepidosperma tetraquetrum*, with the eastern limit of *Melaleuca microphylla* occurring at Waychinnicup, just east of the survey area (DEC 2009). Similar vegetation dominated by *Melaleuca microphylla* and *Lepidosperma tetraquetrum* has been observed in the Denmark-Walpole region (author observations).

### Floristic Summary

Lifeform	%cover	Species
Tree/Shrubs >2m	S-D	<i>Melaleuca microphylla</i> , <i>Taxandria linearifolia</i> +/- <i>Callistachys lanceolata</i> , <i>Trymalium odoratissimum</i> , <i>Acacia divergens</i>
Shrubs 1-2m	V-M	<i>Hypocalymma cordatum</i>
Sedges/rushes	S-D	<i>Empodisma gracillima</i> , <i>Lepidosperma tetraquetrum</i> , <i>Gahnia decomposita</i> , <i>Lepidosperma striatum</i>

### Key identifying Features

- Presence and dominance of *Melaleuca microphylla* and *Lepidosperma tetraquetrum*.
- Occurrence on permanently wet/damp soil.







**Unit 48 *Melaleuca microphylla* Shrubland/Low Forest**



**Unit 49 *Melaleuca preissiana* Low Woodland**

## 49 *Melaleuca preissiana* Low Woodland

No. of relevés 7 Mean spp. richness 15.7 Area 679 ha % of Rem. Veg. 1.5 % in IUCN Reserve 1-IV 7.7

### Description

*Melaleuca preissiana* Low Woodland is found throughout the survey area along drainage lines on dark grey sandy loam and occasionally on sandy peat soil. The overstorey is sparse with *Melaleuca preissiana* an emergent or low open woodland with *Banksia littoralis* occasionally sub dominant. Along creek lines and wetter areas the understorey is a mixed tall open scrub of *Aotus intermedia*, *Homalospermum firmum*, *Callistemon glaucus*, *Hakea ceratophylla*, and *Taxandria parviceps* over a low shrubland and mixed sedgeland usually co-dominated by several species including *Leptocarpus tenax*, *Evandra aristata*, *Schoenus efoliatus*, *Anarthria prolifera* and *Cyathochaeta avenacea*. On drier sites *Taxandria parviceps*, *Aotus intermedia* and *Hakea ceratophylla* dominate the shrub strata with *Cyathochaeta avenacea*, *Leptocarpus tenax*, and *Lepidosperma* sp Down Rd Fan dominant sedges.

This unit often grades into *Homalospermum firmum*/*Callistemon glaucus* Swamp Thicket (47) but occurs on better drained soils either upslope or where water flow is more defined. It differs from unit 47 in its more open structure, dominance of *Melaleuca preissiana* and *Aotus intermedia*, presence of *Sphenotoma gracilis*, *Evandra aristata*, *Anarthria prolifera*, *Taxandria parviceps* and absence of *Empodisma gracillimum*, *Schoenus multiglumis*, *Gymnoschoenus anceps* and *Gahnia decomposita*.

### Comments

Most of the common species in this unit are found throughout the Warren Botanical District. It is likely that this unit is common to the west of the survey area and reaches its eastern limit just east of the survey area which corresponds to the eastern limit of the dominant species *Callistemon glaucus* and *Homalospermum firmum* (DEC 2009).

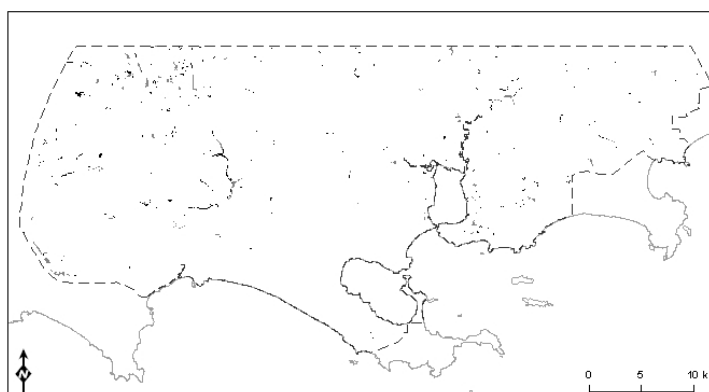
### Floristic Summary

Lifeform	%cover	Species
Trees	E-S	<i>Melaleuca preissiana</i> +/- <i>Banksia littoralis</i>
Shrubs >2m	M	<i>Aotus intermedia</i> , <i>Homalospermum firmum</i> , <i>Callistemon glaucus</i> , <i>Hakea ceratophylla</i> , <i>Taxandria linearifolia</i> , <i>Taxandria parviceps</i>
Shrubs 0.5-1m	V	<i>Sphenotoma gracilis</i> , <i>Sphaerolobium hygrophilum</i> , <i>Astartea corniculata</i> .
Sedges/rushes	M	<i>Leptocarpus tenax</i> , <i>Schoenus efoliatus</i> , <i>Evandra aristata</i> , <i>Anarthria prolifera</i> , <i>Cyathochaeta avenacea</i> , <i>Lepidosperma striatum</i> , <i>Baumea juncea</i> , <i>Lepidosperma</i> sp Down Rd Fan
Herbs		<i>Xyris lanata</i>

### Key identifying Features

- Low Woodland of *Melaleuca preissiana* over shrub stratum dominated by *Aotus intermedia* and *Homalospermum firmum*.
- Absence of *Empodisma gracillimum*

**Conservation species** *Sphaerolobium rostratum* P3





## 50 Miscellaneous Drainage Woodland/Shrubland

No. of relevés 4 Mean spp. richness n/a Area 259 ha % of Rem. Veg. 0.6 % in IUCN Reserve 1-IV 8.0

### Description

Miscellaneous Drainage Shrubland/Woodland is a mapping unit used to describe areas occurring along narrow creek lines, minor drainage lines or small soaks that either do not fit well with other units, appear to be ecotonal or could not be interpreted. These areas are often very narrow or small and share species with adjacent vegetation. Key structural species of other wetland units are often dominant species including *Taxandria juniperina*, *Melaleuca raphiophylla*, *Melaleuca preissiana*, *Eucalyptus patens*, *Callistachys lanceolata*, *Banksia littoralis*, *Taxandria linearifolia*, *Hakea ceratophylla*, *Lepidosperma striatum*, *Baumea juncea*, *Schoenus acuminatus*, *Leptocarpus tenax* and *Cyathochaeta avenacea*. Other species include *Rhadinothamnus anceps*, *Baumea vaginalis*, *Astartea laricifolia* and *Astartea scoparia*.

### Comments

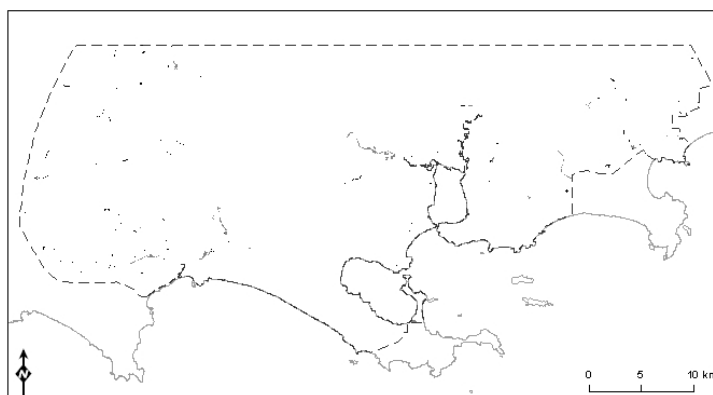
Elucidating patterns within wetland habitats in the southwest of Western Australia is often difficult due to the high floristic and structural diversity that reflects the rapid changes in hydrology and soils occurring over small distances (Wardell-Johnson and Williams 1996).

**Floristic Summary** Not applicable

### Key identifying Features

- Variety of species occurring in mixed shrublands or low woodlands that clearly do not fit other wetland units nor appear to be ecotonal.
- Occurrence often on narrow drainage lines and creeks.

**Conservation species:** *Hakea tuberculata* P3, *Sphaerolobium rostratum* P3



## 51 *Gahnia trifida* Sedgeland/Wet Shrubland

No. of relevés 3 Mean spp. richness 13 Area 21 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 100

### Description

*Gahnia trifida* Sedgeland/Wet Shrubland occurs on the broad flat drainage lines of Mill Brook. This unit appears to be ecotonal between *Homalospermum firmum*/*Callistemon glaucus* Swamp Thicket (47) and *Melaleuca cuticularis*/*M. preissiana* Open Woodland (52). Shrub species are closer floristically to unit 47 and sedges closer to unit 52 whilst this unit contains several species absent in either 47 or 52 including *Melaleuca* aff *densa* "fine"\*, *Astartea renisperma* ms. *Banksia occidentalis* and *Acacia robiniae*.

All areas surveyed were burnt in 2004, with the most common structure observed an open shrubland over closed sedgeland. The association of *Gahnia trifida* with *Homalospermum firmum*, *Callistemon glaucus* and *Banksia occidentalis* dominated shrublands is unusual. Other common species include *Aotus intermedia*, *Acacia hastulata*, *Melaleuca pauciflora*, *Callistemon glaucus*, *Boronia megastigma*, *Boronia crassipes*, *Boronia heterophylla* and a variety of sedges.

\*The identity of this species is unclear and specimens have previously been identified as *Beaufortia empetrifolia* (Griffin 1985) but the multiple seeds per ovule suggest that it is related to *Melaleuca densa* (M Hislop pers. comm.).

### Comments

Further survey is required to define the status and composition of this unit which was only observed within Mill Brook NR and equates to "*Banksia occidentalis*/*Hakea varia* Heath" mapped by Griffin (1985). He noted *Gahnia decomposita* as the dominant sedge, though it is not clear if this was a mistaken identity or if floristic changes have since occurred and *Gahnia trifida* has invaded over the last 20 years (*G. decomposita* is occasionally present in this unit and in adjacent vegetation units 47 and 57). In 1979, the vegetation of the valleys in Mill Brook NR was noted as dense reeds with *Leptocarpus tenax* dominant and no mention of *Gahnia* spp (Beard 1979). Recent deaths of *Banksia occidentalis* observed within this unit were attributed *Phytophthora* dieback.

### Floristic Summary

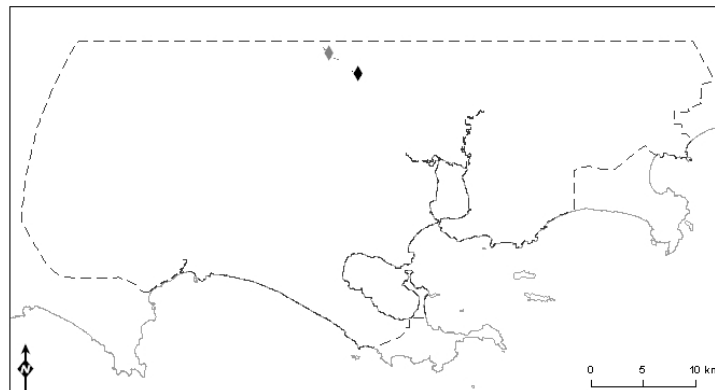
Lifeform	%cover	Species
Shrubs 1-2m	V-M	<i>Homalospermum firmum</i> , <i>Callistemon glaucus</i> , <i>Melaleuca</i> aff. <i>densa</i> "fine", <i>Banksia occidentalis</i> , <i>Boronia crassipes</i> , <i>Acacia hastulata</i> , <i>Aotus intermedia</i> , <i>Boronia heterophylla</i>
Shrubs 0.5-1m	V	<i>Boronia megastigma</i> , <i>Hypocalymma cordatum</i> , <i>Melaleuca pauciflora</i> , <i>Acacia robiniae</i> **
Shrubs <0.5m		<i>Astartea renisperma</i> ms
Sedges/rushes	M-D	<i>Gahnia trifida</i> , <i>Leptocarpus tenax</i> , <i>Cyathochaeta avenacea</i> , <i>Lepidosperma striatum</i> , <i>Baumea juncea</i> , <i>Anarthria laevis</i> , <i>Schoenus subfascicularis</i>
Herbs		<i>Cassytha glabella</i> , <i>Samolus juncea</i>

\*\*Specimens collected are not typical of *Acacia robiniae* in leaf shape or habitat.

### Key identifying Features

- Dense stands of *Gahnia trifida* in association with *Homalospermum firmum* and *Callistemon glaucus* and *Banksia occidentalis*.
- Occurrence of *Melaleuca densa* sp fine, *Astartea renisperma* ms and *Boronia heterophylla*.
- Restricted to the broad drainage lines of Mill Brook in Mill Brook NR.

**Conservation species** *Boronia crassipes* P3, *H tuberculata* P3



**Unit 51 *Gahnia trifida* Sedgeland/Wet Shrubland**

## 52 *Melaleuca cuticularis*/*M. preissiana* Open Woodland

No. of relevés 10 Mean spp. richness 17.9 Area 263 ha % of Rem. Veg. 0.6 % in IUCN Reserve 1-IV 36.9

### Description

*Melaleuca cuticularis*/*M. preissiana* Open Woodland is found on low-lying poorly drained flats and broad drainage depressions on dark grey to dark brown sandy loam overlying a clay layer. Typically this unit is a low open woodland dominated by *Melaleuca cuticularis* and/or *M. preissiana* over a mixed shrubland and sedgeland, though sedgelands and shrublands were also recorded. *Melaleuca pauciflora*, *Melaleuca densa* and *Gastrolobium sericeum* are common dominant shrubs. The sedge layer is distinctive with *Anarthria laevis*, *Gahnia trifida*, *Stenotalis ramosissima*, *Baumea juncea* and *Cyathochaeta avenacea* dominant. *Samolus juncea* and *Stylidium caespitosum* are common perennial herbs. An annual herbland may be common in this unit with a large number of annuals and geophytes recorded in two quadrats established at the beginning of the project (see floristic summary).

When degraded, this unit lacks shrub strata and resembles Coastal *Melaleuca cuticularis* Low Open Forest (65). Small pockets of *Anarthria laevis* Sedgeland have been included in this unit, though it is not clear if these have closer affinities with *Banksia littoralis* Open Woodland over *Anarthria laevis* Sedgeland (43).

### Comments

On the flats in the western and north western parts of the survey area, this unit forms a mosaic with several other units including *Kunzea recurva*/*Petrophile squamata* Wet Shrubland (53), *Melaleuca spathulata*/*M. viminea* Swamp Heath (54) and *Melaleuca raphiophylla* Woodland/Forest Complex (57). Large areas of suitable habitat have been cleared in this western area.

The distribution of this unit outside the survey area is unknown. Similar *Melaleuca cuticularis*/*M. preissiana* dominated units have been described for the Lake Muir system, though there are some floristic differences in common shrubs, geophytes and annual species (Gibson *et al.* 2000).

This unit is vulnerable to increases in salinity and one area near the north western boundary of the survey area showed signs of this with a dominance of *Gahnia trifida* in the understorey and absence of most shrub species evident as a consequence.

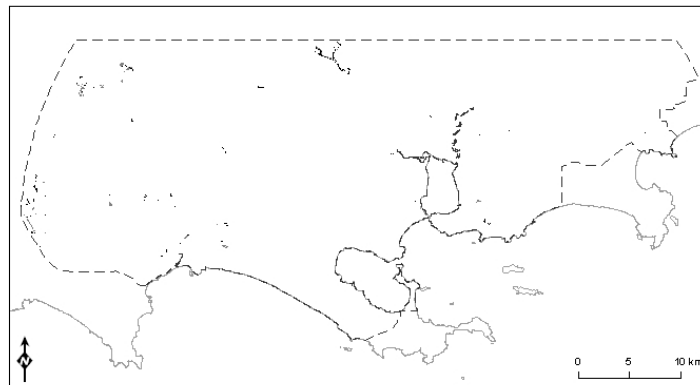
### Floristic Summary

Lifeform	%cover	Species
Trees	E-V	<i>Melaleuca cuticularis</i> , <i>M. preissiana</i>
Shrubs 1-2m	V	<i>Hakea tuberculata</i> , <i>Hakea varia</i> , <i>Hakea linearis</i> , <i>Acacia myrtifolia</i> , <i>Aotus intermedia</i>
Shrubs <1m	S-M	<i>Melaleuca pauciflora</i> , <i>Gastrolobium sericeum</i> , <i>Melaleuca densa</i> , <i>Pericalymma spongiocaula</i> , <i>Boronia juncea</i> , <i>Hakea ceratophylla</i> , <i>Boronia megastigma</i> , <i>Astartea glomerosa</i> , <i>Dampiera leptoclada</i> , <i>Astartea arbuscula</i> , <i>Dampiera alata</i>
Sedges/rushes	M	<i>Gahnia trifida</i> , <i>Anarthria laevis</i> , <i>Stenotalis ramosissima</i> , <i>Baumea juncea</i> , <i>Cyathochaeta avenacea</i> , <i>Schoenus subfascicularis</i> , <i>Schoenus laevigatus</i> , <i>Leptocarpus tenax</i> , <i>Lepyrodia drummondiana</i> , <i>Chordifex laxus</i> , <i>Lepyrodia muirii</i> , <i>Chaetanthes tenellus</i>
Herbs	V	<i>Schoenolaena juncea</i> , <i>Samolus juncea</i> , <i>Stylidium caespitosum</i> , <i>Tribonanthes australis</i> , <i>Burchardia congesta</i> , <i>Philydrella pygmaea</i> , <i>Myriocephalus occidentalis</i> , <i>Selaginella gracillima</i> , <i>Utricularia multifida</i> , <i>Thelymitra flexuosa</i> , <i>Aphelia cyperoides</i> , <i>Goodenia filiformis</i> , <i>Hydrocotyle alata</i> , <i>Siloxerus filifolia</i> , <i>Stylidium calcaratum</i> , <i>Isolepis cernua</i> , <i>Isolepis cyperoides</i> , <i>Schoenus plumosus</i> , <i>Schoenus tenellus</i> , <i>Schoenus discifer</i>
Grasses		<i>Amphipogon debilis</i>

### Key identifying Features

- An Open Woodland of *Melaleuca cuticularis* and/or *M. preissiana* and an open shrubland co-dominated by *Melaleuca pauciflora*, *Gastrolobium sericeum* and *Melaleuca densa*.
- A diverse sedge layer dominated by *Gahnia trifida*, *Stenotalis ramosissima*, *Baumea juncea*, *Anarthria laevis* and *Cyathochaeta avenacea*.
- Presence of a diverse annual and geophyte layer.
- 

**Conservation species:** *Hakea tuberculata* P3, *Astartea arbuscula* P4, *Goodenia filiformis* P4



**Unit 52 *Melaleuca cuticularis*/*M. preissiana* Open Woodland**



## 53 *Kunzea recurva*/*Petrophile squamata* Wet Shrubland

No. of relevés 6 Mean spp. richness 21.8 Area 19 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 1.8

### Description

*Kunzea recurva*/*Petrophile squamata* Wet Shrubland is distributed on poorly drained flats and margins of seasonally wet swamps on grey/brown sand to loam. The upper stratum is a *Petrophile squamata*/*Kunzea recurva* shrubland over a *Pericalymma spongiocaule*/*Hakea sulcata* low shrubland over a mixed sedgeland and *Amphipogon laguroides* very open grassland. Common sedges include *Mesomelaena tetragona*, *Lepyrodia drummondiana*, *Leptocarpus tenax*, *Tricostularia neesii* subsp *neesii* and *Stenotalis ramosissima*.

On the western flats this unit often forms a mosaic with *Melaleuca cuticularis*/*M. preissiana* Open Woodland (52) *Melaleuca spathulata*/*M. viminea* Swamp Heath (54), *Melaleuca raphiophylla* Woodland/Forest Complex (57) and *Melaleuca densa* Swamp Heath (55), with the distribution of units dependent upon soil and hydrological factors.

This unit share many species with sub-unit 39b (*Petrophile squamata*/*Hakea sulcata* Shrubland/ *Pericalymma spongiocaule* Low Open Heath) but differs in the dominance of *Kunzea recurva*, *Cyathochaeta avenacea* and *Amphipogon laguroides*; the presence of *Melaleuca densa* and the absence of *Tremulina tremula*.

### Comments

This unit is scattered throughout the survey area, excluding the coastal fringe, and occurs in small patches forming a mosaic with a number of other units typical of poorly drained areas (see comments unit 52). Its distribution outside the survey area is unknown.

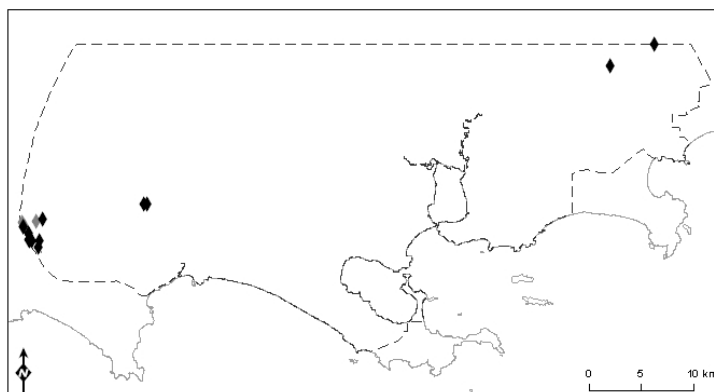
### Floristic Summary

Lifeform	%cover	Species
Shrubs 1-2m	M	<i>Petrophile squamata</i> , <i>Kunzea recurva</i> , <i>Melaleuca densa</i> , <i>Xanthorrhoea preissii</i> , <i>Melaleuca pauciflora</i> . +/- <i>Baeckea pygmaea</i>
Shrubs 0.5-1m	V-S	<i>Pericalymma spongiocaule</i> , <i>Astartea glomerosa</i> , <i>Hakea sulcata</i> , <i>Astartea</i> sp. "small horns"
Shrubs <0.5m		<i>Hibbertia microphylla</i> , <i>Dampiera leptoclada</i> , <i>Dampiera alata</i>
Sedges/rushes	M	<i>Cyathochaeta avenacea</i> , <i>Mesomelaena tetragona</i> , <i>Lepyrodia drummondiana</i> , <i>Leptocarpus tenax</i> , <i>Tricostularia neesii</i> subsp <i>neesii</i> , <i>Stenotalis ramosissima</i> , <i>Chaetanthus leptocarpoides</i> , <i>Chaetanthus tenellus</i> , <i>Chordifex laxus</i> , <i>Desmocladus fasciculatus</i> , <i>Anarthria gracilis</i>
Herbs	V	<i>Patersonia occidentalis</i> , <i>Cassytha glabella</i> , <i>Cassytha racemosa</i>
Grasses	V	<i>Amphipogon laguroides</i> , <i>Amphipogon debilis</i>

### Key identifying Features

- Wet shrubland dominated by *Petrophile squamata*, *Hakea sulcata*, *Kunzea recurva* and *Cyathochaeta avenacea*.
- Occurrence on poorly drained flats and around the margins of swampy sedgeland.

**Conservation species** *Stylidium gloeophyllum* P3 was recorded in this unit in Barrett Meadows Nature Reserve and represents the most south westerly record of this species.





**Unit 53 *Kunzea recurva*/*Petrophile squamata* Wet Shrubland**



**Unit 54 *Melaleuca spathulata*/*Melaleuca viminea* Swamp Heath**

## 54 *Melaleuca spathulata*/*Melaleuca viminea* Swamp Heath

No. of relevés 2 Mean spp. richness 4.5 Area 9 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

*Melaleuca spathulata*/*Melaleuca viminea* Swamp Heath appears to be restricted to seasonally inundated sumplands on flats on the western edge of the survey area and occurs on brown to orange brown loam overlying clay. In the wettest areas, which are inundated up to at least 30cm in winter, this unit is very depauperate and dominated by an *Melaleuca spathulata*/*Melaleuca viminea* subsp *viminea*\* open heath or tall open scrub over *Meeboldina roycei*<sup>#</sup> very open sedgeland. Other species recorded are *Chaetanthus leptocarpoides*, *Chaetanthus tenellus* and *Astartea glomerosa*.

On flatter ground this unit merges with *Melaleuca cuticularis*/*M. preissiana* Open Woodland (52), *Kunzea recurva*/*Petrophile squamata* Wet Shrubland (53), and *Melaleuca raphiophylla* Woodland/Low Forest Complex (57). These ecotonal areas are more diverse than the typical unit with a shrubland to open shrubland of *Gastrolobium sericeum*, *Melaleuca pauciflora*, *Dampiera leptoclada*, *Hakea sulcata* present along with the sedges *Lepidosperma striatum*, *Lepidosperma* aff *pubisquameum* and *Stenotalis ramosissima* and emergent *Melaleuca cuticularis* and *Melaleuca raphiophylla*. These areas may have a diverse annual herbaceous layer.

\*The identity of *Melaleuca viminea* subsp *viminea* is unclear though it appears to be a broad leaf form of this species. It also has similarities to *Melaleuca densa* but differs from typical *M. densa*, with which it sometimes occurs, in its whorled phyllotaxis.

<sup>#</sup>*Meeboldina roycei* is difficult to tell apart from some forms of *M. decipiens* and the identity of this sedge in this unit requires verification.

### Comments

This unit was uncommon and only recorded on the lowland western flats east of Marshall Road and therefore was poorly sampled. The orange brown loam appears distinctive as it was not encountered in other units. Most of the suitable habitat on the flats on the western edge of the survey area has been cleared. These areas are poorly-drained and originally were likely to have been vegetated by a mosaic including at least units 52, 53, 54 and 57. The distribution of this unit outside the survey area is not known, but it is likely to reach its eastern limit within the survey area given the known distribution of dominant sedges. (DEC2009).

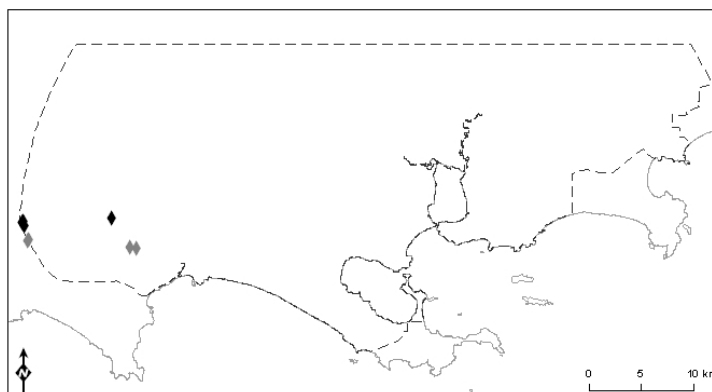
### Floristic Summary

Lifeform	%cover	Species
Trees		+/- <i>Melaleuca cuticularis</i> , <i>M. raphiophylla</i>
Shrubs 1->2m	M-D	<i>Melaleuca spathulata</i> , <i>M. viminea</i> subsp <i>viminea</i> +/- <i>Melaleuca densa</i>
Shrubs <1m		+/- <i>Astartea glomerosa</i> , <i>Melaleuca pauciflora</i> , <i>Gastrolobium sericeum</i> , <i>Hakea sulcata</i> , <i>Isopogon axillaris</i>
Sedges/rushes	M	<i>Meeboldina roycei</i> +/- <i>Lepidosperma striatum</i> , <i>Lepidosperma</i> aff <i>pubisquameum</i> , <i>Stenotalis ramosissima</i>

### Key identifying Features

- Dominance of *Melaleuca spathulata*/*Melaleuca viminea* subsp *viminea*\* and *Meeboldina roycei*\*
- Restricted to orange/brown loam over clay in winter-wet sumplands.

Conservation species None recorded



## 55 *Melaleuca densa* Swamp Heath

No. of relevés 8 Mean spp. richness 8.9 Area 22 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 5.7

### Description

*Melaleuca densa* Swamp Heath is found scattered throughout the study area, excluding the coastal fringe, and is restricted to seasonally inundated sumplands on a variety of sand to loam soils, often with some clay content. It is dominated by an open-closed heath of *Melaleuca densa* with *Pericalymma spongiocaule* sub-dominant. The mixed sedgeland is co-dominated by *Lepidosperma striatum*, *Cyathochaeta avenacea* and *Meeboldina tephрина*, with the latter rarely recorded in other vegetation. Other common species include *Lepyrodia muiirii*, *Schoenus subfascicularis*, *Boronia denticulata*, *Calothamnus lateralis*, *Villarsia parnassiifolia*, *Villarsia lasiosperma* and *Gonocarpus paniculatus*. In the Angove area, *Hakea ceratophylla* and *Hakea tuberculata* are sometimes present as emergent shrubs.

### Comments

The distribution of this unit outside the survey is unknown, however *Melaleuca densa* is a widespread species and similar vegetation dominated by *Melaleuca densa* and containing *Meeboldina tephрина* have been recorded on the plains east of the Porongurup Range (Sandiford 2003-2006).

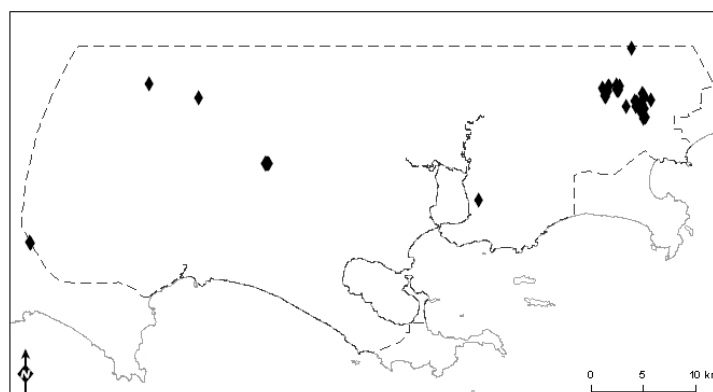
### Floristic Summary

Lifeform	%C	Species
Trees	E	<i>Melaleuca preissiana</i>
Shrubs >2m		<i>Hakea tuberculata</i> , <i>Hakea ceratophylla</i>
Shrubs 1-2	M	<i>Melaleuca densa</i> , <i>Pericalymma spongiocaule</i>
Shrubs 0.5-1	S	<i>Boronia denticulata</i> , <i>Calothamnus lateralis</i> , <i>Astartea glomerosa</i> , <i>Boronia juncea</i>
Sedges/rushes	M-D	<i>Lepidosperma striatum</i> , <i>Meeboldina tephрина</i> , <i>Cyathochaeta avenacea</i> , <i>Lepyrodia muiirii</i> , <i>Schoenus cruentus</i> , <i>Schoenus subfascicularis</i>
Herbs	Nil-V	<i>Villarsia parnassiifolia</i> , <i>Villarsia lasiosperma</i> , <i>Gonocarpus paniculatus</i>

### Key identifying Features

- Dominance of *Melaleuca densa* over a medium to dense sedgeland including *Meeboldina tephрина*.
- Restricted to seasonally inundated sumplands.

**Conservation species** None recorded







**Unit 55 *Melaleuca densa* Swamp Heath**



**Unit 56 *Astartea scoparia* Swamp Thicket**



## 56 *Astartea scoparia* Swamp Thicket

No. of relevés 9 Mean spp. richness 6.9 Area 15 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 3.0

### Description

*Astartea scoparia* Swamp Thicket is restricted to small seasonally inundated sumplands extending in a band from Gull Rock National Park to Bornholm. It occurs on sandy peat soil and may be inundated in winter to a depth of 30 cm or more. This unit is floristically depauperate and dominated by an *Astartea scoparia* tall open scrub or closed heathland over a *Meeboldina scariosa* very open sedgeland with *Sphenotoma squarrosa* often present as a sub-dominant species. *Melaleuca preissiana* is occasionally present as an emergent.

This unit is often surrounded by *Taxandria juniperina* Closed Forest (59) or *Evandra aristata* Sedgeland (46).

### Comments

This unit has distinct boundaries marked by the limits of the sumpland and is one of the few units with a distinctive aerial photographic pattern.

The dominant species, *Astartea scoparia*, resprouts after fire and massive lignotubers were observed indicative of the species longevity. *Taxandria juniperina* was observed to be invading this unit in two sumplands.

Whilst all species recorded within this unit are common outside the study area, this unit may be restricted to the survey area. Similar vegetation was not recorded in the Walpole/Nornalup or Lake Muir area (Wardell-Johnson and Williams 1996; Gibson *et al.* 2000). Information on Perth Herbarium labels for *Astartea scoparia* collections do not list similar vegetation though in many cases the data provided is insufficient for comparison (DEC 2009). *Astartea scoparia* and *Meeboldina scariosa* are widespread in an arc from Albany to north of Perth and *Sphenotoma squarrosa* occurs from Scott River to Albany, with outlying populations in the Stirling Range and Esperance (DEC 2009).

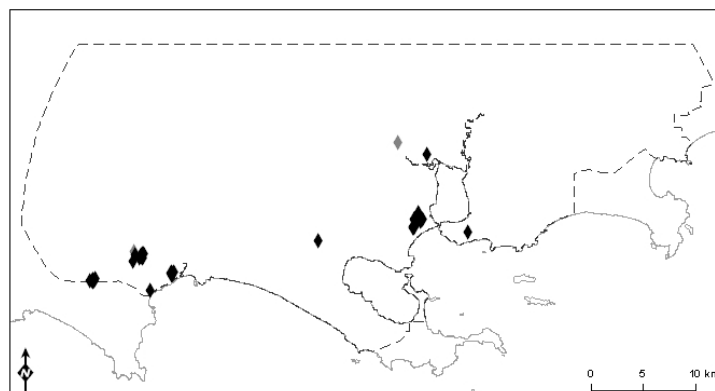
### Floristic Summary

Lifeform	%cover	Species
Trees		+/- <i>Taxandria juniperina</i> , <i>Melaleuca preissiana</i>
Shrubs 1-2m	M-D	<i>Astartea scoparia</i> , <i>Sphenotoma squarrosa</i> +/- <i>Beaufortia sparsa</i> , <i>Cosmelia rubra</i>
Sedges/rushes	V	<i>Meeboldina scariosa</i> +/- <i>Leptocarpus tenax</i> , <i>Baumea vaginalis</i> , <i>Schoenus cruentus</i>
Herbs		<i>Stylidium assimile</i> , <i>Stylidium glaucum</i> +/- <i>Schizaea fistula</i> , <i>Villarsia lasiosperma</i> , <i>Centella asiatica</i>

### Key identifying Features

- Dense stands of *Astartea scoparia*, dominance of *Meeboldina scariosa* in the sedge layer and presence of *Sphenotoma squarrosa*.
- Restricted to small seasonally inundated sumplands on sandy peat soil.

**Conservation species** *Leucopogon alternifolia* P3



## 57 *Melaleuca raphiophylla* Woodland/Low Forest Complex

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No. of relevés 10 Mean spp. richness 6.5 Area 495 ha % of Rem. Veg. 1.1 % in IUCN Reserve 1-IV 12.2

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### Description

*Melaleuca raphiophylla* Woodland/Low Forest Complex is characterized by a canopy of *Melaleuca raphiophylla* and is low in species diversity. It is restricted to low-lying freshwater areas including creek lines, flats and lake margins. The two sub-units described appear to have clear floristic and soil/landform differences, however, they have been amalgamated for mapping purposes as it was not possible to ascribe sub-unit status when only a tree canopy remained.

Sub-units:

### 57a *Melaleuca raphiophylla* Low Open Forest

This sub-unit occurs on a variety of soils along freshwater drainage creek lines and in some swampy flats throughout the survey area. It often lacks a defined shrub layer and consists of a low closed forest to low open forest of *M. raphiophylla* over an open to closed sedgeland with the density of sedges declining with increasing canopy cover. *Baumea vaginalis*, *Lepidosperma effusum* and *Baumea juncea* are often the dominant sedges with *Gahnia decomposita*, *Baumea articulata*, *Lepidosperma striatum* and *Ficinia nodosa* occasionally present. Scattered herbs are often present including *Gratiola peruviana*, *Hydrocotyle hispidula*, *Lobelia anceps*, *Samolus juncea*, *Villarsia parnassiifolia* and *Centella asiatica*. A fringe of *Taxandria linearifolia* (modified, sub-unit 47f) is often adjacent to this sub-unit where it occurs in paddocks and weeds are often present in these areas. This sub-unit is likely to be common outside the survey area (see comments)

### 57b *Melaleuca raphiophylla* Low Woodland over *Melaleuca lateritia* Shrubland

This sub-unit appears to be confined to clay loam soil on poorly drained flats that are inundated in winter. It occurs on the flats in the western part of the survey area with a small occurrence at Manypeaks, which is the eastern limit of *M. lateritia*, and thus the eastern limit of this sub-unit. This sub-unit is distinguished from 57a by the presence of a *Melaleuca lateritia* Shrubland, a more open canopy of *M. raphiophylla* and the absence of *Lepidosperma effusum*. The sedgeland varies in structure and typical species include *Meeboldina scariosus*, *Baumea vaginalis*, *Lepyrodia muirii* and *Baumea articulata*. Herbs include *Centella asiatica*, *Villarsia lasiosperma* and *V. parnassiifolia*.

In the western parts of the survey area, this sub-unit occurs as a mosaic with units 53, 54 and 55.

### Comments

This unit is vulnerable to weed invasion, especially where open to grazing, and infestations of *\*Typha orientalis* were observed within this unit.

Many areas of suitable habitat within the survey area have been cleared.

*Melaleuca raphiophylla* dominated units are common throughout the South Western Botanical Division. They vary considerably in floristics and structure and a *Lepidosperma longitudinale* Sedgeland is often a feature of these units (Gibson *et al.* 1994; Gibson and Keighery 2000). Similar vegetation to sub-unit 57a has been observed along creek lines to the north, and west of the survey area (author observations).

*Melaleuca raphiophylla* / *Melaleuca lateritia* dominated units have been recorded outside the survey area, notably in the Swan Coastal Plain, Lake Muir and Rocky Gully areas. However, these differ in habitat, floristic composition and structure; occur on more heavily clayed soil have a well developed herb layer and a different suite of sedge species (G Keighery pers. comm.; Gibson *et al.* 1994; Gibson and Keighery 2000).

### Key identifying Features

- Dominance of *Melaleuca raphiophylla* in overstorey.
- Occurrence along drainage lines and winter wet flats/swamps.
- Presence of *Melaleuca lateritia* (47b).
- 

**Conservation species** None recorded

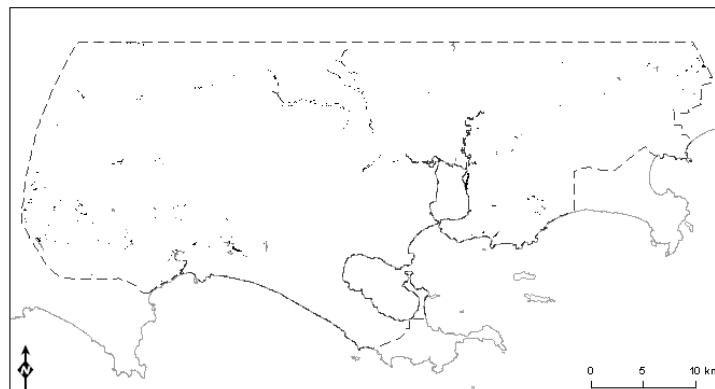
## Floristic Summary

### Subunit 57a

Lifeform	%cover	Species
Trees	MD	<i>Melaleuca raphiophylla</i>
Shrubs >2m	V	<i>Rhadinthamnus anceps</i> , <i>Taxandria linearifolia</i> , <i>Callistachys lanceolata</i> , <i>Callistachys</i> sp. South Coast, <i>Astartea scoparia</i>
Sedges/rushes	V-D	<i>Baumea vaginalis</i> , <i>Lepidosperma effusum</i> , <i>Baumea juncea</i> , <i>Gahnia decomposita</i> , <i>Ficinia nodosa</i> , <i>Baumea articulata</i> .
Herbs		<i>Hydrocotyle hispidula</i> , <i>Samolus juncea</i> , <i>Lobelia anceps</i> , <i>Villarsia parnassiiifolia</i> . <i>Apium prostratum</i> , <i>Gratiola peruviana</i> .

### Sub-unit 57b

Lifeform	%cover	Species
Trees	V-M	<i>Melaleuca raphiophylla</i>
Shrubs 1-2m	V	<i>Melaleuca lateritia</i>
Sedges/rushes	S-D	<i>Meeboldina scariosus</i> , <i>Baumea vaginalis</i> , <i>Lepyrodia muirii</i> , <i>Baumea articulata</i>
Herbs	V	<i>Centella asiatica</i> , <i>Villarsia lasiosperma</i> , <i>Villarsia, parnassiiifolia</i>





***Melaleuca raphiophylla* Low Open Forest Sub-unit 57a**



***Melaleuca raphiophylla* Low Woodland over *Melaleuca lateritia* Shrubland Sub-unit 57b**

## 58 *Melaleuca raphiophylla/Banksia littoralis* Woodland

No. of relevés 2 Mean spp. richness 10 Area 25 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 100

### Description

*Melaleuca raphiophylla/Banksia littoralis* Woodland represents a modified vegetation unit (see comments) and is included here due its extensive area and the co-dominance to *M. raphiophylla* and *B. littoralis* which was not observed in other units. It was found on light grey sands on the flats south of Gull Rock Lake. Structurally this unit is very open, with a low open woodland of *M. raphiophylla* and *B. littoralis* occurring above a *Spyridium globulosum* tall shrubland. Other canopy species include *Agonis flexuosa*, *Melaleuca cuticularis* and *Eucalyptus cornuta*. The ground is usually bare though an open sedgeland or herbland may be present.

This unit occurs as a mosaic with Yate Coastal Forest (1) which occurs on scattered small rises on the flats and abuts *Taxandria juniperina* Closed Forest (59) which fringes the lake.

### Comments

Due to the modified nature of this unit it was not include in the classification analysis. All observed areas of this unit were long unburnt and most *M. raphiophylla* and *B. littoralis* trees were dying or dead. The health of these trees, along with the presence of relatively young *Agonis flexuosa* and *Eucalyptus cornuta* trees as well as species normally associated with well drained sandy soils including *Acacia cyclops* and *Spyridium globulosum*, indicate that this unit has been undergoing hydrological change and drying out for a considerable time.

### Floristic Summary

Lifeform	%cover	Species
Trees <10m	V	<i>Melaleuca raphiophylla</i> , <i>Banksia littoralis</i> , <i>Agonis flexuosa</i> , <i>Eucalyptus cornuta</i> , <i>Taxandria juniperina</i> , <i>Hakea oleifolia</i>
Shrubs >2m	S	<i>Spyridium globulosum</i> , <i>Callistachys lanceolata</i>
Shrubs 1-2m		<i>Acacia cyclops</i> , <i>Leucopogon obovatus</i> , <i>Hibbertia cuneiformis</i> , <i>Acacia myrtifolia</i>
Shrubs < 0.5m		<i>Phyllanthus calycinus</i> , <i>Rhagodia baccata</i>
Sedges/rushes	V	<i>Ficinia nodosa</i> , <i>Lepidosperma striatum</i> , <i>Lepidosperma densiflora</i> forma proliferous
Herbs	V	<i>Anigozanthos flavidus</i> , <i>Opercularia hispidula</i> , <i>Stylidium adnatum</i> , <i>Corybas recurva</i> , <i>Pterostylis</i> sp., <i>Eriochilus</i> sp.

### Key identifying Features

- Modified unit with *Melaleuca raphiophylla* and *B. littoralis* co- dominant.
- Presence of species typical of well-drained sandy soil including *Agonis flexuosa*, *Spyridium globulosum* and *Acacia cyclops*.

**Conservation species** None recorded







**Unit 58 *Melaleuca raphiophylla/Banksia littoralis* Woodland**



**Unit 59 *Taxandria juniperina* Closed Forest**

## 59 *Taxandria juniperina* Closed Forest

No. of relevés 5 Mean spp. richness 7.8 Area 779 ha of Rem. Veg. 1.8 % in IUCN Reserve 1-IV 9.9

### Description

*Taxandria juniperina* Closed Forest is found around swamps, freshwater lakes and along drainage lines and the dense canopy of *Taxandria juniperina* is a characteristic of this unit. Floristically the understorey is depauperate and shrub and sedge layers are often absent. The canopy varies from a low open forest to a closed forest. *Callistachys lanceolata* may be present as a sub-dominant tree or secondary tree stratum and a *Pteridium esculentum* herbland is often present on drier and more disturbed sites. Common sedges include *Baumea vaginalis*, *Leptocarpus tenax*, *Baumea rubiginosa*, *Meeboldina scariosus*, *Lepidosperma effusum* and *Lepidosperma striatum* with common herbs including *Triglochin huegelii*, *Villarsia albiflora*, *Pteridium esculentum* and *Billardiera fusiformis*.

This unit frequently abuts *Homalospermum firmum*/*Callistemon glaucus* Swamp Thicket (47) and *Astartea scoparia* Swamp Thicket (56) and around fresh water lakes is usually fringed by *Baumea articulata* Closed Sedgeland (64). This unit differs from Coastal *Taxandria juniperina* Low Closed Forest (60) in the absence of *Melaleuca incana*, *Gahnia trifida*, *Schoenus* sp South Coast and *Baumea juncea*.

### Comments

This unit is very common around the freshwater lakes in the survey area and was likely to have once formed extensive groves on the Cuthbert/ Elleker flats which have been extensively drained and cleared. *Taxandria juniperina* is an obligate seeder and appears to be an able colonizer with most drains in this area supporting stands of *Taxandria juniperina*. This species was occasionally observed invading *Astartea scoparia* Swamp Thicket (56), *Homalospermum firmum*/*Callistemon glaucus* Wet Heath (47), and *Melaleuca cuticularis*/*M. preissiana* Woodland (52). It is unclear if this as a natural process or driven by recent hydrological change. This unit is vulnerable to weed invasion and a wide variety of species were recorded in this unit including *\*Acacia longifolia*, *\*Psoralea pinnata*, *\*Zantedeschia aethiopica* and *\*Rubus* spp. Isolated stands of old trees often exhibited wind damage.

*Taxandria juniperina* closed forests occur throughout the Warren Botanical District but reach there eastern limit near Cheyne Beach.

### Floristic Summary

Lifeform	%cover	Species
Trees	M-D	<i>Taxandria juniperina</i> , <i>Callistachys lanceolata</i> , +/- <i>Banksia littoralis</i> , <i>Melaleuca preissiana</i>
Shrubs >2m	Nil-V	<i>Rhadinanthus anceps</i> , <i>Homalospermum firmum</i> , <i>Astartea laricifolia</i> , <i>Leucopogon obovatus</i>
Sedges/rushes	V-D	<i>Baumea vaginalis</i> , <i>Leptocarpus tenax</i> , <i>Empodisma gracillimum</i> , <i>Baumea rubiginosa</i> , <i>Meeboldina scariosus</i> , <i>Lepidosperma striatum</i> , <i>Lepidosperma effusum</i>
Herbs	V	<i>Triglochin huegelii</i> , <i>Villarsia albiflora</i> , <i>Pteridium esculentum</i> , <i>Billardiera fusiformis</i>

### Key identifying Features

- Dense canopy of *Taxandria juniperina*
- Occurrence along drainage lines, freshwater lakes and around swamps.

Conservation species None recorded



## 60 Coastal *Melaleuca incana*/*Taxandria juniperina* Shrubland/Closed Forest

No. of relevés 3 Mean spp. richness 9.7 Area 8 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

Coastal *Melaleuca incana*/*Taxandria juniperina* Shrubland/Closed Forest is found along the fringes of Princess Royal Harbour on loam or sand with some clay content. These may be areas where freshwater seepages mix with saline harbour water. Structurally it is a *Taxandria juniperina* low closed forest over *Melaleuca incana* tall open scrub and a mixed sedgeland, with the latter dominated by *Gahnia trifida*, *Baumea juncea* and *Schoenus* sp South Coast. Other common species include *Rhadinothamnus anceps*, *Logania vaginalis*, *Olearia paucidentata*, *Leptocarpus tenax*, *Hypolaena pubescens*, *Baumea vaginalis*, *Amperea protensa*, *Cassytha glabella* and *Lobelia alata*.

This unit differs from the other *Taxandria juniperina* dominated unit (59) in its coastal distribution and the presence of *Melaleuca incana*, *Gahnia trifida*, *Schoenus* sp South Coast and *Baumea juncea*.

### Comments

This unit was recorded in the same vicinity by Penn (1992) and based on the distribution of *Melaleuca incana*, occurs at its eastern limit within the survey area, though it is unclear if it is limited to the survey area.

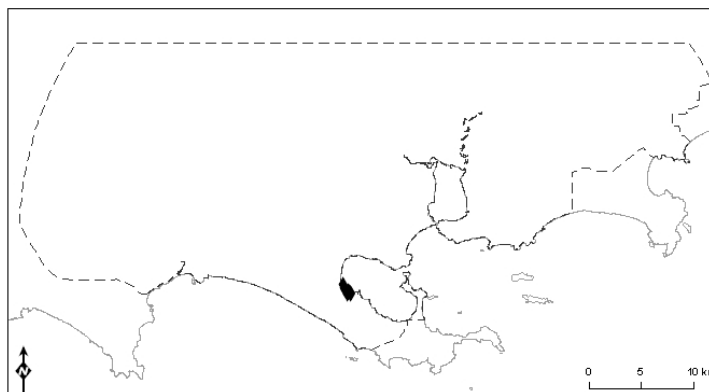
### Floristic Summary

Lifeform	%cover	Species
Trees	M	<i>Taxandria juniperina</i>
Shrubs >2m	S-M	<i>Melaleuca incana</i> +/- <i>Rhadinothamnus anceps</i> , <i>Logania vaginalis</i>
Shrubs <0.5m		<i>Olearia paucidentata</i>
Sedges/rushes	M-D	<i>Gahnia trifida</i> , <i>Baumea juncea</i> , <i>Schoenus</i> sp South Coast +/- <i>Leptocarpus tenax</i> , <i>Hypolaena pubescens</i> , <i>Baumea vaginalis</i> , <i>Chaetanthus aristatus</i> , <i>Ficinia nodosa</i>
Herbs		<i>Amperea protensa</i> , <i>Cassytha glabella</i> , <i>Lobelia alata</i>

### Key identifying Features

- A canopy of *Taxandria juniperina* occurring with *Melaleuca incana*, *Gahnia trifida*, *Baumea juncea* and *Schoenus* sp South Coast.
- Occurrence on the fringe of Princess Royal Harbour.

**Conservation species** *Amperea protensa* P3







**Unit 59 Coastal *Melaleuca incana*/*Taxandria juniperina* Shrubland/Closed Forest**



**Unit 61 *Melaleuca croxfordiae* Low Woodland**

## 61 *Melaleuca croxfordiae* Low Woodland

No. of relevés 1 Mean spp. richness 13 Area) 3 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

*Melaleuca croxfordiae* Low Woodland was only observed near the southern boundary of Angove Water Reserve along a minor drainage line, however, similar vegetation has been observed in Two Peoples Bay NR on the northern side of Gardner Lake. This unit has a canopy of *Melaleuca croxfordiae* over a tall shrubland of *Kunzea ericifolia* and an open sedgeland dominated by *Lepidosperma gracile* and *Anarthria scabra*. The dominance of *Kunzea ericifolia* subsp. *ericifolia* may be influenced by the adjacent vegetation (*Kunzea ericifolia*/*Evandra aristata* Sedgeland 46b).

### Comments

This unit was not well surveyed due to its limited occurrence and its distribution outside the survey area is unclear. *M. croxfordiae* is restricted to the coastal fringe from Walpole to Mt Manypeaks.

*Melaleuca croxfordiae* dominated vegetation has been described to the west of Mt Manypeaks (Hickman 2008) and in West Cape Howe NP DEC unpublished data). However, these occurrences have a different understorey species composition to those in unit 61. *M. croxfordiae* has also been recorded on several granite hills within the survey area and to the west, (Mt Wilyung, Mt Gardner, Mt Hopkins) (DEC 2009), sometimes as a dominant canopy species. Further survey is required to determine the status of all *Melaleuca croxfordiae* dominated vegetation.

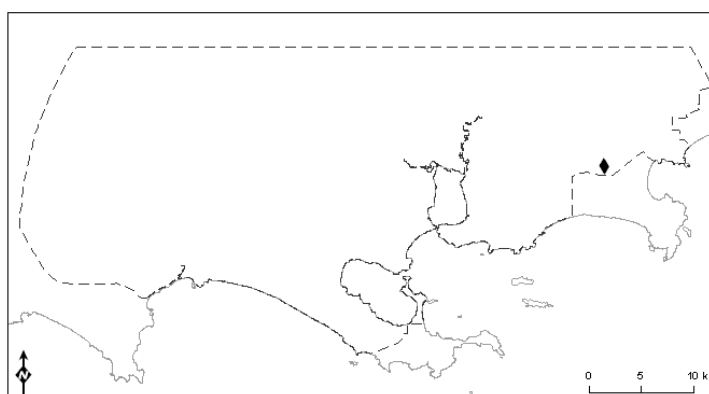
### Floristic Summary

Lifeform	%cover	Species
Trees <10m	S	<i>Melaleuca croxfordiae</i>
Shrubs >2m	S	<i>Kunzea ericifolia</i> subsp <i>ericifolia</i> +/- <i>Leucopogon</i> sp Walpole, <i>Acacia leioderma</i> ,
Shrubs <0.5m		<i>Boronia crenulata</i> , <i>Acacia robiniae</i> , <i>Aotus intermedia</i>
Sedges/rushes	S	<i>Anarthria scabra</i> , <i>Lepidosperma gracile</i>

### Key identifying Features

- Canopy of *Melaleuca croxfordiae*.
- Occurrence on sand along drainage lines

**Conservation species** None recorded





## 62 *Eucalyptus occidentalis* Tall Woodland

No. of relevés 1 Mean spp. richness 4 Area 4 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

*Eucalyptus occidentalis* Tall Woodland is found along the north western and eastern fringe of the survey area and east of the Kalgan River, associated with low lying swamps or drainage lines. Typically this unit is a tall woodland over a mixed sedgeland co-dominated by *Cyathochaeta avenacea*, *Lepidosperma striatum*, *Gahnia trifida* and *Chorizandra enodis*. *Melaleuca cuticularis* is occasionally present. Many of the more common species including *E. occidentalis* are moderately salt tolerant.

### Comments

Whilst many species occurring in this unit area are moderately salt tolerant, they are susceptible to rising salt levels and altered hydrology. No salt affected occurrences were observed within the survey area.

This unit occurs at its southern range within the survey area, *Eucalyptus occidentalis* is recorded from Lake Muir east to Esperance and north to Wagin and Salmon Gums (DEC 2009). This unit is similar in floristic composition to *E. occidentalis* woodlands recorded in swamps north of Manypeaks (Sandiford 2003-2006). The understorey of these woodlands was varied and appeared to be influenced by depth and length of inundation as well as substrate. Newbey noted three *E. occidentalis* groups occurring in the Fitzgerald and Jerramungup areas, each associated with a different landform: swamps, drainage lines and lower valley slopes (Newby 1979).

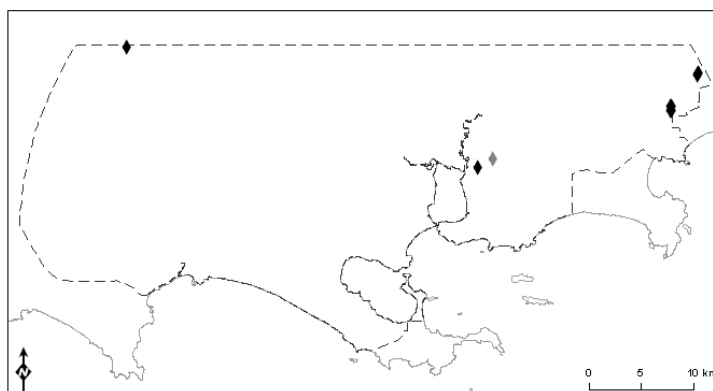
### Floristic Summary

Lifeform	%cover	Species
Trees 10-30m	M	<i>Eucalyptus occidentalis</i> +/- <i>Melaleuca cuticularis</i>
Shrubs >2m		<i>Hakea tuberculata</i>
Sedges/rushes	D	<i>Cyathochaeta avenacea</i> , <i>Lepidosperma striatum</i> , <i>Gahnia trifida</i> , <i>Chorizandra enodis</i>

### Key identifying Features

- Woodland of *Eucalyptus occidentalis* over a sedgeland.
- Occurrence in swamps and drainage lines.

**Conservation species** *Hakea tuberculata* P3.





**Unit 62 *Eucalyptus occidentalis* Tall Woodland**



**Unit 63 Mixed Sedgeland**

## 63 Mixed Sedgeland

No. of relevés 0 Mean spp. richness n/a Area 12 ha % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 0

### Description

Mixed Sedgeland is found in winter wet swamps on loamy peat soil near the eastern boundary of the survey area. This unit has few species with *Baumea vaginalis* and *Lepidosperma striatum* often dominant and occurring over a very open herbland of *Villarsia lasiosperma* and/or *Xyris lacera*. Species composition appears to be influenced by the length and depth of inundation with *Baumea articulata*, *Meeboldina scariosus* and, *Baumea rubiginosa* occurring in the wettest areas. Other common species observed include *Baumea arthropphylla* and *Meeboldina tephрина*. Occasionally this unit grades into *Melaleuca densa* Wet Heath (55) at the margins of swamps.

### Comments

Although this unit was observed several times it was only sampled in one quadrat. The distribution of this unit outside the survey area is not known.

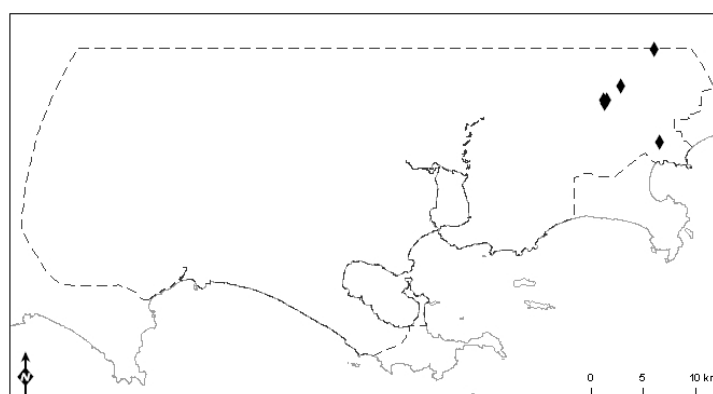
### Floristic Summary

	%cover	
Sedges/rushes	M-D	<i>Baumea vaginalis</i> , <i>Lepidosperma striatum</i> +/- <i>Baumea articulata</i> , <i>B. rubiginosa</i> , <i>Meeboldina tephрина</i> , <i>Baumea arthropphylla</i>
Herbs	V	<i>Villarsia lasiosperma</i> , <i>Xyris lacera</i>

### Key identifying Features

- Sedgeland dominated by *Baumea vaginalis*/ *Lepidosperma striatum* and lacking shrubs.
- Occurrence in flat winter wet swamps.

**Conservation species** None recorded



## 64 *Baumea articulata* Sedgeland

No. of relevés 1 Mean spp. richness 2 Area 54 ha % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 37.8

### Description

*Baumea articulata* Sedgeland is restricted to the fringe of fresh water lakes and permanently inundated swamps. These sedgelands are usually monospecific though closer to the shore other species including *Triglochin huegelii*, *Meeboldina scariosa*, *Baumea vaginalis* and *Juncus pallidus* may be present. *\*Typha orientalis*, an invasive weed of this unit, was recorded in many areas.

This unit is usually fringed by *Taxandria juniperina* Closed Forest (59) on the landward side of lakes and often as occurs as a mosaic with *\*Typha orientalis* Sedgeland (68).

### Comments

*\*Typha orientalis* invasions were noted within this unit in Lake Seppings, Gull Rock Lake and Lake Powell. Aerial photography indicates that the *\*Typha orientalis* Sedgeland (68) at the western end of Gull Rock Lake has expanded greatly between the 1990's and 2007.

*Baumea articulata* Sedgeland is vulnerable to changes in hydrology (Froend and McComb 1994) and a few occurrences of this unit in Gull Rock NP and Torndirrup NP were dead or dying at the time of survey. It is unclear if this will result in permanent change to the vegetation or if it is a temporary response to reduced water availability. Aerial photos of Lake Powell appear to indicate that there were no stands of *B. articulata* present in 1947 with much of the lake margin being bare sand (Bourne 2002).

Extensive stands of this unit occur around the lakes in and near Two Peoples Bay. NR. These are within the ARVS context area but outside the survey area. *B. articulata* Closed Sedgeland is common around freshwater lakes/swamps throughout southern Western Australia and is important roosting and breeding habitat for water birds (Jaensch *et al.* 2009)

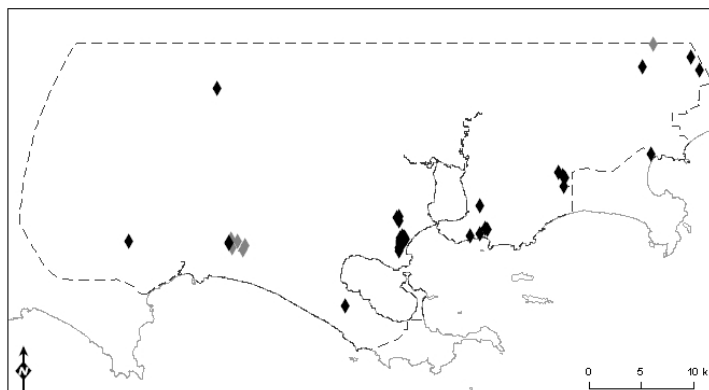
### Floristic Summary

Lifeform	%cover	Species
Sedges/rushes	D	<i>Baumea articulata</i> , <i>Meeboldina scariosa</i> , <i>Baumea vaginalis</i> , <i>Juncus pallidus</i> <i>*Typha domingensis</i>
Herbs		<i>Triglochin huegelii</i>

### Key identifying Features

- Dense stands of *Baumea articulata*.
- Occurrence in permanently inundated fresh water lakes fringes.

### Conservation species -







**Unit 64 *Baumea articulata* Sedgeland**



**Unit 65 Coastal *Melaleuca cuticularis* Low Forest**



## 65 Coastal *Melaleuca cuticularis* Low Forest

No. of relevés 5 Mean spp. richness 6 Area 208 ha % of Rem. Veg. 0.5 % in IUCN Reserve 1-IV 4.8

### Description

Coastal *Melaleuca cuticularis* Low Forest is restricted to the coastal fringe along low energy estuarine and inlet shores. A canopy of *Melaleuca cuticularis* over a sedgeland of *Juncus kraussii* and/or *Gahnia trifida* and *Baumea* species is the distinguishing feature of this unit which, with the exception *Melaleuca viminea* subsp *viminea* found around Torbay Inlet, lacks shrubs. The composition of sedges appears related to salinity and inundation with *Juncus kraussii* prominent at the waters edge, *Gahnia trifida* and *Baumea juncea* occurring on higher ground and *Baumea vaginalis* and *B. arthrophylla* occurring in the least saline areas. The latter species were recorded along the drainage line east of Lake Sepping and in a pocket on the Vancouver Peninsula which is now cut off from the sea but has a substrate of sand and shells. Tidal herbs and shrubs are occasionally present.

This unit lacks the diversity of shrubs and annual flora of the other *Melaleuca cuticularis* dominated unit (52) and can be difficult to differentiate floristically when the latter is degraded.

### Comments

Very small pockets of this unit also occur along the rocky ocean shores but were not mapped due to their size. This unit has been recorded in similar habitats throughout south Western Australia including the Peel-Harvey, Leschenault and Wilson inlets (Pen *et al.* 2000). With the exception of *Melaleuca viminea* subsp *viminea* forma broad leaf and *Baumea vaginalis*, it appears similar to *Melaleuca cuticularis* woodlands found in coastal areas of Southern Australia.

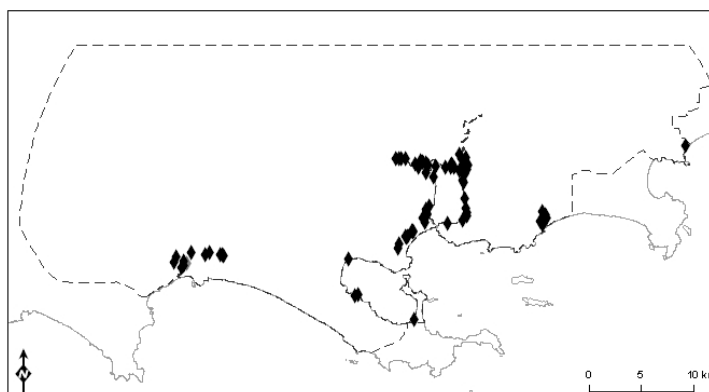
### Floristic Summary

	%cover	
Trees	S-D	<i>Melaleuca cuticularis</i>
Shrubs >2m		<i>Melaleuca viminea</i> subsp <i>viminea</i> forma broad leaf +/- <i>Rhadinothamnus anceps</i>
Sedges/rushes	V_D	<i>Juncus kraussii</i> , <i>Gahnia trifida</i> , <i>Baumea vaginalis</i> , <i>Baumea juncea</i> , <i>Baumea arthrophylla</i>
Herbs	Nil-V-	<i>Samolus repens</i> , <i>Samolus juncea</i> , <i>Wilsonis backhousei</i> , <i>Sarcocornia quinqueflora</i> flora, <i>Atriplex hypoleuca</i> , <i>Suaeda australis</i>
Grasses	-	<i>Sporobolus virginicus</i>

### Key identifying Features

- Canopy of *Melaleuca cuticularis* over a depauperate sedgeland which may include *Juncus kraussii*, *Gahnia trifida*, *Baumea juncea* and occasionally *Baumea vaginalis* and *Baumea arthrophylla*.
- Restricted to estuarine margins and nearby drainage lines.

**Conservation species** -The only WA records for *Selliera radicans* P2 are in similar vegetation outside the context area at Wilson Inlet, Denmark.



## 66 *Juncus kraussii* Sedgeland

No. of relevés 4 Mean spp. richness 3 Area 70 ha % of Rem. Veg. 0.2 % in IUCN Reserve 1-IV 2.4

### Description

*Juncus kraussii* Sedgeland occurs along low energy estuarine margins on sandy/muddy substrates, often occurring in very thin bands at the waters edge where it is inundated by tidal movement. It is dominated by dense stands of *Juncus kraussii* with other species present only in low numbers. These include *Gahnia trifida*, *Baumea juncea*, *Samolus repens*, *Wilsonia backhousei*, *Sarcocornia quinqueflora*, *Wilsonia humilis*, *Suaeda australis* and *Triglochin striata*. Pockets of *Baumea juncea* Sedgeland may be present within this unit where there is intermittent freshwater seepage.

This unit is common along the edges of Oyster Harbour, Princess Royal Harbour and the lower King and Kalgan Rivers where it usually occurs on the landward side of Coastal Saltmarsh (67) and seaward side of Coastal *Melaleuca cuticularis* Low Forest (65).

### Comments

This unit has been recorded around Wilson Inlet (Pen 1996) and in the Walpole/Nornalup, Leschenault, Swan and Peel/Harvey inlets in southern Western Australia (Penn *et al.* 2000). It is recognized as part of the southern Coastal Saltmarsh Community which has a similar species composition throughout southern Australia (Adam 2002) (see comments Coastal Saltmarsh (67)).

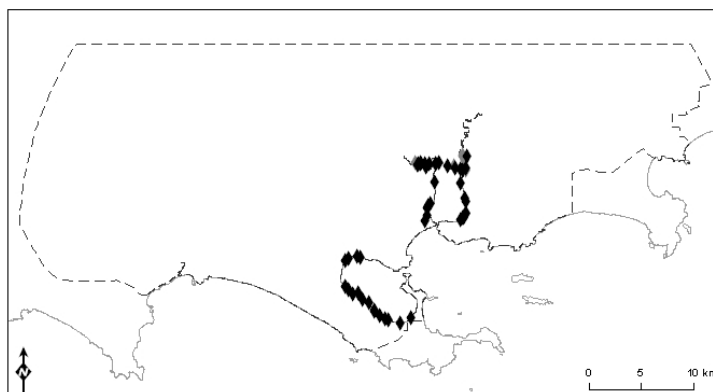
### Floristic Summary

Lifeform	%cover	Species
Sedges/rushes	D	<i>Juncus kraussii</i> +/- <i>Baumea juncea</i> , <i>Gahnia trifida</i>
Herbs	Nil-V	<i>Samolus repens</i> , <i>Wilsonia backhousei</i> , <i>Sarcocornia quinqueflora</i> , <i>Wilsonia humilis</i> , <i>Suaeda australis</i> , <i>Triglochin striata</i>

### Key identifying Features

- Closed Sedgeland dominated by *Juncus kraussii*.
- Occurrence on estuarine fringe.

Conservation species None recorded





**Unit 66 *Juncus kraussii* Sedgeland**



**Zonation Units 65- 67 Coastal Saltmarsh - *Juncus kraussii* Sedgeland  
- Coastal *Melaleuca cuticularis* Low Forest**

## 67 Coastal Saltmarsh

No. of relevés 4 Mean spp. richness 5.3 Area 79 ha % of Rem. Veg. 0.2 % in IUCN Reserve 1-IV 0

### Description

This unit is an inter-tidal community restricted to shallow low energy estuarine shores between the low and high tide marks. It contains a variety of salt tolerant succulent herbs, occurring in a mosaic of distinctive herblands that are often dominated by one species (recognized as sub-units). The zonation of these sub-units is determined by the extent and duration of inundation, soil substrate and salinity. Their distribution varies over time with changes in sedimentation, drainage and shorelines (Zedler *et al.* 1995).

This unit is usually bordered by *Juncus kraussii* Sedgeland (66) on the landward side and is found around Oyster Harbour, Princess Royal Harbour and the mouths of the Kalgan and King rivers.

Sub-units:

#### 67a *Sarcocornia quinqueflora* Herbland

This sub-unit is dominated by *S. quinqueflora*. Other species present include *Samolus repens* and *Triglochin striata*. It occurs at the lowest level of all the sub-units.

#### 67b *Wilsonia backhousei*/W. *humilis* Herbland

This sub-unit is present in very small patches and may include *Samolus repens*, *Juncus kraussii*, *Sarcocornia quinqueflora*, *Triglochin striata* and *Hemichroa pentandra*.

#### 67c *Maireana oppositifolia*/*Suaeda australis* Low Open Shrubland

This sub-unit is restricted to sandy deposits/berms fronting flats or at the edges of estuaries and is the least inundated of all the sub-units.

#### 67d *Tecticornia halocnemoides* Open Herbland

This sub-unit has been recorded in very small patches around Oyster Harbour and King River (Pen, unpublished).

**67e *Tecticornia lepidosperma* Low Open Shrubland** This sub-unit has been recorded in very small patches around Oyster Harbour and King River (Pen, unpublished).

**67f Saltpans** These areas within salt marshes are recognized as part of the saltmarsh mosaic and may be vegetated over time.

### Comments

This unit is vulnerable to degradation caused by vehicle and foot traffic. Vegetation removal and soil compaction has occurred in some areas on the western side of Oyster Harbour as a result of such traffic. Some degradation has also occurred on the eastern side of Oyster Harbour, possibly a result of grazing. Elsewhere this unit is generally in excellent condition with little evidence of weed invasion. \**Juncus acutus*, a major weed in south eastern Australian saltmarshes, was not observed within this unit during this survey.

The distribution of these sub-units varies over time with changes in sedimentation and hydrology and this was evident in the differences between previous mapping (Pen 1992; Pen unpublished) and some areas surveyed during this project. In areas where this unit was not surveyed on foot, Pen's mapping has been used.

Coastal Saltmarsh is important feeding and roosting habitat for migratory water birds protected under Federal legislation and international treaties and is an important habitat and nursery for many marine organisms. The saltmarshes around Oyster Harbour are part of the Oyster Harbour Wetland of National Significance (Department of Environment, Water, Heritage and the Arts (2010).

This unit has been recorded in the Swan, Peel and Leschenault estuaries in southern WA and is similar in species composition to coastal saltmarsh recorded across southern Australia (Pen *et al.* 2000). It is recognized nationally, along with *Juncus kraussii* Sedgeland (66), as a Coastal Saltmarsh community of high ecological value and under threat (Adam 2002). This community is protected in NSW under that states Threatened Species Conservation Act 1994. Australia wide, major threats to this unit include landfill and drainage for urban, industrial and agricultural developments with inundation from predicted sea level rise a potential future threat (Adam 2009; Laegdsgaard *et al.* 2009).

### Key identifying Features

- Dominance of succulent salt tolerant herbs/shrubs
- Restricted to edge of tidal flats and estuarine margins.

**Conservation species** None recorded

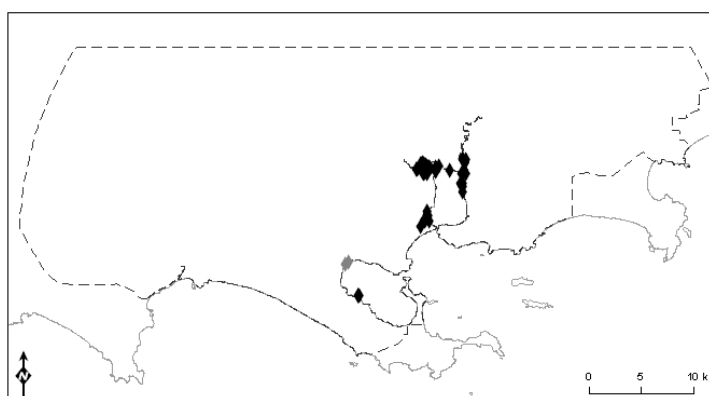


## Floristic Summary

Lifeform	%cover	Species
Sedges/rushes		<i>Juncus kraussii</i>
Herbs	Nil-M	<i>Sarcocornia quinqueflora</i> , <i>Wilsonia backhousei</i> , <i>Wilsonia humilis</i> , <i>Maireana oppositifolia</i> , <i>Suaeda australis</i> , <i>Triglochin striata</i> , <i>Samolus repens</i> , <i>Hemichroa pentandra</i> , <i>Triglochin mucronulata</i> , <i>Tecticornia lepidosperma</i> , <i>Tecticornia halocnemoides</i> , <i>Atriplex hypoleuca</i>
Grasses		<i>Sporobolus virginicus</i>



## Unit 67 Coastal Saltmarsh



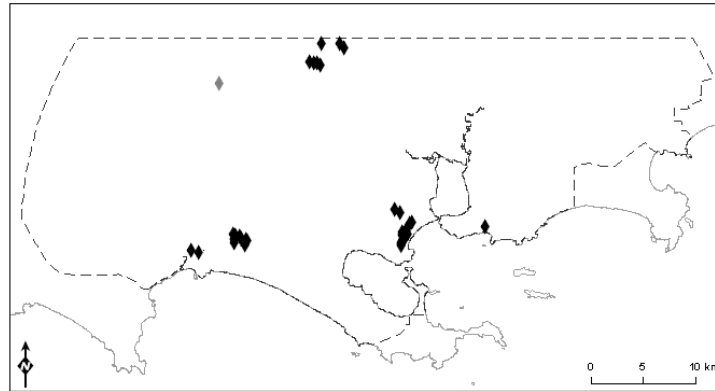


## 68 *\*Typha orientalis* Sedgeland

No. of relevés 0 Mean spp. richness n/a Area (ha) 40 % of Rem. Veg. 0.1 % in IUCN Reserve 1-IV 56.4

### Description

This unit is dominated by the introduced sedge *\*Typha orientalis* and is only mapped where it occurs as a mosaic with remnant vegetation, most notably *Baumea articulata* Closed Sedgeland (64) around lake edges.



## 69 *\*Acacia longifolia* Tall Shrubland

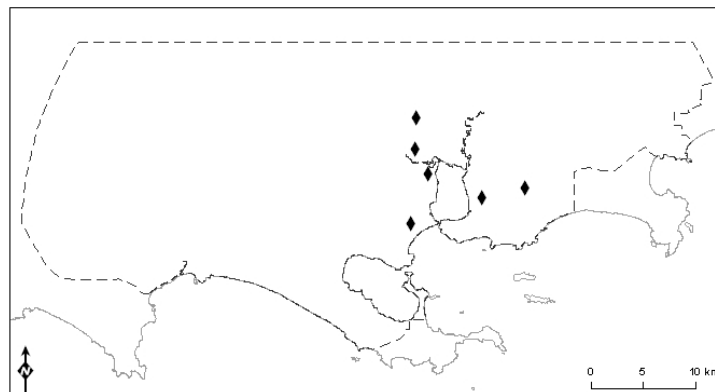
No. of relevés 0 Mean spp. richness n/a Area (ha) 5 % of Rem. Veg. <0.1 % in IUCN Reserve 1-IV 26.1

### Description

This unit is dominated by the environmental weed *\*Acacia longifolia* and is a mapping unit used to differentiate this non-native vegetation where it is surrounded by native vegetation. Some areas of *Acacia longifolia* Tall Shrubland occurring on the edge of remnant vegetation or as isolated stands were not mapped as remnant vegetation.

### Comments

Numerous occurrences of this species were observed, often well removed from disturbed areas, with denser stands forming near monotypic stands and outcompeting native species. Infestations were observed in many vegetation types and occurred on a variety of soil types including sands, lateritic soil, granite outcrops and peats. This weed has proliferated in the region over the last two decades (author observations) and is recognized as a major environmental weed around Albany as well as in Victoria, South Africa and Portugal (Peltzer 2007; Marchante *et al* 2004; Pieterse and Cairns 1988; Muyt 2001). Seed is dispersed by birds, may remain viable in the soil for greater than 10 years with a 10% annual germination rate in the absence of disturbance (Muyt 2001).. Thus, control methods need a long term commitment. Given the relatively rapid recent spread of this species, its ability to invade undisturbed bushland and displace native species, urgent action is required to limit its dispersal and establishment.



**APPENDIX 10: NVIS Information Hierarchy – vegetation description**  
(ESCAVI 2003)

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

Row and column 1 = vegetation unit code, Row 2 and column 2 = number of relevés/unit. Mapping units, modified units and single sampled units excluded.

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## APPENDIX 12: R values for pairwise Analysis of similarity tests (ANOSIM)

Mapping units and modified units excluded. Blank cells = single sampled units, R value not calculated.

	39	13	12	56	46	14	2	57	21	5	1	17	16	10	25	24	38	30	32	31	55	49
39																						
13	0.77																					
12	0.96	0.79																				
56	1.00	1.00	1.00																			
46	0.55	0.88	0.96	0.93																		
14	0.76	0.46	0.98	1.00	0.84																	
2	1.00	1.00	1.00	1.00	0.96	1.00																
57	1.00	1.00	1.00	0.91	0.97	1.00	1.00															
21	0.93	0.90	0.88	0.97	0.93	0.96	0.76	0.97														
5	1.00	1.00	1.00	1.00	0.97	1.00	0.62	1.00	0.90													
1	1.00	1.00	1.00	1.00	0.97	1.00	0.30	0.97	0.83	0.85												
17	0.96	0.88	0.35	1.00	0.97	0.99	0.99	1.00	0.85	1.00	0.98											
16	0.78	0.58	0.99	1.00	0.85	0.51	1.00	1.00	0.27	1.00	1.00	0.97										
10	0.98	0.98	0.81	1.00	0.95	1.00	0.74	1.00	0.86	0.96	0.59	0.53	0.98									
25	0.97	1.00	0.99	0.99	0.96	1.00	0.96	0.99	0.81	0.99	0.95	0.98	0.92	0.98								
24	1.00	1.00	1.00	0.99	0.97	1.00	0.98	0.99	0.94	0.99	0.98	1.00	0.97	1.00	0.68							
38	0.40	0.75	0.98	0.98	0.42	0.73	1.00	1.00	0.83	1.00	1.00	0.95	0.73	0.97	0.97	0.99						
30	0.82	0.80	0.71	1.00	0.94	0.97	1.00	1.00	0.92	1.00	1.00	0.64	0.98	0.98	0.95	1.00	0.93					
32	0.85	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.85	1.00	1.00	0.97	1.00	0.69	0.97	0.98	0.86					
31	0.68	0.72	0.65	1.00	0.94	0.91	1.00	1.00	0.81	1.00	1.00	0.73	0.90	0.97	0.92	1.00	0.87	0.28	0.62			
55	0.98	1.00	1.00	0.91	0.95	1.00	1.00	0.92	0.96	1.00	1.00	1.00	1.00	1.00	0.97	0.98	1.00	1.00	0.96	0.99		
49	0.81	0.99	1.00	0.92	0.52	1.00	1.00	0.98	0.87	1.00	1.00	0.99	0.99	0.99	0.97	0.98	0.65	0.98	0.93	0.94	0.95	
40	0.53	0.98	1.00	1.00	0.87	1.00	1.00	1.00	0.86	1.00	1.00	1.00	0.99	1.00	0.83	0.98	0.92	0.84	0.33	0.55	0.96	0.93
47	0.98	1.00	1.00	0.94	0.61	1.00	1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.93	1.00	1.00	1.00	0.94	0.59
4	0.88	0.83	1.00	1.00	0.88	0.74	0.89	1.00	0.82	0.99	0.95	0.99	0.74	0.92	0.99	0.99	0.85	1.00	1.00	0.99	1.00	1.00
52	0.85	1.00	1.00	0.92	0.89	1.00	0.99	0.93	0.95	0.99	0.98	1.00	0.96	0.99	0.96	0.97	0.91	0.99	0.90	0.98	0.63	0.61
67	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.99	0.96	1.00	1.00	1.00	1.00	1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
66	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.94	0.96	1.00	1.00	1.00	1.00	1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
59	1.00	1.00	1.00	0.80	0.89	1.00	0.99	0.79	0.94	1.00	1.00	1.00	1.00	0.99	0.97	0.98	0.98	1.00	1.00	1.00	0.99	0.81
65	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.80	0.97	1.00	1.00	1.00	1.00	1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
48	0.99	1.00	1.00	0.97	0.96	1.00	0.97	0.84	0.94	0.99	0.96	1.00	0.95	0.98	0.95	0.96	0.97	1.00	0.95	1.00	0.94	0.86
43	0.98	1.00	1.00	0.98	0.95	1.00	1.00	0.97	0.95	1.00	1.00	1.00	1.00	1.00	0.97	0.97	0.95	1.00	0.92	0.99	1.00	1.00
9	1.00	1.00	1.00	0.99	0.97	1.00	0.68	0.97	0.92	0.95	0.31	0.99	0.98	0.77	0.97	0.98	0.99	1.00	0.99	1.00	0.99	0.99
3	0.98	0.97	1.00	1.00	0.95	0.98	0.82	1.00	0.72	0.92	0.88	1.00	0.87	0.94	0.98	0.99	0.97	1.00	1.00	0.99	1.00	1.00
45	0.84	0.96	1.00	0.97	0.78	0.99	0.95	0.97	0.87	1.00	0.96	0.99	0.81	0.95	0.96	0.98	0.55	0.98	0.94	0.98	0.95	0.62
44	1.00	1.00	1.00	1.00	0.97	1.00	0.83	0.93	0.91	0.95	0.90	1.00	1.00	0.98	0.94	0.97	1.00	1.00	1.00	1.00	1.00	1.00
60	1.00	1.00	1.00	0.96	0.95	1.00	1.00	0.69	0.96	1.00	1.00	1.00	1.00	1.00	0.97	0.97	1.00	1.00	1.00	1.00	1.00	1.00
64	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.84	0.96	1.00	1.00	1.00	1.00	1.00	0.97	0.97	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	0.97	1.00	0.93	1.00	0.71	0.56	0.99	1.00	1.00	0.99	0.95	0.98	1.00	1.00	1.00	1.00	1.00	1.00
26	1.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.67	1.00	1.00	1.00	1.00	1.00	0.60	0.88	1.00	1.00	0.98	1.00	1.00	1.00
22	0.85	0.97	0.77	1.00	0.94	1.00	1.00	1.00	0.40	1.00	1.00	0.70	1.00	0.95	0.56	0.97	0.95	0.84	0.84	0.33	1.00	1.00
7	1.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.93	1.00	1.00	1.00	1.00	1.00	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
23	0.99	1.00	0.98	0.99	0.96	1.00	0.77	0.98	0.78	0.95	0.61	0.83	0.96	0.52	0.85	0.97	0.98	0.99	0.98	0.99	0.97	0.98
36	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.95	0.93	1.00	1.00	1.00	1.00	1.00	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	0.96	1.00	0.86	1.00	0.80	0.96	0.97	1.00	1.00	0.95	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00
27	1.00	1.00	1.00	1.00	0.96	1.00	0.99	1.00	0.83	1.00	1.00	1.00	1.00	0.98	0.89	0.97	1.00	1.00	1.00	1.00	1.00	1.00
15	0.67	0.75	1.00	1.00	0.79	0.38	1.00	1.00	0.56	1.00	1.00	0.99	0.73	0.99	0.97	0.98	0.62	0.99	0.99	0.95	1.00	1.00
18	0.93	0.95	0.92	1.00	0.92	1.00	1.00	1.00	0.36	1.00	1.00	0.54	0.98	0.91	0.87	0.98	0.94	0.81	0.95	0.53	1.00	0.99
19	1.00	1.00	1.00	1.00	0.97	1.00	0.92	1.00	0.78	1.00	0.99	0.94	1.00	0.93	0.86	0.97	1.00	1.00	1.00	0.99	1.00	1.00
54	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.94	0.96	1.00	1.00	1.00	1.00	1.00	0.97	0.97	1.00	1.00	1.00	1.00	1.00	1.00
53	0.75	1.00	1.00	0.99	0.91	1.00	1.00	1.00	0.92	1.00	1.00	1.00	1.00	1.00	0.92	0.98	0.97	0.99	0.80	0.91	0.97	0.91
33	0.95	0.98	1.00	0.99	0.83	1.00	0.99	1.00	0.81	1.00	1.00	0.98	1.00	0.93	0.94	0.97	0.78	1.00	1.00	0.99	1.00	0.82
11	0.83	0.73	0.94	1.00	0.85	0.83	0.97	1.00	0.72	1.00	1.00	0.88	0.92	0.76	0.97	0.98	0.57	0.94	1.00	0.92	1.00	0.99
41	0.66	1.00	1.00	0.97	0.83	1.00	1.00	1.00	0.91	1.00	1.00	1.00	1.00	1.00	0.97	0.97	0.76	1.00	0.88	0.97	1.00	0.78
51	0.99	1.00	1.00	0.97	0.86	1.00	1.00	0.91	0.95	1.00	1.00	1.00	1.00	1.00	0.97	0.97	0.96	1.00	0.98	1.00	0.96	0.63
29	0.93	0.99	0.80	1.00	0.96	1.00	1.00	1.00	0.64	1.00	1.00	0.82	1.00	0.98	0.55	0.97	1.00	0.85	0.87	0.71	1.00	1.00
37	0.57	0.95	1.00	1.00	0.55	0.89	1.00	1.00	0.95	1.00	1.00	1.00	0.96	1.00	0.93	0.97	0.54	1.00	1.00	1.00	1.00	1.00
42	1.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.96	1.00	1.00	1.00	1.00	1.00	0.97	0.97	1.00	1.00	0.82	1.00	1.00	1.00
61	0.99	1.00	1.00	1.00	0.89	1.00	0.99	1.00	0.90	1.00	1.00	0.96	1.00	0.96	0.87	0.97	0.98	1.00	1.00	1.00	1.00	0.97
62	1.00	1.00	1.00	0.96	0.96	1.00	1.00	0.87	0.96	1.00	1.00	1.00	1.00	0.99	0.93	0.97	1.00	1.00	0.96	1.00	0.77	1.00
35	0.97	1.00	1.00	1.00	0.94	1.00	1.00	1.00	0.83	1.00	1.00	0.90	1.00	0.88	0.86	0.97	0.90	0.98	1.00	0.98	1.00	0.86
34	0.73	0.99	1.00	0.88	0.68	0.99	1.00	0.99	0.91	1.00	1.00	1.00	1.00	0.98	0.97	0.97	0.44	1.00	0.98	0.99	1.00	0.73

# **APPENDIX 12 cont:** R values for pairwise Analysis of similarity tests (ANOSIM)

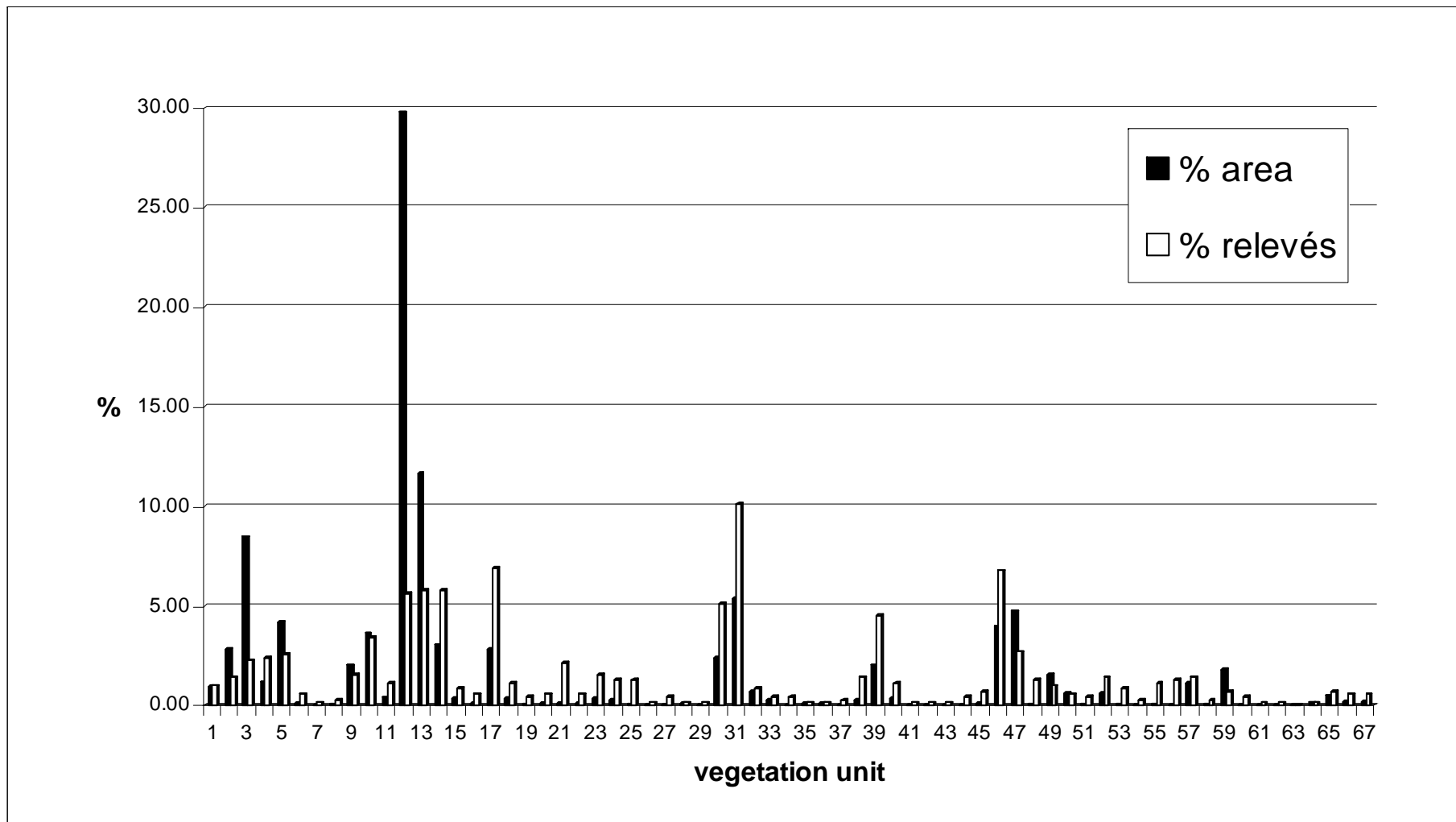
Mapping units and modified units excluded. Blank cells = single sampled units, R value not calculated.

	40	47	4	52	67	66	59	65	48	43	9	3	45	44	60	64	6	26	22	7	23	36	20	27	15	18	19	54	53	33	11	41	51	29	37
47	1.00																																		
4	1.00	1.00																																	
52	0.77	0.91	0.99																																
67	1.00	1.00	1.00	0.98																															
66	1.00	1.00	1.00	0.97	0.15																														
59	1.00	0.72	1.00	0.91	1.00	1.00																													
65	1.00	1.00	1.00	0.86	0.57	0.35	0.97																												
48	0.96	0.73	0.99	0.91	0.95	0.95	0.83	0.94																											
43	1.00	0.97	1.00	0.68	1.00	1.00	0.94	1.00	0.93																										
9	0.99	1.00	0.97	0.98	0.98	0.98	0.97	0.98	0.94	0.98																									
3	1.00	1.00	0.46	0.99	1.00	1.00	1.00	1.00	0.99	1.00	0.95																								
45	0.97	0.91	0.91	0.81	1.00	1.00	0.79	1.00	0.85	0.76	0.96	0.97																							
44	1.00	1.00	1.00	0.86	1.00	1.00	0.94	0.95	0.93	1.00	0.89	0.99	0.76																						
60	1.00	0.96	1.00	0.75	1.00	1.00	0.85	0.99	0.90	1.00	0.98	1.00	0.95	0.96																					
64	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.87		0.98	1.00	1.00	1.00	1.00																				
6	1.00	1.00	0.99	0.98	1.00	1.00	1.00	1.00	0.95	1.00	0.94	0.97	1.00	1.00	1.00	1.00																			
26	1.00	1.00	0.99	0.98	1.00	1.00	1.00	1.00	0.94		0.98	0.95	0.96	1.00	1.00		1.00																		
22	0.89	1.00	1.00	0.91	1.00	1.00	1.00	1.00	0.95	1.00	0.97	1.00	0.98	1.00	1.00	1.00	1.00																		
7	1.00	1.00	1.00	0.98	0.21	1.00	1.00	0.84	0.94		0.96	1.00	1.00	1.00	1.00			1.00																	
23	0.97	1.00	0.97	0.96	0.98	0.98	0.95	0.98	0.92	0.98	0.79	0.96	0.95	0.91	0.98	0.98	0.94	0.94	0.82	0.97															
36	1.00	0.84	1.00	0.97	1.00	1.00	0.84	1.00	0.61		0.98	1.00	0.96	1.00	1.00		1.00				0.95														
20	1.00	1.00	1.00	0.98	1.00	1.00	0.98	1.00	0.94	1.00	0.78	0.97	0.99	1.00	1.00	1.00	0.81	1.00	1.00	1.00	0.73	1.00													
27	1.00	1.00	1.00	0.98	1.00	1.00	0.99	1.00	0.92	1.00	0.95	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.64	1.00	0.94												
15	0.98	1.00	0.82	0.98	1.00	1.00	1.00	1.00	0.96	1.00	0.99	0.95	0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00											
18	0.99	1.00	1.00	0.96	1.00	1.00	1.00	1.00	0.96	1.00	0.98	1.00	0.99	1.00	1.00	1.00	1.00	1.00	0.97	1.00	0.83	1.00	1.00	1.00	1.00										
19	1.00	1.00	0.99	0.98	1.00	1.00	0.98	1.00	0.94	1.00	0.83	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.55	1.00	0.77	1.00	1.00	0.88									
54	1.00	1.00	1.00	0.94	1.00	1.00	1.00	0.93	0.95	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00								
53	0.78	0.97	1.00	0.45	1.00	1.00	0.99	1.00	0.95	0.98	0.98	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
33	0.99	0.94	0.97	0.93	1.00	1.00	0.91	1.00	0.94	1.00	0.95	0.99	0.73	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00						
11	1.00	1.00	0.70	0.98	1.00	1.00	0.99	1.00	0.96	1.00	0.96	0.93	0.76	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.91	1.00	1.00	1.00	0.95	0.99	1.00	1.00	1.00	0.60					
41	0.96	0.96	0.99	0.54	1.00	1.00	0.96	1.00	0.94		0.98	1.00	0.60	1.00	1.00		1.00		1.00		0.98		1.00	1.00	1.00	1.00	1.00	1.00	0.96	1.00	0.98				
51	1.00	0.64	1.00	0.35	1.00	1.00	0.86	1.00	0.92	1.00	0.98	1.00	0.72	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00		
29	0.93	1.00	1.00	0.94	1.00	1.00	1.00	1.00	0.93		0.98	1.00	1.00	1.00	1.00		1.00		1.00		0.83		1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
37	0.98	1.00	0.96	0.95	1.00	1.00	1.00	1.00	0.95	1.00	0.98	1.00	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
42	1.00	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.94		0.98	1.00	1.00	1.00	1.00		1.00		1.00		0.98		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
61	1.00	0.99	1.00	0.97	1.00	1.00	1.00	1.00	0.94		0.98	0.99	0.84	1.00	1.00		1.00		1.00		0.85		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.78	0.95		1.00	
62	1.00	0.94	1.00	0.72	1.00	1.00	0.98	1.00	0.84		0.97	1.00	0.66	1.00	1.00		1.00		1.00		0.87		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
35	1.00	0.90	1.00	0.72	1.00	1.00	0.92	1.00	0.68		0.91	1.00	0.88	1.00	1.00		1.00		1.00		0.53		1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
34	0.98	0.90	0.98	0.72	1.00	1.00	0.91	1.00	0.94	1.00	0.98	0.99	0.42	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.93	1.00	1.00	1.00	

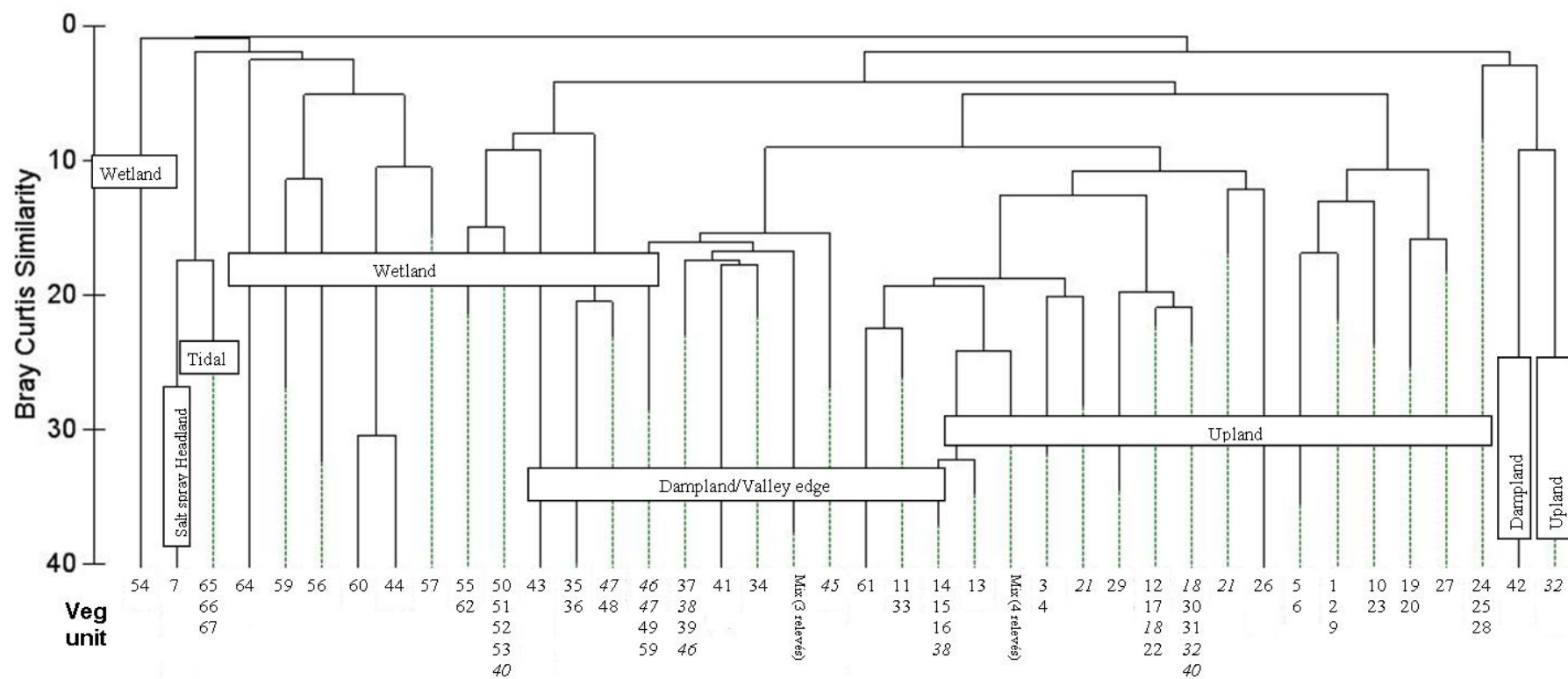
	42	61	62	35
61				
62				
35				
34	1.00	1.00	1.00	1.00



**APPENDIX 13: Comparison of percentage of relevés sampled per unit with percentage area of vegetation occupied by unit**



# APPENDIX 14: Dendrogram of comparative classification of relevés



## APPENDIX 15: Comparison of Beard (1979) Vegetation Associations with ARVS vegetation units

veg code	Beard Name	Digitized code	Digitized name	ARVS equivalent units to Beards written descriptions
e <sup>2</sup> <sub>3</sub> Mc	Jarrah Forest	3	Medium forest:Jarrah Marri	12,10,17
e <sup>2</sup> <sub>65c7</sub> Lc	Jarrah -sheoak low forest	978	Low Forest, Jarrah, E. staeri & Allocasuarina fraseriana	12,13,14, 31
e <sub>2</sub> Lc	Jarrah low forest	14	Low forest: Jarrah	
ecLc		994	Low forest: Jarrah and Casuarina probably A. fraseriana	
e <sub>1</sub> Tc	Karri tall forest	1	Karri Forest	9
aLi	Peppermint low woodland	22	Low Woodland: Agonis flexuosa	1,2,3,4,5
xZc	Heath	49	Shrubland: mixed heath	
aSZc	Scrub-heath on dunes	423	Shrubland: Acacia scrub heath unknown species	3, 5
xGc	Reed swamp	51	Sedgeland: reed swamps occasionally with heath	includes 36,39,46,47,52,59
mLc	Paperbark low forest	973	Low Forest Paper (Melaleuca raphiophylla)	52*
mLi	Paperbark low woodland	27	Low Woodland paperbark (Melaleuca sp.)	
k <sub>3</sub> Ci	Samphire	not mapped		66, 67
-	Rock outcrops	128	Bare rock	includes 24,25,

\* Beard does not mention *Melaleuca raphiophylla* in descriptions of associations within relevant vegetation systems

### Errors noted in the digitised version of Beard's Map

Several errors have occurred in the digitised format of Beard's map. Areas of "Samphire" at the mouth of the King River were not mapped, an area of "Scrub heath on dunes" in Gull Rock NP was wrongly ascribed to "Medium Woodland, Jarrah, Marri and wandoo" and two woodland mosaics were digitised as distinct units, (digitised codes 979 and 969). The mosaic nature of drainage lines in the north-west of the survey area is not reflected in Beard's digitised map, although there is difficulty in interpreting the original map as there appears to be some unit boundaries missing (Beard 1979).

**APPENDIX 16: ARVS vegetation unit comparison with smaller mapping projects within the ARVS context area**

ARVS Vegetation unit	Vegetation units in other mapping surveys within ARVS context area								
	Bakers Junction NR, Mill Brook NR Griffin 1985	Princess Royal & Oyster Harbour Pen 1995, & unpub.	WindFarm area Halpern, Glick, Maunsell 2000	Mt Martin Sandiford 2000	Two Peoples Bay Hopkins <i>et al.</i> unpub.	Nanarup, Emu Pt, Little Grove Hickman 2005a, 2005b, 2006	ITC Remnants Sandiford 2003-2006, unpub.	Yakamia area ENV Australia 2000	Bayonet Head Coffey Environments 2009
1		FF1	D3		T7	YW			
2		FF2	B2, B5	S9	T5, T7, T11	CPW, PT		•	
3			B1 C1 D1		S7, T9	DH, OPH			
4		•				SW, OPH, DH			
5		CF3, CS2	A1, A2, B3	S6	T11, T12, S3, S4, S10	OPH, PT, DH, PW			
6									
7						LZ			
8									
9									
10		FF4		T1					
11			D2						
12	3,4,5,6	•			T6	JMW, MW	•	•	•
13	8,10			T4		SW1, SW2, PW	•	•	•
14	9,10			S3	T15, T14	S3, BH	•		•
15									
16									
17				T2, S1	T8				
18									
19									
20									
21									
22				T3, S5					
23					T10				
24				R3	S12				
25				R1, S9					
26									
27									
28		•		R2					
29	7								
30									
31	1,2			S2					
32									
33									
34									
35					T7				
36		FF3		S4	S6			•	•
37	12								
38							•		
39	10,11,15			T5	?S13		•		•
40									
41									
42									

**APPENDIX 16 Cont. ARVS vegetation unit comparison with smaller mapping projects within the ARVS context area**

ARVS Vegetation unit	Vegetation units in other mapping surveys within ARVS context area								
	Bakers Junction NR, Mill Brook NR Griffin 1985	Princess Royal & Oyster Harbour, Pen 1995, & unpub.	WindFarm area Halpern, Glick, Maunsell 2000	Mt Martin Sandiford 2000	Two Peoples Bay Hopkins <i>et al.</i> unpublished	Nanarup, Emu Pt, Little Grove Hickman 2005a, 2005b, 2006	ITC Remnants Sandiford 2003-2006, unpub.	Yakamia area ENV Australia 2006	Bayonet Head Coffey Environments 2009
43							•		
44		CS4, CF2							
45					T4,				
46	13, 14				S6, V1			•	
47	14			S7,	S6, S13	LS, TS	•		•
48							•		
49	16						•		
50			E1	S8	T7, T12		•		•
51	15								
52	15				T13		•		
53									
54									
55							•		
56									
57		EF2			T13	PC			
58									
59			E1		T1, T2, T3	TS		•	
60		CF1							
61					T13				
62									
63									
64	17			T6	V3				
65		EF1-3							
66		R1-4, CS3							
67		B1, B2, S1.1 -1.4, S1-4							



## APPENDIX 17: Vegetation patterning within broad landform and geographic areas

Broad landform or geographic area	Vegetation pattern
Coastal dune system, Meerup landform unit (Churchward <i>et al.</i> (1988))	Higher areas contained a mosaic of Limestone Heath (5), Coastal Heath (4) Peppermint Low Forest (2), and less commonly <i>E. goniantha</i> / <i>E. angulosa</i> Mallee (6) with distribution of units appearing to be dependant upon soil pH and soil depth. Inland and downslope <i>Banksia ilicifolia</i> /Peppermint Woodland (5) occurred as a band interspersed with these units. On the lower and more protected slopes and flats overlying limestone pavements Coastal Yate Woodland (1), Peppermint Low Forest (2) and less commonly Coastal Heath (4) and Limestone Heath (5) formed mosaics.
Undulating low relief hills and valleys inland from the coast	A gradational sequence of units was evident. Jarrah/Marri/Sheoak Forest (12) occurred on crests and upper-mid slopes on shallow lateritic well drained soils, followed by Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland (13) on mid-low slopes on sandy soils overlying the laterite and <i>Banksia coccinea</i> Shrubland/ <i>Eucalyptus staeri</i> /Sheoak Open Woodland on deeper sands of the lower slopes and well drained valley floors. <i>Taxandria parviceps</i> Transitional Shrubland (38) and <i>Pericalymma spongiocaula</i> Low Heath (39) occurred on the valley floor edges at the transition zone from upland to wetland units, followed by a band of <i>Evandra aristata</i> Sedgeland/Shrubland (46), then <i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket (47) (peat soils) or <i>Melaleuca preissiana</i> Low Woodland (49) (sandy loams) along drainage lines. with <i>Melaleuca raphiophylla</i> Woodland Complex present along larger creek lines.
Coastal granitic hills overlying the Gardner landform unit (Churchward <i>et al.</i> (1988))	<i>Taxandria marginata</i> Granite Shrubland (24) and <i>Gastrolobium bilobum</i> / <i>Hakea elliptica</i> Granite Shrubland/Yate Woodland (23) commonly occurred on and around the granite exposures, with Marri/Jarrah Forest/Peppermint Woodland (10) present on lower damper slopes and Marri/Jarrah Coastal Hills Forest (17) and <i>Hakea</i> spp Granite Shrubland (22) present on lower, drier skeletal soils. Coastal <i>Banksia ilicifolia</i> /Peppermint Woodland (4), Jarrah Woodland (11) or <i>Banksia coccinea</i> Shrubland/ <i>Eucalyptus staeri</i> /Sheoak Open Woodland (14) occurred on pockets of deep sand on these slopes
Plains in the north east of the survey area overlying spongelite	Jarrah/Marri/Sheoak Forest (12) occurred on the higher lateritic rises and formed a mosaic with Eastern Jarrah/Sheoak Woodland (30) and the woodland form of <i>Hakea</i> spp Shrubland/Woodland Complex (31) on lower slopes and small rises. On the skeletal soils of flatter areas <i>Taxandria spathulata</i> Heath (32), Takalarup Damp Heath (40), shrubland forms of <i>Hakea</i> spp Shrubland/Woodland Complex (31) and <i>Melaleuca densa</i> Swamp Heath (55) formed mosaics. .
South western hills (primarily Keystone landform unit)	A gradational sequence of units was evident with Karri Forest (9) present on the summits and upper slopes followed by Marri/Jarrah Forest/Peppermint Woodland (10) on the mid slopes, Jarrah Woodland (11) on lower slopes with <i>Eucalyptus patens</i> Low Woodland (33) at valley edges.
Western flats	Several wetland units occurred in complex mosaics including <i>Melaleuca cuticularis</i> / <i>M. preissiana</i> Open Woodland (52), <i>Kunzea recurva</i> / <i>Petrophile squamata</i> Wet Shrubland (53), <i>Melaleuca spathulata</i> / <i>Melaleuca viminea</i> Swamp Heath (54), <i>Melaleuca densa</i> Wet Heath (55) and <i>Melaleuca raphiophylla</i> Woodland/Low Forest Complex (57) with Marri/Jarrah Forest/Peppermint Woodland (10) common on the rises
Bettys Beach	<i>Taxandria marginata</i> Granite Shrubland (24) and <i>Gastrolobium bilobum</i> / <i>Hakea elliptica</i> Granite Shrubland/Yate Woodland (23) occurred on and around the granite exposures, with Gardner/ <i>Hakea</i> spp Shrubland (18) present on the upper slopes, Marri/Jarrah Coastal Hills Forest (17) in gullies, <i>Hakea</i> spp Shrubland/Woodland Complex (31) and <i>Banksia coccinea</i> / <i>Melaleuca striata</i> / <i>Leucopogon flavescens</i> Heath (15) on the mid- lower slopes and <i>Hakea elliptica</i> Shrubland/ <i>Eucalyptus doratoxylon</i> Mallee (19), <i>Melaleuca viminea</i> Granite Thicket (27), <i>Eucalyptus goniantha</i> Mallee (20) and Coastal Shrubland Complex (21) on the lower slopes. Three units were only recorded in this area: Gardner/ <i>Hakea</i> spp Shrubland (18), <i>Hakea elliptica</i> Shrubland/ <i>Eucalyptus doratoxylon</i> Mallee (19) and <i>Melaleuca viminea</i> Granite Thicket (27) with a further two units <i>Banksia coccinea</i> / <i>Melaleuca striata</i> / <i>Leucopogon flavescens</i> Heath (15) and <i>Eucalyptus goniantha</i> Mallee (20) only occurring in the eastern areas of ARVS survey area.
Estuarine fringes	A gradational sequence of units was evident along the estuarine fringe with Coastal Saltmarsh (67) occurring on the upper margins of tidal flats followed by <i>Juncus kraussii</i> Sedgeland (66) and Coastal <i>Melaleuca cuticularis</i> Low Forest (65) on the landward fringe.



