WILSON INLET CATCHMENT COMMITTEE

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LINDESAY LINK PROTEACEOUS VEGETATION SURVEY

Australian Government

SOUTHCOAST NATURAL RESOURCE MANAGEMENT INC.

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Disclaimer

Every effort has been made to ensure the accuracy of the information provided, however I do not accept responsibility for any omissions or errors or in how this information is used subsequently by others.

Cover photo

The flowering and fruiting prostrate Banksia gardneri.

Introduction

The Lindesay Link Proteaceous Survey was commissioned by the Wilson Inlet Catchment Committee to help inform strategic planning and actions to progress the implementation of the Lindesay Link Nature Conservation Plan (NCP). The Lindesay Link NCP forms part of the broader conservation initiative known as the Gondwana Link which aims to protect and restore ecological resilience to a 1,000 km stretch in south-western Australia "from the wet karri forests in the far south to the mallee and woodland on the edge of the Nullarbor Plain to the east" (WICC, 2013, p.2).

The Lindesay Link NCP focus area stretches approximately 70 km from the Walpole Wilderness Area (Mt. Lindesay National Park) in the west to the Porongurup Range National Park in the east. The aim of this plan is "to maintain and improve the distinctive nature of our landscape including native bush, wildlife and healthy waterways co-existing with a productive & vibrant rural and farming community" (WICC, 2013, p. 1).

The Lindesay Link NCP has interlinked conservation targets – with species that have similar management requirements nested together under relevant targets – to manage the enormous complexity of biodiversity conservation planning and actions. Of particular interest for this survey are the proteaceous plants and their importance for Environment Protection and Biodiversity Conservation (EPBC) listed species such as Carnaby's Cockatoo (*Calyptorrhynchus latirostris)*, Baudin's Cockatoo (*Calyptorrhynchus baudinii)* and the Forest Red-tailed Black Cockatoo (*Calyptorrhynchus banksia naso*). Proteaceous plants are nested under the Conservation Targets: Honey Possums, Jarrah and Marri Forest and Albany Blackbutt in the Lindesay Link NCP (WICC, 2013).

The purpose of this proteaceous vegetation survey is to build knowledge of proteaceous plants and the areas and communities in which they occur, and describe threats and management recommendations to help protect and enhance these communities. As described by Hopper (1994b, 1997), recognising and naming species and ecological communities is required to understand their needs and design appropriate management strategies.

The area of the Lindesay Link with the highest rainfall occurs to the west and south of the link. This area is primarily native forests, with some plantation forestry, viticulture and agriculture. Moving north, there is more farmland relative to bushland with mainly mixed and broadacre farming (livestock and grain cropping).

Included in this report are maps showing survey locations and distribution of vegetation units, methods, limitations, results and discussion of results. Also included are the vegetation survey recording sheet template used in this survey (Appendix 1); condition and structural classification systems used (Appendix 2); species list of vascular plants recorded overall listed by family (Appendix 3); floristics (two-way table) (Appendix 4); relevé data sheet results (excluding species that occur less than three times or occupy <5% of the relevé) (Appendix 5), descriptions of vegetation units derived from floristics data (Appendix 6) and photographs of proteaceous species included in the overall species list (Appendix 7).

1.1 Area and location of sites

Locations of reserves where surveys were carried out all occur within the Plantagenet Shire (Figure 1). Shire Reserves surveyed include Mondurup Reserve (Reserves 27185 and 27189), located to the south of Muir Highway; Narrikup Reserve (Reserve 25638), located south of Narrikup and west of Narrikup Chorkerup Rd;

Reserve 12266 located to the south of Denbarker Rd; Reserve 15986 located on the east and west of Barrow Rd. Department of Parks and Wildlife managed Lake Barnes Nature Reserve (Reserve 14493) located to the west of Lake Barnes Rd was also included in the survey effort.

1.2 Geology

The context area is underlain by the Albany-Fraser Oregon composed of Proterozoic age (1200 to 1800 million years ago) gneissic and granitic rocks. Slumping of the south coast after Antartica began to separate from Australia about 100 million years ago, caused the sea to cover the low-lying parts of the area, when the Stirling Range and Porongurups were islands. Silt and spongolite (Pallinup Siltstone) was deposited under the sea and swampy sediments (Werrilup Formation) were deposited in low lying areas (RAP & SCRIPT, 1996). Uplift and warping associated with the down-warps of the southern edge raised the land and caused faulting and shearing of the basement rocks, the rejuvenation of drainage lines and the formation of new surfaces along the ancient river systems (Mulcahy, 1960). Lateritisation occurred in the Tertiary (about 30 million years ago) (RAP & SCRIPT, 1996, p. 10).

The land surface of the context area is now a plain composed of sand and laterite that slopes gently south to the coast from the base of the Stirling Range, formed from the weathering of sediments and wind-blown sands over time. The lower parts of the plain are “broad, flat valleys containing lakes, sand dunes and erosional remnants of lateritized continental sandstone, Eocene spongolite and fossil wood”, drained at the southern edge by the headwaters of the Hay and Kalgan Rivers. “Above the plain project monadnocks of fresh granite and gneiss which were once islands of the Plantagenet Sea. The highest mondanocks include the Porogurup Range (up to 670 m) and Mount Barrow (486 m)” (Muhling *et al.* 1985, p. 2).

1.3 Climate

The climate is Mediterranean, with generally cool and wet winters and warm to hot, dry summers. Mt Barker has an average rainfall of 726 mm. The wettest months are May to October. Average monthly winter rainfall is 96 mm and average monthly summer rainfall is 25 mm. Average minimum and maximum summer temperatures are 12°C and 25°C and average winter minimum and maximum temperatures of 6 °C and 15 °C respectively. Frosts are most likely to occur from June to September (Bureau of Meterology, 2015). Climate statistics are shown in Table 1.

Table 1: Climate statistics for Mount Barker (Source: Bureau of Meterology, May 2015)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	26.3	26.1	24.2	21.3	17.8	15.3	14.4	15.1	16.8	18.8	21.9	24.2	20.2	96	1905 2015
Mean minimum temperature (°C)	12.8	13.1	12.4	10.7	8.8	7.1	6.1	6.1	7.0	8.1	9.9	11.4	9.5	96	1905 2015
Rainfall															
Mean rainfall (mm)	23.1	23.8	36.2	54.4	82.7	94.5	103.3	88.7	79.4	68.8	42.7	29.4	726.1	128	1886 2015
Decile 5 (median) rainfall (mm)	14.6	16.0	26.6	44.8	74.3	87.7	100.4	84.6	76.6	63.7	35.1	24.9	725.4	108	1886 2015
Other daily elements															

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Mean number of clear days	8.5	6.9	5.7	3.6	4.1	3.8	3.7	3.9	2.9	3.2	4.6	6.4	57.3	39	1957 2009
Mean number of cloudy days	9.5	9.7	11.6	12.7	13.4	12.0	13.0	13.2	13.1	15.2	13.3	10.6	147.3	39	1957 2009
9 am conditions															
Mean 9am temperature (°C)	19.2	19.0	17.9	15.5	13.1	10.7	9.7	10.3	11.9	13.9	16.2	17.9	14.6	40	1957 2010
Mean 9am relative humidity (%)	67	69	73	78	82	86	87	85	81	74	69	66	76	29	1957 2010
Mean 9am wind speed (km/h)	9.3	9.5	9.0	7.8	7.6	9.0	8.9	9.3	10.8	10.0	10.8	9.7	9.3	37	1957 2010
3 pm conditions															
Mean 3pm temperature (°C)	24.5	24.5	22.9	19.9	17.1	14.4	13.4	13.9	15.1	17.3	20.0	22.3	18.8	39	1957 2009
Mean 3pm relative humidity (%)	51	51	53	59	65	71	73	69	68	62	57	54	61	28	1957 2009
Mean 3pm wind speed (km/h)	12.6	12.2	11.1	9.6	9.4	11.2	11.0	11.6	12.1	11.1	12.5	13.1	11.5	35	1957 2009

red = highest value blue = lowest value

1.4 Vegetation

Vegetation systems that are represented in the area of the Lindesay Link include the Kwornicup System, Hay System and Narrikup System, occurring in the Menzies Subdistrict of the Darling Botanical District of the South West Botanical Province (Beard, 1979). The upper reaches of the Hay River are located within the eastern end of the Kwornicup System. This system is generally poorly drained swampy plain. Jarrah (*Eucalyptus marginata* ssp. *marginata)*/Marri (*Corymbia calophylla)* forests dominate with patches of Jarrah, low forest paperbark (*Melaleuca preissiana*), and rush (commonly *Baumea articulata)* swamps. In swampy areas, Yate (*Eucalyptus cornuta)*, Swamp Yate (*Eucalyptus occidentalis*) and Wandoo (*Eucalyptus wandoo*) may also be present in the forest. The Narrikup System covers a laterite plain and includes the Narrikup and Mt Barker areas. This system is predominantly Jarrah/Marri forest with small patches of Banksia woodland occuring on sand with Swamp Yate occurring along creeklines. The Hay System contains most of the Hay River Basin with Jarrah/Marri forest on the upper slopes and ridges, Jarrah/Sheoak (*Allocasuarina fraseriana)* low forest on lower slopes and swamps in the valley bottoms. Swamps consist predominantly of rushes with scattered shrubs (SCRIPT, 1996).

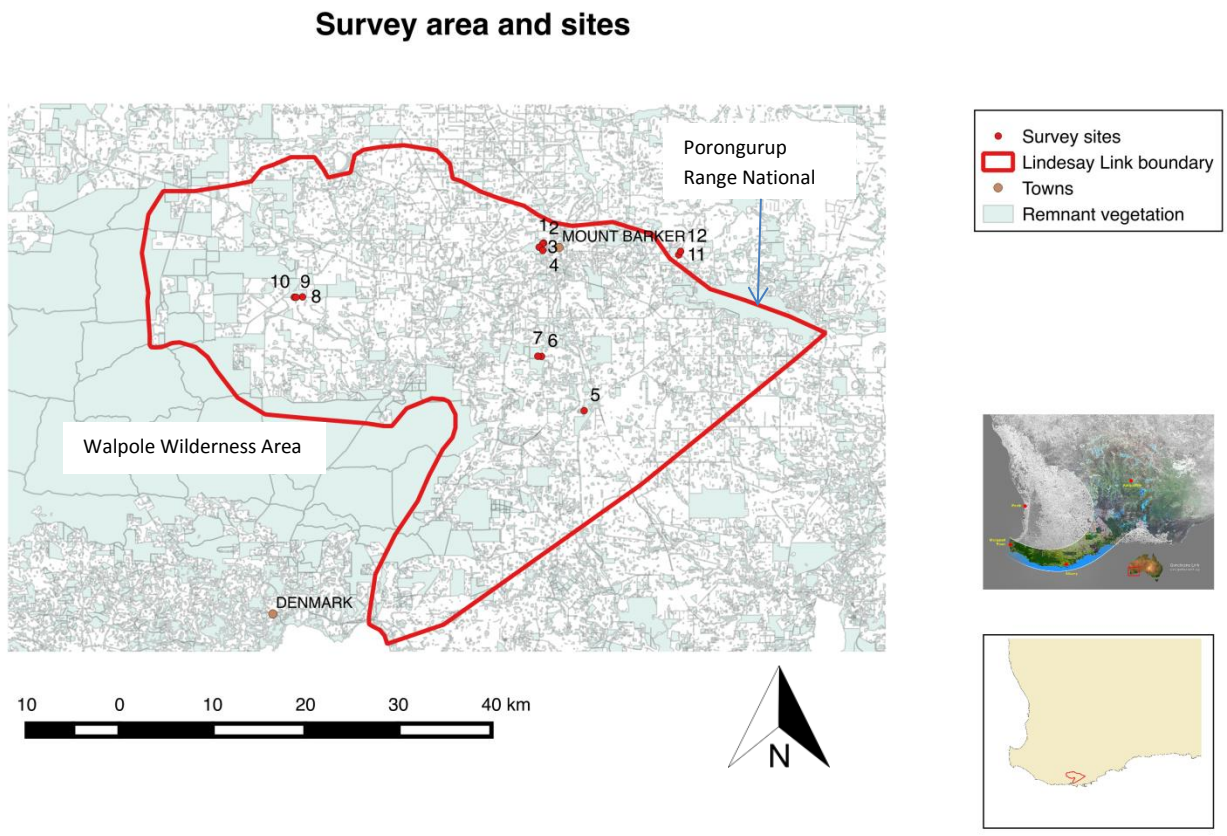


Figure 1: Survey area and location of survey sites

2. Method

Shire Reserves were the primary target for undertaking surveys, supplemented by one Department of Parks and Wildlife Reserve with the aim of capturing known varieties of landform and broad vegetation types within or close to the Lindesay Link boundary identified in the Lindesay Link NCP (Figure 1). Survey sites (relevés) 11 and 12 located in Reserve 15986 on Barrow Rd were just outside the boundary of the Lindesay Link – located to the east of Mount Barker – but still within a reasonable buffer area of the boundary to be relevant to this study. Reserves targeted to undertake survey work were identified through a process of collaboration with local banksia expert Kevin Collins, Department of Parks and Wildlife Conservation (DPaW) Operations Graphic (maps) (2014), and GIS mapping to locate Plantagenet Shire vested/managed reserves by WICC Project Officer Shaun Ossinger. Vegetation surveys were carried out over a period of three days between 29 October, 2015 and 3 March, 2016. An additional day was spent searching for the threatened species *Lambertia orbifolia* at Lake Barnes Nature Reserve.

Due to time constraints, it was not possible to undertake systematic traverses of remnants to ensure thorough capture of variation of relevant vegetation communities. Aerial photographs were used to identify variations in vegetation cover and landscape topography. Proteaceous vegetation survey sites were identified while undertaking a rapid reconnaissance of reserves where accessible by driving on tracks or on foot targeting variations of vegetation as shown in aerial photographs. Survey sites at Mondurup Reserve were identified by Kevin Collins who has intimate knowledge of locations of important proteaceous species within the reserve. The criteria for proteaceous survey site identification was to capture variation of proteaceous composition and structure to broaden our understanding of the diversity of proteaceous plants as well as their level of dominance but not just dominance alone.

The relevé survey method was used. The relevé method has been shown to be an effective rapid survey method rather than marked quadrats where every species is recorded. Although marked quadrats contain more data, they are a lot more time consuming and would compromise the number of surveys being able to be undertaken in the time available. The relevé method was used for the Ravensthorpe Range (Craig et al. 2008), the Albany Regional Vegetation Survey (Sandiford & Barrett, 2010), Proteaceous Rich Vegetation Survey in the Forest to Stirlings section of the Gondwana Link (Sandiford, 2012), and for the Ranges Link Survey (Bradshaw, 2013, 2014 and 2015).

Site data (Appendix 5) recording methods as per relevé reporting template (Appendix 1) include:

- Structure using standardised height and cover classes, composition, percent cover and species dominance in each stratum for each relevé area. Rules governing inclusion of species in site data are that they are required to either project at least 5% canopy cover or be represented by at least three individuals in the relevé area to be included. If not, they are listed at the bottom as 'other species' and are included in the overall summary of species but not used in site data.
- Relevé area for trees, mallees and shrubs >2m in height strata are taken over an unmarked 20 x 20 m area and the remaining strata are recorded from an unmarked 10 x 10 m plot;
- Photographs and GPS waypoints were taken from a corner of each relevé. Vegetation structure was determined using Keighery (1994), adapted from Muir (1977) and Aplin (1979). Condition was determined using Keighery (1994) modified from Trudgen (1991) (Appendix 2).
- Site attributes including visual assessment of soil colour and texture to a depth of 10 cm, geology, percentage surface rock, land form, hydrology and drainage status were recorded, where known, as per relevé sheet (Appendix 1).

Samples of species that could not be identified in the field were collected, given a unique identifiying name, and pressed for identification. Where possible, all species that could not be identified in the field were identified through cross referencing between Department of Parks and Wildlife Florabase website, relevant plant identification keys/reference books, and the Albany Herbarium. Plants that were not able to be identified to species level were identified to genus level where possible. The genus of *Lepidosperma* is currently being revised with a large number of new species being named (pers. comm. E. Sandiford). *Lepidosperma* species are therefore given a number instead of species name.

2.1 Limitations

This survey builds from existing vegetation survey work that was carried out in the Narrikup Reserve in 2012 (Bradshaw, 2012) which described a number of vegetation associations with proteaceous species not covered again in this survey due to resource constraints. For example, the *Eucalyptus staeri* open woodland and low open woodland associations which were not surveyed again in this effort. Proteaceous species that were not included in floristic data in this report that were recorded with *Eucalyptus staeri* associations include *Banksia coccinea* and *Banksia quercifolia.* This report should be viewed together with the Narrikup Report for a more comprehensive understanding of the different proteaceous vegetation communities that occur in the Lindesay Link.

Vegetation units have been formed based on limited sampling rates (three units (Units 1, 2 and 5) are formed from one survey site each) – meaning that these units are indicative only and likely to be expanded/changed in some way with further surveying. It also should be noted that no surveys in this or the 2012 survey were undertaken in the Karri and Wandoo Outliers target.

Soil and hydrology data was assessed briefly and subjectively and thus any conclusions regarding these attributes need to be treated with caution. Not all species could be identified to species level due to lack of flowering/fruiting matieral or current taxonomic uncertainties. Also the Albany Herbarium does not have a complete collection of flora from the area and some specimens in the herbarium are likely to be incorrectly named (pers. comm. E. Sandiford).

3. Results

Twelve sites (relevés) were surveyed from a total of five reserves comprising four sites at Mondurup Shire Reserve, 1 site at Narrikup Shire Reserve, 2 sites at Lake Barnes Nature Reserve, 3 sites at Shire Reserve 12266, and 2 sites at Shire Reserve 15986 (Figure 1). A total of 220 native vascular species were recorded representing 34 families (Appendix 3b). Of the 220 native species, the Proteaceae family had the greatest species diversity (41 species), followed by Fabaceae (34 species), Myrtaecae (22 species), Ericaceae (12 species), and Restionaceae (11 species). The remaining 29 families were represented by less than 10 species each. As described in the methods section, only species recorded three or more times or having a minimum of 5% canopy cover in relevés were used in the dataset (2-way table floristics, shown in Appendix 4). The number of species recorded in the dataset was 206. There were no sightings of the threatened species *Lambertia orbifolia*. Priority species recorded include *Banksia sphaerocarpa* var. *latifolia* P2, and *Banksia porrecta* P4, recorded only in survey sites at Mondurup Reserve.

Following analysis of field observations and quantitative analysis using a two-way table, vegetation associations from relevés (survey sites) were grouped to common landscape positions, hydrological conditions and key vegetation structural and species dominance characteristics to develop indicative vegetation units. It is acknowledged that one relevé site (as in Units 1, 2 and 5) is inconclusive information on which to form units and these are formed as a basis from which to build – with the understanding that they may change once more knowledge is gained and is why they are described as indicative. The location of the vegetation units is shown in Figure 2. Data for each relevé is shown in Appendix 5. Detailed descriptions of vegetation units are shown in Appendix 6.

Following is a summary of the five vegetation units determined from relevé data, listed by landform and soil type, with vegetation associations included where more than one relevé included in the unit:

1. **Drainage depression on sand:**
   Melaleuca preissiana Low Open Woodland/*Hakea varia* Open Heath (Mpre, Relevé 6)

2. **Deep well drained sand:**
   Banksia attenuata/Banksia illicifolia Low Woodland (Batt/Bill, Relevé 7)

3. **Gullies, flats to lower slopes**
   Jarrah/Marri Forest (Ccor/Emar, Relevés 8, 9, 10, 11, 12)
   Includes the following vegetation associations:

   Relevé 8: *Corymbia calophylla/Eucalyptus marginata* open forest over *Hakea florida/Taxandria parviceps* shrubland

   Relevé 9: *Corymbia calophylla/Eucalyptus marginata* open forest over mixed shrubland

Relevé 10: *Corymbia calophylla/Eucalyptus marginata* open forest over *Banksia grandis/Bossiaea linophylla* open shrubland

Relevé 11: *Corymbia calophylla/Eucalyptus marginata* woodland over mixed shrubland

Relevé 12: *Corymbia calophylla/Eucalyptus marginata* open forest over *Bossiaea linophylla* tall open scrub

4. **Loamy/gravelly soils on laterite on slopes:**
   Jarrah Open Forest (Emar, Relevés 1, 2, 4, 5)
   Includes the following vegetation associations:

   Relevé 1: *Eucalyptus marginata* open woodland over *Allocasuarina fraseriana* low open woodland over *Eucalyptus marginata* open mallee over *Agonis theiformis* shrubland

   Relevé 2: *Eucalyptus marginata* very open mallee over *Allocasuarina humilis* open heath

   Relevé 4: *Eucalyptus marginata* mallee over *Hakea trifurcata* open heath with emergent *Corymbia calophylla*

   Relevé 5: *Eucalyptus marginata* open forest over *Nuytsia floribunda* low open woodland over *Hakea trifurcata* tall open shrubland

5. **Granitic clay loam on upper slopes:**
   Moit Very Open Mallee/*Daviesia horrida* Open Heath (Edec, Relevé 3)

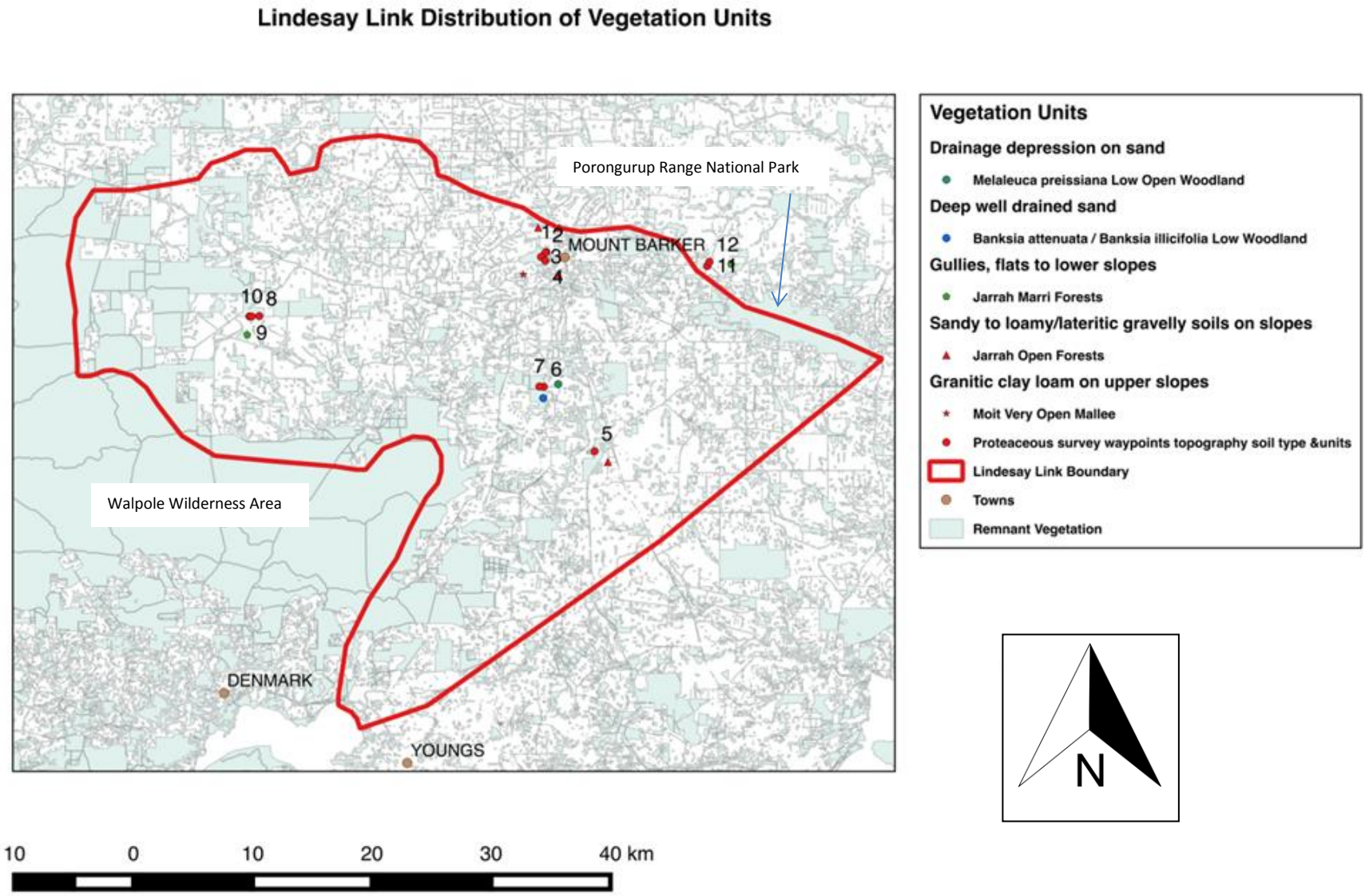


Figure 2: Distribution of Lindesay Link vegetation units

3.1 Condition

All survey sites were in excellent to pristine condition, with intact native vegetation. One invasive weed – *Acacia longifolia* – was recorded mostly as young specimens and in low numbers at Lake Barnes Nature Reserve in the vicinity of coordinates S34.73552 and E117.64794. A small area that appeared to be affected by *Phytophthora* dieback was also observed at Lake Barnes Nature Reserve in the vicinity of S34.728233° and E117.64275° near a graded firebreak. Fire was a major disturbance – observed in the Mondurup Reserve with sites 1, 2 and 3 being burnt four years ago (pers. comm. K. Collins). Some of the recently burnt sites are now predominantly Jarrah Mallee rather than Jarrah Forest. These sites have been classified in the Jarrah Open Forest unit because of the disturbance factor – based on the assumption that if allowed to grow to maturity this vegetation would be expected to grow into a Jarrah Open Forest as it is similar in composition to the recently unburnt site surveyed at Narrikup Reserve (Relevé 5).

Of great interest was the finding of what appear to be quenda (*Isoodon obeselus)* diggings at the Barrow Rd Reserve (Figures 3 and 4). This was the only recording of fresh diggings of this nature at any of the sites.

Figure 3: Conical diggings resemble quenda diggings

Figure 4: Close up of conical digging

4. Discussion

Due to the small sampling size of this survey effort, sites were prioritized to build on earlier survey work carried out in the Narrikup Reserve for the Wilson Inlet Catchment Committee (Bradshaw, 2012). All six of the vegetation associations described in Bradshaw (2012) recorded proteaceous species dominance in at least one stratum. A range of structural variations of *Eucalyptus staeri* low to open woodlands in particular were covered in the 2012 survey and not included in this survey at all. It is suggested that a valuable exercise in the future would be to amalgamate the two sets of data to enable a more complete picture of vegetation units to be determined for the study area. In addition, the proteaceous communities that occur in Karri Forest and Wandoo Woodlands need to be surveyed as they have not been covered at all in this survey.

While acknowledging that vegetation communities with different proteaceous species were targeted in this survey, it is interesting to note that the species richness (number of species) represented from the Proteaceae family was also greatest in the survey carried out in the Narrikup Reserve (Bradshaw, 2012) when the target was to capture different vegetation associations without a focus targeting proteaceous

species. Seventeen of the 40 proteaceous species recorded in this survey were recorded as dominants in at least one relevé each (Appendix 4).

Key differences in proteaceous species between different reserves were that four Grevilleas were recorded at Mondurup Reserve, of which only one species (*Grevillea depauperata)* was recorded elsewhere. Mondurup Reserve was also a hot spot for priority species, with *Banksia sphaerocarpa* var. *latifolia* P2, and *Banksia porrecta* P4, recorded only in survey sites at this reserve.

A gradational change of species composition between different units was recorded, as shown in the floristics (Appendix 4). The species composition of the lower landscape Jarrah/Marri Forest (Unit 3) has most commonality of species composition with other units – it would appear likely that this is because Unit 3 is located intermediate between the moist drainage depression (Unit 1: *Melaleuca preissiana* Low Open Woodland) and deep sand (Units 2: *Banksia attenuata/Banksia illicifolia* Low Woodland) and the upper landscape Jarrah Open Forest (Unit 4) and granitic clay loam Moit Very Open Mallee.

As would be expected with a common dominant upper storey species (*Eucalyptus marginata),* there was considerable commonality of species between the jarrah vegetation unit and jarrah/marri unit, with proteaceous species such as *Persoonia longifolia, Isopogon attenuatus, Banksia lindeyana* and *Hakea trifurcata* recorded in both units. Variation in soil types and landscape positions accounted for key differences in proteaceous composition, such as *Banksia littoralis* with *Hakea varia* dominant shrub stratum species on damp peaty sand depressions, and *Banksia attenuata* and *Banksia illicifolia* on deep sand plain.

The richness of proteaceous species in the Plantagenet Shire is exemplified with the Banksia Atlas distribution of banksia species prior to the amalgamation of the Dryandra genus with the Banksia genus (within a 50 km radius of the township of Mount Barker) totalling 24 species. This number of proteaceous species is six higher than any other town for the same area within Australia (pers. comm. K. Collins). Inclusion of Dryandra into the Banksia genus would greatly enhance the richness of Banksia species occurring in the Plantagenet Shire.

A key factor determining the abundance of proteaceous species in the study area appears to be that proteaceous species are known to prefer phosphorus-deficient soils that are characteristic of sand and gravel which are also the soil type on which jarrah and marri are commonly found. As described under Vegetation in 1.4, Jarrah and Marri based vegetation communities – which are represented in three quarters of the sites surveyed in this study – are widespread in the area of the Lindesay Link. The predominance of proteaceous species in this and the 2012 survey indicate that these species play key structural and functional roles in maintaining the respective ecosystems in which they occur – as is reflected by their inclusion as nested targets under three targets of the Lindesay Link NCP.

4.1 Lindesay Link targets and proteaceous plants

The three species of black cockatoo are nested under the Jarrah and Marri Forest target in the Lindesay Link NCP. Black cocaktoos feed on seeds of proteaceous species generally – and Banksias are a particularly valuable food source for these species because they are rich in protein (pers. comm. C. Bartron). It is less commonly known that cockatoos are highly skilled at eating grubs out of banksia flowers after the banksia moth lays its eggs on flower buds. Cockatoos also predate bardi grubs and borers living under bark of Banksias, Marri and within recently dead Xanthorrhoea species. Red-tailed Black Cockatoos prefer eucalypt seeds and frequent Marri and Jarrah. White-tailed Black Cockatoos predate on seeds of Marri,

Xanthorrhoea platyphylla/preissii & many Hakea species. White-tailed Black Cockatoos time collecting seeds out of banksia cones, just before they are mature so they can remove seeds prior to the follicles going hard. Once seed cones are mature and very hard the cockatoos leave them alone due to the unsustainably lengthy time constraints to get a feed (pers. comm. K. Collins - observations).

Honey Possums are another target where proteaceous species are nested in the Lindesay Link NCP – where proteaceous species are particularly mentioned as a food source during the autumn and winter food gap. Due to the high proteaceous species composition of the Jarrah and Marri Forest and Albany Blackbutt (*Eucalyptus staeri)* and Banksia Woodland targets, these targets have high importance for the Honey Possum target.

4.2 Management Issues and Recommendations

Threats to targets are listed in the Lindesay Link NCP. This discussion picks up on a few that are of particular interest in context of utilising the information gained through this report for implementation purposes in relation to vegetation communities rich in proteaceous species. These include: disease including Marri canker, *Phytophthora* dieback, inappropriate fire regimes, fragmentation and climate change.

4.2.1 Marri Canker

Marri canker is caused by a fungal infection that is believed to be endemic on Marri in the South West which has increased in incidence and severity in the last decade. A strong healty tree in a normal functioning forest ecosystem should be able to defend itself against the fungus, but when under stress away from the support of a healty ecosystem are more vulnerable to harm. Once a limb or trunk is ringbarked by the fungus, it will die. Researchers at Murdoch University are studying the role played by beneficial symbiotic mycorrhizal fungi to help Marri access nutrients not otherwise available. The roles of fertiliser, pesticides and herbicides and changes to pH may also be implicated (Kennedy, 2014).

4.2.2 Phytophthora Dieback

Phytyphthora dieback infection is chronic on the South Coast of Western Australia (pers. comm. E. Edmonson, 2012). Over 40% of native plant species in the Southwest of Australia Ecoregion are susceptible (Shearer et al., 2004). Most species in the Proteaceae family are susceptible to *Phytyphthora* dieback. Three proteaceous species that have been tested through field observations to be resistant to *Phytophthora* Dieback that were recorded in this survey include *Hakea lissocarpha, Hakea corymbosa* and *Hakea amplexicaulis* (Groves et al, n.d.). References for hygiene guidelines that should be strictly followed are available on the web from the Dieback Working Group (2008).

A small area of what appeared to be dieback infection as indicated by a pattern of fresh deaths was noted along the track into Ongerup Lagoon Nature Reserve (not formally surveyed for this report) which is a proteaceous rich bushland of Jarrah/Marri forest on sandy soil with *Banksia attenuata, Banksia quercifolia, Adnenathos cuneatus, Adenanthos obovatus* and *Persoonia longifolia* present in the tree and shrub strata,

all of which are vulnerable to this disease. It is known that there areas area of infection in the Mondurup Reserve as a *Phytophthora* dieback survey of this reserve was conducted in 2012 (pers. comm. K. Collins). As described in the results section, a small area of what appears to be *Phytophthora* dieback was also noted in the Lake Barnes Nature Reserve.

A management plan prepared by the friends of Mondurup Reserve has been adopted and all relevant parties have supported changes to reduce spread and educate users about *Phytophthora* dieback.

A link between increasing vulnerability to *Phytophthora* dieback linked to deliberate application of frequent cool fires instead of occasional high temperature fires – which are acknowledged in the reference to cause thousands of dollars of damage to property and endanger human lives – has been documented by Buchanan (1999, pp. 51-52), as follows:

> It appears that frequent cool fires encourage mycorrhizal associations with soil fungi which do not offer as much protection as mycorrhizal associations in the leaf letter. Infrequent hot fires allow leaf litter to build up and this type of association to form. It also seems that these cool, frequent fires encourage other species of plant which are susuceptible to *Phytophthora,* thus allowing the disease to build up in high densities. Hot fires encourage *Phytophthora*-resistant species. The change of fire frequency and temperature has certainly helped this epidemic of dieback from fungal disase in Western Australia.

While not within the scope of this report to do so, it would be interesting to explore more deeply the exact meaning of the claims made by Buchanan (1999) and how they are currently viewed in the broader context of the science community involved in trying to better understand this serious disease.

4.2.3 Fire

Species that require fire to regenerate, don't have long-lived seeds in the soil seed bank, and don't resprout after fire (obligate seeders from canopy such as oak-leaf banksia (*Banksia quercifolia*)) – are particularly sensitive to inappropriate fire regimes. For these types of species, too little fire and fire too often are both threats. Regeneration needs to occur before the seed stored in the canopy of dead or senescent plants is dessicated or predated by insects and then not to burn again until mature or the species will be lost. It is important that bushland that has been burnt is not burnt again until the slowest maturing species have reached maturity and set viable quantities of seed.

To give the bush the best chance of successful reproduction, the time between fires should be about twice as long as the time to maturity of the slowest growing seeders (Hussey & Wallace, 1993, p. 150). Timing of fire is also important. Hussey and Wallace (1993, p. 142) conclude that autumn burning is recommended for most regeneration burns, especially where regrowth of coloniser species such as wattles and peas are targeted. It is also important to have rabbit and kangaroo populations that are likely to graze on any regeneration after the fire managed to a level where they will graze out regenerating plants.

Ideally, vegetation mapping of key remnants would be a valuable tool to approach the science community to seek support such as academics/agency staff and other stakeholders to create and implement a management plan to deal with the challenging issue of appropriate fire regimes in unmanaged remnants. The Friends of the Mondurup Reserve in conjunction with the Shire and other stakeholders have a fire management plan in place for Mondurup Reserve. Due to the complexities inherent in managing fire in natural ecosystems, monitoring of the effects of the fire regime on key indicators of forest ecosystems is an important part of such a plan to inform adaptive management if needed.

4.2.4 Connectivity and Climate Change

Increasing extreme weather events associated with a warming and drying climate are major threats to natural ecosystems. Making the most of the rain that falls and buffering edge effects of small remnants are important strategies to achieve to try to buffer these threats. Anecdotes from early settlers/explorers in the South West reported that digging small mammals such as woylies and bandicoots (quenda) 'swarmed across the landscape' (pers. comm. M. Garkakalis). Research over a period of years in the Dryandra Forest at Narrogin into the effects of woylie diggings on water repellence found that the area of the digging created preferential water flow and sped up cycling of nutrients (Garkakalis et al, 1998, 2003, 2004), thus enhancing the progression of ecological successional processes. Woylies and quenda are also known to eat fungi and thereby also play the important ecological role of spreading spores through their scats. Ninety percent of the diet of woylies is fungi (pers. comm. Katrina Syme). Mycorrhizal fungi species have symbiotic relationships with native plants which assist with providing nutrients to the plants in exchange for photosynthate material (Bougher & Syme, 1998).

Clearly targeting woylie population re-establishment is not an option at this point in time for the Lindesay Link area as woylies are fighting for their very existence. However, the possible presence of quenda in the Barrow Rd Reserve presents an opportunity for targeted infra-red camera monitoring as a basis for ongoing conservation planning for revegetation to link and expand their habitat if proven to be in existence. The quality of the bushland in which they appear to be living (Figure 5) shows quite a dense understorey, most obviously of shrubs and dryland sedges (Restionaceae family) and possibly tussock grasses such as *Poa drummondiana*. The author has observed that dense understorey is a pre-requisite of quenda population persistence without fox/cat baiting.

Efforts to undertake connectivity to enable expansion of habitat of ecosystem engineers such as quenda (Soule et al, 2004) therefore must achieve dense understorey without which the critical weight mammals (0.5kg-5kg) are highly vulnerable to predation from introduced predators. This is particularly easy to achieve in moist areas by direct seeding/replanting dense stands of commonly-occurring rush and sedge species are that are easy to propagate from seed. Also, robust clumping grasses that occur in the area, such as the salt tolerant *Austrostipa juncifolia* in wet/damp areas and *Poa drummondiana* in drier areas could be considered to be established from seed and/or seedlings. Among many other species/families, *Banksia grandis* is a good species in the Proteaceae family to target for connectivity because it is common and grows on a range of sandy and lateritic soils (pers comm. K. Collins). The principle of selecting diversity of species should always be strived for revegetation. Seed and/or seedlings from all strata of representative vegetation communities that match soil type and landscape position should be targeted for building landscape connectivity to maximise biodiversity outcomes. Expertise is required to manage the complexities involved with revegetation that aims to maximise biodiversity outcomes.

Figure 5: Bushland adjacent to where the diggings were seen at the Barrow Rd Reserve

5. Conclusion

Fire, *Phytphthora* dieback and Marri canker are complex intertwined issues and clearly good understanding of the vegetation is required to develop management plans to manage these issues. The role of well mulched ecosystems in reducing evaporation and cycling nutrients is clearly vital to the sustainability of healthy ecosystems. The question then is how to manage fire so as to try to balance the needs to maintain healthy ecosystems while reducing the risk of fire to humans and property.

A multi-pronged, whole of landscape approach is needed to tackle the threats of degrading ecosystems due to disease, fragmentation, climate change and influences of agricultural practice. The Southwest Australian Floristic Region (SWAFR) has been listed among 25 global biodiversity hot spots (Hooper & Gioia, 2004). Biodiversity hot spots are those regions on Earth richest in enedimc species under threat (Myers et al. 2000). The species-rich flora of the SWAFR with high levels of "endemism and rapid turnover of species over short distances across the landscape is ancient", and dates back at least to the Eocene (55.8 to 33.9 million years ago) (Hopper & Gioia, 2004, p. 643). As discussed by Hopper & Gioia (2004), the challenge of conserving the flora of the SWAFR is daunting, and managers need all the help scientists can provide.

A summary of recommendations for management in the context of the findings of this report are as follows:

- Utilise infra-red cameras to monitor digging activities located in the area of Relevé 11 and other reserves if sightings or signs identified.
- If good population of quenda found, survey to find extent of diggings and likely hot spots of their habitation;
- Use the information gained to undertake desk-top study to determine target areas to extend and link up with other remnants and to maximise capture of other species that may also be at risk due to fragmentation/loss of habitat such as wallabies;
- Utilise social ecological principles such as story telling and collaboration in context with the aims of the Lindesay Link NCP to gain support of landholders, funders and other stakeholders for on-ground activities;
- Target wetlands and deep sands on private land that are free of dieback to protect and enhance habitats, especially targeting those within sight of the flight paths of Black Cockatoos and with strategic linkages to existing remnants;

- Undertake more extensive vegetation surveys to enable vegetation mapping of key remnants that can be used to work with the science community (academics and agencies), friends groups, fire brigades etc. to develop and implement fire management plans as well as inform revegetation planning;
- Support soil health initiatives on farmland that target improved water and nutrient cycling through long term increases in soil carbon storage and therefore improves the sustainability of agriculture and the ecological health of the broader landscape.

5. References:

Banksia Atlas (1987). Anne Taylor & Stephen Hopper.

Bougher, N. L. & Syme K. S. (1998). *Fungi of Southern Australia.* Nedland, Western Australia: University of Western Australia Press, pp. 16-17.

Bradshaw, W. (2013). Ranges Link Vegetation Survey. Oyster Harbour Catchment Group.

Bradshaw, W. (2014). Ranges Link Vegetation Survey. Oyster Harbour Catchment Group.

Bradshaw, W. (2015). Ranges Link Vegetation Survey. Oyster Harbour Catchment Group.

Bureau of Meteorology (2014). www.bom.gov.au/climate/averages/tables/cw_009581,shtml

Buchanan, R. (1999). *Bush regeneration: recovering Australian landscapes.* Strathfield, NSW: Open Training and Education Network – Distance Education, pp. 51-52.

Department of Environment and Conservation Western Australian Herbarium (2012*). FloraBase: The Western Australian Flora.* Government of Western Australia. www.florabase.dec.wa.gov.au

Dieback Working Group (2008). Managing Phytophthora dieback in bushland: A guide for landholders and community conservation groups. Edition 4, 2008. Dieback Working Group, Western Australia. www.dwg.org.au

Garkaklis M.J., Bradley, J.S. & Wooller, R. D. 1998, 'The effects of Woylie (Bettongia penicillata) foraging on soil water repellency and water infiltration in heavy textured soils in southwestern Australia', in the *Australian Journal of Ecology,* 25, pp. 492-496.

Garkaklis M.J., Bradley, J.S. & Wooller, R. D. 2003, 'The relationship between animal foraging and nutrient patchiness in south-west Australian woodland soils' in *Australian Journal of Soil Research,* 41, pp. 665-673.

Garkaklis M.J., Bradley, J.S. & Wooller, R. D. 2004, 'Digging and soil turnover by a mycophagous marsupial' in *Journal of Arid Environments* 56 pp. 569-578.

Gondwana Link (2015). 'Lindesay Link'. Gondwana Link, Western Australia. Available online at: www.gondwanalink.org/whatshapwhere/Lindesay.aspx

Groves, E., Hardy, G., McComb, J. (n.d.). Western Australian native resistant to Phytpthora cinnamomi. Brochure compiled for the Dieback Working Group, Western Australia. Web: www.dwg.org.au

Hussey, B.M.J. & Wallace, K.J., (1993). *Managing your Bushland*, Como, Western Australia: Department of Conservation and Land Management, pp. 28, 37, 140-164.

Hopper, S.D. (1994b). Plant taxonomy and genetic resources: foundations for conservation. In *Conservation Biology in Australia and Oceania,* ed. C. Moritz, J Kikkawa, pp. 269-285. Chipping Norton, NSW: Surrey Beatty & Sons.

Hopper, S.D. (1997). An Australian perspective on plant conservation biology in practice. In *Conservation Biology for the Coming Decade,* ed. P.L. Fiedler, P.M. Kareiva, pp. 255-78. New York: Chapman and Hall.

Hopper, S.D & Gioia, P. (2004). The Southwest Australian Floristic Region: Evolution and conservation of a global hot spot of biodiversity in *Annual Review of Ecology, Evolution, and Systematics.* 2004. 35:623-50 doi: 10.1146/annurev.ecolsys.35.112202.130201

Keighery, B. (1994). *Bushland plant survey: A guide to plant community survey for the community.* Wildflower Society of WA (Inc.), Western Australia, p. 52, Appendix 1.

Kennedy, S. (2014). *Marri canker in the South West from Perth to Albany is killing trees.* South West WA: Australian Broadcasting Commission. Available online at: www.abc.net.au/local/photos/2014/12/05/4143214.htm

Mondurup Reserve Management Plan. (2011). Friends of Mondurup Reserve & Lynn Heppell WICC.

Muhling, P.C., Brakel, A.T. & Moncrieff, J.S. (1984). *Geological Survey of Western Australia: Mount Barker-Albany Western Australia.* 1:250,000 Geological Series – Explanatory Notes, Sheets SI.50-11, 15 International Index. WA: Department of Mines, pp. 2-3.

Mulcahy, M. J. (1960). Laterites and lateritic soils in southwestern Australia. *Journal of Soil Science*. 11, 206-225.

Perth Biodiversity Project Natural Area Initial Desktop Assessment template (n.d., n.p), Appendix 2.

Soule, M.E., Mackey, B.G., Recher, H.F., Williams, J.E., Winarski, J.C.Z., Driscoll, D., Dennison, W.C., & Jones, M.E. (2004). 'The role of connectivity in Australian conservation' in *Pacific Conservation Biology.* Vol. **10:** 266-79.

South Coast Regional Assessment Panel (RAP) and South Coast Regional Initiative Planning Team (SCRIPT) (1996). *South Coast Regional Land and Water Care Strategy: The Albany Hinterland Sub-region.* Albany, W.A.: SCRIPT, p. 10.

Sandiford, E.M. & Barrett, S. (2010). Albany Regional Vegetation Survey, Extent Type and Status, A project funded by the 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. Unpublished report. Department of Environment and Conservation, Western Australia, pp. 9-11.

Shearer, B.L., Crane, C.E. & Cochrane, A. (2004). Quantification of the susceptibility of the native flora of the south-west botanical province, Western Australia, to Phytophthora cinnamomi. *Australian Journal of Botany.* 52: 435-443.

Appendix 1 – Survey recording sheet template

		SITE_ID:
Date:	Wp:	mE
Recorder:	VegCode:	mN
Location and Site Notes:		

Condition: *Pristine Excellent Very Good Good Degraded --- RESIDUAL MODIFIED TRANFORMED*	
Aspect: *N NE E SE S SW W NW*	Slope: *Flat Gentle Mod Steep*
Geology: *Gnei Gran Lat Lime Silt*	Rock: *0 <2 2-10 10-20 20-50 >50*
Soil Colour: *Brown Grey Dark Brown Dark Grey Light Grey Light Brown Orange/Brown White Yellow Yellow/Grey*	Soil Type: *C CL CLS CS L LS S SCL SL SP ZCL ZL ZS P GL GS*
Hydrology: *Good drain Poor drain Perm wet Seasonal wet*	Landform: *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*

Growth form	Ht	Cvr	NVIS/dominant	Others
T_1	>30			
T_2	10-30			
T_3	<10			
M_1	>8			
M_2	<8			
S_1	>2			
S_2	1-2			
S_3	0.5-1			
S_4	<0.5			
V	NA			
H	NA			
G	NA			

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

Other Species:

Appendix 2 – 2a Growth Form Layer definitions, 1b Condition Scale and 1c Structural Classification

1a. Growth Form Layers (Perth Biodiversity Project Natural Area Initial Assessment Templates)

Adapted from Keighery 1994, McDonald et al. 1990 and Executive Steering Committee for Australian Vegetation Information 2003)

Tree:	woody plant with a single trunk and canopy, the canopy is less than or equal to ⅔ of the height of the trunk, no lignotuber apparent
Mallee:	woody plant with many woody stems, canopy well above the base, lignotuber usually apparent, commonly of the genus *Eucalyptus*
Shrub:	woody plant with one or many woody stems, foliage all or part of the total height of the plant, includes grass trees (*Xanthorrhoea spp*.) and cycads (*Macrozamia spp*.)
Herb:	non-woody plant with stems, generally under 0.5 m tall and not a grass, sedge or rush
Grass:	non-woody plant that comes from the plant family Poaceae; all have inconspicuous individual flowers that are pollinated by wind; leaf sheath always split, ligule present, leaf usually flat, stem cross-section circular, evenly spaced internodes
Sedge:	non-woody, tufted or spreading plant that comes from the plant family Cyperaceae; most have inconspicuous flowers that are pollinated by wind; leaf sheath never split, usually no ligule, leaf not always flat, extended internode below inflorescence
Rush:	same as sedge but comes from the plant families Juncaceae, Restionaceae, Typhaceae or Xyridaceae; leaf sheath may be split in Restionaceae
Climbers:	plants that climb or scramble over other plants for support

2b. Classification System Used to Describe Vegetation Structure (Keighery 1994), as adapted from Muir (1977) and Aplin (1979)

Growth Form/ Height Class	Canopy Cover			
	100% to 70 %	**70% to 30 %**	**30% to 10 %**	**10% to 2 %**
Trees over 30 m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10-30 m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10 m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Mallee over 8 m (Tree Mallee)	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee under 8 m (Shrub Mallee)	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub
Shrubs over 2 m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1-2 m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1 m	Closed Low Heath	Open Low Heath	Low Shrubland	Very 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

2c Condition Scale (Keighery, 1994)

Pristine Pristine or nearly so, no obvious signs of disturbance
Excellent Vegetation structure intact; disturbance affecting individual species; weeds are non-aggressive species
Very good Vegetation structure altered; obvious signs of disturbance *For example, disturbance to vegetation structure caused by repeated fires; the presence of some more aggressive weeds; dieback; logging; grazing*
Good Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. *For example, disturbance to vegetation structure caused by very frequent fires; the presence of some very aggressive weeds at high density; partial clearing; dieback; grazing.*
Degraded Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. *For example, disturbance to vegetation structure caused by very frequent fires; the presence of very aggressive weeds; partial clearing; dieback; grazing*
Completely Degraded The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. *These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.*

Appendix 3 – Species names

Appendix 3a – Species difficult to identify

***Banksia sphaerocarpa* var. sphaerocarpa** Two different forms of *Banksia sphaerocarpa* were recorded in the Jarrah Forest unit. *Banksia sphaerocarpa* var. *latifolia* was recorded only at one site at Mondurup Reserve, while a form that has affinities with *Banksia sphaerocarpa* var. *sphaerocarpa* such as follicle size and leaf width as described by George (2008), but has shorter leaves which are <2.5 cm long when the range is described as 2.5-10 cm long was located at the Narrikup Reserve (Relevé 5). The Relevé 5 form of thas been named *Banksia sphaerocarpa* var. *sphaerocarpa* as it appears closest to this species.

Hibbertia amplexicaulis* vs *H. cunninghammi. In observing the differences between these species, E. Sandiford (2012) references J. Wheeler (pers comm.) that "these species are separated on leaf width though a whole range may be present within one site and the species separation may not be a valid one". These species were recorded as *H. amplexicaulis.*

Xanthorrhoea platyphylla* vs. *X. preissii. These two species are difficult to tell apart without examining the flowers (pers. comm. E. Sandiford). The phyllodes of *X. preissii* also appear narrower than *X. platyphylla* (Sandiford, 2012). No *Xanthorrhoea* plants were found flowering at the time of the survey and the phyllodes appear to be aligned with *X. platyphylla*. This species has been identified as *Xanthorrhoea platyphylla* in this study.

Appendix 3b – Species list

Anarthriaceae

Anarthria gracilis

Lyginia imberbis

Anarthria laevis

Anarthria prolifera

Anarthria scabra

Apiaceae

Platysace effusa

Xanthosia huegelii

Xanthosia rotundifolia

Asparagaceae

Chamaescilla corymbosa

Chameaxeros serra

Lomandra nigricans

Lomandra pauciflora

Lomandra purpurea

Lomandra sp.

Thysanotus multiflorus

Thysanotus thysroideus

Asteraceae

Hyalosperma cotula

Leucophyta brownii

Casuarinaceae

Allocasuarina fraseriana

Allocasuarina humilis

Colchicaceae

Burchardia congesta

Cyperaceae

Cyathochaeta avenacea

Lepidosperma sp. 1

Lepidopserma sp. 2

Mesomelaena stygia

Mesomelaena tetragona

Schoenus caespititius

Schoenus pleiostemoneus

Tetraria octandra

Tetraria sp. Jarrah Forest

Dasypogonaceae

Calectasia grandiflora

Dasypogon bromeliifolius

Kingia australis

Dilleniaceae

Hibbertia amplexicaulis

Hibbertia depressa

Hibbertia enervia

Hibbertia inconspicua

Hibbertia lineata

Hibbertia microphylla

Droseraceae

Drosera menziesii

Drosera neesii ssp. *neesii*

Elaeocarpaceae

Tetratheca affinis

Ericaceae

Andersonia caerulea

Astroloma baxteri

Astroloma epacridis

Astroloma pallidum

Leucopogon assimilis

Leucopogon australis

Leucopogon capitellatus

Leucopogon gibbosus

Leucopogon glabelllus

Leucopogon obtusatus

Lysinema ciliatum

Leucopogon verticillatus

Fabaceae

Acacia baxteri

Acacia browniana

Acacia crispula

Acacia drummondii ssp. *elegans*

Acacia extensa

Acacia myrtifolia

Acacia pulchella

Acacia saligna

Bossiaea linophylla

Bossiaea ornate

Bossiaea praetermissa

Chorizema aciculare

Daviesia benthamii

Daviesia decurrens

Daviesia gracilis

Daviesia horrida

Daviesia oppositifolia

Daviesia preissii

Euchilopsis linearis

Gastrolobium latifolium

Gastrolobium velutinum

Gompholobium capitatum

Gompholobium confertum

Gompholobium knightianum

Gompholobium marginatum

Gompholobium ovatum

Gompholobium polymorphum

Gompholobium scabrum

Gompholobium venustum

Hovea chorizemifolia

Appendix 3b – Species list continued

Fabaceae
Hovea trisperma
Jacksonia furcellata
Jacksonia spinosa
Pultenaea reticulata
Sphaerolobium vimineum
Goodeniaceae
Dampiera alata
Dampiera lavendulacea
Dampiera linearis
Goodenia incana
Goodenia laevis
Scaevola calliptera
Velleia trinervis
Haemodoraceae
Anigozanthos bicolor
Conostylis aculeata ssp. *aculeata*
Conostylis setigera ssp. *setigera*
Haemodorum spicatum
Hemerocallidaceae
Agrostocrinum ?*hirsutum*
Johnsonia lupulina
Stypandra glauca
Tricoryne humilis
Iridaceae
Patersonia occidentalis
Patersonia limbata
Patersonia pygmaea
Patersonia umbrosa
Lauraceae
Cassytha ?pomiformis
Lindsaeaceae
Lindsaea linearis
Loganiaceae
Logania campanulata
Logania serpyllifolia
Loranthaceae
Nuytsia floribunda
Menyanthaceae
Ornduffia parnassifolia
Myrtaceae
Agonis theiformis
Astartea ?*arbuscular* x *corniculata*
Astartea pulchella
Astartea sp.
Callistemon glaucus
Calytrix ?flavescens
Corymbia calophylla

Myrtaceae (cont.)
Darwinia vestita
Eucalyptus decipiens
Eucalyptus marginata
Eucalyptus occidentalis
Hypocalymma angustifolium
Kunzea recurva
Melaleuca densa
Melaleuca pauciflora
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca thymoides
Melaleuca subtrigona
Pericalymma ellipticum
Taxandria juniperina
Taxandria parviceps
Orchidaceae
Caladenia ?*abbreviata* (P3)
Caladenia lobate
Cryptostylis ovata
Lyperanthus serratus
Pterosylis vittata
Pterosylis recurva
Prasophyllum sp.
Pyrorchis nigricans
Thelymitra ?*crinita*
Pittosporaceae
Billardiera fusiformis
Billardiera variifolia
Marianthus erubescens
Poaceae
Amphipogon ?turbinatus
Amphipogon strictus
Austrostipa mollis
Austrostipa sp.
Deyeuxia quadriseta
Neurachne alopecuroidea
Rytidosperma setaceum
Rytidosperma caespitosum
Tetrarrhena laevis
Polygalaceae
Comesperma virgatum
Comesperma volubile
Proteaceae
Adenanthos cuneatus
Adenanthos obovatus
Banksia acuminata
Banksia armata

Appendix 3b – Species list continued

Proteaceae (cont.)

Banksia attenuata
Banksia dallanneyi var. *dallanneyi*
Banksia grandis
Banksia gardneri var. gardneri
Banksia ilicifolia
Banksia lindleyana
Banksia littoralis
Banksia porrecta P4
Banksia quercifolia
Banksia sphaerocarpa var. *latifolia* P2
Banksia sphaerocarpa var. *sphaerocarpa*
?Conospermum sp.
Grevillea depauperata
Grevillea pulchella
Grevillea quercifolia
Grevillea trifida
Hakea amplexicaulis
Hakea ceratophylla
Hakea corymbosa
Hakea falcata
Hakea florida
Hakea lissocarpha
Hakea marginata
Hakea ruscifolia
Hakea trifurcata
Hakea undulata
Hakea varia
Isopogon attenuatus
Isopogona formosus
Isopogon sphaerocephalus
Persoonia longifolia
Petrophile media
Petrophile serruriae
Petrophile squamata
Synaphea gracillima/preissii P3?
Synaphea polymorpha
Synaphea reticulata

Ranunculaceae

Clematis pubescens

Restionaceae

Chordifex laxus
Desmocladus fasciculatus
Desmocladus flexuosus
Harperia confertospicata
Harperia lateriflora
Hypolaena exsulca

Restionaceae (cont.)

Leptocarpus tenax
Lepyrodia hermaphrodita
Lyginia imberbis
Mesomelaena stygia
Mesomelaena tetragona

Rhamnaceae

Spyridium majoranifolium

Rubiaceae

Opercularia hispidula
Opercularia vaginata

Rutaceae

Boronia juncea ssp. *laniflora*
Boronia spathulata

Stylidiaceae

Levenhookia pusilla
Stylidium amoenum
Stylidium hirsutum
Stylidium piliferum
Stylidium repens
Stylidium scandens
Stylidium spathulatum
Stylidium spinulosum
Stylidium tenue

Thymelaeaceae

Pimelea cracens
Pimelea imbricata
Pimelea longiflora ssp. *longiflora*
Pimelea rosea
Pimelea sauveolens

Xanthorrhoeaceae

Xanthorrhoea platyphylla

Appendix 4: Two way table of site and species data (proteaceous = red, **bold = dominant**
D=drainage, G=gully, R=rocky outcrop, B=breakaway, S=slope)

Landform	D	F	D	F	F	S	S	S	S	S	S	S
Site (Releve) No.	6	7	9	8	11	10	12	3	4	1	2	5
Vegetation units	Mpre	BattBill	Coor/Emar	Coor/Emar	Coor/Emar	Coor/Emar	Coor/Emar	Edec	Emar	Emar	Emar	Emar
Remnant number	3	3	4	4	5	4	5	1	1	1	1	2
Condition	E	E	E	P	E	P	P	E	E	E	E	P
Soil type (broad)	S	S	LS	LS	CLS	LS	GL	CL	LS	L	LG	LS
Leptocarpus tenax	1	1										
Drosera neesii ssp. neesii	1	1										
Lyginia imberbis	1	1										
Pimelea imbricate	1	1										
Banksia littoralis	1		**1**									
Cyathochaeta avenacea	**1**	1	1	1	1	1						
Hibbertia amplexicaulis	1		1	1		1	1					
Melaleuca preissiana	**1**			**1**								
Velleia trinervis	1			1	1							
Deyeuxia quadriseta	**1**			**1**		**1**						
Dampiera alata	1				1							
Melaleuca pauciflora	**1**					1						
Hakea varia	**1**						1					
Lepidosperma sp. 1	**1**					1				1	1	1
Taxandria parviceps	1	1	**1**	**1**								1
Chordifex laxus	**1**	1							1			1
Tetraria sp. Jarrah Forest	1	1	1	**1**	1	**1**	**1**	1		1	1	
Billardiera fusiformis	1	1									1	
Acacia drummondii ssp elegans	1				1		1	1				
Trycoyne humilis	1				1	1				1	1	**1**
Opercularia hispidula	1		1	1			1		1			
Rytidosperma setaceum	1				1				1			**1**
Cassytha pomiformis	1							1				
Darwinia vestita	1							1	1		1	
Boronia spathulata	1				1		1	1	1	1	1	1
Agonis theiformis	1		1		**1**	**1**	**1**		1	1	1	**1**
Stylidium spathulatum	1										1	
Adenanthos obovatus		1	1									
Acacia myrtifolia		1	**1**	1								
Burchardia congesta		1	1	1		1						
Xanthosia huegelii		1			1							
Kunzea recurva		1			1							
Anarthria gracilis		1			1			1				
Opercularia vaginata		1		1	1			1				
Gompholobium confertum		1	1						1			
Astroloma baxteri		**1**	1	1					1			1
Stylidium repens		1		1	1				1			
Patersonia pygmaea		1			1			1	1			
Anarthria prolifera		1	**1**	**1**	**1**	**1**	1			1		**1**
Dasypogon bromeliifolius		1	1									**1**
Levenhoolia pusilla		1	1			1						1
Patersonia limbata		1							1			
Melaleuca thymoides		**1**								1		1
Gompholobium capitatum		1								1		
Lepidosperma sp.2		1								**1**		
Patersonia occidentalis		1								1		1
Stylidium spinulosum		1										1
Thelymitra ?crinita		1						1	1	1	1	
Hypolaena exsulca			1	1								
Billardiera variifolia			1	1		1						
Hakea florida			**1**	**1**								
Johnsonia lupulina			1	1								
Patersonia umbrosa			**1**	**1**		**1**						
Leucopogon australis			1	**1**		1						
Lomandra pauciflora				1		1						
Bossiaea linophylla												

Appendix 4 (cont.): Two way table of site and species data (proteaceous = red, **bold = dominant** D=drainage, G=gully, R=rocky outcrop, B=breakaway, S=slope)

Landform	D	F	D	F	F	S	S	S	S	S	S	S
Site (Releve) No.	6	7	9	8	11	10	12	3	4	1	2	5
Vegetation units	Mpre	BattBill	Ccor/Emar	Ccor/Emar	Ccor/Emar	Ccor/Emar	Ccor/Emar	Edec	Emar	Emar	Emar	Emar
Remnant number	3	3	4	4	5	4	5	1	1	1	1	2
Condition	E	E	E	P	E	P	P	E	E	E	E	P
Soil type (broad)	S	S	LS	LS	CLS	LS	GL	CL	LS	L	LG	LS
Astroloma epacridis					1		1					
Leucopogon capitellatus				1			**1**					
Leucopogon verticillatus						1	1					
Hibbertia inconspicua						1	1					
Gastrolobium latifolium			1					1				
Acacia extensa			1	1				1				
Leucopogon assimilis					1			1				
Hakea lissocarpha					**1**			1				
Hibbertia microphylla					1			1				
Neurachne aloepcuroidea					**1**			**1**				
Hakea marginata					**1**			**1**				
Corymbia calophylla			**1**	**1**	**1**	**1**	**1**		1			
Isopogon attenuatus			1	1		1				1	1	
Eucalyptus marginata			**1**	**1**	**1**	**1**	**1**		**1**	**1**	**1**	**1**
Scaevola calliptera			1	1		1		1	1			1
Marianthus erubescens						1			1			
Pimelia rosea			1						1	1	1	
Tetraria octandra			1	1	1	**1**		**1**	**1**	**1**	**1**	1
Desmocladus fasciculatus			1	**1**	**1**	**1**	1	**1**	**1**	**1**	**1**	1
Xanthorrhoea platyphylla			1		1	1			1	**1**		
Lindsaea linearis			1	1		**1**			1	1		
Grevillea depauperata			1	1	1				1		1	
Mesomelaena tetragona			1						1		1	
Hakea amplexicaulis			1	1		1	1			1		
Xanthosia rotundifolia			1	**1**		**1**	1			**1**		
Hakea ruscifolia			1			1				1		1
Daviesia preissii			1			1				1		1
Acacia browniana			1	1						1	**1**	**1**
Persoonia longifolia			1	1		**1**						1
Hovea chorizemifolia				1		1			1	1	1	
Agrostrocrinum ?hirsutum				1			1		1			1
Synaphea gracillima/preissii P3					1			1		1		
Banksia lindleyana					1	1		1	1	**1**	1	1
Hakea trifurcata					**1**			1	**1**		1	**1**
Stylidium piliferum					1				1	1		
Bossiaea ornata					1		1		1	**1**	1	**1**
Hovea trisperma					1							1
Gompholobium polymorphum						1			1	1	1	1
Dampiera linearis						1			1	1	1	1
Logania serpillifolia						1	1			1	1	
Tetratheca affinis						1	1				1	
Banksia grandis						**1**						1
Comesperma virgatum							1			1		
Allocasuarina humilis								1			**1**	**1**
Leucopogon obtusatus								1	1			
Chorizema aciculare								1	1			
Lomandra sp.								1		1		
Astroloma pallidum								1			1	
Mesomelaena stygia								1	1	1	1	
Stylidium tenue								1	1	1	1	
Lepyrodia hermaphrodita								1	1	1	1	1
Daviesia gracilis									1	1		
Hakea undulata									1	1	1	
Grevillea trifida									**1**		1	
Hibbertia lineata									1	1	**1**	1
Gompholobium knightianum									1	1	1	1

Appendix 4 (cont.): Two way table of site and species data (proteaceous = red, **bold = dominant**
D=drainage, G=gully, R=rocky outcrop, B=breakaway, S=slope)

Landform	D	F	D	F	F	S	S	S	S	S	S	S
Site (Releve) No.	6	7	9	8	11	10	12	3	4	1	2	5
Vegetation units	Mpre	BattBill	Coor/Emar	Coor/Emar	Coor/Emar	Coor/Emar	Coor/Emar	Edec	Emar	Emar	Emar	Emar
Remnant number	3	3	4	4	5	4	5	1	1	1	1	2
Condition	E	E	E	P	E	P	P	E	E	E	E	P
Soil type (broad)	S	S	LS	LS	CLS	LS	GL	CL	LS	L	LG	LS
Conostylis aculeata ssp. aculeata									**1**	**1**	**1**	1
Allocasuarina fraseriana										**1**	1	
Pimelea cracens										1	1	
Grevillea pulchella										1	1	
Petrophile media										1	1	
Sphaerolobium vimineum										1	1	
Thysanotus thyrsoideus										1	1	
Lomandra purpurea										1	1	
Banksia gardneri										**1**	1	**1**
Isopogon formosus										1	1	1
?Conospermum sp.	1											
Melaleuca rhaphiophylla	1											
Melaleuca densa	1											
Ornduffia parnassifolia	1											
Daviesia decurrens	**1**											
Prasophyllum sp.	1											
Anarthria laevis	1											
Caladenia ?abbreviata P3	1											
Astartea pulchella	**1**											
Banksia attenuata		1										
Banksia illicifolia		1										
Jacksonia spinosa		**1**										
Adenanthos cuneatus		1										
Pultenaea reticulata		1										
Boronia juncea ssp. laniflora		1										
Bossiaea praetermissa		**1**										
Gompholobium scabrum		1										
Leucopogon glabellus		1										
Callytrix ?flavescens		1										
Hibbertia depressa		1										
Dampiera lavendulacea		1										
Schoenus caespititius		1										
Lomandra nigricans		1										
Haemodorum spicatum		1										
Anarthria scabra		1										
Austrostipa sp.		**1**										
Astartea ?arbuscular x corniculata			**1**									
Hakea ceratophylla			1									
Logania campanulata			1									
Eucalyptus occidentalis					1							
Petrophile squamata					1							
Astartea sp.					1							
Anigozanthos bicolor					1							
Leucopogon gibbosus					1							
Gastrolobium velutinum					1							
Acacia baxteri					1							
Conostylis setigera ssp. setigera					1							
Goodenia laevis					1							
Hyalosperma cotula					1							
Kingia australis						**1**						
Gompholobium ovatum							1					
Stylidium amoenum							1					
Clematis pubescens							1					

Appendix 4 (cont.): Two way table of site and species data (proteaceous = red, **bold = dominant**
D=drainage, G=gully, R=rocky outcrop, B=breakaway, S=slope)

Landform	D	F	D	F	F	S	S	S	S	S	S	S
Site (Releve) No.	6	7	9	8	11	10	12	3	4	1	2	5
Vegetation units	Mpre	BattBill	Coor/Emar	Coor/Emar	Coor/Emar	Coor/Emar	Coor/Emar	Edec	Emar	Emar	Emar	Emar
Remnant number	3	3	4	4	5	4	5	1	1	1	1	2
Condition	E	E	E	P	E	P	P	E	E	E	E	P
Soil type (broad)	S	S	LS	LS	CLS	LS	GL	CL	LS	L	LG	LS
Tetrarrhena laevis							**1**					
Spyridium majoranifolium							1					
Hakea falcata							1					
Eucalyptus decipiens								**1**				
Daviesia horrida								**1**				
Hakea corymbosa								1				
Euchilopsis linearis								1				
Gompholobium marginatum								1				
Melaleuca subtrigona								1				
Pimelea longiflora ssp. longiflora								1				
Hypocalymma angustifolium								1				
Stylidium hirsutum								1				
Caladenia lobate								1				
Leucophyta brownie								1				
Comesperma volubile								1				
Rytidosperma caespitosum								1				
Amphipogon ?turbinatus								1				
Harperia lateriflora								1				
Chamaexeros serra								1				
Drosera menziesii								1				
Lysinema ciliatum									1			
Banksia porrecta P4									**1**			
Acacia crispula									1			
Synaphea reticulate									1			
Pimelea sauveolens									1			
Pterostylis recurva									1			
Platysace effuse									1			
Austrostipa mollis									**1**			
Amphipogon strictus									1			
Petrophile serruriae										1		
Banksia sphaerocarpa var latifolia P2										**1**		
Synaphea polymorpha										1		
Schoenus pleistemoneus										1		
Pterostylis vittata										1		
Banksia armata											**1**	
Daviesia oppositifolia											1	
Banksia acuminata											1	
Calectasia grandiflora											1	
Nuytsia floribunda												**1**
Isopogon sphaerocephalus												1
Banksia sphaerocarpa var sphaerocarpa												1
Goodenia incana												1
Banksia dallanneyi var. dallanneyi												1
Gompholobium venustum												1
Total no. native species/relevé	63	77	82	74	92	82	80	59	66	61	57	64
Total proteaceous species	3	4	6	5	7	6	4	5	7	13	12	10

Appendix 5: Site Data (from relevés)

SITE 1 WP 1 DATE 29/10/2015 RECORDERS W. Bradshaw

LAT/LONG S34.62614 E117.64985 LOCATION Mondurup Reserve (See Figure 3)

VEGETATION TYPE *Eucalyptus marginata* open woodland over *Allocasuarina fraseriana* low open woodland over *Eucalyptus marginata* open mallee over *Agonis theiformis* shrubland

LANDFORM Mid-slope SLOPE Gentle GEOLOGY Laterite
ROCKS 0% SOIL TYPE Loam SOIL COLOUR Brown
HYDROLOGY Good drainage CONDITION Excellent

VEG LAYER	% COVER	SPECIES (Bold = dominant)
Trees 10-30 m	2-10	***Eucalyptus marginata***
Trees <10 m	2-10	***Allocasuarina fraseriana***
Mallee <8m	10-30	***Eucalyptus marginata***
Shrubs 1-2m	10-30	***Agonis theiformis*** *Hakea undulata* *Hakea amplexicaulis* *Hakea ruscifolia* *Isopogon attenuatus*
Shrubs 0.5-1m	30-70	***Xanthorrhoea platyphylla*** ***Bossiaea ornata*** ***Petrophile serruriae*** ***Banksia sphaerocarpa* var. *latifolia* P2** ***Xanthosia rotundifolia*** *Synaphea polymorpha* *Daviesia preissii* *Comesperma virgata* *Daviesia gracilis* *Isopogon formosus* *Melaleuca thymoides* *Pimelea rosea* *Pimelea cracens*
Shrubs <0.5m	10-30	***Banksia lindleyana*** ***Banksia gardneri var.gardneri*** *Gompholobium knightianum* *Gompholobium capitatum* *Hibbertia lineata* *Dampiera linearis* *Hovea chorizemifolia* *Boronia spathulata* *Grevillea pulchella* *Petrophile media* *Sphaerolobium vimineum* *Synaphea gracillima/preissii* P3? *Acacia browniana* *Gompholobium polymorphum*
Sedges	2-10	***Desmocladus fasciculatus*** ***Tetraria octandra*** ***Lepidosperma* sp. 2** *Lepidosperma* sp. 1 *Tetraria* sp. Jarrah Forest *Anarthria prolifera*

		Lepyrodia hermaphrodita
		Mesomelaena stygia
		Schoenus pleiostemoneus
Herbs	<2e	***Conostylis aculeata* ssp. *aculeata***
		Stylidium piliferum
		Stylidium tenue
		Patersonia occidentalis
		Thelymitra ?*crinita*
		Lomandra purpurea
		Lomandra sp.
		Lindsaea linearis
		Pterostylis vittata
		Trycoryne humilis
		Thysanotus thyrsoideus
		Logania serpillifolia

Relevé 1 showing *Banksia sphaerocarpa* var. *latifolia* in foreground

Relevé 1 showing *Banksia lindleyana* in foreground

SITE 1 WP 2 DATE 29/10/2015 RECORDERS W. Bradshaw

LAT/LONG S34.62671 E117.64891 LOCATION Mondurup Reserve (See Figure 3)

VEGETATION TYPE *Eucalyptus marginata* very open mallee over *Allocasuarina humilis* open heath

LANDFORM Mid-slope SLOPE Gentle GEOLOGY Laterite
ROCKS <2% SOIL TYPE Loamy gravel SOIL COLOUR Brown
HYDROLOGY Good drainage CONDITION Excellent

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees <10 m	e	***Allocasuarina fraseriana***
Shrub mallees <8m	2-10	***Eucalyptus marginata***
Shrubs 1-2 m	2-10	***Allocasuarina humilis***
		Hakea trifurcata
		Agonis theiformis
Shrubs 0.5-1 m	30-70	***Banksia armata***
		Bossiaea ornata
		Hakea undulata
		Isopogon formosus
		Isopogon attenuatus
		Billardiera fusiformis
Shrubs <0.5 m	10-30	***Hibbertia lineata***
		Acacia browniana
		Petrophile media
		Darwinia vestita
		Daviesia oppositifolia
		Boronia spathulata
		Dampiera linearis
		Pimelea rosea
		Gompholobium knightianum
		Grevillea trifida
		Astroloma pallidum
		Gompholobium polymorphum
		Banksia acuminata
		Grevillea pulchella
		Pimelea cracens
		Hovea chorizemifolia
		Sphaerolobium vimineum
		Banksia lindleyana
		Banksia gardneri var. gardneri
		Calectasia grandiflora
		Grevillea depauperata
Sedges	10-30	***Tetraria octandra***
		Desmocladus fasciculatus
		Lepyrodia hermaphrodita
		Tetraria sp. Jarrah Forest
		Mesomelaena tetragona
		Mesomelaena stygia
		Lepidospema sp. 1
Herbs	<2e	***Conostylis aculeata* ssp. *aculeata***
		Tetratheca affinis
		Thysanotus thyrsoideus
		Stylidium tenue
		Thelymitra ?crinita

	Stylidium spathulata
	Lomandra purpurea
	Tricoryne humilis
	Logania serpyllifolia

Relevé 2

SITE 1 WP 3 DATE 29/10/2015 RECORDERS W. Bradshaw

LAT/LONG S34.62984 E117.64502 LOCATION Mondurup Reserve (See Figure 3)

VEGETATION TYPE *Eucalyptus decipiens* very open shrub mallee over *Daviesia horrida* open heath

LANDFORM Upper slope SLOPE Gentle GEOLOGY Granite
ROCKS <2% SOIL TYPE Clay loam SOIL COLOUR Orange-brown
HYDROLOGY Poor drainage CONDITION Excellent

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Shrub mallees <8m	2-10	***Eucalyptus decipiens***
Shrubs 1-2 m	30-70	***Daviesia horrida***
		Acacia extensa
Shrubs 0.5-1 m	2-10	*Allocasuarina humilis*
	mix	*Boronia spathulata*
		Acacia drummondii ssp. *elegans*
		Hakea corymbosa
		Leucopogon assimilis
		Hakea lissocarpha
		Leucopogon obtusatus
Shrubs <0.5 m	30-70	***Hakea marginata***
		Gastrolobium latifolium
		Darwinia vestita
		Synaphea gracillima
		Astroloma pallidum
		Banksia lindleyana
		Euchilopsis linearis
		Gompholobium marginatum
		Hakea trifurcata
		Melaleuca subtrigona
		Chorizema aciculare
		Pimelea longiflora ssp. *longiflora*
		Hibbertia microphylla
		Hypocalymma angustifolium
Sedges	10-30	***Tetraria octandra***
		Desmocladus fasciculatus
		Tetraria sp. Jarrah Forest
		Lepyrodia hermaphrodita
		Harperia lateriflora
		Mesomelaena stygia
		Anarthria gracilis
Herbs	2-10	*Opercularia vaginata*
	Mix dom.	*Stylidium hirsutum*
		Lomandra sp.
		Chamaexeros serra
		Drosera menziesii
		Stylidium tenue
		Patersonia pygmaea
		Thelymitra ?crinita
		Caladenia lobata
		Leucophyta brownii
		Scaevola calliptera
		Cassytha pomiformis
		Comesperma volubile

Grasses	2-10	***Neurachne alopecuroidea*** *Rytidosperma caespitosum* *Amphipogon ?turbinatus*

Relevé 3

SITE 1 WP 4 DATE 29/10/2015 RECORDERS W. Bradshaw

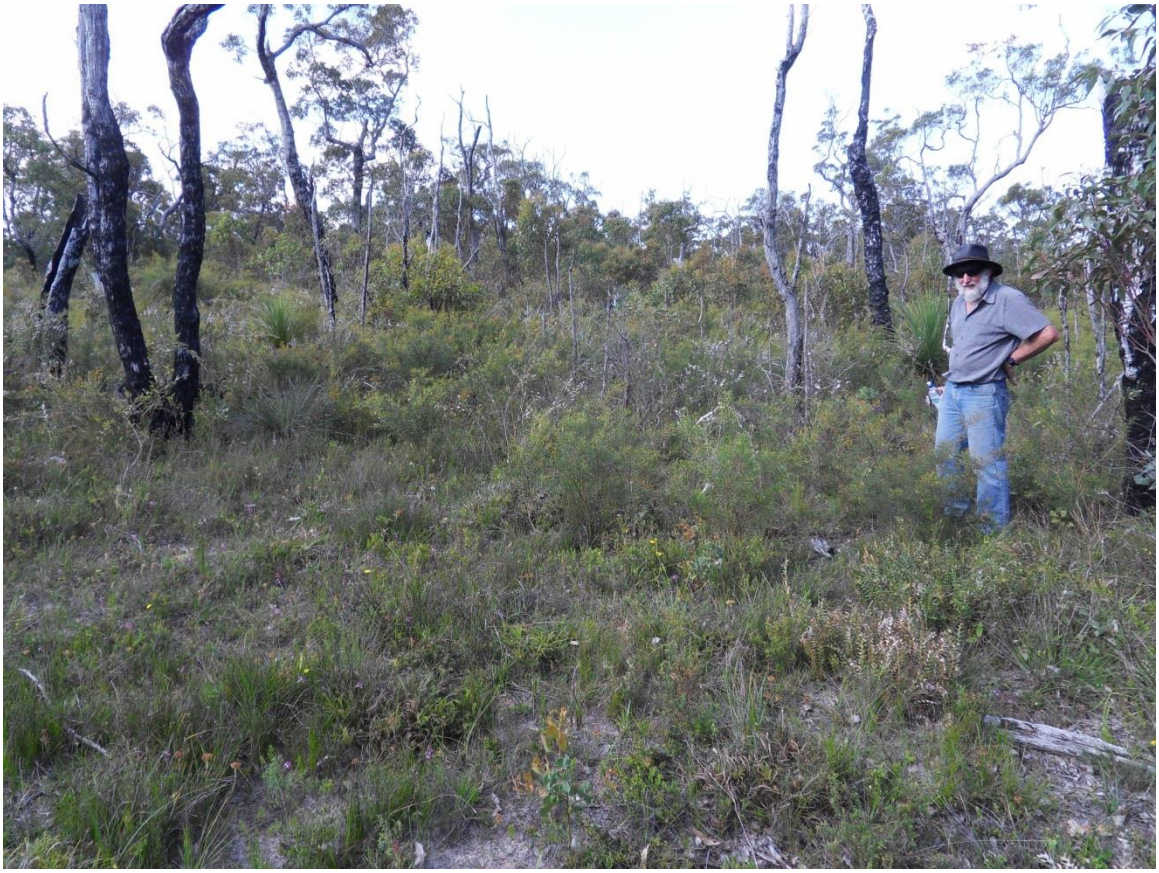
LAT/LONG S34.63271 E117.64904 LOCATION Mondurup Reserve (See Figure 3)

VEGETATION TYPE *Eucalyptus marginata* mallee over *Hakea trifurcata* open heath with emergent *Corymbia calophylla*

LANDFORM Mid-slope SLOPE Gentle GEOLOGY Laterite
ROCKS <2% SOIL TYPE Loamy sand SOIL COLOUR Light brown
HYDROLOGY Good drainage CONDITION Excellent

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees <10 m	<2e	***Corymbia calophylla***
Shurb mallees <8m	2-10	***Eucalyptus marginata***
Shrubs 1-2 m	30-70	***Hakea trifurcata***
		Xanthorrhoea platyphylla
		Agonis theiformis
		Hakea undulata
Shrubs <0.5-1 m	2-10	***Grevillea trifida***
		Daviesia gracilis
		Lysinema ciliatum
		Andersonia caerulea
		Gompholobium confertum
		Leucopogon obtusatus
Shrubs <0.5	2-10	***Banksia porrecta*** **P4**
		Gompholobium polymorphum
		Darwinia vestita
		Banksia lindleyana
		Hibbertia lineata
		Acacia crispula
		Synaphea reticulata
		Synaphea gracillima/preissii P3
		Hovea chorizemifolia
		Gompholobium knightianum
		Dampiera linearis
		Pimelea sauveolens
		Boronia spathulata
		Pimelea rosea
		Astroloma baxteri
		Grevillea depauperata
		Chorizema aciculare
		Bossiaea ornata
Sedges	30-70	***Desmocladus fasciculatus***
		Tetraria octandra
		Chordifex laxus
		Lepyrodia hermaphrodita
		Mesomelaena tetragona
		Mesomelaena stygia
Herbs	2-10	***Conostylis aculeata*** **ssp.** ***aculeata***
		Stylidium repens
		Agrostocrinum ?hirsutum
		Pterostylis recurva
		Stylidium tenue
		Opercularia hispidula
		Scaevola calliptera

		Marianthus erubescens *Patersonia limbata* *Thelymitra ?crinita* *Lindsaea linearis* *Stylidium piliferum* *Platysace effusa* *Patersonia pygmaea*
Grasses	<2e	***Austrostipa mollis*** *Amphipogon strictus* *Rytidosperma setaceum*



Releveé 4

SITE 2 WP 5 DATE 05/11/2015 RECORDERS W. Bradshaw

LAT/LONG 0563524E 6151471N LOCATION Narrikup Reserve (See Figure 3)

VEGETATION TYPE *Eucalyptus marginata* open forest over *Nuytsia floribunda* low open woodland over *Hakea trifurcata* tall open shrubland

LANDFORM Mid-slope SLOPE Gentle GEOLOGY Laterite
ROCK <2% SOIL TYPE Loamy sand SOIL COLOUR Light grey
HYDROLOGY Good drainage CONDITION Pristine

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees 10-30 m	30-70	***Eucalyptus marginata***
Trees <10 m	2-10	***Nuytsia floribunda***
Shrubs >2m	2-10	***Hakea trifurcata***
Shrubs 1-2m	30-70	***Agonis theiformis*** ***Allocasuarina humilis*** *Banksia grandis* *Taxandria parviceps* *Hakea ruscifolia* *Melaleuca thymoides* *Persoonia longifolia*
Shrubs 0.5-1 m	30-70	***Bossiaea ornata*** *Acacia browniana*
Shrubs <0.5 m	2-10	***Isopogon sphaerocephalus*** ***Banksia gardneri*** *Daviesia preissii* *Isopogon formosus* *Andersonia caerulea* *Hibbertia lineata* *Gompholobium knightianum* *Boronia spathulata* *Hovea trisperma* *Astroloma baxteri* *Banksia sphaerocarpa* var. *sphaerocarpa* *Banksia lindleyana* *Goodenia incana* *Banksia dallanneyi* var. *dallanneyi* *Gompholobium polymorphum* *Dampiera linearis*
Sedges	30-70	***Anarthria prolifera*** *Desmocladus fasciculatus* *Tetraria octandra* *Lepyrodia hermaphrodita* *Lepidosperma* sp. 2 *Chordifex laxus*
Herbs	10-30	***Dasypogon bromeliifolius*** ***Tricoryne humilis*** *Patersonia occidentalis* *Gompholobium venustum* *Conostylis aculeata* ssp. *aculeata* *Stylidium spinulosum* *Levenhookia pusilla* *Scaevola calliptera* *Agrostrocrinum* ?*hirsutum*

Grasses	<2e	***Rytidospermum setaceum***

Relevé 5

SITE 3 WP 6 DATE 03/03/2016 RECORDERS W. Bradshaw

LAT/LONG 0559295E 6156912N LOCATION Lake Barnes Nature Reserve (See Figure 3)

VEGETATION TYPE *Melaleuca preissiana* low open woodland over *Hakea varia* open heath

LANDFORM Drainage depression SLOPE Flat GEOLOGY Laterite
ROCK 0% SOIL TYPE Sand SOIL COLOUR Grey
HYDROLOGY Good drainage CONDITION Pristine

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees <10 m	2-10	***Melaleuca preissiana***
		Banksia littoralis
		Melaleuca rhaphiophylla
Shrubs 1-2m	30-70	***Hakea varia***
		Agonis theiformis
		Taxandria parviceps
Shrubs 0.5-1 m	30-70	***Astartea pulchella***
		Acacia pulchella
		Acacia drummondii ssp. *elegans*
		Melaleuca densa
		Billardiera fusiformis
Shrubs <0.5 m	30-70	***Melaleuca pauciflora***
		Daviesia decurrens
		Hibbertia amplexicaulis
		Pimelea imbricata
		Darwinia vestita
		Boronia spathulata
Sedges	30-70	***Lepidosperma* sp. 1**
		Cyathochaeta avenacea
		Anarthria laevis
		Chordifex laxus
		Leptocarpus tenax
		Tetraria sp. Jarrah Forest
		Lyginia imberbis
Herbs	2-10	*Dampiera alata*
	Mix dom.	*Tricoryne humilis*
		Ornduffia parnassifolia
		Agrostocrinum ?*hirsutum*
		Prasophyllum sp.
		Opercularia hispidula
		Cassytha pomiformis
		Velleia trinervis
		Drosera neesii ssp. *neesii*
		Stylidium spatulatum
		Caladenia ?abbreviata P3
		? *Conospermum* sp.
Grasses	2-10	***Rytidospermum setaceum***
		Deyeuxia quadriseta

Relevé 6

SITE 3 WP 7 DATE 03/03/2016 RECORDERS W. Bradshaw

LAT/LONG 0558923E 6156930N LOCATION Lake Barnes Nature Reserve (See Figure 3)

VEGETATION TYPE *Banksia attenutata/Banksia illicifolia* low woodland over *Jacksonia spinosa* open heath

LANDFORM Flat SLOPE Flat GEOLOGY Laterite
ROCK 0% SOIL TYPE Sand SOIL COLOUR Light grey
HYDROLOGY ?Good drainage CONDITION Excellent

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees <10 m	10-30	***Banksia attenuata***
		Banksia ilicifolia
Shrubs 1-2m	30-70	***Jacksonia spinosa***
		Taxandria parviceps
		Kunzea recurva
Shrubs 0.5-1 m	30-70	***Melaleuca thymoides***
		Adenanthos cuneatus
		Adenanthos obovatus
		Gompholobium confertum
		Pultenaea reticulata
		Acacia myrtifolia
		Boronia juncea ssp. *laniflora*
Shrubs <0.5 m	10-30	***Bossiaea praetermissa***
		Astroloma baxteri
		Gompholobium capitatum
		Billardiera fusiformis
		Gompholobium scabrum
		Leucopogon glabellus
		Pimelea imbricata
		Calytrix ?flavescens
		Dampiera lavendulacea
		Hibbertia depressa
Sedges	10-30 Mix dom.	*Lepidosperma* sp. 2
		Cyathochaeta avenacea
		Anarthria scabra
		Chordifex laxus
		Leptocarpus tenax
		Tetraria sp. Jarrah Forest
		Lyginia imberbis
		Anarthria prolifera
		Schoenus caespititius
		Anarthria gracilis
Herbs	10-30 Mix dom.	*Dasypogon bromeliifolius*
		Patersonia occidentalis
		Stylidium repens
		Burchardia congesta
		Opercularia vaginata
		Patersonia limbata
		Stylidium spinulosum
		Drosera neesii ssp. *neesii*
		Levenhookia pusilla
		Patersonia pygmaea
		Xanthosia huegelii
		Lomandra nigricans

		Haemodorum spicatum
		Thelymtra ?crinita
Grasses	<2e	***Austrostipa* sp.**

Relevé 7

Relevé 8

SITE 4 WP 8 DATE 03/12/2015 RECORDERS W. Bradshaw

LAT/LONG 0535360E 6162969N LOCATION Shire Reserve 12266 Pile Rd, Denbarker

VEGETATION TYPE *Corymbia calophylla/Eucalyptus marginata* open forest over *Hakea florida/Taxandria parviceps* shrubland

LANDFORM Flat SLOPE Gentle GEOLOGY Laterite
ROCK 0% SOIL TYPE Loamy sand SOIL COLOUR Light brown
HYDROLOGY Good drainage CONDITION Pristine

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees 10-30 m	30-70	***Corymbia calophylla***
		Eucalyptus marginata
Trees <10 m	e <2	***Melaleuca preissiana***
Shrubs >2 m	e <2	***Bossiaea linophylla***
Shrubs 1-2m	10-30	***Hakea florida***
		Taxandria parviceps
		Acacia myrtifolia
		Hakea amplexicaulis
		Persoonia longifolia
Shrubs 0.5-1 m	2-10	***Leucopogon australis***
		Leucopogon capitellatus
		Acacia extensa
Shrubs <0.5 m	2-10	***Xanthosia rotundifolia***
		Astroloma baxteri
		Hibbertia amplexicaulis
		Acacia browniana
		Hovea chorizemifolia
		Opercularia hispidula
		Grevillea depauperata
		Isopogon attenuatus
Sedges	30-70	***Tetraria* sp. Jarrah Forest**
		Anarthria prolifera
		Desmocladus fasciculatus
		Tetraria octandra
		Cyathochaeta avencea
		Hypolaena exsulca
Herbs	2-10	***Patersonia umbrosa***
		Stylidium repens
		Burchardia congesta
		Opercularia vaginata
		Johnsonia lupulina
		Lomandra pauciflora
		Scaevola calliptera
		Velleia trinervis
		Billardiera variifolia
		Agrostocrinum ?hirsutum
		Lindsaea linearis
Grasses	e <2	***Deyeuxia quadriseta***

SITE 4 WP 9 DATE 03/12/2015 RECORDERS W. Bradshaw

LAT/LONG 0534532E 6162941N LOCATION Shire Reserve 12266 Pile Rd, Denbarker

VEGETATION TYPE *Corymbia calophylla/Eucalyptus marginata* open forest over mixed shrubland

LANDFORM Drainage depression SLOPE Gentle GEOLOGY Laterite
ROCK 0% SOIL TYPE Loamy sand SOIL COLOUR Light brown
HYDROLOGY Good drainage CONDITION Excellent

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees 10-30 m	10-30	***Corymbia calophylla***
		Eucalyptus marginata
Trees <10 m	e <2	***Banksia littoralis***
Shrubs 1-2m	10-30	***Hakea florida***
		Taxandria parviceps
		Acacia myrtifolia
		Agonis theiformis
		Hakea amplexicaulis
		Persoonia longifolia
		Xanthorrhoea platyphylla
Shrubs 0.5-1 m	10-30	***Astartea ?arbuscular x corniculata***
		Hakea ceratophylla
		Adenanthos obovatus
		Gompholobium confertum
		Daviesia preissii
		Leucopogon australis
		Hakea ruscifolia
		Acacia extensa
Shrubs <0.5 m	2-10	*Xanthosia rotundifolia*
	Mix dom	*Astroloma baxteri*
		Hibbertia amplexicaulis
		Acacia browniana
		Opercularia hispidula
		Grevillea depauperata
		Isopogon attenuatus
		Pimelia rosea
		Gastrolobium latifolium
Sedges	30-70	***Anarthria prolifera***
		Mesomelaena tetragona
		?*Tetraria* sp. Jarrah Forest
		Desmocladus fasciculatus
		Tetraria octandra
		Hypolaena exsulca
		Cyathochaeta avenacea
Herbs	2-10	***Patersonia umbrosa***
		Dasypogon bromeliifolius
		Logania campanulata
		Levenhookia pusilla
		Burchardia congesta
		Johnsonia lupulina
		Scaevola calliptera
		Billardiera variifolia
		Lindsaea linearis

Relevé 9

Relevé 10

SITE 4 WP 10 DATE 03/12/2015 RECORDERS W. Bradshaw

LAT/LONG 0534722E 6162937N LOCATION Shire Reserve 12266, Denbarker Rd

VEGETATION TYPE *Corymbia calophylla/Eucalyptus marginata* open forest over *Banksia grandis/Bossiaea linophylla* open shrubland

LANDFORM Lower slope SLOPE Gentle GEOLOGY Laterite
ROCK 0% SOIL TYPE Loamy sand SOIL COLOUR Brown
HYDROLOGY Good drainage CONDITION Pristine

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees 10-30f m	30-70	***Corymbia calophylla***
		Eucalyptus marginata
Shrubs >2 m	e <2	***Kingia australis***
Shrubs 1-2m	2-10	***Banksia grandis***
		Bossiaea linophylla
		Persoonia longifolia
		Hakea amplexicaulis
		Hakea ruscifolia
Shrubs 0.5-1 m	10-30	***Agonis theiformis***
		Leucopogon australis
		Leucopogon verticillatus
		Xanthorrhoea platyphylla
Shrubs <0.5 m	30-70	***Xanthosia rotundifolia***
		Hibbertia inconspicua
		Gompholobium polymorphum
		Daviesia preissii
		Hibbertia amplexicaulis
		Dampiera ?linearis
		Hovea chorizemifolia
		Melaleuca pauciflora
		Banksia lindleyana
		Isopogon attenuatus
Sedges	30-70	***Tetraria* sp. Jarrah Forest**
		Anarthria prolifera
		Desmocladus fasciculatus
		Tetraria octandra
		Cyathochaeta avencea
		Lepidosperma sp. 1
Herbs	2-10	***Patersonia umbrosa***
		Lindsaea linearis
		Burchardia congesta
		Lomandra pauciflora
		Scaevola calliptera
		Billardiera variifolia
		Marianthus erubescens
		Tetratheca affinis
		Trycoryne humilis
		Logania serpyllifolia
		Levenhookia pusilla
Grasses	e <2	***Deyeuxia quadriseta***

SITE 5 WP 11 DATE 03/12/2015 RECORDERS W. Bradshaw

LAT/LONG 0573120E 6166949N LOCATION Barrow Rd Shire Reserve 15986

VEGETATION TYPE *Corymbia calophylla/Eucalyptus marginata* woodland over mixed shrubland

LANDFORM Flat SLOPE Flat GEOLOGY Laterite, siltstone
ROCK <2% SOIL TYPE Clay loamy sand SOIL COLOUR Brown
HYDROLOGY Poor drainage CONDITION Excellent

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees 10-30 m	10-30	***Corymbia calophylla***
		Eucalyptus marginata
		Eucalyptus occidentalis
Shrubs >2 m	e <2	***Hakea trifurcata***
Shrubs 0.5-2 m	10-30	***Hakea marginata***
		Hakea lissocarpha
		Agonis theiformis
		Petrophile squamata
		Xanthorrhoea platyphylla
		Acacia drummondii ssp. *elegans*
Shrubs <0.5 m	30-70	*Hovea trisperma*
		Synaphea gracillima/preissii P3
		Hibbertia microphylla
		Banksia lindleyana
		Astartea sp.
		Gastrolobium velutinum
		Astroloma epacridis
		Bossiaea ornata
		Leucopogon assimilis
		Acacia baxteri
		Kunzea recurva
		Boronia spathulata
		Leucopogon gibbosus
		Grevillea depauperata
Sedges	30-70	***Anarthria prolifera***
		Desmocladus fasciculatus
		Cyathochaeta avenacea
		Tetraria octandra
		Anarthria gracilis
		etraria sp. Jarrah Forest
Herbs	2-10 Mix dom.	*Conostylis setigera* ssp. *setigera*
		Stylidium repens
		Patersonia pygmaea
		Opercularia vaginata
		Trycoryne humilis
		Dampiera alata
		Goodenia laevis
		Velleia trinervis
		Xanthosia huegelii
		Anigozonthos bicolor
		Stylidium piliferum
		Hyalosperma cotula
Grasses	2-10	***Neurachne alopecuroidea***
		Rytidosperma setaceum

Relevé 11

Relevé 12

SITE 5 WP 12 DATE 03/12/2015 RECORDERS W. Bradshaw

LAT/LONG 0573313E 6167283N LOCATION Barrow Rd Shire Reserve 15986

VEGETATION TYPE *Corymbia calophylla/Eucalyptus marginata* open forest over *Bossiaea linophylla* tall open scrub

LANDFORM Lower slope SLOPE Gentle GEOLOGY Laterite, siltstone
ROCK 20-50% SOIL TYPE Loam with siltstone gravel SOIL COLOUR Brown
HYDROLOGY Good drainage CONDITION Pristine

VEG LAYER	**% COVER**	**SPECIES (Bold = dominant)**
Trees 10-30 m	10-30	***Corymbia calophylla***
		Eucalyptus marginata
Shrubs >2 m	30-70	***Bossiaea linophylla***
		Hakea varia
		Hakea falcata
Shrubs 1-2 m	10-30	***Agonis theiformis***
		Spyridium majoranifolium
		Bossiaea ornata
		Leucopogon verticillatus
Shrubs 0.5-1 m	2-10	***Leucopogon capitellatus***
		Acacia drummondii ssp. *elegans*
Shrubs <0.5 m	10-30 Mix dom.	*Hibbertia amplexicaulis*
		Xanthosia rotundifolia
		Hibbertia inconspicua
		Astroloma epacridis
		Bossiaea ornata
		Gompholobium ovatum
		Boronia spathulata
		Opercularia hispidula
		Comesperma virgatum
Sedges	30-70	***Tetraria* sp. Jarrah Forest**
		Anarthria prolifera
		Desmocladus fasciculatus
Herbs	e <2	*Stylidium amoenum*
		Tetratheca affinis
		Logania serpyllifolia
		Agrostocrinum ?hirsutum
		Clematis pubescens
Grasses	2-10	***Tetrarrhena laevis***

Appendix 6: Summary of site data

Following are descriptions of the vegetation units determined from vegetation associations described in relevé site data (floristics summary, Appendix 6). Photographs of individual relevés are shown with relevé data in Appendix 5.

1 *Melaeluca preissiana* Low Open Woodland Relevé 6

Unit 1: *Melaleuca preissiana* Low Open Woodland was recorded on sandy soil in a drainage depression in the Lake Barnes Nature Reserve. *Banksia littoralis* and *Melaleuca rhaphiophylla* were sub-dominant upper storey species. Shrub strata include *Hakea varia* open heath over *Astartea pulchella/Acacia pulchella* open low heath. Ground layer strata include *Cyathochaeta avenacea/Lepidosperma* sp. 1 sedgeland, *Rytidosperma setaceum* very open grassland and mixed very open herbland. The herb stratum is highly diverse, featuring herbs characteristic of damplands not recorded in other units such as *Ornduffia parnassifolia* and *Stylidium spathulatum,* and several orchids including *Caladenia ?abbreviata,* and *Prasophyllum* sp.

A number of shrub, sedge and herb species found are common to nearby unit – Unit 2 *Banksia attenuata/Bankisa ilicifolia* Low Woodland which also occurs on sand. These include shrubs: *Taxandria parviceps, Pimelea imbricata, Billaridera fusiformis;* sedges: *Cyathochaeta avenacea, Leptocarpus tenax, Lyginia imberbis, Chordifex laxus* and *Tetraria* sp. Jarrah Forest.

Further survey of similar geology and vegetation in the Lyndesay Link area is needed to gain a deeper understanding structure and composition variability that might be found in this unit. The high density of *Hakea varia* together with the more sparse upper-storey *Banksia littoralis* indicate the important contribution this unit makes in broadening our understanding of the habitats in which proteaceous species are significant because of their species richness (representativeness of different species) or because of their contribution through dominance in any stratum.

Unit 1: *Melaleuca preissiana* Low Open Woodland

2 *Banksia attenuata/Banksia illicifolia* Low Woodland Relevé 7

Unit 2: *Banksia attenuata/Banksia illicifolia* Low Woodland was recorded at Lake Barnes Nature Reserve on deep sand on gentle slope to flat lower landscape. *Banksia attenuata/Banksia illicifolia* low woodland stratum occurs over *Jacksonia spinosa* open heath over *Melaleuca thymoides/Adenanthos cuneatus* open low heath. *Astroloma baxteri* and *Bossiaea praetermissa* are dominant shrubs in the <0.5m shrub stratum.The open sedgeland and open herbland strata are both mixed dominance with – similarly to Unit 1 – a particularly diverse herbland stratum. Examples of different sedges and herbs found in this unit that were not recorded in any other units include sedges: *Schoenus caespititius* and *Anathria scabra;* and herbs: *Stylidium spinulosum, Haemodorum spicatum.* Grasses occur as an emergent stratum of *Austrostipa* sp.

Common with Unit 3 is the sedge *Anarthria prolifera* which was recorded in all Unit 3 sites – in most cases as dominant sedge – indicative of moist peaty sand or loam soils. The dominance of proteaceous species in the upper storey, together with *Adenanthos cuneatus* and *Adenanthos obovatus* that are restricted to deep sands make this an important unit from the point of view of sheer proteaceous biomass as well as species representativeness.

Unit 2: *Banksia attenuata/Banksia illicifolia* Low Woodland

3 Jarrah/Marri Forest Relevés 8, 9, 10, 11, 12

Unit 3: Jarrah/Marri Forest was recorded in Shire Reserves 12266 and 15986 located on Denbarker Rd and Barrow Rd respectivey. This unit was recorded in lower landscapes/flats and depressions on loamy sand to gravelly loam, with laterite and at the Barrow Rd site, with both laterite and siltstone geology. Jarrah and marri are dominant upper storey species, recorded as a forest to woodland stratum.

This unit could be split into sub-units but due to lack of replication are left together at this juncture. At a flat site (Relevé 11) on Barrow Rd, *Eucalyptus occidentalis* occurs as a sub-dominant upper storey species on clay loamy sand – but was not recorded in any other relevés. Other features distinguishing this potential sub-unit from others in this unit are dominance of *Hakea marginata* and *Hakea lissocarpha* with sub-dominant *Petrophile squamata* in the shrubland stratum. Rapid survey data used to support observations shows that this possible sub-unit occurs close by with *Hakea ceratophylla* also present. Another variation of hakea composition a short distance up the road (Relevé 12) features *Hakea varia* and *Hakea falcata* together with *Bossiaea linophylla* to form a tall open scrub stratum, associated with a siltstone rocky site on loam with siltstone gravel. At the Denbarker Rd location, on loamy sand sites low in the landscape (Relevés 8) and in a depression (Relevé 9) include *Melaleuca preissiana* and *Banksia littoralis* are sub-dominant upper-storey stratum species respectively.

Both the Denbarker and Barrow Rd locations have species that are often associated with damp sites: *Eucalyptus occidentalis, Hakea marginata* and *Hakea ceratophylla* (Relevé 11), forest ricegrass *Tetrarrhena laevis* (Relevé 12), abundance of screw fern *Lindsaea linearis* (Relevé 10), *Banksia littoralis* (Relevé 9), and *Melaleuca pressiana* (Relevé 8). There are no signs of recent fire at any of these sites.
Common to all relevés in this unit, +/- dominant are rushes/sedges: *Anarthria prolifera, Tetraria* sp. Jarrah Forest, and *Desmocladus fasciculatus.* The shrubs *Hakea amplexicaulis* and *Persoonia longifolia,* together with herb *Patersonia umbrosa,* were recorded at all Denbarker sites and not at all at the Barrow Rd sites.

Common species include shrubs: *Agonis theiformis, Bossiaea linophylla, Hibbertia amplexicaulis,* and sedges *Cyathochaeta avenacea* and *Tetraria octandra.* This unit has commonalities with many other units – for example, *Banksia littoralis* is a sub-dominant upper-storey species in Unit 1, *Hakea marginata* is common dominant shrub species with Unit 5, *Persoonia longifolia* is found in Unit 4. This variable unit contains 17 proteaceous species which need to be considered in context with their particular slight differences of habitats such as slightly wetter leaning to *Banksia littoralis* and slightly drier moving to *Banksia grandis.*

Unit 3: Jarrah/Marri Forest

4 Jarrah Open Forest Relevés 1, 2, 4, 5

Unit 4: Jarrah Open Forest was recorded in Monjebup and Narrikup Reserves on gentle slopes on loamy sand to loamy gravel on laterite geology. Jarrah is dominant upper storey species, and occurs as a forest to a very open mallee stratum. More frequent fire is a feature of the more open, mallee dominant upperstorey compared to the forest stratum associated with the relatively long unburnt site located at the Narrikup Reserve. *Hakea trifurcata* occurs as a tall open shrubland dominant at the site at the Narrikup Reserve, and is smaller at the Monjebup Reserve which is burnt every 5 years and is currently 4 years post fire where low to medium sized shrubs form a shrubland to open heath stratum. All sites have an open low heath stratum. The mid to lower shrub strata are highly diverse and variable, tending to occur as a mix rather than one species commonly dominant. *Agonis theiformis, Boronia spathulata, Banksia lindleyana, Gompholobium polymorphum, Hibbertia lineata, Gompholobium knightianum,* and *Bossiaea ornata* are present at all sites, +/- dominant. Commonly dominant sedgeland stratum species are *Tetraria octandra* and *Desmocladus fasciculatus,* with *Lepyrodia hermaphrodita* also present but not dominant at all sites surveyed in this unit. Grasses were recorded only in two relevés as an emergent stratum, including species from the genera *Austrostipa, Rytidosperma* and *Amphipogon*.

Two different forms of *Banksia sphaerocarpa* were recorded in this unit, as described under species difficult to identify (Appendix 3a). In comparison with other units, this unit has by far the most proteaceous species with 21 recorded, including four species of Grevillea which were not recorded in any other unit. *Grevillea quercifolia* was not included in relevé data as it wasn't in sufficient numbers to meet the rules to be included in site data and is included in overall species list (Appendix 3b) – but was noted in higher densities outside the boundaries of the releve.

From a protecaceous perspective, this unit is the most diverse of all recorded in this survey effort, with 27 proteaceous species. It is particularly rich in Grevillea species, represented by four: *Grevillea pulchella, Grevillea quercifolia, Grevillea depauperata* and *Grevillea trifida.* Only one of these species was recorded in other units (*Grevillea depauperata).*

Unit 4: Jarrah Open Forest

5 Moit Very Open Mallee Relevé 3

Unit 5: Moit Very Open Mallee occurs on granitic clay loam on upper landscape in Mondurup Reserve. Moit (*Eucalyptus decipiens)* very open mallee stratum occurs over *Daviesia horrida* open heath and *Hakea marginata* open low heath. Dominant sedges are the same as those recorded in Unit 4, forming *Tetraria octandra/Desmocladus fasciculatus* open sedgland stratum. As is generally the case with all units, the mixed very open herbland stratum is highly diverse. Distinct species that stand out in this unit as different to all other units surveyed include: shrubs: *Euchilopsis linearis, Gompholobium marginatum, Pimelea longiflora* ssp. *longiflora, Hypocalymma angustifolium;* sedges: *Anarthria gracilis, Harperia lateriflora;* herbs: *Stylidium hirsutum, Caladenia 57rifur, Leucophyta 57rifurc, Comesperma volubile, Chamaexeros serra.* This is the only unit in which moit is recorded in this overall survey effort. *Hakea marginata* is also recorded as dominant lower shrub stratum species in one relevé (11) broadly included under Unit 3.

A total of six proteaceous species were recorded in this unit – including four Hakeas: *Hakea marginata, Hakea trifurcata, Hakea corymbosa* and *Hakea lissocarpha* as well as other shrubs *Synaphea gracillima/preissii* P3 and *Banksia lindleyana.* The high species richness and dominance of *Hakea marginata* together with the species diversity of proteaceae provide significance to this unit from a proteaceous perspective.

Unit 5: Moit Very Open Mallee

Appendix 7: Photos of Proteaceous species recorded within sites

Adenanthos cuneatus

Adenanthos obovatus

Banksia acuminata

Banksia armata

Banksia attenuata (1)

Banksia attenuata (2)

Banksia dallanneyi ssp. dallanneyi (1)

Banksia dallanneyi ssp. dallanneyi (2)

Banksia grandis

Banksia gardneri var. gardneri

Banksia illicifolia (1)

Banksia illicifolia (2)

Banksia lindleyana

Banksia littoralis

Banksia porrecta

Banksia sphaerocarpa var. unknown

Banksia quercifolia

Banksia sphaerocarpa var. latifolia

Grevillea depauperata

Grevillea pulchella

Grevillea quercifolia (1)

Grevillea quercifolia (2)

Grevillea trifida (1)

Grevillea trifida (2)

Hakea amplexicaulis

Hakea corymbosa in foreground regenerating post fire

Hakea falcata

Hakea ferruginea

Hakea lissocarpha

Hakea marginata

Hakea ruscifolia

Hakea trifurcata

Hakea undulata

Hakea varia (1)

Hakea varia (2)

Isopogon attenuatus

Isopogon formosus

Isopogon sphaerocephalus

Persoonia longifolia

Petrophile media

Petrophile serruriae

Petrophile squamata

Synaphea gracillima/preissii P3?

Synaphea polymorpha

Synaphea reticulata