Wheatbelt Baselining Project

Benchmarking Wheatbelt Vegetation

Classification and Description of Eucalypt Woodlands

Eucalyptus accedens woodland Tutanning Nature Reserve

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wheatbelt natural resource management

Department of Environment and Conservation

Our environment, our future

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Classification and Description of Eucalypt Woodlands

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SUMMARY

The Wheatbelt Baselining Project, initiated by the now Wheatbelt Natural Resource Management (Wheatbelt NRM) region, identified the need to provide benchmarks of vegetation against which assessments of vegetation condition can be made. Benchmarks need to be attributed to recognisable plant communities. A classification of eucalypt woodlands in the Western Australian Wheatbelt is presented here to trial a process which may be expanded to other vegetation types and regions. This is primarily a qualitative classification, similar to one carried out in Tasmania, based on site and polygon data and descriptions, interpretation of floristic analyses, interrogation of Geographic Information Systems (GIS) based spatial data, photographic interpretation and consultation with experts.

The Wheatbelt NRM region covers the 12 million hectares of the Avon River Basin, an area equivalent to the Avon River catchment, and encompasses a complex array of vegetation associations. Eucalypt woodlands once dominated the region, and are now restricted to reserves, roadsides, and remnants on private property.

Descriptions and data from 889 survey sites and 338 mapped polygons were the basis of a classification of 29 *Eucalyptus* species into 18 eucalypt woodland communities (12 of these, the mallets, have been considered one community group), and 62 sub-communities. Eucalypt woodland communities were defined primarily by the dominant *Eucalyptus* species; the sub-communities were defined by commonly observed structural formations, common co-dominant tree species, commonly occurring understorey genera or species, landform features or geographic distribution. The classification is open to challenge and further development, and serves as a 'first cut' presentation of the information currently collated.

The results of the classification have been presented as a set of web-based factsheets that include: for communities, soils, landforms, associated overstorey and understorey species, and sub-communities; for sub-communities, descriptions, maps, lists of sites including reference sites (where available) and photographs; and for reference sites, descriptions, species lists and photographs.

Benchmarking involves describing the near pristine state of a defined community in terms of species composition, species richness, vegetation structure and habitat value. Benchmark descriptions for 17 communities (excluding *Eucalyptus marginata*) and the mallet community group have been drafted against attributes used in the eastern states to give an indication of what the woodland communities look like when they are in pristine or excellent condition. This highlighted the need for collection of further data on attributes such as litter characteristics, regenerative strategies and faunal habitat needs.

The Benchmarking Wheatbelt Vegetation Project has produced:

- a comprehensive structural – dominance classification of woodland communities and sub-communities which will help land managers, community organisations and students to understand these communities and their diversity and variability, to establish monitoring sites, and to assess their conservation status as a contribution to the nomination of potential Threatened Ecological Communities (TECs)
- benchmark descriptions of main communities and draft methodology for recording selected attributes which will aid in the assessment of vegetation condition and direct and evaluate restoration activities
- a set of web-based factsheets designed to provide information to land managers, community groups, scientists, students and naturalists about the diversity, composition and condition of the Wheatbelt woodlands and provide a framework for vegetation mapping, restoration and monitoring. The information can also inform enthusiasts wishing to travel through the Wheatbelt looking at the range of eucalypts
- background information for the nomination of the eucalypt woodlands of the Avon Wheatbelt IBRA bioregion and western Mallee IBRA subregion as a Threatened Ecological Community under the federal Environment Protection and Biodiversity Conservation Act.

1. INTRODUCTION

1.1 Background

The Baselining Project is one of the natural diversity projects funded largely by the federal government through the Wheatbelt Natural Resource Management, NRM (previously Avon Catchment Council, ACC). The Project's primary purpose is to collate the biodiversity data and interpret these data to support other projects in the Wheatbelt NRM's biodiversity theme. A preliminary role of Baselining was to identify key knowledge and operational gaps in natural diversity conservation within the Wheatbelt NRM region.

One of the five foundational gaps (typically higher-order gaps in knowledge that are required to inform the development, management and evaluation of natural diversity projects) identified was the need to benchmark Vegetation and to develop a condition assessment methodology (Richardson & Gamblin 2009). A detailed survey and analysis of floristic & environmental variables of the terrestrial and wetland vegetation of the WA agricultural region, funded by the Salinity Action Plan, SAP (Gibson *et al.* 2004), has identified 23 assemblages and related these to soils and topography. Vegetation mapping at a 1:250,000 scale has been amalgamated into a 1:1,000,000 scale map (Beard 1981). Numerous large scale maps, mainly of reserves and potential reserves, exist and have been compiled into a database to be incorporated into NatureMap. However, it was found that there is little knowledge of the extent (at a local scale) and condition of vegetation within the region (Richardson *et al.* 2007).

Knowledge of vegetation condition is critical for many of the Wheatbelt's natural diversity projects; vegetation condition information is required to identify management actions, prioritise on-ground work and as a tool to evaluate project outputs. Assessing condition against benchmarks is an established way of identifying management actions and monitoring changes (Parkes *et al.* 2003). Benchmarks are defined from vegetation in a mature, long undisturbed state. Benchmarking involves describing the near pristine state of a defined community in terms of species composition, species richness, vegetation structure and habitat value. The definition of a benchmark adopted here is:

> "A measure, for the purposes of biodiversity conservation, of indicators of vegetation composition, structure and function relative to a reference state (i.e. within the context of the presence or absence of threatening processes) at a patch or landscape (community or ecosystem) scale"(Bleby *et al.* 2008)

Before benchmark descriptions can be developed, the unit of assessment or vegetation community needs to be defined.

The native vegetation in the Avon River Basin is very diverse and complex with high species turnover at a patch and landscape scale, and a mosaic of structural formations varying with climate, landforms, soils and hydrology (Beard 1990). These issues present many challenges to those trying to map the vegetation.

The vegetation associations mapped by Beard at 1:250,000 are (in the majority) largely based on structure and dominant species. At this scale, the associations are too broad to account for the fine scale variations in the vegetation. For example, many of the woodland associations in the Wheatbelt are mapped as large units with up to six eucalypt species. These eucalypts do not all occur together but rather in patches, some together and others in mono-specific stands on localised specific soil types, e.g. mallet on breakaways. Vegetation is strongly linked to soil type which, in turn, is determined by the gently undulating landscape (Beard 1981, 1990).

Communities have been mapped at reserve scale (about 1:50,000) using a variety of methods (e.g. (Muir 1977; Coates 1990; Mattiske 1992). These and many more maps are being digitised and their attributes standardised according to the National Vegetation Information System, NVIS (ESCAVI 2003) as part of the Wheatbelt Baselining Project (Richardson *et al.* 2008); this work has been done by Ban Bayliss and is included on NatureMap.

Vegetation classifications tend to be based on: physiognomic characteristics, that is, structure and dominant species (Muir 1977; Beard 1981); or on numerical analysis of floristic composition, that is, species presence and absence, into assemblages, and incorporating environmental factors, such as soil types and climatic variables, into site groupings (e.g. (Gibson *et al.* 2004; Griffin 2008)).

There are inherent problems with defining vegetation as it may gradually change across the landscape, and time since fire, grazing pressure, nutrient enrichment, weed infestation, salinity, and hydrological changes may influence floristic composition and structure.

It was decided to initially focus on the woodlands due to the complexity of the Wheatbelt vegetation; the knowledge available about eastern states woodlands; the fact that a relatively high proportion of woodlands have been cleared compared to other communities (Shepherd *et al.* 2002); the identification of three woodlands communities as potential Threatened and Priority Ecological Communities (DEC 2007); and the recent nomination of the WA Wheatbelt Woodlands as a Threatened Ecological Community under the federal Environment Protection and Biodiversity Conservation Act.

The Wheatbelt Woodlands are easily recognisable in the landscape, the eucalypt species are relatively easy to identify and they have been the focus of surveys (WWF 2001-2008), guides (Bamford 1995; Hussey 1999; McQuoid (in press)), descriptive catalogues (French 2012) and reviews (Yates *et al.* 2000).

Future extension of this exercise for the mallee, shrublands and kwongan will be challenging due to the way these formations intergrade, their high species richness and the lack of dominant species.

The following classification is based on descriptions of 889 sites and 338 polygons, species lists and photographs (where available), results of two floristic analyses, an existing list of communities and expert opinion from botanists working in the region.

1.2 Aims of the Project

The objectives and outputs of the Benchmarking Wheatbelt Vegetation component of the Wheatbelt Baselining Project are to:

- classify and describe Wheatbelt eucalypt woodland communities based on available data from floristic surveys, GIS analysis, baseline vegetation mapping and expert opinion
- document benchmarking methodology and prepare benchmark descriptions of the selected communities
- develop a condition assessment methodology based on a selection of attributes and methods developed and tested in the eastern states, and some being developed in WA, and expert consultation.

An additional aim is to:

- recommend necessary research and surveys to support nomination of communities as potential Priority Ecological Communities or Threatened Ecological Communities.

1.3 Intended users

The classification and benchmark descriptions are intended to assist:

- Wheatbelt NRM to better understand the diversity and variability of these communities, to monitor and evaluate restoration activities, and to assess their conservation status
- DEC regional staff doing reserve surveys to assess the conservation significance of woodlands on their reserves and crown land being considered for reserves
- DEC officers to assess native vegetation clearance applications
- Land for Wildlife and WWF personnel to assess the diversity and condition of woodland remnants in a regional context in order to implement land covenants
- private land managers to assess and manage their woodland remnants
- federal and state government officers to assess the nomination of the eucalypt woodlands of the Avon Wheatbelt IBRA bioregion and western Mallee IBRA subregion as a Threatened Ecological Community under the federal Environment Protection and Biodiversity Conservation Act
- tourists, naturalists and eucalypt enthusiasts to plan their visits to the WA Wheatbelt

- students and scientists to carry out related research
- community groups to plan and monitor restoration activities.

1.4 Study area

The area of focus for this Project is the Avon River Basin, which is the catchment for the Avon-Mortlock, Yilgarn and Lockhart river systems, and defines the Wheatbelt NRM region (referred to as the 'Wheatbelt' throughout this report). **Figure 1** shows the Wheatbelt NRM region in relation to the Interim Biogeographic Regionalisation for Australia (IBRA) regions and subregions of the South West. In assessing whether communities are confined to the Wheatbelt NRM region, some site observations from outside the region were incorporated in the classification.

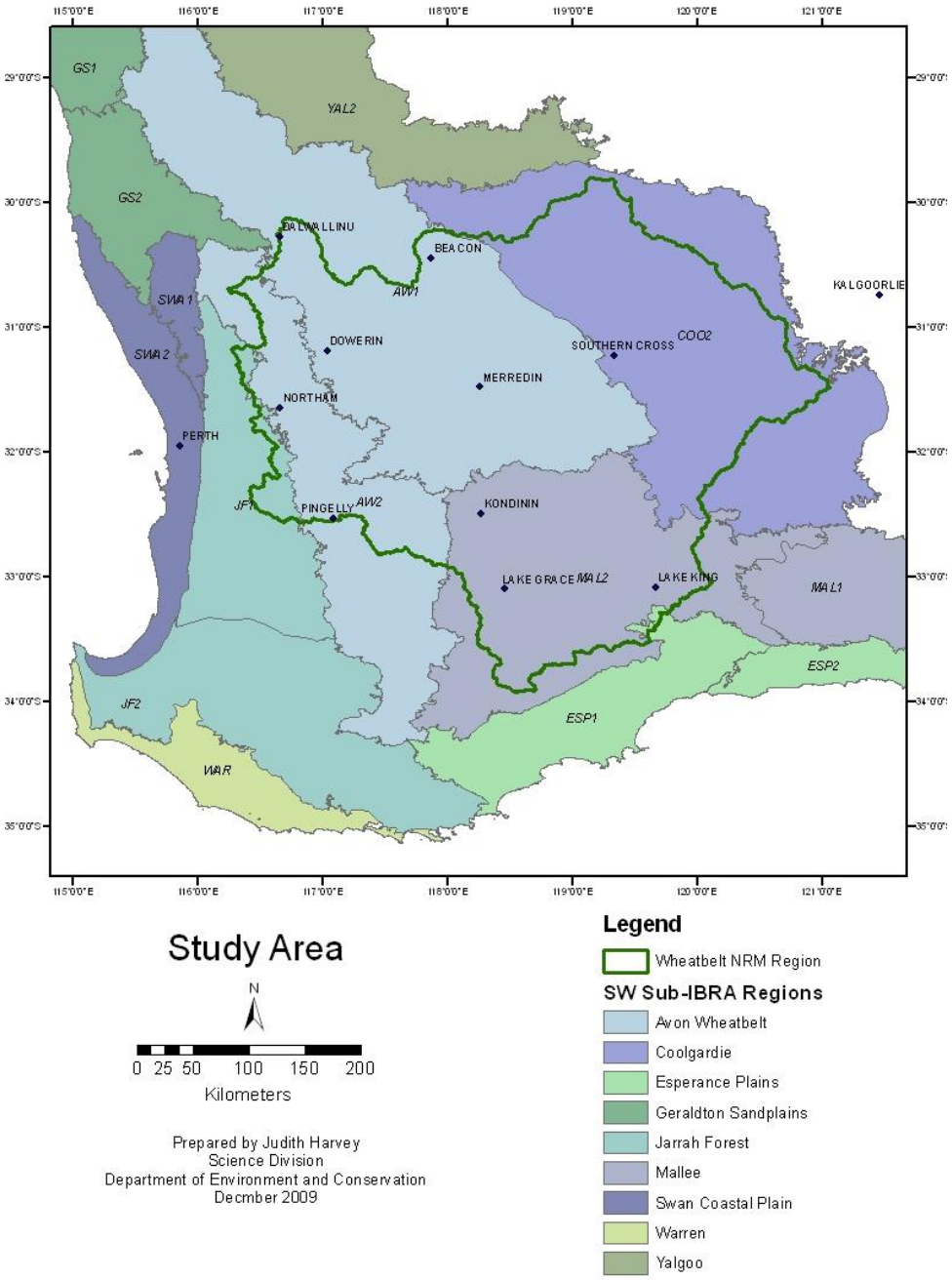


Figure 1 The Wheatbelt NRM region, defined by the Avon River Basin, in relation to the IBRA subregions of the South West of WA.

Historically the wheatbelt is referred to as the agricultural area east of the forest and west of the rabbit proof fence and Goldfields woodlands, extending from Geraldton to east of Esperance.

The four IBRA subregions that intersect with the Wheatbelt NRM region are described in detail, in terms of their physical and biodiversity values, by May and McKenzie (2003).

The Avon Wheatbelt bioregion is a dissected plateau of Tertiary laterite in the Yilgarn Craton. Its climate is semi-arid (dry) warm Mediterranean. There are two subregions – the eastern Avon Wheatbelt (AW1) and the western Avon Wheatbelt (AW2).

The Mallee bioregion occurs on the south-eastern part of the Yilgarn Craton which is gently undulating, with partially occluded drainage. The climate is Mediterranean to semi-arid, with winter rainfall of 250-500mm. Only the western Mallee (MAL2) is of interest here.

The Coolgardie bioregion is also within the Yilgarn Craton. Its granite basement includes Archaean Greenstone intrusions in parallel belts. Drainage is occluded. The climate is arid to semi-arid warm Mediterranean with 250-300mm of mainly winter rainfall. The western or Southern Cross subregion, COO2, is a largely uncleared area of gently undulating uplands on granite strata interspersed with broad valleys with bands of low greenstone hills. This is not included in this classification because of the lack of data and non-fragmented nature of the vegetation.

So the Project is actually focused on the area defined by the cleared area in the Avon River Basin covered by the AW1, AW2 and MAL2 IBRA regions.

1.5 Woodlands of the South West

Woodlands are defined as widely spaced trees with a canopy cover of less that 30% (ESCAVI 2003; Muir 1977; Specht 1970). Cover may exceed 30% after a disturbance such as fire but, over time, it tends to thin out. Woodlands featured here are all dominated by *Eucalyptus* species. Other woodlands of sheoak and banksia also occur in the Wheatbelt. The distribution of woodlands in the Wheatbelt, in relation to topography and soils, is presented in **Figure 2** and **Figure 3** (Bamford 1995).

In the Wheatbelt, woodland trees include *Eucalyptus salmonophloia* (Salmon Gum), *E. loxophleba* (York Gum) and *E. salubris* (Gimlet), all of which tend to regenerate from seed but may resprout from the stem and form multiple stems if logged. Some, such as *E. loxophleba*, may develop lignotubers and multiple stems following disturbance. Another group of trees, known as mallets, only regenerate from seed, are killed by fire and have no lignotuber; these include *E. astringens, E. gardneri*, *E. urna* and *E. sargentii*.

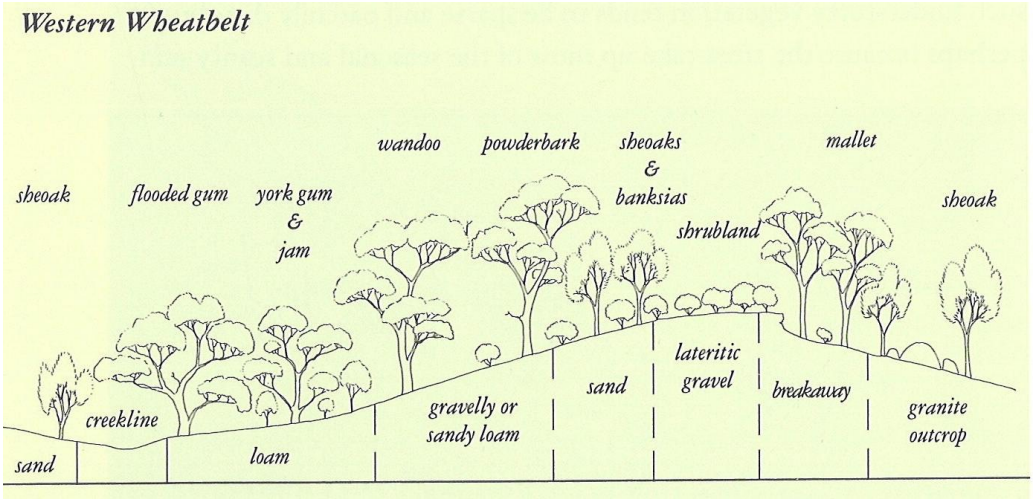


Figure 2 Woodlands of the western Wheatbelt in relation to topography and soils (Bamford 1995).

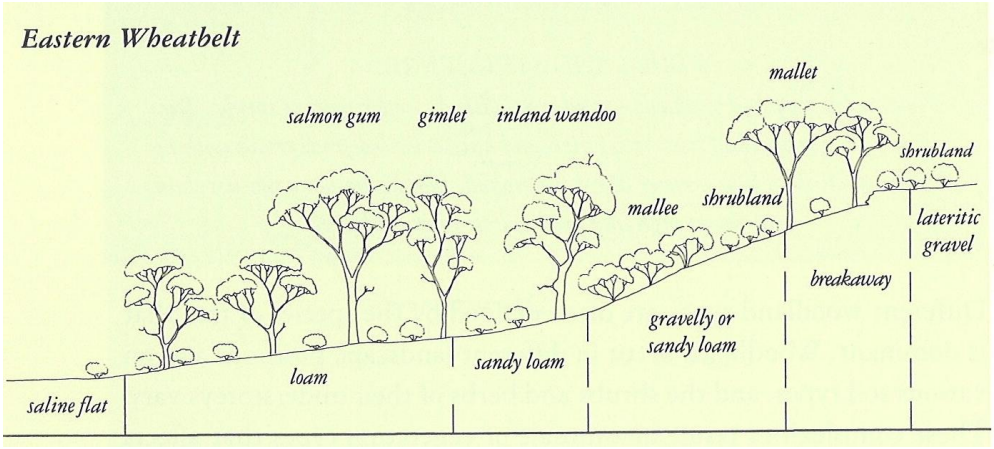


Figure 3 Woodlands of the eastern Wheatbelt in relation to topography and soils (Bamford 1995).

2. VEGETATION CLASSIFICATION

2.1 Introduction

Hnatiuk *et al.* (2009) describe vegetation classification for the purpose of mapping as being based on '*Structure* (*the vertical and horizontal distribution of vegetation – its growth form, height, cover and strata*) *and floristics (dominant general or species in various strata and characteristic plant species'.* Their comparison of some of the current systems of classification levels in Australia is presented in hierarchical form in **Table 1**.

Table 1 Comparison of selected vegetation classification systems (ESCAVI 2003; Hnatiuk, Thackway and Walker 2009; Walker and Hopkins 1990)

Key Attributes	Walker & Hopkins	Hnatiuk, Thackway & Walker	NVIS	Examples (NVIS)
Growth form and cover	N/A	1 Formation	I Class	Tree
Growth form, cover and height of the dominant stratum and emergents	Structural formation	2 Structural formation	II Structural formation	Open woodland
Growth form, cover, height and characteristic species/genera in the dominant stratum	Floristic association	3 Broad floristic formation	III Broad floristic formation	*Eucalyptus* open woodland
Above plus the dominant genera for each stratum (upper mid and ground)	Structural sub formation	4 Broad floristic sub formation	IV Broad floristic sub formation	*Eucalyptus* open woodland*Acacia* tall sparse shrubland*Austrostipa* open grassland
Above with three dominant or co-dominant species in each stratum		Species can be added for substrata	V Association	U+^*Eucalyptus salmonophloia*, *Eucalyptus*\^tree\7\i;M*Acacia acuminata**Acacia*\shrub\3\r;G*Acacia erinacea**Acacia*\shrub\1\r;
Above with five dominant or co-dominant species in each stratum		Species can be added for substrata	VI Sub association	U1+^*Eucalyptus salmonophloia*, *Eucalyptus*\^tree\7\i;U2 *Eucalyptus* wandoo*Eucalyptus*\tree\6\r;M1*Acacia acuminata**Acacia*\shrub\3\r;M2^*Olearia muelleri**Olearia*\^shrub\3\i;G1 *Acacia erinacea**Acacia*\shrub\1\r; G2^^*Lepidosperma pubisquameum*, *Loxocarya "asper", Austrostipa* sp., *Stypandra glauca, Lepidosperma brunonianum**Lepidosperma*\^sedge, tussock grass,rush\1\i

Classifying Vegetation is important for:

- systematically mapping the vegetation
- assessing conservation values (how much is left and how much is in reserves)
- identifying Threatened Ecological Communities and Priority Ecological Communities
- developing benchmark descriptions which are required to effectively assess and monitor changes in vegetation condition
- helping land managers and land owners identify their bush remnants
- guiding and monitoring revegetation activities
- planning pest and weed control, fire management and visitor use.

The term vegetation is applied to plant communities and can be described at a range of scales. A plant ecological community has been defined in WA as a naturally occurring biological assemblage of plants that occurs in a particular type of habitat (DEC 2007). Community structure is defined as follows: "The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage", for example, *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs (DEC 2007). It is noted that the scale at which ecological communities are defined will often depend on the level of detail in the information source; therefore, no particular scale is specified.

For this Benchmarking Project we consider vegetation units on a broader scale as being characterised by structural and floristic features that are more or less consistent across its range. It may include specific topographic or soil parameters.

Units of vegetation need to be:

1. Scientifically recognised and defensible:
    - It must have sufficiently consistent floristics and structure to allow it to be recognised in the field. It may occur in various states as it recovers from fire, grazing or other disturbance. There is some knowledge about this for some communities e.g. Salmon Gum (Yates *et al.* 1994). A community affected by dieback is transformed permanently and may be described as a different (post dieback) community. In Tasmania, successional stages may be classed as communities if they are temporally stable for about 20 years (Harris & Kitchener 2005).
    - It must be based on an accepted vegetation classification system (e.g. Muir 1977; ESCAVI 2003) which emphasises floristic dominance (i.e. lists the most dominant species).
    - It must be considered by botanical experts to be a common and/or recognisable unit.
    - It does not need to be supported by floristic pattern analysis as this is based on total species or total perennial species and does not take abundance or cover into account.
2. Mappable (desirable):
    - If a vegetation unit is mappable it can be defined on aerial photography and consistently recognised on the ground. Some communities, such as those that make up mosaics of kwongan and mallee, will be difficult to map at a fine scale or to be discerned from remote sensing and will have to be delineated at a broader scale.
    - With the use of GIS, communities can be mapped to quite a small size; for example, vegetation of the reserves of the south coast have been mapped to 25m x 25m (Sandiford & Barrett 2010). Remote sensing may assist in defining boundaries.
    - The community should be defined at the appropriate resolution for incorporation into a statewide vegetation map. In the South West, this is probably a scale of 1:50,000. This may not be a necessary requirement with the current flexibility of GIS.
    - Small patches of unusual vegetation may be listed as Threatened Ecological Communities.
    - Future vegetation maps may be models based on classified structural and dominant floristic data.

For the development of benchmarks, the community definitions need to be in a statewide context and this has been taken into account in the development in this pilot study.

Systems developed in other Australian states were examined. Plant communities in Tasmania are characterised by floristics and structural features that are more or less consistent across each community's range (Harris & Kitchener 2005). They form the TASVEG statewide vegetation map on which benchmarks for the assessment of vegetation condition are based (Neldner *et al.* 2005; Michaels 2006)

In Victoria the units of vegetation classification on which benchmark descriptions are based are the Victorian Ecological Vegetation Classes (EVCs). These are defined by a combination of floristics, growth form and reproductive strategy profiles, position in the landscape, and an inferred fidelity to particular environments There are about 300 EVCs that have been mapped or modelled at either the 1:100,000 or 1:250,000 scale. They are defined as 'consisting of one or a number of floristic communities that appear to be associated with a recognisable environmental niche, and which can be characterised by a number of their adaptive responses to ecological processes that operate at the landscape scale level.'

In Queensland the vegetation is mapped as Regional Ecosystems which comprise vegetation that is consistently associated with a particular combination of geology, landform and soil (Neldner *et al.* 2005).

In WA 820 vegetation associations were mapped by Beard at 1:250,000 as the Pre-European extent; these were further subdivided by Beard's 'Systems' into 2,155 units (Hopkins *et al.* in press) These associations are (in the majority) largely based on structure and dominant species and are so broad that they do not account for the fine scale variation in the vegetation. For example, many of the woodland associations in the Wheatbelt are mapped as large units with up to six eucalypt species. These eucalypts do not all occur together but rather in patches, some together and other in mono-specific stands on localised specific soil types; for example, mallet on breakaways. At a finer scale, mapping developed by Muir (1977) is commonly used but no agglomerative process has been undertake to standardise unit descriptions across the Wheatbelt. The classification system of Muir has been matched with the NVIS system (ESCAVI 2003) and the system developed in Walker and Hopkins (1990) by B. Bayliss (pers. comm.) as part of the Avon Vegetation Mapping Project.

For this Project, eucalypt woodland communities were defined primarily by the dominant *Eucalyptus* species; sub-communities were defined by commonly observed structural formations (e.g. scrub, herbs), common co-dominant tree species, commonly occurring understorey genera (e.g. *Melaleuca*) or species (e.g. Jam, *Acacia acuminata*), landform features (e.g. on dunes or near salt lakes) or geographic distribution. The results of the classification are presented as a set of web-based factsheets that include, for each community, brief species identification notes, a description of its soils and landform, associated species, number of sites and polygons, a preliminary benchmark description (in the case of the mallets, a benchmark describes the community group, rather than the individual communities) and a list of some general reference sites; for each sub-community, a general structural and floristic description, average species richness, the number of sites and polygons, a map, a list of sites including a specific reference site (where available), and a photographic example of a site; and, for each specific reference site, a structural and floristic description, its location, project name(s), a species list and a photograph.

Data were not uniformly available from across the region and some communities were sampled more that others, for example WWF targeted four species: *Eucalyptus salmonophloia*, *E. salubris*, *E. loxophleba and E. longicornis*.

2.2 Limitations to classifying vegetation

The classification of vegetation is fraught with difficulties due to gradual changes across the landscape, within and between communities, due to climatic and soil gradients and the intricate 'marbling' (S. Prober pers. comm.) pattern in soils and topography in the South West. As communities intergrade, it becomes difficult to define and map them. The dynamic nature of species turnover across the landscape further complicates the matter (Brown 1989; Burgman 1988; Gibson *et al.* 2004; Muir 1977). Simply put, the short coming of the classification process is that plant communities don't fit neatly into boxes and there is inevitable overlap between them.

Within any one community there may be different 'states' due to time since fire, grazing pressure, nutrient enrichment, weed infestation, salinity, and hydrological changes, all of which influence floristic

composition and structure. A 'State in Transition' model, based on one developed in the rangelands by Westoby (1989), was developed to help understand the pressures and so better manage the Box Gum Grassy Woodlands across Queensland, New South Wales and Victoria (Rawlings *et al.* 2010). This model has also been applied in WA to the Salmon Gum (Yates & Hobbs 1997; Standish *et al.* 2009), York Gum (Prober *et al.* 2009) and, in a more general way, to Wandoo woodlands (Hussey 1999). The federal Department of Sustainability, Environment, Water, Population and Communities now recognises the significance of such 'states' and has incorporated this concept into their listing of the Box Gum Grassy Woodlands as a nationally Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act. Therefore, it is necessary to be aware of the fire and grazing history of a site so as not to confuse a difference between communities with different states of a community.

Ongoing taxonomic revisions such as French (2012) are an additional complicating factor in the classification of vegetation, especially for the structurally significant tree species. Recently, some tree eucalypt species, which have been observed to develop lignotubers and regenerate as mallees after fire or scrub-rolling, have been split into tree species and mallee species.

Although *E. loxophleba* is described as a tree and, rarely, a multi-stemmed mallee (Western Australian Herbarium 1998 -; Brooker & Kleinig 2001; French 2012), it is traditionally regarded as a low branching tree forming woodlands in the western Wheatbelt. The mallee form has been described as *E. loxophleba* subsp. *lissophloia.*

It may be difficult to reconcile defined ecological communities with what is seen on the ground (M. Hislop pers. comm.) and, conversely, it may be difficult to assign what is seen at a site to a community classification.

2.3 Data input

Following on from similar exercises in the eastern states e.g. Harris and Kitchener (2005), the woodland classification for this Project has been based on a synthesis of existing survey data, results of floristic analyses, available maps at appropriate scales and expert opinion.

The information used in the classification consists of:

- quadrat data from:
  - terrestrial and wetland vegetation surveys carried out as part of the Biodiversity Survey of the Western Australian Agricultural Zone by the Department of Environment and Conservation (DEC), from 1997 to 2001 funded by the Salinity Action Plan (SAP)
  - WWF Woodland Watch project surveys from 2000 to 2008, funded and organised though the WA Branch of the World Wildlife Fund (WWF)
  - selected surveys by Ted Griffin
  - surveys on reserves and private land for the DEC Wheatbelt Region
- data from the Biological Survey of the Eastern Goldfields of WA, carried out between 1977 and 1983
- descriptions of mapped vegetation polygons (available to 2009) extracted from a database of Avon Vegetation maps which is being compiled as part of the Baselining Project (available on NatureMap)
- a list of vegetation of the Wheatbelt, classified by Greg Keighery and based on his extensive knowledge of the area, field work (including the SAP survey) and familiarisation with many of the mapping projects carried out in the region (Appendix 1)
- advice from botanists Greg Keighery, Nathan McQuoid, Peter White, Mike Hislop, Anne Rick, Jenny Borger and Malcolm French, and naturalists Penny Hussey, Mick Davis and Mike Griffiths who have expert knowledge of the vegetation of the region
- other incidental information.

Vegetation survey data was extracted from 244 woodland sites from the SAP terrestrial survey (Gibson *et al.* 2004) and 76 wetland survey sites (Lyons *et al.* 2004) including the vegetation descriptions, site descriptions (landforms and soil), species lists and site photographs. Most of these sites were visited a number of times to capture all the annuals & geophytes. The site descriptions of

the vegetation, following the format developed by Muir (1977) specifically for the Wheatbelt, were presence-absence floristic data were also considered and descriptions of the relevant groups are listed in Appendix 2.

Eight of the 25 groups resulting from the SAP quadrat analysis, based on the presence or absence of species, were characterised by eucalypt tree species. Few were dominated by a single species of eucalypt tree such as *Eucalyptus astringens* subsp. *astringens* (G19) or occasional *E. salmonophloia* over mallee (G6). Instead, most woodland groups were dominated by more than one species, for example *E. salmonophloia* and *E. salubris* (G24); *E. loxophleba* and *E. wandoo (G12); E. salmonophloia, E. longicornis, E. occidentalis* or *E. astringens* (G5); and *E. longicornis, E. kondininensis* or *E. salmonophloia* (G4). For descriptions of these groups see Appendix 2; this presents the similarities between communities based on presence and absence of species. An analysis incorporating the dominance or cover values may produce different results.

Similarly, the assemblages generated by the SAP analysis, based on bioregional and subregional location and with a weighting against species richness to look at phytogeographic patterns within the study area, include some with several canopy species, for example, *Eucalyptus loxophleba* and *E. capillosa* (A1); *E. salmonophloia, E. longicornis, E. yilgarnensis* and *E. salubris* (A3); and *E. spathulata* and *E. kondininensis* (A6 - salt lake). Associations with only one typical eucalypt tree included *E. wandoo* (A13), *E. accedens* (A17), *E. occidentalis* (A12) and *E. astringens* subsp. *astringens* (A5). For descriptions of these groups see Appendix 2.

Data were used from most of the sites used by Griffin (2008) in his analysis of woodland floristic data for the Species and Communities Branch of DEC. His classification was based on 606 sites with typical Wheatbelt tree species, including *E. salmonophloia*, *E. loxophleba*, *E. wandoo*, etc., and involved analysing the woody vegetation species present using the PATN program. These sites were selected from the SAP dataset (336 sites) (Gibson *et al.* 2004; Lyons *et al.* 2004); Griffin's floristic survey of the Northern Sandplains (69 sites) (Griffin 1994); WWF Woodland Watch project surveys (186 sites to 2006) (WWF 2001-2008); and Lake Bryde survey (15 sites). A dendrogram produced a hierarchy of sites divided into 25, 50, 100 or 200 groups; these were related to the Wheatbelt vegetation types table of compiled by Keighery (Appendix 1). Most of the woodland classification groups identified from Griffin's PATN analysis (Appendix 3) were considered when forming the current classification (there are some mallee and shrublands which are not included). Griffin's (2008) Appendix 7, listing the species common to each group, was also incorporated into the descriptions of the current classification. Griffin compared the results of his 25, 50 and 100 groupings to Keighery's table (Appendix 1).

WWF Woodland Watch (2001-2008) project surveys focused on four targeted species (*E. longicornis, E. salmonophloia, E. salubris* and *E. loxophleba*), mainly on private land or in shire reserves. Other woodlands were sampled and included in the current classification, but sites of other woodlands (e.g. banksia and casuarina woodland), and mallee (e.g. *E. loxophleba* subsp. *lissophloia*), were removed. Sites were generally in very good condition but were only visited once. Annual project reports, site distribution maps and site species lists are available through the Western Australian Herbarium's *FloraBase* website http://*FloraBase*.dec.wa.gov.au/wwatch/. A total of 196 sites, including 38 sites surveyed in 2007 and 2008, were used in the current classification. The latter sites were manually assigned to sub-communities derived from the classification produced by Griffin (2008) and from the available species lists, vegetation descriptions and site photographs.

Descriptions from 270 sites, and species lists from 232 of these sites, were extracted from the Wheatbelt Reserves Database (WbDb). This dataset was supplied by Brett Beecham (DEC Wheatbelt Region, Narrogin) and was designed by Ecoscape (Australia) Pty Ltd for DEC using methods based on Safstrom (1995). The Database was set up to help manage data relevant to assessing the nature conservation values of native vegetation remnants in the context of other land management and social values. It contains data from 896 sites collected during various surveys carried out by DEC staff from Merredin, Narrogin and Katanning and consultants between 2000 and 2005. Site identification prefixes include KS (Kent Shire); LB, LG, MD005, MM, ND, PEG, RLB (Lake Bryde recovery catchment); RTR (Tarin Rock area); TL33 (east of Kondinin and west of Lake Grace); and M (Lake Magenta).

Fifteen woodland and open woodland sites were used from the survey of the Boorabbin-Southern Cross area (Newbey *et al.* 1995) and the Hyden-Lake Johnson area (Newbey & Hnatiuk 1988). This was a regional biological survey by the Biological Surveys Committee involving WA Museum, Fisheries & Wildlife (later CALM and now DEC), WA Herbarium and National Parks Authority between 1977 and 1983. These sites were included in this project to give an indication of the woodland

communities that extend into the Goldfields woodlands (now know as the Great Western Woodlands, GWW). It was decided not to investigate other surveys in the GWW such as the surveys of the eastern Golfields ranges co-ordinated by Gibson (e.g.Gibson & Lyons 1998) and to concentrate on the cleared agricultural area

Three hundred and thirty-eight vegetation descriptions attributed to polygons were extracted from the Avon Vegetation Mapping database (data to November 2009). Some of these included additional environmental descriptions (e.g. soil, topography, disturbance level). This dataset, prepared by Ben Bayliss for the Wheatbelt Baselining Project, is confined to the cleared Wheatbelt NRM region and consists of many reserve and non-reserve vegetation maps prepared by a range of people and organisations between 1978 and 1996. These maps are available through the NatureMap website.

Other incidental information used:

- 24 sites surveyed by Judith Harvey in 2009 and 2010. These were largely based on reference sites nominated by Nathan McQuoid, Penny Hussey and Greg Keighery. Additional condition data were also collected during revisits to several SAP sites.
- *FloraBase* species' distribution maps and descriptions were consulted; however, individual specimen collection data were not examined.
- survey work by Denise True, performed as part of a review of grassy woodlands in the WA Wheatbelt (Mattiske 1995). The sites were not incorporated into the current classification as the data were not available. Four eucalypt woodlands groups were identified:
  - York Gum (*Eucalyptus loxophleba* subsp. *loxophleba*) – Jam (*Acacia acuminata*) low woodlands over tall shrubs/low trees over closed grasses and herbs (3 sites)
  - York Gum mallee (*E. loxophleba* subsp. *lissophloia*) over open tall shrubs/low trees over tall grasses (1 site)
  - Wandoo (*E. wandoo*) woodlands over tall open shrubs over closed grasses and herbs (4 sites)
  - mixed eucalypt woodland over tall open shrubs/low trees over grasses and herbs (1 site).

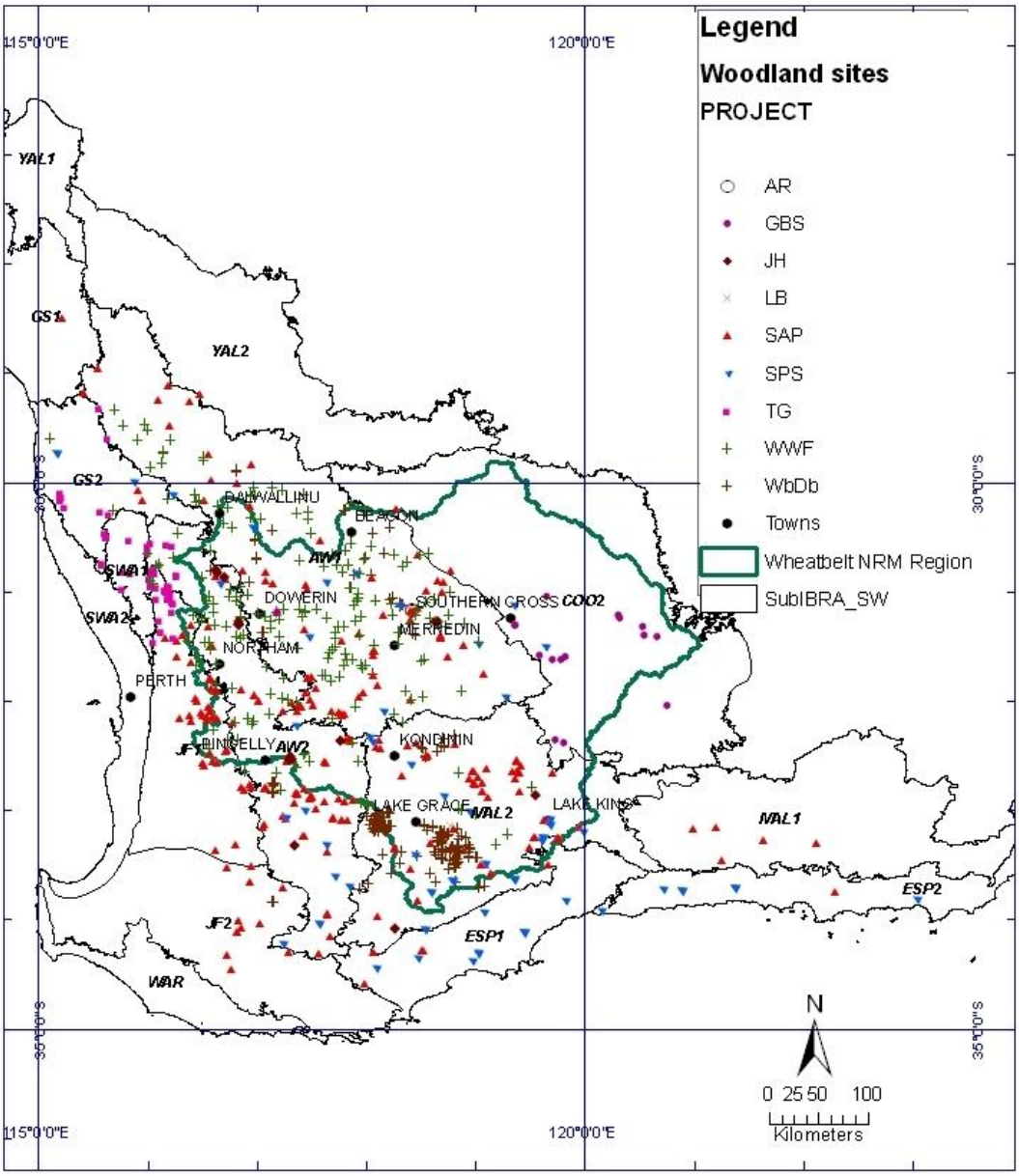
Included are SAP, WWF and Griffin sites located outside the Avon River Basin, so as to indicate the extent of the communities and sub-communities and thereby ascertain which are confined to the Wheatbelt NRM region. The distribution of some species, such as *Eucalytus salmonophloia, E. salubris* and *E. longicornis,* extend well out of the Wheatbelt into the Great Western Woodlands (GWW) as is indicated by FloraBase.

A total of 889 sites and 338 polygon descriptions, from 9 surveys or groups of surveys (**Table 2**), were used in this Project classification.

Table 2 Summary of projects and number of sites and polygons used in this woodland classification.

Code	Project/Survey	Number
AVM	Avon Vegetation Mapping	338 (polygons)
WbDb	Wheatbelt Reserves Database	270
SAP	Salinity Action Plan - terrestrial	248
WWF	World Wildlife Fund Woodland Watch	196
SPS	Salinity Action Plan - wetlands	76
TG	Ted Griffin	67
JH	Judith Harvey	24
GBS	Goldfields Biological Survey	15
Total		1,227

The distribution of sites by survey or project source is shown in **Figure 4**. See **Table 2** for definition of Project codes and the introduction for definition of IBRA codes. The locations of the Avon Vegetation Mapping polygons are not shown on the map and may be viewed through NatureMap.



Map prepared by Judith Harvey
Science Division
Department of Envionment and Conservation
March 2011

Figure 4 Location of sites used in the classification of eucalypt woodlands of the Wheatbelt.

Site locations (realising possible inaccuracies) were overlayed over various spatial layers in the GIS to provide additional information on:

- proximity to granite rocks and salt lakes (Wheatbelt Wetland layer produced in a sister project for Wheatbelt Baselining)
- landscape context and vegetation patterns from digital Orthophoto mosaics
- IBRA bioregions.

2.4 Limitations of the data

There were many limitations of the data, some of which are listed below:

- Data are biased by the survey coverage and purpose: SAP is representative, WWF focused on four main species, and there is a concentration of sites in areas such as the Lake Bryde catchment.
- Descriptions that were incomplete, or did not follow a standard or consistent schema such as Muir (1977) or NVIS (ESCAVI 2003), were difficult to compare. For example, only truncated vegetation descriptions were available for 202 records (RLB, RTR and TL33 quadrats) from the Wheatbelt Reserves Database but these did have structural descriptions and lists of dominant woody species so more complete vegetation descriptions were reconstructed to some extent. Some of the vegetation mapping descriptions were comprehensive, for example NVIS level 6 (ESCAVI 2003).
- WWF Woodland Watch project quadrats may have been placed on sites of maximum species diversity, more representative of an ecotone rather that of a homogeneous community. There were also a few inconsistencies between site descriptions and species lists which were based on specimens lodged in the Perth Herbarium; for example, if the common eucalypt stated in the vegetation description was not vouchered, it did not appear on the species list. Checking the original data sheets usually resolved this.
- Not all the sites were in very good to excellent condition (Keighery 1994) as indicated by the number and type of weeds in available species lists. Several sites were eliminated when the species list was poor and contained many weeds and/or when there was photographic evidence of poor condition.
- Within the Wheatbelt Reserves Database there is a concentration of sites in the Wheatbelt recovery catchment areas, e.g. Lake Bryde, and this biases the number of sites in certain sub-communities and IBRA subregions.
- SAP and Wheatbelt Reserves Database site locations (georeferences) were not accurate; for example, some SAP sites appeared in paddocks when viewed in the GIS data overlay.
- More than one polygon description from the Avon Mapping database may be assigned to a single polygon to account for the occurrence of subtle variations in the vegetation.
- Soil descriptions were not consistent.
- Environmental descriptions and site photographs were not available for all sites.
- Recent taxonomic work based on improved understanding of ecology and genetics has resulted in splitting of several species into new species based on floristic characteristics or lifeform. For example mallet forms of *E. falcata* (Silver mallee) are *E. argyphea*, *E. recta, E. ornata* and *E. rugluata (Nicolle 2005).* Earlier works referred to a species as a mallet or mallee or as subspecies and now they recognised as new species (Nicolle 2006). Other information has been compiled from various sources (Western Australian Herbarium 1998 -; Nicolle & Conran 1999; Nicolle 2005; Centre for Plant Biodiversity Research 2006) and P. White pers. comm.). When data was recorded .subspecies were not always indicated for a species and, when the subspecies was not stated in the vegetation description, it was difficult to allocate the site to the appropriate community; for example, *E. loxophleba* may be a mallee (*E. loxophleba* subsp. *lissophloia)* or a tree (*E. loxophleba* subsp. *loxophleba*). Eucalypt taxonomy is under constant revision. An up-to-date explanation is presented in French (2012)

Table 3 Taxonomy recognizing the tree and mallee forms of some eucalypts in the Wheatbelt.

Tree/Mallet	Mallee
Eucalyptus argyphea	*Eucalyptus falcata*
Eucalyptus recta	*Eucalyptus falcata*
Eucalyptus ornata	*Eucalyptus falcata*
Eucalyptus rugulata	*Eucalyptus falcata*
Eucalyptus urna	*Eucalyptus flocktoniae* subsp. *flocktoniae*
Eucalyptus loxophleba subsp. *loxophleba*	*Eucalyptus loxophleba* subsp. *lissophloia*
Eucalyptus transcontinentalis	*Eucalyptus neutra*
Eucalyptus gardneri subsp. *gardneri*	*Eucalpytus pluricaulis*
Eucalyptus densa subsp. *densa*	*Eucalyptus densa* subsp. *improcera*
Eucalyptus sargentii subsp. *sargentii*	*Eucalyptus* subsp *onesia*
Eucalyptus occidentalis	*Eucalyptus sporadica*
Eucalyptus astringens	*Eucalyptus thamnoides*
Eucalyptus extensa	*Eucalyptus annulata*
Eucalyptus singularis	*Eucalyptus incrassata*
Eucalyptus spathulata	*Eucalyptus vegrandis*
Eucalyptus spathulata	*Eucalyptus orthostemon*
Eucalyptus prolixa	*Eucalyptus calycogona*

2.5 Methods summary

The data and available information were compiled into site-based spreadsheets, a spreadsheet containing sites' species lists, and into ArcGIS. The site-based spreadsheet included the locations, vegetation descriptions, 25, 50 and 100 group categories produced by Griffin (where available), soil and condition information, and links to photographs (where available).

The sites were initially allocated to a community, based on the dominant eucalypt species; then the sub-communities were developed, based on the groupings, vegetation descriptions, Keighery's list of Wheatbelt vegetation units, photographs and discussions with experts. Each site was only allocated to one sub-community. In some cases, they may also fall within the description of another. Where there was another eucalypt present, this took precedence over whether it was over scrub, heath or herbs. If the next dominant eucalypt species was not common and not recognised by the experts as signfiicant, the code reflected the understorey structure. For example, *Eucalyptus wandoo, E. astringens, Allocasuarina huegeliana* low woodland A over open *Polianthion wichurae* moderately dense shrubs may be assigned to Ewanast (*E. wandoo*/*E. astringens*), EwanSheoak or EwanScrub. The photograph and data sheet indicate very low cover of *E. astringens*, and greater cover of shrubs (especially *Allocasuarina campestris* as mentioned on the data sheet). The resulting classification was EwanSheoak.

To assist with sorting and map display, each community and sub-community was assigned a code which incorporated the dominant eucalypt and the associated eucalypt or understorey; for example, EastScrub represents *Eucalyptus astringens* over scrub, and Esalmwan represents *E. salmonophloia* and *E. wandoo*.

The lists of main associated species were created by the use of:

- a matrix of communities/sub-communities (columns) and species (rows), with each column selectively sorted in descending order
- a species count through word searches of site and polygon vegetation descriptions
- other information where available, e.g. plant communities on the gypsum report (Rick 2011)

- advice from with experts including Peter White, Greg Keighery, Mike Griffiths and Anne Rick
- site photographs to get an idea of dominance and general mix of species.

2.6 Limitations of the classification

This is not a finite classification and can be refined in the future as more data and knowledge develops.

- Sites and mapped polygon descriptions could be allocated to two or more sub-communities and photographs were a useful supplementary input into the decision process. There are sometimes two eucalypts which may vary in dominance and thus form two sub-communities e.g. Salmon Gum and Gimlet, and Gimlet and Salmon Gum. To avoid this sort of repetition, they have been assigned to Salmon Gum and Gimlet, based on the taller species or, in other cases, based on the more common combination.
- Some of the Wheatbelt eucalypts occur in mixture of more that two species see mosaics in Appendix 1 but it was decided to limit this classification to only two dominants rather that have a variable sub-community of various mixtures of species but this classification only considers t
- For the Avon Vegetation Mapping database, the vegetation descriptions reflected a mapped interpretation rather than an explicit set of site point data. Sometimes several descriptions were interpreted for a single polygon. An attempt was made to select only one description for each polygon.
- There is generally such a high species turnover that it is not possible to clearly define characteristic species and the species listed are only a small sample of species that may be found in the community. In general, species names have not been updated from when the surveys were done.
- Complete environmental and condition data were not always available to clearly allocate sites to sub-communities. Further data collected in the future will help clarify the condition.
- Variation occurs within sub-communities, for example Sub- communities with a Melaleuca understory may occur on a variety of soils and on a range of landforms reflected in the preferences of the individual Melaleuca sp
- There were not enough sites to adequately describe some sub-communities or to clearly define sub-communities. This is a preliminary classification to highlight areas and species needing further survey.
- Identifying these communities in the field may be challenging and several sub- communities may appear present in one small remnant.

3. RESULTS

Twenty-nine species of eucalypt that form trees were considered in this Project (**Table 4**).

Table 4 The dominant eucalypt species considered in this Project.

Eucalypt Species
Eucalyptus accedens (Powderbark Wandoo)
Eucalyptus alipes (Mallet)
Eucalyptus argyphea (Silver Mallet)
Eucalyptus astringens (Brown Mallet)
Eucalyptus capillosa (Wheatbelt Wandoo)
Eucalyptus densa (Mallet)
Eucalyptus extensa (Mallet)
Eucalyptus gardneri (Blue Mallet)
Eucalyptus kondininensis (Kondinin Blackbutt)
Eucalyptus longicornis (Red Morrel)
Eucalyptus loxophleba (York Gum)
Eucalyptus marginata (Jarrah)
Eucalyptus melanoxylon (Black Morrel)
Eucalyptus moderata (Redwood)
Eucalyptus myriadena (Blackbutt)
Eucalyptus occidentalis (Flat-topped Yate)
Eucalyptus ornata (Ornate Mallet)
Eucalyptus polita (Mallet)
Eucalyptus recta (Cadoux Mallet)
Eucalyptus rudis (Flooded Gum)
Eucalyptus salicola (Salt Salmon Gum)
Eucalyptus salmonophloia (Salmon Gum)
Eucalyptus salubris (Gimlet)
Eucalyptus sargentii (Salt River Gum)
Eucalyptus singularis (Mallet)
Eucalyptus spathulata (Swamp Mallet)
Eucalyptus urna (Merrit)
Eucalyptus wandoo (Wandoo)
Eucalyptus yilgarnensis (Yorrell)

A total of 62 sub-communities were classified based on common occurrences and previous recognition through floristic analysis and expert opinion. The number of common sub-communities is influenced by the focus of some of the surveys. For example, the WWF Woodland Watch project survey targeted four species (*E. longicornis, E. salmonophloia, E. salubris* and *E. loxophleba*), and the DEC wheatbelt database had a large concentration of sites in the Lake Bryde area (**Figure 4**).

Sub-communities are defined either in terms of the co-dominant tree species, e.g. Salmon Gum and Gimlet (18 sub-communities); understorey growth-form, e.g. Scrub or Herbs (22); dominant understorey family, e.g. Chenopods (3); dominant understorey genus, e.g. *Melaleuca* (8); dominant understorey species, e.g. Jam (*Acacia acuminata*) (1); landform features, e.g. Dune (6); or geographic distribution, e.g. northern Wheatbelt (4). Growth forms e.g. Heath, Scrub and Herbs follow definitions by Muir (1977).

Table 5 presents the classification and lists, for each community (in grey shading) and sub-community, the code, associated species, landform, soil, IBRA bioregion, number of sites and polygons, and distribution (of the dominant species) in relation to the Wheatbelt NRM region. Most of this information is captured in the set of 155 web-based factsheets on NatureMap. There are some differences in the groupings between **Table 5** and the factsheets; for example, *E. occidentalis* groups have been simplified on the factsheets. Also, some of the descriptions on the factsheets include supplementary information obtained as the factsheets were developed. The fields in **Table 5** are explained below.

Codes for each community or sub-community were derived for this Project to assist with sorting, analysis and GIS display. Examples include: EwanHeath for the *Eucalyptus wandoo* over heath community; Eloxwan for the *E. loxophleba* and *E. wandoo* sub-community.

Main associated species were derived from several sources (as outlined in the methods summary above).

Landform information was compiled from available descriptions, existing GIS spatial data such as contours, wetlands, granite rocks and orthophoto images, as well as information compiled from herbarium specimens (Western Australian Herbarium 1998 -). There may be a range of topographic positions for sites within a community.

Soil descriptions were available for most sites but the notation was inconsistent. There are often a range of soil descriptions for the sites within a community. The final soil description for each community also includes information from *FloraBase.*

Distribution of communities and sub-communities within **IBRA** subregions were calculated from the intersection of all sites with the subregion GIS layers. IBRA subregions are listed in order of decreasing abundance of community and sub-community sites located within the subregions. Where a sub-community is listed to occur in any of the IBRA subregions AW1, AW2 and MAL2 it does not follow that it is restricted to these subregions as further sampling may extend the

Distribution of *Eucalyptus* species, obtained from *FloraBase,* was used to assess their distribution in relation to the **Wheatbelt NRM** region.

Table 5 The classification of eucalypt woodlands in the Wheatbelt.

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
Eucalyptus longicornis (Red Morrel)	Elon	*Sclerolaena diacantha, Lycium australe, Maireana trichoptera, Rhagodia drummondii.*	valley floor	dark red loams	AW1, MAL2, AW2, COO2	Extends well to the E	46	12
Red Morrel over Melaleuca	ElonMel	*Melaleuca teuthidoides, M. lanceolata, M. pauperiflora, Olearia muelleri, Atriplex vesicaria* and other chenopods & occasional mallee.	mid to lower slopes	calcareous loamy earth, clay loam, loamy sand	AW1, MAL2, AW2, COO2		20	4
Red Morrel and Gimlet	Elonsalu	*Eucalyptus salubris, Melaleuca lanceolata, M. adnata.*	mid slope of undulating plain	loam & sandy clay	AW1, MAL2		2	8
Red Morrel over Chenopods	ElonChen	*Atriplex vesicaria, A paludosa, Rhagodia drummondii, Eucalyptus myriadena.*	valley flats	loam	AW1, AW2		5	
Red Morrel on Dunes	ElonDune	*Callitris tuberculata (gypsum), Atriplex paludosa, Scaevola spinescens.*	dune	gypsum, clayey sand	AW1, MAL2		2	
Red Morrel and Wandoo	Elonwan	*Eucalyptus wandoo, Acacia acuminata, Gastrolobium* spp., *Olearia dampieri* subsp. *eremicola* or herbs and grasses.	mid to upper slopes	deep grey sandy duplex	AW2		3	
Red Morrel and Black Morrel	Elonmelx	*Eucalyptus melanoxylon, Atriplex vesicaria, A. acutibractea, Olearia muelleri, Eremophila decipiens.*	lower slope, lake edge	clay loam	AW1, MAL2		3	
Red Morrel and York Gum	Elonlox	*Eucalyptus loxophleba, Acacia acuminata* over *Austrostipa hemipogon* or *Desmocladus asper.*	upper slope valley or near granite	loamy sand	AW2		2	
Red Morrel over Mallee	ElonMallee	*Eucalyptus phenax, E. yilgarnensis, E. myriadena* over *Melaleuca acuminata,*	upper slope,	laterite, sandy	MAL2, AW1,		4	

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
		Acacia colletioides, A. erinacea.	lower slope	loam & clay	AW2			
Red Morrel over Scrub	ElonScrub	Dwarf scrub of mixed *Melaleuca uncinata* group*, Acacia erinacea, Eremophila ionantha* and sedges.	mid slope	loam & sandy clay	MAL2, AW1, COO2		4	
Red Morrel and Brown Mallet	Elonast	*Eucalyptus astringens, E. wandoo* over little understorey.	upper slope	loamy sand	AW2		1	
Eucalyptus salmonophloia (Salmon Gum)	Esalm	*Acacia erinacea, Sclerolaena diacantha, Olearia muelleri, Rhagodia drummondii.*	plains & low hills; upper slopes (west) & broad valleys (east)	red clay loam or clay, red sand, often with gravel; granitic soils (west) & calcareous & red loams (east)	AW1, AW2, MAL2, JF1, COO2, SWA1	Extends well to the E	227	129
Salmon Gum over Scrub	EsalmScrub	Mixed understorey often with *Acacia erinacea, Olearia muelleri, Scaevola spinescens, Acacia hemiteles, Templetonia sulcata, Eremophila* spp.*, Pittosporum angustifolium,* occasional *E. loxophleba, E. salubris.* Ground layer includes *Lepidosperma, Lomandra effusa, Austrostipa elegantissima.*	upper slope	sandy clay, loam	AW1, MAL2, AW2, COO2, SWA1, JF1		45	17
Salmon Gum over Chenopod Scrub	EsalmChen	*Rhagodia preissii, R. drummondii, Sclerolaena dicantha, Atriplex paludosa, A stipitata, Enchylaena tomentosa, Maireana* spp.	lower slopes	brown loam	AW1, AW2, MAL2, ESP1		6	4
Salmon Gum and Wandoo	Esalmwan	*Eucalyptus wandoo,* occasional *E. loxophleba Allocasuarina campestris, Acacia acuminata, A. erinacea, Gastrolobium parviflorum,* mallee *E.*	lower, mid & upper slopes	sandy clay, loam	AW2, AW1, JF1, MAL2		23	16

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
		sheathiana over *Borya* spp., *Lomandra effusa, Desmocladus* spp., *Austrostipa* spp., *Neurachne* spp.						
Salmon Gum and Gimlet	Esalmsalu	*Eucalyptus salubris,* over acacia and or melaleuca scrub, chenopods, mallee or herbs. *Santalum acuminatum, Acacia erinacea, Acacia merrallii, Exocarpos aphyllus, Melaleuca adnata, M. pauperiflora, Olearia muelleri, Rhagodia preissii.* Other eucalypts include *E. loxophleba, E. longicornis, E. capillosa.*	upper slope	loam	AW1, AW2 MAL2		33	44
Salmon Gum and York Gum	Esalmlox	*Eucalyptus loxophleba* subsp. *loxophleba, Acacia acuminata, Acacia erinacea, Rhagodia preissii, R. drummondii, Olearia muelleri, Melaleuca uncinata* group, *M adnata, Acacia hemiteles, Templetonia sulcata.* Mallees *E. erythronema. Occasional E. wandoo, E. salubris.*	lower slopes	loam near granite in the west	AW2, AW1, SWA1		16	33
Salmon Gum over Melaleuca	EsalmMel	*Melaleuca acuminata, M. uncinata* group, *M. adnata, M. lateriflora, Templetonia sulcata, Olearia muelleri, Acacia erinacea, Santalum acuminatum.*	upper mid & lower slopes	loamy sand, sandy clay, clay	MAL2, AW1, JF1		32	1
Salmon Gum and Red Morrel	Esalmlon	*Eucalyptus longicornis, Rhagodia preissii, Santalum acuminatum, Templetonia sulcata, Acacia erinacea, Olearia muelleri, Grevillea huegelii.*	mid to upper slopes	clay loam, sandy clay	AW1, MAL2, AW2, JF1, COO2		16	2
Salmon Gum over Mallee	EsalmMallee	*Eucalyptus eremophila, E. sheathiana, E. calycogona, E. phenax, E. loxophleba* subsp. *lissophloia, E. celastroides, E. yilgarnensis, Olearia muelleri, Acacia erinacea.*	mid slopes	sand, loamy sand	MAL2, AW1, AW2		38	4

Community or Sub-community	**Code**	**Main Associated Species**	**Landform**	**Soil**	**IBRA**	**Wheatbelt NRM**	**No. Sites**	**No. Polygons**
Salmon Gum and Wheatbelt Wandoo	Esalmcap	*Eucalyptus capillaris, E. loxophleba, E. salubris, Acacia acuminata, Santalum acuminata and S. spicatum, Melaleuca uncinata* group .*Acacia hemiteles, Olearia muelleri.*	upper slopes	sandy gravel, sandy loam	AW1, AW2		10	8
Salmon Gum on Dunes	EsalmDune	*Eucalyptus kondininensis, E. myriadena, Atriplex vesicaria, Acacia microbotrya, A. erinacea, Olearia dampieri Templetonia sulcata, Austrostipa elegantissima.*	around salt lakes	sand	MAL2, AW1, AW2, ESP1		6	
Salmon Gum and Merrit	Esalmurn	*Eucalyptus urna, E. phenax, Melaleuca adnata, M. lateriflora.*	lower slope	loam	MAL2		2	
Eucalyptus salubris (Gimlet)	Esalu	*Acacia erinacea, Sclerolaena diacantha, Enchylaena lanata.*	undulating plains, slopes	red clay loam or loam, yellow or red sand, laterite	AW1, MAL2, COO2, AW2	Extends to the E	65	36
Gimlet over Melaleuca	EsaluMel	*Melaleuca pauperiflora, M. lateriflora, M. acuminata, M. adnata, M. cucullata.*	variable	variable including gilgais	AW1, MAL2		25	6
Gimlet over Scrub	EsaluScrub	*Olearia muelleri, Acacia erinacea, A. merrallii, A. mackeyana, A. colletioides, Santalum acuminatum, Eremophila oppositifolia, Exocarpos aphyllus, Rhagodia drummondii, Melaleuca pauperiflora.*	mid to upper slopes	loams	AW1, MAL2, COO2		28	19
Gimlet over Mallee	EsaluMallee	*Eucalyptus celastroides, E. erythronema, E. yilgarnensis, E. sheathiana, Melaleuca pauperiflora, M. lateriflora, M. uncinata.*	upper slopes	brown loam/clay	AW1, MAL2		10	4
Gimlet and York Gum	Esalulox	*Eucalyptus loxophleba* subsp. *loxophleba, & Acacia acuminata, A. hemiteles,*	lower slopes	silty/clay loam	AW1		1	7

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
		Exocarpos aphylla, Olearia muelleri scrub & various mallees.						
Gimlet on Dunes	EsaluDune	*Casuarina obesa (*dominant) *Hakea preissii, Grevillea acuaria.*	dune adj. to degraded salne wetland	gypsum	AW1		1	
Eucalyptus loxophleba (York Gum)	Elox	*Acacia acuminata, Allocasuarina huegeliana*, herbs and grasses.	around granite & on lower slopes	loam, rocky loam, clay loam, sand	AW1, AW2, MAL2, GS2, JF1, SWA1, GS1	Extends to NW and SW	137	75
York Gum and Jam over Herbs	EloxJamHerbs	*Acacia acuminata, Neurachne alopecuroidea, Podolepis lessonii, Austrostipa elegantissima, Trachymene cyanopetala, T. ornata, Goodenia berardiana, Velleia cycnopotamica, Actinobole uliginosum, Parentucellia latifolia, Crassula colorata, Lawrencella rosea, Waitzia acuminata* var. *acuminata, Borya sphaerocephala.* May include rare emergent *E. salmonophloia* and *Allocasuarina huegeliana.*	lower to mid slopes often near granite	brown (sandy) loam over granite	AW2, AW1, MAL2, JF1		48	26
York Gum and Jam over Scrub and Herbs	EloxJamScrubHerbs	*Acacia acuminata, Allocasuarina huegeliana, Acacia acuaria, A. hemiteles, Enchylaena tomentosa, Scaevola spinescens, Podolepis lessonii, Austrostipa elegantissima, Neurachne alopecuroidea, Borya nitida, Waitzia acuminata.*	mid to upper slopes	brown (sandy) loam over granite	AW2, AW1, GS2, GS1, MAL2, JF1		22	12
York Gum and Jam over Scrub	EloxJamScrub	*Acacia acuminata, A. micorbotrya, Scaevola spinescens.*	mid slope	loam	AW1, JF1		2	2

Community or Sub-community	**Code**	**Main Associated Species**	**Landform**	**Soil**	**IBRA**	**Wheatbelt NRM**	**No. Sites**	**No. Polygons**
York Gum over Scrub and Herbs	EloxScrubHerbs	*Acacia hemiteles, A. lineolata, A. erinacea, A. microbotrya, Hakea lissocarpha, Podolepis lessonii, Austrostipa elegantissima, Neurachne alopecuroidea.*	often around granites	loam	AW1, SWA1, AW2, MAL2, GS2, JF1, YAL2		14	9
York Gum over Melaleuca	EloxMel	*Melaleuca lateriflora, M. uncinata* group, *M. acuminata, M. radula, M. atroviridis M. adnata, Allocasuarina acutivalvis.*	near fresh water lake	clay	MAL2, GS2		4	13
York Gum in Saline Areas	EloxSaline	*Enchylaena tomentosa, Rhagodia drummondii, Comesperma integerrimum, Olearia dampieri, Halosarcia lepidosperma.*	lower slopes	alluvial	AW1, AW2, MAL2, GS2		15	
York Gum on Dunes	EloxDune	*Acacia acuminata, Senecio glossanthus, Calandrinia calyptrata, Goodenia berardiana, *Mesembryanthemum nodiflorum.*	lower slope	sand	AW1, AW2		2	
York Gum and Sheoak	EloxSheoak	*Allocasuarina huegeliana, A, campestris, Acacia acuminata, Austrostipa nitida, Calandrinia calyptrata.*	near granite	brown (sandy) loam over granite	AW2, AW1		3	3
York Gum North (*Eucalyptus loxophleba* subsp. *supralaevis*)	EloxN	*Acacia acuminata, Scaevola spinescens, Rhagodia drummondii,* scattered dwarf scrub. Rich in herbs (Asteraceae family).	mid to lower slopes	brown sandy loams	AW1, AW2, GS2		28	
Eucalyptus wandoo (Wandoo)	Ewan	*Hakea lissocarpha, Hibbertia commutata, Bossiaea eriocarpa.*	undulating terrain	sandy, often gravelly soils over laterite or granite	JF1, AW2, JF2, MAL2, GS2, SWA1, SWA2,	mostly to the W and SW	122	55

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
					ESP1			
Wandoo over Heath	EwanHeathW EwanHeathN EwanHeathS	*Acacia pulchella, Allocasuarina huegeliana, A. campestris, A. humilis, Corymbia calophylla, Hakea lissocarpha, H. prostrata, H. varia, Hypocalymma angustifolium, Meeboldina coangustata, Melaleuca coronicarpa, Petrophile squamata, Santalum acuminatum, Trymalium ledifolium, Xanthorrhoea drummondii.*	flats & mid slopes	laterite & sands	JF1, AW2, JF2, ESP1		47	7
Wandoo over Herbs	EwanHerbs	*Borya sphaerocephala, Desmocladus* spp., *Lomandra* spp., *Austrostipa* spp., *Austrodanthonia* spp., *Neurachne alopecuroides, Gahnia* sp., *Dampiera* spp. *and Corymbosa* sp. Scattered shrubs including *Hakea lissocarpha.*	winter wet drainage flats	clay loams	JF1, AW2, AW1, MAL2		12	9
Wandoo over Scrub	EwanScrub	Mixtures of *Acacia acuminata, A. lasiocalyx, A. erinacea, Allocasuarina campestris, Gastrolobium parviflorum, Calothamnus quadrifidus, Melaleuca uncinata* group. *Borya* spp., *Loxocarya* spp.	lower slopes, often poorly drained	sandy clay	AW2, JF1		5	14
Wandoo and Sheoak	EwanSheoak	*Allocasuarina huegeliana, Gastrolobium parviflorum, Calothamnus quadrifidus, Acacia acuminata, [A. lasiocarpa, Dryandra sessilis, Hakea lissocarpha, H. petiolaris, Dampiera lindleyi, D. juncea, Borya sphaerocephala, Lepidosperma viscidum, L. resinosum, Melaleuca resinosum, Eucalyptus salmonophloia, E. astringens].*	mid slopes often near granite	deep sandy duplex, yellow brown sand, light brown sandy clay	AW2, JF1, JF2		15	5
Wandoo over Tammar	EwanTammar	*Allocasuarina campestris Lepidosperma* sp., *Melaleuca uncinata.*	low lying poorly drained	brown sandy loam, grey clay loam	MAL2		2	9

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
Wandoo over Melaleuca	EwanMel	*Melaleuca uncinata* group*, M. coronicarpa, M. acuminata, Gastrolobium trilobum. Allocasuarina microstachya, Dampiera lindleyi.*	upper slope		AW2, MAL2		4	
Wandoo and Jam	EwanJam	*Acacia acuminata,* scattered *Hakea lissocarpha, Loxocarya* spp.*, Lepidosperma* spp.*, Harperia* sp.*, Neurachne* sp.	lower slopes	deep sands	JF1, AW2		4	1
Wandoo and Mallee	EwanMallee	Mallee *Eucalyptus sheathiana, E. leptopoda, E. phenax, E. drummondii*. Also *Santalum acuminatum, Allocasuarina campestris, Gastrolobium spinosum, Senna artemisioides* subsp. *nemophila, Desmocladus* spp., *Schoenus* spp.	upper slopes	grey sandy clay or yellow sandy loam over laterite	AW2		1	2
Wandoo and York Gum	Ewanlox	*Eucalyptus loxophleba, Acacia acuminata, A. merrallii, A. lasiocarpa, A. leptospermoides, Melaleuca adnata.* Understorey of grasses, sedges and herbs.	mid to lower slopes	grey sandy clay	JF1, AW2		3	8
Wandoo and Powderbark Wandoo	Ewanacc	*Dryandra sessilis, Hibbertia hypericoides, Acacia lasiocarpa, Gastrolobium parviflorum and Petrophile divaricata.*	upper slopes & breakaways	gravelly	JF1, AW2		8	
Wandoo and Flooded Gum	Ewanrud	Herb-rich.	drainage lines	alluvial sands	JF1		1	1
Wandoo and Flat-topped Yate	Ewanocc	*Eucalyptus occidentalis, Acacia lasiocarpa, Allocasuarina lehmanniana, Hakea lissocarpha, Daviesia triflora* and sedges, mat plant, lilies and herbs.	valley flats	sandy duplex	AW2		2	
Wandoo in Saline Areas	EwanSaline	*Eucalyptus loxophleba, Casuarina obesa*	lower slopes valley floor		JF1, AW2		3	

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
Wandoo North (*Eucalyptus wandoo* subsp. *pulverea*)	EwanN	*Eucalyptus loxophleba, Hakea lissocarpha, Xanthorrhoea preissii, Grevillea delta, Hypocalymma linifolium* Heath or Scrub with rare *E. salmonophloia & E. loxophleba.* Herbs.	upland	laterite & clay loam	GS2, SWA1, JF1		15	
Eucalyptus capillosa (Wheatbelt Wandoo)	Ecap	With and without a shrub layer. Mixed shrubs such as *Acacia acuaria, A. erinacea, Nemcia tricuspidata, Gastrolobium trilobum, Hakea lissocarpha; Borya* spp., *Lomandra* spp. and *Austrostipa* spp. dominate the ground cover. *Eucalyptus loxophleba, Acacia acuminata & Allocasuarina acutivalvis* may occur & rare mallees such as *E. erythronema, E. moderata.* Also *Callitris canescens* occurs where the woodland is open.	decomposing granitic breakaways	red, white or grey sand, sandy loam, clay	AW1, COO2, AW2, MAL2	Extends to the E	19	6
Wheatbelt Wandoo over Herbs	EcapHerbs	*Acacia acuaria, A. erinacea, Nemcia tricuspidata, Gastrolobium trilobum, Hakea lissocarpha.*	mid to upper slopes	loamy & deep grey sandy duplex soils	AW1		8	2
Wheatbelt Wandoo over Scrub	EcapScrub	Scattered shrubs over *Borya* spp., *Lomandra* spp. and *Austrostipa* spp., *Trachymene cyanopetala, Waitzia acuminata* and *Velleia cycnopotamica.*	mid to upper slopes	yellow or grey sands	AW1, COO2, AW2 MAL2		11	4
Eucalyptus accedens (Powderbark)	Eacc	*Hakea lissocarpha, Hibbertia hypericoides, Hovea chorizemifolia.*	upland lateritic breakaways or stony ridges	lateritic gravelly soils, clay loam	JF1, AW2, SWA1, GS2	Extends to NW and W	27	
Powderbark Wandoo over Scrub	EaccScrub	*Eucalyptus marginata, Dryandra armata, Hibbertia hypericoides, Petrophile divaricata, Nemcia tricuspidata, Melaleuca uncinata* group *(Hypocalymma*	breakaway, upper slope	gravel, sandy duplex	JF1, AW2, SWA1, GS2		27	

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
		angustifolium, Xanthorrhoea drummondii).						
MALLETS								
Eucalyptus melanoxylon (Black Morrel)	Emelx	*Eucalyptus salmonophloia, E. longicornis, Olearia muelleri, Melaleuca pauperiflora, Eremophila scoparia, Templetonia sulcata Acacia merrallii, Atriplex vesicaria.*	valley floor depressions & flats	sand, clay loam	AW2, COO2	Extends well to the E	2	
Eucalyptus astringens (Brown Mallet)	East	*Eucalyptus wandoo, Gastrolobium tricuspidatum*. Few herbs and grasses.	rocky outcrops, ridges, breakaways, hills, occasionally valley floors	Red-brown gravelly clay, brown clayey sand, sandy loam, spongolite, laterite, sandstone	AW2, MAL2, JF2	Extends to the S and SW	25	
Brown Mallet over Little Understorey	East	Little or no understorey; rare herbs, grasses and sedges. *Eucalyptus wandoo* often present.	below breakways	gravel over clay	AW2, JF2		7	
Brown Mallet over Scrub	EastScrub	Scrub over varying heights and cover: *Melaleuca uncinata* group, *Exocarpos aphyllus, Allocasuarina* spp., *Nemcia tricuspidata.* Other trees include *E. salmonophloia, E. gardneri, E. urna, E. wandoo* and mallees.	breakaways	clay beneath breakaway	AW2, MAL2		12	
Brown Mallet over Mallee	EastMallee	*Eucalyptus falcata, E. phaenophylla.*			AW2		2	
Brown Mallet and Merrit	Easturn	*Melaleuca uncinata* group.	breakaways		MAL2		3	
Brown Mallet and Flat-topped Yate	Eastocc	*Eucalyptus occidentalis, E. wandoo.*	valley floor		AW2		1	

Community or Sub-community	**Code**	**Main Associated Species**	**Landform**	**Soil**	**IBRA**	**Wheatbelt NRM**	**No. Sites**	**No. Polygons**
Eucalyptus argyphea (Silver Mallet)	Earg	Often with no understorey or scrub of varying ht, cover and species. Occasionally includes *E. astringens, E. wandoo, E. gardneri,* and some mallee species.	upper slopes, lateritic rises	sandy clay with gravel, sandy loam, yellow sand	MAL2, AW2	Confined to Wheatbelt	44	3
Silver Mallet over Little Understorey	Earg	There is little or no understorey, except for scattered *Exocarpos aphyllus, Santalum acuminatum, Beyeria brevifolia* and *Callitris roei.*	upper slopes, lateritic rises	sandy clay with gravel, sandy loam, yellow sand	MAL2, AW2		17	
Silver Mallet over Scrub	EargScrub	*Melaleuca uncinata* group, *Westringia cephalantha*, *Exocarpos aphyllus*, *Phebalium filifolium, P. tuberculosum, Eucalyptus gardneri, Leptomeria preissiana, Rhadinothamnus rudis* and *Hakea multilineata.*	upper slopes, lateritic rises	sandy clay with gravel, sandy loam, yellow sand	MAL2, AW2		27	3
Eucalyptus urna (Merrit)	Eurn	*Eucalyptus salubris, E. kondininensis, E. longicornis, E. melanoxylon, E. salmonophloia, E. extensa.* Mallee *E. cylindriflora, E. cylindrocarpa, E. olivina, E. phaenophylla, E. polita, E. subangusta, E. tenera, E. vittata, E. yilganensis, E. eremophila, E. annulata, E. phenax, E. platypus. Melaleuca acuminata* subsp. *acuminata, M. adnata, M. pauperiflora, M. lateriflora, M. coronicarpa, M. thyoides, M. scalena, Templetonia sulcata,* chenopods.	lower slopes	reddish brown alkaline sandy loams to soft, grey clay-loams over limestone	MAL2, MAL 1, COO2		22	
Eucalyptus gardneri (Blue Mallet)	Egar	*Eucalyptus argyphea, E. urna, [E. astringens* subsp. *astringens, E. extensa, E. longicornis, E. recta, & E. wandoo* and mallees *E. drummondii, E. falcata, E. flocktoniae, E. incrassata, E. pluricaulis, & E. tenera (MF)]* over *Melaleuca acuminata, M. uncinata* group, *Allocasuarina acutivalvis.*	breakaways, upper lateritic ridges & slopes	gravelly soils, laterite	MAL2, AW1	Largely confined to the Wheatbelt, outlier to SE	4	3

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
Eucalyptus ornata (Ornate Mallet)	Eorn	*Melaleuca lateriflora, M. pauperiflora, Allocasuarina acutivalvis*	ridges	laterite	MAL2	Confined to Wheatbelt	3	
Eucalyptus spathulata (Swamp Mallet)	Espa	*Eucalyptus platypus, Melaleuca acuminata, M. pauperiflora, M. thyoides, M. preissiana, M. brophyi.*	Flats, broad valley floors, saline depressions, edges salt lakes, rises	grey-white sand, pale brown sandy clay over granite, saline soils	MAL2	Largely confined to the Wheatbelt, outliers to SE and NE	3	3
Eucalyptus singularis (Mallet)	Esin	*Eucalyptus argyphea, Exocarpos aphyllus, Gastrolobium spinosum, Hakea multilineata.*	rises	shallow sand over laterite	MAL2	Confined to Wheatbelt	2	
Eucalyptus densa (Mallet)	Eden	*Santalum acuminatum, Exocarpos aphyllus Trymalium elachophyllum, Westringia cephalantha, Phebalium lepidotum .*	lateritic ridges, flats, drainage lines	clay loam, clay, sandy soils	MAL2	Extends to the S and SE	1	
Eucalyptus extensa (Mallet)	Eext	*Melaleuca acuminata, M. pauperiflora, Eucalyptus salmonophloia.*	sandplains, undulating areas	red loam, grey sandy loam, sometimes gravelly	MAL2	Extends to the S and SE	2	
Eucalyptus recta (Mallet)	Erec	*Calothamnus aspera, Allocasuarina campestris, Allocasuarina acutivalvis Acacia lasiocarpa, Alyxia buxifolia, Goodenia scapigera, Austrostipa* sp.	upper slopes	sandy laterite	AW2	Confined to Wheatbelt	1	
OTHERS								
Eucalyptus kondininensis (Kondinin Blackbutt)	Ekon	*Eucalyptus longicornis, Acacia merrallii, Eremophila deserti, Atriplex vesicaria, Olearia muelleri.*	salty flats, near salt lakes, seasonally waterlogged areas, rises	clay, sandy clay, gravel, laterite, gypsum	MAL2, AW1, AW2	Confined to Wheatbelt	30	1

Community or Sub-community	**Code**	**Main Associated Species**	**Landform**	**Soil**	**IBRA**	**Wheatbelt NRM**	**No. Sites**	**No. Polygons**
Kondinin Blackbutt over Chenopods	EkonChen	*Atriplex paludosa, A. vesicaria, Rhagodia drummondii, Lycium australe, Templetonia sulcata.* Occasional *Eucalyptus longicornis, E. urna* and *E. salmonophloia.*	usually on salty flats & associated dunes		MAL2, AW1 AW2		13	1
Kondinin Blackbutt over Melaueca	EkonMel	*Melaleuca acuminata, M. lateriflora M. thyoides, M. pauperiflora* thickets and scrub with occasional chenopods.	usually on salty flats & associated dunes		MAL2		17	
Eucalyptus myriadena (Blackbutt)	Emyr	*Eucalyptus urna* and mallees *E. calycogona, E. yilgarnensis, Rhagodia drummondii, Rhagodia preissii, Senna artemisioides.*	valley floors	clay, often saline, sandy clay, gravelly loam over kankar	AW1, MAL2, MAL1 COO2,	Mostly confined. Small extension to NW and SW	10	
Eucalyptus salicola (Salt Salmon Gum)	Esali	*Rhagodia drummondii, Olearia dampieri* subsp. *eremicola.*	near salt lakes & salt pans on plains, low rises & dunes	yellow or red sand, red clay, loam & calcareous soils	AW1, MAL2, COO2.	Extends to the E	15	
Eucalyptus sargentii (Salt River Gum)	Esar	*Rhagodia drummondii, Melaleuca uncinata* group, *M. brevifolia.*	salt swamps & flats, along creek lines, flood plains, drainage lines	yellow sand, sandy clay or clay, grey loam; calcareous soils	MAL2, AW1	Largely confined	5	
Eucalyptus occidentalis (Flat-topped Yate)	Eocc	*Melaleuca strobophylla, M. cuticularis*.	alluvial flats, low-lying wet areas, around salt lakes, hills	sandy or clayey soils	ESP1, ESP2, MAL2 MAL1, AW2	Mostly to the S	74	
Flat-topped Yate	EoccSWb	*Melaleuca strobophylla, M. lateritia, M. uncinata* group, *Olearia dampieri* subsp.	bottom saline & freshwater		MAL2,	Mostly in wheatbelt;	37	

Community or Sub-community	Code	Main Associated Species	Landform	Soil	IBRA	Wheatbelt NRM	No. Sites	No. Polygons
Southern Wheatbelt		*eremicola.*	basins		AW2	extending to the S		
Flat-topped Yate South Coast	EoccSCst	*Melaleuca cuticularis, Acacia cyclops Baumea* sp. Other *Melaleuca* spp. on dry sites.	drainage lines & on the plain		ESP1, ESP2, MAL1	All outside	27	
Flat-topped Yate West	EoccW	*Melaleuca viminea, M. rhaphiophylla, Baumea articulata*.	bottom creeks & swamps	clay beneath breakaway	AW2, MAL2, ESP1, JF2	outside Wheatbelt to the SW	8	
Eucalyptus rudis (Flooded Gum)	Erud	*Acacia acuminata, Allocasuarina huegeliana, Melaleuca viminea, Lepidosperma* aff. *tenue, Borya nitida.*	Wetter parts of south-western WA, flats, drainage lines, hillsides	sandy or loam soils	AW2, JF1	mainly to the W and SW	1	1
Eucalyptus moderata (Redwood)	Emod	*Eucalyptus capillosa, E. subangusta, E. erythronema, Westringia cephalantha, Melaleuca hamulosa, M. undulata.*	flat sites or sites high in landscape, slopes, hillsides	red sand to loam, laterite, granite		Extends to the NW and NE of the Wheatbelt		6
Eucalyptus yilgarnensis (Yorrell)	Eyil	*Acacia colletioides, Melaleuca hamulosa, M. cymbifolia, Grevillea acuaria, Atriplex paludosa.* Rare *Eucalyptus salmonophloia, E. salubris.*	sandplains & rises	undulating plains, slopes	MAL2	Extends well into the NE	1	7
Eucalyptus marginata (Jarrah)	Emar	*Eucalyptus accedens, Dryandra nobilis, Hibbertia commutata*.	rises, hill slopes (near granite rocks)	grey sand, clay loam, laterite	AW2, JF1	All to the W. Two eastern outliers found in the Wheatbelt	2	

The most and least common communities and sub-communities are presented in **Table 6** and **Table 7** respectively; this is influenced by survey focus, site concentration and distribution.

Table 6 The eucalypt woodland communities and sub-communities most commonly represented in sites and polygons in this Project.

Community	**No. Sites or Polygons**
Eucalyptus salmonophloia (Salmon Gum)	356
Eucalyptus loxophleba (York Gum)	213
Eucalyptus wandoo (Wandoo)	178
Eucalyptus salubris (Gimlet)	101
Eucalyptus occidentalis (Flat-topped Yate)	72
Eucalyptus longicornis (Red Morrel)	58
Sub-community	**No. Sites or Polygons**
Salmon Gum and Gimlet	77
York Gum and Jam over Herbs	74
Salmon Gum over Scrub	62
Wandoo over Heath	54
Salmon Gum and York Gum	49
Gimlet over Scrub	47
Salmon Gum over Mallee	42
Salmon Gum and Wandoo	39
Flat-topped Yate Southern Wheatbelt	37
York Gum and Jam over Scrub and Herbs	34
Salmon Gum over Melaleuca	33

Table 7 The eucalypt woodland communities and sub-communities most poorly represented in sites and polygons in this Project.

Community	**No. Sites or Polygons**
Eucalyptus extensa (Mallet)	2
Eucalyptus melanoxylon (Black Morrel)	2
Eucalyptus singularis (Mallet)	2
Eucalyptus rudis (Flooded Gum)	2
Eucalyptus densa (Mallet)	1
Eucalyptus recta (Mallet)	1
Sub-community	**No. Sites or Polygons**
Brown Mallet over Mallee	2
Red Morrel and York Gum	2
Red Morrel on Dunes	2
Salmon Gum and Merrit	2
Wandoo and Flat-topped Yate	2
Wandoo and Flooded Gum	2
York Gum on Dunes	2
Brown Mallet and Flat-topped Yate	1
Gimlet on Dunes	1
Red Morrel and Brown Mallet	1

3.1 Factsheets

A total of 155 factsheets were prepared: 29 community factsheets, 62 sub-community factsheets, and 63 reference site factsheets, as well as one for the Mallets group.

Reference sites for sub-communities, and some communities where there were no sub-communities, were included when available. There are two reference sites for sub-communities such as Wandoo over Tammar or Melaleuca, and Wandoo and Flooded Gum or Flat-topped Yate.

Reference sites needed to be on public land and accessible (although not all sites have been visited to confirm accessibility).

Common names have been used in the sub-community titles to reduce repetition of lengthy scientific names, and to enable links to be created in the factsheets.

There are references cited on the fact sheets but not cited in this report (Wandoo Recovery Group ; Chippendale 1973; Brooker & Hopper 1991; McArthur 1991; Hussey & Wallace 1993; Rose 1993; Marcar *et al.* 2002; Nicolle 2005; Veneklaas & Manning 2007; Manning & White 2009)

4. DISCUSSION

This classification of eucalypt woodlands of the Wheatbelt is an attempt to define communities in terms of their dominant *Eucalyptus* species, structure, and associated understorey species, into a hierarchy of communities and sub-communities. It acknowledges the inherent difficulty in trying to put vegetation into 'boxes' and recognised a range of attributes that can be used to define a subcommunity. However there is a need for vegetation classification to enable the conservation, management and mapping native vegetation. The results reveal gaps in our knowledge about woodland communities in the Wheatbelt and so are open for modification and improvement as more data and ecological knowledge becomes available. Its implementation by land managers, vegetation mappers and plant ecologists will evaluate its accuracy and value.

The site-based data is influenced by the availability, focus and distribution of sites; the SAP sites have a good spread but the WWF survey focused on four main species, and the surveys entered into the Wheatbelt Reserves Database concentrated on areas such as the recovery catchments. The Avon Vegetation Mapping polygons are more widespread but, again, their locations were influenced by the purpose of the survey. The number of sub-communities in each community was largely governed by the number of sites and polygons, which didn't always reflect the common occurrence of the community or dominant eucalypts.

The 28 eucalypt tree species range from having widespread to localised distributions. Some, such as *Eucalyptus kondininensis, E. singularis, E argyphea, E. ornata,* and *E. recta* are restricted to the Wheatbelt. Other such as *E. myriadena, E spathulata* and *E gardneri are* largely restricted to the area (Western Australian Herbarium 1998 -). *Eucalyptus wandoo*, *E. rudis* and *E. occidentalis,* have most of their distributions outside the Wheatbelt, to the west and south. *Eucalyptus longicornis, E. salmonophloia, E. salubris, E. melanoxylon, E. salicola, E. moderata* and *E. yilgarnensis* extend into the Great Western Woodlands (GWW). A considerable part (about a third) of the Wheatbelt NRM region is in the GWW and incorporation of survey data from surveys such as Gibson and Lyons (1998) and further on ground survey, are needed to ascertain whether Wheatbelt communities of these species are similar to or different from those in the GWW.

There may be more than one sub-community to which a site or polygon could have been allocated to, as the sub-communities are defined by a range of perceptible attributes (occurrence of other eucalypts, common associated genera and species, understorey structure, landform features or geographical location). Sub-communities where two eucalypt species were co-dominant were either allocated to the taller species, as in the case of *E. salmonophloia*, or to the more common species, evident from the majority of the sites' descriptions and photographs. It is subjective as to how many and what kind of sub-communities exist within each community, and even whether each eucalypt species forms its own community. Several communities, for example *E. longicornis* and *E. loxophleba*, have many sub-communities, largely based on the availability of many survey sites. Other communities could be further subdivided according to the attributes mentioned previously but, with the limited amount of sites and information, it was decided not to do so as it would yield sub-communities based on few sites and produce an unmanageable number of options.

Many of the sub-communities were recorded as growing on a range of soils and landforms. This may be accurate or it may reflect the different approaches to sampling and describing soil and landforms. Improved soil mapping and consistent soil sampling and descriptions would help to more accurately ascertain soil preferences of each community (if they exist).

It is not possible to say which sub-communities are restricted to the Wheatbelt as there are not enough samples from outside the Wheatbelt to confirm this. However Wando and Flat-topped Yate sub-community may be restricted to the Wheatbelt as the distributions of these two species barely overlaps (Western Australian Herbarium 1998 -)

Comparing the current classification with Keighery's list (Appendix 1), the groups and assemblages produced by the SAP analysis of floristic and bioregional variables (Appendix 2), and Griffin's analysis of floristics (Appendix 3) highlights the influence of the understorey species and the similarities that may exist between communities dominated by different eucalypts e.g. *E. salicola* and *E. kondininensis*. These appendices list corresponding communities and sub-communities classified during this project. The similarities with Keighery's list of Wheatbelt vegetation types (Appendix 1) is high, as shown by the allocation of most of the community and sub-community codes, and highlights the focus on the well sampled *E. salmonophloia, E. loxophleba, E. wandoo, E. longicornis* and *E. salubris* woodlands. Species not so well surveyed, such as the mallets, *E. occidentalis* and *E. moderata*, can be the focus for further surveys. Communities mentioned by Keighery and not recognised here may be unusual such as *E. kondininensis* Woodland over *Templetonia* or *Acacia* Shrubland, or occur mainly outside the study area such as *E marginata* communities. This classification did not include occurrences of more that two species of *Eucalyptus* and so a future task could be to examine the data for occurrences of the mosaics mentioned by Keighery such as *E. salmonophloia*/*E. salubris*/*E. loxophleba* Woodland. A sub-community, *E. salmonophloia* Woodland over *Gahnia trifida* Sedgeland, did not emerge from the data although they both occurred in the EsalmDune sub-community and there were other species of Gahnia under *E. salmonophloia* in EsalmMel and EsalmMallee.

The current classification differs from previous analyses (Gibson *et al.* 2004; Griffin 2008) which were based on presence/absence data because:

- the first consideration is the dominant eucalypt
- the vegetation layers are considered, that is, the overstorey is considered separately from the mid (shrub) and lower (ground) strata
- the dominant species in each layer is delineated.

The current classification restricted the dominant eucalypt to two species to moderate the potential number of sub-communities. More than two species may co-occur. For example, the SAP analysis grouped *Eucalyptus salmonophloia, E. longicornis, E. occidentalis* or *E. astringens* (G5), and *Eucalyptus longicornis, E. kondininensis* or *E. salmonophloia* (G4). Again further investigations of the data used in this classification may reveal how common similar groups of eucalypts.

Sub-communities which were similar to groups and assemblages produced by Gibson *et al.* (see Appendix 2) include:

- Salmon Gum and Wandoo similar to G2
- Salmon Gum and Gimlet similar to G24
- Salmon Gum over Mallee similar to G6
- Salmon Gum and Red Morrel could fit into G4 or G5
- Salmon Gum over Chenopod Scrub could fit into G4
- Salmon Gum and Red Morrel, Salmon Gum and Gimlet, Salmon Gum over Scrub and Salmon Gum over Chenopod Scrub could all fit into Assemblage 3.

Griffin's analysis (Griffin 2008) was a strong influence on the classification, providing the bases for grouping sites into sub-communities; however, the influence of dominants in the understorey, such as *Rhagodia drummondii*, was incorporated into the descriptions of the dominant trees (*E. salicola*, *E. kondininensis* and *E. loxophleba* subsp. *supralaevis*). His groupings, presented in Appendix 3, show the corresponding community and sub-community codes resulting from this classification. Some of the sub-communities in *E. occidentalis*, *E. wandoo* and *E. loxophleba* subsp. *loxophleba* communities appeared in two or more of Griffin's groups, highlighting the complexity of the vegetation.

There are several areas needing further investigation and survey.

- Mallets especially those listed in **Table 7** *Eucalyptus extensa*, *E. singularis*, *E. densa*, and *E. recta* to see if they are more common than the result show or if they are actually unusual.
- There are other mallets such as *E. rugulata* which occurs near Kondinin and Lake Grace, *E. alipes* common in the Mallee2 IBRA subregion but probably recorded as *E. spathulata,* and *E. prolixa* and *E. polita* which occur on the eastern edge of the Wheatbelt and into the GWW, which all require further survey before they are included as factsheets
- If there are more of the *E. melanoxylon* Community in the Wheatbelt.
- The extent and condition of *E. rudis* communities as there may be no weed free example of this.
- *Eucalyptus occidentalis* communities in dry sites in the Wheatbelt and the relation with the main distribution south of the study area.
- Other sub-communities mentioned in **Table 7**.
- Incorporation of the existing data from the Great Western Woodlands e.g Gibson and Lyons (1998), and further sampling of woodlands of the broad valleys in the GWW, will assist in the comparison of the sub-communities in the cleared and uncleared areas.
- Incorporation of Mosaics, which appear to be a real feature at a range of scales greater that at the quadrat scale. This would lead to the possible description of communities with more that 2 species of Eucalyptus.

The classification, based on data from 889 sites and 338 mapped polygons (also taking input from previous analyses, relevant literature and expert knowledge) is still a far cry from what is needed to effectively model the extent of the woodlands considering that in Victoria over 15,000 data points were incorporated in its statewide modelling of native vegetation (VEAC 2010).

5. POSSIBLE PRIORITY OR THREATENED ECOLOGICAL COMMUNITIES

Generally, woodlands in the Wheatbelt have been extensively cleared and are poorly conserved.

Early in 2011, a preliminary nomination to list the WA Wheatbelt Woodlands as a Threatened Ecological Community under the federal Environment Protection and Biodiversity Conservation Act was prepared by the Humane Society International, following a request by the Commonwealth. A draft of this report, and several community profiles (*E. salmonophloia, E. loxophleba and E. wandoo*), were submitted to assist with this nomination. In 2012 this nomination progressed to be included on the Finalised Priority Assessment List for the Threatened Species Scientific Committee to provide advice to the Federal Minister of the Environment by the 31st December 2013.

These eucalypt woodland communities have also been identified by DEC as a Priority Ecological Community in the agricultural region of the South West.

Eucalypt woodlands of the Western Australian Wheatbelt Priority 3(iii)

Eucalypt-dominated woodlands in the Western Australian Wheatbelt region as defined by the IBRA Avon Wheatbelt 1 and 2 and Western Mallee subregions with the specific exceptions of: woodlands and forests dominated by Jarrah (*E. marginata*) or Marri (*Corymbia calophylla*) where they occur without York Gum present; and non-woodland communities dominated by eucalypts, specifically those dominated by eucalypts with a mallee growth form. Community is defined primarily by its structure as a woodland. The presence in the canopy layer of eucalypt trees - most commonly salmon gum (*Eucalyptus salmonophloia*), York gum (*Eucalyptus loxophleba*), red morrel (*Eucalyptus longicornis*) or gimlet (*Eucalyptus salubris*) defines the Wheatbelt woodlands. Several of the other emergent eucalypt species which may be present as a defining species (e.g. Kondinin blackbutt (*E. kondinensis*), *E. myriadena*, salt river gum (*E. sargentii*), silver mallet (*E. ornata*) and mallet (*E. singularis*) are found only in the Western Australian Wheatbelt.

DEC also recognises the following specific Priority Ecological Communities that feature Wheatbelt eucalypts.

Red Morrel Woodland of the Wheatbelt Priority 1

Tall open woodlands of *Eucalyptus longicornis* (red morrell) found in the Wheatbelt on lateritic, ironstone or granitic soil types. Sometimes found with *Eucalyptus salmonophloia* (Salmon Gum), or *E. loxophleba* (York Gum) woodlands and has very little understorey. It is also found directly above lake systems in the central and eastern Wheatbelt. The landscape unit in which it is found is valley floors, usually adjacent to saline areas.

Brown mallet *Eucalyptus astringens* communities in the western Wheatbelt on alluvial flats (previously 'Beaufort River Flats') Priority 1

Near York and on the Arthur River on grey clays the understorey is dominated by *Melaleuca viminea* over sedges (*Gahnia trifida*) and bunch grasses. At Kojunup and near Tambellup on brown clays sparse shrubs and succulent shrubs (*Disphyma crassifolium*) dominate the understorey

Yate (*Eucalyptus occidentalis*) dominated alluvial claypans of the Jingalup Soil System

Priority 2

Some unusual communities were identified in the field during the SAP survey, for example:

- *E.wandoo* and *E. occidentalis,* corresponding with the Ewanocc sub-community
- *E. wandoo* over *Mesomelaena,* included in the EwanHeath sub-community
- *E. astringens* over *Melaleuca* and *Gahnia*, included in EastScrub Sub community.

6. BENCHMARKING AND VEGETATION CONDITION ASSESSMENT

The underlying purpose of the classification of vegetation such as the Eucalypt Woodlands of the Wheatbelt is to provide a framework for the assessment of vegetation condition measured against benchmark descriptions. Significant loss of, and changes to, native vegetation in Australia since European settlement drives the need to conserve remnant vegetation. Effective conservation programs need accurate information about the extent and condition of the native vegetation that remains.

An effective conservation program must collect vital information and data on native vegetation condition, to assess whether the program is effective and achieving its set goals and outcomes. The management body must be able to measure whether the program's set goals and outcomes were met, and report accordingly. Monitoring of vegetation condition involves collecting quantitative data to measure trends over time against a list of 'indicators'. Benchmarks provide a contextual framework but need to relate to an overall question(s) resulting from the goals set by the program.

Benchmarks are defined from vegetation in a mature, long undisturbed state. Benchmarking involves describing the near pristine state of a defined community in terms of species composition, species richness, vegetation structure and habitat values. The definition of a benchmark adopted here is:

> "A measure, for the purposes of biodiversity conservation, of indicators of vegetation composition, structure and function relative to a reference state (i.e. within the context of the presence or absence of a threatening processes) at a patch or landscape (community or ecosystem) scale"(Bleby *et al.* 2008) (

A benchmark can be a synthetic description generated from existing floristic and habitat data collected from reference sites, and/or elicited from experts with knowledge on vegetation units. It aims to equate to the state of the area prior to settlement. It may be taken as the desired or end state for research and restoration activities.

Considerable work on the assessment of vegetation condition as measures against benchmarks has been carried out in Victoria, New South Wales, Queensland and Tasmania. **Table 8** presents a comparison of the intentions and definitions of benchmarks in various states. **Table 9** lists the attributes measured by each toolkit. These attributes are often given a weighting; for example, with Habitat Hectares and BioMetric (Parkes *et al.* 2003; Gibbons *et al.* 2008), in pristine vegetation attribute values adds up to 100%. Then measurements are made, generally as a percentage of the benchmark, to determine the vegetation condition.

Benchmark descriptions have been compiled and included on the factsheets.

WA is a long way off developing these measures but the benchmark descriptions developed in this Project for 17 woodland communities, and the Mallets as a group, are a positive step in that direction. These are loosely based on the descriptions of the Ecological Vegetation Classes (EVCs) developed in Victoria and TASVEG units in Tasmania. In many cases we did not have the all relevant information, for example cover of natives and weeds, or depth of litter. The attributes we have included in the benchmark descriptions such as recruitment, are based on available information relevant to understanding how the woodlands function.

Table 8 Definition of benchmarks: a comparison of major eastern states' toolkits or approaches.

	VIC	**TAS**	**QLD**	**NSW**
Name	Habitat Hectares (Parkes *et al.* 2003)	TASVEG (Michaels 2006)	BioCondition (Eyre *et al.* 2010)	BioMetric (Gibbons *et al.* 2008)
Intention	Initially developed for determining offset scenarios for an environmental assessment project.	To enable vegetation condition to be accounted for in planning, monitoring and decision-making processes. Based on Habitat Hectares	To provide a framework that provides a measure of how well a terrestrial ecosystem is functioning for the maintenance of biodiversity values. Based on Habitat Hectares.	To assess the impacts (positive and negative) on terrestrial biodiversity of applications for clearing and applications for incentives in native vegetation under the NSW Native Vegetation Act (2003).
Definition of benchmarks	The 'benchmark' represents the average characteristics of a mature and apparently long-undisturbed state for the same vegetation type	Represents the average characteristics of a mature and apparently long-undisturbed state of the same vegetation type.	A quantitative value for each site condition attribute assessed in BioCondition. They are used as a reference value for comparison purposes. They are based on the average or median value of a mature and long undisturbed reference sites, or from Best on Offer.	Benchmarks are quantitative measures of the range of variability in vegetation with relatively little evidence of modification by humans since European settlement. Benchmarks derived from quantitative data and expert knowledge.

Table 9 Structural, compositional and functional attributes to describe benchmarks in the eastern states.

	VIC	TAS	QLD	NSW
Name of toolkit/ approach	Habitat Hectares (Parkes *et al.* 2003)	TASVEG (Michaels 2006)	BioCondition (Eyre *et al.* 2010)	BioMetric (Gibbons *et al.* 2008)
Site	Large Trees	Large Trees	Large Trees	
Attributes	Tree Canopy Cover	Tree Canopy Cover	Tree Canopy Cover Tree Canopy Height	Native over-storey percent cover
	Understorey	Understorey Life Forms	Shrub Layer Cover	Native mid-storey percent cover
	Recruitment	Recruitment	Recruitment of Woody Perennial Species	Proportion of over-storey species occurring as regeneration
			Native Plant Species Richness	Native plant species richness
			Native Perennial Grass Cover	Native ground percent cover (shrubs)
			Native Perennial Non-Grass Cover	Native ground percent cover (other)
		Persistence Potential	Native Annual Grass, Forb and Non-Grass Cover	
	Lack of Weeds	Lack of Weeds	Weed Cover	Exotic plant percent cover
	Organic Litter	Organic Litter	Litter Cover	
	Logs	Logs	Fallen Woody Material	Total length of fallen logs
				Number of trees with hollows
Landscape Value Measures	Patch Size	Patch Size	Size of Patch	Change in the total cover of native vegetation in the landscape
	Neighbourhood	Neighbourhood	Context	Total area of native vegetation adjacent to the proposal
	Distance to Core Area	Distance to Core Area	Connection	Change in connectivity
			Distance to Water	Proximity of the site to riparian areas

Most sites selected in the SAP and WWF surveys were not recently burnt, SAP sites were ungrazed and presence of saline soils recorded so they provide useful benchmark information. The presence of weeds is seasonal and can be determined from species lists and an idea of cover obtained from photographs and site descriptions.

Benchmark descriptions for the communities and the mallet group were derived from the site descriptions, field survey, available literature and expert knowledge. Recognising benchmarks and vegetation in pristine condition comes with experience but will be assisted by visiting reference sites and understanding the impacts of fire, grazing and other disturbances.

DEFINITIONS

Woodland

Woodlands are defined as a combination of species composition and structure. The species considered here are commonly recognised as Wheatbelt woodlands species rather that forest species, with the exception of *Eucalyptus wandoo* which occurs both in the forest and the Wheatbelt. Structurally, woodlands contain trees with projected foliage cover of 10-30%, that is, crowns do not touch, equating to about 5 to 20 trees per hectare. But many of the above species also occur in denser stands with projected foliage cover of 30-70% (strictly speaking, a forest).

Community

An [plant] ecological community has been defined in WA as a naturally occurring biological [plant] assemblage (group) that occurs in a particular type of habitat. Community structure is defined as follows: "The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage", for example, *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs (DEC 2007). It is noted that the scale at which ecological communities are defined will often depend on the level of detail in the information source; therefore no particular scale is specified.

Benchmark

Benchmarking involves describing the near pristine state of a defined community in terms of species composition, species richness, structure and habitat value. The definition of a benchmark adopted here is:

> "A measure, for the purposes of biodiversity conservation, of indicators of vegetation composition, structure and function relative to a reference state (i.e. within the context of the presence or absence of a threatening processes) at a patch or landscape (community or ecosystem) scale" (Bleby *et al.* 2008)

Reference sites

Sites which give an indication of what the sub-community looks like in good condition. They may not be pristine but aim to be the 'best on offer'. They need to be on public land and easy to access. The terrestrial SAP sites were chosen to sample vegetation in excellent to very good condition. Further survey may reveal other sites worthy of inclusion as reference sites. The fact sheets include reference sites suggested by McQuoid but some of these may not be weed free e.g. *Eucalyptus rudis* woodland.

Sites

A floristic sampling site, usually a quadrat, which may or may not be permanently marked.

Polygons

Polygon descriptions extracted from the Avon Vegetation Mapping Project which has digitised and documented large scale vegetation maps of reserves and remnants within the Wheatbelt NRM region. These descriptions may apply to many polygons and some polygons may contain many descriptions.

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Workshop attendees Northam June 11th 2009

Rebecca, Palumbo, ACC, Natural Diversity Program Manager
Chris , David, ACC, Communications Facilitator
Cilla, Kuiper, ACC, Communications Officer
Mike, Fitzgerald, DEC, Ecoscape Planning Officer
Margaret, Redfern, DEC, Conservation Officer (Ecoscape Project) DEC
Jill, Symington, DEC, Conservation Officer
Mick, Davis, DEC , Ecologist RegSer / WheReg (ex WWF)
Ian, Steward, DEC , GIS Analyist
Alan, Kietzmann , DEC , District Manager DEC
Mike, Griffiths, WWF,
Phil, Lewis, WWF,
Julia, Murphy, GAWA,
Glen, Daniel , DEC, Environmental Officer (Wetlands)
Brett, Glossop, DEC,
Judith, Harvey, DEC,
Ben, Bayliss, DEC,
Brett, Beecham, DEC ,
Dianne, Robinson, ACC, Reception and admin
Rhonda, Colyer, ACC, Reception and admin
Nathan, Heal, ACC, Aboriginal NRM Officer

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APPENDICES

APPENDIX 1 Wheatbelt vegetation classification by Keighery

Wheatbelt vegetation types compiled by Greg Keighery from previous mapping and extensive field experience. Non-woodland vegetation is in grey. Vegetation is coded corresponding to communities and sub-communities defined in this Project.

	VEGETATION	CORRESPONDING CODE
	FOREST OR WOODLAND	
1	***Eucalyptus kondininensis***	**Ekon**
a	Closed Tall Forest over *Melaleuca* Tall Shrubland	EkonMel
b	Closed Tall Forest over *Melaleuca* Open Shrubland	EkonMel
c	Woodland over *Templetonia* or *Acacia* Shrubland	
d	/*E. salmonophloia* Woodland	
2	***Eucalyptus occidentalis***	**Eocc**
a	Tall Forest	EoccSWb, EoccSCst, EoccW
b	Tall Forest over *Melaleuca* Low Woodland	
c	Low Forest	
d	Woodland	
e	Woodland over *Melaleuca* Shrubland	
f	Low Woodland	
g	/*E. rudis*	Further to the SW
i	Tall Woodland	Further to the SW
ii	Woodland	Further to the SW
3	***Eucalyptus wandoo***	**Ewan**
a	Woodland over Shrubland	EwanHeath
b	Woodland over *Acacia acuminata* Low Woodland	EwanJam
c	Woodland over *Allocasuarina campestris* Shrubland	EwanTammar
d	Woodland over *Gastrolobium microcarpus* Shrubland	EwanScrub
e	Woodland over *Oxylobium parviflorum* Shrubland	EwanScrub
f	Woodland over *Melaleuca undulata* Shrubland	EwanMel
g	Woodland over *Melaleuca radula* Shrubland	EwanMel
h	Woodland over *Melaleuca uncinata* group Shrubland	EwanMel
i	Woodland over mixed *Melaleuca* Shrubland	EwanMel
j	Woodland over *Acacia*/*Calytrix* Low Shrubland	EwanScrub
k	Woodland over Low Sedgeland	EwanHerbs
l	/*Allocasuarina huegeliana* Woodland	EwanSheoak
m	/*Corymbia calophylla* Woodland	Further to the W
n	/*E. decipiens* Woodland	Further to the W
o	/*E. loxophleba* Woodland	Ewanlox
p	/*E. marginata* Woodland	Further to the W
q	/*E. occidentalis*	Ewanocc

	VEGETATION	CORRESPONDING CODE
i	Tall Woodland	Ewanocc
ii	Open Tall Woodland	Ewanocc
iii	Woodland	Ewanocc
r	/*Melaleuca preissiana* Woodland	
4	***Eucalyptus rudis***	**Erud**
a	Woodland over Open Low Shrubland	Erud
b	Woodland over *Melaleuca viminea* Shrubland over Sedgeland	Erud
c	/*E. decipiens* Woodland	
d	/*E. wandoo*	Ewanrud
i	Open Tall Woodland	
ii	Woodland	
iii	Open Woodland	
e	/*Melaleuca preissiana* Woodland	
f	/*Melaleuca rhaphiophylla* Woodland	
5	***Eucalyptus marginata***	Further to the W
a	Woodland over Laterite Shrubland	Further to the W
b	Woodland over *Dryandra* Shrubland	Further to the W
c	/*Allocasuarina fraseriana* Woodland	Further to the W
d	/*Corymbia calophylla* Woodland	Further to the W
e	/*E. falcata* Woodland	Further to the W
f	/*E. wandoo* Woodland	Further to the W
6	***Corymbia calophylla***	Further to the W
a	/*E. accedens* Woodland	Further to the W
b	/*E. decipiens* Woodland	Further to the W
c	/*E. marginata* Woodland	Further to the W
d	/*E. rudis* Woodland	Further to the W
e	/*E. wandoo* Woodland	Further to the W
7	***Eucalyptus longicornis***	**Elon**
a	Low Forest	ElonChen?
b	Woodland over *Melaleuca* Shrubland	ElonMel
c	/*E. astringens* Woodland	Elonast
d	/*E. wandoo* Woodland	Elonwan
8	***Eucalyptus loxophleba***	**Elox**
a	Woodland over *Acacia acuminata* Low Woodland	EloxJamHerbs, EloxJamScrubHerbs, EloxJamScrub
b	Woodland over *Acacia microbotrya* Tall Shrubland	EloxScrubHerbs
c	Woodland over *Acacia nyssophylla* Tall Shrubland	EloxScrubHerbs
d	Woodland over Shrubland or Low Shrubland	EloxScrubHerbs
e	Woodland over *Melaleuca* Shrubland	EloxMel

	VEGETATION	CORRESPONDING CODE
f	Woodland over Closed Herbland and Closed Grassland	EloxJamHerbs
g	/*Casuarina obesa* Woodland	
h	/*E. spathulata* group Woodland, no understorey	
9	***Eucalyptus capillosa***	**Ecap**
a	Open Forest-Open Woodland over Heath	EcapScrub
b	/*E. transcontinentalis* group Open Forest-Open Woodland	
c	/*E. loxophleba* Open Forest-Open Woodland	
d	/*E. salmonophloia* Open Forest-Open Woodland	Esalmcap
e	/*E. salmonophloia* Open Forest-Open Woodland (on breakaways)	Esalmcap
10	***Eucalyptus salubris***	**Esalu**
a	Woodland over Mallee	EsaluMallee
b	Woodland over *Melaleuca* Open Scrub	EsaluMel
c	Woodland over *Cassia nemophila* Shrubland	EsaluScrub
d	Woodland over Low Shrubland	EsaluScrub
e	Woodland over *Atriplex stipitata* Low Shrubland	EsaluScrub
f	/*E. gracilis* group Low Woodland over *Melaleuca* Shrubland	
g	/*E. loxophleba* Woodland	Esalulox
h	/*E. transcontinentalis* group Woodland	
11	***Eucalyptus urna*** Woodland over *Melaleuca* Shrubland	**Eurn**
12	***Eucalyptus salmonophloia***	**Esalm**
a	Woodland (lake dune)	EsalmDune
b	Woodland over Tree Mallee	EsalmMallee
c	Woodland over Mallee	EsalmMallee
d	Woodland over Heath and/or Shrubland	EsalmScrub
e	Woodland over *Melaleuca* Shrubland	EsalmMel
f	Woodland over samphire Shrubland	EsalmChen
g	Woodland over *Gahnia trifida* Sedgeland	
h	/*Acacia acuminata* Low Woodland	
i	/*E. longicornis* Woodland	Esalmlon
j	/*E. loxophleba* Woodland	Esalmlox
k	/*E. salubris* Woodland	Esalmsalu
l	/*E. wandoo* Woodland	Esalmwan
m	/*E. yilgarnensis* Woodland over *Melaleuca* Shrubland	EsalmMel
13	***Eucalyptus astringens***/*E. accedens* Forest or Woodland	**East**
14	***Eucalyptus decipiens*** Woodland over *Banksia attenuata*/*B. prionotes* Low Woodland	Further to the W
15	***Eucalyptus transcontinentalis* group** Woodland	**Emod**?
16	***Eucalyptus accedens***	**Eacc**
a	Woodland over *Dryandra* Shrubland	EaccScrub
b	Woodland over Open Low Shrubland	EaccScrub

	VEGETATION	CORRESPONDING CODE
17	***Eucalyptus gardneri*** Woodland	**Egar**
18	***Eucalyptus falcata***	**Earg** or **Eorn**
a	/*E. gardneri* Woodland	Egar or Earg or Eorn
b	/*E. gardneri*/*E. astringens* Woodland	Egar or Earg or Eorn or East
19	***Eucalyptus flocktoniae* group** Woodland	**Eurn**
20	***Eucalyptus incrassata*** Woodland	
21	***Eucalyptus densa*** Woodland	**Edens**
22	***Eucalyptus spathulata* group** Open Low Woodland	**Espa**
23	***Eucalyptus myriadena*** Woodland	**Emyr**
24	***Eucalyptus platypus*** Forest or Woodland	Further to the S
25	***Eucalyptus suggrandis* subsp. *alipes*** Woodland over Open Tall Shrubland	**Eali**
26	**Mosaic Woodlands**	
a	*Corymbia calophylla*/*E. wandoo*/*E. decipiens*/*E. occidentalis* Woodland	Ewanocc
b	*E. accedens*/*Corymbia calophylla*/*E. marginata*/*E. wandoo* Woodland	Further to the W
c	*E. longicornis*/*E. wandoo*/*E. salmonophloia* Woodland	Esalmlon, Elonwan
d	*E. loxophleba*/*E. wandoo*/*E. salmonophloia* Woodland	Esalmlox, Ewanlox
e	*E. occidentalis*/*E. decipiens*/*E. rudis* Woodland	
f	*E. occidentalis*/*E. rudis*/*Melaleuca preissiana* Woodland	
g	*E. occidentalis*/*E. rudis*/*E. wandoo* Woodland	Ewanocc, Ewanrud
h	*E. salmonophloia*/*E. capillosa*/*E. loxophleba* Woodland	Esalmcap, Esalmlox
i	*E. salmonophloia*/*E. salubris*/*E. loxophleba* Woodland	Esalmsalu, Esalmlox, Esalulox
j	*E. salmonophloia*/*E. wandoo*/*E. salubris*/*E. loxophleba* Woodland	Esalmwan, Esalmsalu, Esalmlox, Ewanlox, Esalulox
k	*Eucalyptus urna*/*E. eremophila* group/*E. annulata* /*E. phenax* Woodland	Eurn
l	*E. urna*/*E. salmonophloia*/*E. phenax* Woodland over *Melaleuca* Shrubland	Eurn, Esalmurn
m	*E. wandoo*/*Corymbia calophylla*/*Melaleuca preissiana* Woodland	Further to W
n	*E. wandoo*/*E. marginata*/*E. decipiens* Woodland	Further to W
o	*E. wandoo*/*E. occidentalis*/*E. decipiens* Woodland	Further to the W
p	*E. wandoo*/*E. occidentalis*/*E. marginata* Woodland	Further to the W
27	***Acacia acuminata***	
a	Woodland with scattered *E. loxophleba*	EloxJam
b	/*Allocasuarina huegeliana* Woodland	
28	***Allocasuarina huegeliana***	
a	Forest, no understorey	
b	Woodland	
c	Woodland with scattered *E. wandoo*	EwanSheoak
d	Woodland over *Allocasuarina campestris* Shrubland	
e	/*Acacia acuminata*/*E. wandoo* Woodland	EwanJam, EwanSheoak

	VEGETATION	CORRESPONDING CODE
f	/*Acacia lasiocalyx* Woodland	
g	/*Banksia prionotes* Woodland	
h	/*E. loxophleba* Forest	EloxSheoak
29	***Acacia lasiocalyx*** Closed Low Forest or Low Forest	
30	***Casuarina obesa***	
a	Woodland over *Melaleuca cymbifolia* Tall Shrubland	
b	Woodland over samphire Shrubland	
c	/*Melaleuca strobophylla* Woodland	
31	***Banksia attenuata***	
a	/*B. prionotes*/*Allocasuarina huegeliana* Low Woodland	
b	/*E. todtiana*/*B. menziesii* Low Woodland over Low Shrubland	
32	***Banksia prionotes***	
a	Forest	
b	Low Woodland over Heath	
c	/*Allocasuarina huegeliana* Low Woodland	
d	/*Xylomelum angustifolium* Low Woodland over Sedgeland	
e	/*Xylomelum angustifolium*/*Banksia attenuata* Low Woodland	
33	***Melaleuca***	
a	*M. cuticularis* Forest	
b	*M. rhaphiophylla* Forest	
c	*M. preissiana* Forest over Shrubland	
34	***Allocasuarina fraseriana*** Woodland	
35	***Eucalyptus annulata*** Open Low Forest over *Melaleuca acuminata* Tall Shrubland	
36	***Acacia rostellifera*** Forest	
37	***Eucalyptus gracilis* group** (?normally a mallee) Woodland	**Eyil?**
38	***Eucalyptus leptocalyx*** Low Woodland over Open Low Shrubland	
39	***Callitris glaucophylla*** Low Woodland over *Melaleuca*/*Acacia*/*Allocasuarina* Low Shrubland	
40	***Banksia menziesii***/*Xylomelum angustifolia* Woodland over mixed Shrubland and Low Shrubland	
41	***Callitris columellaris*** Low Forest	
	MALLEE	
42	***Eucalyptus eremophila* group**	
a	Very Open Mallee over *Melaleuca* Shrubland	
b	Mallee over *Melaleuca uncinata* group Open Shrubland	
c	/*E. calycogona*/*E. pileata* Open Tall Mallee Woodland over *Melaleuca*	
d	/*E. pileata*/*E. flocktoniae* group Mallee over Tall Shrubland	
43	***Eucalyptus sporadica***	
a	Tree Mallee over *Melaleuca* Shrubland	

	VEGETATION	CORRESPONDING CODE
b	Shrub Mallee over *Melaleuca* Shrubland	
44	***Eucalyptus transcontinentalis* group**	
a	/*E. conglobata*/*E.* spp. Mallee over *Melaleuca* Shrubland over Heath	
b	/*E. eremophila* group Mallee over *Melaleuca* Shrubland	
c	/*E. redunca* group Mallee over Shrubland	
d	/*E. redunca* group/*E. calycogona*/*E. eremophila* group Mallee	
e	/*E. scyphocalyx* Mallee over *Melaleuca* Shrubland	
45	***Eucalyptus incrassata***	
a	Mallee over *Banksia media* Shrubland over Low Heath	
b	/*E. pluricaulis* subsp. *pluricaulis* Mallee	
46	***Eucalyptus leptocalyx***	
a	Mallee over Low Shrubland and Low Grassland	
b	/*E. gracilis* group over *Melaleuca* Shrubland over Heath	
47	***Eucalyptus platypus***	
a	Mallee over Low Shrubland	
b	Mallee over *Melaleuca* Shrubland	
c	/*E. annulata*/*E. transcontinentalis* group over *Melaleuca* Shrubland over Shrubland	
d	/*E. transcontinentalis* group Mallee over *Melaleuca* Shrubland	
48	***Eucalyptus scyphocalyx***	
a	/*E. transcontinentalis* group/*E.* spp. Mallee over Heath	
b	/*E. eremophila* group/*E. flocktoniae* group Mallee over Open Tall Shrubland	
49	***Eucalyptus conglobata***	
a	Mallee over *Melaleuca* Shrubland	
b	/*E. eremophila* group Mallee	
50	***Eucalyptus erythronema***	
a	Mallee over *Melaleuca acuminata*/*M. adnata* Shrubland	
b	/*E. myriadena*/*E. redunca* group/*E. eremophila* group/*E. transcontinentalis* group Mallee over Very Open Shrubland	
c	/*E. yilgarnensis* Mallee	
51	***Eucalyptus burracoppinensis***	
a	Mallee over *Allocasuarina campestris* Shrubland	
b	Mallee over Shrubland	
52	***Eucalyptus suggrandis* subsp. *alipes***	
a	/*E. calycogona* Mallee over *Melaleuca* Tall Shrubland	
b	/*E. calycogona*/*E. phenax*/*E. perangusta* Mallee over *Melaleuca* Tall Shrubland	
53	***Eucalyptus phenax***	
a	/*E. perangusta*/*E. scyphocalyx* Tall Open Mallee over *Melaleuca* Tall Shrubland	

	VEGETATION	CORRESPONDING CODE
b	/*E. perangusta* /*E. sporadica* Tall Open Mallee over *Melaleuca* Tall Shrubland	
c	/*E. suggrandis*/*E. perangusta* Tall Open Mallee over *Melaleuca* Tall Shrubland	
54	***Eucalyptus phaenophylla***	
a	Mallee over *Melaleuca* Tall Shrubland	
b	/*E. leptophylla*/*E. conglobata* Mallee	
c	/*E. sporadica* Mallee	
55	***Eucalyptus sheathiana*** Mallee over *Melaleuca acuminata* Shrubland	
56	***Eucalyptus calycogona***	
a	Mallee over *Phebalium tuberculosum* Shrubland	
b	/*E. calycogona*/*E. eremophila* group Shrub Mallee	
c	/*E. conglobata*/*E. sargentii Mallee* over Shrubland	
d	/*E. eremophila* group/*E. sheathiana*/*E. transcontinentalis* group Mallee with scattered *E. capillosa*	
e	/*E. prolixa*/*E. densa* Tree Mallee	
f	/*E. sheathiana* Mallee over *Melaleuca uncinata* group Shrubland	
57	***Eucalyptus celastroides***/*E. eremophila* group/*E. spathulata* group/*E. flocktoniae* group Mallee over Shrubland	
58	***Eucalyptus perangusta*** Mallee over Open Tall Shrubland	**Mallee**
59	**Mixed Mallee**	
a	*E. brachycorys*/*E. erythronema* subsp. *marginata*/*E. flocktoniae* group/*E. oldfieldii*/*E. pluricaulis*/*E. tenera* Mallee	
b	*E. flocktoniae* group/*E. eremophila* group/*E. conglobata*/*E. pluricaulis* Mallee	
c	*E. transcontinentalis* group/*E. subangusta* Mallee over *Allocasuarina acutivalvis* Shrubland	
d	*Eucalyptus* Shrub Mallee /*Melaleuca* Shrubland over Low Heath	
60	***Eucalyptus tenera***/*E. erythronema* subsp. *marginata* Mallee	
61	***Eucalyptus oldfieldii***/*E. flocktoniae* group Mallee	
62	***Eucalyptus rigidula*** Mallee	
63	***Eucalyptus capillosa* subsp. *polyclada*** Mallee over Melaleuca Tall Shrubland	
64	***Eucalyptus flocktoniae* group**	
a	Mallee over Heath	
b	/*E. incrassata* or *E. conglobata* Mallee	
c	/*E. phenax* Mallee over *Melaleuca* Tall Shrubland	
65	***Eucalyptus subangusta* subsp. *subangusta*** Mallee over *Allocasuarina campestris* Shrubland	
66	***Eucalyptus pileata*** Very Tall Open Mallee Forest	
67	***Eucalyptus falcata*** Mallee	
68	***Eucalyptus hypochlamydea*** Mallee	
69	***Eucalyptus brachycorys***/*E. hypochlamydea* (*E. comitae-vallis*)	

	VEGETATION	CORRESPONDING CODE
	Mallee over *Melaleuca uncinata* group Shrubland	
70	***Eucalyptus annulata*** Mallee	
71	***Eucalyptus decipiens*** Mallee	
	SHRUBLAND	
72	***Allocasuarina campestris*** **(Tammar)**	
a	Shrubland over mixed Closed Low Heath	
b	Shrubland over *Borya nitida* Herbland	
c	Shrubland over *Ecdeicolea* Open Low Sedgeland	
d	/*Acacia acuminata*/*Allocasuarina*/*Melaleuca* Shrubland	
e	/*Hakea subsulcata* Shrubland over *Dryandra*/*Melaleuca* Shrubland	
73	***Allocasuarina acutivalvis***	
a	Shrubland over *Melaleuca uncinata* group Shrubland	
b	/*Melaleuca* Shrubland	
c	/*Hakea scoparia*/*H. francisiana*/*Melaleuca uncinata* group Shrubland	
74	***Melaleuca***	
a	*Melaleuca acuminata* Shrubland over Sedgeland and Herbland	
b	*Melaleuca hamulosa*/*Callistemon phoeniceus* Shrubland	
c	*Melaleuca lateriflora*/*M. uncinata* group Shrubland	
d	*Melaleuca thyoides*/*Casuarina* Shrubland over samphire Shrubland	
e	*Melaleuca uncinata* group Shrubland	
f	*Melaleuca viminea* Shrubland	
g	/*Hakea erecta* Shrubland	
75	***Acacia***	
a	*Acacia acuminata*/*Melaleuca uncinata* group Shrubland	
b	*Acacia multispicata* Shrubland, no understorey	
c	*Acacia multispicata*/*Melaleuca* Shrubland	
76	***Actinostrobus***/***Banksia***/***Xylomelon*** Shrubland	
77	***Leptospermum erubescens*** Tall Shrubland	
78	***Hakea varia*** Shrubland	
	SEDGELAND	
79	***Baumea articulata*** Tall Sedgeland	
	GRANITE COMPLEX	
	SALT LAKE	
	UNVEGETATED	

APPENDIX 2 Wheatbelt groups and assemblages produced by the SAP analysis of floristic and bioregional variables

Woodlands groups identified by the SAP analysis (extract from (Gibson *et al.* 2004). Vegetation is coded corresponding to communities and sub-communities defined in this Project.

ID	Description	Corresponding code
G2	Northern herb-rich woodlands generally on duplex soils dominated by ***Eucalyptus loxophleba*** or ***E. salmonophloia***, with a wider distribution than G1 extending into the Avon 2 and Geraldton Sandplains 3 subregions.	Esalmlox
G4	Central and southern woodland Woodlands dominated by ***Eucalyptus longicornis, E. kondininensis*** or ***E. salmonophloia*** and almost exclusively recorded from duplex soils. Less species-rich than G1 and G2 and generally lacking many of the herbs. Chenopods were a common component of the understorey with *Sclerolaena diacantha* and *Atriplex vesicaria* the most typical species of these quadrats. This group was generally restricted to the Mallee 2 subregion.	ElonChen Esalmlon EkonChen EsalmChen
G5	Central and southern woodlands of ***Eucalyptus salmonophloia, E. longicornis, E. occidentalis*** or ***E. astringens*** are widespread, occurring from Jarrah Forest 2 through Avon 2, Avon I, Mallee 2 subregions and into Mallee 1 subregion. This group generally lacks the chenopod understorey of G4.	Esalmlon Elonast Eastocc
G6	Mallees and woodlands mostly on duplex soils in the Mallee 2 subregion extending into the Avon 2 and the Avon 1 subregions. Eucalypt dominance was variable but *Eucalyptus calycogona* was the most typical mallee and ***Eucalyptus salmonophloia*** was occasionally present.	EsalmMallee
G7	Woodlands in the wettest part of the study area and generally dominated by ***Eucalyptus marginata, E. calophylla*** or ***E. wandoo***. Soil type was variable with quadrats recorded from granite, duplex laterite and deep sand soils. Quadrats were almost totally confined to Jarrah Forest bioregion.	Too far to the W EwanHeath
G12	Woodlands dominated by ***Eucalyptus loxophleba, Allocasuarina huegeliana, Acacia acuminata*** or ***Eucalyptus wandoo*** are species rich woodland quadrats (mean 48.3 taxa/quadrat) on granite or duplex soils were generally. They generally occurred in the Avon bioregion and the Jarrah Forest 1, and Mallee 2 subregions.	EloxSheoak EloxJam Eloxwan EwanSheoak
G19	***Eucalyptus astringens*** subsp. ***astringens*** woodlands generally occurred on breakaways or as mallet stands on laterites. They were typically species poor (mean 11.1 taxa/quadrat) and mainly in Avon 2 bioregion	East
G24	Woodlands of ***Eucalyptus salubris***, some ***E. salmonophloia*** and two subspecies of *Melaleuca pauperiflora* form a group of species-poor eucalypt woodlands and mallee on duplex soils restricted to the Mallee bioregion. Mean species richness was low at 6.3 taxa/quadrat.	Esalmsalu

As a second approach to assessing phytogeographical patterns within the study area, Gibson *et al.* (2004) classified the 682 quadrats in terms of their relative weighting for the various species assemblages identified from the quadrat classification analysis (described above), and compared the results with the existing bioregions and subregions. For this analysis, species assemblages were weighted equally by using the proportion of an assemblage's maximum species richness recorded at each quadrat as input data.

Assemblages relevant to the current classification are listed below.

ID	Description	Code
A1.	The taxa of assemblage 1 are widespread across the Avon and Coolgardie bioregions with some of the annual and shrub components extending into Acacia shrublands of the Eremaean. It is overwhelmingly composed of annual herbs and geophytes. The species are more abundant on the more fertile duplex and granite soils in drier areas of the SWBP. Typical sp de include the canopy species ***Eucalyptus loxophleba*** subsp. ***loxophleba***, *Acacia acuminata**, E. capillosa*** subsp. ***capillosa*** and *Santalum acuminatum* and numerous annual herbs that are common in ***Eucalyptus loxophleba*** woodlands (e.g. *Waitzia acuminata, Rhodanthe laevis, Hyalosperma demissum*).	EloxJamHerbs Ecap
A3.	Semi-arid and arid woodland species of the duplex soils of broad valley floors in the Coolgardie bioregion, the southern part of the Yalgoo, the eastern part of the Avon and the northern part of the Mallee bioregions form assemblage 3. It also includes woodland species of calcareous soils. Canopy species include ***Eucalyptus salmonophloia, E. longicornis, E. yilgarnensis, E. salubris***, and the shrubs *Acacia erinacea, Olearia muelleri, Enchylaena tomentosa, Rhagodia drummondii* and *Sclerolaena diacantha*. Typical herbs include *Velleia rosea, Myriocephalus guerinae* and *Ptilotus exaltatus.* This assemblage faces significant risk from dryland salinity.	Esalmlon Esalmsalu EsalmScrub EsalmChen ElonChen ElonScrub Eyil EsaluScrub EsaluChen
A5.	The composition of assemblage 5 is variable, made up of taxa typical of breakaways and/or heavy duplex soils but also including some taxa more common on sandy soils. Most taxa occur from the boundary of the Jarrah Forest and Avon bioregions extending eastward into the Mallee bioregion. Typical taxa of breakaways and duplex soils include ***Eucalyptus astringens*** subsp. ***astringens***, mallee *E. capillosa* subsp. *polyclada*, over shrubs of *Gastrolobium* parvifolium, Nemcia tricuspidata, and the orchid Oligochaetochilus sargentii.	East
A6.	Woodland and mallee species of the Avon, Mallee and Coolgardie bioregions, occurring on duplex soil associated with uplands and side slopes comprise assemblage 6. Typical mallee eucalypts include *E. platypus, E. flocktoniae, E. phenax, E. calycogona, E. conglobata* and *E. eremophila.* The assemblage also includes some species common on low lake dunes sands adjacent to salt lakes (e.g. Swamp Mallet ***E. spathulata, E. kondininensis***). Other typical species include *Melaleuca teuthidoides, Melaleuca acuminata, M. adnata, Zygophyllum ovatum* and *Westringia rigida*. This assemblage faces significant risk from dryland salinity in specific topographical positions.	Espa EkonMel
A12.	Taxa primarily of granite aprons and seasonally inundated clay flats comprise assemblage 12. Some of the taxa can also occur on sands. In this assemblage herbs and geophytes predominate, with distributions centred on the Jarrah Forest and Avon bioregions but also extending onto the Swan Coastal Plain bioregion and east into the wetter parts of the Mallee bioregion. Typical taxa include *Allocasuarina huegeliana*, ***Eucalyptus occidentalis***, *Stypandra glauca, Borya laciniata, B. sphaerocephala, Siloxerus multiflorus, Aphelia cyperoides, Waitzia suaveolens, Caesia micrantha, Sowerbaea laxiflora* and *Centrolepis drummondii.*	Eocc
A13.	A13 Assemblage 13 is comprised of taxa typical of ***Eucalyptus***	EwanHerbs

	wandoo (Wandoo) woodlands on duplex soils; some taxa in this assemblage are also common on sandy soils. The distribution patterns of taxa in this assemblage are similar to assemblage 12, being centred on the eastern edge of the Jarrah Forest bioregion. Characteristic taxa include ***Eucalyptus wandoo***, *Chamaescilla versicolor, Hyalosperma cotula, Hibbertia commutata, Bossiaea eriocarpa, Diuris corymbosa, Desmocladus asper* and *Craspedia variabilis*. This assemblage faces some risk from dryland salinity in susceptible landscape positions.	
A17.	Small group of taxa of lateritic and duplex soils form assemblage 17. Distributions are centred on the eastern part of the Jarrah Forest and western part of the Avon bioregions but there is little congruence between the distributions of individual taxa. Some taxa extend into the southwest corner and one extends to the Esperance Sandplains bioregion, other are restricted to the Geraldton Sandplain, Avon and the northern part of the Jarrah Forest bioregion. This assemblage was not we1l sampled in the current survey. Typical taxa include ***Eucalyptus falcata, E. accedens****, Astroloma drummondii, Gahnia australis, Dryandra squarrosa* subsp*. squarrosa* and *Gastrolobium microcarpum*.	Eorn Earg Eacc

APPENDIX 3 Wheatbelt woodlands classification by Griffin

Classification of Wheatbelt woodlands at the 25 group level by (Griffin 2008). Non-woodland vegetation is in grey. Vegetation is coded corresponding to communities and sub-communities defined in this Project.

Group No	Description	Number of Sites	Corresponding Code
1	*Eucalyptus wandoo* subsp. *pulverea*	13	EwanN
2	*Eucalyptus accedens*	14	Eacc
3	*Allocasuarina campestris* shrublands with a number of distinct different trees, e.g. *E. loxophleba, E. salmonophloia, E. wandoo, E. oldfieldii*	7	EloxSheoak EwanSheoak
4	*Melaleuca undulata* shrubland, often with *Dodonaea bursariifolia* and or *Allocasuarina acutivalvis*	16	
5	*Isopogon buxifolius* and/or *Banksia media* shrublands	6	
6	Heterogeneous unit. Many apparently distinct units each with a number of different eucalypts	16	
7	*Eucalyptus myriadena*	5	Emyr
8	*Eucalyptus astringens* subsp. *redacta*	2	Too far S
9	*Eucalyptus capillosa* subsp. *capillosa*	12	Ecap
10	*Melaleuca acuminata* subsp. *acuminata*	10	
11	*Eucalyptus astringens* subsp. *astringens*, often with *E. wandoo*	14	EastScrub or EastHerbs
12	*Eucalyptus loxophleba* subsp. *lissophloia*	23	mallee
13	*Eucalyptus longicornis*	18	Elon
14	*Rhagodia drummondii*	16	Esali?
15	*Rhagodia drummondii*	32	Ekon?
16	*Rhagodia drummondii*	19	EloxN?
17	*Eucalyptus loxophleba* subsp. *loxophleba*	51	Elox
18	*Eucalyptus salmonophloia*	79	Esalm
19	*Eucalyptus salubris, some E. salmonophloia*	77	Esalmsalu
20	*Eucalyptus wandoo* subsp. *wandoo*	73	EwanScrub Ewanacc
21	*Eucalyptus wandoo* subsp. *wandoo*	28	EwanJam
22	*Eucalyptus occidentalis*	12	Eocc
23	*Eucalyptus occidentalis*	21	Eocc
24	*Eucalyptus occidentalis*	21	Eocc
25	*Eucalyptus loxophleba* subsp. *loxophleba* & *Acacia acuminata*	50	EloxJam

APPENDIX 4 Wheatbelt eucalypt woodland communities and sub-communities factsheets

[Click on blue links to get to the community factsheets]

Availability of reference sites for the communities or sub-communities are indicated by asterisks.

***Eucalyptus longicornis* (Red Morrel) Woodland**

- Red Morrel over Melaleuca *
- Red Morrel and Gimlet
- Red Morrel over Chenopods *
- Red Morrel on Dunes *
- Red Morrel and Wandoo *
- Red Morrel and Black Morrel *
- Red Morrel and York Gum *
- Red Morrel over Mallee *
- Red Morrel over Scrub
- Red Morrel and Brown Mallet *

***Eucalyptus salmonophloia* (Salmon Gum) Woodland**

- Salmon Gum over Scrub *
- Salmon Gum over Chenopod Scrub *
- Salmon Gum and Wandoo *
- Salmon Gum and Gimlet *
- Salmon Gum and York Gum *
- Salmon Gum over Melaleuca *
- Salmon Gum and Red Morrel *
- Salmon Gum over Mallee *
- Salmon Gum and Wheatbelt Wandoo *
- Salmon Gum on Dunes *
- Salmon Gum and Merrit *

***Eucalyptus salubris* (Gimlet) Woodland**

- Gimlet over Melaleuca *
- Gimlet over Scrub *
- Gimlet over Mallee *
- Gimlet and York Gum *
- Gimlet on Dunes *

***Eucalyptus loxophleba* (York Gum) Woodland**

- York Gum and Jam over Herbs *
- York Gum and Jam over Scrub and Herbs *
- York Gum and Jam over Scrub *
- York Gum over Scrub and Herbs *

- York Gum over Melaleuca *
- York Gum in Saline Areas *
- York Gum on Dunes *
- York Gum and Sheoak
- York Gum North *

***Eucalyptus wandoo* (Wandoo) Woodland**

- Wandoo over Heath *
- Wandoo over Herbs *
- Wandoo over Scrub *
- Wandoo and Sheoak *
- Wandoo over Tammar or Melaleuca **
- Wandoo and Jam *
- Wandoo and Mallee
- Wandoo and York Gum
- Wandoo and Powderbark Wandoo
- Wandoo and Flooded Gum or Flat-topped Yate **
- Wandoo in Saline Areas *
- Wandoo North

***Eucalyptus capillosa* (Wheatbelt Wandoo) Woodland**

- Wheatbelt Wandoo over Herbs *
- Wheatbelt Wandoo over Scrub *

***Eucalyptus accedens* (Powderbark Wandoo) Woodland**

- Powderbark Wandoo over Scrub *

***Eucalyptus melanoxylon* (Black Morrel) Woodland** *

MALLET WOODLANDS

Eucalyptus astringens (Brown Mallet) Woodland

- Brown Mallet over Little Understorey *
- Brown Mallet over Scrub *
- Brown Mallet over Mallee
- Brown Mallet and Merrit *
- Brown Mallet and Flat-topped Yate *

Eucalyptus argyphea (Silver Mallet) Woodland

- Silver Mallet Over Little Understorey *
- Silver Mallet over Scrub *

Eucalyptus urna (Merrit) Woodland *

Eucalyptus gardneri (Blue Mallet) Woodland *

Eucalyptus ornata (Ornate Mallet) Woodland

Eucalyptus spathulata (Swamp Mallet) Woodland

Eucalyptus singularis (Mallet) Woodland

Eucalyptus densa (Mallet) Woodland *

Eucalyptus extensa (Mallet) Woodland

Eucalyptus recta (Cadoux Mallet) Woodland

Eucalyptus alipes (Mallet) Woodland

Eucalyptus polita (Mallet) Woodland

OTHERS

Woodlands associated with salt lakes

Eucalyptus kondininensis (Kondinin Blackbutt) Woodland

- Kondinin Blackbutt over Chenopods *
- Kondinin Blackbutt over Melaleuca *

Eucalyptus myriadena (Blackbutt) Woodland *

Eucalyptus salicola (Salt Salmon Gum) Woodland *

Eucalyptus sargentii (Salt River Gum) Woodland *

Woodlands associated with drainage lines

Eucalyptus occidentalis (Flat-topped Yate) Woodland

- Flat-topped Yate Southern Wheatbelt *
- Flat-topped Yate South Coast
- Flat-topped Yate West

Eucalyptus rudis (Flooded Gum) Woodland

Eastern Woodlands

Eucalyptus moderata (Redwood) Woodland

Eucalyptus yilgarnensis (Yorrell) Woodland *

Outlying Woodlands

Eucalyptus marginata (Jarrah)

See the factsheet glossary for explanation of terms.