An assessment of ecosystems within the Coorong, Lower Lakes and Murray Mouth (CLLMM) region

DEWNR Technical report 2016/32

Government of South Australia
Department of Environment, Water and Natural Resources

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Foreword

The Department of Environment, Water and Natural Resources (DEWNR) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEWNR's strong partnerships with educational and research institutions, industries, government agencies, Natural Resources Management Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

Sandy Pitcher
CHIEF EXECUTIVE
DEPARTMENT OF ENVIRONMENT, WATER AND NATURAL RESOURCES

Acknowledgements

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Summary

One of South Australia's Ramsar wetlands of international importance, the Coorong, Lower Lakes and Murray Mouth (CLLMM), has been in decline due to human-driven changes in its hydrology and the use of surrounding landscapes. In 2010, the Department of Environment, Water and Natural Resources (DEWNR) began a revegetation program (CLLMM Vegetation Program) in an attempt to restore some of the region's terrestrial ecosystems, create resilience in the system, and arrest declines in biodiversity. In order to maximise the effectiveness of the revegetation activities, the CLLMM Vegetation Program required guidance to prioritise investment and activities. The objective of this report was to inform that prioritisation with an ecological analysis of where such revegetation activities would be most effectively delivered to support these broader program objectives.

A landscape assessment (LA) was applied to the CLLMM region in order to identify ecosystems, provide indicators of biodiversity decline, and prioritise restoration efforts through the analysis, synthesis and interpretation of the following information:

- the nature of the ecosystems in the landscape
- status and trends of terrestrial bird species and their associations with ecosystems
- land use and native vegetation clearance history.

Quantitative analyses were augmented with expert knowledge to improve interpretation of the results.

Seventeen terrestrial ecosystems were identified within the region, and 40% of terrestrial bird species were found to have decreasing frequencies of occurrence in these landscapes. Bird decline was strongly correlated with ecosystem types with a long and extensive history of native vegetation clearance. Eight terrestrial bird Ecosystem Response Groups were identified and associated with ecosystems. This information was used to formulate management recommendations (focussing on revegetation) for each ecosystem, in the context of investment available from the CLLMM VP for on-ground activities.

This study suggests management activities should focus on ecosystem groups identified as those at greatest risk of biodiviersity loss via declining resilience or changing to undesirable states. Terrestrial ecosystems identified by this project as most at risk of biodiversity loss include:

1. **Mallee communities** of the eastern Mount Lofty Ranges, specifically in the proximity of larger remnants such as Ferries–McDonald Conservation Park (i.e. Ecosystem 6.3: Ridge-fruited / Narrow-leaf Red (*Eucalyptus incrassata* / *leptophylla*) Mallee (MLR sands))

2. **Grassy woodland communities** of the eastern Mount Lofty Ranges (i.e. Ecosystem 6.1: Mallee Box (*Eucalyptus porosa*) Grassy Woodland (LL loams); Ecosystem 6.2: Peppermint Box (*E. odorata*) Grassy Woodland (MLR loams); Ecosystem 6.4: SA Blue Gum (*E. leucoxylon*) Grassy Woodland (SE/LL loams); Ecosystem 10.2: Red Gum Grassy Woodland (MLR river flats); and Ecosystem 10.4: Sheoak (*Allocasuarina verticillata*) / Native Pine (*Callitris gracilis*) Grassy Woodland (LL loams))

3. **Samphire / Paperbark shrubland communities** associated with saline wetlands (i.e. Ecosystem 9: Samphire (*Tecticornia* spp.) / Paperbark (*Melaleuca halmaturorum*) Shrubland (saline clays)).

1 Introduction

1.1 Background

The Coorong, Lower Lakes and Murray Mouth (CLLMM) region is the terminus for the drainage of the Murray-Darling Basin, which covers about 14% (1 073 000 km^2) of Australia (Cann and Barnett 2000). It features a complex mosaic of lakes, coastal lagoons, interconnecting channels and vegetation communities (Seaman 2003; Fluin et al. 2007). The region contain wetlands of international importance, listed under the Ramsar Convention in 1985. Water extraction across three Australian states has reduced freshwater discharge from the River Murray to the sea by 75% (Cann et al. 2000). As a result, negative impacts on the unique ecology of the system have substantially increased since 2007 when it became evident that ecosystem processes were collapsing in association with decreasing water levels within the Lakes (DEH 2009). In addition, terrestrial ecosystems associated with the Ramsar site have been perceived to be in a slow decline since European settlement, primarily due to preferential historic clearance of native vegetation in the region (Butcher and Rogers 2013). In response, the Australian and South Australian Governments funded DEWNR to deliver the "CLLMM Vegetation Program" as part of the CLLMM Recovery Project, whose broad objectives included increasing the ecological resilience of the region, primarily through revegetation activities. The landscape assessment presented here has the primary objective of providing the ecological information to support the prioritisation of this revegetation activity, such that it most effectively addresses this loss of ecological resilience.

1.2 Landscape assessment

Landscape assessment is an approach (or framework) for identifying priority ecosystems for restoration, while informing the development of evidence-based landscape-specific goals for nature conservation (Rogers et al. 2012). It facilitates the development of comprehensive, explicit and outcome-driven nature conservation strategies, and contributes to the maintenance of ecological resilience in South Australia's landscapes. This approach is intended to guide managers beyond the simple concept of conserving the native extant biodiversity, to a more nuanced and prioritised suite of interventions that target those components of the landscape that have suffered loss of resilience, and are approaching thresholds that would cause transition to an undesirable state. Landscape assessment is founded on the nested, hierarchical nature of biodiversity – operating on the principle that the conservation requirements at higher levels of organisation (e.g. landscapes, ecosystems) should meet the requirements of the majority of biodiversity at lower levels (e.g. species; Noss 1987; Hunter et al. 1988; Hunter 1991; 2005).

Broadly, the principle objective of landscape assessment is to identify landscape-scale systemic issues that are driving loss of ecological resilience, such that these underlying causes of decline can be addressed through management (Rogers et al. 2012). For the purposes of this assessment, the focus of the analyses are on identifying ecosystems within landscapes that are associated with decline. This ecosystem focus was adopted for two main reasons:

- An environmental history of the CLLMM region suggested that, overwhelmingly (although not universally), the systemic driver of biodiversity loss in the region's *terrestrial* systems is the historic preferential conversion of native vegetation for European agricultural systems (Paton *et al.* 1999). The pattern of clearance targeted some ecosystems over others, depending on the suitability of the underpinning environment (soil, climate, topography) to support these European agricultural activities, suggesting that ecosystem is a strong predictor of decline (as has been observed elsewhere, e.g. for the southern Mount Lofty Ranges, see Rogers 2011a)
- Given the *a priori* requirement for the CLLMM Vegetation Program to invest specifically in revegetation activities, the Program required particular information on where revegetation activity would provide the

most ecological benefit (rather than the broader suite of interventions that one might identify through a more comprehensive analysis of systemic drivers of decline).

- Broadly, landscape assessment (as defined by Rogers et al., 2012) relies on a synthesis of three elements (see Figure 1.1) to identify systematic patterns associated with biodiversity decline within landscapes. The key groups of components - Ecosystem Assessment, Species Assessment and Land Use Assessment are synthesised, primarily to identify the alternate states and trends of ecosystems within a landscape, and to identify the drivers (e.g. historic clearance of vegetation for intensive agriculture) for these alternative trends:

  1. Ecosystem Assessment - An understanding of the ecosystems that comprise the landscape of interest. Including information on the environmental settings of each ecosystem and the typical (or best remaining) ecological expression of that setting

  2. Species Assessment - An understanding of the current state (i.e. species conservation status) and recent trajectory (i.e. declining, stable or increasing occurrence trends) of species (for which adequate information is available) within the landscape.

  Information on the ecological requirements of each species, with particular reference to their association with the ecosystems - i.e. their preferred habitat types.

  Using that information to determine groups of species with similar trajectory that can be associated with particular habitat types

  3. Land Use Assessment - An understanding of the spatial and temporal variation in human modification of the landscape (e.g. the location and chronology of vegetation clearance/modification within landscapes).

The landscape assessment approach has now been applied to several regions of South Australia (Rogers, 2010; Willoughby, 2010; Rogers, 2011a, b; Willoughby et al., 2011; Rogers 2012a, b, c, d; Rogers et al., 2012; Gillespie et al., 2013), some of which overlap with the geographic boundary of concern in this study. Preliminary landscape assessment analyses of the region (Butcher and Rogers 2013) were based on existing generalised frameworks for conservation decision making (McIntyre and Hobbs, 1999, 2000). Butcher and Rogers (2013) provide an overview of the environmental history, patterns of vegetation clearance, and generic priorities for conservation investment or further research in terrestrial landscapes located with 5 km (entirely or partially) of the CLLMM.

Landscape assessment uses both spatial biological survey information and knowledge gathered via expert opinion or key informants (Northrip et al. 2008). The use of expert opinion or key informants as a technique in gathering information has been extensively used in the medical field (e.g. Muhit et al. 2007; Kalua et al. 2009) but has been adapted to investigate environmental problems (Wacker 2005; Bonifacio et al, 2010; http://www.unitedway-weld.org/compass/ environmental_issues.htm). Results using key informants (i.e. 'local champions') can be comparable with formal surveys but is financially more efficient (Pal et al. 1998).

In this study, bird species are used to represent ecosystem-scale processes and interactions (i.e. 'systemic' issues). The decision to use avifauna for the region is based on both previous applications of the landscape assessment approach and the difficulties involved in obtaining useful information for most fauna that is informative about the state and trajectory of ecological communities. Birds are a visible, relatively diverse and relatively well-studied fauna occurring in most agricultural settings. This reflects the ease of collecting bird data compared to other taxa (Mac Nally et al. 2004). In addition, the spatial scale over which terrestrial bird populations operate is comparable to the scale over which human activities operate; thus the scale at which we define our landscapes may be comparable between terrestrial birds and human impacts (Major, 2010).

Despite the availability of bird data, presence-only data from a plethora of sources is difficult to use with respect to assigning trends to species (Elphick 2008). To help address this, a Bayesian Belief Network (BBN) was used to help quantify uncertainty in bird trends.

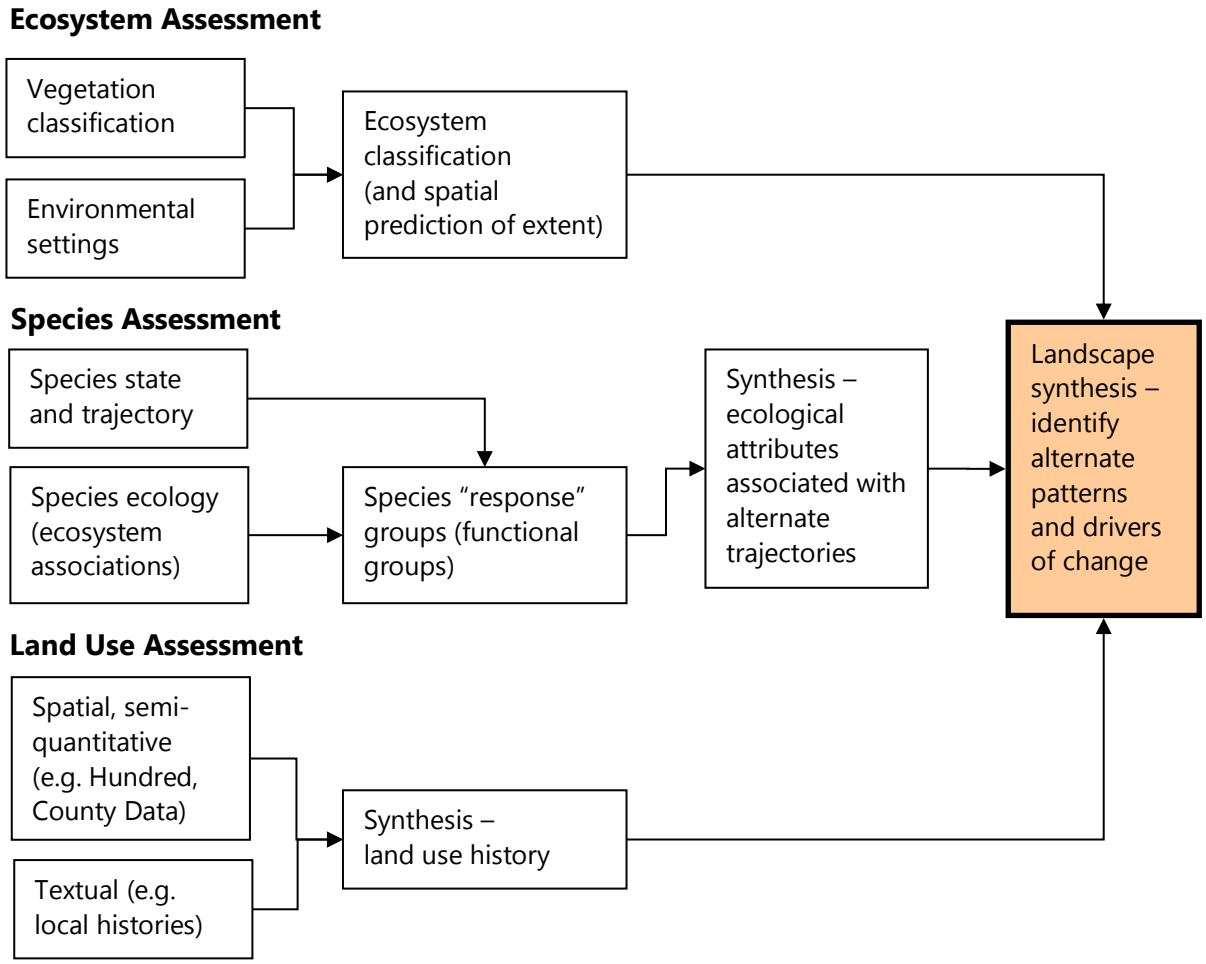

Figure 1.1 The information components and linkages that comprise the landscape assessment approach (Rogers et al. 2012)

1.3 Study objectives

This landscape assessment study within the CLLMM region of South Australia has the following objectives:

1. to identify and describe the different terrestrial ecosystem types of the region
2. to assess changes in biodiversity within these ecosystems
3. identify drivers of change within these ecosystem
4. identify priority terrestrial ecosystems for conservation investment.

Thus, landscape assessment provides the situation assessment component of a generic planning process (Figure 1.2). Landscape assessment alone does not provide detail on the specific interventions required to realise a conservation goal (e.g. Situation Model). Further, while landscape assessment is designed to help set context-specific conservation goals, that process (setting, and acting on, conservation goals) requires a more inclusive approach for the diverse range of stakeholders involved (e.g. TNC 2007, CMP 2007).

Figure 1.2 Landscape assessment provides the situation assessment component of a planning process – represented by the green oval in this generic planning-process example (based on Margoluis and Salafsky, 1998)

2 Methods

2.1 Study area

This study considers terrestrial landscapes and associated ecosystems in close proximity (<5 km) to the estuarine Coorong and lacustrine Lower Lakes of the River Murray in South Australia (see Figure 2.1). The study area intersects three biogeographic regions (i.e. Kanmantoo, Murray–Darling Depression, Naracoorte Coastal Plain; IBRA Version 7, DotE 2012) and includes five IBRA sub-regions (i.e. Fleurieu, Murray Mallee, Murray Lakes and Coorong, Tintinara, Bridgewater). These lands are dominated by annual cereal cropping and livestock grazing production systems, with smaller components of high intensity agriculture and conservation areas containing predominately native vegetation communities (Figure 2.2). The region experiences a Mediterranean climate with cool wet winters and warm dry summers. Mean annual rainfall (Figure 2.3) in the study area ranges between 352-734 mm/year, and mean annual temperature (Figure 2.4) between 14.3–16.3 °C (ANUCLIM Version 6.1, 1976 to 2005, Xu & Hutchison 2013). Topographic variation is low, with a maximum elevation of 180 m AHD on the south-eastern slopes of the Mount Lofty Ranges.

The natural vegetation is diverse – ranging from wetland-associated communities (e.g. reeds and sedges) to terrestrial communities (grassland, shrub/heath, mallee and grassy woodlands). Major terrestrial vegetation types of the region include open grassy woodlands (structurally dominated by Pink Gum *Eucalyptus fasciculosa*, Native Pine *Callitris gracilis*, SA Blue Gum *E. leucoxylon*, Mallee Box *E. porosa* and Peppermint Box *E. odorata*, woodlands with a shrubby understorey, Sheoak *Allocasuarina verticillata*, mallee communities (Coastal Mallee *E. diversifolia*, Ridge-fruited Mallee *E. incrassata*, Narrow-leaf Red Mallee *E. leptophylla* and Beaked Red Mallee *E. socialis*), and coastal or saline shrublands (Wattles *Acacia* spp., Samphire *Tecticornia* spp., Swamp Paperbark *Melaleuca halmaturorum*). The region also contain smaller components of woodlands (Brown Stringybark *E. baxteri*, Cup Gum *E. cosmophylla*, Red Gum *E. camaldulensis*), native grasslands, sedgelands and fringing wetland communities.

2.2 Data

2.2.1 Landscapes and environment

Landsystems and soil types have been classified and mapped for the agricultural areas of South Australia (DWLBC Soil and Land Program 2007; Hall et al. 2009). Each mapped 'Soil Landscape Unit' (SLU) polygon represents a landscape with similar topographic and soil properties (DEWNR SDE 'LANDSCAPE.SALAD_Soil_Subgroup'). SLU polygons can contain multiple landscape elements and soil types when the size of each component is lower than the spatial scale of original mapping. The estimated areal proportion of each component within the polygon is also documented. Soil attributes (e.g. depth, clay content) within components are described using semi-quantitative classes (DWLBC Soil and Land Program 2007; Hall et al. 2009). Soil landscape units (SLU) located wholly or partially within 5 km of Lake Alexandrina, Lake Albert and the Coorong provide a foundation (i.e. abiotic characteristics) for identifying ecosystems of the region (Figure 2.5). Landscape subgroups (Table 2.1) were identified by geographic regions with similar climate, topography and soil landscape units (Figure 2.6).

Table 2.1 Description of landscape subgroups within the CLLMM region of South Australia

Landscape subgroups	Description
Mount Lofty Ranges	Terrestrial plains north and west of the Lake Alexandrina and Lake Albert, and extending into hills and slopes of the Mount Lofty Ranges
Lower Lakes	a) Terrestrial plains and low hills surrounding Lake Alexandrina and Lake Albert b) Aquatic and periodically inundated areas fringing Lake Alexandrina and Lake Albert
Coastal Dunes	Coastal dunefields and aquatic fringes of the Coorong lagoon
South East	Terrestrial landscapes southeast of the Coorong lagoon

2.2.2 Vegetation

Remnant native vegetation (Figure 2.2) has been surveyed, mapped and described over recent decades by DEWNR (DEWNR 2008, 2015, Heard and Channon 1997; e.g. DEWNR SDE 'VEG.SAVegetation'). Vegetation surveys used a standard methodology (Heard and Channon 1997) to identify and describe the structure, crown cover class and species composition within each vegetation 'Patch' (i.e. DEWNR SDE 'FLORA.SurveySites'). Vegetation survey (i.e. unique 'PatchID') data from patches =< 900 m^2 in size or with fewer than four species were excluded to minimize errors in local ecosystem classifications.

Taxonomic issues resulting from data collected over many years by observers with differing skill levels were resolved, where possible, by natural historians with local knowledge.

2.2.3 Birds

Information on the presence and location of terrestrial birds between 1908 and 2013 within the region were compiled from Biological Databases of South Australia (BDBSA) and the database of BirdLife Australia (July 2013). Only indigenous species were included in the analysis. Each record contained the species taxonomy, common name, year, month, location (map coordinates), spatial accuracy (m) of each record and source of the data. Records with a spatial accuracy of >1000 m were excluded from analyses to reduce errors in associations with ecosystems.

Taxonomic issues resulting from data collected over many years by observers with differing skill levels were resolved, where possible, by natural historians with local knowledge.

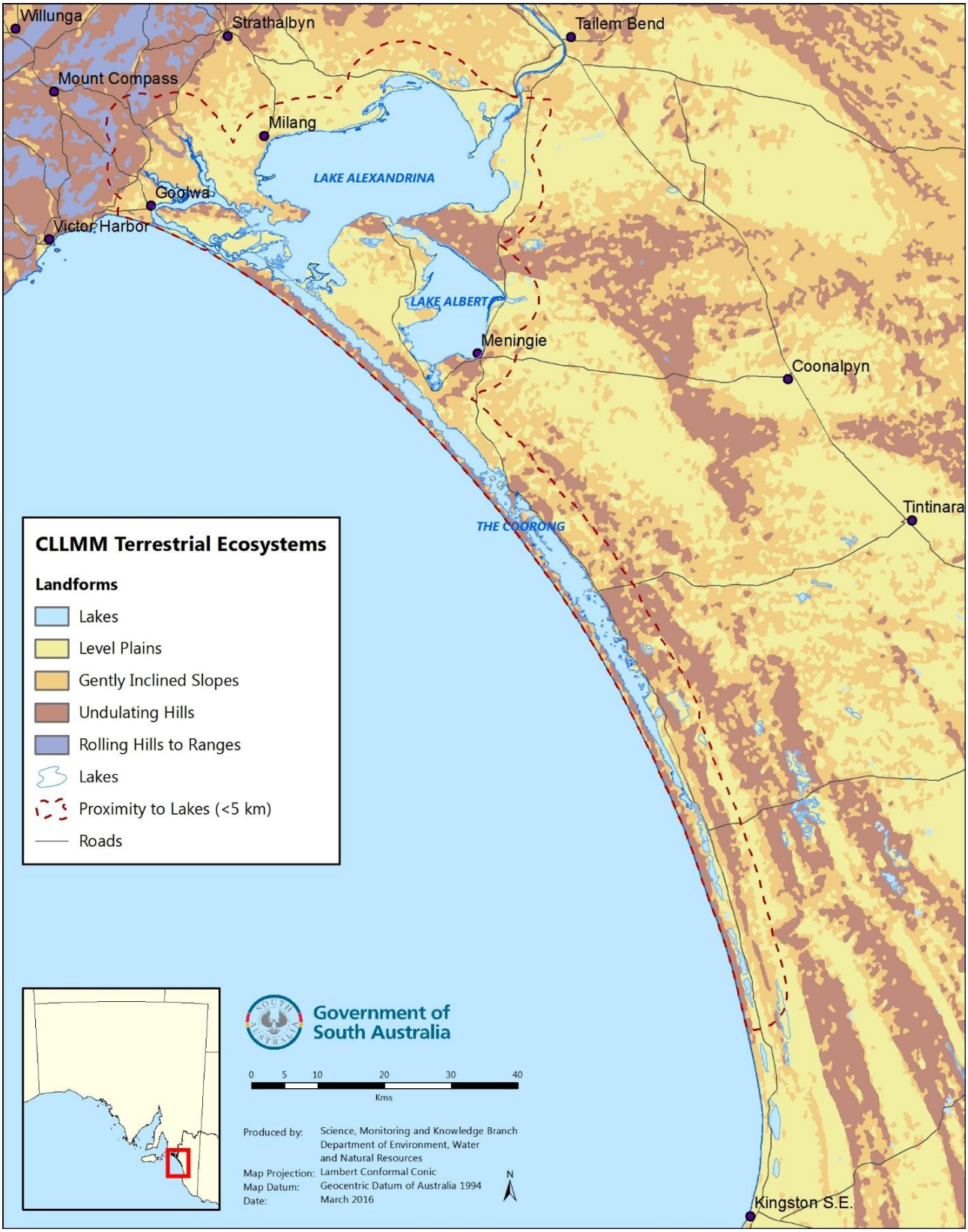

Figure 2.1 Topography and landforms of the CLLMM region of South Australia

Figure 2.2 Remnant native vegetation extent and conservation reserves in the CLLMM region of South Australia

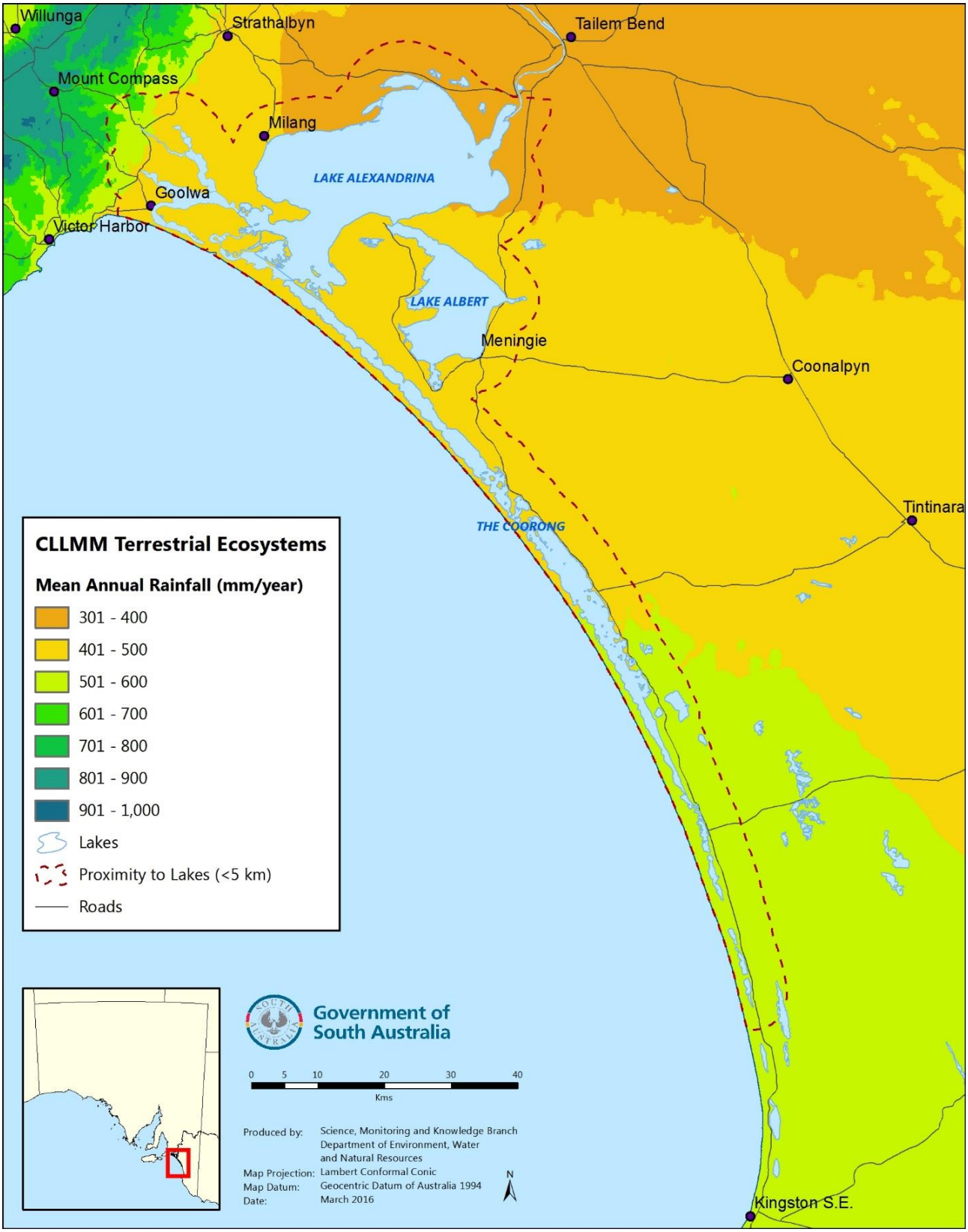

Figure 2.3 Mean annual rainfall of the CLLMM region of South Australia

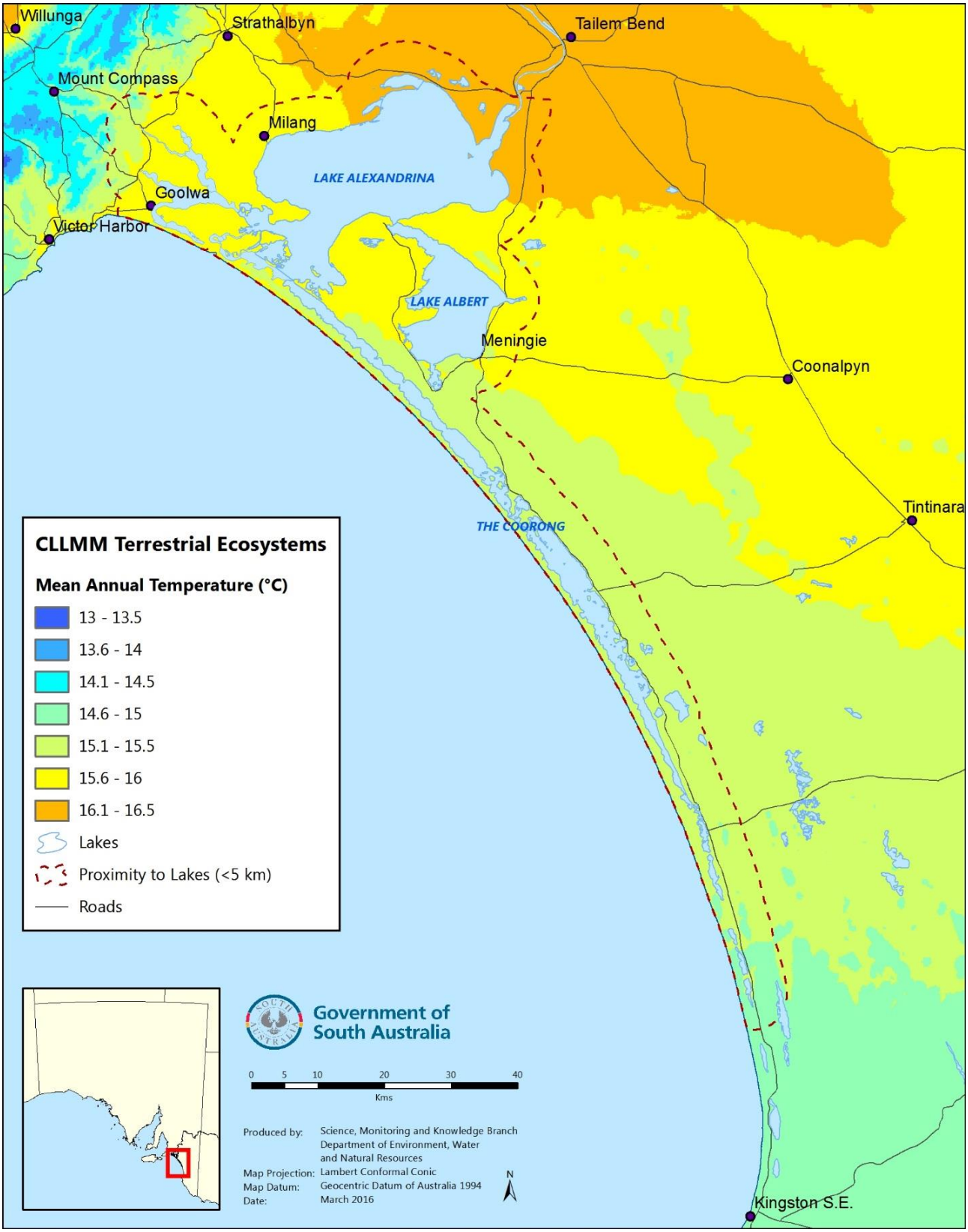

Figure 2.4 Mean annual temperature of the CLLMM region of South Australia

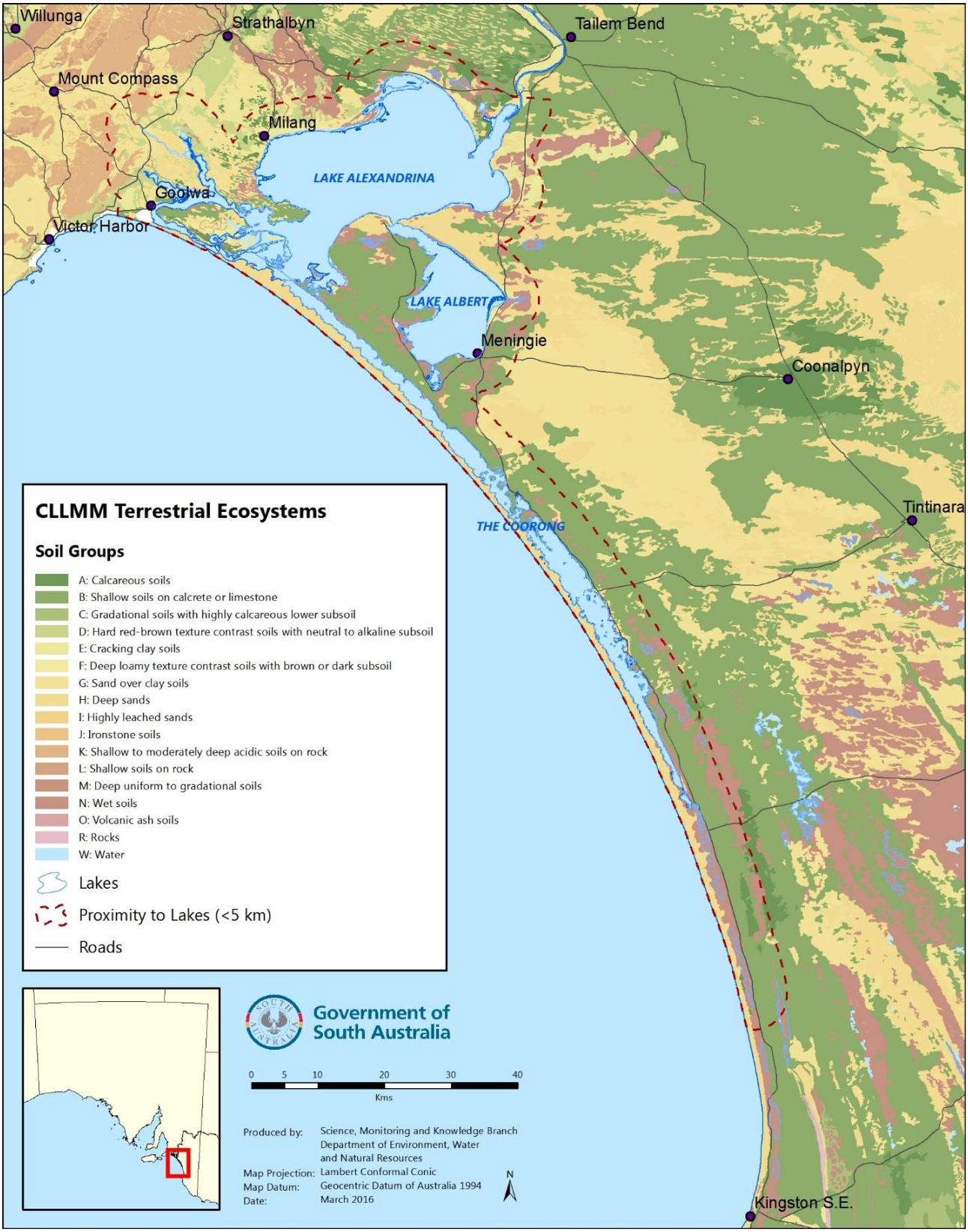

Figure 2.5 Soils groups of the CLLMM region of South Australia

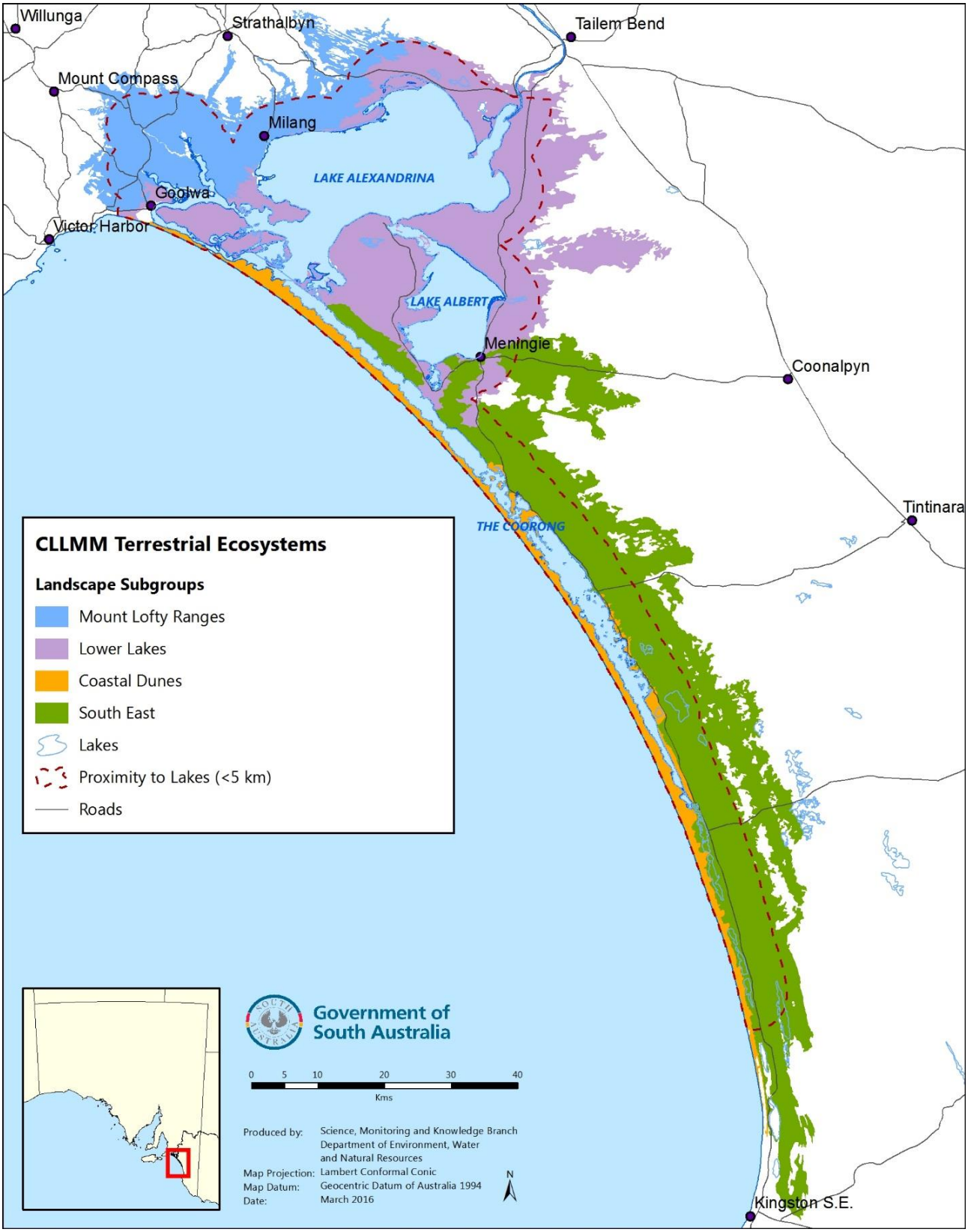

Figure 2.6 Landscape subgroups of the CLLMM region of South Australia

2.3 Ecosystem assessment

2.3.1 Ecosystem classification

Ecosystems for the region were identified from vegetation survey site (i.e. 'Patch') floristic composition, plant species cover and abiotic characteristics (i.e. soil subgroups, mean annual rainfall, topographic slope, landscape subgroups) using hierarchical cluster analysis (Legendre and Legendre 1998). Cluster analyses used the 'hclust' function in the 'vegan' package, (Oksanen et al. 2011), with the number of groups informed by the 'kgs' function (White and Gramacy 2012). Clustering methods used Bray-Curtis dissimilarity measure and WPGMA agglomeration. Non-metric Multidimensional Scale (NMDS) was also used to help with visualisation of dissimilarity between sites, using the metaMDS function in the vegan package (Oksanen et al. 2011). The 'abundance' measure used was based on species-level categorical cover class descriptions from vegetation surveys which converted to representative numeric values (Table 2.2). All analyses were done using R (R Core Team 2013).

Table 2.2 Vegetation survey species cover classes and their corresponding numeric values (i.e. proportion cover) used in cluster analyses of vegetation associations

Cover class description	Proportion cover
Sparsely or very sparsely present - cover very small (less than 5%)	0.01
Not many, 1–10 individuals	0.02
Plentiful but of small cover (less than 5%)	0.03
Any number of individuals covering 5–25% of the area	0.05
Any number of individuals covering 25–50% of the area	0.25
Any number of individuals covering 50–75% of the area	0.50
Covering more than 75% of the area	0.75

2.3.2 Other ecosystems

Vegetation survey sites that did not strongly cluster to ecosystem classifications, and pre-1750 native vegetation types (DEWNR 2015; DEWNR SDE 'VEG.PEVegetation') that did not match ecosystem classifications from the cluster analysis, were used to identify additional ecosystems within the region. For each of these additional ecosystem types abiotic characteristics (i.e. soil subgroups, mean annual rainfall, topographic slope, landscape subgroups) for vegetation survey sites or DEWNR pre-1750 vegetation mapping units (i.e. DEWNR SDE 'VEG.PEVegetation') were used to define these additional ecosystems.

2.3.3 Ecosystem mapping

Ecosystem mapping for the region is constrained to the soil landscape units (SLU) located wholly or partially within 5 km of Lake Alexandrina, Lake Albert and the Coorong (Figure 2.5 & Figure 2.6) to minimize potential misclassifications from insufficient calibration data. Soil and landscape characteristics (i.e. proportions of SLU soil subgroups, landscape subgroups) associated with each ecosystem were used to construct spatial domain models to represent their likely distribution (see Sect. 6.2). Additional ecosystems are mapped from their pre–1750 native vegetation extent (DEWNR 2015; DEWNR SDE 'VEG.PEVegetation'), topographic data (DEWNR SDE 'TOPO.WaterCourses') or recent landuse mapping (DEWNR SDE 'LANDSCAPE.LandUse2008').

2.4 Species assessment

2.4.1 Trends in bird occurrence

Biological databases

To quantify historic trends in bird species occurrence within the region all bird records (i.e. BDBSA + Bird Atlas data) were assigned to 100 ha hexagonal subdivisions of the study area (Figure 2.7) and changes in occurrence of each species within each 100 ha area between historic (1908–2013) and recent (2000–13) periods were analysed to identify species declines or increases (Franklin 1999). Hexagons without any bird species records were excluded as false negatives for any species. The degree of change (i.e. 'Current vs All Time') was calculated as the proportion of hexagons in which a species was recently recorded (≥2000), compared to the number of times it had been recorded over the entire survey period (1908–2013). To reduce potential biases resulting from less reliable data this analysis excluded species with <10 records and/or those that had been recorded in <5 hexagons.

Linear regression was performed on the proportion of 100 ha areas that were occupied by each species per year (i.e. Number Observed'). Species were identified as declining in this analysis (i.e. 'Trend Analysis') if the results of the regression (i.e. 'P Value'; 'R-squared') indicated p values of <0.1, and a negative slope value (i.e. 'Slope'). Again, steps were taken to address issues of variable effort in species surveys. Lists with less than three species were removed (to reduce bias associated with surveys that target particular species), and years with less than five surveys were removed.

Expert bird assessment model

For each species, information on current status and trend of occurrence from prior DEWNR regional assessments (Gillam 2011; Gillam 2012), including results from the analysis of biological databases, were reviewed by panel of experts (i.e. eight ecologists). Species were given the following 'status scores' by these experts based on their assigned conservation status: Extinct = 6, Critically Endangered = 5, Endangered = 4, Vulnerable = 3, Rare = 2, Near Threatened = 1, Least Concern or Data Deficient = 0. Species trends were scored as: definite decline=-2, probable decline = -1, stable= 0, probable increase= +1, or definite increase= +2. Threat scores were generated from the sum of status and trend scores, where: 0–1 = Least Concern; 2 = Rare but Stable; 3 = Widespread but Declining; 4 = Rare and Declining; and 5 = Extinct (locally). The mean of each species threat score for each IBRA subregion (i.e. Fleurieu, Murray Mallee, Murray Lakes and Coorong, Tintinara, Bridgewater/Lucindale; Figure 2.7) and the number of IBRA subregions where the species once existed were calculated (i.e. 'Status Trends Scores', 'Number of SubRegions'). Species that were assigned an overall threat score of 3 or 4 were identified as declining in this analysis.

Synthesis bird assessment

The outputs of analyses of data from biological databases and expert assessment were added as a parent node into a Bayesian Belief Network (BBN; McCann et al. 2006) to determine whether birds were "increasing", "stable", or "decreasing" in the region. Uncertainties in biological data (e.g. BDBSA surveys are not standardised through time), and confidence levels of expert assessments of bird species status and trends, are incorporated into the BBN analysis. The structure of the model is shown in Figure 2.8 and the conditional probability table behind the output node is shown in Table 2.3. Sensitivity analyses of the BBN model using entropy reduction identified the contribution of each assessment method on the synthesis bird assessment of trends in occurrence (Pearl 1988, Korb and Nicholson 2004, Marcot et al. 2006, Pollino et al. 2007, Smith et al. 2007). Entropy measures the degree of uncertainty in a variable. Entropy reduction describes the expected reduction, l ,in mutual information of a query variable Q due to a finding F and is calculated as:

$$l = \sum_q \sum_f P(q, f) \log[P(q, f) / P(f)]$$

where q is a state of the query variable Q, f a state of the findings variable F, and the summation refer to the sum of all states q or f of variables Q or F. It provides a ranking of parent nodes importance described as their ability to change the posterior probability of a given state of a child node (Korb and Nicholson 2004).

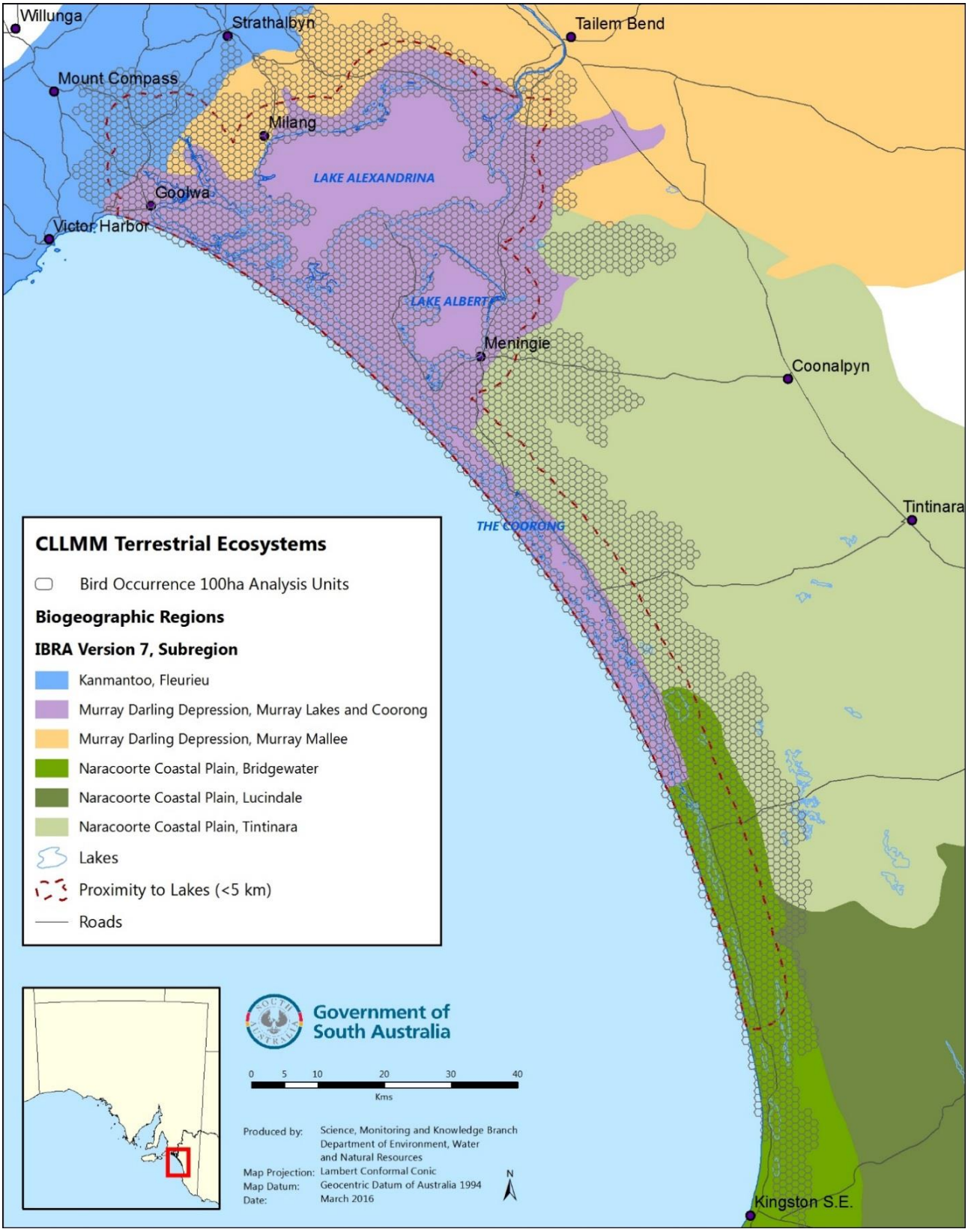

Figure 2.7 Location of 100 ha areas used to analyse historic changes in bird occurrence within IBRA subregions of the CLLMM region of South Australia

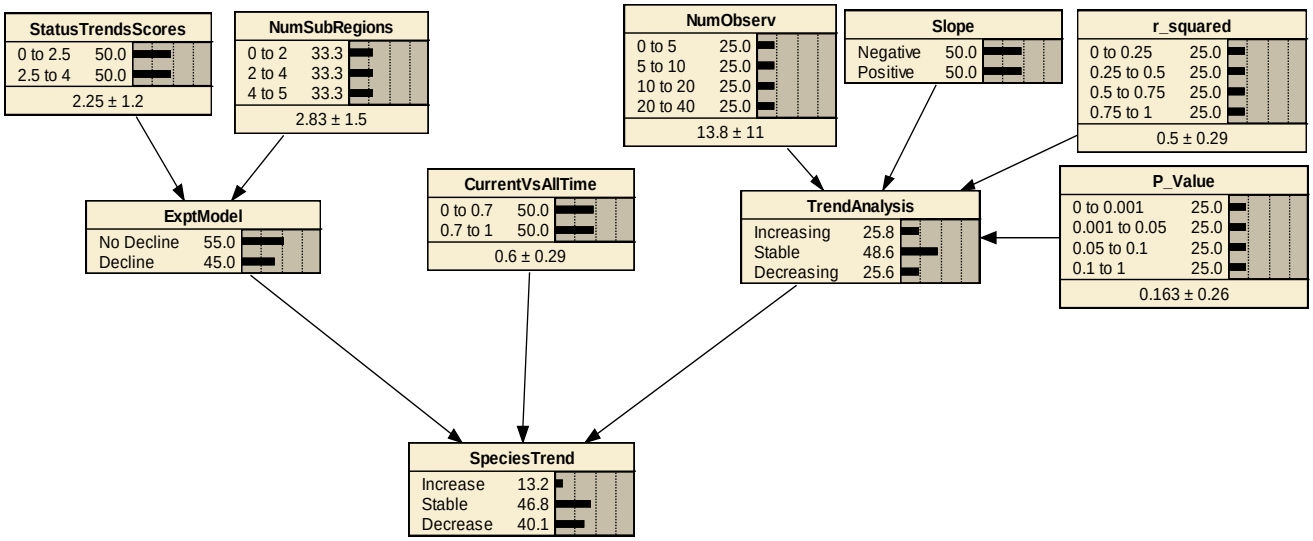

Figure 2.8 The graphical structure of the Bayesian Belief Network used in determining bird trends within the CLLMM region of South Australia

Table 2.3 Conditional probability table behind the output node 'Species Trend' in the Bayesian Belief Network used to determine bird trends within the CLLMM region of South Australia

Parent node states			**Outcome states (bird trends)**		
Expert model	Current vs All time	Trend analysis	Increase	Stable	Decrease
No Decline	0 to 0.7	Increasing	25	50	25
No Decline	0 to 0.7	Stable	0	60	40
No Decline	0 to 0.7	Decreasing	0	30	70
No Decline	0.7 to 1	Increasing	50	45	5
No Decline	0.7 to 1	Stable	30	60	10
No Decline	0.7 to 1	Decreasing	5	65	30
Decline	0 to 0.7	Increasing	10	30	60
Decline	0 to 0.7	Stable	0	40	60
Decline	0 to 0.7	Decreasing	0	10	90
Decline	0.7 to 1	Increasing	50	40	10
Decline	0.7 to 1	Stable	0	60	40
Decline	0.7 to 1	Decreasing	0	30	70

2.4.2 Response groups

As the targeted focus of this assessment related to the identification of ecosystems to be prioritised for revegetation, the focus of response groups related to the strength of association that bird species had with particular ecosystems or habitat types. Information on the habitat requirements for each species was gathered from literature (e.g. Handbook of Australian, New Zealand and Antarctic Birds series). This information was supplemented by expert assessments to identify associations between each bird species and ecosystem (Rogers et al. 2012). Each expert rated the strength of these associations: 0 = no likelihood of the species in the ecosystem; 1 = little likelihood of the species in the ecosystem; 2 = some likelihood of the species in the ecosystem; 3 = high likelihood of the species in the ecosystem; 4 = certainly found in the ecosystem; 5 = certainly found in the

ecosystem with a strong association with that ecosystem. Results across experts were averaged and consensus integer values were agreed for each species and ecosystem.

Based on these information sets, each bird species was classified to an 'Ecosystem Response Groups' (ERG), that grouped species based on common habitat type associations (as per 'ecosystem groups' of Chin et al. 2010). Species were classified to ERG using hierarchical cluster analysis (Legendre and Legendre 1998). Cluster analyses used the 'hclust' function in the 'vegan' package, (Oksanen et al. 2011), with the number of groups informed by the 'kgs' function (White and Gramacy 2012). Clustering methods used Bray-Curtis dissimilarity measure and WPGMA agglomeration. Non-metric Multidimensional Scale (NMDS) was also used to help with visualisation of dissimilarity between species, using the metaMDS function in the vegan package (Oksanen et al. 2011). Natural breaks in similarity measures were checked against expert rankings to adjust some break points between clusters. The outputs of the cluster analysis was further refined with qualitative analyses in cases where a large cluster was evident but thought to represent a number of smaller groups based on expert knowledge of birds in the region. All analyses were done using R (R Core Team 2013).

2.5 Land use assessment

2.5.1 Land use history

A comprehensive synthesis of the post-European land use history of the CLLMM region was recently undertaken by Butcher and Rogers (2013) that provided a summary of the spatial and temporal history of environmental modification since European settlement. This summary was used in conjunction with spatial information (e.g. Figure 2.2) to assess the timing, location and extent of native vegetation clearance, with particular reference to differences among landscapes and ecosystems within landscapes. This published information was augmented using two local historians (i.e. key informants) with extensive knowledge about pre-European vegetation in the study area. Estimates of the extent of change within each ecosystem and the confidence levels of this information were collated. All information gathered from key informants was classified by the informant on their confidence in reliability of the information (i.e. 'Low' 1–45%, 'Medium' 46–75%, 'High' 76–90%, 'Very High' >90%). Recent landuse mapping (DEWNR SDE 'LANDSCAPE.LandUse2008') was also used to identify current landuse activities with the region.

2.6 Landscape assessment

The analyses were synthesised to inform the state and trend of the systems within each CLLMM landscape, and the most likely drivers of these patterns of change. In summary, the analyses above provide the following information to this synthesis:

- **Ecosystem Assessment** – provides a description of the important ecosystems that comprise each landscape. This provides a framework for the inherent ecological variation that occurs in the system, and the ecological structure and function (e.g. habitat types) variability among systems. In addition, the drivers of environmental change that have resulted in loss of biodiversity can often vary with among these ecosystems (Paton et al. 1999). In agricultural landscapes in particular, understanding the nature and distribution of these different ecosystems is critical to understanding where intervention is required to reduce the risk of biodiversity loss. Ecosystem assessment thus provides the biophysical context on which the landscapes assessment is based.
- **Species Assessment** – by understanding the state and trend of individual species, and the strength of their association with different ecosystems, we are able to use groups of species as indicators of the state and trend of different ecosystems. This provides the foundation for assessing where (which ecosystems) intervention is most urgent to prevent biodiversity loss within a landscape.

- **Land Use Assessment** – understanding the history of environmental change, including the nature and extent of impact, provides information regarding the drivers of ecological change inferred from the species assessment, as well as correlative support for this ecological change. Understanding the nature of land-use change allows us to better understand the key systemic drivers of decline, in order to design objectives that address these drivers. A widespread example is the historic preferential clearance of different ecosystems in agricultural landscapes that are correlated with agricultural potential.

3 Results

3.1 Ecosystem assessment

Nine ecosystems were initially identified from hierarchical cluster analysis (see Table 3.1, Appendix 6.1, Figure 6.1) of species composition and vegetation cover data from biological surveys in the region (i.e. DEWNR SDE 'FLORA.SurveySites'), and abiotic data. The cluster analysis identified anticipated (e.g. Gillespie et al 2013) associations between vegetation floristics, soil types and/or landscape subgroups (i.e. geomorphology, topography, climate). Comparisons between ecosystems resulting from the classification of vegetation survey sites, unclassified vegetation survey sites and pre-1750 native vegetation mapping (DEWNR 2015; DEWNR SDE 'VEG.PEVegetation'), detected four subdivisions of Ecosystem 6 (i.e. 'Mixed Eucalypt woodland / Mallee ecosystem') and four additional native ecosystems. The modern 'Agroecosystems (agricultural lands)' was recognised and included in the list of ecosystems for the region. The combination of results from cluster analyses using vegetation survey data, pre-1750 vegetation mapping, modern landuse mapping and expert opinion identified 17 Ecosystems within the CLLMM region of South Australia (Table 3.1).

The relationships between the 17 Ecosystems and soil groups (i.e. DEWNR soil mapping), Landscape subgroups (i.e. geographic regions with similar climate, topography and soil landscape units), pre-1750 vegetation mapping, topographic data or recent landuse mapping are given in Appendix 6.2. More detailed descriptive information, including vegetation composition are shown in Appendix 6.3.

Potential distribution maps for each ecosystem (Figure 3.1 to Figure 3.17) are constrained to the outer boundary of soil landscape units (SLU) polygons located wholly or partially within 5 km of Lake Alexandrina, Lake Albert and the Coorong (e.g. Landscape Subgroups; Figure 2.5 & Figure 2.6). Maps for each ecosystem include estimates of the proportion of each mapped soil-landscape unit, pre-1750 vegetation mapping unit or land use polygons that matches each ecosystem model's criteria (see Appendix 6.2). Ecosystems 10.1, 10.2, 10.3 and 10.5 with models based on mapped polygons without proportional data were assigned a nominal value of 75%. Proportions were classified into four levels for mapping outputs: >60% (high); 30–60% (medium); 5–30% (low); and 0–5% (very low).

Table 3.1 Terrestrial ecosystems of the CLLMM region of South Australia

Ecosystems	Methods used
1. Pink Gum Low Open Grassy Woodland (MLR sands)	Cluster analysis
2. Stringybark / Cup Gum Woodland (MLR hills)	Cluster analysis
3. Mixed Shrubland (coastal dunes)	Cluster analysis
4. Coastal White Mallee (SE/LL sandy loams)	Cluster analysis
5. Sheoak Low Shrubby Woodland (SE/LL sandy loams)	Cluster analysis
6. Mixed Eucalypt woodland / Mallee ecosystem	Cluster analysis,
6.1 Mallee Box Grassy Woodland (LL loams)	pre-1750
6.2 Peppermint Box Grassy Woodland (MLR loams)	vegetation
6.3 Ridge-fruited / Narrow-leaf Red Mallee (MLR sands)	mapping, expert
6.4 SA Blue Gum Grassy Woodland (SE/LL loams)	knowledge
7. Reeds and Rushes (freshwater fringes)	Cluster analysis
8. Lignum Shrubland (non-saline clays)	Cluster analysis
9. Samphire / Paperbark Shrubland (saline clays)	Cluster analysis
10. Other ecosystems	Pre-1750
10.1 Chaffy Saw-sedge Swampland	vegetation
10.2 Red Gum Grassy Woodland (MLR river flats)	mapping, expert
10.3 Tussock Grassland (dryland)	knowledge,
10.4 Sheoak / Native Pine Grassy Woodland (LL loams)	modern landuse
10.5 Agroecosystems (agricultural lands)	mapping

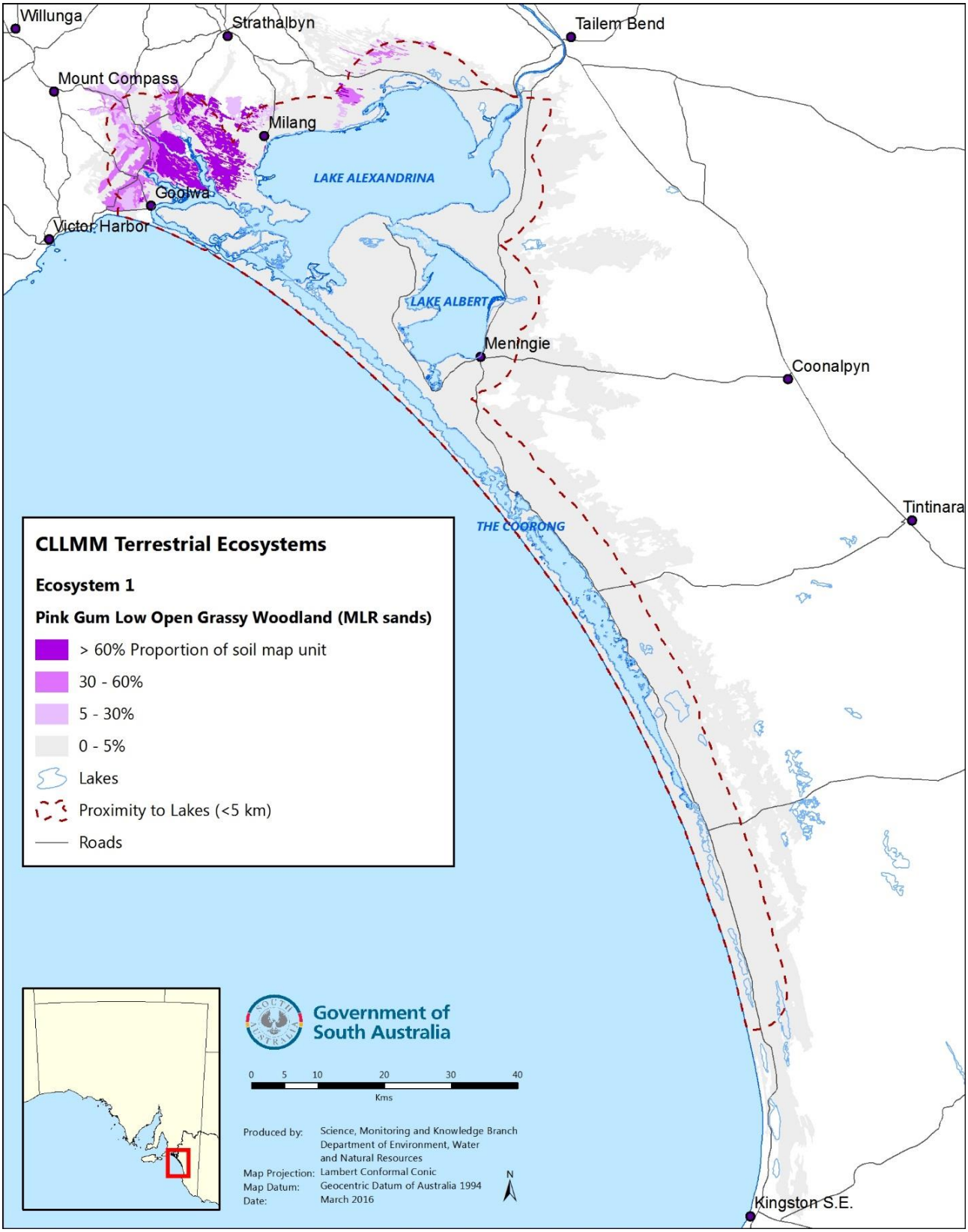

Figure 3.1 Potential distribution of Ecosystem 1: Pink Gum Low Open Grassy Woodland (MLR sands) of the CLLMM region of South Australia

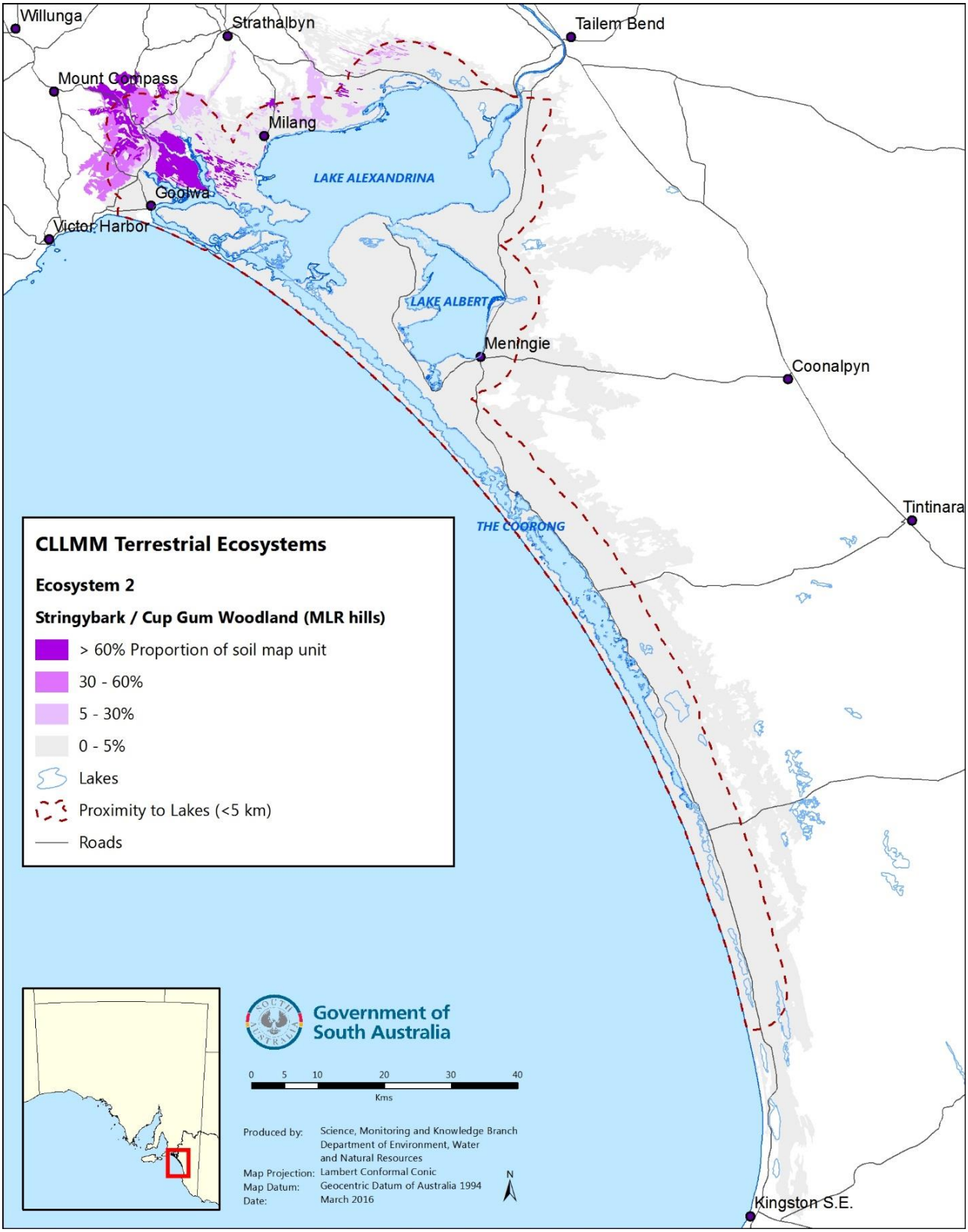

Figure 3.2 Potential distribution of Ecosystem 2: Stringybark / Cup Gum Woodland (MLR hills) of the CLLMM region of South Australia

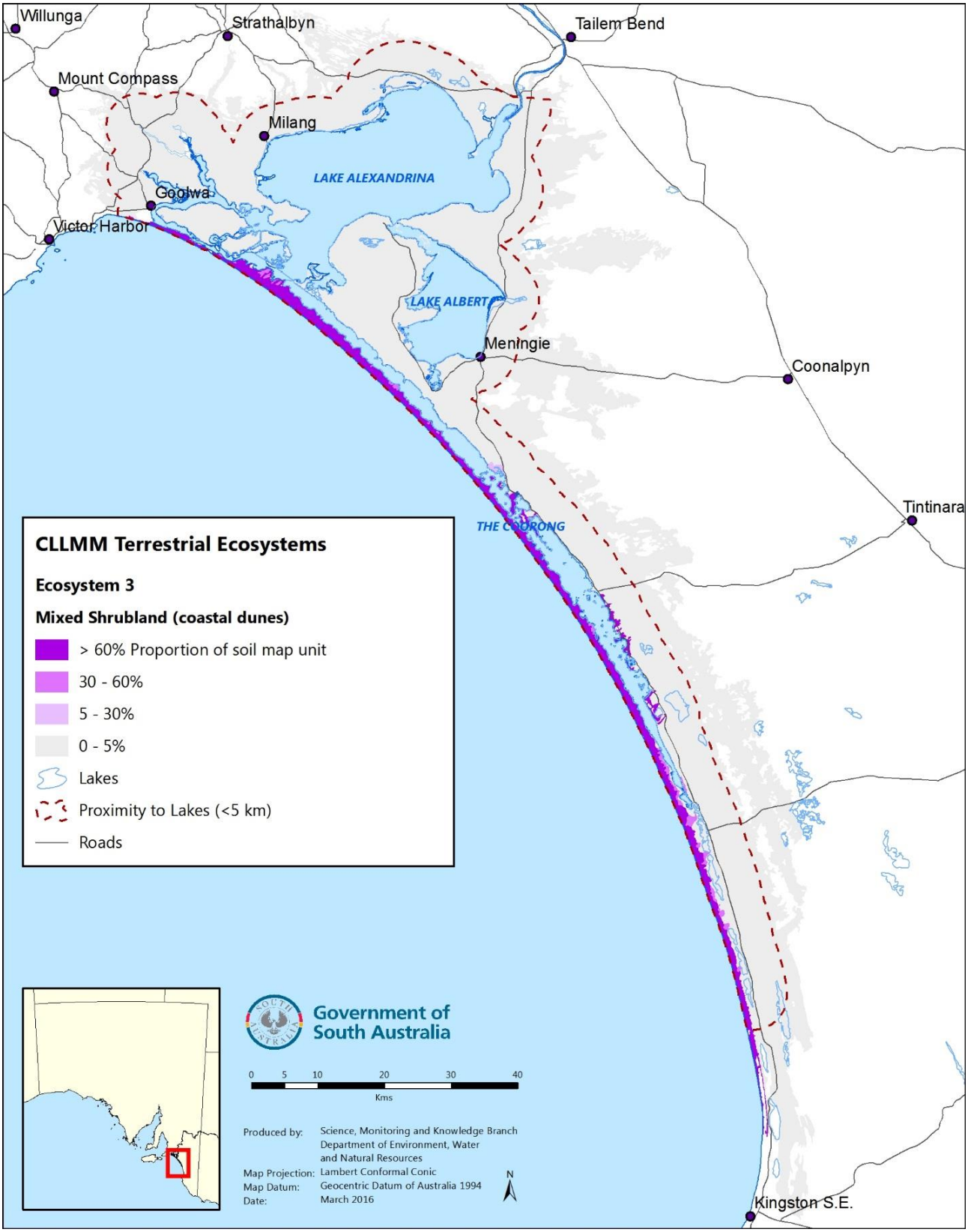

Figure 3.3 Potential distribution of Ecosystem 3: Mixed Shrubland (coastal dunes) of the CLLMM region of South Australia

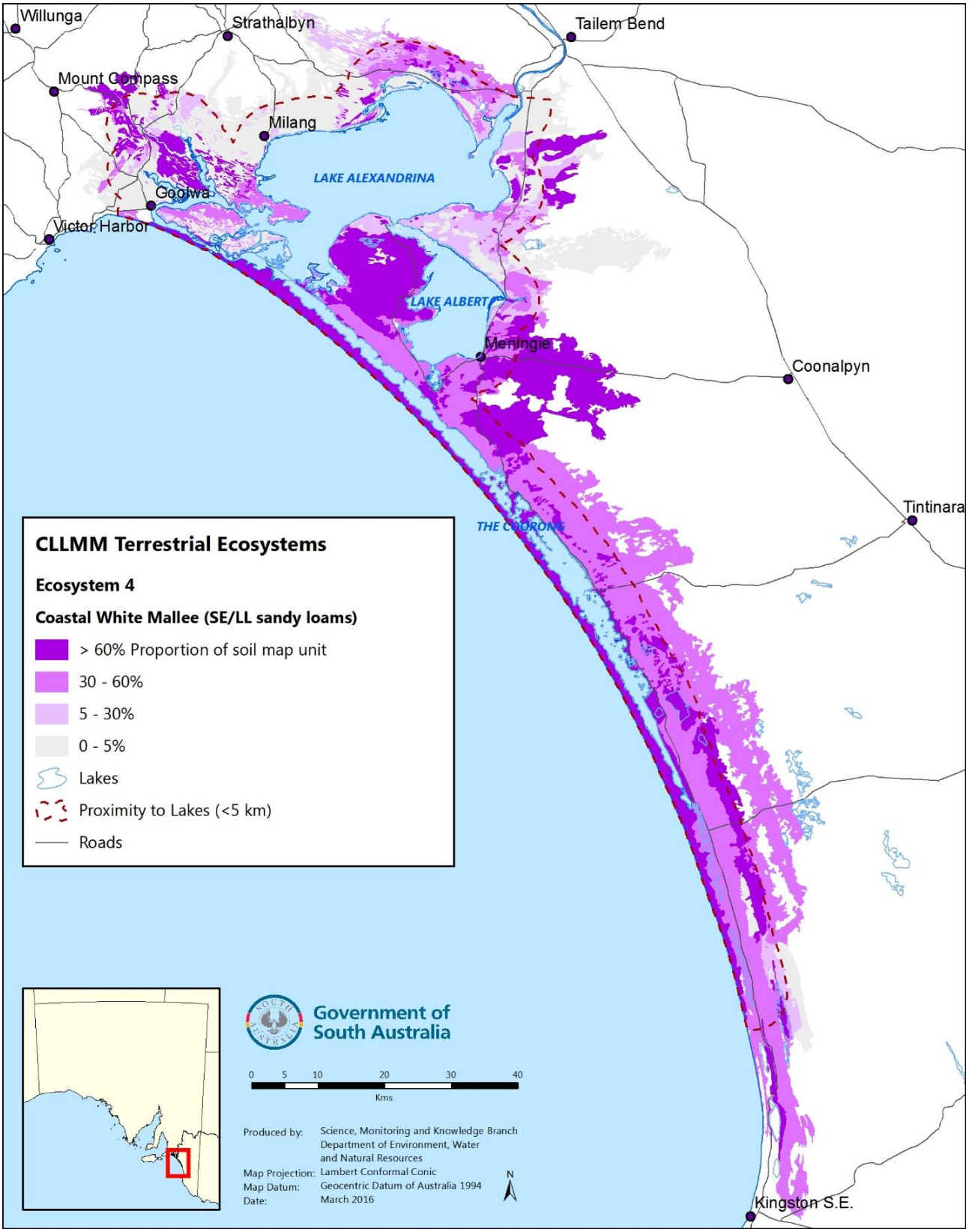

Figure 3.4 Potential distribution of Ecosystem 4: Coastal White Mallee (SE/LL sandy loams) of the CLLMM region of South Australia

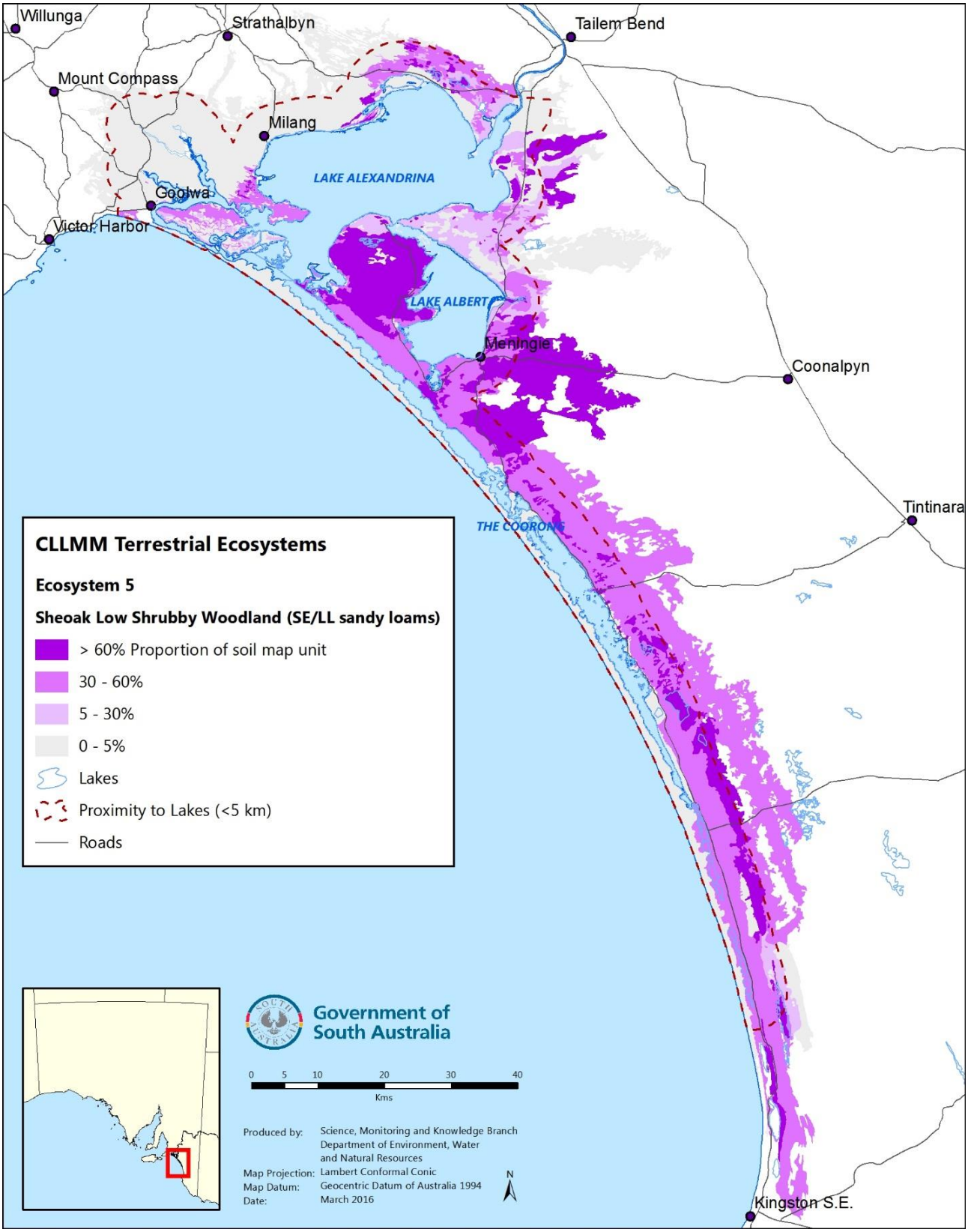

Figure 3.5 Potential distribution of Ecosystem 5: Sheoak Low Shrubby Woodland (SE/LL sandy loams) of the CLLMM region of South Australia

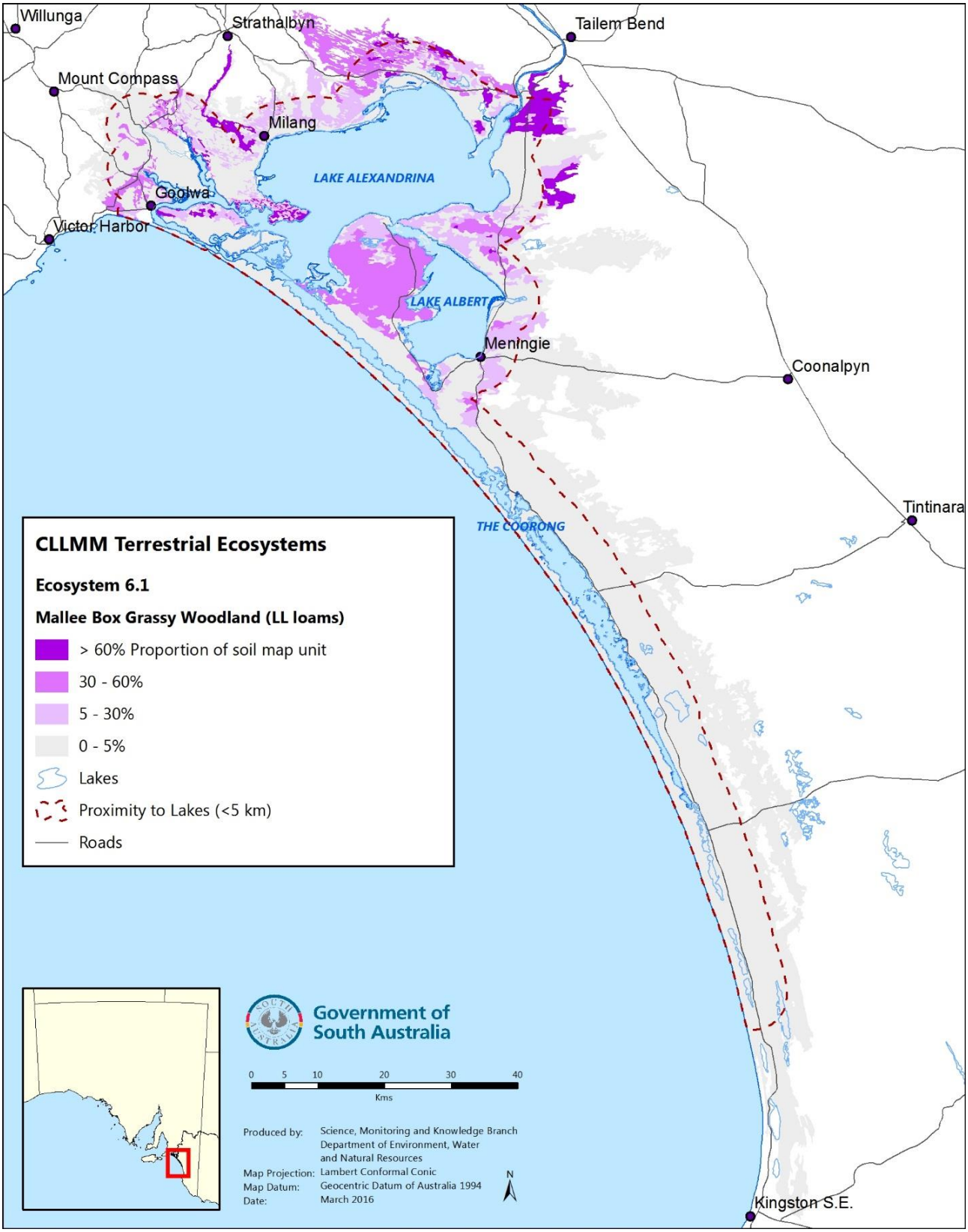

Figure 3.6 Potential distribution of Ecosystem 6.1: Mallee Box Grassy Woodland (LL loams) of the CLLMM region of South Australia

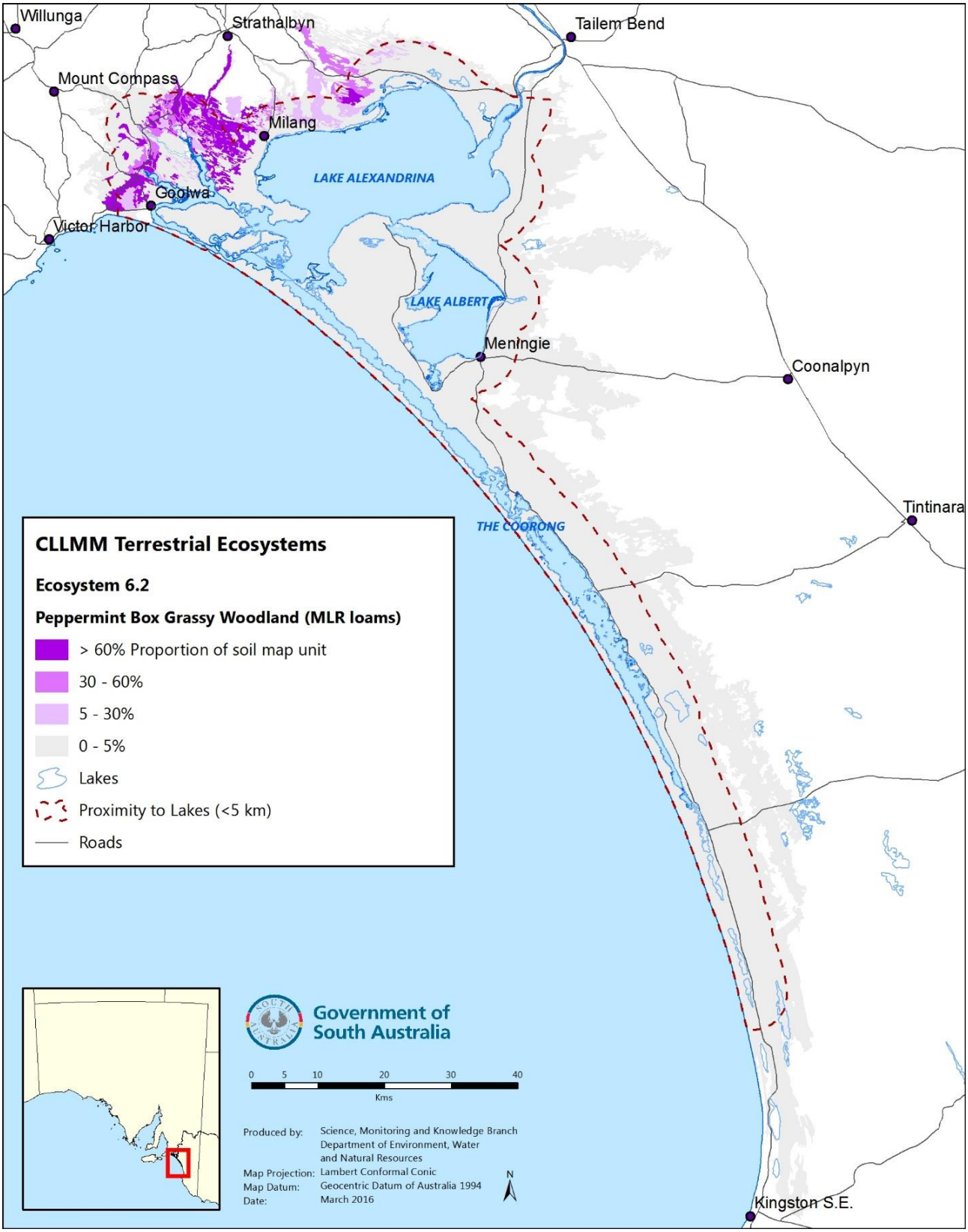

Figure 3.7 Potential distribution of Ecosystem 6.2: Peppermint Box Grassy Woodland (MLR loams) of the CLLMM region of South Australia

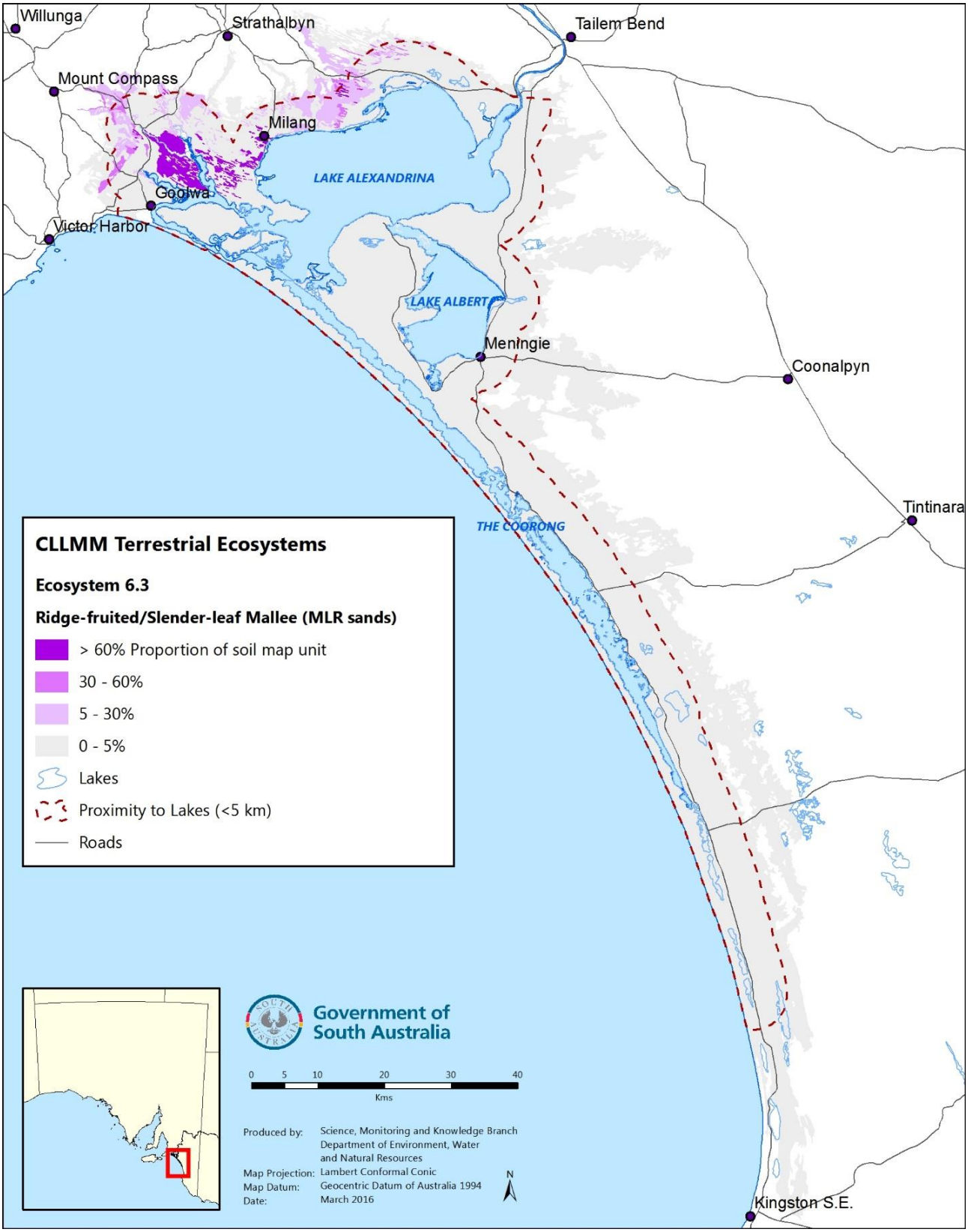

Figure 3.8 Potential distribution of Ecosystem 6.3: Ridge-fruited / Narrow-leaf Red Mallee (MLR sands) of the CLLMM region of South Australia

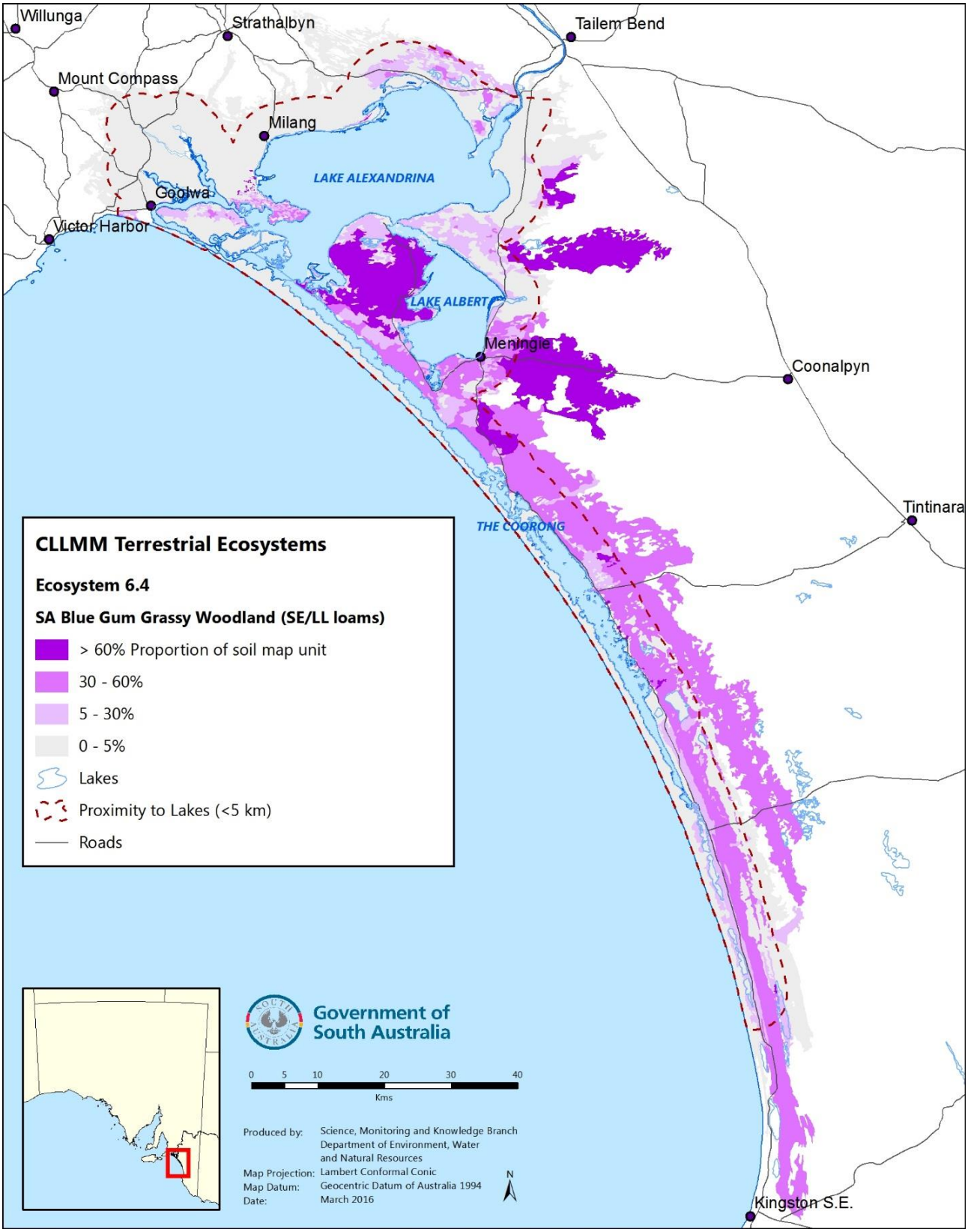

Figure 3.9 Potential distribution of Ecosystem 6.4: SA Blue Gum Grassy Woodland (SE/LL loams) of the CLLMM region of South Australia

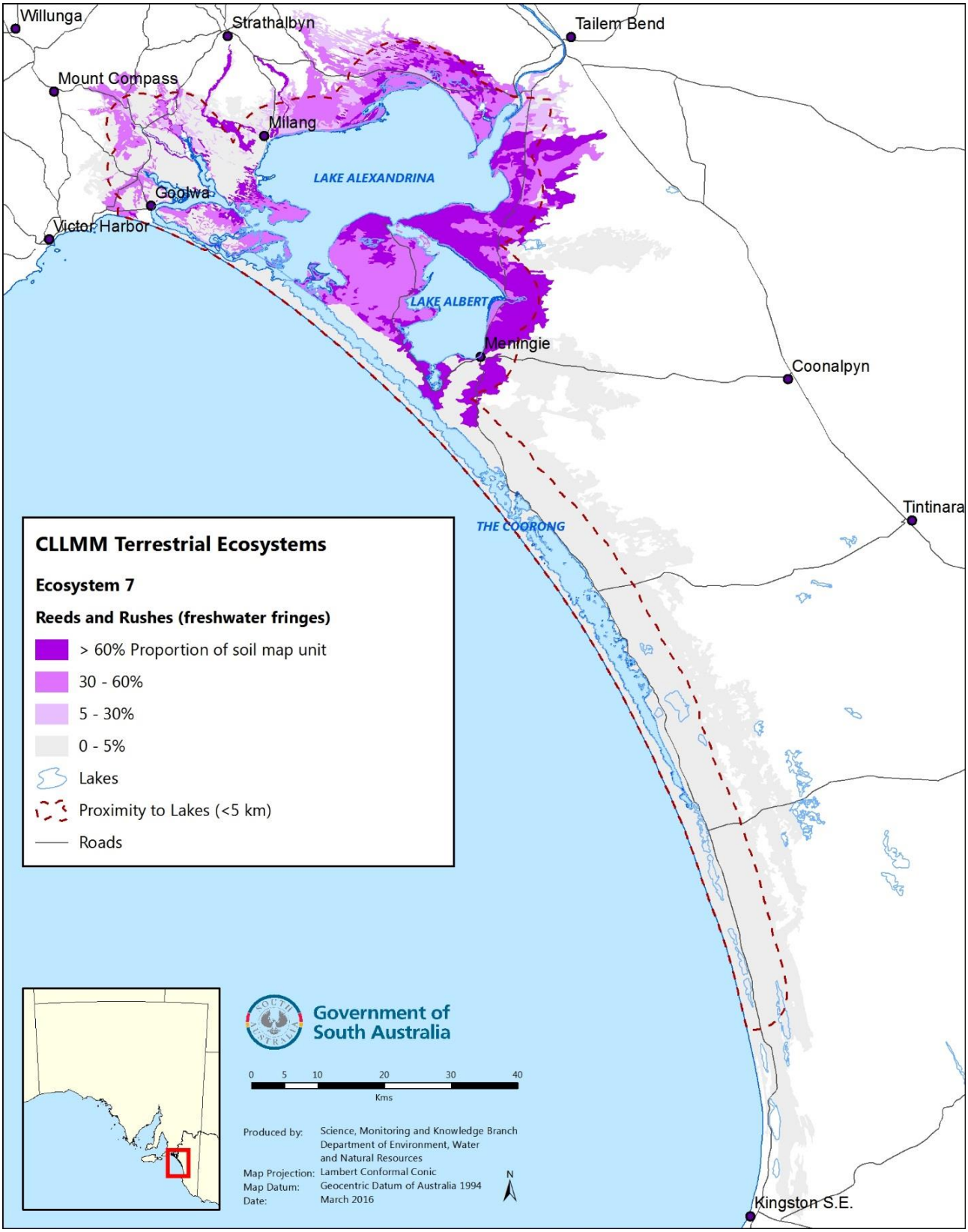

Figure 3.10 Potential distribution of Ecosystem 7: Reeds and Rushes (freshwater fringes) of the CLLMM region of South Australia

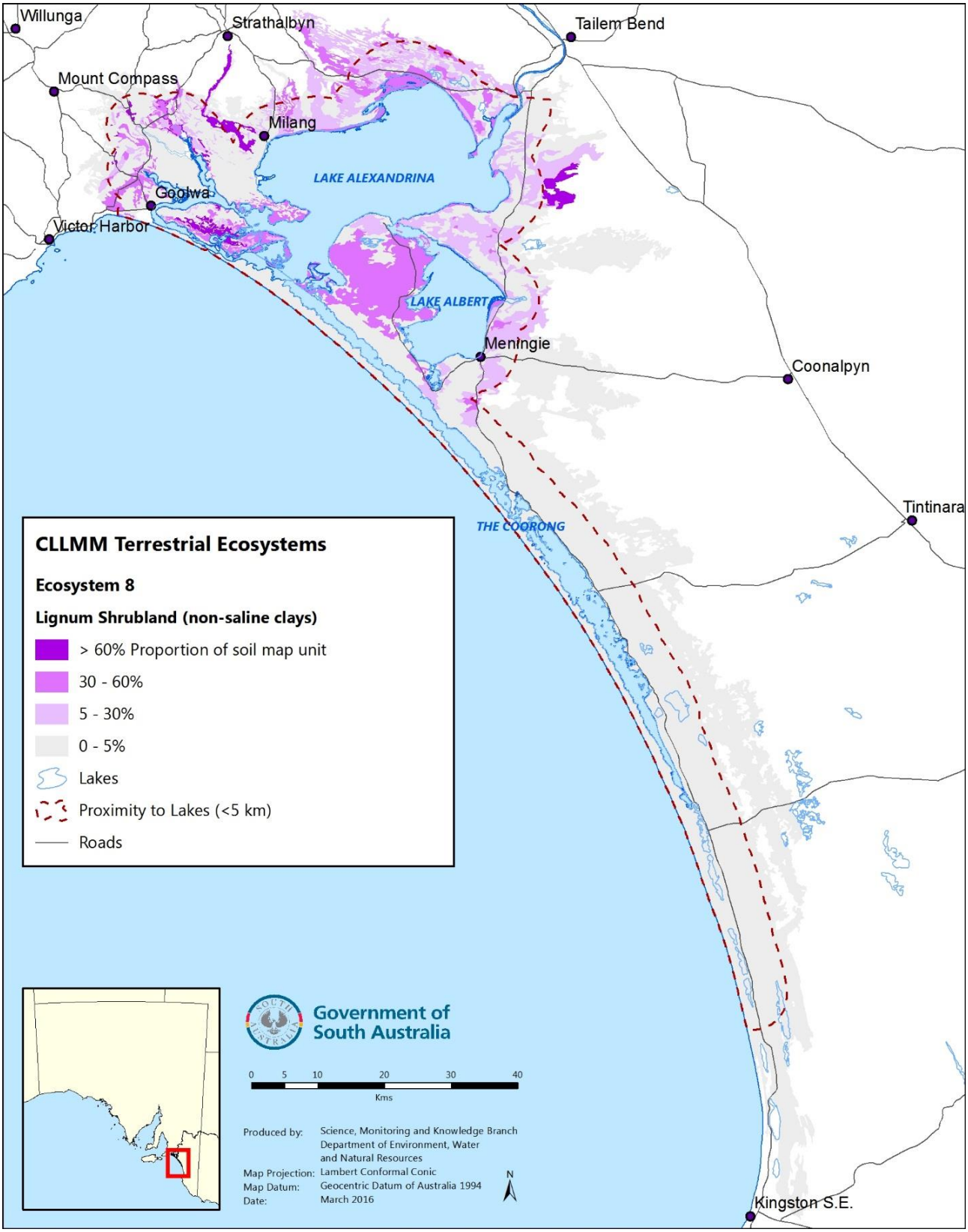

Figure 3.11 Potential distribution of Ecosystem 8: Lignum Shrubland (non-saline clays) of the CLLMM region of South Australia

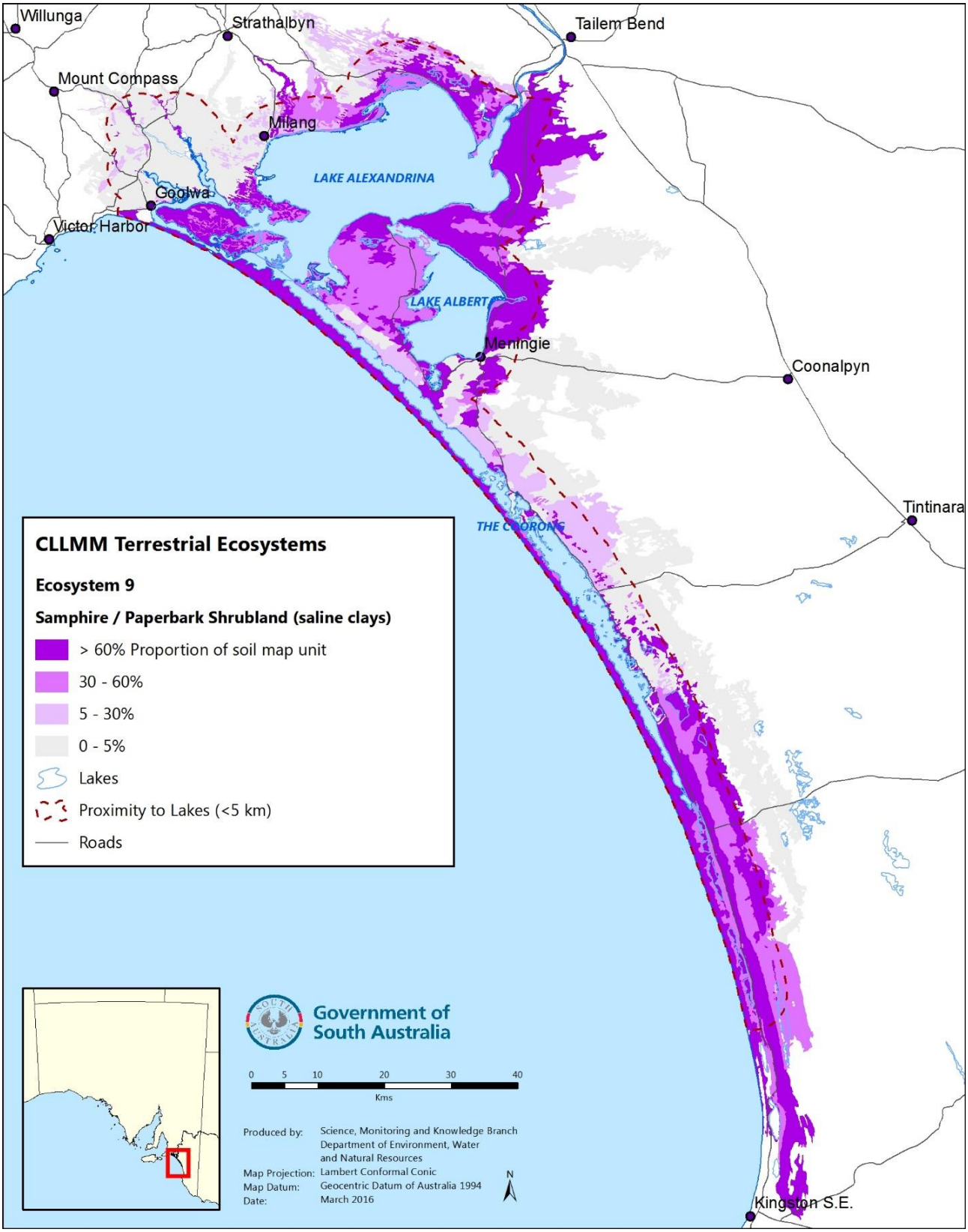

Figure 3.12 Potential distribution of Ecosystem 9: Samphire / Paperbark Shrubland (saline clays) of the CLLMM region of South Australia

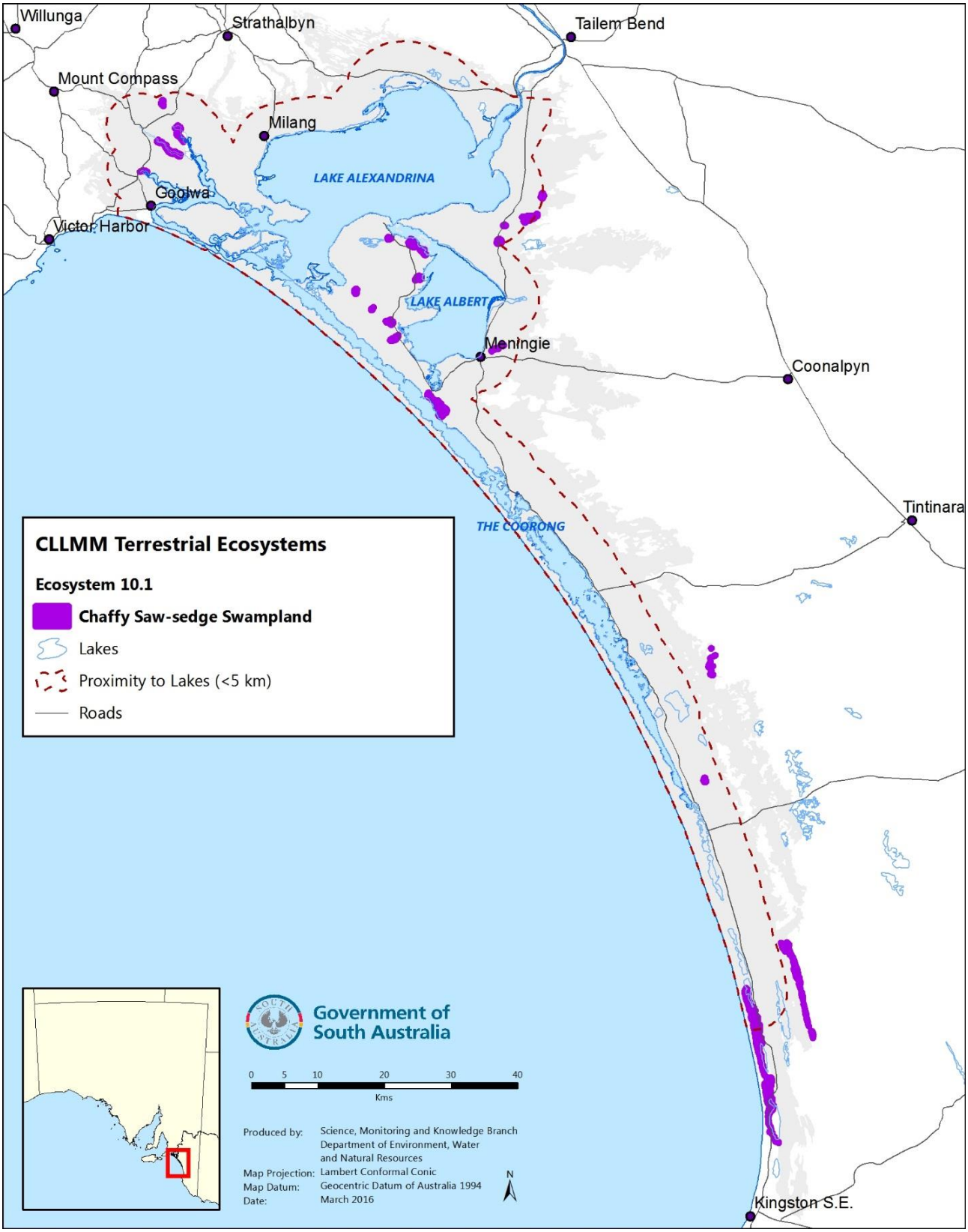

Figure 3.13 Potential distribution of Ecosystem 10.1: Chaffy Saw-sedge Swampland of the CLLMM region of South Australia

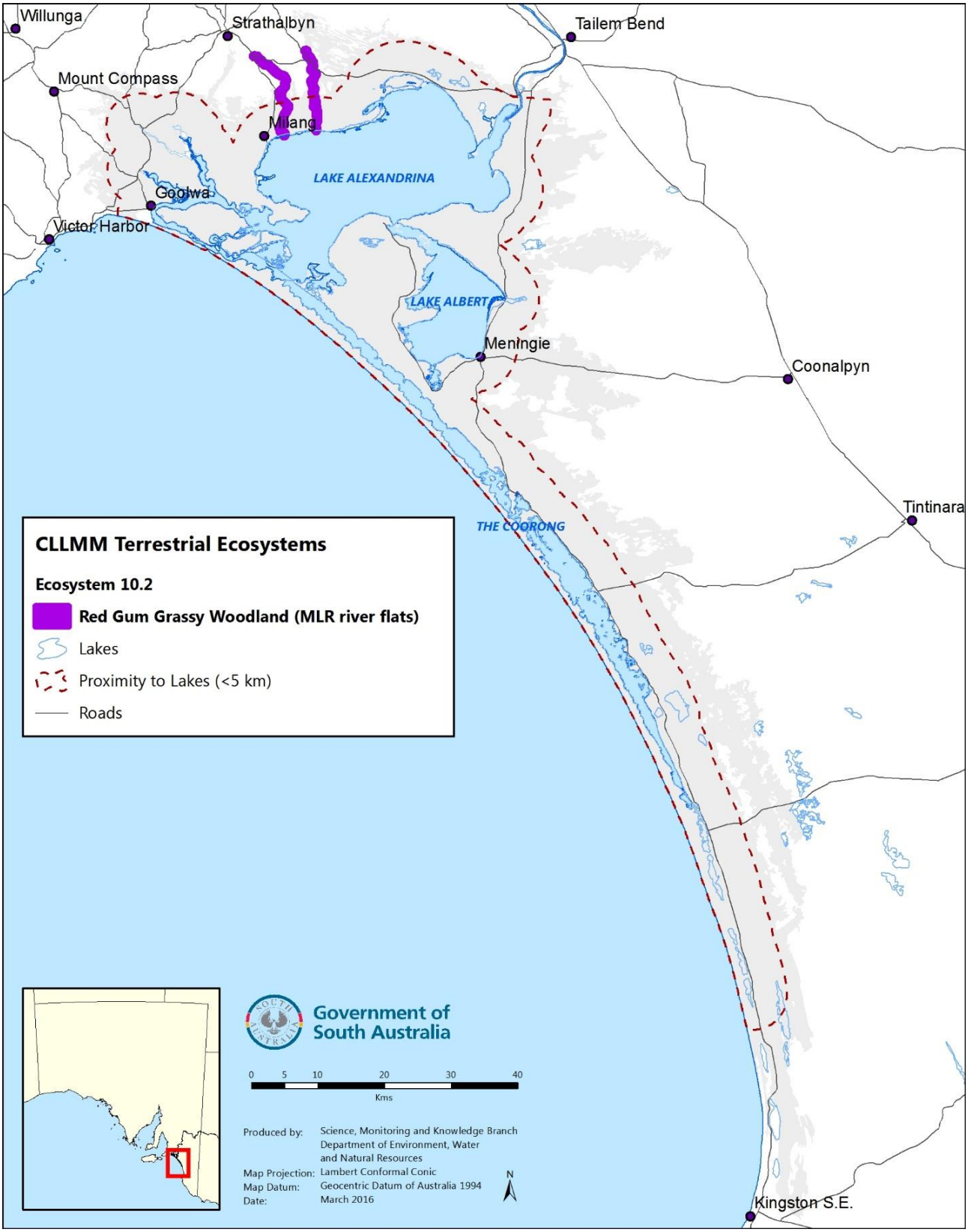

Figure 3.14 Potential distribution of Ecosystem 10.2: Red Gum Grassy Woodland (MLR river flats) of the CLLMM region of South Australia

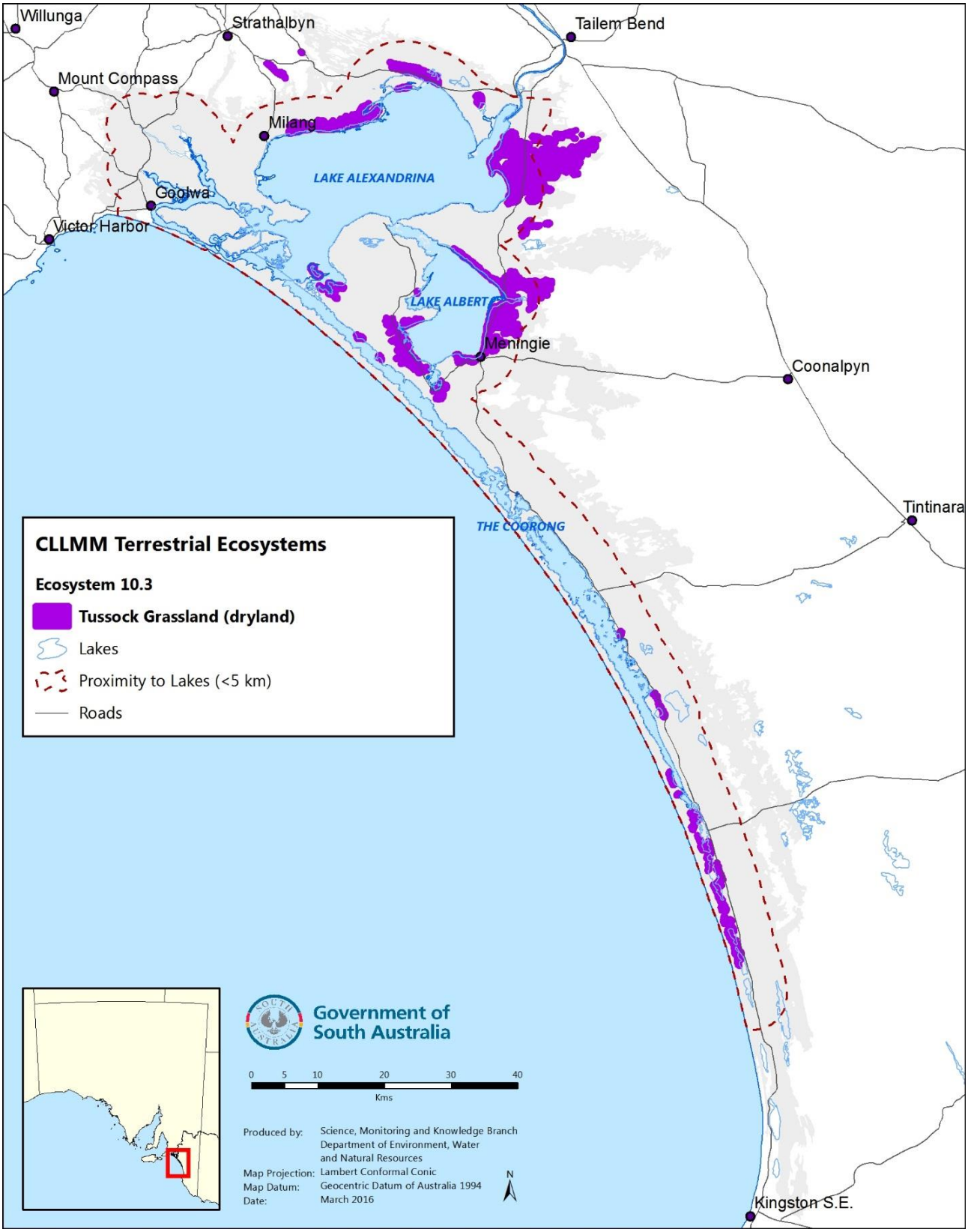

Figure 3.15 Potential distribution of Ecosystem 10.3: Tussock Grassland (dryland) of the CLLMM region of South Australia

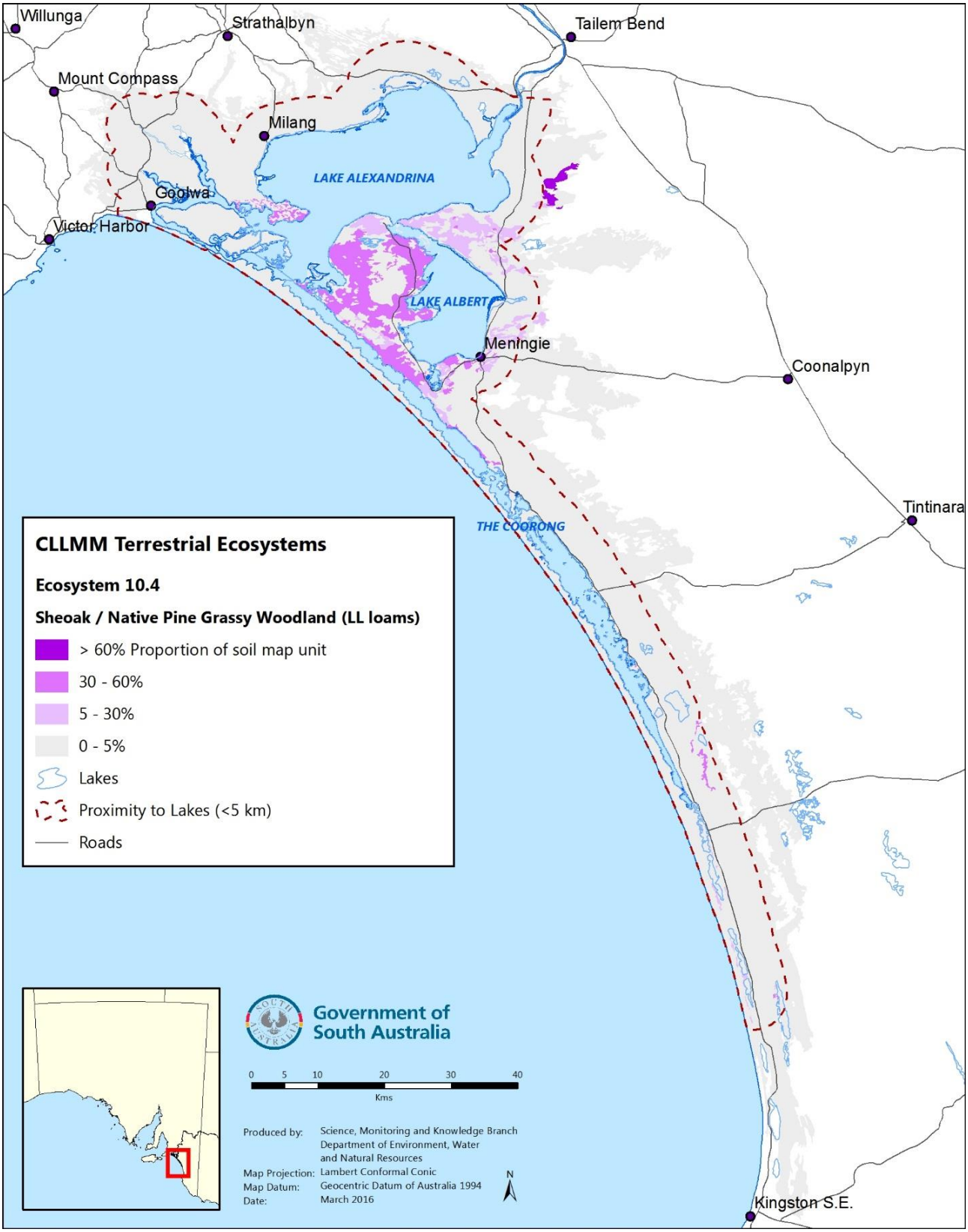

Figure 3.16 Potential distribution of Ecosystem 10.4: Sheoak / Native Pine Grassy Woodland (LL loams) of the CLLMM region of South Australia

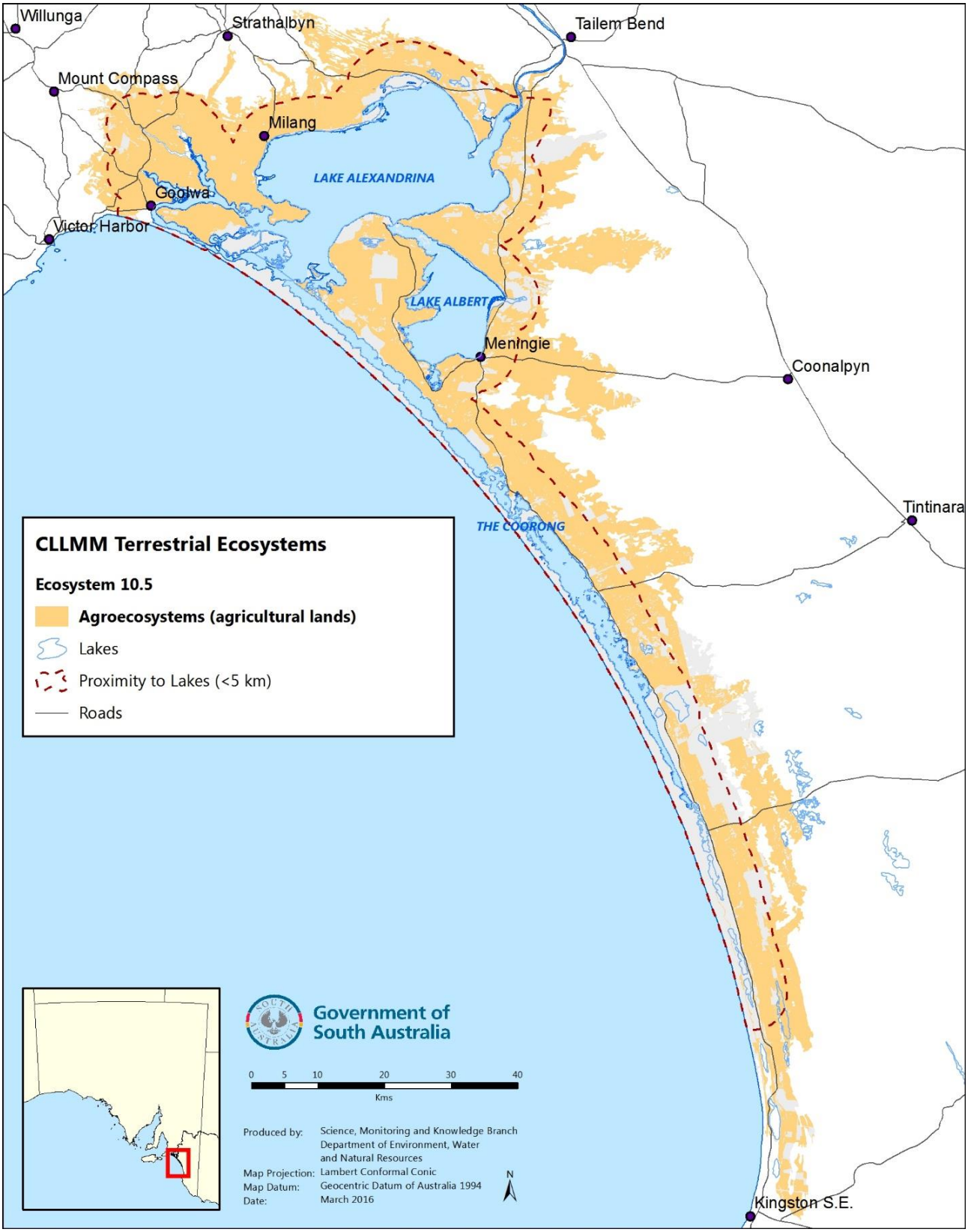

Figure 3.17 Potential distribution of Ecosystem 10.5: Agroecosystems (agricultural lands) of the CLLMM region of South Australia

3.2 Species assessment

3.2.1 Trends in bird occurrence

A total of 80 588 bird occurrence records from DEWNR and Bird Atlas databases were used to identify species and their occurrence between 1908 and 2013 within the region (138 taxa, see Table 3.2). Bayesian Belief Network models using trends in bird occurrence from biological databases (i.e. change over time '*Current vs All Time*', regression slopes '*Trend Analysis*') and expert scores (i.e. '*Expert bird assessment model*') provide a synthesis assessment of trends in bird occurrence in the region (Table 3.2), including measures of confidence in classifications. Uncertainties in the synthesis assessment were calculated from statistical variations in trends and regression slopes from analyses of biological databases, and confidence levels of expert scores, within a BBN model. Entropy analyses within BBN model provide measures of the importance of each assessment method on the synthesis assessment of trends in bird occurrence within the region (Figure 3.18).

The 'synthesis bird assessment' of trends in occurrence identified 56 declining species (i.e. 41% of total species), 73 stable species (53%) and 2 increasing species (1%) within the region (Table 3.2). Two species (1%) are borderline decreasing and 5 species (4%) are borderline increasing in the region.

Table 3.2 Bird species and trends in occurrence (i.e. 'synthesis bird assessment') within the South Australian CLLMM region, including trend probabilities (numbers) and the most likely trend classification (shaded cells) from BBN modelling

Common name	*Scientific name*	Probability of trend		
		Declining	Stable	Increasing
Australasian Pipit	*Anthus australis*	0.190	0.623	0.188
Australian Bustard	*Ardeotis australis*	0.595	0.388	0.018
Australian Hobby	*Falco longipennis*	0.180	0.620	0.200
Australian Magpie	*Gymnorhina tibicen*	0.053	0.458	0.490
Australian Owlet-nightjar	*Aegotheles cristatus*	0.855	0.145	0.000
Australian Raven	*Corvus coronoides*	0.150	0.613	0.237
Australian Reed-Warbler	*Acrocephalus australis*	0.085	0.555	0.360
Australian Ringneck	*Barnardius zonarius*	0.685	0.315	0.000
Barn Owl	*Tyto javanica*	0.270	0.642	0.088
Beautiful Firetail	*Stagonopleura bella*	0.845	0.155	0.000
Black Falcon	*Falco subniger*	0.270	0.642	0.088
Black Kite	*Milvus migrans*	0.655	0.345	0.000
Black-chinned Honeyeater	*Melithreptus gularis*	0.800	0.200	0.000
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	0.130	0.608	0.262
Black-shouldered Kite	*Elanus axillaris*	0.085	0.555	0.360
Blue Bonnet	*Northiella haematogaster*	0.800	0.200	0.000
Blue-winged Parrot	*Neophema chrysostoma*	0.655	0.345	0.000
Brown Falcon	*Falco berigora*	0.130	0.608	0.262
Brown Goshawk	*Accipiter fasciatus*	0.655	0.345	0.000
Brown Quail	*Coturnix ypsilophora*	0.063	0.487	0.450
Brown Songlark	*Cincloramphus cruralis*	0.190	0.623	0.188
Brown Thornbill	*Acanthiza pusilla*	0.190	0.623	0.188
Brown Treecreeper	*Climacteris picumnus*	0.655	0.345	0.000
Brown-headed Honeyeater	*Melithreptus brevirostris*	0.190	0.623	0.188
Brush Bronzewing	*Phaps elegans*	0.655	0.345	0.000

Common name	*Scientific name*	Probability of trend		
		Declining	Stable	Increasing
Budgerigar	*Melopsittacus undulatus*	0.580	0.420	0.000
Buff-rumped Thornbill	*Acanthiza reguloides*	0.685	0.315	0.000
Chestnut-rumped Heathwren	*Calamanthus pyrrhopygius parkeri*	0.488	0.472	0.040
Cockatiel	*Nymphicus hollandicus*	0.640	0.360	0.000
Collared Sparrowhawk	*Accipiter cirrhocephalus*	0.290	0.647	0.063
Common Bronzewing	*Phaps chalcoptera*	0.085	0.555	0.360
Crescent Honeyeater	*Phylidonyris pyrrhoptera*	0.369	0.581	0.050
Crested Pigeon	*Ocyphaps lophotes*	0.058	0.472	0.470
Crested Shrike-tit	*Falcunculus frontatus*	0.885	0.115	0.000
Crimson Rosella	*Platycercus elegans*	0.130	0.608	0.262
Diamond Firetail	*Stagonopleura guttata*	0.640	0.360	0.000
Dusky Woodswallow	*Artamus cyanopterus*	0.655	0.345	0.000
Eastern Rosella	*Platycercus eximius*	0.270	0.642	0.088
Eastern Spinebill	*Acanthorhynchus tenuirostris*	0.290	0.647	0.063
Eastern Yellow Robin	*Eopsaltria australis*	0.675	0.325	0.000
Elegant Parrot	*Neophema elegans*	0.130	0.608	0.262
Emu	*Dromaius novaehollandiae*	0.535	0.465	0.000
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	0.190	0.623	0.188
Galah	*Eolophus roseicapilla*	0.060	0.480	0.460
Golden Whistler	*Pachycephala pectoralis*	0.130	0.608	0.262
Golden-headed Cisticola	*Cisticola exilis*	0.445	0.555	0.000
Grey Butcherbird	*Cracticus torquatus*	0.655	0.345	0.000
Grey Currawong	*Strepera versicolor*	0.190	0.623	0.188
Grey Fantail	*Rhipidura albiscapa*	0.085	0.555	0.360
Grey Shrike-thrush	*Colluricincla harmonica*	0.085	0.555	0.360
Hooded Robin	*Melanodryas cucullata*	0.655	0.345	0.000
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	0.445	0.555	0.000
Jacky Winter	*Microeca fascinans*	0.885	0.115	0.000
Laughing Kookaburra	*Dacelo novaeguineae*	0.260	0.640	0.100
Little Button-quail	*Turnix velox*	0.565	0.435	0.000
Little Corella	*Cacatua sanguinea*	0.130	0.608	0.262
Little Eagle	*Hieraaetus morphnoides*	0.885	0.115	0.000
Little Grassbird	*Megalurus gramineus*	0.130	0.608	0.262
Little Raven	*Corvus mellori*	0.080	0.540	0.380
Little Wattlebird	*Anthochaera chrysoptera*	0.260	0.640	0.100
Magpie-lark	*Grallina cyanoleuca*	0.080	0.540	0.380
Malleefowl	*Leipoa ocellata*	0.825	0.175	0.000
Masked Woodswallow	*Artamus personatus*	0.655	0.345	0.000
Mistletoebird	*Dicaeum hirundinaceum*	0.270	0.642	0.088
Musk Lorikeet	*Glossopsitta concinna*	0.200	0.625	0.175
Nankeen Kestrel	*Falco cenchroides*	0.078	0.532	0.390
New Holland Honeyeater	*Phylidonyris novaehollandiae*	0.078	0.532	0.390
Noisy Miner	*Manorina melanocephala*	0.190	0.623	0.188

Common name	*Scientific name*	Probability of trend		
		Declining	Stable	Increasing
Orange Chat	*Epthianura aurifrons*	0.314	0.586	0.100
Orange-bellied Parrot	*Neophema chrysogaster*	0.775	0.225	0.000
Painted Button-quail	*Turnix varius*	0.855	0.145	0.000
Pallid Cuckoo	*Cacomantis pallidus*	0.840	0.160	0.000
Peaceful Dove	*Geopelia placida*	0.075	0.525	0.400
Peregrine Falcon	*Falco peregrinus*	0.270	0.642	0.088
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	0.535	0.465	0.000
Purple-gaped Honeyeater	*Lichenostomus cratitius*	0.840	0.160	0.000
Rainbow Bee-eater	*Merops ornatus*	0.655	0.345	0.000
Rainbow Lorikeet	*Trichoglossus haematodus*	0.085	0.555	0.360
Red Wattlebird	*Anthochaera carunculata*	0.078	0.532	0.390
Red-browed Finch	*Neochmia temporalis*	0.270	0.642	0.088
Red-capped Robin	*Petroica goodenovii*	0.855	0.145	0.000
Red-rumped Parrot	*Psephotus haematonotus*	0.130	0.608	0.262
Restless Flycatcher	*Myiagra inquieta*	0.840	0.160	0.000
Rock Parrot	*Neophema petrophila*	0.074	0.484	0.442
Rose Robin	*Petroica rosea*	0.362	0.544	0.094
Rufous Bristlebird	*Pachycephala rufiventris*	0.690	0.310	0.000
Rufous Songlark	*Cincloramphus mathewsi*	0.250	0.637	0.113
Rufous Whistler	*Pachycephala rufiventris*	0.535	0.465	0.000
Sacred Kingfisher	*Todiramphus sanctus*	0.685	0.315	0.000
Scarlet Robin	*Petroica boodang*	0.685	0.315	0.000
Shy Hylacola	*Calamanthus cautus*	0.840	0.160	0.000
Silvereye	*Zosterops lateralis*	0.080	0.540	0.380
Singing Bushlark	*Mirafra javanica*	0.855	0.145	0.000
Singing Honeyeater	*Ptilotula virescens*	0.053	0.458	0.490
Southern Boobook	*Ninox boobook*	0.870	0.130	0.000
Southern Emu-wren (MLR ssp)	*Stipiturus malachurus intermedius*	0.438	0.445	0.117
Southern Emu-wren (SE ssp)	*Stipiturus malachurus malachurus*	0.815	0.185	0.000
Southern Scrub-robin	*Drymodes brunneopygia*	0.855	0.145	0.000
Southern Whiteface	*Aphelocephala leucopsis*	0.855	0.145	0.000
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	0.130	0.608	0.262
Spotted Harrier	*Circus assimilis*	0.270	0.642	0.088
Spotted Nightjar	*Eurostopodus argus*	0.855	0.145	0.000
Spotted Pardalote	*Pardalotus punctatus*	0.130	0.608	0.262
Striated Pardalote	*Pardalotus striatus*	0.130	0.608	0.262
Striated Thornbill	*Acanthiza lineata*	0.260	0.640	0.100
Stubble Quail	*Coturnix pectoralis*	0.250	0.637	0.113
Sulphur-crested Cockatoo	*Cacatua galerita*	0.270	0.642	0.088
Superb Fairy-wren	*Malurus cyaneus*	0.058	0.472	0.470
Swamp Harrier	*Circus approximans*	0.145	0.430	0.425
Tawny Frogmouth	*Podargus strigoides*	0.840	0.160	0.000
Tawny-crowned Honeyeater	*Gliciphila melanops*	0.885	0.115	0.000

Common name	*Scientific name*	Probability of trend		
		Declining	Stable	Increasing
Tree Martin	*Petrochelidon nigricans*	0.270	0.642	0.088
Varied Sittella	*Daphoenositta chrysoptera*	0.685	0.315	0.000
Variegated Fairy-wren	*Malurus lamberti*	0.655	0.345	0.000
Wedge-tailed Eagle	*Aquila audax*	0.655	0.345	0.000
Weebill	*Smicrornis brevirostris*	0.085	0.555	0.360
Welcome Swallow	*Hirundo neoxena*	0.058	0.472	0.470
Western Whipbird	*Psophodes nigrogularis*	0.540	0.425	0.035
Whistling Kite	*Haliastur sphenurus*	0.085	0.555	0.360
White-browed Babbler	*Pomatostomus superciliosus*	0.445	0.555	0.000
White-browed Scrubwren	*Sericornis frontalis*	0.180	0.620	0.200
White-browed Woodswallow	*Artamus superciliosus*	0.685	0.315	0.000
White-eared Honeyeater	*Nesoptilotis leucotis*	0.670	0.330	0.000
White-fronted Chat	*Epthianura albifrons*	0.080	0.540	0.380
White-fronted Honeyeater	*Purnella albifrons*	0.220	0.630	0.150
White-naped Honeyeater	*Melithreptus lunatus*	0.290	0.647	0.063
White-plumed Honeyeater	*Ptilotula penicillata*	0.085	0.555	0.380
White-throated Treecreeper	*Cormobates leucophaea*	0.270	0.642	0.088
White-winged Chough	*Corcorax melanoramphos*	0.240	0.635	0.125
White-winged Triller	*Lalage tricolor*	0.655	0.345	0.000
Willie Wagtail	*Rhipidura leucophrys*	0.058	0.472	0.470
Yellow Thornbill	*Acanthiza nana*	0.260	0.640	0.100
Yellow-faced Honeyeater	*Caligavis chrysops*	0.260	0.640	0.100
Yellow-plumed Honeyeater	*Ptilotula ornata*	0.625	0.375	0.113
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	0.130	0.608	0.262
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	0.130	0.608	0.262
Yellow-throated Miner	*Manorina flavigula*	0.200	0.625	0.175
Zebra Finch	*Taeniopygia guttata*	0.780	0.220	0.000
Total species (138)		**56 [2]**	**73 [5]**	**2**
Proportion (%)		***40.6 [1.4]***	***52.9 [3.6]***	***1.4***

[ ] denotes totals for species with similar probability values across two neighbouring trend classes; BBN = Bayesian Belief Network

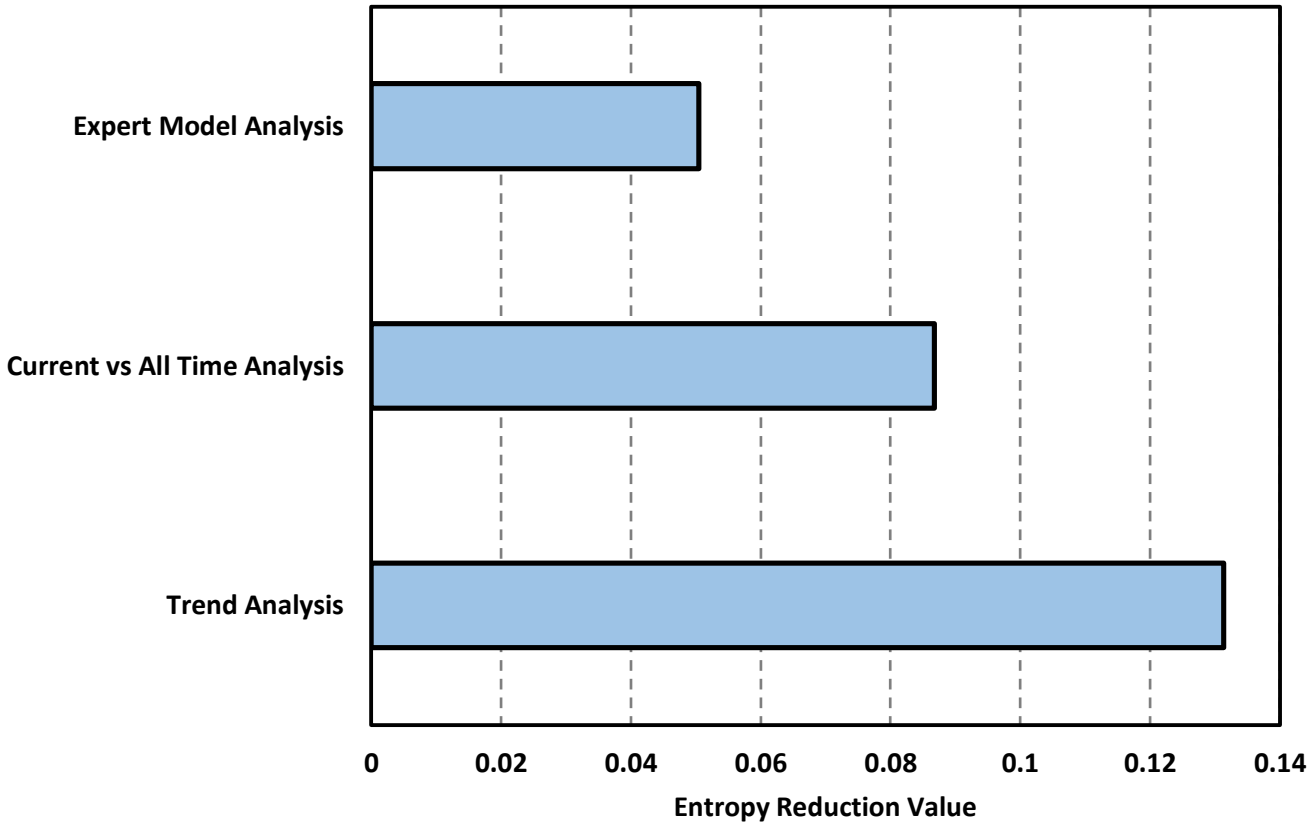

Figure 3.18 The average contribution of the method type on synthesis assessments of bird occurrence trends within the South Australian CLLMM region (greater entropy reduction values suggest greater influence of the method type on determining occurrence trends)

3.2.2 Ecosystem response groups

Information on landscape-scale habitat type preferences of each species from literature searches and consensus expert opinion ratings were tabulated for the 17 terrestrial Ecosystems within the region (see Appendix 6.4). Hierarchical cluster analysis of this data (see Appendix 6.5) initially identified 11 clusters of species. The cluster analysis ordination plot (see Appendix 6.5) represents the similarity in ecological requirements at landscape-scale of all bird species (i.e. similar birds species are plotted closer together). Two small clusters were discarded as they were represented by vagrant species to the region (i.e. 'nMDS Group 4/8', Blue Bonnet, Budgerigar, Cockatiel). Two clusters were combined into a single ERG based on expert knowledge of similarities of habitat requirements of those bird species. This combination of cluster analysis and expert opinion resulted in the identification of eight 'Ecological Response Groups' (ERGs) for the region. The bird species within each ERG are tabulated within Appendix 6.6 and declining bird species within each ERG are listed within Table 3.3.

As individual species within ERGs often occupy multiple Ecosystem types (with varying degrees of likelihood, see Appendix 6.4) a matrix of associations exists between ERGs and Ecosystem types (i.e. Ecosystems can be allocated to multiple ERGs, see Table 3.3, Appendix 6.6). The cluster analysis ordination plot (see Appendix 6.6) demonstrates the similarities (e.g. nMDS distances) between bird species and their habitat requirements, and likely associations with Ecosystem types.

Table 3.3 Response groups and associated bird species and ecosystems within the CLLMM region of South Australia

Ecological response group / brief description	Declining bird species in ERG % of species in ERG declining		Associated ecosystem(s)
ERG Group 1: General Woodland A big cluster in the analysis associated with various ecosystems. The individual ecosystem is impossible to tease apart visually in the ordination space. However, declining species of this ERG Group are associated with grassy woodland ecosystems, namely Eucalyptus grassy woodlands and Non-eucalypt (Sheoak and *Callitris*) grassy woodland.	Australian Owlet-nightjar Black Kite Black-chinned Honeyeater Brown Goshawk Brown Treecreeper Crested Shrike-tit Diamond Firetail Dusky Woodswallow Grey Butcherbird Hooded Robin Jacky Winter Little Eagle Pallid Cuckoo Purple-crowned Lorikeet	Rainbow Bee-eater Red-capped Robin Restless Flycatcher Rufous Whistler Sacred Kingfisher Scarlet Robin Southern Boobook Southern Whiteface Tawny Frogmouth Varied Sittella Wedge-tailed Eagle White-browed Woodswallow White-winged Triller Zebra Finch	A mixture of: 1. Pink Gum (*Eucalyptus fasciculosa*) Low Open Grassy Woodland of the Mount Lofty Ranges; 2. Cup Gum (*Eucalyptus cosmophylla*) / Brown Stringybark (*E. baxteri*) Woodland over heath of the Mount Lofty Ranges; 4. *Eucalyptus diversifolia* Mallee Communities of the South East; 6.1 *Eucalyptus porosa* (Mallee Box) Grassy Woodland 6.2 Peppermint Box (*Eucalyptus odorata*) Grassy Woodland; 6.4 *Eucalyptus leucoxylon* Grassy Woodland; and 10.2 *Eucalyptus camaldulensis var. camaldulensis* woodland 10.4 Non eucalypt grassy woodland
	Proportion of species in group declining: 36%		
ERG Group 2: High Rainfall Stringy bark The ERG is associated with the Stringy Bark community. The response group is relatively stable, although contains threatened and declining species (e.g. Chestnut-rumped Heathwren and Southern Emu-wren (MLR ssp)) associated with dense Sclerophyll understorey (Rogers, 2011)	Buff-rumped Thornbill Chestnut-rumped Heathwren	Southern Emu-wren (MLR ssp)	1. Pink Gum (*Eucalyptus fasciculosa*) Low Open Grassy Woodland of the Mount Lofty Ranges; 2. Cup Gum (*Eucalyptus cosmophylla*) / Brown Stringybark (*E. baxteri*) Woodland over heath of the Mount Lofty Ranges; and 6.4 *Eucalyptus leucoxylon* Grassy Woodland
	Proportion of species in group declining: 30%		
ERG Group 3: Sand Mallee The ERG has the highest proportion of declining species. The *E. incrassata* mallee response group is associated with sand mallee ecosystems dominated by *Eucalyptus incrassata* / *E. leptophylla* +/- *E. socialis*.	Malleefowl Masked Woodswallow Purple-gaped Honeyeater Shy Hylacola Southern Scrub-robin	Honeyeater Variegated Fairy-wren Western Whipbird White-eared Honeyeater	4. *Eucalyptus diversifolia* Mallee Communities of the South East; and 6.3 *Eucalyptus incrassata* / *E. leptophylla* +/- *E. socialis* mallee communities

Ecological response group / brief description	Declining bird species in ERG % of species in ERG declining		Associated ecosystem(s)
	Tawny-crowned Honeyeater	Yellow-plumed Honeyeater	
	Proportion of species in group declining: 83%		
ERG Group 4: Coastal Heath The ERG is primarily associated with the Coastal Shrubland of the Coorong (e.g. Younghusband Peninsula), along with associated coastal ecosystems with shrubby understoreys.	Beautiful Firetail Brush Bronzewing Eastern Yellow Robin Emu	Painted Button-quail Rufous Bristlebird White-browed Scrubwren	3. Coastal Shrubland of the Coorong and possibly; 4. *Eucalyptus diversifolia* Mallee Communities of the South East; and 5. Sheoak low woodland with shrubby understorey
	Proportion of species in group declining: 78%		
ERG Group 5: Samphire The ERG is associated with the Samphire (+/- *Melaleuca halmaturorum*) Shrubland Community with high a proportion of declining species.	Blue-winged Parrot Orange-bellied Parrot	Southern Emu-wren (SE ssp)	9. Samphire (+/- *Melaleuca halmaturorum*) Shrubland Community
	Proportion of species in group declining: 60%		
ERG Group 6: Reeds The ERG is associated with the Freshwater fringing wetland community and *Gahnia filum* sedgeland. The species associated with this ecosystem are mostly stable with no declining species	No declining birds		7. Freshwater fringing wetland community; 8. Lignum shrubland 10.1 Gahnia filum sedgeland
	Proportion of species in group declining: 0%		
ERG Group 7: Grassland The ERG is associated with the native grasslands in CLLMM	Australian Bustard	Little Button-quail	10.3 Grassland community
	Proportion of species in group declining: 50%		
ERG Group 8: Farmland / Agricultural The ERG is associated with farmland and agricultural land within the region	Singing Bushlark		10.5 Agroecosystem
	Proportion of species in group declining: 10%		

3.3 Land use assessment

In general, the CLLMM region has undergone significant changes in character since European settlement (c. 1836). The key driver of landscape change, particularly in the first century since European settlement, was the conversion of native ecosystems to European agricultural systems (cereal cropping and pastoralism). The timing and extent of these landscape-scale changes are captured in further detail by Butcher and Rogers (2013).

In summary, the early (1850s) post-European settlement history of the region was driven by the need to establish transport corridors, including stock routes, between Adelaide and Melbourne. The western plains between the Mt Lofty Ranges and Lake Alexandrina were particularly heavily utilised during this period due to their inherent grazing value. This activity began to expand geographically (e.g. Narrung Peninsula), and intensify to include cropping from the 1870s, partly due to legislative drivers aimed at increasing the rate of land clearance for agriculture in South Australia, and due to technological changes (Mullenizing, Stump-jump Plow). While the Federation drought slowed the rate of land clearance, post-war soldier-settlement schemes (1920s) and further technological advances (trace mineral and fertilizer application further expanded clearance to less desirable soil types (particularly calcareous soils from the 1940s).

While changes to the CLLMM landscape have been extensive, inherent variation in the suitability of different ecosystems for European agricultural systems has led to different impacts on these ecosystems (Paton *et al*. 1999; Butcher and Rogers 2013). Sheoak / Native Pine Grassy Woodland (LL loams) (Ecosystem 10.4) and Tussock Grassland (dryland) (Ecosystem 10.3) ecosystems have been documented (both through published literature and key informants) as being preferentially targeted for historic conversion to agriculture, and thereby having the lowest remnancy (medium confidence). The Coorong's Mixed Shrubland (coastal dunes) (Ecosystem 3) and the Samphire / Paperbark Shrubland (saline clays) (Ecosystem 9) were identified as having increased in area since European settlement (medium confidence).

3.4 Landscape assessment and integration

Given that the broad-scale conversion of native ecosystems to European agricultural systems is the key driver of environmental change in the CLLMM region (Butcher and Rogers 2013), we assume that the key driver of native biodiversity decline in the region strongly relates to the ecological response to this historic clearance. As such, the general response to biodiversity decline should focus on addressing these historic impacts of clearance, through ecosystem restoration (including revegetation).

As suggested above, however, the historic clearance of native vegetation has not occurred homogenously in space or time, with different ecosystems having been impacted differently depending primarily on their inherent suitability for agriculture.

4 Discussion

4.1 Landscape assessment

This landscape assessment study identifies and describes the terrestrial ecosystems ('*Ecosystem Assessment*'), assesses changes in biodiversity within these ecosystems ('*Species Assessment*'), identify drivers of biodiversity change ('*Land Use Assessment*') and identifies priority terrestrial ecosystems for conservation investment within the CLLMM region of South Australia.

The Ecosystem Assessment process identified 17 Ecosystems within the landscapes of the CLLMM region of South Australia based on a hybrid of cluster analysis and expert knowledge. Data which informed this process included vegetation survey data, soil type mapping, landscape subgroups (i.e. geographic regions with similar climate, topography and soil landscape units), pre-1750 vegetation mapping, topographic data and recent landuse mapping. The likely distribution of each Ecosystem was mapped across the region based on models developed from these data sources.

The Species Assessment process used information on bird species occurrence (i.e. historic trends, regional status assessments, expert knowledge) and bird habitat information (e.g. literature searches, expert knowledge) to identify eight Ecosystem Response Groups (ERGs) to represent landscape-scale indicators of faunal biodiversity and function. Linkages between Ecosystem types and ERGs were identified to facilitate a better understanding of the likely influences revegetation or restoration activities on ecosystems and bird communities.

The assignment of species to Ecosystem Response Groups (ERGs) is one of the key ways to identify coarse filter (or, systemic) issues in a landscape (Rogers, 2012). Ideally, selection of ERGs should use taxa that have high site affinity (e.g. ground mammals or reptiles with specific habitat requirements) and are commonly associated with the ecosystems being investigated. However, historical records for non-avifaunal taxa are insufficient for the region, reflecting the relative ease of collecting information on birds compared with other fauna (Mac Nally et al. 2004). In addition, birds have been recognised as important indicators of environmental change – including change in use from one agricultural activity to another (Ormerod and Watkinson 2000), which is the dominant land use in the region.

The Land Use Assessment process documented the historic drivers of change in the extent and function of abiotic landscapes, vegetation types and Ecosystem types. Ecosystem types most influenced by this history or most susceptible to change (e.g. low resilience) were identified.

These three key pieces of information were synthesised qualitatively, identifying common patterns of change to identify declining ecosystems in the landscape, and the relative urgency for intervention. For example, an ecosystem that continued to support dependent declining species, and had undergone large-scale vegetation clearance historically, should be prioritised for intervention over another ecosystem that had also undergone large-scale vegetation clearance, but that no longer supported dependent species. This qualitative triangulation method is described in Rogers et al. (2012).

4.2 Limitations

Databases of bird occurrence in the region (i.e. DEWNR BDBSA, BirdLife Australia Atlas) provide information on the location and temporal presence of bird species in the region. In spite of patchy historic records for the region, the assigning of birds to 100 ha Analysis Unit polygons to quantifying species occurrence change over time ('*Current vs All Time*') and trend regression slopes ('*Trend Analysis*') provide statistical measures of change (with quantifiable errors). Variable bird field survey techniques, patchy or low number of records, and low species detectability (e.g. cryptic or difficult to observe) results in uncertainty in bird database analyses of trends in occurrence. It is accepted that high-quality data collected over long periods would yield greater predictive power to the results,

but this requires considerable investment and institutional support (Reid et al. 2003). Expert knowledge of bird species trends ('*Expert bird assessment model*') provides supplementary information (with error estimates) to provide additional evidence of historic change in distribution and/or abuundance. The synthesis of bird survey data and expert knowledge of trends in bird species' occurrence, using Bayesian Belief Network models with error estimates and entropy analyses (Korb and Nicholson 2004, McCann et al. 2006), provides a valid hybrid method to assessment trends in bird occurrence in the region.

While statistically valid analyses of large datasets are typically preferred forms of scientific evidence, credible decisions are still required when insufficient survey data or analyses exist. Expert opinions (including key informants) are recognised as a valuable source of information in many cases (Burgman et al. 2011, McBride et al. 2012). Expert knowledge was used in this study to augment quantitative analyses of field survey data, and synthesise relationships between ecosystems, biodiversity decline and drivers of change in the region. The robustness of this approach is reliant on explicitly capturing and analysing stated uncertainties in the information provided by experts. Future landscape assessment applications will benefit from the utilisation of properly structured techniques in expert knowledge elicitation such as those employed by Burgman et al. (2011) and McBride et al. (2012), and the integration of this structured, expert-derived data into Bayesian networks.

A limitation of combining quantitative and expert-driven assessments in this way is that the expert driven models may not be able to discriminate between historic declines (that have now stabilised, for example) from more recent, or ongoing declines. However, the nature of the quantitative data in this assessment means that quantitatively discriminating between these options was similarly difficult. Across both information sets (expert-driven and quantitative), it has been assumed that the assessment of each species' trend across this information reflects a change in distribution and abundance that essentially compares the current distribution with the presumed historic distribution. Bird species with ongoing evidence of decline may be given a higher priority for management intervention than those species which have historically declined but have now stablised. This limitation reinforces the argument for long-term, targeted monitoring of biodiversity that can detect these different patterns of change through time (Lindenmayer *et al.* 2012).

4.3 Implications

Forty percent of terrestrial birds analysed showed a decline in the region, where 20 have a high likelihood of decline (≥80%) since 1908. Fifty percent of these are associated with woodland-type ecosystems, indicating a general decline of these broad habitats in the region. Conservation efforts should therefore focus on restoring these types of ecosystems to arrest biodiversity decline, at least for avifauna diversity, within the region. Species that are increasing in the region are widespread generalists (e.g. Australian Magpie, Crested Pigeon and Galah).

Revegetation and restoration activities in and around the Lower Lakes and Coorong Ramsar site are important steps in arresting further declines in biodiversity. However, in the face of declining resources and funding, identification of priority ecosystems is necessary to inform investments that maximise biodiversity benefits from conservation projects/programs. The identification of ecosystems in the region and the suite of declining bird species that are associated with those ecosystems will contribute to the understanding of where priority actions should be taken.

4.4 Recommended management actions

We suggest restoration and management activities (and further investigations/research) focus on ecosystem groups identified by Landscape Assessment which are at greatest risk of declining resilience, changing to undesirable states, and likely to benefit from revegetation activities.

Priority terrestrial ecosystem groups for restoration within the landscapes of the CLLMM region of South Australia are summarised below in Table 4.1, with justification provide here.

4.4.1 Highest priority

Ecosystem 6.3: Ridge-fruited / Narrow-leaf Red (*Eucalyptus incrassata / leptophylla*) Mallee (MLR sands)

In the CLLMM landscape, this ecosystem is most strongly associated with declining species:

- Maintain or improve the condition of the best remaining patches of this ecosystem by buffering existing patches. Specifically in the proximity of larger remnants (e.g. Ferries McDonald Conservation Park and surrounds) that continue to support declining bird populations.

Rationale: The ERG associated with this ecosystem has the highest proportion of declining species. The *E. incrassata* mallee response group is associated with sand mallee ecosystems dominated by *E. incrassata* / *E. leptophylla* +/- *E. socialis*. This is in agreement with other landscape analyses conducted for the Murray Mallee subregion where the same ecosystems (*E. incrassata* mallee on deep sands) were identified as conservation focus (Willoughby 2010; Willoughby 2011; Gillespie 2013). Buffering through revegetation of land adjacent to larger intact patches will reduce the risk of habitat degradation (through edge effects) and therefore reduce the risk of patch-scale extinction for these declining species.

Grassy Woodland ecosystems, especially in the eastern Mount Lofty Ranges, including **Ecosystem 6.1**: Mallee Box (*Eucalyptus porosa*) Grassy Woodland (LL loams), **Ecosystem 6.2**: Peppermint Box (*E. odorata*) Grassy Woodland (MLR loams), **Ecosystem 6.4**: SA Blue Gum (*E. leucoxylon*) Grassy Woodland (SE/LL loams), **Ecosystem 10.2**: Red Gum Grassy Woodland (MLR river flats), and **Ecosystem 10.4**: Sheoak (*Allocasuarina verticillata*) / Native Pine (*Callitris gracilis*) Grassy Woodland (LL loams):

- Maintain patches that support the habitat value of declining species associated with these ecosystems.
- Identification of priority patches for restoration. In the eastern Mt Lofty Ranges, this has already been undertaken (Rogers 2011a) and is being used to inform on ground activity in that landscape.
- Restore patches of woodland through appropriate interventions (e.g. grazing management, soil nutrient management and revegetation). Prescott (2011) has developed an ecological state-and-transition model for these woodland types to support the identification of suitable interventions.

Rationale: This ERG contains many bird species (28 species), including a large number of declining birds (10 species). Further, this ERG and associated ecosystems have a large conceptual overlap (and partial spatial overlap) with landscape analysis conducted in the southern Mount Lofty Ranges where the same broad ecosystems were identified as the primary focus of conservation (Rogers 2011a).

Ecosystem 9: Samphire (*Tecticornia* spp.) / Paperbark (*Melaleuca halmaturorum*) Shrubland (saline clays)

- Hydrological management to support the maintenance and restoration of samphire habitats.
- Careful planning of revegetation (with Swamp Paperbark *Melaleuca halmaturorum*) to ensure that the habitat values of samphire shrublands are not compromised.

Rationale: This ecosystem has a high proportion of declining species. The major driver of processes in this ecosystem is hydrology – both groundwater and surface water runoff, (GWLAP 2003; Seaman 2003). Decline of some species associated with this ecosystem may be due to factors outside of the region (e.g. largely operating in Tasmania in the case of the Orange-bellied Parrot: Orange-bellied Parrot Recovery Team 2006) and therefore outside the scope of any management action at the scale of the region. In addition, some of the declining species have been associated with poor samphire condition due to changes in hydrology (e.g. increased salinity: Ehmke et al. 2009). Furthermore, the natural history of the declining species in this group identifies them as associated with the structure of the understorey (samphire) of this ecosystem rather than the overstorey (*Melaleuca halmaturorum*). Careful consideration of the habitat requirements of these samphire dependent, declining species is required when revegetation of saline habitats with *M. halmaturorum* is being considered to ensure that these shrubland habitats are maintained or improved.

4.4.2 Lower priority

Ecosystem 2: Stringybark / Cup Gum Woodland (MLR hills)

- Revegetation is not recommended.
- Further investigation of the driver(s) of declining species is recommended.
- Implement the recovery plans for Mt Lofty Ranges Southern Emu-wren and Chestnut-rumped Heathwren at a site scale.

Rationale: The ERG associated with this ecosystem is relatively stable. Declining species within this group (i.e. Chestnut-rumped Heathwren and Mt Lofty Ranges Southern Emu-wren) are associated with a particular structural element that is expressed in parts of this ecosystem (closed shrubland understorey). This closed shrubland understorey structure has also been associated with a broader suite of declining bird species in the Mt Lofty Ranges (Rogers 2011a), including Beautiful Firetail and Tawny-crowned Honeyeater. However, the drivers of decline in this ecosystem are not well understood, but may include the loss and degradation of sclerophyllous gum woodlands, changes to the fire regime of heathlands, and hydrological changes to swamps (Rogers 2011a). The recovery plans for the Southern Emu-wren (MLR Southern Emu-wren & Fleurieu Peninsula Swamps Recovery Team 2007) and Chestnut-rumped Heathwren (Garnett et al. 2011) and the broad recommendations presented in Rogers (2011a), should be followed, including addressing knowledge gaps regarding the causes of decline and management of habitat for the declining species in this group.

Ecosystem 3: Mixed Shrubland (coastal dunes)

- No intervention is required for coastal shrublands of the Coorong.
- Further investigation of the drivers of declining species is recommended.

Rationale: The Coastal Shrubland, mostly found in the Younghusband Peninsula of the Coorong is a contiguous and relatively intact habitat, with some evidence for an increase in vegetation cover in some areas (e.g. Younghusband Peninsula). Therefore, habitat availability is unlikely to be the main driver of decline for associated species. Some of the declining species associated with this ecosystem (e.g. Eastern Yellow Robin, Painted Button-quail), are also associated with other ecosystems (e.g. Eucalyptus diversifolia Mallee Communities of the South East and Sheoak low woodland with shrubby understorey). In addition, some species (Brush Bronzewing, White-browed Scrubwren, Beautiful Firetail, Painted Button-quail) are also associated with the higher rainfall

stringybark forests with closed understoreys of the southern Mt Lofty Ranges (as revealed, for example, by the proportion of records in the Kanmantoo IBRA Region; Painted Button-quail 59%, Brush Bronzewing 27%, and Beautiful Firetail 31%). The decline of these species in the landscape may be associated more with change in the availability of these closed shrubland forest habitats, rather than changes in the availability of coastal shrublands on sand, as suggested in the southern Mt Lofty Ranges landscape assessment (Rogers 2011a). Identifying the particular drivers of decline for these species may require more detailed spatial and ecological analyses (Rogers 2011a, see above).

Ecosystem 4: Coastal White Mallee (SE/LL sandy loams)

- Maintain and protect remaining patches of this ecosystem, and undertake surveillance monitoring to identify emerging issues should they arise.

Rationale: This ecosystem is associated with the '*E. incrassata* mallee Ecosystem Response Group' but declining species in this group are also associated with the 'Coastal Shrubland of the Coorong', which is a relatively intact habitat.

Ecosystem 5: Sheoak Low Shrubby Woodland (SE/LL sandy loams)

- Maintain and protect remaining patches of this ecosystem, and undertake surveillance monitoring to identify emerging issues should they arise.

Rationale: This ecosystem is associated with the 'Coastal Heath Ecosystem Response Group' thus no significant intervention is required (see recommendations for Coastal Shrubland of the Coorong above), beyond maintaining the current state of the system in the landscape (e.g. protection). This ecosystem was identified as a potential threatened ecosystem and therefore may warrant investment in some protection and maintenance actions (Bonifacio and Pisanu 2013).

Ecosystem 7: Reeds and Rushes (freshwater fringes) and **Ecosystem 10.1 Chaffy Saw-sedge Swampland**

- No definitive management action until more data is available.
- Further research is recommended on the use and drivers of aquatic birds associated with this ecosystem.

Rationale: The species associated with this ecosystem are stable. Understanding of this ecosystem is incomplete as data are limited to its associated bird diversity. Data on some terrestrial birds that use this ecosystem exist but information on aquatic birds that can be closely associated with fringing wetlands in the region is now only being collected (O'Connor et al. 2013).

Ecosystem 8: Lignum Shrubland (non-saline clays)

- Improve our understanding of the landscape conservation value of this ecosystem. The current analysis only identified that this ecosystem contributes to the broader habitat extent of reed-dependent passerines that are considered stable in this landscape.
- Improve our understanding of the hydro-ecological dynamics of this system, such that protection and intervention can be specifically designed where the need to identified.

Rationale: The bird species associated with this ecosystem have not been clearly identified beyond those reed-dependent passerines that are considered stable in this region. The same recommendation was given to this type of ecosystem in a separate analysis of the landscape features of the region (Butcher and Rogers 2013).

Ecosystem 10.3: Tussock Grassland (dryland)

- Restoration does not appear to be required, but the identification and protection of remaining patches of native grassland is recommended.
- Further investigation of the drivers of declining species, including Little Button-quail, is recommended.

Rationale: Broadly, grassland ecosystems in this landscape appear to be stable, with dependent species either extinct (e.g. Australian Bustard) or stable. However, Little Button-quail, a grassland specialist, appear to be declining in this landscape. This may reflect an unidentified conservation issue that is specifically associated with this species.

Ecosystem 10.5: Agroecosystems (agricultural lands)

- No intervention or management actions.

Rationale: The development of farmland and agricultural land within the region commenced in 1840s resulting in clearance of natural habitat and conversion to agricultural land. There has thus been a strong increase in the availability of suitable habitats for the bird species that are tolerant or prefer these modified habitats. Thus bird species of the ERG for this system are relatively stable.

Table 4.1 Summary of recommendations for priority ecosystem groups for restoration within the landscapes of the SA CLLMM region

Highest priority ecosystems (not ranked)	**Recommendations**
Ecosystem 6.3: Ridge-fruited / Narrow-leaf Red (*Eucalyptus incrassata / leptophylla*) Mallee (MLR sands)	Maintain or improve the condition of the best remaining patches of this ecosystem by buffering existing patches. Specifically in the proximity of larger remnants (e.g. Ferries McDonald Conservation Park and surrounds) that continue to support declining bird populations.
Grassy Woodland ecosystems (Ecosystem 6.1, 6.2, 6.4, 10.2, 10.4)	Maintain patches that support the habitat value of declining species associated with these ecosystems. Identification of priority patches for restoration. In the eastern Mt Lofty Ranges, this has already been undertaken (Rogers 2011a) and is being used to inform on ground activity in that landscape. Restore patches of woodland through appropriate interventions (e.g. grazing management, soil nutrient management and revegetation). Prescott (2011) has developed an ecological state-and-transition model for these woodland types to support the identification of suitable interventions.
Ecosystem 9: Samphire (*Tecticornia* spp.) / Paperbark (*Melaleuca halmaturorum*) Shrubland (saline clays)	Hydrological management to support the maintenance and restoration of samphire habitats. Careful planning of revegetation (with Swamp Paperbark Melaleuca halmaturorum) to ensure that the habitat values of samphire shrublands are not compromised.
Lower priority ecosystems (not ranked)	
Ecosystem 2: Stringybark / Cup Gum Woodland (MLR hills)	Revegetation is not recommended. Further investigation of the driver(s) of declining species is recommended. Implement the recovery plans for Mt Lofty Ranges Southern Emu-wren and Chestnut-rumped Heathwren at a site scale.
Ecosystem 3: Mixed Shrubland (coastal dunes)	No intervention is required for coastal shrublands of the Coorong. Further investigation of the drivers of declining species is recommended.
Ecosystem 4: Coastal White Mallee (SE/LL sandy loams)	Maintain and protect remaining patches of this ecosystem, and undertake surveillance monitoring to identify emerging issues should they arise.
Ecosystem 5: Sheoak Low Shrubby Woodland (SE/LL sandy loams)	Maintain and protect remaining patches of this ecosystem, and undertake surveillance monitoring to identify emerging issues should they arise.
Ecosystem 7: Reeds and Rushes (freshwater fringes) and Ecosystem 10.1 Chaffy Saw-sedge Swampland	No definitive management action until more data is available. Further research is recommended on the use and drivers of aquatic birds associated with this ecosystem.

Ecosystem 8: Lignum Shrubland (non-saline clays)	Improve our understanding of the landscape conservation value of this ecosystem. The current analysis only identified that this ecosystem contributes to the broader habitat extent of reed-dependent passerines that are considered stable in this landscape. Improve our understanding of the hydro-ecological dynamics of this system, such that protection and intervention can be specifically designed where the need to identified.
Ecosystem 10.3: Tussock Grassland (dryland)	Restoration does not appear to be required, but the identification and protection of remaining patches of native grassland is recommended. Further investigation of the drivers of declining species, including Little Button-quail, is recommended.
Ecosystem 10.5: Agroecosystems (agricultural lands)	No intervention or management actions.

5 References

Benshemesh, J., 2007. *National recovery plan for malleefowl*. Government of South Australia, Department of Environment and Heritage, Adelaide.

Bonifacio, R., Pisanu, P., 2013. *The framework for the identification, description and assessment of threatened ecological communities in South Australia*. Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

Bonifacio, R., Whiterod, N., Bachmann, M., 2011. *Habitat management plan for the CLLMM region. Volume 1: Prioritisation assessment for weed and pest management*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Bray J.R., Curtis J.T., 1957. An ordination of the upland forest communities of Southern Wisconsin. *Ecological Monographs, 27*, 326-349.

Burgman, M.A., McBride, M., Ashton, R., Speirs-Bridge, A., Flander, L., Wintle, B., Fidler, F., Rumpff, L., Twardy, C., 2011. Expert status and performance. *PLoS One, 6*, e22998.

Butcher, C., Rogers, D., 2013. *Conservation planning in the CLLMM region. Phase I: A description of the landscapes of the CLLMM region*. Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

Cann, J.H., Bourman, R.P., Barnett E.J., 2000. Holocene foraminifera as indicators of relative estuarine-lagoonal and oceanic influences in estuarine sediments of the River Murray, South Australia. *Quaternary Research, 53*, 378-391.

Chin, A., Kyne, P.M., Walker, T.I., McAuley, R.B., 2010. An integrated risk assessment for climate change: analysing the vulnerability of sharks and rays on Australia's Great Barrier Reef. *Global Change Biology, 16*, 1936-1953.

Christidis, L., Boles, W.E., 1994. *The taxonomy and species of birds of Australia and its territories*. Royal Australasian Ornithologists Union, Melbourne.

CMP, 2007. *Open standards for the practice of conservation. Version 2.0*. The Conservation Measures Partnership (CMP). http://cmp-openstandards.org/

DEH, 2009. *Lower Lakes and Coorong recovery*. Government of South Australia, Department for Environment and Heritage (DEH), Adelaide.

DEWNR, 2008. *Biological surveys of South Australia: Vegetation surveys*. Government of South Australia, Department of Environment, Water and Natural Resources (DEWNR), Adelaide. http://www.environment.sa.gov.au/Knowledge_Bank/Information_data/Biological_Survey_of_South_Australia/Biological_surveys

DEWNR, 2015. *Native vegetation cover - statewide*. Government of South Australia, Department of Environment, Water and Natural Resources (DEWNR), Adelaide. http://www.naturemaps.sa.gov.au/download_spatial_layers.html

DotE, 2012. *Australia's bioregions (IBRA)*. Commonwealth of Australia, Department of the Environment (DotE), Canberra. http://www.environment.gov.au/land/nrs/science/ibra

DWLBC Soil and Land Program, 2007. *Regional land resource information for southern South Australia*. Government of South Australia, Department of Water, Land and Biodiversity Conservation (DWLBC), Adelaide.

Ehmke, G., Herrod, A., Green R., Tzaros, C., 2009. *Habitat protection and restoration plan for the Orange-bellied Parrot Neophema chrysogaster in the south east of South Australia*. Birds Australia, Melbourne.

Elphick, C.S., 2008. How you count counts: the importance of methods research in applied ecology. *Journal of Applied Ecology, 45*, 1313–1320.

Faull, J. (ed), 1981. *Alexandrina's shore : a history of the Milang district*. Milang and District Historical Society: Milang, South Australia.

Fluin, J., Gell, P., Haynes, D., Tibby, J., Hancock, G., 2007. Palaeolimnological evidence for the independent evolution of neighbouring terminal lakes, the Murray–Darling Basin, Australia. *Hydrobiologia, 591*, 117-134.

Franklin D.C., 1999. Evidence of disarray amongst granivorous bird assemblages in the savannas of northern Australia, a region of sparse human settlement. *Biological Conservation, 90*, 53-68.

Garnett, S.T., Szabo, J.K., Dutson, G., 2011. *The action plan for Australian birds 2010*. CSIRO Publishing, Melbourne.

Gillam, S., 2011. *Regional species conservation assessment project – Phase 2: Species prioritisation, Murraylands region*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Gillam, S., 2012. *Regional species conservation assessment project – Phase 2: Species prioritisation, South East region*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Gillespie, C.G., Willoughby, N., Allan, J., 2013. *Landscape assessment for the south-western portion of the Murray Mallee IBRA sub-region. Version 1.0*. Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

Hall, J., Maschmedt, D., Billing, N.B., 2009. *The soils of southern South Australia*. The South Australian Land and Soil Book Series, Volume 1; Geological Survey of South Australia, Bulletin 56, Volume 1. Government of South Australia, Department of Water, Land and Biodiversity Conservation, Adelaide.

Heard L., Channon B., 1997. *Guide to native vegetation survey (agricultural region) using the biological survey of South Australia methodology*. Government of South Australia, Department of Housing and Urban Development, Adelaide.

Hunter M.L., 1991. Coping with ignorance: the coarse-filter strategy for maintaining biodiversity. In: *Balancing on the Brink of Exctinction: The Endangered Species Act and lessons for the future* (ed K.A. Kohn), pp. 266–281. Island Press, Washington, DC.

Hunter M.L., 2005. A mesofilter conservation strategy to complement fine and coarse filters. *Conservation Biology, 19*(4), 1025-9.

Hunter M.L., Jacobson G.L., Webb T., 1988. Paleoecology and the coarse-filter approach to maintaining biological diversity. *Conservation Biology, 2*(4), 375-85.

Ihaka, R., Gentleman, R., 1996. R: a language for data analysis and graphics. *Journal of Computational and Graphical Statistics, 5*(3), 299–314.

Jaccard, P., 1912. The distribution of the flora in the alpine zone. *New Phytology, 11*, 37–50.

Jenkin, G., 1979. *Conquest of the Ngarrindjeri*. Rigby, Adelaide.

Kalua, K., Patel D., Muhit, M., Courtright, P., 2009. Productivity of key informants for identifying blind children: evidence from a pilot study in Malawi. *Eye, 23*, 7–9.

Korb K.B., Nicholson A.E., 2004. *Bayesian artificial intelligence*. Chapman and Hall/CRC Press, London.

Legendre, P., Legendre, L., 1998. *Numerical ecology*. Elsevier Publishing Company, Amsterdam.

Lindenmayer, D., Fischer, J., 2006. *Habitat fragmentation and landscape change*. Island Press, Washington, DC.

Lindenmayer, D., Likens, G.E., Andersen, A., Bowman, D., Bull, C.M., Burns, E., Dickman, C.R., Hoffmann, A.A., Keith, D.A., Liddell, M.J., Lowe, A.J., Metcalfe, D.J., Phinn, S.R., Russell-Smith, J., Thurgate, N., Wardle, G.M., 2012. Value of long-term ecological studies. *Austral Ecology, 37*(7), 745-757.

Mac Nally, R., Ellis, M., and Barrett, G., 2004. Avian biodiversity monitoring in Australian rangelands. *Austral Ecology, 29*, 93-99.

Major, R.E., 2010. Fragmentation responses of birds, insects, spiders and genes: fiverse lessons for woodland conservation. In: *Temperate Woodland Conservation and Management* (eds D. Lindenmayer, A. Bennett, R. Hobbs), pp. 199-207. CSIRO Publishing, Collingwood, Vic.

Marcot, B.G., Steventon, J.D., Sutherland, G.D., McCann, R.K., 2006. Guidelines for developing and updating Bayesian belief networks applied to ecological modelling and conservation. *Canadian Journal of Forest Research, 36*, 3063-3074.

Margoluis, R., Salafsky, N., 1998. *Measures of success: Designing, managing, and monitoring conservation and development projects*. Island Press, Washington, DC.

McBride, M.F., Garnett, S.T., Szabo, J.K., Burbidge, A.H., Butchart, S.H.M., Christidis, L., Dutson, G., Ford, H.A., Loym, R.H., Watson, D.M., Burgman, M.A., 2012. Structured elicitation of expert judgments for threatened species assessment: a case study on a continental scale using email. *Methods in Ecology and Evolution, 3*, 906-920.

McCann, R.K., Marcot, B.G., Ellis, R., 2006. Bayesian belief networks: applications in ecology and natural resource management. *Canadian Journal of Forest Research, 36*, 3053-3062.

McCourt, T., Mincham, H., 1987. *The Coorong and lakes of the lower Murray*. H. Micham, Underdale, SA.

McIntyre, S., Hobbs, R.J., 1999. A framework for conceptualizing human impacts on landscapes and its relevance to management and research models. *Conservation Biology, 13*, 1282-92.

McIntyre, S., Hobbs, R.J., 2000. Human impacts on landscapes: matrix condition and management priorities. In: *Nature Conservation 5: Nature Conservation in Production Environments: Managing the Matrix* (eds J.L. Craig, N. Mitchell, D.A. Saunders), pp. 301-307. Surrey Beatty & Sons, Chipping Norton, NSW.

McQuitty, L.L., 1966. Similarity Analysis by Reciprocal Pairs for Discrete and Continuous Data. *Educational and Psychological Measurement, 26*, 825–831.

MLR Southern Emu-wren and Fleurieu Peninsula Swamps Recovery Team, 2007. *Recovery plan for the Mount Lofty Ranges (MLR) Southern Emu-wren Stipiturus malachurus intermedius: 2006–2011*. Conservation Council of South Australia, Adelaide.

Muhit, M.A., Shah, S.P., Gilbert, C.E., Hartley, S.D., Foster, A., 2007. The key informant method: a novel means of ascertaining blind children in Bangladesh. *British Journal of Opthalmology, 91*, 995–999.

Northrip, K., Chen, C., Marsh, J., 2008. Vocational bias: A potential pitfall in the use of key informant interviews in pediatric community needs assessments. *The Scientific World Journal, 8*, 502-506.

Noss R.F., 1987. From plant communities to landscapes in conservation inventories: a look at the Nature Conservancy USA. *Biological Conservation, 41*, 11-37.

O'Connor, J.A., Rogers, D., Pisanu, P., 2013. *Cryptic and colonial-nesting waterbirds in the Coorong, Lower Lakes and Murray Mouth: distribution, abundance and habitat associations*. Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

Oksanen, J., Blanchet, F.G., Kindt, R., Legendre, P., O'Hara, R.B., Simpson, G.L., Solymos, P., Stevens, M.H.H., Wagner, H., 2011. *vegan: Community ecology package*. http://CRAN.R-project.org/package=vegan

Orange-bellied Parrot Recovery Team, 2006. *National recovery plan for the Orange-bellied Parrot (Neophema chrysogaster)*. Tasmanian Department of Primary Industries and Water, Hobart.

Ormerod, S.J., and Watkinson, A.R., 2000. Birds and agriculture - Editor's introduction. *Journal of Applied Ecology, 37*, 699-705.

Pal, D.K., Das, T., Sengupta S., 1998. Comparison of key informant and survey methods for ascertainment of childhood epilepsy in West Bengal, India. *International Journal of Epidemiology, 27*, 672–676.

Paton, D.C., Prescott, A.M., Davies, R.J.P., Heard, L.M., 1999. The distribution, status and threats to temperate woodlands in South Australia. In: *Temperate Eucalypt Woodlands in Australia: Biology, Conservation, Management and Restoration* (eds R.J. Hobbs, C.J. Yates), pp. 57–85. Surrey Beatty and Sons, Chipping Norton, NSW.

Pearl J., 1998. *Probabilistic reasoning in intelligent systems: Networks of plausible inference*. Morgan Kaufmann, San Mateo, CA.

Pollino C.A., Woodberry O., Nicholson A.E., Korb K.B., Hart B.T., 2007. Parameterisation and evaluation of a Bayesian network for use in an ecological risk assessment. *Environmental Modelling & Software, 22*, 1140-1152.

R Core Team, 2013. *R: a language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria.

Reid, P.C., Colebrook, J.M., Matthews, J.B.L., Aiken, J., Continuous Plankton Recorder Team, 2003. The continuous plankton recorder: concepts and history, from plankton indicator to undulating recorders. *Progress in Oceanography, 58*, 117–173.

Rogers D.J., 2010. *A landscape assessment for the Southern Flinders CAP Landscape of the Northern & Yorke NRM region. Version 1.0*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Rogers D.J., 2011a. *A landscape assessment for the Southern Mt Lofty Ranges Landscape. Version 2.2*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Rogers D.J., 2011b. *A landscape assessment for the Southern Yorke Peninsula Landscape of the Northern and Yorke NRM region*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Rogers D.J., 2012a. *A landscape assessment for the Broughton Landscape*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Rogers D.J., 2012b. *A landscape assessment for the Northern Eyre Hills Landscape of the Eyre Peninsula NRM region*. Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

Rogers D.J., 2012c. *A landscape assessment for the Southern Eyre Hills Landscape of the Eyre Peninsula NRM region*. Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

Rogers D.J., 2012d. *A landscape assessment for the St. Vincent Landscape*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Rogers D.J., Willoughby N., Pisanu P., McIllwee A., Gates J., 2012. *Landscape assessment: A process for identifying ecosystem priorities for nature conservation*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Seaman, R.L., 2003. *Coorong and Lower Lakes habitat-mapping program*. Government of South Australia, Conservation Programs, Department for Environment and Heritage, Adelaide.

Smith, C.S., Howes, A.L., Price, B., McAlpine, C.A., 2007. Using a Bayesian belief network to predict suitable habitat of an endangered mammal – The Julia Creek Dunnart (*Sminthopsis douglasi*). *Biological Conservation, 139*, 333–347.

Tansley A.G., 1935. The use and abuse of vegetational concepts and terms. *Ecology, 16*, 284–307.

TNC, 2007. *Conservation action planning handbook: Developing strategies, taking action and measuring success at any scale*. The Nature Conservancy (TNC), Arlington, VA.

Wacker, R.R., 2005. *Weld County assessment of needs and strengths*. Compass Needs Assessment Steering Committee / University of Northern Colorado, Greeley, CO.

White, D., Gramacy, R.B., 2012. *maptree: Mapping, pruning, and graphing tree models. R package version 1.4-7*. http://CRAN.R-project.org/package=vegan

Williams, M., 1974. *The making of the South Australian landscape: a study in the historical geography of Australia*. Academic Press, London.

Willoughby, N., 2010. *A landscape assessment framework: As applied to the Murray Mallee IBRA sub-region. Version 1.0*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Willoughby, N., Armstrong, D., McDonald, J., Croft, T., 2011. *Landscape assessment for the western portion of the Murray Mallee IBRA sub-region. Version 1.0*. Government of South Australia, Department of Environment and Natural Resources, Adelaide.

Xu, T., Hutchinson, M.F., 2013. New developments and applications in the ANUCLIM spatial climatic and bioclimatic modelling package. *Environmental Modelling and Software, 40*, 267–279

6 Appendices

6.1 Cluster analysis of vegetation survey data to identify terrestrial Ecosystems of the CLLMM region of South Australia

6.1.1 Cluster analysis dendrogram

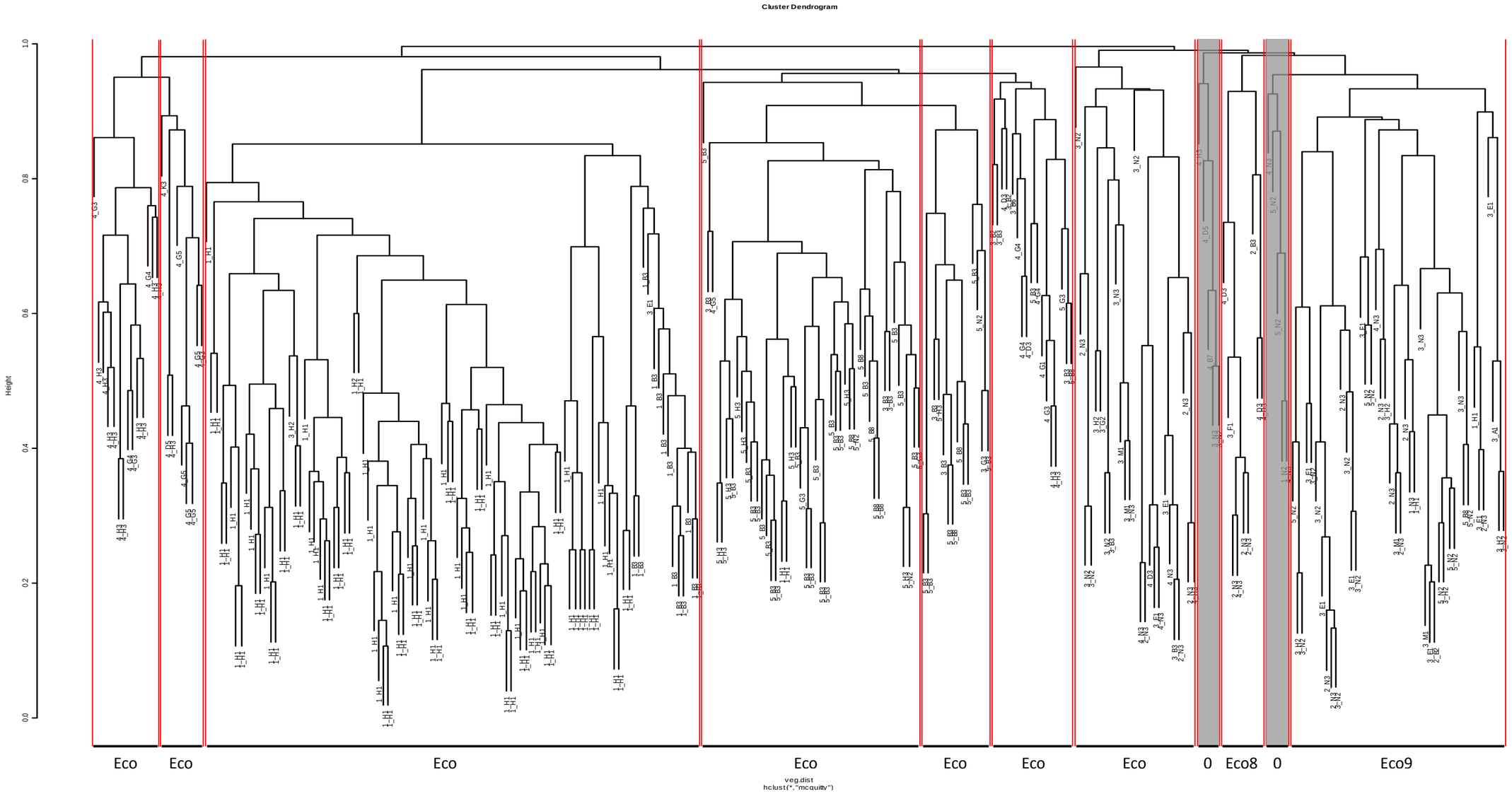

Figure 6.1 Dendogram of the hierarchical cluster analysis showing vegetation survey sites (e.g. "4_G3"), similarity in vegetation species composition and cover values (e.g. lines, linkages), and their natural groupings to classify terrestrial ecosystems (e.g. "Eco1") of the CLLMM region of South Australia. Very small groups (shaded) were discarded from the classification, but used to help inform the identification of 'Other' terrestrial ecosystems

6.2 Models of the potential distribution of terrestrial Ecosystems within the CLLMM region of South Australia

6.2.1 Ecosystems 1 to 9 (from cluster analysis)

Each Ecosystem model is based on Soil landscape units (SLU) polygons located wholly or partially within 5 km of Lake Alexandrina, Lake Albert and the Coorong (e.g. Landscape Subgroups; Figure 2.5 & Figure 2.6). Two new fields were added to the output polygon feature class (ECOTYPE and SOIL_SUBGROUP_PROP). The ECOTYPE field was calculated to the unique numeric ecosystem number (1 to 9). The SOIL_SUBGROUP_PROP field was calculated as the sum of each of the percentages of soil subgroup listed for the ecosystem. Landscape Subgroups and Soil Subgroups were used to generate distribution models (i.e. maps) for Ecosystems 1 to 9 based on the following criteria:

Model	Landscape subgroups (% of sites)	Soil subgroups (% of sites)
Ecosystem 1	Mount Lofty Ranges (100%)	Predominantly bleached siliceous sand (H3 71%), sand over clay soils (G3/G4 29%)
Ecosystem 2	Mount Lofty Ranges (100%)	Predominantly sand over clay soils (G3/G5 67%), others (D5/H3/K3 33%)
Ecosystem 3	Coastal Dunes (98%) Excluded: Lower Lakes (2%)	Predominantly deep sands (H1 84%, H2 2%), shallow sandy loam on calcrete (B3 13%), others (E1 1%)
Ecosystem 4	South East (87%), Lower Lakes Terrestrial (7%), Others (Coastal Dunes/Mount Lofty Ranges/Lower Lakes 6%)	Predominantly shallow sandy soil on calcrete (B3/B8 68%), deep sands (H1/H3 21%), sand over clay (G3/G5 6%), saline soils (N2 5%)
Ecosystem 5	South East (75%), Lower Lakes Terrestrial (25%)	Predominantly shallow sandy soil on calcrete (B3/B8 76%), bleached sand over sandy clay soil (G3 8%), bleached siliceous sands (H3 8%), saline soils (N2 8%)
Ecosystem 6	Mount Lofty Ranges (56%), Lower Lakes Terrestrial (25%), South East (19%)	Predominantly shallow sandy soil on calcrete (B2/B3/B6/B8 37%), sand over clay soils (G1/G3/G4 38%), loam over poorly structured red clay (D3 13%), bleached siliceous sand (H3 13%)
Ecosystem 6.1	Mount Lofty Ranges, Lower Lakes Terrestrial	Shallow soils on calcrete (B2/B3), loam over poorly structured red clay (D3)
Ecosystem 6.2	Mount Lofty Ranges	Sand over poorly structured clay (G4), loam over poorly structured red clay (D3).
Ecosystem 6.3	Mount Lofty Ranges	Sand over clay soils (G1/G3), bleached siliceous sand (H3)
Ecosystem 6.4	Lower Lakes Terrestrial, South East	Shallow soils on calcrete (B3/B6/B8), thick sand over clay (G3)
Ecosystem 7	Lower Lakes Terrestrial (60%), Mount Lofty Ranges (20%), Lower Lakes Aquatic (20%)	Predominantly wet soils (N3 40%, N2 20%), deep sands (H2/H3 8%), shallow sandy loam on calcrete (B3 8%), black cracking clay (E1 8%), deep sandy loam (M1 8%), others (D3/H3 8%)
Ecosystem 8	Mount Lofty Ranges (44%), Lower Lakes Aquatic (44%), Lower Lakes Terrestrial (12%)	Predominantly wet soil (N3 44%), loam over poorly structured red clay (D3 33%), shallow sandy loam on calcrete (B3 11%), loam over brown or dark clay (F1 11%)
Ecosystem 9	Lower Lakes Terrestrial (51%), Lower Lakes Aquatic (21%), South East (19%), Others (Coastal Dunes/Mount Lofty Ranges 9%)	Predominantly wet soil (N2 33%, N3 28%), deep sands (H1/H2 14%), black cracking clay (E1 12%), deep sandy loam (M1 5%), shallow sandy soil on calcrete (B2/B8 4%), others (A1/F1 4%)

6.2.2 Other ecosystems (from additional data)

Each additional Ecosystem model is bounded by soil landscape units (SLU) polygons located wholly or partially within 5 km of Lake Alexandrina, Lake Albert and the Coorong (e.g. Landscape subgroups 'LANDSCAPE_CLLMM_ManagementLandscapes'; Figure 2.5 and Figure 2.6). These models are based on pre-1750 vegetation mapping (DEWNR 2015; DEWNR SDE 'VEG.PEVegetation'), topographic data or recent landuse mapping (DEWNR SDE 'LANDSCAPE.LandUse2008'). Two new fields were added to each output polygon feature class (ECOTYPE and SOIL_SUBGROUP_PROP). The ECOTYPE field was calculated to the unique numeric ecosystem number (10.1 – 10.5). The SOIL_SUBGROUP_PROP field was: calculated as the sum of each of the percentages of soil subgroup listed for the ecosystem and used in the definition query for Ecosystem 10.4; and assigned a nominal value of 75 for Ecosystems 10.1, 10.2, 10.3, 10.4 and 10.5.

Model	Source	ARCGIS query
Ecosystem 10.1	Pre-1750 vegetation mapping (DEWNR SDE 'VEG.PEVegetation')	"VEG_ID1" IN ('AP0032PE' , 'ML5001PE')
Ecosystem 10.2	250 m buffer of Angas and Bremer Rivers using 1:50 000 topographic watercourse features (DEWNR SDE 'TOPO.WaterCourses')	"NAME" IN ('Bremer River' , 'Angas River')
Ecosystem 10.3	Pre-1750 vegetation mapping (DEWNR SDE 'VEG.PEVegetation')	"VEG_ID1" IN ('MN0039PE' , 'WM1301PE' , 'SE0042PE')
Ecosystem 10.4	Intersection of Pre-1750 vegetation mapping (DEWNR SDE 'VEG.PEVegetation'); and Landscape Subgroups ('LANDSCAPE_CLLMM_ManagementLandscapes')	("SoilLandsy" IN ('Lower Lakes - terrestrial' , 'Southeast') AND ("B3" > 0) AND "VEG_ID1" IN ('MN0017PE' , 'SE0022PE')) OR ("SoilLandsy" IN ('Mount Lofty Ranges' , 'Lower Lakes - terrestrial') AND ("B3" > 0) AND "VEG_ID1" IN ('MN0010PE'))
Ecosystem 10.5	Landuse 2008 (DEWNR SDE 'LANDSCAPE.LandUse2008')	"DES_PRI_V6" IN ('Intensive Uses' , 'Production from Dryland Agriculture and Plantations' , 'Production from Irrigated Agriculture and Plantations')

6.3 Detailed description of terrestrial Ecosystems identified from cluster analysis of vegetation survey site data within the CLLMM region

6.3.1 Ecosystem 1: Pink Gum (*Eucalyptus fasciculosa*) Low Open Grassy Woodland (MLR sands)

Landscape subgroup: Mount Lofty Ranges (100% of sites)

Soil subgroup: Predominantly bleached siliceous sand (H3 71%), sand over clay soils (G3/G4 29%)

Brief description: The understorey of the community is grassy with sparse shrubs. Common grassy understoreys are those of *Austrodanthonia* spp. and *Austrostipa* spp. The ecosystem is limited to the northwest of Lake Alexandrina occurring on carbonate sands (H3) and sand over clay soils (G3, G4). This ecosystem is highly disturbed in its current state.

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min cover	Avg cover	Max cover
Eucalyptus fasciculosa	1.00	0.01	0.07	0.25
Austrodanthonia geniculata (grass)	0.71	0.01	0.01	0.03
Clematis microphylla (vine)	0.71	0.01	0.01	0.03
Lepidosperma concavum (sedge)	0.71	0.01	0.02	0.03
Austrostipa mollis (grass)	0.57	0.01	0.02	0.02
Muehlenbeckia gunnii (shrub)	0.57	0.01	0.02	0.03
Pimelea humilis (shrub)	0.57	0.01	0.01	0.03
Helichrysum leucopsideum (herb)	0.57	0.01	0.01	0.03
Amyema miquelii (mistletoe)	0.57	0.01	0.02	0.03
Austrostipa scabra (grass)	0.57	0.01	0.02	0.05
Oxalis perennans (herb)	0.57	0.01	0.01	0.01
Austrodanthonia setacea (grass)	0.50	0.01	0.01	0.01
Acacia paradoxa	0.50	0.01	0.04	0.05
Podotheca angustifolia (herb)	0.50	0.01	0.01	0.01
Hibbertia virgata (shrub)	0.50	0.01	0.02	0.03
Thomasia petalocalyx (shrub)	0.43	0.01	0.02	0.05
Lepidosperma carphoides (sedge)	0.43	0.01	0.02	0.03
Lomandra collina (herb)	0.43	0.01	0.02	0.02
Dianella revolute (herb)	0.43	0.01	0.02	0.05
Lomandra multiflora (grass)	0.36	0.01	0.02	0.02
Lomandra juncea (rush)	0.36	0.01	0.02	0.02
Enchylaena tomentose (shrub)	0.36	0.01	0.01	0.02
Hypolaena fastigiata (herb)	0.36	0.01	0.02	0.03
Arthropodium fimbriatum (herb)	0.36	0.01	0.02	0.02
Billardiera cymosa	0.29	0.01	0.01	0.01
Millotia tenuifolia	0.29	0.01	0.01	0.01
Melaleuca uncinata	0.29	0.02	0.04	0.05
Kunzea pomifera	0.29	0.01	0.02	0.02
Lomandra sororia	0.29	0.02	0.02	0.02
Hibbertia sp. glabriuscula	0.29	0.01	0.02	0.03
Acacia pycnantha	0.29	0.02	0.02	0.02
Xanthorrhoea semiplana	0.29	0.01	0.02	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Schoenus breviculmis	0.21	0.01	0.01	0.01
Neurachne alopecuroidea	0.21	0.01	0.01	0.01
Austrostipa elegantissima	0.21	0.01	0.02	0.02
Bursaria spinosa	0.21	0.01	0.02	0.03
Eucalyptus incrassata	0.21	0.02	0.03	0.05
Acacia euthycarpa	0.21	0.01	0.02	0.03
Astroloma humifusum	0.21	0.01	0.02	0.02
Lysiana exocarpi	0.21	0.02	0.02	0.02
Crassula sieberiana	0.21	0.01	0.01	0.01
Drosera whittakeri	0.14	0.02	0.03	0.03
Dillwynia hispida	0.14	0.01	0.01	0.02
Wahlenbergia stricta	0.14	0.01	0.01	0.01
Brachyloma ericoides	0.14	0.01	0.02	0.03
Blennospora drummondii	0.14	0.02	0.02	0.02
Walwhalleya proluta	0.14	0.02	0.02	0.02
Elymus scaber	0.14	0.02	0.02	0.02
Leptospermum myrsinoides	0.14	0.02	0.04	0.05
Lomandra micrantha	0.14	0.01	0.01	0.01
Acrotriche depressa	0.14	0.01	0.01	0.01
Lomandra nana	0.14	0.01	0.01	0.02
Crassula colorata	0.14	0.02	0.03	0.03
Lomandra leucocephala	0.14	0.01	0.01	0.01
Arthropodium strictum	0.14	0.02	0.02	0.02
Lepidobolus drapetocoleus	0.14	0.01	0.02	0.03
Allocasuarina verticillata	0.14	0.02	0.04	0.05
Austrostipa exilis	0.14	0.01	0.01	0.01
Olearia passerinoides	0.14	0.03	0.03	0.03
Pyrorchis nigricans	0.14	0.02	0.03	0.03
Convolvulus remotus	0.07	0.02	0.02	0.02
Convolvulus angustissimus	0.07	0.02	0.02	0.02
Comesperma calymega	0.07	0.02	0.02	0.02
Austrodanthonia caespitosa	0.07	0.01	0.01	0.01
Chrysocephalum apiculatum	0.07	0.01	0.01	0.01
Callistemon rugulosus	0.07	0.01	0.01	0.01
Acacia spinescens	0.07	0.01	0.01	0.01
Aristida behriana	0.07	0.02	0.02	0.02
Austrostipa blackii	0.07	0.01	0.01	0.01
Calytrix glaberrima	0.07	0.01	0.01	0.01
Lasiopetalum baueri	0.07	0.03	0.03	0.03
Wahlenbergia luteola	0.07	0.02	0.02	0.02
Wahlenbergia gracilenta	0.07	0.01	0.01	0.01
Vittadinia cuneata	0.07	0.01	0.01	0.01
Triodia compacta	0.07	0.01	0.01	0.01
Tricoryne tenella	0.07	0.02	0.02	0.02
Trachymene pilosa	0.07	0.01	0.01	0.01
Thysanotus patersonii	0.07	0.01	0.01	0.01
Thelymitra nuda/pauciflora	0.07	0.02	0.02	0.02

Species	Frequency	Min cover	Avg cover	Max cover
Tetragonia implexicoma	0.07	0.02	0.02	0.02
Senecio picridioides	0.07	0.02	0.02	0.02
Poranthera microphylla	0.07	0.02	0.02	0.02
Plantago sp. B (R.Bates 44765)	0.07	0.01	0.01	0.01
Olearia ramulosa	0.07	0.02	0.02	0.02
Eucalyptus rugosa	0.07	0.02	0.02	0.02
Eucalyptus odorata	0.07	0.05	0.05	0.05
Dampiera rosmarinifolia	0.07	0.01	0.01	0.01
Dianella brevicaulis	0.07	0.02	0.02	0.02
Dichelachne crinita	0.07	0.01	0.01	0.01
Dodonaea hexandra	0.07	0.01	0.01	0.01
Drosera peltata	0.07	0.01	0.01	0.01
Millotia muelleri	0.07	0.01	0.01	0.01
Eucalyptus leptophylla	0.07	0.03	0.03	0.03
Levenhookia pusilla	0.07	0.01	0.01	0.01
Acacia calamifolia	0.07	0.02	0.02	0.02
Gonocarpus tetragynus	0.07	0.01	0.01	0.01
Helichrysum scorpioides	0.07	0.02	0.02	0.02
Hibbertia crinita	0.07	0.01	0.01	0.01
Hibbertia sericea	0.07	0.01	0.01	0.01
Cynoglossum suaveolens	0.07	0.02	0.02	0.02
Einadia nutans	0.07	0.01	0.01	0.01

6.3.2 Ecosystem 2: Stringybark (*Eucalyptus baxteri*) / Cup Gum (*E. cosmophylla*) Woodland (MLR hills)

Landscape subgroup: Mount Lofty Ranges (100% of sites)

Soil subgroup: Predominantly sand over clay soils (G3/G5 67%), others (D5/H3/K3 33%)

Brief description: Dominant overstorey of Brown Stringybark (*Eucalyptus baxteri*) and Cup Gum (*E. cosmophylla*) with the occasional occurrence of Pink Gum (*E. fasciculosa*) with a heathy understorey. Grass tree (*Xanthorrhoea semiplana*) is a common species of the understorey mixed with Sheoak (*Allocasuarina verticillata*) and/or Acacia, Banksia and Calytrix species. The ecosystem is primarily found in the Mount Lofty Ranges in higher elevation and rainfall compared to Pink Gum (*Eucalyptus fasciculosa*) Low Open Grassy Woodland of the Mount Lofty Ranges. The community predominantly occurs on sand over clay soils.

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min cover	Avg cover	Max cover
Xanthorrhoea semiplana (grass tree)	1.00	0.03	0.04	0.05
Lomandra micrantha (herb)	0.78	0.01	0.01	0.03
Leptospermum myrsinoides (shrub)	0.67	0.03	0.03	0.05
Allocasuarina striata (shrub to small tree)	0.67	0.01	0.03	0.05
Lepidosperma semiteres (grass)	0.67	0.01	0.04	0.05
Correa reflexa (shrub)	0.67	0.01	0.01	0.01
Eucalyptus cosmophylla	0.67	0.01	0.04	0.05
Platylobium obtusangulum (shrubs)	0.67	0.01	0.03	0.03
Billardiera cymosa (heath)	0.56	0.02	0.03	0.03
Acacia pycnantha (shrub to small tree)	0.56	0.01	0.02	0.03
Astroloma humifusum (shrub)	0.56	0.01	0.03	0.03
Isopogon ceratophyllus (shrub)	0.56	0.01	0.02	0.03
Eucalyptus baxteri	0.44	0.05	0.21	0.50
Hibbertia exutiacies (shrub)	0.44	0.03	0.03	0.03
Lepidobolus drapetocoleus	0.44	0.03	0.03	0.03
*Olearia ramulosa (*shrub)	0.44	0.01	0.02	0.03
Lepidosperma concavum (sedge)	0.44	0.01	0.03	0.03
Micrantheum demissum	0.44	0.01	0.03	0.05
Neurachne alopecuroidea (grass)	0.44	0.03	0.03	0.03
Schoenus breviculmis (rush)	0.44	0.03	0.03	0.03
Acacia myrtifolia (shrub)	0.44	0.01	0.01	0.01
Astroloma conostephioides (heath)	0.44	0.01	0.02	0.05
Calytrix tetragona (shrub)	0.44	0.01	0.01	0.02
Dianella revoluta (herb)	0.44	0.01	0.01	0.02
Burchardia umbellate (herb)	0.44	0.01	0.02	0.03
Arthropodium strictum (herb)	0.33	0.01	0.02	0.03
Banksia ornata (shrub)	0.33	0.01	0.02	0.03
Boronia coerulescens	0.33	0.01	0.02	0.03
Brachyloma ericoides (heath)	0.33	0.03	0.03	0.03
Austrodanthonia setacea (grass)	0.33	0.01	0.02	0.03
Calytrix glaberrima (shrub)	0.33	0.03	0.04	0.05
Grevillea lavandulacea (shrub)	0.33	0.01	0.02	0.03
Gonocarpus tetragynus (herb)	0.33	0.01	0.02	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Eucalyptus fasciculosa	0.33	0.01	0.03	0.05
Cassytha glabella	0.33	0.01	0.02	0.03
Cassytha pubescens	0.33	0.01	0.02	0.03
Hakea rostrata (shrubs)	0.33	0.01	0.02	0.03
Hypolaena fastigiata	0.33	0.01	0.03	0.05
Xanthosia pusilla	0.33	0.01	0.01	0.01
Phyllota pleurandroides	0.33	0.01	0.10	0.25
Austrostipa semibarbata	0.33	0.01	0.02	0.03
Austrostipa mollis	0.33	0.03	0.03	0.03
Stackhousia monogyna	0.33	0.03	0.03	0.03
Spyridium thymifolium	0.33	0.01	0.02	0.03
Bursaria spinosa	0.22	0.03	0.04	0.05
Acacia dodonaeifolia	0.22	0.02	0.04	0.05
Eucalyptus odorata	0.22	0.02	0.14	0.25
Platysace heterophylla	0.22	0.01	0.01	0.02
Poa labillardieri	0.22	0.01	0.02	0.03
Dillwynia sericea	0.22	0.03	0.03	0.03
Deyeuxia quadriseta	0.22	0.03	0.03	0.03
Daviesia brevifolia	0.22	0.01	0.02	0.03
Hakea carinata	0.22	0.03	0.03	0.03
Hakea rugosa	0.22	0.03	0.04	0.05
Cassytha melantha	0.22	0.01	0.01	0.02
Daviesia ulicifolia	0.22	0.01	0.01	0.02
Senecio quadridentatus	0.22	0.01	0.01	0.02
Banksia marginata	0.22	0.01	0.03	0.05
Allocasuarina muelleriana	0.22	0.01	0.03	0.05
Acacia spinescens	0.22	0.01	0.02	0.03
Austrodanthonia geniculata	0.22	0.03	0.03	0.03
Hibbertia riparia (glabriuscula)	0.22	0.01	0.03	0.05
Opercularia varia	0.22	0.01	0.01	0.02
Leucopogon virgatus	0.22	0.01	0.02	0.03
Hibbertia virgata	0.22	0.01	0.02	0.03
Microlaena stipoides	0.22	0.03	0.03	0.03
Lepidosperma carphoides	0.22	0.03	0.03	0.03
Lomandra collina	0.22	0.01	0.01	0.02
Lomandra juncea	0.22	0.03	0.03	0.03
Callistemon macropunctatus	0.11	0.05	0.05	0.05
Schoenus apogon	0.11	0.01	0.01	0.01
Leptospermum continentale	0.11	0.03	0.03	0.03
Scaevola albida	0.11	0.02	0.02	0.02
Pultenaea trinervis	0.11	0.03	0.03	0.03
Opercularia scabrida	0.11	0.03	0.03	0.03
Microtis parviflora	0.11	0.01	0.01	0.01
Cassytha peninsularis	0.11	0.03	0.03	0.03
Brunonia australis	0.11	0.03	0.03	0.03
Spyridium phylicoides	0.11	0.02	0.02	0.02
Boronia filifolia	0.11	0.03	0.03	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Calandrinia granulifera	0.11	0.03	0.03	0.03
Pultenaea teretifolia	0.11	0.03	0.03	0.03
Austrostipa flavescens	0.11	0.03	0.03	0.03
Choretrum glomeratum	0.11	0.01	0.01	0.01
Lomandra sororia	0.11	0.01	0.01	0.01
Themeda triandra	0.11	0.05	0.05	0.05
Amyema miquelii	0.11	0.02	0.02	0.02
Thysanotus baueri	0.11	0.03	0.03	0.03
Adenanthos terminalis	0.11	0.02	0.02	0.02
Acaena echinata	0.11	0.01	0.01	0.01
Lomandra densiflora	0.11	0.01	0.01	0.01
Acacia rupicola	0.11	0.05	0.05	0.05
Xanthosia dissecta	0.11	0.01	0.01	0.01
Acacia paradoxa	0.11	0.05	0.05	0.05
Lepidosperma viscidum	0.11	0.03	0.03	0.03
Pteridium esculentum	0.11	0.01	0.01	0.01
Zieria veronicea	0.11	0.02	0.02	0.02
Pimelea humilis	0.11	0.03	0.03	0.03
Helichrysum scorpioides	0.11	0.01	0.01	0.01
Goodenia blackiana	0.11	0.03	0.03	0.03
Pimelea linifolia	0.11	0.02	0.02	0.02
Glischrocaryon behrii	0.11	0.03	0.03	0.03
Gahnia deusta	0.11	0.05	0.05	0.05
Gahnia ancistrophylla	0.11	0.03	0.03	0.03
Eucalyptus leptophylla	0.11	0.03	0.03	0.03
*Hibbertia riparia (*long-leaved *aff. H. stricta)*	0.11	0.01	0.01	0.01
Pratia pedunculata	0.11	0.01	0.01	0.01
Eucalyptus arenacea	0.11	0.05	0.05	0.05
Drosera macrantha	0.11	0.01	0.01	0.01
Cheilanthes austrotenuifolia	0.11	0.03	0.03	0.03
Pultenaea largiflorens	0.11	0.03	0.03	0.03
Cheiranthera alternifolia	0.11	0.01	0.01	0.01
Hardenbergia violacea	0.11	0.03	0.03	0.03
Chrysocephalum apiculatum	0.11	0.01	0.01	0.01
Chrysocephalum baxteri	0.11	0.01	0.01	0.01
Clematis microphylla	0.11	0.01	0.01	0.01
Hybanthus floribundus	0.11	0.01	0.01	0.01
Conospermum patens	0.11	0.01	0.01	0.01
Dichondra repens	0.11	0.03	0.03	0.03
Dampiera rosmarinifolia	0.11	0.03	0.03	0.03
Laxmannia orientalis	0.11	0.01	0.01	0.01
Isolepis cernua	0.11	0.01	0.01	0.01
Lomandra nana	0.11	0.01	0.01	0.01
Persoonia juniperina	0.11	0.01	0.01	0.01
Pultenaea involucrata	0.11	0.01	0.01	0.01
Comesperma calymega	0.11	0.01	0.01	0.01

6.3.3 Ecosystem 3: Mixed Shrubland (Coast Daisy-bush *Olearia axillaris* / Coast Beard-heath *Leucopogon parviflorus* / Coastal Wattle *Acacia longifolia* ssp. *sophorae*) (coastal dunes)

Shrublands of the Coorong coastal dunes

Landscape subgroup: Coastal Dunes (98%), Lower Lakes Terrestrial (2%)

Soil subgroup: Predominantly deep sands (H1 84%, H2 2%), shallow sandy loam on calcrete (B3 13%), others (E1 1%)

Brief description: Dominant species are *Olearia axillaris*, *Leucopogon parviflorus* and *Acacia longifolia ssp. sophorae*, and commonly comprised of shrubland and grassland species of the Coorong. This ecosystem primarily occurs in the coastal area of the Coorong (Young Husband Peninsula) where soil is predominantly deep sands and those found on the islands and inland side of the Coorong have shallow sandy loam on calcrete.

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min Cover	Avg Cover	Max Cover
Olearia axillaris (shrub)	0.97	0.01	0.07	0.25
Carpobrotus rossii	0.93	0.01	0.02	0.05
Rhagodia candolleana	0.91	0.01	0.03	0.25
Muehlenbeckia gunnii	0.84	0.01	0.03	0.25
Tetragonia implexicoma	0.83	0.01	0.02	0.05
Isolepis nodosa	0.78	0.01	0.04	0.25
Myoporum insulare	0.73	0.01	0.08	0.50
Pimelea serpyllifolia	0.72	0.01	0.02	0.05
Exocarpos syrticola	0.71	0.01	0.03	0.05
Leucopogon parviflorus	0.68	0.01	0.09	0.50
Senecio lautus	0.67	0.01	0.03	0.05
Acacia longifolia spp. *sophorae*	0.65	0.01	0.08	0.50
Daucus glochidiatus	0.65	0.01	0.03	0.05
Dianella revoluta	0.58	0.01	0.02	0.05
Pelargonium australe	0.54	0.01	0.02	0.03
Crassula sieberiana	0.53	0.01	0.03	0.05
Clematis microphylla	0.45	0.01	0.02	0.05
Threlkeldia diffusa	0.42	0.01	0.02	0.05
Geranium potentilloides	0.40	0.01	0.04	0.25
Spinifex sericeus	0.38	0.01	0.04	0.25
Crassula closiana	0.37	0.01	0.03	0.03
Billardiera cymosa	0.33	0.01	0.02	0.05
Stackhousia spathulata	0.30	0.01	0.02	0.03
Lepidosperma gladiatum	0.28	0.01	0.08	0.25
Leucophyta brownii	0.26	0.01	0.07	0.50
Austrostipa flavescens	0.22	0.01	0.02	0.03
Crassula decumbens	0.22	0.01	0.03	0.03
Calandrinia brevipedata	0.20	0.01	0.03	0.05
Lotus australis	0.20	0.01	0.01	0.03
Ozothamnus turbinatus	0.20	0.01	0.05	0.25
Kunzea pomifera	0.18	0.01	0.07	0.25
Parietaria debilis	0.17	0.01	0.02	0.03

Species	Frequency	Min Cover	Avg Cover	Max Cover
Dianella brevicaulis	0.16	0.01	0.02	0.03
Gnaphalium indutum	0.14	0.01	0.02	0.03
Myosotis australis	0.14	0.01	0.03	0.03
Hydrocotyle laxiflora	0.13	0.01	0.03	0.05
Adriana klotzschii	0.12	0.01	0.02	0.05
Geranium retrorsum	0.11	0.01	0.03	0.05
Alyxia buxifolia	0.11	0.01	0.04	0.25
Apium prostratum	0.11	0.01	0.02	0.03
Sonchus megalocarpus	0.11	0.01	0.02	0.03
Acacia leiophylla	0.10	0.01	0.07	0.25
Crassula colorata	0.10	0.01	0.03	0.03
Geranium solanderi	0.09	0.01	0.03	0.05
Cotula australis	0.09	0.01	0.03	0.03
Austrofestuca littoralis	0.09	0.01	0.03	0.05
Dichondra repens	0.09	0.01	0.02	0.03
Helichrysum leucopsideum	0.07	0.01	0.02	0.03
Enchylaena tomentosa	0.06	0.01	0.01	0.02
Beyeria lechenaultii	0.06	0.01	0.03	0.05
Lasiopetalum discolor	0.06	0.01	0.05	0.25
Poa poiformis	0.06	0.01	0.02	0.03
Kennedia prostrata	0.06	0.01	0.02	0.03
Pomaderris paniculosa	0.05	0.01	0.02	0.05
Acaena novae-zelandiae	0.05	0.01	0.02	0.03
Triglochin centrocarpum	0.05	0.01	0.03	0.03
Cynoglossum australe	0.05	0.01	0.01	0.01
Atriplex paludosa	0.05	0.01	0.03	0.05
Cassytha pubescens	0.05	0.01	0.02	0.03
Austrostipa nodosa	0.05	0.01	0.03	0.03
Scaevola calendulacea	0.05	0.01	0.03	0.05
Dodonaea viscosa	0.04	0.01	0.03	0.05
Lavatera plebeia	0.04	0.03	0.03	0.03
Aphanes australiana	0.04	0.01	0.02	0.03
Comesperma volubile	0.03	0.01	0.01	0.02
Distichlis distichophylla	0.03	0.03	0.03	0.03
Sporobolus virginicus	0.03	0.01	0.01	0.01
Wurmbea dioica	0.03	0.01	0.01	0.02
Frankenia pauciflora	0.03	0.02	0.03	0.05
Hibbertia sericea	0.03	0.01	0.02	0.03
Scaevola crassifolia	0.03	0.01	0.09	0.25
Goodenia varia	0.03	0.01	0.01	0.02
Austrodanthonia caespitosa	0.03	0.01	0.02	0.03
Calandrinia eremaea	0.03	0.01	0.02	0.03
Allocasuarina verticillata	0.03	0.01	0.02	0.02
Suaeda australis	0.03	0.01	0.02	0.03
Acacia cupularis	0.03	0.01	0.02	0.03
Caladenia latifolia	0.02	0.01	0.02	0.02
Bursaria spinosa	0.02	0.01	0.03	0.05

Species	Frequency	Min Cover	Avg Cover	Max Cover
Cassytha glabella	0.02	0.01	0.01	0.01
Correa alba	0.02	0.01	0.02	0.03
Juncus kraussii	0.02	0.01	0.02	0.03
Pseudognaphalium luteoalbum	0.02	0.03	0.03	0.03
Disphyma crassifolium	0.02	0.01	0.02	0.03
Pultenaea tenuifolia	0.02	0.01	0.01	0.01
Ranunculus sessiliflorus	0.02	0.03	0.03	0.03
Sclerostegia arbuscula	0.02	0.01	0.02	0.03
Austrostipa exilis	0.02	0.01	0.02	0.03
Hypoxis glabella	0.02	0.01	0.02	0.02
Hemichroa pentandra	0.02	0.01	0.01	0.01
Haloragis acutangula	0.02	0.01	0.01	0.01
Lawrencia spicata	0.02	0.01	0.02	0.03
Austrostipa stipoides	0.01	0.05	0.05	0.05
Austrostipa mollis	0.01	0.01	0.01	0.01
Maireana oppositifolia	0.01	0.05	0.05	0.05
Neurachne alopecuroidea	0.01	0.01	0.01	0.01
Swainsona lessertiifolia	0.01	0.03	0.03	0.03
Atriplex cinerea	0.01	0.02	0.02	0.02
Samolus repens	0.01	0.03	0.03	0.03
Veronica hillebrandii	0.01	0.01	0.01	0.01
Xanthorrhoea caespitosa	0.01	0.03	0.03	0.03
Zygophyllum apiculatum	0.01	0.01	0.01	0.01
Podotheca angustifolia	0.01	0.03	0.03	0.03
Lawrencia squamata	0.01	0.02	0.02	0.02
Epilobium billardierianum	0.01	0.03	0.03	0.03
Eucalyptus diversifolia	0.01	0.05	0.05	0.05
Eucalyptus fasciculosa	0.01	0.25	0.25	0.25
Tecticornia halocnemoides	0.01	0.05	0.05	0.05
Hydrocotyle callicarpa	0.01	0.03	0.03	0.03
Calandrinia calyptrata	0.01	0.01	0.01	0.01
Corybas despectans	0.01	0.03	0.03	0.03
Melaleuca halmaturorum	0.01	0.02	0.02	0.02
Lepidosperma concavum	0.01	0.01	0.01	0.01
Centrolepis polygyna	0.01	0.01	0.01	0.01
Logania crassifolia	0.01	0.01	0.01	0.01
Logania ovata	0.01	0.03	0.03	0.03
Melaleuca brevifolia	0.01	0.01	0.01	0.01
Imperata cylindrica	0.01	0.25	0.25	0.25
Zygophyllum billardierei	0.01	0.02	0.02	0.02

6.3.4 Ecosystem 4: Coastal White Mallee (*Eucalyptus diversifolia*) (SE/LL sandy loams)

Landscape subgroup: South East (87%; Lower Lakes Terrestrial 7%; Others (Coastal Dune, Mount Lofty Ranges & Lower Lakes 6%)

Soil subgroup: Predominantly shallow sandy soil on calcrete (B3/B8 68%), deep sands (H1/H3 21%), sand over clay (G3/G5 6%), saline soils (N2 5%)

Brief description: The community has a dominant *E. diversifolia* +/- *E. incrassata* overstorey with heathy-shrubby understorey. Common understorey species are *Xanthorrhoea caespitosa*, *Lepidosperma carphoides* and *Billardiera cymosa*. Majority of the ecosystem's distribution is in the South East with minor distribution in Lower Lakes Terrestrial, Lower Lakes, Coastal Dunes and Mount Lofty Ranges. The ecosystem predominantly occurs on sandy soil on calcrete (B3 & B8) and deep sands (H1 & H3).

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min cover	Avg cover	Max cover
Eucalyptus diversifolia	0.83	0.01	0.29	0.75
Xanthorrhoea caespitosa (grass tree)	0.83	0.01	0.06	0.25
Lepidosperma carphoides (sedge)	0.66	0.01	0.05	0.25
Billardiera cymosa (vine)	0.66	0.01	0.01	0.03
Hibbertia sericea (shrub)	0.64	0.01	0.04	0.25
Drosera whittakeri (herb)	0.60	0.01	0.02	0.03
Correa reflexa (shrub)	0.60	0.01	0.02	0.05
Dianella revoluta	0.57	0.01	0.02	0.05
Clematis microphylla	0.51	0.01	0.01	0.05
Schoenus breviculmis	0.49	0.01	0.02	0.05
Astroloma conostephioides	0.47	0.01	0.02	0.05
Astroloma humifusum	0.47	0.01	0.02	0.05
Hydrocotyle laxiflora	0.47	0.01	0.02	0.05
Acacia longifolia	0.45	0.01	0.06	0.25
Thysanotus patersonii	0.45	0.01	0.01	0.03
Banksia marginata	0.43	0.01	0.05	0.25
Eucalyptus incrassata	0.40	0.01	0.13	0.50
Goodenia geniculata	0.40	0.01	0.02	0.03
Kunzea pomifera	0.38	0.01	0.13	0.50
Acacia spinescens	0.38	0.01	0.02	0.05
Millotia tenuifolia	0.38	0.01	0.02	0.03
Leptospermum myrsinoides	0.38	0.01	0.06	0.25
Drosera macrantha	0.36	0.01	0.01	0.03
Isopogon ceratophyllus	0.36	0.01	0.02	0.03
Gonocarpus tetragynus	0.34	0.01	0.02	0.03
Daviesia brevifolia	0.32	0.01	0.02	0.05
Allocasuarina muelleriana	0.32	0.01	0.15	0.50
Burnettia nigricans	0.32	0.01	0.01	0.03
Austrostipa mollis	0.32	0.01	0.01	0.03
Banksia ornata	0.32	0.01	0.11	0.25
Hakea vittata	0.30	0.01	0.03	0.05
Muehlenbeckia gunnii	0.30	0.01	0.02	0.05
Hypolaena fastigiata	0.30	0.01	0.02	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Helichrysum leucopsideum	0.30	0.01	0.02	0.05
Cassytha glabella	0.28	0.01	0.02	0.03
Hakea rostrata	0.28	0.01	0.02	0.03
Hibbertia riparia	0.28	0.01	0.09	0.25
Senecio picridioides	0.26	0.01	0.01	0.02
Daucus glochidiatus	0.26	0.01	0.02	0.03
Thomasia petalocalyx	0.26	0.01	0.03	0.05
Neurachne alopecuroidea	0.23	0.01	0.01	0.03
Acrotriche affinis	0.23	0.01	0.02	0.05
Leucopogon parviflorus	0.23	0.01	0.02	0.05
Dichondra repens	0.23	0.01	0.01	0.03
Boronia coerulescens	0.23	0.01	0.02	0.05
Podotheca angustifolia	0.23	0.01	0.01	0.03
Acrotriche cordata	0.23	0.01	0.03	0.05
Caladenia carnea	0.23	0.01	0.02	0.03
Cynoglossum australe	0.21	0.01	0.02	0.03
Melaleuca lanceolata	0.21	0.01	0.04	0.25
Acacia pycnantha	0.19	0.02	0.05	0.05
Hibbertia riparia (glabriuscula)	0.19	0.02	0.04	0.05
Eucalyptus fasciculosa	0.19	0.01	0.15	0.50
Adenanthos terminalis	0.19	0.01	0.01	0.03
Hakea muelleriana	0.19	0.01	0.02	0.03
Phyllota pleurandroides	0.19	0.01	0.02	0.05
Lepidobolus drapetocoleus	0.19	0.01	0.03	0.05
Cyrtostylis robusta	0.17	0.01	0.01	0.01
Dillwynia hispida	0.17	0.01	0.02	0.05
Wahlenbergia gracilenta	0.17	0.01	0.02	0.03
Acianthus pusillus	0.17	0.01	0.01	0.02
Austrodanthonia setacea	0.17	0.01	0.02	0.03
Opercularia turpis	0.17	0.01	0.02	0.03
Allocasuarina pusilla	0.17	0.01	0.02	0.05
Styphelia exarrhena	0.17	0.01	0.02	0.03
Calytrix tetragona	0.17	0.01	0.02	0.05
Olearia axillaris	0.17	0.01	0.03	0.05
Pultenaea tenuifolia	0.17	0.01	0.01	0.03
Lepidosperma concavum	0.15	0.01	0.03	0.05
Cassytha pubescens	0.15	0.01	0.03	0.03
Crassula decumbens	0.15	0.01	0.01	0.03
Lomandra juncea	0.15	0.01	0.02	0.05
Persoonia juniperina	0.15	0.01	0.01	0.03
Crassula sieberiana	0.15	0.01	0.01	0.03
Xanthosia dissecta	0.15	0.01	0.01	0.03
Thelymitra antennifera	0.15	0.01	0.02	0.03
Acacia myrtifolia	0.15	0.01	0.01	0.02
Bursaria spinosa	0.15	0.01	0.03	0.05
Levenhookia pusilla	0.15	0.01	0.02	0.03
Crassula colorata	0.15	0.01	0.01	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Carpobrotus modestus/rossii	0.13	0.01	0.06	0.25
Lepidosperma laterale	0.13	0.01	0.03	0.05
Stackhousia aspericocca	0.13	0.01	0.01	0.01
Leucopogon costatus	0.13	0.01	0.01	0.01
Caladenia latifolia	0.13	0.01	0.01	0.01
Lepidosperma concavum/congestum/laterale	0.13	0.01	0.03	0.05
Lomandra effusa	0.13	0.01	0.02	0.05
Levenhookia dubia	0.13	0.01	0.02	0.03
Logania linifolia	0.13	0.01	0.01	0.01
Cryptandra tomentosa	0.13	0.01	0.02	0.03
Kennedia prostrata	0.13	0.01	0.01	0.02
Xanthosia pusilla	0.13	0.01	0.01	0.03
Pterostylis nana	0.13	0.01	0.02	0.03
Gahnia deusta	0.13	0.01	0.03	0.05
Poranthera microphylla	0.13	0.01	0.02	0.03
Acaena novae-zelandiae	0.13	0.01	0.02	0.03
Tetragonia implexicoma	0.13	0.01	0.09	0.25
Senecio lautus	0.13	0.01	0.06	0.25
Parietaria debilis	0.13	0.01	0.02	0.03
Oxalis perennans	0.13	0.01	0.01	0.03
Isolepis nodosa	0.11	0.01	0.02	0.05
Eucalyptus foecunda	0.11	0.01	0.01	0.01
Comesperma volubile	0.11	0.01	0.01	0.02
Thelymitra nuda	0.11	0.01	0.01	0.02
Lepidosperma congestum	0.11	0.01	0.02	0.03
Rutidosis multiflora	0.11	0.01	0.02	0.03
Spyridium subochreatum	0.11	0.01	0.01	0.01
Rhagodia candolleana	0.11	0.01	0.08	0.25
Lomandra collina	0.11	0.01	0.02	0.03
Austrodanthonia geniculata	0.11	0.01	0.03	0.03
Tetraria capillaris	0.11	0.01	0.03	0.05
Diuris pardina	0.11	0.01	0.01	0.02
Allocasuarina verticillata	0.11	0.01	0.04	0.05
Tricoryne elatior	0.11	0.01	0.01	0.02
Dampiera rosmarinifolia	0.11	0.01	0.02	0.03
Schoenus deformis	0.11	0.01	0.02	0.05
Argentipallium obtusifolium	0.11	0.01	0.01	0.02
Tricoryne tenella	0.11	0.01	0.02	0.03
Lomandra micrantha	0.11	0.01	0.01	0.02
Goodenia blackiana	0.11	0.01	0.01	0.03
Arthropodium fimbriatum	0.11	0.01	0.01	0.01
Lepidosperma congestum/laterale	0.09	0.01	0.03	0.05
Choretrum glomeratum	0.09	0.01	0.02	0.03
Senecio quadridentatus	0.09	0.01	0.01	0.01
Spyridium vexilliferum	0.09	0.01	0.01	0.02
Calytrix alpestris	0.09	0.01	0.03	0.05
Helichrysum scorpioides	0.09	0.01	0.02	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Thelymitra benthamiana	0.09	0.01	0.01	0.02
Hyalosperma demissum	0.09	0.01	0.01	0.01
Microseris lanceolata	0.09	0.01	0.01	0.02
Mitrasacme paradoxa	0.09	0.01	0.01	0.01
Ranunculus sessiliflorus	0.09	0.01	0.02	0.03
Acrotriche serrulata	0.09	0.01	0.02	0.02
Gahnia lanigera	0.09	0.01	0.01	0.01
Melaleuca brevifolia	0.09	0.01	0.03	0.05
Crassula closiana	0.06	0.01	0.02	0.03
Comesperma calymega	0.06	0.01	0.02	0.02
Dichelachne crinita	0.06	0.01	0.02	0.03
Pultenaea acerosa	0.06	0.01	0.02	0.03
Millotia muelleri	0.06	0.01	0.01	0.01
Pterostylis vittata	0.06	0.01	0.01	0.01
Pterostylis sanguinea	0.06	0.02	0.02	0.03
Pterostylis longifolia	0.06	0.01	0.01	0.02
Pterostylis dolichochila	0.06	0.01	0.01	0.01
Pimelea serpyllifolia	0.06	0.01	0.10	0.25
Pimelea glauca	0.06	0.01	0.01	0.01
Amyema miquelii	0.06	0.01	0.02	0.05
Triglochin centrocarpum	0.06	0.01	0.02	0.03
Olearia ramulosa	0.06	0.01	0.04	0.05
Myosotis australis	0.06	0.01	0.02	0.03
Hydrocotyle callicarpa	0.06	0.01	0.02	0.03
Thysanotus juncifolius	0.06	0.01	0.01	0.02
Brachycome perpusilla	0.06	0.01	0.01	0.01
Brachyloma ericoides	0.06	0.01	0.01	0.01
Chamaescilla corymbosa	0.06	0.01	0.01	0.01
Burchardia umbellata	0.06	0.01	0.01	0.02
Caladenia cardiochila	0.06	0.01	0.01	0.01
Caladenia patersonii complex	0.06	0.01	0.01	0.02
Leptocarpus brownii	0.06	0.01	0.01	0.02
Centrolepis aristata	0.06	0.01	0.01	0.01
Convolvulus erubescens	0.04	0.01	0.02	0.02
Centrolepis strigosa	0.04	0.01	0.02	0.03
Stylidium graminifolium	0.04	0.01	0.01	0.01
Centrolepis polygyna	0.04	0.01	0.02	0.03
Enchylaena tomentosa	0.04	0.01	0.02	0.03
Swainsona lessertiifolia	0.04	0.01	0.02	0.03
Wahlenbergia litticola	0.04	0.01	0.02	0.02
Drosera glanduligera	0.04	0.01	0.01	0.01
Baumea juncea	0.04	0.01	0.01	0.01
Carpobrotus rossii	0.04	0.01	0.01	0.01
Brachycome uliginosa	0.04	0.01	0.01	0.01
Alyxia buxifolia	0.04	0.01	0.02	0.02
Eucalyptus viminalis	0.04	0.01	0.01	0.01
Calandrinia brevipedata	0.04	0.01	0.02	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Cotula australis	0.04	0.01	0.01	0.01
Brachycome lineariloba	0.04	0.01	0.01	0.01
Dodonaea viscosa	0.04	0.01	0.02	0.03
Muehlenbeckia adpressa	0.04	0.01	0.01	0.01
Gnaphalium indutum	0.04	0.01	0.01	0.01
Poa labillardieri	0.04	0.01	0.02	0.03
Austrostipa scabra	0.04	0.01	0.02	0.03
Grevillea ilicifolia	0.04	0.01	0.01	0.01
Hakea rugosa	0.04	0.01	0.03	0.05
Glossodia major	0.04	0.02	0.02	0.02
Myoporum insulare	0.04	0.05	0.05	0.05
Austrostipa flavescens	0.04	0.01	0.02	0.03
Hibbertia virgata	0.04	0.01	0.01	0.01
Laxmannia orientalis	0.04	0.01	0.02	0.02
Lepidosperma viscidum	0.04	0.01	0.03	0.05
Lomandra leucocephala	0.04	0.01	0.02	0.03
Eucalyptus leucoxylon	0.04	0.05	0.05	0.05
Leucopogon clelandii	0.04	0.01	0.02	0.02
Olearia ciliata	0.04	0.01	0.01	0.01
Pterostylis plumosa	0.04	0.01	0.02	0.02
Geranium solanderi	0.04	0.01	0.01	0.01
Pterostylis pedunculata	0.04	0.01	0.01	0.01
Eucalyptus rugosa	0.04	0.03	0.27	0.50
Prasophyllum odoratum	0.02	0.01	0.01	0.01
Microtis unifolia complex	0.02	0.02	0.02	0.02
Billardiera versicolor	0.02	0.03	0.03	0.03
Acacia paradoxa	0.02	0.05	0.05	0.05
Blennospora drummondii	0.02	0.01	0.01	0.01
Threlkeldia diffusa	0.02	0.01	0.01	0.01
Brachycome ciliaris	0.02	0.02	0.02	0.02
Brachycome leptocarpa	0.02	0.01	0.01	0.01
Pelargonium rodneyanum	0.02	0.01	0.01	0.01
Lomandra sororia	0.02	0.03	0.03	0.03
Baeckea ericaea	0.02	0.01	0.01	0.01
Lomandra multiflora	0.02	0.01	0.01	0.01
Linum marginale	0.02	0.02	0.02	0.02
Acacia ligulata	0.02	0.01	0.01	0.01
Thelymitra pauciflora	0.02	0.01	0.01	0.01
Leucopogon woodsii	0.02	0.02	0.02	0.02
Caesia calliantha	0.02	0.01	0.01	0.01
Acacia leiophylla/pycnantha	0.02	0.01	0.01	0.01
Leucopogon virgatus	0.02	0.01	0.01	0.01
Lysiana exocarpi	0.02	0.02	0.02	0.02
Pultenaea largiflorens	0.02	0.05	0.05	0.05
Poa sieberiana	0.02	0.02	0.02	0.02
Wurmbea dioica	0.02	0.02	0.02	0.02
Actinobole uliginosum	0.02	0.01	0.01	0.01

Species	Frequency	Min cover	Avg cover	Max cover
Platylobium obtusangulum	0.02	0.05	0.05	0.05
Ajuga australis	0.02	0.01	0.01	0.01
Allocasuarina mackliniana	0.02	0.05	0.05	0.05
Pultenaea canaliculata	0.02	0.02	0.02	0.02
Vittadinia cuneata	0.02	0.02	0.02	0.02
Pimelea octophylla	0.02	0.01	0.01	0.01
Xanthorrhoea semiplana	0.02	0.25	0.25	0.25
Pimelea humilis	0.02	0.01	0.01	0.01
Acacia verticillata	0.02	0.02	0.02	0.02
Amphipogon strictus	0.02	0.02	0.02	0.02
Callitris gracilis	0.02	0.01	0.01	0.01
Pomaderris obcordata	0.02	0.03	0.03	0.03
Caladenia cardiochila x reticulata	0.02	0.01	0.01	0.01
Pelargonium australe	0.02	0.01	0.01	0.01
Ophioglossum lusitanicum	0.02	0.01	0.01	0.01
Arthropodium strictum	0.02	0.01	0.01	0.01
Vittadinia australasica	0.02	0.01	0.01	0.01
Opercularia scabrida	0.02	0.02	0.02	0.02
Acrotriche depressa	0.02	0.05	0.05	0.05
Allocasuarina striata	0.02	0.02	0.02	0.02
Drosera auriculata	0.02	0.01	0.01	0.01
Leptospermum coriaceum	0.02	0.05	0.05	0.05
Thelymitra aristata	0.02	0.01	0.01	0.01
Cyrtostylis reniformis	0.02	0.01	0.01	0.01
Austrostipa hemipogon	0.02	0.03	0.03	0.03
Grevillea lavandulacea	0.02	0.05	0.05	0.05
Austrodanthonia caespitosa	0.02	0.03	0.03	0.03
Goodenia ovata	0.02	0.01	0.01	0.01
Austrostipa mundula	0.02	0.01	0.01	0.01
Tetratheca pilosa	0.02	0.01	0.01	0.01
Daviesia ulicifolia	0.02	0.03	0.03	0.03
Hakea repullulans	0.02	0.02	0.02	0.02
Glischrocaryon behrii	0.02	0.01	0.01	0.01
Austrostipa elegantissima	0.02	0.01	0.01	0.01
Geranium potentilloides	0.02	0.03	0.03	0.03
Templetonia retusa	0.02	0.03	0.03	0.03
Exocarpos syrticola	0.02	0.02	0.02	0.02
Exocarpos sparteus	0.02	0.02	0.02	0.02
Eriochilus cucullatus	0.02	0.02	0.02	0.02
Eucalyptus arenacea	0.02	0.05	0.05	0.05
Eucalyptus arenacea/baxteri	0.02	0.02	0.02	0.02
Eutaxia microphylla	0.02	0.01	0.01	0.01
Euchiton sphaericus	0.02	0.02	0.02	0.02
Austrostipa trichophylla	0.02	0.03	0.03	0.03
Eucalyptus leptophylla	0.02	0.03	0.03	0.03
Gonocarpus mezianus	0.02	0.03	0.03	0.03
Sonchus megalocarpus	0.02	0.03	0.03	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Caladenia dilatata complex	0.02	0.03	0.03	0.03
Santalum murrayanum	0.02	0.01	0.01	0.01
Caladenia reticulata	0.02	0.01	0.01	0.01
Eucalyptus odorata	0.02	0.01	0.01	0.01
Calandrinia eremaea	0.02	0.01	0.01	0.01
Leptospermum continentale	0.02	0.01	0.01	0.01
Leptomeria aphylla	0.02	0.02	0.02	0.02
Carpobrotus modestus	0.02	0.01	0.01	0.01
Lepidosperma semiteres	0.02	0.03	0.03	0.03
Lepidosperma gladiatum	0.02	0.05	0.05	0.05
Cyanicula deformis	0.02	0.01	0.01	0.01
Senecio biserratus	0.02	0.03	0.03	0.03
Thelymitra nuda/pauciflora	0.02	0.01	0.01	0.01
Spyridium phylicoides	0.02	0.03	0.03	0.03
Thelymitra epipactoides	0.02	0.01	0.01	0.01
Hibbertia stricta	0.02	0.03	0.03	0.03
Comesperma polygaloides	0.02	0.02	0.02	0.02
*Hibbertia riparia (*long-leaved *aff. H. stricta)*	0.02	0.02	0.02	0.02
Zygophyllum billardierei	0.02	0.01	0.01	0.01
Acacia hakeoides	0.02	0.02	0.02	0.02
Corybas despectans	0.02	0.03	0.03	0.03
Hardenbergia violacea	0.02	0.02	0.02	0.02
Craspedia glauca	0.02	0.01	0.01	0.01
Haloragis acutangula	0.02	0.03	0.03	0.03
Sebaea ovata	0.02	0.03	0.03	0.03

6.3.5 Ecosystem 5: Sheoak (*Allocasuarina verticillata*) Low Shrubby Woodland (SE/LL sandy loams)

Landscape subgroup: South East (75% of sites) and Lower Lakes Terrestrial (25%)

Soil subgroup: Predominantly shallow sandy soil on calcrete (B3/B8 76%), bleached sand over sandy clay soil (G3 8%), bleached siliceous sands (H3 8%), saline soils (N2 8%)

Brief description: The ecosystem have shrubby understorey (but may have a grassy understorey in its original state based on expert opinion). This ecosystem has been severely cleared in the past. Current remnants have Allocasuarina verticillata as dominant overstorey species. Common understorey species are *Xanthorrhoea caespitosa*, *Hibbertia sericea*, *Kunzea pomifera* and *Clematis microphylla*. Majority of the ecosystem's distribution is in the South East with minor distribution in the Lower Lakes Terrestrial. The ecosystem predominantly occurs on sandy soil on calcrete (B3 & B8) with some occurring on sand over clay (G3) deep sands (H3) and saline soils (N2).

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min cover	Avg cover	Max cover
Xanthorrhoea caespitosa (grass tree)	0.75	0.01	0.22	0.25
Hibbertia sericea (shrub)	0.75	0.01	0.03	0.05
Kunzea pomifera (shrub)	0.75	0.01	0.13	0.25
Clematis microphylla (vine)	0.75	0.01	0.02	0.03
Hydrocotyle laxiflora (herb)	0.67	0.01	0.03	0.03
Acacia longifolia (shrub to small tree)	0.67	0.01	0.03	0.05
Thysanotus patersonii (herb)	0.67	0.01	0.02	0.03
Dianella revolute (herb)	0.58	0.01	0.03	0.05
Allocasuarina verticillata	0.50	0.01	0.14	0.25
Oxalis perennans	0.50	0.01	0.02	0.03
Drosera whittakeri	0.50	0.01	0.02	0.03
Comesperma volubile	0.50	0.01	0.02	0.03
Millotia muelleri	0.42	0.01	0.02	0.03
Leucopogon parviflorus	0.42	0.01	0.02	0.05
Helichrysum leucopsideum	0.42	0.01	0.02	0.03
Bursaria spinosa	0.42	0.01	0.04	0.05
Hakea vittata	0.42	0.01	0.03	0.05
Cynoglossum australe	0.42	0.01	0.01	0.02
Cyrtostylis robusta	0.42	0.01	0.02	0.03
Melaleuca brevifolia	0.33	0.25	0.38	0.50
Poranthera microphylla	0.33	0.01	0.02	0.03
Muehlenbeckia gunnii	0.33	0.01	0.02	0.03
Cassytha glabella	0.33	0.01	0.02	0.03
Wahlenbergia gracilenta	0.33	0.01	0.02	0.03
Acacia spinescens	0.33	0.01	0.08	0.25
Austrostipa flavescens	0.33	0.01	0.03	0.03
Lepidosperma carphoides	0.33	0.01	0.08	0.25
Daucus glochidiatus	0.33	0.01	0.02	0.05
Banksia marginata	0.33	0.03	0.04	0.05
Caladenia latifolia	0.33	0.01	0.02	0.03
Billardiera cymosa	0.33	0.01	0.02	0.03
Senecio picridioides	0.33	0.01	0.02	0.03
Carpobrotus modestus/rossii	0.25	0.01	0.02	0.05

Species	Frequency	Min cover	Avg cover	Max cover
Caladenia carnea	0.25	0.01	0.02	0.03
Parietaria debilis	0.25	0.01	0.02	0.03
Crassula decumbens	0.25	0.01	0.01	0.01
Centrolepis strigosa	0.25	0.01	0.02	0.03
Leptocarpus brownii	0.25	0.01	0.10	0.25
Hydrocotyle callicarpa	0.25	0.01	0.03	0.05
Rutidosis multiflora	0.25	0.01	0.02	0.03
Eucalyptus diversifolia	0.25	0.03	0.04	0.05
Triglochin centrocarpum	0.25	0.01	0.02	0.03
Astroloma humifusum	0.25	0.01	0.01	0.01
Astroloma conostephioides	0.25	0.01	0.01	0.01
Ranunculus sessiliflorus	0.25	0.03	0.03	0.03
Arthropodium strictum	0.25	0.01	0.01	0.02
Eucalyptus fasciculosa	0.25	0.05	0.18	0.25
Austrostipa mollis	0.25	0.01	0.03	0.05
Tetragonia implexicoma	0.25	0.01	0.03	0.05
Baumea juncea	0.25	0.02	0.03	0.05
Amyema miquelii	0.25	0.01	0.03	0.05
Acaena novae-zelandiae	0.25	0.01	0.02	0.03
Acrotriche affinis	0.25	0.03	0.04	0.05
Centrolepis aristata	0.25	0.01	0.02	0.03
Eucalyptus leucoxylon	0.17	0.05	0.15	0.25
Convolvulus erubescens	0.17	0.01	0.01	0.01
Dichondra repens	0.17	0.01	0.02	0.03
Lepidosperma congestum	0.17	0.03	0.14	0.25
Exocarpos sparteus	0.17	0.01	0.03	0.05
Correa reflexa	0.17	0.01	0.01	0.01
Gahnia lanigera	0.17	0.01	0.01	0.01
Austrodanthonia geniculata	0.17	0.03	0.03	0.03
Isopogon ceratophyllus	0.17	0.01	0.02	0.03
Hakea muelleriana	0.17	0.05	0.05	0.05
Hakea rugosa	0.17	0.01	0.02	0.03
Crassula colorata	0.17	0.01	0.02	0.03
Acacia hakeoides	0.17	0.01	0.03	0.05
Crassula sieberiana	0.17	0.01	0.01	0.01
Gahnia filum	0.17	0.05	0.05	0.05
Brachycome goniocarpa	0.17	0.01	0.02	0.03
Wurmbea dioica	0.17	0.01	0.01	0.01
Acacia ligulata	0.17	0.01	0.03	0.05
Acacia pycnantha	0.17	0.05	0.05	0.05
Tetraria capillaris	0.17	0.03	0.04	0.05
Austrostipa scabra	0.17	0.01	0.02	0.02
Ajuga australis	0.17	0.02	0.03	0.03
Allocasuarina muelleriana	0.17	0.01	0.02	0.02
Sebaea ovata	0.17	0.03	0.03	0.03
Arthropodium fimbriatum	0.17	0.01	0.01	0.01
Beyeria lechenaultii	0.17	0.01	0.02	0.02
Leptospermum myrsinoides	0.17	0.01	0.02	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Pelargonium rodneyanum	0.17	0.01	0.02	0.03
Brachyloma ericoides	0.17	0.03	0.04	0.05
Olearia axillaris	0.17	0.01	0.01	0.01
Leucopogon clelandii	0.17	0.01	0.01	0.01
Levenhookia dubia	0.17	0.01	0.02	0.03
Linum marginale	0.17	0.01	0.02	0.02
Melaleuca lanceolata	0.17	0.01	0.01	0.01
Lomandra effusa	0.17	0.01	0.01	0.01
Neurachne alopecuroidea	0.17	0.01	0.01	0.01
Austrodanthonia caespitosa	0.08	0.03	0.03	0.03
Centrolepis polygyna	0.08	0.01	0.01	0.01
Acacia verticillata	0.08	0.01	0.01	0.01
Dichelachne crinita	0.08	0.03	0.03	0.03
Acrotriche cordata	0.08	0.01	0.01	0.01
Acrotriche serrulata	0.08	0.01	0.01	0.01
Comesperma polygaloides	0.08	0.02	0.02	0.02
Cassytha melantha	0.08	0.02	0.02	0.02
Brachycome cuneifolia	0.08	0.02	0.02	0.02
Calandrinia granulifera	0.08	0.01	0.01	0.01
Amyema melaleucae	0.08	0.01	0.01	0.01
Amyema pendulum	0.08	0.02	0.02	0.02
Aphanes australiana	0.08	0.01	0.01	0.01
Cryptandra tomentosa	0.08	0.03	0.03	0.03
Drosera glanduligera	0.08	0.01	0.01	0.01
Calandrinia eremaea	0.08	0.01	0.01	0.01
Caesia calliantha	0.08	0.03	0.03	0.03
Cotula australis	0.08	0.03	0.03	0.03
Brachycome perpusilla	0.08	0.01	0.01	0.01
Crassula closiana	0.08	0.01	0.01	0.01
Burchardia umbellata	0.08	0.03	0.03	0.03
Darwinia micropetala	0.08	0.05	0.05	0.05
Schoenus breviculmis	0.08	0.01	0.01	0.01
Myosotis australis	0.08	0.01	0.01	0.01
Opercularia turpis	0.08	0.02	0.02	0.02
Pelargonium littorale	0.08	0.01	0.01	0.01
Pimelea glauca	0.08	0.03	0.03	0.03
Pimelea serpyllifolia	0.08	0.03	0.03	0.03
Plantago sp. B	0.08	0.01	0.01	0.01
Podotheca angustifolia	0.08	0.01	0.01	0.01
Prasophyllum elatum	0.08	0.01	0.01	0.01
Pterostylis pedunculata	0.08	0.01	0.01	0.01
Pterostylis plumosa	0.08	0.02	0.02	0.02
Pultenaea tenuifolia	0.08	0.02	0.02	0.02
Rhagodia candolleana	0.08	0.02	0.02	0.02
Samolus repens	0.08	0.03	0.03	0.03
Hibbertia riparia	0.08	0.05	0.05	0.05
Swainsona lessertiifolia	0.08	0.01	0.01	0.01
Triodia irritans	0.08	0.01	0.01	0.01

Species	Frequency	Min cover	Avg cover	Max cover
Triglochin calcitrapum	0.08	0.01	0.01	0.01
Tricoryne tenella	0.08	0.02	0.02	0.02
Tricoryne elatior	0.08	0.01	0.01	0.01
Thysanotus juncifolius	0.08	0.01	0.01	0.01
Sarcocornia quinqueflora	0.08	0.05	0.05	0.05
Thelymitra epipactoides	0.08	0.02	0.02	0.02
Schoenus apogon	0.08	0.03	0.03	0.03
Stuartina muelleri	0.08	0.01	0.01	0.01
Austrostipa nitida	0.08	0.01	0.01	0.01
Solanum simile	0.08	0.02	0.02	0.02
Schoenus nitens	0.08	0.01	0.01	0.01
Schoenus deformis	0.08	0.03	0.03	0.03
Mitrasacme pilosa	0.08	0.01	0.01	0.01
Thelymitra nuda	0.08	0.01	0.01	0.01
Gonocarpus tetragynus	0.08	0.01	0.01	0.01
Myoporum insulare	0.08	0.02	0.02	0.02
Hyalosperma demissum	0.08	0.01	0.01	0.01
Hibbertia virgata	0.08	0.01	0.01	0.01
Hemichroa pentandra	0.08	0.03	0.03	0.03
Hakea nodosa	0.08	0.01	0.01	0.01
Isolepis platycarpa	0.08	0.03	0.03	0.03
Goodenia blackiana	0.08	0.02	0.02	0.02
Juncus bufonius	0.08	0.03	0.03	0.03
Gnaphalium indutum	0.08	0.01	0.01	0.01
Gahnia trifida	0.08	0.02	0.02	0.02
Eutaxia microphylla	0.08	0.02	0.02	0.02
Euchiton sphaericus	0.08	0.02	0.02	0.02
Eucalyptus porosa	0.08	0.05	0.05	0.05
Eucalyptus incrassata	0.08	0.03	0.03	0.03
Goodenia geniculata	0.08	0.01	0.01	0.01
Leptospermum continentale	0.08	0.02	0.02	0.02
Drosera macrantha	0.08	0.01	0.01	0.01
Microtis unifolia complex	0.08	0.01	0.01	0.01
Microseris lanceolata	0.08	0.03	0.03	0.03
Lysiana exocarpi	0.08	0.01	0.01	0.01
Lomandra micrantha	0.08	0.01	0.01	0.01
Isolepis nodosa	0.08	0.03	0.03	0.03
Logania linifolia	0.08	0.01	0.01	0.01
Muehlenbeckia adpressa	0.08	0.05	0.05	0.05
Lepidosperma viscidum	0.08	0.03	0.03	0.03
Lepidosperma laterale	0.08	0.25	0.25	0.25
Lepidosperma congestum/laterale	0.08	0.25	0.25	0.25
Lepidosperma concavum/congestum/laterale	0.08	0.03	0.03	0.03
Lawrencia squamata	0.08	0.03	0.03	0.03
Lasiopetalum baueri	0.08	0.05	0.05	0.05
Lomandra juncea	0.08	0.01	0.01	0.01

6.3.6 Ecosystem 6: Mixed Eucalypt (Mallee Box / Peppermint Box / SA Blue Gum) Woodland / Mallee (Ridge-fruited / Narrow-leaf Red Mallee) Ecosystem

Landscape subgroup: Mount Lofty Ranges - 56% and Lower Lakes Terrestrial - 25%; Others (South East - 19%)

Soil subgroup: Predominantly shallow sandy soil on calcrete (B2/B3/B6/B8 37%), sand over clay soils (G1/G3/G4 38%), loam over poorly structured red clay (D3 13%), bleached siliceous sand (H3 13%)

Brief description: The cluster analysis did not differentiate between different woodland and mallee communities located mostly in the Mount Lofty Ranges and the Lower Lakes Terrestrial. However, on-ground knowledge and expert opinion on pre-European vegetation of the sites separated this ecosystem into four distinct communities – (6.1) Mallee Box (*Eucalyptus porosa*) Grassy Woodland; (6.2) Peppermint Box (*Eucalyptus odorata*) Grassy Woodland; (6.3) Ridge-fruited Mallee (*Eucalyptus incrassata*) / Narrow-leaf Red Mallee (*E. leptophylla*) +/- Red Mallee (*E. socialis*) community; and (6.4) SA Blue Gum (*Eucalyptus leucoxylon*) Grassy Woodland. The aggregation of these distinct communities into one broad "Mixed Eucalypt Woodland / Mallee Ecosystem" in the cluster analysis might be due to similarity in the understorey layers.

6.1: Mallee Box (*Eucalyptus porosa*) Grassy Woodland (MLR loams) occurs in the Mount Lofty Ranges and Lower Lakes Terrestrial on shallow soils on calcrete (B2/B3) and loam over poorly structured red clay (D3). Allocasuarina verticillata can occur in the ecosystem with some Acacia spp. Common understorey species are *Dianella revoluta*, *Clematis microphylla*, *Rhagodia candolleana*, *Oxalis perennans*, *Threlkeldia diffusa*, *Austrostipa* spp., and *Austrodanthonia caespitosa*. Expert elicitation indicated that this community occurs on low dunes and rises.

6.2: Peppermint Box (*Eucalyptus odorata*) Grassy Woodland occurs in the Mount Lofty Ranges on sand over poorly structured clay (G4) and loam over poorly structured red clay (D3). Other eucalypt species (*Eucalyptus conglobata, E. anceps*) can be seen in this ecosystem as well as other overstorey species such as *Allocasuarina verticillata*. Common understorey species are *Austrostipa* spp, *Dianella revoluta*, *Clematis microphylla*, *Oxalis perennans*, *Lomandra effusa* and *Melaleuca* spp. Expert elicitation indicated that this community is found along flats (drainage lines) in the Mount Lofty Ranges but analysis of site elevation indicated that the community occurs within an elevation range of 8–30 m (low to mid-slope).

6.3: Ridge-fruited/ Narrow-leaf Red (*Eucalyptus incrassata / leptophylla*) Mallee (MLR sands) can also include Red Mallee (*E. socialis*) and occurs on sand over clay soils (G1/G3) and bleached siliceous sand (H3) in the Mount Lofty Ranges. A mixture of *Acacia* spp and *Melaleuca* spp as well as Eucalyptus anceps can occur in this ecosystem. Common understorey species are *Clematis microphylla*, *Dianella revoluta*, *Rhagodia candolleana*, *Austrostipa* spp., *Lomandra effusa* and *Oxalis perennans*.

6.4: SA Blue Gum (*Eucalyptus leucoxylon*) Grassy Woodland (SE/LL loams) occurs on shallow soils on calcrete (B3/B6/B8) and thick sand over clay (G3) in the Lower Lakes Terrestrial and the South East. The community is also found in the Mount Lofty Range on shallow sand over clay (mid-slope) based on on-ground knowledge. Other eucalypt species (*Eucalyptus diversifolia*, *E. incrassata*) can be seen in this ecosystem as well as other overstorey species such as *Allocasuarina verticillata*. A mixture of *Acacia* spp and *Melaleuca* spp can occur in the ecosystem. Common understorey species are *Austrostipa* spp., *Clematis microphylla*, *Dianella revoluta*, *Rhagodia candolleana*, *Lomandra effusa* and *Oxalis perennans*.

Vegetation composition (from BDBSA vegetation surveys sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community.

Species	Frequency	Min cover	Avg cover	Max cover
Rhagodia candolleana	0.50	0.01	0.03	0.05
Austrostipa elegantissima	0.50	0.01	0.02	0.03
Clematis microphylla	0.50	0.01	0.02	0.03
Dianella revoluta	0.50	0.01	0.01	0.03
Enchylaena tomentosa	0.44	0.01	0.03	0.05
Melaleuca lanceolata	0.38	0.01	0.14	0.25
Acacia pycnantha	0.38	0.01	0.02	0.03
Lomandra effusa	0.38	0.01	0.03	0.05
Oxalis perennans	0.38	0.01	0.02	0.03
Eucalyptus incrassata	0.31	0.25	0.30	0.50
Threlkeldia diffusa	0.31	0.01	0.03	0.05
Lomandra micrantha	0.31	0.01	0.02	0.03
Melaleuca acuminata	0.31	0.01	0.01	0.02
Einadia nutans	0.31	0.01	0.02	0.03
Lepidosperma viscidum	0.25	0.01	0.02	0.03
Austrostipa drummondii	0.25	0.01	0.01	0.01
Allocasuarina verticillata	0.25	0.05	0.10	0.25
Acacia spinescens	0.25	0.01	0.02	0.03
Helichrysum leucopsideum	0.25	0.01	0.02	0.03
Muehlenbeckia gunnii	0.25	0.01	0.02	0.02
Eucalyptus leucoxylon	0.25	0.05	0.20	0.25
Austrodanthonia caespitosa	0.25	0.02	0.03	0.03
Thysanotus patersonii	0.25	0.01	0.01	0.01
Tetragonia implexicoma	0.25	0.01	0.03	0.05
Bursaria spinosa	0.19	0.01	0.02	0.02
Eucalyptus odorata	0.19	0.02	0.04	0.05
Hibbertia riparia	0.19	0.01	0.01	0.01
Xanthorrhoea caespitosa	0.19	0.01	0.04	0.05
Vittadinia gracilis	0.19	0.01	0.02	0.03
Pomaderris paniculosa	0.19	0.02	0.04	0.05
Maireana enchylaenoides	0.19	0.01	0.02	0.03
Lomandra multiflora	0.19	0.01	0.01	0.01
Dianella brevicaulis	0.19	0.02	0.02	0.03
Lomandra leucocephala	0.19	0.03	0.03	0.03
Lepidosperma concavum	0.19	0.01	0.02	0.03
Austrodanthonia setacea	0.19	0.01	0.02	0.03
Billardiera cymosa	0.19	0.01	0.02	0.02
Austrostipa semibarbata	0.19	0.01	0.02	0.03
Acacia longifolia	0.19	0.01	0.02	0.03
Austrostipa flavescens	0.19	0.01	0.02	0.03
Eucalyptus leptophylla	0.19	0.01	0.01	0.02
Crassula sieberiana	0.19	0.01	0.02	0.03
Acacia ligulata	0.19	0.01	0.02	0.02
Eucalyptus porosa	0.19	0.01	0.10	0.25

Species	Frequency	Min cover	Avg cover	Max cover
Drosera whittakeri	0.13	0.01	0.01	0.01
Crassula colorata	0.13	0.01	0.02	0.03
Eucalyptus 'anceps'	0.13	0.01	0.01	0.02
Drosera macrantha	0.13	0.01	0.01	0.01
Eucalyptus diversifolia	0.13	0.01	0.03	0.05
Convolvulus remotus	0.13	0.01	0.01	0.02
Lasiopetalum baueri	0.13	0.01	0.01	0.01
Hybanthus floribundus	0.13	0.01	0.01	0.01
Eutaxia microphylla	0.13	0.01	0.01	0.01
Leptospermum coriaceum	0.13	0.01	0.01	0.01
Dodonaea viscosa	0.13	0.01	0.01	0.01
Cheilanthes austrotenuifolia	0.13	0.01	0.01	0.01
Hibbertia virgata	0.13	0.01	0.02	0.03
Dillwynia hispida	0.13	0.01	0.01	0.01
Hibbertia sericea	0.13	0.01	0.02	0.03
Hydrocotyle laxiflora	0.13	0.03	0.03	0.03
Arthropodium strictum	0.13	0.01	0.02	0.03
Salsola kali	0.13	0.03	0.03	0.03
Lomandra densiflora	0.13	0.01	0.02	0.03
Senecio picridioides	0.13	0.01	0.02	0.03
Acacia paradoxa	0.13	0.01	0.03	0.05
Arthropodium fimbriatum	0.13	0.01	0.01	0.01
Acacia microcarpa	0.13	0.02	0.03	0.03
Austrostipa acrociliata	0.13	0.01	0.02	0.03
Austrostipa eremophila	0.13	0.03	0.04	0.05
Austrostipa exilis	0.13	0.01	0.02	0.03
Austrostipa mollis	0.13	0.03	0.03	0.03
Austrostipa scabra	0.13	0.01	0.01	0.01
Amyema miquelii	0.13	0.01	0.02	0.03
Lomandra juncea	0.13	0.02	0.03	0.03
Astroloma humifusum	0.13	0.01	0.01	0.01
Atriplex semibaccata	0.13	0.02	0.03	0.03
Wilsonia rotundifolia	0.13	0.01	0.01	0.01
Thomasia petalocalyx	0.13	0.01	0.02	0.03
Themeda triandra	0.13	0.01	0.01	0.01
Vittadinia cuneata	0.13	0.03	0.03	0.03
Vittadinia cervicularis	0.13	0.01	0.01	0.01
Cyrtostylis robusta	0.06	0.01	0.01	0.01
Acaena echinata	0.06	0.01	0.01	0.01
Austrodanthonia geniculata	0.06	0.03	0.03	0.03
Acacia brachybotrya	0.06	0.05	0.05	0.05
Cryptandra leucophracta	0.06	0.01	0.01	0.01
Acacia calamifolia	0.06	0.01	0.01	0.01
Cynoglossum australe	0.06	0.02	0.02	0.02
Acacia halliana	0.06	0.01	0.01	0.01
Acrotriche affinis	0.06	0.01	0.01	0.01
Acacia dodonaeifolia	0.06	0.01	0.01	0.01

Species	Frequency	Min cover	Avg cover	Max cover
Comesperma volubile	0.06	0.02	0.02	0.02
Calandrinia eremaea	0.06	0.01	0.01	0.01
Blennospora drummondii	0.06	0.01	0.01	0.01
Gahnia deusta	0.06	0.05	0.05	0.05
Boronia coerulescens	0.06	0.01	0.01	0.01
Billardiera versicolor	0.06	0.02	0.02	0.02
Brachycome ciliaris	0.06	0.01	0.01	0.01
Billardiera uniflora	0.06	0.01	0.01	0.01
Baumea juncea	0.06	0.25	0.25	0.25
Bulbine bulbosa	0.06	0.01	0.01	0.01
Austrodanthonia geniculata	0.06	0.02	0.02	0.02
Asperula conferta	0.06	0.03	0.03	0.03
Chrysocephalum semipapposum	0.06	0.01	0.01	0.01
Caladenia latifolia	0.06	0.01	0.01	0.01
Amyema melaleucae	0.06	0.01	0.01	0.01
Callitris gracilis	0.06	0.50	0.50	0.50
Calocephalus citreus	0.06	0.01	0.01	0.01
Calytrix tetragona	0.06	0.01	0.01	0.01
Carpobrotus modestus	0.06	0.02	0.02	0.02
Carpobrotus modestus/rossii	0.06	0.01	0.01	0.01
Cassytha glabella	0.06	0.01	0.01	0.01
Cassytha melantha	0.06	0.01	0.01	0.01
Aristida behriana	0.06	0.03	0.03	0.03
Austrodanthonia linkii	0.06	0.05	0.05	0.05
Chloris truncata	0.06	0.03	0.03	0.03
Burnettia nigricans	0.06	0.01	0.01	0.01
Santalum acuminatum	0.06	0.01	0.01	0.01
Ficinia nodosa	0.06	0.03	0.03	0.03
Lysiana exocarpi	0.06	0.01	0.01	0.01
Melaleuca brevifolia	0.06	0.25	0.25	0.25
Melaleuca uncinata	0.06	0.03	0.03	0.03
Muehlenbeckia adpressa	0.06	0.02	0.02	0.02
Myoporum insulare	0.06	0.02	0.02	0.02
Myoporum montanum	0.06	0.02	0.02	0.02
Myoporum platycarpum	0.06	0.03	0.03	0.03
Poa labillardieri	0.06	0.03	0.03	0.03
Pterostylis cycnocephala/mutica	0.06	0.01	0.01	0.01
Pultenaea densifolia	0.06	0.01	0.01	0.01
Lepidosperma laterale	0.06	0.50	0.50	0.50
Samolus repens	0.06	0.03	0.03	0.03
Lawrencia squamata	0.06	0.05	0.05	0.05
Sarcocornia blackiana	0.06	0.50	0.50	0.50
Sarcocornia quinqueflora	0.06	0.03	0.03	0.03
Sebaea ovata	0.06	0.03	0.03	0.03
Senecio lautus	0.06	0.03	0.03	0.03
Spyridium subochreatum	0.06	0.01	0.01	0.01
Stackhousia monogyna	0.06	0.01	0.01	0.01

Species	Frequency	Min cover	Avg cover	Max cover
Stenopetalum sphaerocarpum	0.06	0.01	0.01	0.01
Austrostipa nitida	0.06	0.03	0.03	0.03
Austrostipa nodosa	0.06	0.01	0.01	0.01
Tetraria capillaris	0.06	0.01	0.01	0.01
Tricoryne elatior	0.06	0.01	0.01	0.01
Vittadinia megacephala	0.06	0.03	0.03	0.03
Rumex brownii	0.06	0.02	0.02	0.02
Gahnia filum	0.06	0.03	0.03	0.03
Daucus glochidiatus	0.06	0.01	0.01	0.01
Dichondra repens	0.06	0.03	0.03	0.03
Disphyma crassifolium	0.06	0.03	0.03	0.03
Distichlis distichophylla	0.06	0.03	0.03	0.03
Eleocharis acuta	0.06	0.03	0.03	0.03
Enneapogon nigricans	0.06	0.03	0.03	0.03
Eremophila subfloccosa	0.06	0.03	0.03	0.03
Eriochilus cucullatus	0.06	0.01	0.01	0.01
Eucalyptus conglobata	0.06	0.01	0.01	0.01
Eucalyptus socialis	0.06	0.05	0.05	0.05
Exocarpos sparteus	0.06	0.02	0.02	0.02
Lomandra nana	0.06	0.03	0.03	0.03
Frankenia pauciflora	0.06	0.03	0.03	0.03
Austrodanthonia pilosa	0.06	0.03	0.03	0.03
Gahnia lanigera	0.06	0.05	0.05	0.05
Galium gaudichaudii	0.06	0.02	0.02	0.02
Geranium solanderi	0.06	0.01	0.01	0.01
Gonocarpus mezianus	0.06	0.01	0.01	0.01
Goodenia robusta	0.06	0.03	0.03	0.03
Goodenia varia	0.06	0.02	0.02	0.02
Goodenia willisiana	0.06	0.02	0.02	0.02
Grevillea ilicifolia	0.06	0.01	0.01	0.01
Hakea muelleriana	0.06	0.01	0.01	0.01
Hakea vittata	0.06	0.01	0.01	0.01
Homopholis proluta	0.06	0.03	0.03	0.03
Kennedia prostrata	0.06	0.01	0.01	0.01
Acacia acinacea	0.06	0.01	0.01	0.01

6.3.7 Ecosystem 7: Reeds and Rushes (Common Reed *Phragmites australis* / Bullrush *Typha domingensis* / Sea Rush *Juncus kraussii*) (freshwater fringes)

Landscape subgroup: Lower Lakes Terrestrial - 60%; Mount Lofty Ranges - 20%; Lower Lakes - 20%

Soil subgroup: Predominantly wet soils (N3 40%, N2 20%), deep sands (H2/H3 8%), shallow sandy loam on calcrete (B3 8%), black cracking clay (E1 8%), deep sandy loam (M1 8%), others (D3/H3 8%)

Brief description: The community requires regular inundation and have some tolerance to salinity up to brackish water. Dominant species are Common Reed (*Phragmites australis*) Bullrush (*Typha domingensis*) and Sea Rush (*Juncus kraussii*). The ecosystem is predominantly found on wet soils and fringing wetlands.

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min cover	Avg cover	Max cover
Phragmites australis	0.60	0.01	0.21	0.75
Hydrocotyle verticillata	0.56	0.01	0.02	0.03
Samolus repens	0.40	0.01	0.02	0.03
Typha domingensis	0.36	0.01	0.22	0.75
Eleocharis acuta	0.36	0.01	0.07	0.50
Suaeda australis	0.36	0.01	0.02	0.05
Juncus kraussii	0.36	0.01	0.31	0.75
Schoenoplectus validus	0.36	0.01	0.08	0.50
Muehlenbeckia florulenta	0.32	0.01	0.02	0.05
Calystegia sepium	0.32	0.01	0.02	0.03
Ranunculus amphitrichus	0.32	0.01	0.02	0.03
Persicaria lapathifolia	0.28	0.01	0.02	0.03
Typha orientalis	0.24	0.01	0.19	0.75
Azolla filiculoides	0.20	0.01	0.02	0.03
Crassula helmsii	0.20	0.01	0.02	0.05
Persicaria decipiens	0.20	0.01	0.01	0.02
Lycopus australis	0.16	0.01	0.02	0.03
Distichlis distichophylla	0.16	0.01	0.03	0.05
Bolboschoenus caldwellii	0.16	0.01	0.01	0.01
Triglochin striatum	0.12	0.01	0.01	0.01
Isolepis cernua	0.12	0.01	0.02	0.03
Triglochin procerum	0.12	0.01	0.01	0.01
Lythrum hyssopifolia	0.12	0.01	0.02	0.03
Sarcocornia quinqueflora	0.12	0.01	0.02	0.05
Epilobium pallidiflorum	0.12	0.01	0.01	0.01
Agrostis avenacea	0.12	0.01	0.01	0.01
Schoenoplectus pungens	0.12	0.01	0.10	0.25
Carex appressa	0.08	0.01	0.03	0.05
Myriophyllum caput-medusae	0.08	0.02	0.04	0.05
Lobelia alata	0.08	0.01	0.01	0.01
Centella asiatica	0.08	0.01	0.02	0.03
Eleocharis sphacelata	0.08	0.01	0.01	0.01
Mimulus repens	0.08	0.01	0.03	0.05
Tecticornia pergranulata	0.08	0.02	0.02	0.02

Species	Frequency	Min cover	Avg cover	Max cover
Isolepis nodosa	0.08	0.02	0.03	0.03
Asperula gemella	0.04	0.02	0.02	0.02
Enchylaena tomentosa	0.04	0.02	0.02	0.02
Atriplex semibaccata	0.04	0.01	0.01	0.01
Azolla pinnata	0.04	0.01	0.01	0.01
Carex fascicularis	0.04	0.01	0.01	0.01
Cyperus gymnocaulos	0.04	0.01	0.01	0.01
Amyema preissii	0.04	0.02	0.02	0.02
Cotula vulgaris	0.04	0.01	0.01	0.01
Baumea juncea	0.04	0.01	0.01	0.01
Melaleuca halmaturorum	0.04	0.02	0.02	0.02
Spirodela punctata	0.04	0.01	0.01	0.01
Sonchus hydrophilus	0.04	0.01	0.01	0.01
Selliera radicans	0.04	0.01	0.01	0.01
Sclerostegia arbuscula	0.04	0.03	0.03	0.03
Salsola kali	0.04	0.03	0.03	0.03
Potamogeton crispus	0.04	0.05	0.05	0.05
Poa labillardieri	0.04	0.03	0.03	0.03
Myriophyllum salsugineum	0.04	0.01	0.01	0.01
Juncus pallidus	0.04	0.01	0.01	0.01
Microtis arenaria	0.04	0.02	0.02	0.02
Euchiton involucratus	0.04	0.02	0.02	0.02
Leptospermum lanigerum	0.04	0.02	0.02	0.02
Leptospermum continentale	0.04	0.02	0.02	0.02
Juncus sarophorus	0.04	0.25	0.25	0.25
Acacia retinodes	0.04	0.05	0.05	0.05
Juncus caespiticius	0.04	0.01	0.01	0.01
Juncus aridicola	0.04	0.01	0.01	0.01
Green alga	0.04	0.01	0.01	0.01
Gahnia trifida	0.04	0.02	0.02	0.02
Gahnia filum	0.04	0.25	0.25	0.25
Montia australasica	0.04	0.01	0.01	0.01

6.3.8 Ecosystem 8: Lignum (*Muehlenbeckia florulenta*) Shrubland (non-saline clays)

Landscape subgroup: Mount Lofty Ranges - 44%) and Lower Lakes - 44%; others (Lower Lakes Terrestrial - 12%)

Soil subgroup: Predominantly wet soil (N3 44%), loam over poorly structured red clay (D3 33%), shallow sandy loam on calcrete (B3 11%), loam over brown or dark clay (F1 11%)

Brief description: Occurs on wet soils (freshwater) in the Mount Lofty Ranges and Lower Lakes (aquatic), with some minor distribution in the Lower Lakes (terrestrial) landscapes. The community is dominated by lignum (*M. florulenta*) with some flora species tolerant of water logging such as *Agrostis avenacea*, *Atriplex semibaccata* and *Distichlis distichophylla*.

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min cover	Avg cover	Max cover
Muehlenbeckia florulenta	1.00	0.01	0.32	0.75
Calystegia sepium	0.33	0.01	0.02	0.02
Agrostis avenacea	0.33	0.02	0.02	0.03
Enchylaena tomentosa	0.33	0.01	0.02	0.03
Atriplex semibaccata	0.33	0.01	0.02	0.05
Hydrocotyle verticillata	0.33	0.01	0.02	0.03
Einadia nutans	0.33	0.02	0.03	0.05
Distichlis distichophylla	0.33	0.03	0.04	0.05
Phragmites australis	0.22	0.01	0.02	0.03
Eucalyptus largiflorens	0.22	0.03	0.03	0.03
Crassula helmsii	0.22	0.01	0.02	0.03
Marsilea drummondii	0.22	0.03	0.03	0.03
Ranunculus amphitrichus	0.22	0.01	0.02	0.03
Isolepis nodosa	0.22	0.01	0.02	0.03
Chloris truncata	0.22	0.01	0.02	0.03
Acacia pycnantha	0.22	0.02	0.02	0.02
Eleocharis acuta	0.22	0.02	0.14	0.25
Maireana brevifolia	0.22	0.03	0.14	0.25
Salsola kali	0.22	0.01	0.01	0.01
Samolus repens	0.22	0.01	0.02	0.03
Sarcocornia quinqueflora	0.22	0.03	0.04	0.05
Triglochin procerum	0.22	0.01	0.02	0.03
Senecio glomeratus	0.22	0.02	0.02	0.02
Rumex bidens	0.22	0.03	0.04	0.05
Suaeda australis	0.22	0.03	0.03	0.03
Austrostipa nodosa	0.22	0.03	0.03	0.03
Austrodanthonia setacea	0.11	0.01	0.01	0.01
Enneapogon nigricans	0.11	0.03	0.03	0.03
Asperula gemella	0.11	0.02	0.02	0.02
Bothriochloa macra	0.11	0.01	0.01	0.01
Callistemon rugulosus	0.11	0.03	0.03	0.03
Disphyma crassifolium	0.11	0.05	0.05	0.05
Dichondra repens	0.11	0.03	0.03	0.03
Convolvulus remotus	0.11	0.01	0.01	0.01

Species	Frequency	Min cover	Avg cover	Max cover
Dianella longifolia	0.11	0.02	0.02	0.02
Calostemma purpureum	0.11	0.03	0.03	0.03
Carex bichenoviana	0.11	0.05	0.05	0.05
Austrodanthonia caespitosa	0.11	0.03	0.03	0.03
Cyperus gymnocaulos	0.11	0.05	0.05	0.05
Centipeda cunninghamii	0.11	0.01	0.01	0.01
Dianella revoluta	0.11	0.02	0.02	0.02
Persicaria decipiens	0.11	0.01	0.01	0.01
Wahlenbergia gracilis	0.11	0.02	0.02	0.02
Urtica incisa	0.11	0.01	0.01	0.01
Typha orientalis	0.11	0.03	0.03	0.03
Threlkeldia diffusa	0.11	0.02	0.02	0.02
Themeda triandra	0.11	0.01	0.01	0.01
Austrostipa gibbosa	0.11	0.01	0.01	0.01
Austrostipa eremophila	0.11	0.03	0.03	0.03
Solanum esuriale	0.11	0.03	0.03	0.03
Sclerolaena muricata	0.11	0.03	0.03	0.03
Pratia concolor	0.11	0.01	0.01	0.01
Glyceria australis	0.11	0.03	0.03	0.03
Persicaria prostrata	0.11	0.01	0.01	0.01
Eucalyptus camaldulensis	0.11	0.50	0.50	0.50
Paspalidium jubiflorum	0.11	0.03	0.03	0.03
Lythrum hyssopifolia	0.11	0.01	0.01	0.01
Lomandra collina	0.11	0.02	0.02	0.02
Lobelia alata	0.11	0.02	0.02	0.02
Wilsonia rotundifolia	0.11	0.03	0.03	0.03
Haloragis aspera	0.11	0.05	0.05	0.05
Gahnia filum	0.11	0.05	0.05	0.05
Frankenia serpyllifolia	0.11	0.01	0.01	0.01
Euphorbia drummondii	0.11	0.02	0.02	0.02
Euchiton involucratus	0.11	0.02	0.02	0.02
Eucalyptus odorata	0.11	0.03	0.03	0.03
Poa labillardieri	0.11	0.01	0.01	0.01

6.3.9 Ecosystem 9: Samphire (*Tecticornia pergranulata* / *Suaeda australis* / *Sarcocornia quinqueflora*) / Paperbark (*Melaleuca halmaturorum*) Shrubland (saline clays)

Landscape subgroup: Lower lakes Terrestrial - 51%; Lower Lakes - 21%; South East - 19%; Others (Coastal Dunes & Mount Lofty Ranges - 9%)

Soil subgroup: Predominantly wet soil (N2 33%, N3 28%), deep sands (H1/H2 14%), black cracking clay (E1 12%), deep sandy loam (M1 5%), shallow sandy soil on calcrete (B2/B8 4%), others (A1/F1 4%)

Brief description: The ecosystem mostly occurs in the Lower Lakes (terrestrial and aquatic) with minor distribution in the Coastal Dunes and Mount Lofty Ranges. It is dominated by samphire species (e.g. *Tecticornia* spp., *Suaeda australis*, and *Sarcocornia quinqueflora*) and Swamp Paperbark (*Melaleuca halmaturorum*). The ecosystem predominantly occurs on wet soil that tolerate a level of salinity.

Vegetation composition (from BDBSA vegetation survey sites): Species with a frequency of ≥0.30 have the greatest contribution to vegetation community. *Structurally dominant species are shaded*.

Species	Frequency	Min cover	Avg cover	Max cover
Samolus repens	0.81	0.01	0.02	0.05
Suaeda australis	0.60	0.01	0.11	0.50
Sarcocornia quinqueflora	0.58	0.01	0.17	0.50
Melaleuca halmaturorum	0.42	0.02	0.33	0.75
Frankenia pauciflora	0.40	0.01	0.02	0.05
Distichlis distichophylla	0.37	0.01	0.06	0.25
Tecticornia pergranulata	0.30	0.01	0.19	0.75
Triglochin striatum	0.23	0.01	0.02	0.05
Juncus kraussii	0.21	0.01	0.06	0.25
Threlkeldia diffusa	0.19	0.01	0.05	0.25
Muehlenbeckia florulenta	0.19	0.01	0.08	0.50
Disphyma crassifolium	0.19	0.01	0.02	0.03
Amyema melaleucae	0.19	0.01	0.02	0.03
Tecticornia indica	0.16	0.03	0.27	0.75
Sclerostegia arbuscula	0.14	0.01	0.22	0.50
Gahnia filum	0.14	0.02	0.04	0.05
Enchylaena tomentosa	0.14	0.01	0.02	0.03
Puccinellia stricta	0.14	0.01	0.01	0.02
Atriplex paludosa	0.14	0.03	0.11	0.25
Comesperma volubile	0.14	0.01	0.02	0.03
Myoporum insulare	0.12	0.01	0.02	0.03
Lawrencia squamata	0.12	0.01	0.03	0.05
Bolboschoenus caldwellii	0.12	0.01	0.04	0.05
Sarcocornia blackiana	0.12	0.02	0.22	0.75
Maireana oppositifolia	0.12	0.03	0.04	0.05
Dianella revoluta	0.12	0.01	0.01	0.02
Cyperus gymnocaulos	0.09	0.01	0.01	0.01
Cotula vulgaris	0.09	0.01	0.02	0.03
Phragmites australis	0.09	0.01	0.02	0.05
Tetragonia implexicoma	0.09	0.01	0.03	0.05
Angianthus preissianus	0.09	0.01	0.03	0.03
Rhagodia candolleana	0.09	0.01	0.02	0.03
Leucopogon parviflorus	0.09	0.01	0.02	0.03

Species	Frequency	Min cover	Avg cover	Max cover
Apium annuum	0.09	0.01	0.03	0.03
Wilsonia backhousei	0.07	0.02	0.03	0.05
Muehlenbeckia gunnii	0.07	0.02	0.03	0.03
Clematis microphylla	0.07	0.01	0.02	0.02
Centella asiatica	0.07	0.01	0.02	0.03
Sporobolus virginicus	0.07	0.01	0.09	0.25
Sebaea ovata	0.07	0.02	0.03	0.03
Darwinia micropetala	0.07	0.01	0.01	0.02
Brachycome exilis	0.07	0.01	0.02	0.03
Rhagodia parabolica	0.07	0.02	0.02	0.03
Sonchus hydrophilus	0.07	0.01	0.02	0.03
Daucus glochidiatus	0.05	0.01	0.01	0.01
Einadia nutans	0.05	0.02	0.02	0.02
Melaleuca brevifolia	0.05	0.05	0.05	0.05
Hydrocotyle verticillata	0.05	0.02	0.03	0.03
Eleocharis acuta	0.05	0.01	0.03	0.05
Isolepis cernua	0.05	0.01	0.02	0.02
Hydrocotyle laxiflora	0.05	0.01	0.02	0.03
Leptocarpus brownii	0.05	0.03	0.03	0.03
Melaleuca lanceolata	0.05	0.01	0.03	0.05
Hemichroa pentandra	0.05	0.03	0.04	0.05
Wurmbea dioica	0.05	0.01	0.01	0.01
Acacia longifolia	0.05	0.01	0.01	0.01
Isolepis nodosa	0.05	0.01	0.02	0.02
Gahnia trifida	0.05	0.01	0.02	0.02
Schoenus nitens	0.05	0.03	0.03	0.03
Acaena novae-zelandiae	0.05	0.01	0.01	0.01
Wilsonia humilis	0.05	0.03	0.04	0.05
Agrostis billardieri	0.05	0.01	0.02	0.02
Triglochin procerum	0.05	0.01	0.02	0.03
Triglochin mucronatum	0.05	0.03	0.03	0.03
Tetraria capillaris	0.05	0.03	0.03	0.03
Senecio glossanthus	0.05	0.02	0.03	0.03
Senecio glomeratus	0.05	0.03	0.03	0.03
Selliera radicans	0.05	0.01	0.01	0.01
Microseris lanceolata	0.05	0.01	0.01	0.01
Baumea juncea	0.05	0.01	0.02	0.03
Billardiera cymosa	0.05	0.02	0.03	0.03
Pimelea serpyllifolia	0.05	0.01	0.02	0.02
Calystegia sepium	0.05	0.02	0.03	0.03
Mimulus repens	0.05	0.01	0.01	0.01
Carpobrotus rossii	0.05	0.01	0.01	0.01
Parietaria debilis	0.05	0.03	0.03	0.03
Crassula helmsii	0.02	0.01	0.01	0.01
Acrotriche cordata	0.02	0.01	0.01	0.01
Agrostis avenacea	0.02	0.02	0.02	0.02
Dichondra repens	0.02	0.01	0.01	0.01

Species	Frequency	Min cover	Avg cover	Max cover
Comesperma polygaloides	0.02	0.02	0.02	0.02
Dianella brevicaulis	0.02	0.02	0.02	0.02
Angianthus tomentosus	0.02	0.02	0.02	0.02
Caladenia latifolia	0.02	0.03	0.03	0.03
Atriplex stipitata	0.02	0.05	0.05	0.05
Cassytha glabella	0.02	0.02	0.02	0.02
Cassytha pubescens	0.02	0.03	0.03	0.03
Carex fascicularis	0.02	0.01	0.01	0.01
Cyrtostylis robusta	0.02	0.03	0.03	0.03
Cynoglossum australe	0.02	0.01	0.01	0.01
Senecio runcinifolius	0.02	0.02	0.02	0.02
Lilaeopsis polyantha	0.02	0.03	0.03	0.03
Ranunculus amphitrichus	0.02	0.03	0.03	0.03
Ranunculus sessiliflorus	0.02	0.01	0.01	0.01
Rumex bidens	0.02	0.01	0.01	0.01
Ruppia polycarpa	0.02	0.05	0.05	0.05
Schoenoplectus pungens	0.02	0.03	0.03	0.03
Potamogeton pectinatus	0.02	0.01	0.01	0.01
Senecio picridioides	0.02	0.01	0.01	0.01
Poranthera microphylla	0.02	0.02	0.02	0.02
Senecio squarrosus	0.02	0.03	0.03	0.03
Austrostipa stipoides	0.02	0.50	0.50	0.50
Thysanotus patersonii	0.02	0.01	0.01	0.01
Triptilodiscus pygmaeus	0.02	0.01	0.01	0.01
Urtica incisa	0.02	0.03	0.03	0.03
Wahlenbergia gracilenta	0.02	0.01	0.01	0.01
Wilsonia rotundifolia	0.02	0.01	0.01	0.01
Senecio lautus	0.02	0.01	0.01	0.01
Microtis unifolia complex	0.02	0.02	0.02	0.02
Exocarpos syrticola	0.02	0.01	0.01	0.01
Hydrocotyle capillaris	0.02	0.03	0.03	0.03
Hydrocotyle medicaginoides	0.02	0.03	0.03	0.03
Isolepis platycarpa	0.02	0.03	0.03	0.03
Juncus bufonius	0.02	0.03	0.03	0.03
Juncus sarophorus	0.02	0.25	0.25	0.25
Pterostylis pedunculata	0.02	0.01	0.01	0.01
Linum marginale	0.02	0.02	0.02	0.02
Epilobium billardierianum	0.02	0.03	0.03	0.03
Mitrasacme paradoxa	0.02	0.02	0.02	0.02
Muehlenbeckia adpressa	0.02	0.02	0.02	0.02
Myoporum montanum	0.02	0.02	0.02	0.02
Myriophyllum salsugineum	0.02	0.01	0.01	0.01
Olearia axillaris	0.02	0.01	0.01	0.01
Persicaria decipiens	0.02	0.01	0.01	0.01
Podotheca angustifolia	0.02	0.03	0.03	0.03
Kennedia prostrata	0.02	0.01	0.01	0.01

6.3.10 Other ecosystems (10.1–10.5)

Pre–1750 native vegetation mapping and expert on-ground knowledge of the region was used to define four additional native ecosystems not revealed by the cluster analysis of vegetation survey site data. Agricultural ecosystems were acknowledged as being highly relevant to biodiversity in the region. These 'Other ecosystems' include:

10.1: Chaffy Saw-sedge (*Gahnia filum*) Swampland ecosystem is associated with wetlands and dominated by *G. filum*. The distribution of this ecosystem is now very limited within the region (Tim Croft, pers. comm., July 2013).

10.2: Red Gum (*Eucalyptus camaldulensis*) Grassy Woodland (MLR river flats) ecosystem is dominated in the overstorey *E. camaldulensis* var. *camaldulensis* with a grassy understorey. Majority of its distribution is limited along creeklines of Langhorne Creek.

10.3: Tussock Grassland (dryland) ecosystem is composed of tussock grassland species including *Lomandra effusa*, *Austrostipa* spp., *Austrodanthonia* spp. and *Poa* spp. in dryland environments.

10.4: Sheoak (*Allocasuarina verticillata*) / Native Pine (*Callitris gracilis*) Grassy Woodland (LL loams) - these non-eucalypt grassy woodland ecosystems primarily include Sheoak (*Allocasuarina verticillata*) Grassy Woodlands and Native Pine (*Callitris gracilis, C. verrucosa*) woodland with a grassy understorey.

10.5: Agroecosystems (agricultural lands) are primarily agricultural and livestock grazing farmland.

6.4 Associations between bird species and terrestrial Ecosystems within the CLLMM region of South Australia

Consensus ratings (i.e. from panel of three experts) of the associations between bird species and terrestrial ecosystems of the CLLMM region of South Australia. Association strengths were rated as:

0 = no likelihood of the species in the ecosystem
1 = little likelihood of the species in the ecosystem
2 = some likeihood of the species in the ecosystem
3 = high likelihood of the species in the ecosystem
4 = certainly found in the ecosystem
5 = certainly found in the ecosystem with a strong preference to that ecosystem.

	Ecosystem																
Bird species	**1**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**6.3**	**6.4**	**7**	**8**	**9**	**10.1**	**10.2**	**10.3**	**10.4**	**10.5**
Australasian Pipit	2	2	3	2	2	2	2	2	2	2	2	4	3	2	4	2	5
Australian Bustard	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	2
Australian Hobby	3	3	1	2	3	4	4	2	4	2	2	2	2	4	1	1	1
Australian Magpie	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5
Australian Owlet-nightjar	3	3	1	3	3	4	4	4	4	1	1	1	1	3	1	2	2
Australian Raven	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1
Australian Reed-Warbler	1	1	1	1	1	1	1	1	1	5	3	1	1	1	1	1	1
Australian Ringneck	1	1	3	3	2	5	3	5	1	1	2	2	2	2	2	3	1
Barn Owl	2	2	1	2	1	2	2	2	2	1	1	2	2	3	3	3	3
Beautiful Firetail	4	2	3	2	3	2	2	1	4	1	1	1	1	1	1	1	1
Black Falcon	1	1	2	2	1	2	2	2	2	1	2	3	2	2	3	2	3
Black Kite	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	1	4
Black-chinned Honeyeater	4	2	1	1	1	3	3	1	4	1	1	1	1	2	1	1	1
Black-faced Cuckoo-shrike	3	3	3	3	3	3	3	3	3	2	2	2	2	3	2	3	1
Black-shouldered Kite	3	1	3	2	1	2	2	2	2	2	2	2	2	1	2	3	3
Blue Bonnet	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1
Blue-winged Parrot	1	1	4	1	1	1	1	1	1	1	1	4	2	1	1	1	1
Brown Falcon	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
Brown Goshawk	3	3	1	3	1	3	3	3	3	1	1	1	1	3	1	3	1
Brown Quail	1	1	3	1	1	1	1	1	1	1	3	1	1	1	3	1	3
Brown Songlark	1	1	1	1	1	1	1	1	1	1	1	1	2	1	5	1	5
Brown Thornbill	2	5	4	2	4	2	2	3	3	1	1	1	1	1	1	1	1
Brown Treecreeper	2	1	1	1	1	4	2	1	4	1	1	1	1	2	1	1	1
Brown-headed Honeyeater	3	3	1	3	1	3	3	3	3	1	1	1	1	2	1	2	1
Brush Bronzewing	2	2	4	3	3	1	1	1	1	1	1	1	1	1	1	1	1
Budgerigar	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1
Buff-rumped Thornbill	2	4	1	1	1	2	2	1	2	1	1	1	1	1	1	1	1
Chestnut-rumped Heathwren	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cockatiel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
Collared Sparrowhawk	3	3	1	3	1	3	3	3	3	1	1	1	1	3	1	3	1
Common Bronzewing	3	3	3	3	3	3	3	3	3	1	1	1	1	3	1	3	1
Crescent Honeyeater	3	4	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1
Crested Bellbird																	
Crested Pigeon	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	3	5
Crested Shrike-tit	3	1	1	1	1	1	2	1	4	1	1	1	1	4	1	1	1
Crimson Rosella	3	3	1	2	1	3	3	2	4	1	1	1	1	4	1	3	1
Diamond Firetail	2	1	1	1	1	4	1	1	4	1	1	1	1	3	4	4	1
Dusky Woodswallow	3	3	1	2	1	3	3	2	3	1	1	1	1	2	1	3	1
Eastern Rosella	2	2	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1
Eastern Spinebill	3	4	1	1	1	1	2	1	4	1	1	1	1	2	1	1	1

	Ecosystem																
Bird species	**1**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**6.3**	**6.4**	**7**	**8**	**9**	**10.1**	**10.2**	**10.3**	**10.4**	**10.5**
Eastern Yellow Robin	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Elegant Parrot	3	2	3	2	3	2	2	2	3	1	1	3	1	3	2	2	1
Emu	1	1	4	4	1	1	1	1	1	1	1	1	1	1	3	2	1
Fairy Martin																	
Fan-tailed Cuckoo	4	4	1	2	1	2	3	2	4	1	1	1	1	3	1	1	1
Flame Robin																	
Fork-tailed Swift																	
Galah	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
Golden Whistler	3	3	1	3	1	3	3	3	3	1	1	1	1	1	1	3	1
Golden-headed Cisticola	1	1	1	1	1	1	1	1	1	5	3	1	2	1	1	1	1
Grey Butcherbird	2	1	1	3	1	3	3	3	1	1	1	1	1	1	1	3	1
Grey Currawong	2	4	2	4	2	3	3	3	3	1	1	1	1	1	1	2	1
Grey Fantail	4	4	3	4	4	4	4	4	4	1	1	1	1	3	1	3	1
Grey Shrike-thrush	4	4	4	4	4	4	4	4	4	1	1	1	1	4	1	3	1
Hooded Robin	4	2	1	2	1	4	4	2	4	1	1	1	1	2	1	4	1
Horsfield's Bronze-Cuckoo	4	4	2	4	2	4	4	4	4	1	1	1	1	3	1	3	1
Inland Thornbill	1	1	1	3	3	1	1	5	1	1	1	1	1	1	1	2	1
Jacky Winter	4	2	1	1	1	4	4	2	4	1	1	1	1	1	1	4	1
Laughing Kookaburra	2	2	1	1	1	3	3	1	3	1	1	1	1	4	1	1	2
Little Button-quail	1	1	2	1	1	1	1	1	1	1	1	1	2	1	4	1	1
Little Corella	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
Little Eagle	3	3	1	2	1	3	3	3	4	1	1	1	1	4	1	3	1
Little Grassbird	1	1	1	1	1	1	1	1	1	5	4	1	1	1	1	1	1
Little Raven	3	3	3	2	1	3	3	3	3	1	1	1	1	3	4	2	3
Little Wattlebird	1	5	4	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Magpie-lark	1	1	1	1	1	3	1	1	1	1	1	1	1	5	1	1	5
Malleefowl	1	1	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1
Masked Woodswallow	1	1	1	3	1	3	1	3	1	1	1	1	1	1	1	3	1
Mistletoebird	4	3	1	3	1	3	3	3	4	1	1	2	1	4	1	3	1
Musk Lorikeet	3	3	1	3	1	4	4	4	4	1	1	1	1	3	1	1	1
Nankeen Kestrel	3	1	3	1	1	3	3	1	3	1	3	3	3	3	4	3	4
New Holland Honeyeater	3	5	4	4	2	3	3	3	4	1	1	1	1	2	1	1	1
Noisy Miner	4	2	2	3	1	3	3	1	4	1	1	1	1	5	1	1	4
Orange Chat	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1
Orange-bellied Parrot	1	1	2	1	1	1	1	1	1	1	1	3	2	1	1	1	3
Painted Button-quail	1	4	4	3	3	1	1	2	1	1	1	1	1	1	1	1	1
Pallid Cuckoo	3	1	1	3	1	3	3	2	3	1	1	1	1	1	1	3	1
Peaceful Dove	4	1	1	3	1	4	4	1	4	1	1	1	1	3	1	5	1
Peregrine Falcon	3	1	1	1	1	4	4	3	4	1	1	1	1	5	1	4	3
Purple-crowned Lorikeet	4	3	1	4	1	3	3	3	3	1	1	1	1	1	1	1	1
Purple-gaped Honeyeater	1	1	4	4	1	1	1	4	1	1	1	1	1	1	1	1	1
Rainbow Bee-eater	2	1	1	3	1	3	3	3	3	1	1	1	1	4	1	3	1
Rainbow Lorikeet	4	4	1	4	1	2	4	1	4	1	1	1	1	4	1	1	1
Red Wattlebird	3	4	3	4	2	3	3	3	4	1	1	1	1	3	1	1	3
Red-browed Finch	4	4	1	1	1	1	3	1	4	2	1	1	1	3	1	1	1
Red-capped Robin	2	1	1	1	1	3	3	2	2	1	1	1	1	1	1	4	1
Red-rumped Parrot	3	1	1	3	1	4	4	3	4	1	1	1	1	4	3	1	3
Restless Flycatcher	4	1	2	1	1	4	4	1	3	1	1	3	1	3	3	3	2
Rock Parrot	1	1	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Rose Robin	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1
Rufous Bristlebird	1	1	5	3	3	1	1	1	1	1	1	2	1	1	1	1	1
Rufous Songlark	1	1	1	1	1	3	3	1	2	1	1	1	3	2	5	3	3
Rufous Whistler	3	2	1	3	1	2	2	4	3	1	1	1	1	1	1	4	1

	Ecosystem																
Bird species	**1**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**6.3**	**6.4**	**7**	**8**	**9**	**10.1**	**10.2**	**10.3**	**10.4**	**10.5**
Sacred Kingfisher	4	3	1	2	1	3	3	3	4	1	1	1	1	5	1	1	1
Scarlet Robin	3	4	2	3	1	2	2	2	4	1	1	1	1	1	1	1	1
Shy Hylacola	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1
Silvereye	4	4	5	5	4	3	3	4	4	1	1	3	1	3	1	2	1
Singing Bushlark	1	1	1	1	1	2	2	1	1	1	1	1	2	1	4	1	4
Singing Honeyeater	2	1	5	4	2	2	2	2	2	1	2	2	1	1	1	3	1
Southern Boobook	3	3	1	2	1	3	3	3	3	1	1	1	1	3	1	3	1
Southern Emu-wren (MLR ssp)	1	4	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
Southern Emu-wren (SE ssp)	1	1	1	1	1	1	1	1	1	1	1	3	3	1	1	1	1
Southern Scrub-robin	1	1	4	3	3	1	1	4	1	1	1	1	1	1	1	1	1
Southern Whiteface	3	1	1	1	1	4	4	1	3	1	1	1	1	1	1	2	1
Spiny-cheeked Honeyeater	3	2	4	4	1	3	3	3	3	1	1	1	1	1	1	3	1
Spotted Harrier	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
Spotted Nightjar	2	2	1	2	1	3	2	2	1	1	1	1	2	1	2	2	1
Spotted Pardalote	2	3	3	3	3	2	2	4	2	1	1	1	1	1	1	1	1
Striated Pardalote	3	3	3	3	3	3	3	4	3	1	1	1	1	4	1	1	1
Striated Thornbill	1	5	1	2	1	1	2	1	3	1	1	1	1	1	1	1	1
Stubble Quail	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
Sulphur-crested Cockatoo	1	3	1	1	1	1	1	1	3	1	1	1	1	4	1	1	4
Superb Fairy-wren	3	4	4	3	4	2	2	4	3	2	3	3	1	4	1	3	1
Swamp Harrier	1	1	1	1	1	1	1	1	1	4	3	2	2	1	1	1	3
Tawny Frogmouth	3	3	1	3	1	3	3	2	3	1	1	1	1	3	1	3	1
Tawny-crowned Honeyeater	1	2	1	3	1	1	1	4	1	1	1	1	1	1	1	1	1
Tree Martin	3	1	1	3	1	3	3	3	3	1	1	1	1	4	1	3	1
Varied Sittella	4	3	1	3	1	4	4	3	3	1	1	1	1	2	1	3	1
Variegated Fairy-wren	1	1	1	3	1	3	1	3	1	1	1	1	1	1	1	1	1
Wedge-tailed Eagle	2	2	2	2	1	2	2	2	2	1	1	1	3	3	3	1	3
Weebill	4	1	1	4	1	4	4	4	4	1	1	1	1	3	1	1	1
Welcome Swallow	2	2	2	2	1	3	3	1	2	3	3	3	3	2	5	2	3
Western Whipbird	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1
Whistling Kite	1	1	1	1	1	1	1	1	1	2	2	2	1	4	3	1	1
White-backed Swallow																	
White-browed Babbler	3	2	4	4	3	3	3	4	3	1	1	1	1	1	1	3	1
White-browed Scrubwren	1	4	4	4	3	1	1	1	1	1	1	1	1	1	1	1	1
White-browed Woodswallow	2	1	1	3	1	4	2	3	2	1	1	1	1	1	1	3	1
White-eared Honeyeater	1	1	1	2	1	1	1	3	1	1	1	1	1	1	1	1	1
White-fronted Chat	1	1	3	1	1	1	1	1	1	1	1	5	3	1	1	1	1
White-fronted Honeyeater	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1
White-naped Honeyeater	3	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1
White-plumed Honeyeater	3	1	1	3	1	1	1	1	3	1	1	1	1	5	1	1	1
White-throated Treecreeper	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
White-winged Chough	4	2	1	3	1	4	4	3	4	1	1	1	1	3	1	2	1
White-winged Triller	3	1	1	2	1	3	3	2	2	1	1	1	1	1	1	3	1
Willie Wagtail	3	1	3	3	1	3	3	2	3	1	1	3	3	3	3	3	3
Yellow Thornbill	2	1	1	1	1	3	3	1	2	1	1	1	1	1	1	4	1
Yellow-faced Honeyeater	3	5	1	1	1	2	3	1	3	1	1	1	1	1	1	1	1
Yellow-plumed Honeyeater	1	1	1	1	1	2	2	3	1	1	1	1	1	1	1	1	1
Yellow-rumped Thornbill	3	2	3	3	3	3	2	3	3	1	1	1	1	3	3	3	3
Yellow-tailed Black-Cockatoo	1	5	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1
Yellow-throated Miner	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1
Zebra Finch	3	1	1	1	1	3	3	1	3	1	1	1	1	3	3	3	1

6.5 Cluster analysis of bird habitat requirements to identify Ecosystem Response Groups, and their associations with Ecosystems, in the CLLMM region of South Australia

6.5.1 Cluster analysis dendrogram

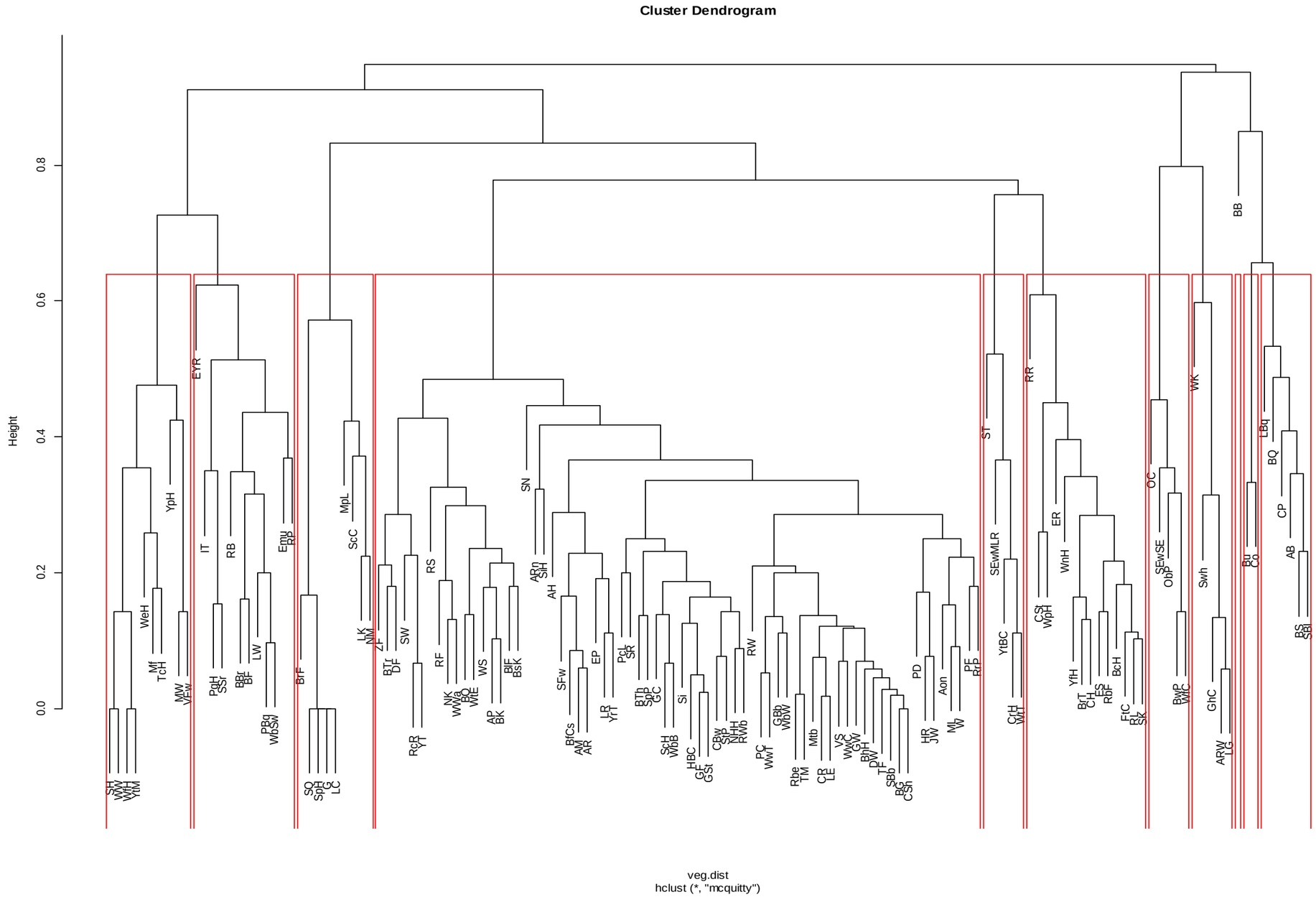

Figure 6.2 Dendogram of the hierarchical cluster analysis showing bird species (e.g. "SH"), similarity in habitat requirements (e.g. lines, linkages), and their natural groupings to classify ecosystem response groups of the CLLMM region of South Australia

6.5.2 Cluster analysis ordination plot

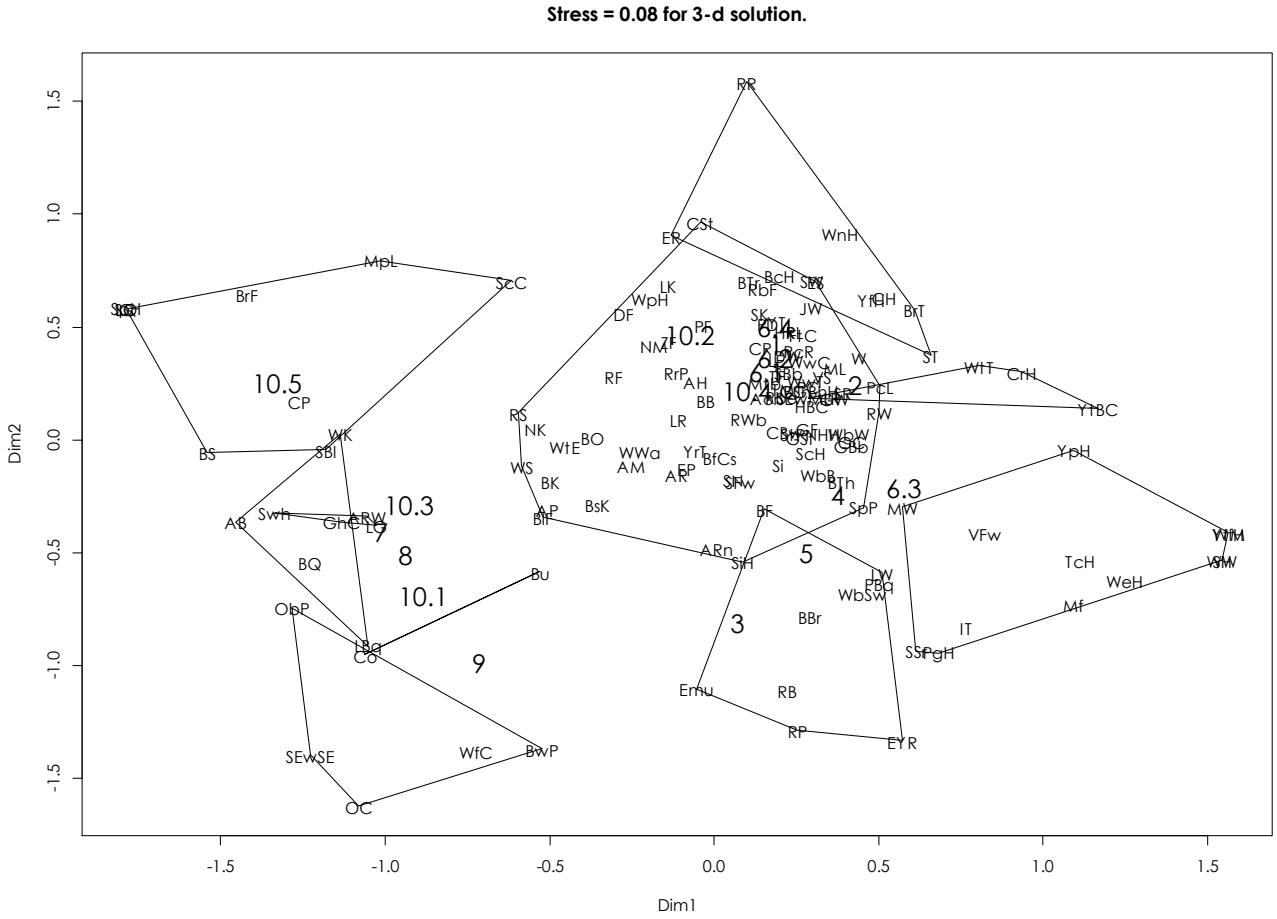

Figure 6.3 Plot of cluster analysis associations between bird species (e.g. "BrF"), similarity in habitat requirements (i.e. non-metric multidimensional scaling, NMDS) and their natural groupings to Ecosystems (e.g. "10.5") within the CLLMM region of South Australia

6.6 Bird species lists for each Ecosystem Response Group (ERG) within the CLLMM region of South Australia

Produced through cluster analysis and non-metric multidimensional scale ordination

ID no.	Bird species	Bird code	Bird group	nMDS group	Bird Group, brief description	Associated ecosystem
1	Blue Bonnet	BB	1	4	Vagrants in the region. No further analysis.	None
2	Budgerigar	Bu	2	8		
3	Cockatiel	Co	2	8		
4	Orange Chat	OC	3	9	Samphire	9. Samphire / Paperbark Shrubland (saline clays)
5	Orange-bellied Parrot	OBP	3	9		
6	Southern Emu-wren (SE ssp)	SEwSE	3	9		
7	Blue-winged Parrot	BwP	3	9		
8	White-fronted Chat	WfC	3	9		
9	Magpie-lark	MpL	4	6	Farmland / Agricultural	10.5 Agroecosystems (agricultural lands)
10	Sulphur-crested Cockatoo	ScC	4	6		

ID no.	Bird species	Bird code	Bird group	nMDS group	Bird Group, brief description	Associated ecosystem
11	Brown Falcon	BrF	4	6		
12	Stubble Quail	SQ	4	6		
13	Spotted Harrier	SpH	4	6		
14	Galah	G	4	6		
15	Little Corella	LC	4	6		
16	Crested Pigeon	CP	4	6		
17	Brown Songlark	BS	4	6		
18	Singing Bushlark	SBI	4	6		
19	Swamp Harrier	SwH	5	3	Reeds	7. Reeds and Rushes (freshwater fringes); 8. Lignum Shrubland (non-saline clays); 10.1 Chaffy Saw-sedge Swampland
20	Little Grassbird	LG	5	3		
21	Australian Reed-Warbler	ARW	5	3		
22	Golden-headed Cisticola	GhC	5	3		
23	Whistling Kite	WK	6	1	Grassland (with the exemption of Whistling Kite but it is noted the WK is also seen in grassland habitat)	10.3 Tussock Grassland (dryland)
24	Brown Quail	BQ	6	1		
25	Australian Bustard	AB	6	1		
26	Little Button-quail	LBq	6	1		
27	Yellow-plumed Honeyeater	YpH	7	11	*E. incrassata* Mallee (nested in this group are the ones found purely in *E. incrasssata* mallee (YPH to YtM) and a group found in mix mallee and coastal shrubs (MW to TcH)).	6.3 Ridge-fruited / Narrow-leaf Red Mallee (MLR sands) and possibly 4. Coastal White Mallee (SE/LL sandy loams)
28	White-eared Honeyeater	WeH	7	11		
29	Shy Hylacola	SH	7	11		
30	Western Whipbird	WW	7	11		
31	White-fronted Honeyeater	WfH	7	11		
32	Yellow-throated Miner	YtM	7	11		
33	Masked Woodswallow	MW	7	11		
34	Variegated Fairy-wren	VFw	7	11		
35	Purple-gaped Honeyeater	PgH	7	11		
36	Southern Scrub-robin	SSr	7	11		
37	Malleefowl	Mf	7	11		
38	Tawny-crowned Honeyeater	TcH	7	11		
39	Eastern Yellow Robin	EYR	8	5	Coastal Heath	3. Mixed Shrubland (coastal dunes) and possibly 5. Sheoak Low Shrubby Woodland (SE/LL sandy loams)
40	Little Wattlebird	LW	8	5		
41	Painted Button-quail	PBq	8	5		
42	White-browed Scrubwren	WbSw	8	5		
43	Rufous Bristlebird	RB	8	5		
44	Brush Bronzewing	BBr	8	5		
45	Beautiful Firetail	BF	8	5		
46	Emu	EMU	8	5		
47	Rock Parrot	RP	8	5		
48	Southern Emu-wren (MLR ssp)	SEwMLR	9	10	High Rainfall Stringybark over heath	2. Stringybark / Cup Gum Woodland (MLR hills)
49	White-throated Treecreeper	WtT	9	10		
50	Chestnut-rumped Heathwren	CrH	9	10		
51	Yellow-tailed Black-Cockatoo	YtBC	9	10		
52	Spotted Nightjar	SN	10.1	2	Open habitat	A mixture of: 10.2 Red Gum Grassy Woodland (MLR river flats); 10.3 Tussock Grassland (dryland); and 10.4 Sheoak /
53	Elegant Parrot	EP	10.2	2		
54	Superb Fairy-wren	SFw	10.2	2		
55	Black-faced Cuckoo-shrike	BfCs	10.2	2		
56	Australian Magpie	AM	10.2	2		

ID no.	Bird species	Bird code	Bird group	nMDS group	Bird Group, brief description	Associated ecosystem
57	Australian Raven	AR	10.2	2		Native Pine Grassy Woodland (LL loams)
58	Restless Flycatcher	RF	10.2	2		
59	Zebra Finch	ZF	10.2	2		
60	Nankeen Kestrel	NK	10.2	2		
61	Willie Wagtail	WWa	10.2	2		
62	Little Raven	LR	10.2	2		
63	Yellow-rumped Thornbill	YrT	10.2	2		
64	Rufous Songlark	RS	10.3	2		
65	Welcome Swallow	WS	10.3	2		
66	Black-shouldered Kite	BsK	10.3	2		
67	Barn Owl	BO	10.3	2		
68	Wedge-tailed Eagle	WtE	10.3	2		
69	Black Kite	BIF	10.3	2		
70	Australasian Pipit	AP	10.3	2		
71	Black Falcon	BK	10.3	2		
72	Rufous Whistler	RW	10.4	2	Woodland (more intact, continuous habitat)	A mixture of: 1. Pink Gum Low Open Grassy Woodland (MLR sands); 22. Stringybark / Cup Gum Woodland (MLR hills); 4. Coastal White Mallee (SE/LL sandy loams); 6.1 Mallee Box Grassy Woodland (LL loams); 6.2 Peppermint Box Grassy Woodland (MLR loams); and 10.4 Sheoak / Native Pine Grassy Woodland (LL loams)
73	Rainbow Bee-eater	Rbe	10.4	2		
74	Tree Martin	TM	10.4	2		
75	Mistletoebird	Mtb	10.4	2		
76	Crimson Rosella	CR	10.4	2		
77	Little Eagle	LE	10.4	2		
78	Brown-headed Honeyeater	BhH	10.4	2		
79	Golden Whistler	GW	10.4	2		
80	Dusky Woodswallow	DW	10.4	2		
81	Tawny Frogmouth	TF	10.4	2		
82	Southern Boobook	SBb	10.4	2		
83	Brown Goshawk	BG	10.4	2		
84	Collared Sparrowhawk	CSh	10.4	2		
85	Pallid Cuckoo	PC	10.4	2		
86	White-winged Triller	WwT	10.4	2		
87	Grey Butcherbird	GBb	10.4	2		
88	White-browed Woodswallow	WbW	10.4	2		
89	Silvereye	Si	10.5	2	Woodland (general woodland)	A mixture of: 2. Stringybark / Cup Gum Woodland (MLR hills); 4. Coastal White Mallee (SE/LL sandy loams); 6.1 Mallee Box Grassy Woodland (LL loams); 6.2 Peppermint Box Grassy Woodland (MLR loams); and 10.4 Sheoak / Native Pine Grassy Woodland (LL loams)
90	Horsfield's Bronze-Cuckoo	HBC	10.5	2		
91	Grey Fantail	GF	10.5	2		
92	Grey Shrike-thrush	GST	10.5	2		
93	Common Bronzewing	CBw	10.5	2		
94	Striated Pardalote	StP	10.5	2		
95	New Holland Honeyeater	NHH	10.5	2		
96	Red Wattlebird	RWb	10.5	2		
97	Spiny-cheeked Honeyeater	ScH	10.5	2		
98	White-browed Babbler	WbB	10.5	2		
99	Grey Currawong	GC	10.5	2		
100	Purple-crowned Lorikeet	PcL	10.5	2		
101	Scarlet Robin	SR	10.5	2		
102	Brown Thornbill	BTh	10.5	2		
103	Spotted Pardalote	SpP	10.5	2		
104	Australian Ringneck	ARn	10.6	2		

ID no.	Bird species	Bird code	Bird group	nMDS group	Bird Group, brief description	Associated ecosystem
105	Singing Honeyeater	SiH	10.6	2	Open Woodland (nested in this group are those found in Grassy Woodland (BtR to YT and AH to JW), Red Gum (CSt and WpH) and Big Gum (ES to NM))	A mixture of: 1. Pink Gum Low Open Grassy Woodland (MLR sands); 6.1 Mallee Box Grassy Woodland (LL loams); 6.2 Peppermint Box Grassy Woodland (MLR loams); 6.4 SA Blue Gum Grassy Woodland (SE/LL loams); and 10.2 Red Gum Grassy Woodland (MLR river flats)
106	Brown Treecreeper	BtR	10.7	2		
107	Diamond Firetail	DF	10.7	2		
108	Southern Whiteface	SW	10.7	2		
109	Red-capped Robin	RcR	10.7	2		
110	Yellow Thornbill	YT	10.7	2		
111	Crested Shrike-tit	CSt	10.8	2		10.2 Red Gum Grassy Woodland (MLR river flats)
112	White-plumed Honeyeater	WpH	10.8	2		
113	Australian Hobby	AH	10.9	2		A mixture of: 1. Pink Gum Low Open Grassy Woodland (MLR sands); 6.1 Mallee Box Grassy Woodland (LL loams); 6.2 Peppermint Box Grassy Woodland (MLR loams); 6.4 SA Blue Gum Grassy Woodland (SE/LL loams); 10.2 Red Gum Grassy Woodland (MLR river flats); 10.4 Sheoak / Native Pine Grassy Woodland (LL loams)
114	Peregrine Falcon	PF	10.9	2		
115	Red-rumped Parrot	RrP	10.9	2		
116	Varied Sittella	VS	10.9	2		
117	White-winged Chough	WwC	10.9	2		
118	Weebill	W	10.9	2		
119	Australian Owlet-nightjar	AoN	10.9	2		
120	Musk Lorikeet	ML	10.9	2		
121	Peaceful Dove	PD	10.9	2		
122	Hooded Robin	HR	10.9	2		
123	Jacky Winter	JW	10.9	2		
124	Eastern Spinebill	ES	10.91	2		
125	Red-browed Finch	RbF	10.91	2		
126	Black-chinned Honeyeater	BcH	10.91	2		
127	Rainbow Lorikeet	RL	10.91	2		
128	Fan-tailed Cuckoo	FtC	10.91	2		
129	Sacred Kingfisher	SK	10.91	2		
130	Laughing Kookaburra	LK	10.91	2		
131	Noisy Miner	NM	10.91	2		
132	Rose Robin	RR	11	7	High Rainfall Forest (with the exemption of RR and ER)	A mixture of: 1. Pink Gum Low Open Grassy Woodland (MLR sands); 2. Stringybark / Cup Gum Woodland (MLR hills); and 6.4 SA Blue Gum Grassy Woodland (SE/LL loams)
133	Eastern Rosella	ER	11	7		
134	White-naped Honeyeater	WnH	11	7		
135	Striated Thornbill	ST	11	7		
136	Yellow-faced Honeyeater	YfH	11	7		
137	Buff-rumped Thornbill	BrT	11	7		
138	Crescent Honeyeater	CH	11	7		

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