Natural Vegetation of the New South Wales Wheat-belt (Cobar–Nyngan–Gilgandra, Nymagee–Narromine–Dubbo 1:250 000 vegetation sheets)

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Abstract: The vegetation of the Central Division of New South Wales (lat. 31°–33° S, long. 146° 30’–149° E) was classified and mapped (Cobar–Nyngan–Gilgandra, Nymagee–Narromine–Dubbo 1:250 000 mapsheets) as part of the NSW National Parks & Wildlife Service wheat-belt mapping series. The vegetation classification was derived using traditional air photo interpretation and quantitative analysis of data from 428 field sites. Analyses included hierarchical classification in PATN to define floristic groups, then Fidel and ANOSIM to elucidate the characteristic species of the groups and explore the consistency of these relationships at various levels of similarity. Maps and descriptions show the floristic composition and structure, the geographic distribution of assemblages, the current extent, and shape and degree of connectivity of vegetation and changes in native woody vegetation cover over time.

22 vegetation units were defined, 19 were woodlands and forests dominated by eucalypts including *Eucalyptus populnea* subsp. *bimbil* — P4 Poplar Box Woodlands and P16 Simple Poplar Box Woodlands; *Eucalyptus largiflorens* — R3 Black Box Woodlands; *Eucalyptus microcarpa* — P12 Woodlands on Jurassic Sandstone and P13 Grey Box Woodlands; *Eucalyptus camaldulensis* — R1 River Red Gum Forests and Woodlands; *Eucalyptus intertexta* — P14 Red Box, Poplar Box and Pine Woodlands, U1 Red Box, Poplar Box, Pine and Green Mallee Woodlands and U2 Red Box, Poplar Box and Pine Woodlands on Granite Hillslopes; *Eucalyptus dwyeri* — U3 Dwyer’s Red Gum Low Open Woodland on Granite Crests, H1 Dwyer’s Red Gum, Ironbark and Green Mallee Woodlands and H9 Dwyer’s Red Gum Open Woodlands on Granite Hills; *Eucalyptus viridis* — H2 Green Mallee Woodlands; *Eucalyptus morrisii* — H6 Grey Mallee Open Woodlands; Mallee — H7 Mallee Woodlands on Rolling Hills and P1 Mallee Woodlands on Plains; *Eucalyptus dealbata* — H8 Tumble-down Red Gum Woodlands on Basalt Hills; and *Eucalyptus chloroclada* — P15 Dirty Red Gum, Pine and Poplar Box Woodlands. These eucalypt woodlands exhibit diversity in structure and associated species composition. Two tall open shrublands of *Acacia pendula* — R5 Myall Woodlands and *Flindersia maculosa* — P11 Leopardwood Open Shrublands and a woodland dominated by *Callitris glaucophylla* — P6 White Cypress Pine Woodlands are included in the mapping.

The current extent of native woody vegetation is 1.2 million ha (29%) of the total 4.1 million ha study area. Over a period of 15 years approximately 130 000 ha or 10% of the extant vegetation was cleared. Only four of the 22 vegetation units are represented in conservation reserves. These reserves are not considered to adequately represent the diversity of the vegetation units they contain nor do they comprehensively represent the diversity of the vegetation. Threatening processes including; continued clearing, changing water regimes, habitat fragmentation, over-grazing by domestic, feral and native animals, nutrient enrichment, compaction of soil, firewood collection and weed invasion operate in this predominantly agricultural landscape, all of which have implications for the long-term persistence of the vegetation of the area.

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Introduction

Inventory of natural resources is a pre-requisite for land management and conservation (Brooker & Margules 1996, Pressey & Taffs 2001). A vegetation map can provide quantitative information including: the composition and structure of floristic assemblages; the total remaining area of vegetation types; the degree of connectivity between remnant vegetation and conservation reserves; proximity of vegetation to important natural or cultural features; and probable locations of rare, endangered or vulnerable species in the landscape. Information of this type allows management decisions to be discussed on a factual rather than speculative basis and provides a consistent base-line for monitoring further change. This mapping is the second in the NSW National Parks & Wildlife Service (NP&WS) wheat-belt study (Fig. 1) and follows the Forbes and Cargelligo 1:250 000 map sheets (Sivertsen & Metcalfe 1995).

Thematic mapping has always relied on a variety of techniques to depict and summarise the real world. Improvements in analysis of quantitative data, geographic information systems and remote sensing techniques has led to an increased ability to classify and use complex data to inform and quantify decisions about map categories. The maps presented here rely on qualitative patterns, recognised from

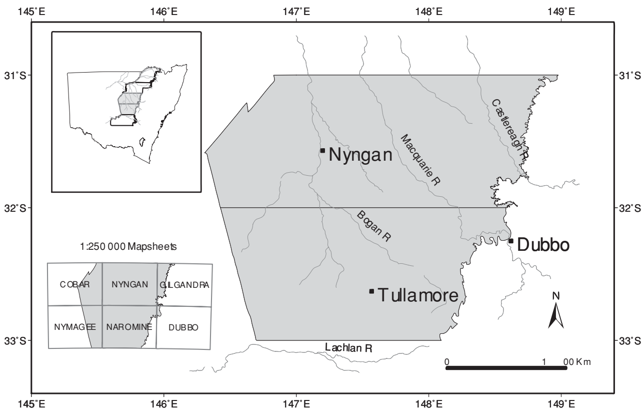

Fig. 1. Study area of NP&WS wheat-belt vegetation mapping showing Cobar–Nyngan–Gilgandra and Nymagee–Narromine–Dubbo 1:250 000 map sheets.

broad scale aerial photography interpretation (API), combined with analyses of quantitative information collected at spatially explicit site locations. Techniques such as: PATN analysis, an hierarchical classification of floristic site data; ANOSIM, comparison within and between groups from an hierarchical classification; and a technique to compare independent data to the hierarchical groups were all used to assess quantitative support for the qualitative interpretations of the vegetation. Systematic quantitative analyses allows an increased level of transparency in assigning and describing map categories, and the ability to repeat and revise such mapping in the light of additional data.

Quantitative information collected on structural diversity and species composition can also be used to reconstruct the original extent and distribution of vegetation types (Austin et al. 2000), determine potential sources of native seed and guide appropriate species selection for revegetation programmes to ameliorate the effects of salinity and excessive clearing (DLWC 2000).

This section of the NSW NP&WS wheat-belt study area covers the central west of NSW, west of Dubbo, and includes the towns of Nyngan, Girilambone, Warren, Gulargambone Gilgandra, Narromine, Nevertire, Tullamore, Tottenham, Trangie, Fifield, and Trundle (lat. 31°–33° S long. 146° 30'–149° E). The eastern edge is the beginning of the South Western slopes at approximately the 300 m contour line (~149°) and the western edge is the Western Division boundary (~146°30') (Fig. 1). The total study area is 4 177 500 ha and includes four of the Interim Biogeographic Regionalisation for Australia (IBRA) units (Laut et al. 1980, Thackway & Cresswell 1995, Fig. 2, Table 1) and ten Local Government Areas (Table 2).

Prior to European settlement the NSW wheat-belt area was predominantly vegetated by temperate eucalypt woodlands (Beadle 1981) which are some of the most poorly conserved ecosystems in Australia (Yates & Hobbs 1997). In this agricultural landscape of chiefly freehold title, eucalypt woodlands have been substantially cleared (MDBMC 1987, Benson 1991, Graetz 1992, Benson 1999, Barson 2000, Sivertsen & Clarke 2000) and are subject to many threatening processes such as: continued clearing (Cox et al. 2001, Bedward et al. 2001); changing water regimes (Kingsford & Thomas 1995); habitat fragmentation; over-grazing by domestic, feral and native animals; nutrient enrichment; compaction of soil; firewood collection and weed

Table 1. IBRA units in the NP&WS wheat-belt study area showing total area, area mapped with native woody vegetation cover on Cobar–Nyngan–Gilgandra, Nymagee–Narromine–Dubbo 1:250 000 mapsheets.

IBRA unit	Area mapped (this paper) (ha) (% total area)		Area vegetated (this paper) (ha) (% area mapped)		Total area (wheatbelt study, ha)
Brigalow Belt South	213 230	(4)	28 122	(13)	5 271 990
Cobar Peneplain	1 693 216	(23)	680 826	(40)	7 346 050
Darling Riverine Plains	1 861 183	(19)	433 463	(23)	9 704 600
NSW South Western Slopes	409 798	(5)	52 463	(13)	8 083 833

Table 2. Area of Local Government Areas (LGA) mapped in this paper

LGA	Extent of LGA in study area (ha)	%	Total area LGA (ha)
Bogan	1 178 021	96	1 230 447
Cobar	224	9	2 598
Coonabarabran	4 805	7	68 004
Coonamble	291 445	30	960 516
Dubbo	50 380	100	50 380
Gilgandra	233 156	100	233 156
Lachlan	805 125	54	1494 874
Narromine	481 403	100	481 403
Parkes	324 167	71	454 089
Warren	808 703	76	1 068 835

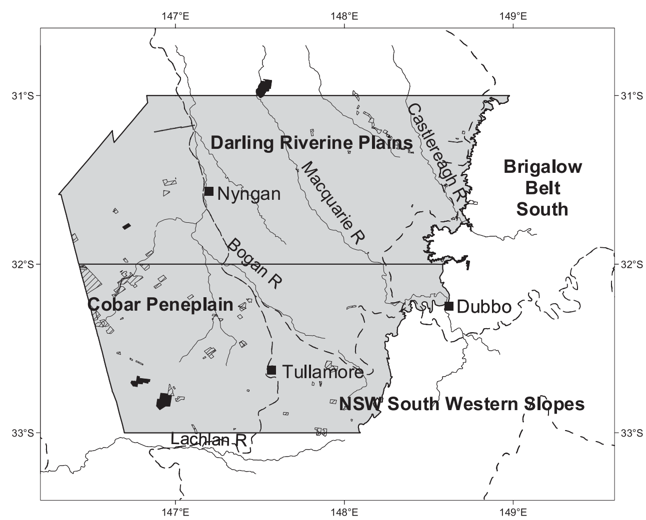

Fig. 2. IBRA areas represented in the NP&WS wheat-belt study area and the location of State Forest, hatched; National Parks &Wildlife Service estate, black; IBRA units, dashed line.

Table 3. Previous vegetation mapping within the study area: Cobar–Nyngan–Gilgandra, Nymagee–Narromine–Dubbo 1:250 000 mapsheets). Total area of NSW NP&WS wheat-belt study is 4 177 500 ha.

Reference	Scale	Area (ha) in study area	Mapping approach
Beadle 1981	1:360 000	2 992 830	Intuitive classification developed from extensive field reconnaissance. Mapping extrapolated to cleared areas using field observations and inferred relationships between vegetation, climate and soils.
Biddiscombe 1963	1:60 000	661 186	Intuitive classification developed from extensive field reconnaissance. Floristic alliances mapped using API. Mapping extrapolated to cleared areas using field observations and inferred relationships between vegetation, climate and soils.
Chinnick & Key 1971	1:127 000	1 849 985	Air photo interpretation (API), soils and density of timber.
Johnson et al. 1991	1:25 000	99 295	Quantitative classification from field sites reconciled with API
Pickard & Norris 1994	1:1 000 000	931 555	Intuitive classification developed from limited field reconnaissance and literature. Floristic alliances mapped using API (photomosaics) and geological mapping. Mapping extrapolated to cleared areas using geological and climatic maps.
Steenbeeke 1996	1:50 000	356 000	Quantitative classification from field sites reconciled with API
Hassle & Associates 1996	1:250 000	72 000	Interpretation of 1:250 000 Landsat TM
Porteners 1998	1:50 000	854	Quantitative classification from field sites reconciled with API
Austin et al. 2000	N/A	518 781	Distribution models developed for frequently occurring tree species from field samples and spatial data on soils, climate and terrain. Pixels classified into classes based on the predicted composition of modelled tree species.
Porteners 2001	1:100 000	9 797	Quantitative classification from field sites reconciled with API
Lewer et al. 1998	1:100 000	1 049 776	Quantitative classification from intensive field sampling across all tenure reconciled with API

invasion (Yates & Hobbs 1997, Hobbs &Yates 2000). The resources and time required to redress these problems are substantial (Prober et al. 2001). Despite the *Native Vegetation Conservation Act* (1997), extensive clearing has continued, particularly the already fragmented vegetation of the agricultural areas (EPA 1997, 2000, ERIC 1998, Cox et al. 2001). Clearing has been recognised as a major concern for the persistence of biodiversity and has been listed as a key threatening process under the NSW *Threatened Species Conservation Act* (1995). These legislative measures appear to have only had limited success in reducing clearing in the wheat-belt.

We have systematically mapped and described the remaining native woody vegetation at the 1:250 000 scale, across all tenures, occurring on the Cobar–Nyngan–Gilgandra and Nymagee–Narromine–Dubbo 1:250 000 map sheets (Fig. 1). The maps show composition and structure of floristic assemblages, extent, shape, and configuration of native woody vegetation. These allow land managers to assess the value and vulnerability of vegetation that occurs on various land tenures and determine the implications for management and sustainability of this natural resource. These maps have also been used successfully to provide a consistent base-line for monitoring further change in native woody vegetation cover (see Cox et al. 2001).

Previous mapping

Various maps and descriptions of the vegetation exist (Fig. 3, Table 3). Beadle (1948, 1981) described the general location of plant alliances; Biddiscombe (1963) mapped (at 1:60 000 scale) 22 floristic associations on the lower north-western slopes and on the plains in the east of the study area. Soils and timber density on the Bogan–Macquarie floodplain affected by an outbreak of the locust *Chortoicetes terminifera* were mapped by Chinnick & Key (1971). A small part of Macquarie Marshes Nature Reserve 1:25 000 mapping (Johnson et al. 1991) and the eastern margin of Pickard & Norris (1994) 1:1 000 000 map are in the study area. Steenbeeke's (unpub.) draft mapping identified 20 vegetation units, including five *Eucalyptus populnea* Poplar Box Woodland sub-alliances at 1:25 000 scale in the lower Macquarie floodplain. Macquarie Valley Landcare (Hassall & Associates 1996) investigated tree density, historical changes and current health of vegetation in the upper Macquarie River. A small amount of systematic data collection and mapping on an *ad hoc* basis has been done in conservation reserves (e.g. Porteners 1998, 2001). Distribution models for frequently occurring plant species developed by Austin et al. (2000) from field samples and spatial data on soils, climate and terrain are available for part of the south-eastern corner. Recent detailed mapping by Lewer et al. (unpub.) covers the Tottenham, Dandaloo, Boona Mount, Tullamore, Condobolin and Bogan Gate 1:100 000 map sheets.

A general overview of the predicted distribution and broad floristic associations of the vegetation was obtained from Biddiscombe (1963), Beadle (1948, 1981), Norris and Pickard (1994). As the data collection for this study was completed in 1988 and the digitising completed in 1999, some of the mapping since these dates has been informed by this work.

Porteners (1998 and 2001) used this mapping for a general overview of the vegetation for the area in and around the Woggoon and Tollingo Nature Reserves, then sampled more intensively within the Nature Reserves. Floristic data from this survey was provided to Austin et al. (2000) for inclusion in the floristic distribution models. Johnson et al. (1991) mapping is predominantly outside the study area and the mapping within the study area identifies non-woody floodplain vegetation not covered in this work. Similarly the focus of Steenbeeke's (unpub.) work is non-woody floodplain vegetation and was examined specifically in relation to the Eucalypt Box Woodland vegetation. The site data from Lewer (unpub.) is used in this mapping to examine the adequacy of sampling on public land and to determine if the sampling regime was comprehensive for the floristic diversity of a subset of the study area. While these mapping exercises contribute to the understanding of floristic diversity, they do not collectively provide a map of extant vegetation for the whole area. The maps presented here, across all tenure, address the needs of land managers on both public and private lands for management and conservation planning at a regional scale.

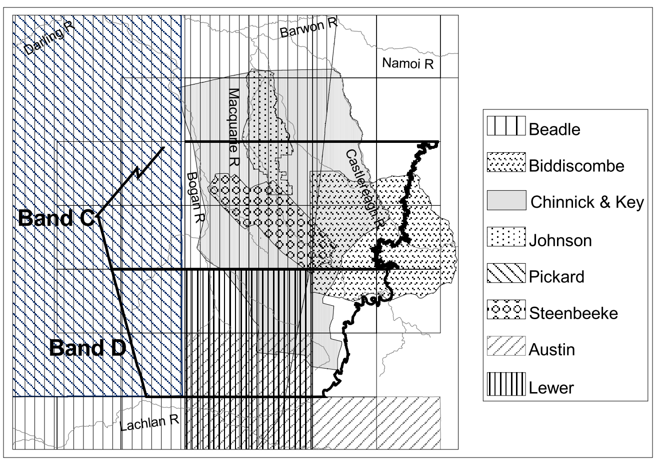

Fig. 3. Coverage of previous vegetation mapping: Beadle, 1948; Biddiscombe, 1963; Chinnick & Key, 1971; Johnson et al., 1991; Steenbeeke, unpub.; Pickard & Norris, 1994; and Lewer et al., unpub.

History of occupation and land use

Indigenous people occupied the area for thousands of years prior to European settlement (Pearson 1973). The Wiradjuri people are recognised as the main Aboriginal group with an affinity to the area, but little evidence of their occupation has been recorded (Pearson 1973). Some ceremonial grounds and burial mounds were documented around Dubbo (Garnsey 1946) and Dorothy McLelland photographed dendroglyphs marking burial sites in the Narromine area (Payne unpub.). Since the introduction of pastoralism and agriculture, land use has changed radically and rapidly. Permanent camps, borah rings, canoe scar trees, dendroglyphs, artefacts and significant natural sites are susceptible to clearing, ploughing and land disturbance (Pearson 1973, Pearson & Sullivan 1995). Many permanent camps, artefacts and sites were located along the most favourable routes and in the best locations for access to water and resources, and were displaced or destroyed by townships and rural settlement (Garnsey 1946, Pearson 1973). Many indigenous people were displaced by the advancing pastoralists (Garnsey 1946) and forcibly removed to missions or reserves (Payne unpub.). Aboriginal Land Councils represented in this area include Pilliga, Coonamble, Quambone, Nyngan, Coonabarabran, Weilwan, Cobar, Warren-Macquarie, Gilgandra, Condobolin, Dubbo, Trangie, Narromine and Peak Hill. These Land Councils have a limited role in the determination of land use and management in the area via Local Government and Regional Vegetation Management Committees (NVCA 1997).

Official European exploration of the area began with John Oxley, who travelled along the Macquarie and Castlereagh Rivers in 1818. Charles Sturt's observations on the landform, rivers, soils and vegetation (1828–29) encouraged pastoral leases west of Wellington from 1837 (Brennan 1972). Thomas Mitchell travelled through the area in 1846 and navigated to the western side of the Macquarie Marshes and on to the Bogan River. Rapid expansion of agricultural activities such as grazing of cattle and sheep followed. The first towns to be proclaimed include: Dubbo, in 1848; Warren, in 1860; and the village of Canonba, in 1866, which all but vanished by 1887, as the railhead at Nyngan was developed. Nevertire sprang up in 1883 as a railhead town transporting wool from the region and copper from Nymagee (Brennan 1972). The Narromine area is an historically important mining area. Tottenham and Albert were major copper producers and Fifield was the leading platinum producer in Australia in the late twentieth century. Currently, copper and gold are mined at Northparkes, 30 km north of Parkes, Peak Hill 1:100 000 (Sherwin 1996). Since 1993 the copper mining industry has been redeveloped west of Girilambone, where copper was first discovered in 1875 (Gilligan et al. 1995).

Management of river flows led to broad acre cropping of cereals and fodder close to the rivers. Irrigation has expanded since the 1940s and cropping now occurs across most of the study area. The intensity of production varies across the landscape. In the west, sheep grazing with occasional cereal or fodder cropping occurs. In the basin of the Bogan River, a mixture of grazing and cropping occurs, ground water is saline and stock are dependent upon dams filled by rainfall (Sherwin 1996). The intensity and frequency of cropping increases in the east, with large-scale irrigation along the Macquarie River. On the alluvial plains and deep soils, sheep grazing complements intense and frequent cereal cropping. Firewood collection for the domestic markets of Canberra and Sydney is widespread. Irrigated cropping of cotton is now an economically important activity in the Macquarie valley (ABS 1996). Increasing river regulation on the Macquarie River (Kingsford & Thomas 1995) has occurred since completion of the Burrendong Dam in 1965 and Windamere Dam in 1984.

Tenure

Freehold title accounts for 92% of the area. Land formally dedicated to nature conservation comprises four Nature Reserves: Macquarie Marshes; Quanda; Tollingo and Woggoon (14 860 ha or 0.35% of the study area). There are 56 small, often isolated State Forests (Table 5) occupying 1.4% of the study area. The remaining 248 000 ha or 6% is Public Land as Leasehold, Vacant Crown Land, Travelling Stock and Road Reserves (Table 4).

Table 4. Tenure of land in the study area (adapted from Pressey et al. 2000)

Tenure	Area (ha)	%
Freehold	3 857 600	92
Leasehold	182 600	4.4
Other Crownland	65 400	1.6
State Forest	58 550	1.4
Conservation Reserves	14 860	0.35
Total	4 174 700	

Table 5. Extent of State Forests that occur in the study area. Note the small size of most forests

State Forest	ha in study area	State Forest	ha in study area
Albert	1 062	Mellerstain	194
Balgay	1 091	Merri Merri	191
Barrow	1 224	Merrinele	536
Berida	73	Meryula	560
Blow Clear West	1 206	Miandetta	738
Bobadah	106	Mount Nobby	1 535
Bourbah	623	Mount Tilga	543
Boyben	44	Nangerybone	5 899
Bulbodney	2 390	Narraway	380
Carolina	479	Pangee	1 104
Carrabear	174	Peisley	1 274
Coradgery	784	Sandgate	780
Cowal	504	Strahorn	2 260
Cumbine	10 711	Tabratong	463
Curban	198	Tailby	911
Curra	274	Talgong	651
Derriwong	61	Tallegar	1 797
Eringanerin	88	Taratta	955
Euchabil	212	Tenandra	491
Eumungerie	135	Thorndale	1 761
Fifield	108	Tottenham	1 374
Gilgandra	192	Trundle	440
Gin Gin	38	Tullamore	124
Girilambone	972	Vermont Hill	426
Grahway	8 418	Warrie	295
Grayrigg	485	Wharfdale	599
Holybon	125	Wombin	405
Limestone	86	Yalgogrin	6
Total	58 550		

Climate

The climate is semi-arid with average annual rainfall usually less than 500 mm. Rainfall decreases from east to west, with a slight summer peak and a lesser winter peak (Table 6). Autumn and spring are usually drier but there is high variability (BOM 2002). Actual evapotranspiration rate varies between 400 to 600 mm, (BOM 2001) and exceeds annual average rainfall, leading to the potential for a moisture deficit in all but the most favourable rainfall years. Summers are mild to hot and winters are mild to cold (Watkins & Meakin 1996, BOM 2001).

Table 6. Climatic data for selected weather stations in the NSW NP&WS wheat-belt study area (BOM 2002)

Station	Average rainfall (mm)	Monthly av. annual rainfall (mm) Su	Wi	Temperature range °C Summer min	Summer max	Winter min	Winter max
Gilgandra	564	57	46	4	44	-6	31
Peak Hill	564	53	44	7	44	-3	26
Warren	512	56	30	7	44	-5	26
Tullamore	492	47	37	8	43	-4	26
Nyngan Airport	444	47	31	9	47	-3	29
Cobar	337	23	23	9	47	-3	29

Hydrology

The study area is part of the Murray Darling Basin. Three major rivers flow through from the south east to the north west (Fig. 1); the Castlereagh rises in the Warrumbungle Range and eventually joins the Macquarie Marshes; the Macquarie begins in the slopes of the Great Dividing Range and terminates in the Macquarie Marshes; and the Bogan begins in the plains north of Parkes; in full flood, it contributes to the flow of the Darling River via the Barwon.

The Macquarie River is of major agricultural and economic importance to the region, with Burrendong Dam providing regulated water flows (Kingsford & Thomas 1995). The Macquarie River channel terminates in the Macquarie Marshes, a wetland of international importance (Blackley et al. 1996). Of the extensive 131 000 ha Macquarie Marshes, only 18 150 ha are protected from clearing and irrigation development within the Nature Reserve, however, even the Nature Reserve is threatened by hydrological changes induced by upstream water use (Kingsford & Thomas 1995). The Castlereagh and Bogan rivers currently have limited regulation and water extraction. Important perennial and intermittent watercourses such as Merri Merri, Pangee, Bulbodney, Mulga and Gunningbar Creeks flow during local, irregular rainfall events.

Topography

Extensive level to gently sloping fluvial plains are associated with the Castlereagh, Macquarie and Bogan Rivers. These floodplains, channels and swamps are lower in the landscape than the low hill-lands to the east (up to approximately 300 m ASL) and the colluvial apron in the west (Watkins & Meakin 1996). The small rounded low hills of Mount Foster (266 m) and Mount Harris (242 m), north of Warren, and Mogometon Hill (282 m) north of Tenandra, contrast with the very low relief of the fluvial plains, as do the more extensive chain of hills of the Gobondry Mountains (429 m) east of Fifield in the south-east, and the Boona Mountains (461 m) east of Bobadah, in the south west. Associated with the colluvial apron is the gently rolling country of the eastern edge of the Cobar peneplain, where low gravelly slopes rise from the plain. Further west, on the colluvial apron on the Western Division boundary, are the more abrupt, high, steep slopes associated with granite intrusions.

Geology, geomorphology and soils

The landscape can be described in terms of three geomorphological subdivisions: (1) low hill-lands in the east; (2) riverine plains in the centre; (3) colluvial aprons of the Cobar Peneplain and the edge of the Central Western Slopes (Watkins & Meakin 1996). Within these subdivisions a range of geological variation is reflected in soil types, from heavy cracking clays to sandy and gravelly loams.

Low Hill-Lands of Jurassic Pilliga Sandstone and overlying Cretaceous Keelindi beds form the undulating low hill-lands that have well-defined drainage patterns to the south-east of Nyngan and north-east of Narromine respectively. Soils here are red-brown sandy loams over clay loams and are associated with the slight rises and the low hill-lands of the Jurassic Pilliga sedimentaries (Watkins & Meakin 1996). North-west striking ridges of mostly buried Devonian porphyritic intrusives give rise to the Boona Mountains west of Fifield, and isolated peaks of Mount Foster and Mount Harris, north of Warren (Watkins & Meakin 1996).

Riverine plains are dominated by the Castlereagh, Macquarie and Bogan rivers eroding through the sedimentary layers of relict Quaternary river systems. Four fluvial units are recognised by Watkins & Meakin (1996): Marra Creek; Bugwah, Carrabear and Trangie formations.

The Marra Creek formation is confined to the major channels of the Macquarie and Bogan Rivers and has heavy textured dark grey and brown cracking clayey soils. The soil profiles are poorly-developed, with clay content increasing with depth. The Bugwah formation is located between Macquarie and Bogan Rivers, associated with the Backplains of the Riverine plains, the soils here are similar to those of the Marra Creek formation with grey cracking clay soils dominating. Located between Castlereagh and Macquarie Rivers, the Carrabear formation exhibits orange sandy soils with well-defined profiles. The soils of the Trangie formation, associated with the Riverine plains south-east of Nyngan, are dark red to orange-brown sandy soils with weathering profiles up to tens of metres thick. Transitional soils occur within all these formations, on the slightly elevated meander plains, light textured red to red brown earths occur in close association with grey-brown heavy textured soils. Coarser material gives stability to these soils, but silt is readily dispersed by water and wind, making some meander plains soils susceptible to erosion and scalding (Watkins & Meakin 1996).

Colluvial aprons form the slightly elevated areas to the east (Central Tablelands) and to the west (Cobar peneplain). This narrow belt of colluvial material from Siluro-devonian sedimentary rock forms the base of the Central Tablelands. Soils on the low hills of these colluvial aprons are generally light textured, red to brown coloured, acidic, with poorly-developed profiles, commonly containing gravel and lacking in calcium carbonate (Watkins & Meakin 1996). The colluvial apron of the Cobar peneplain is characterised by an abundance of chert and fine grained quartz rich Quaternary sediments, that obscure Cambro-ordivician Girilambone Group sedimentary rock (Watkins & Meakin 1996, Sherwin 1996). The slightly undulating to level low hills in the west display shallow, gravelly, loamy soils and red earths (Watkins & Meakin 1996). A small area of late Ordovician siltstone and sandstone outcrops near Narromine (Sherwin 1996). A distinctive outcropping of late Ordovician hornblendite, recognised as the Honeybugle complex, occurs west of Nyngan and is associated with an extensive area of mallee (Gilligan et al. 1995).

Methods

The vegetation maps presented here are a synthesis of vegetation patterns identified subjectively by air photo interpretation (API) and analyses of quantitative survey data. These analyses were iterative, in that the initial analyses directed more detailed consideration of some vegetation patterns. A new quantitative technique was used to compare floristic classifications using dissimilarity matrices derived from the survey data.

Native woody vegetation was mapped at the 1:250 000 scale to ensure an accurate and comprehensive representation of the structural diversity of vegetation and in recognition of the resource limitations of the project. The following criteria were used to identify the remaining native woody vegetation; a minimum tree canopy cover of 5%, treating canopies as solid objects, as per the crown cover projection method outlined in McDonald et al. (1990). If an area was identified as reaching the minimum threshold then remnants down to approximately 10 ha in size were identified. Some remnants slightly smaller than 10 ha were included in this mapping to ensure a more accurate representation of the extent and fragmented nature of the vegetation. In the east where clearing has been more extensive, the number of remnants less than 10 ha is greatest. These small remnants are easily distinguished on air photos in the agricultural landscape. Remnants of less than 10 ha in size account for 20% of the polygons mapped but only 11 000 ha (1%) of the total area of native woody vegetation mapped. Vegetation remnants vary in structure and composition from having all layers dominated by native species to having only native canopy species with other layers in the understorey dominated by introduced species.

The native woody vegetation remnants were then allocated to a photo-pattern based on the structure, height, density, species composition, position in the landscape, and relation to other geological or geomorphological formations that could be determined on air photos. 30 vegetation patterns were recognised.

Certain categories of vegetation could not be mapped consistently using the criteria and API outlined above. Lignum, Myall, Chenopod Shrublands, wetlands, patches of native vegetation less than 10 ha in size, and naturally treeless plains (grasslands) are difficult to discern on photographs less than 1:50 000 scale, the smallest scale used for these maps (Table 7. Extensive grasslands are present in the study area, under Open Woodlands and in open pasture or cleared areas. These grasslands are mostly secondary or derived grasslands that may or may not be dominated by native species. Pure native grasslands have not been mapped because of the difficulty in distinguishing grassland from improved pasture and some chenopod shrublands. Grasslands ideally need to be mapped at a larger scale, with landuse information indicating the extent of pasture improvement and time since last tilling.

Table 7. 1:250 000 map-sheet, scale and dates of aerial photography.

Map-sheet	Scale	Date air photo
Cobar	1:80 000	1987
Nyngan	1:85 000	1985
Gilgandra	1:50 000	1981
Nymagee	1:83 900	1987
Narromine	1:50 000	1985
Dubbo	1:50 000	1985

Site selection and survey

Survey sites were selected across the range of API vegetation patterns and throughout their geographic extent. For ease of access and due to time limitations, sites were located on public land including State Forests, Nature Reserves, Vacant Crown Lands, Travelling Stock Reserves and Road Reserves. Sites were supplemented with opportunistic recording of remnants on both public and private land.

Data collection methods follow Sivertsen & Metcalfe (1995). At each site, usually 400 m^2 area, a description of the physical characteristics of the site, vegetation structure and relative abundance of each vascular plant species were recorded using a modified seven point Braun-Blanquet scale. Terminology for descriptions of the geology, landforms, soils, vegetation structure and growth form follow McDonald et al. (1990). A total of 428 sites were collected, 414 during fieldwork in April and May 1988 and an additional 14 sites were completed in November 1994. Botanical classification and nomenclature follow Harden (1990–1993, 2000, 2002).

Data analysis

Quantitative classification

Affinities between sites in terms of plant species composition were examined by constructing alternative classifications using the PATN package (Belbin 1994). The symmetric form of the Kulczynski coefficient was used to calculate dissimilarity between sites and the clustering algorithm UPGMA with beta parameter set to 0 was used to generate hierarchical classifications (Belbin 1991).

Three alternative classifications were generated using the following site data components: (1) all species; (2) exotic species excluded; (3) restricted (where exotic, annual and species recorded only once in the survey were excluded) (Table 8). From these alternative classifications a single classification that best explained the relationship between sites needed to be selected. To assess the contribution that exotics, annuals and infrequently occurring species made to the position of individual sites between classifications, each pair of classifications in turn had their association matrices subtracted from one another to generate matrices of dendrogram differences i.e. all species minus exotics excluded, all species minus restricted, restricted minus exotics excluded. The resulting dendrogram differences were used to identify site affinities that changed most between the classifications. A list was generated that contained absolute dendrogram differences greater than 0.25. Subsequently, the 10 sites most frequently represented in the list and the 10 sites with the largest absolute dendrogram differences were selected. These sites were examined to determine what trends in species composition influenced the dendrogram differences and the original classifications. From this comparison a final classification was selected.

The three classifications were examined using the homogeneity algorithm (Bedward et al. 1992) to determine an appropriate minimum number of groups in a classification based on the floristic site data and to assess the likelihood of adequately representing the heterogeneity within the data. To identify and eliminate potentially misclassified sites the classification was examined using nearest neighbour analyses (Keith & Bedward 1999). Misclassified sites were then reallocated to the group that contained their nearest neighbours.

Table 8. Number and percentage of species used in the three alternative classifications

Classification	1 All	(%)	2 Exotics excluded	3 Restricted
Native perennial	290	(56%)	290	290
Exotic	44	(8%)	–	–
Native annual	26	(4%)	26	–
Single occurrence	166	(32%)	166	–
Total species	526	(100%)	482	290

Reconciling quantitative and qualitative classifications

The qualitative classification of the vegetation was based on API. These photo-patterns or photo-types represent the structure of the vegetation, landscape variables and floristic associations. The 30 photo-types were reconciled with the quantitative analysis (classification groups), which are based on the floristic component of the site information only. Lineages within the dendrogram were explored at different levels of dissimilarity to distinguish between photo-types. Photo-types with distinctive floristic assemblages and narrow biophysiological tolerances were recognised at high levels of dissimilarity in the dendrogram. Where photo-types had similar floristic composition, overlapped in their position in the landscape or represented a mosaic of vegetation, the dendrogram was explored at lower levels of dissimilarity. The process of defining and reconciling quantitative and qualitative classification was iterative in that the initial analyses directed revision or more detailed consideration of some of the photo-types. The final classification groups were then matched to photo-types. Where there was a one to one relationship, characteristic species were used to build a description of the vegetation. In some cases photo-types did not correspond to single classification group and a description of the vegetation was derived from more than one classification group. In some cases photo-types were not clearly differentiated in classification groups and could not be separated using other quantitative techniques (see below), these photo-types were incorporated into the photo-type that dominated the classification group.

Photo-types may overlap in species composition, but usually have different structure or occupy different positions in the landscape. Where a single classification group represented more than one photo-type, the variation within the classification group was examined to identify any quantitative differences between the sites representing each photo-type compared to the variation in the entire classification group. Sites within a single classification group were assigned their photo-type and the relationship of the sites examined using the ranked association matrix values and the ANOSIM algorithm (Clarke 1993). A difference in the floristic data would demonstrate quantitative support for the floristic composition of the vegetation corroborating distinctions based on differences in structure and position in the landscape. The converse, where photo-types were subsumed into the dominant photo-type because of lack of quantitative support, also occurred.

The final photo-types have characteristic species from their corresponding classification group identified using the Fidel computer routine (Keith & Bedward 1999). Fidel examines each group in terms of the way species occur in the sites within a group compared to sites outside the group. The fidelity of a species to a group is expressed in terms of categories: positive and negative (diagnostic), constant (characteristic) and uninformative (Table 9). Positive species are more likely to occur within the group than outside the group. Negative species are unlikely to occur in the group but are abundant outside the group. Constant species are similar in abundance and frequency inside and outside the group; uninformative species are less frequent or abundant in the group but also likely to be less frequent or abundant outside the group (Table 9). Map unit descriptions were developed from the positive and constant species derived from the Fidel analysis, the structure of the vegetation and the physical characteristics recorded at the sites, (elevation, slope, geology, landform, soil surface texture and soil type). Map unit descriptions are given in Appendix 1. The map unit naming convention follows Sivertsen & Metcalfe (1995).

Table 9. Definition of Fidelity Classes from Fidel programme (comparing in-group with out-group). Adapted from Keith & Bedward (1999).

C/A = Braun-Blanquet cover abundance values.
F: Frequency is proportion of sites in which the species was recorded.
M: median

		Outside the group		
		F 0.5 & M C/A 2	**F < 0.5 or M C/A < 2**	**F = 0 (Species absent)**
Within group	**F 0.5 & M C/A 2**	Constant	Positive	Positive
	F < 0.5 or M C/A < 2	Negative	Uninformative	Positive
	F = 0 (Species absent)	Negative	Uninformative	–

Comparison of vegetation mapping with independent data

In recognition of our sampling limitations i.e. restricted to public land, limited numbers of sites per map sheet and data collection during autumn 1988, we examined if the mapping was floristically adequate. We examined a subset of the original survey area with independent site data from four 1:100 000 map sheets: Tottenham, Dandaloo, Boona Mount, and Tullamore (Lewer et al. unpub.) (Fig. 3). The independent site data was collected in 2000, after favourable growing conditions, across all tenures, with more intensive sampling (approximately 100 sites per 1:100 000 map sheet compared to approximately 35 sites per 1:100 000 map sheet for our data).

Due to the differences between these two data sets, seasons, time, sampling intensity, and tenure, a quantitative rather than qualitative approach was taken. The two data sets were standardised to reduce the effect of the 12 years between the sampling efforts, and the large seasonal differences in rainfall events leading up to the surveys — below average rainfall for our survey and above average for Lewer et al. (Table 10). Species that occurred twice or more in either data set were used; exotics, annuals and cryptic species such as orchids were eliminated, and nomenclatural inconsistencies resolved.

To take into account the dispersion of the sites within classification groups, independent sites were not compared to the centroid of the classification groups as in ALOC (Belbin 1994). Due to the large differences in species richness between the data sets, the average value of the classification group was also avoided (Clarke 1993). Instead, the independent sites were allocated to a classification group based on the nearest value in the group. To avoid imposing an arbitrary critical distance or cut-off, progressively lower levels of dissimilarity were used to identify which independent quadrats fell within the domain of the classification. This approach was a conservative use of the independent data, as successively more stringent levels were used to assess the dissimilarity between two data sets. At each level the unallocated independent sites were examined. This can best be described as using a numerical approach to guide expert assessment.

The independent sites were compared to each site in our classification using custom written routines in the statistical package R (Venables & Smith 2001). The dissimilarity between each independent site and the sites in our classification groups was calculated. Independent sites were allocated to a classification group at 0.8, 0.7, and 0.6 levels of dissimilarity. Where the dissimilarity value calculated for the independent site was less than or equal to the nominated value, the site was allocated to a classification group. Independent sites that did not allocate to a classification group were identified and their floristic composition and spatial location examined.

Table 10. Climatic records at selected weather stations prior to field work for this study in autumn 1988 and Lewer et al. in 2000.

	Highest rainfall day (mm)		Average rainfall (mm)	
Year	**Nyngan**	**Tullamore**	**Nyngan**	**Tullamore**
1985	53	35	455	440
1986	48	41	349	359
1987	61	77	450	531
1988[a]	69	49	630	523
1997	54	29	366	253
1998	80	46	695	709
1999	97	78	749	604
2000	97	48	741	579
Annual average rainfall			444	492

[a] Note in 1988 72% of rain fell after May for Tullamore and 60% for Nyngan.

Field checking

To check spatial accuracy and to validate the attribute consistency of the maps, extensive ground truthing was carried out during three field reconnaissance trips along public roads. Vegetation remnants adjacent to public roads were inspected and alterations annotated on field maps and corrected by referring to field observations, notes recorded during the original field-work and further API where necessary. Corrections were then made to the digital data.

Mapping of clearing

The original API used 1980s photos (Table 7). Marked changes in land cover were noted during subsequent field checking. To measure changes in native woody vegetation cover, the original mapping boundaries were compared to satellite imagery and areas of clearing recorded to produce an updated coverage of native woody vegetation. Clearing was defined as a change in average canopy cover from greater than 5% to less than 5%. Using satellite imagery, it was possible to detect in some instances the complete removal of the understorey while retaining a canopy of 5%, these situations occurred for a very small proportion of the areas defined as clearing. The extent of clearing of native woody vegetation was derived from visual interpretation of Landsat Thematic Mapper satellite imagery as described in Cox et al. (2001) and documented for this area in Bedward et al. (2001).

Results

Taxa recorded in the survey

For the quantitative analysis and classification of the map units, 395 (92%) of the 428 survey quadrats were used. 33 sites were eliminated from the analysis: ten of these fell outside the survey boundary; three sites had no species recorded; and 20 sites had inadequate cover abundance scores. From the sites used in the analysis, 526 plant taxa were recorded from 84 families, 40% of all recorded species were in the families Poaceae, Fabaceae, and Asteraceae (Table 11). None of the plants listed under ROTAP (Briggs & Leigh 1995), nor any of the 10 species listed under the *NSW Threatened Species Conservation Act* (1995) or *Environment Protection Biodiversity Act* (1999) were recorded in the survey quadrats. This may have been because of low rainfall prior to fieldwork (Table 10) or that these species may require targeted searches rather than the stratified random sampling used in this survey.

Table 11. The ten most commonly represented families in the quadrat data

Family	No. of taxa	%
Poaceae	90	17
Fabaceae Total	61	12
Asteraceae	57	11
Fabaceae Mimosoideae	37	7
Myrtaceae	31	6
Chenopodiaceae	28	5
Fabaceae Faboideae	20	4
Malvaceae	14	3
Cyperaceae	13	3
Solanaceae	13	3
Myoporaceae	12	2
Sapindaceae	12	2
Fabaceae Caesalpinioidae	4	2

Comparison of quantitative classifications

Based on the comparison of the dendrogram differences, classification 1 containing all species and classification 2, with only exotics removed, were the least different from each other (Table 8). The greatest difference in distance matrices was between classification 2 exotics removed and 3 restricted. The floristic composition of the 10 most frequently represented sites and the 10 sites with the largest absolute dendrogram differences were examined. The 10 sites with largest absolute dendrogram differences had low species diversity i.e. were depauperate and had a high proportion of exotic and annual species present. In these sites more than one species was excluded from the analysis in the restricted classification (Table 12). The 10 sites that most frequently had dendrogram differences with an absolute value greater than 0.25 also had low species diversity at the time of the survey. These sites usually had only perennial shrubs and canopy species recorded (Table 12). Sites that were species poor and sites with a high proportion of exotics were most affected by restricting the data (Table 12).

Table 12. A comparison of the total number of species and number of species masked in the 10 sites with the most frequent absolute dendrogram differences and highest absolute dendrogram differences. Exotic, annual and singly occurring species were masked

10 most-frequent absolute dendrogram difference										
Frequency	57	41	41	41	28	24	24	23	15	15
No. species in the site	6	10	12	15	8	4	5	7	11	12
No. species masked	0	0	0	0	1	0	0	0	0	0
Highest absolute dendrogram difference										
Frequency	1	2	2	4	1	1	1	1	1	1
No. species in the site	2	8	3	4	33	7	2	3	11	2
No. species masked	0	1	3	0	6	3	0	0	7	0

Exotic, ephemeral and singly occurring species exhibit a high degree of variability in distribution and abundance in relation to climatic conditions, particularly rainfall (Cunningham et al. 1992). Rainfall events in the central west are often patchy, and fieldwork for the survey was completed in late autumn 1988 after an extended dry period (Table 10). Such climatic conditions can account for variations in species composition, particularly among ephemeral and short-lived perennials (Fox 1990). Inclusion of such species in the final analysis and classification would introduce unwanted bias to the quantitative classification. Accordingly, the restricted classification (Table 8) considering only native, perennial (herbaceous and woody) species that occurred more than once in the data set, was selected as the final classification and used to quantitatively define the floristic attributes of the map units. Of the 526 species recorded in the quadrat data, 290 were used in the final quantitative analysis (Table 8).

Nearest neighbour analysis

Based on the results above, 20 classification groups were initially identified. Group size ranged from 1 to 166 sites. Nearest neighbour analysis (Keith & Bedward 1999) identified two sites, members of classification group 15 that were misclassified. These sites were moved to classification groups 1 and 2 respectively reducing the number of classification groups to 19 (Fig. 4).

Consideration of quantitative classification in relation to the definition of map units

The characteristic species from Fidel analysis (Keith & Bedward 1999) were examined for each of the classification groups. Most classification groups corresponded to a photo type except in two cases: group 19, which consisted of non-woody wetland species which were not identified consistently in the air photo interpretation and thus not represented in the mapping; and three classification groups with suspected misidentification of the dominant canopy species; Red Gum species identified as the dominant canopy species classification groups 12 (3 sites), 13 (1 site) and 14 (2 sites) (Fig. 4, Table 13). Groups 12 and 13 had *Eucalyptus chloroclada* recorded and group 14 had *Eucalyptus dealbata*. The accompanying information recorded for these sites such as associated species, structure, landform, soil surface texture, and geology suggest that the identification of the Red Gums was incorrect. Red Gums are known to hybridise in this area particularly *Eucalyptus dealbata* with *Eucalyptus dwyeri* and *Eucalyptus chloroclada* with *Eucalyptus camaldulensis* (Harden 2002), which makes their appearance in the field variable. Group 12, 13 and 14 had similarities in their species composition as indicated by their juxtaposition in the dendrogram but due to the uncertainty in the identification of the Red Gums they were eliminated from further consideration. The remaining 15 classification groups provided the quantitative basis for further exploration of the dendrogram lineages and ultimately the map unit descriptions.

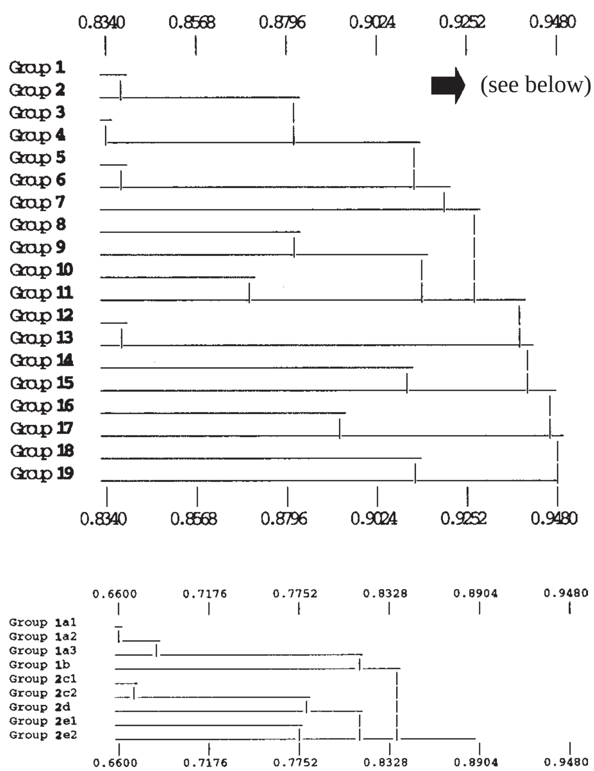

Fig. 4. Schematic dendrogram of classification 3, the final classification selected to define the floristic composition of the map units, representing the 20 original groups resulting from the quantitative PATN analysis.

Table 13. Classification groups from PATN matched to API photo-types

PCG: Primary cassification group; SCG: Secondary classification group; MU: Corresponding map unit; SMU: Secondary map unit.

PCG	SCG	MU/API	No. sites	SMU/API
1	1a1	P6	8	P15
1	1a2	P12	24	P6
1	1a3	H1	9	
1	1b	P13	24	H1
2	2c1	P4	52	P7
2	2c2	P4	75	P16
2	2d	P14	15	
2	2e1	P7	13	P4
2	2e2	P4	7	
3	3	R3	28	
4	4	R5	9	
5	5	H7	19	P1
6	6	P1	6	
7	7	P4	4	
8	8	H1	14	H2
9	9	P12	3	
10	10	H1	6	P12
11	11	H1	26	H2
12, 13, 14	12, 13, 14	No API unit uncertain identification	3,1, 2	
15	15	H8	1	
16	16	H9	3	
17	17	H6	1	
18	18	R1	33	
19	19	No API unit wetland	2	
–	No group	P11	–	
–	No group	U1	3	
–	No group	U2	3	
–	No group	U3	1	

Reconciling quantitative classification with qualitative photo-types

To produce map descriptions, the 30 qualitative photo-types were matched to the 15 primary quantitative classification groups. Some photo-types had very few survey sites due to either limited distribution or difficulty of access. Four photo-types had no corresponding classification group (Table 13). The map unit descriptions for these were derived from the site data that had not been used in the quantitative classification (Table 8) and from informal sites and field observations.

Eleven photo-types corresponded to a single classification group; the characteristic species defined by fidelity analysis were used to construct the floristic descriptions of these map units. Where a photo-type represented a mosaic of floristic assemblages, more than one classification group would be expected to correspond to this photo-type. This was the case for photo-types H1, H2, P4, P7, P12 (Table 13) and the map unit descriptions are based on a compilation of the fidelity analyses of the combined classification groups corresponding to the photo-type.

Classification group 5 (Fig. 4, Table 13) contained sites with mallee on two distinct landforms. Photo-types had been distinguished based on differences in structure of the canopy and the landform on which the mallee occurred. ANOSIM gave an R value of 0.45, using 10 000 random allocations compared to the observed R=0.391 which gives quantitative floristic support to the recognition of photo-types based on structural differences in Mallee vegetation. The floristic composition of these photo-types was described by separating the sites in group 5 based on photo-types, to maintain consistency in the map unit descriptions.

Heterogeneity within map units

An obvious separation in the classification groups was observed between distinctive floristic assemblages that occupy narrow ecological tolerances e.g. between River Red Gum and outcropping hills, or between Black Box woodlands and Mallee woodlands. Floristic assemblages that are associated with a narrow set of environmental conditions are easily identified as photo-types and are relatively homogeneous, and readily matched to a classification group. Where the subjective distinction between the photo-types was difficult (because of fine scale complexity, the fragmented nature of the vegetation, the variation in land management and the extremely subtle changes in the elevation, soils and other abiotic conditions) the quantitative definition of floristic composition was also difficult to achieve. Classification groups 1 and 2 (65 and 166 sites respectively) contained most of the Eucalypt Box Woodlands sites and represented nine photo-types. These groups required thorough interrogation at lower levels of dissimilarity in the dendrogram and resulted in 9 further secondary classification groups to ascertain quantitative support for subtle distinctions in vegetation assemblages, that were recognisable photo-types within the scope of this mapping project (Fig. 4, Table 13). Eight photo-types were subsumed into the photo-types and floristic groups that most closely reflected their composition. In summary, 30 photo-types identified from the API and 15 PATN classification groups were identified at the primary level of dissimilarity. Groups 1 and 2 of this classification were examined at a secondary level of dissimilarity which provided a further 9 classification groups, resulting in a total of 24 classification groups. The final dendrogram structure shows 24 classification groups corresponding to 22 photo-types (Fig. 4, Table 13).

Homogeneity

The homogeneity curve from Classification 3, the restricted classification, indicates the heterogeneity of the data set is most efficiently represented at about 24 groups. Further sub-division in the classification above the change in the curve (at about 24 groups) gives small increases in the homogeneity of the groups and below this level some improvement in the degree of group homogeneity in the data can be made. Further subdivisions of the floristic groups were considered unwarranted for the small gain in homogeneity.

Comparison of vegetation mapping with independent data

At the highest level of dissimilarity 420 (97%) of 433 independent sites were allocated to our classification. The 13 independent sites not allocated at this level were located outside the area designated as native woody vegetation in our mapping. The floristic composition of 11 out of the 13 independent sites was non-woody i.e. composed of grasses, forbs and some low chenopod shrubs. The focus of our mapping was on native woody vegetation; grasslands, chenopod shrublands and wetlands were not specifically sampled or represented separately in the maps. Independent sites in these associations were not allocated to our classification.

At the next level of dissimilarity, 91 independent quadrats were not allocated to a classification group. Eighty one percent, (64) of these sites were located on private property and the floristic composition for 70% was grasses, forbs and low chenopods and corresponded to 'Null — not mapped as woody vegetation' category for our mapping. Of the remaining sites, 26 out of the 27 occurred on private property and had woody components to their floristic composition. Examination of the floristic composition of these sites revealed 60% (16 of the 26) had an overstorey of *Eucalyptus populnea* with many grass and forb species and 3 sites had *Eucalyptus sideroxylon* with many species of *Acacia* and other peas. The species diversity of the independent sites was high (with an average of 53 (median 56) species per site, compared to an average of 23 (median 22) species per site in our data). The high species diversity in the unallocated independent sites affects the allocation of these sites. When the location of these sites were compared to our vegetation mapping, the independent sites occur in vegetation communities that reflect their overstorey species composition. The greater species diversity in the understorey of the independent sites suggests that some of the understorey associations identified in the independent data would not be reflected in our maps. Four of the unallocated independent quadrats contained *Eucalyptus vicina*, all of these quadrats occurred in H1 Dywer's Red Gum *Eucalyptus dwyeri*, *Eucalyptus sideroxylon* and *Eucalyptus viridis* Woodland remnants. At the time of our survey *Eucalyptus vicina* was synonymous with *Eucalyptus dwyeri*. At the lowest level of dissimilarity, 204 or just less than 50% of the independent quadrats were not allocated to a classification group.

The independent sites fit within the native woody floristic associations defined in our mapping, indicating that the floristic groups defined by the original data are comprehensive for native woody vegetation in this area at the 1:250 00 scale. There appear to be no unsampled native woody vegetation classes in the classification, supporting the notion that our sites on public land adequately sampled the floristic diversity of native woody vegetation. The sampling regime for the independent sites intentionally located on private land has provided valuable additional information, particularly in relation to grasslands, shrublands and understorey composition of shrubs and annuals in favourable growing seasons (Lewer et al. unpub.).

Floristic composition and extent of native vegetation

The final 22 map units, named using the dominant association and structural formation (McDonald et al. 1990), are described in Appendix 1. The maps depict the floristic assemblages, structure, spatial configuration and extent of the 22 units. The map units correspond to four broad landform types: riverine plains (R), floodplains (P), peneplains (U) and hills (H). Eucalypt species dominate 19 of the units. Associated with the riverine plains is R1 *Eucalyptus camaldulensis* (River Red Gum) confined to the channels of the major river systems of the Castlereagh, Macquarie and Bogan (Fig. 7). Adjacent to the channels are areas of R3 *Eucalyptus largiflorens* (Black Box, Fig. 8) and R5 *Acacia pendula* (Myall) Woodlands (Fig. 9). The floodplains units reflect the changes in soil and rainfall across the area. P4 *Eucalyptus populnea* (Poplar Box) Woodlands (Fig. 11) are widely distributed across the peneplain and floodplains. P7 *Casuarina cristata* (Belah) (Fig. 13) and Poplar Box Woodlands are associated with drainage lines and depressions. P15 *Eucalyptus chloroclada* (Dirty Red Gum), *Callitris glaucophylla* (Pine) and Poplar Box Woodlands (Fig. 18) most commonly occur on the sandy lenses of relict streams of the meander plains. P6 *Callitris glaucophylla* (White Cypress Pine) Woodlands (Fig. 12) and P13 *Eucalyptus microcarpa* (Grey Box), Poplar Box and Pine Woodlands (Fig. 16) occur on the inter-grade between the floodplain and the peneplain.

The peneplains in the east are dominated by P12 Woodlands on Jurassic Sandstone (Fig. 15) and in the west by P14 *Eucalyptus intertexta* (Red Box), Poplar Box and Pine Woodlands (Fig. 17) that grade into P16 Simple Poplar Box Woodlands (Fig. 19). U1 Red Box, Poplar Box Pine and *Eucalyptus viridis* (Green Mallee) Woodlands (Fig. 20) occupy the slopes of the hills in the west of the study area. P1 Mallee Woodlands on plains (Fig. 10) are restricted to the sandy soils on the rolling country of the Cobar Peneplain. U2 Red Box, Poplar Box and Pine woodlands and U3 *Eucalyptus dwyeri* (Dwyer's Red Gum) Low Open Woodlands occur on granite intrusions.

There are six vegetation units associated with the hills. H1 *Eucalyptus dwyeri*, *Eucalyptus sideroxylon* (Ironbark) and *Eucalyptus viridis* (Green Mallee*)* Woodlands (Fig. 21) are the most extensive hill unit and occur across the study area on the low rises and extensive chain of hills associated with the Gobondry and Boona Mountains. On the gravelly crest of these hills, pure stands of H2 *Eucalyptus viridis* (Green Mallee*)* Woodlands (Fig. 22) occur. H8 *Eucalyptus dealbata* (Tumble-down Red Gum) Woodlands (Fig. 25) are restricted to outcropping basalt hills and H9 Dwyer's Red Gum Open Woodland (Fig. 26) is restricted to out cropping granite hills. In the west of the study area on steep rocky hills are H6 *Eucalyptus morrisii* (Grey Mallee) Open Woodlands (Fig. 23).

Some vegetation units change gradually over subtle abiotic gradients and it was difficult to discern a distinct boundary between them e.g. *Eucalyptus microcarpa* (Grey Box*)* Woodlands and areas of *Eucalyptus populnea* (Poplar Box*)* Woodlands on the plains. Other vegetation units are more striking in their abrupt and definite boundaries usually related to distinct changes in soils, landform or landuse e.g. *Eucalyptus dealbata* (Tumble-down Red Gum*)* restricted to basalt hills and *Eucalyptus camaldulensis* (River Red Gum*)* Woodlands primarily associated with major rivers and streams, rarely extending beyond the confines of the river bank.

Across the entire range of *Eucalyptus populnea* (Poplar Box) distribution for Australia, Beeston et al. (1980) identify 8 broad groups subdivided into 31 communities based on structure and floristics. In NSW *Eucalyptus populnea* subsp. *bimbil* is the only subspecies. Four of these groups occur in the study area. *Eucalyptus populnea* with grassy lower layer and *Eucalyptus populnea* with shrubby lower layer equate to 3 map units; P4 Poplar Box Woodlands, P16 Simple Poplar Box Woodlands, and U2 Red Box, Poplar Box, Pine and Green Mallee Woodlands. *Eucalyptus populnea* with *Casuarina* species equates to map unit P7 *Casuarina cristata* (Belah) and Poplar Box Woodlands and *Eucalyptus populnea* with *Callitris glaucophylla* equates to map unit P6 *Callitris glaucophylla* (White Cypress Pine) Woodlands.

Due to the variety within the P4 Poplar Box Woodland and P16 Simple Poplar Box Woodland and their gradients across the study area, there was considerable overlap of sites between classification groups. Using the classification and additional biogeographic elements — sub-catchments, rainfall, and terrain, these Poplar Box woodlands were split into western P16 Simple Poplar Box Woodland and eastern P4 Poplar Box Woodland classes. The boundary between P16 Woodland and P4 Woodland loosely follows the Cobar Peneplain IBRA boundary, the Bogan River and then a string of ranges and hills (Quartz Ridge, Tottenham Hills, Albert Hills, East of the Boona Ranges and the Deriwong Mountains).

Only three units are not dominated by Eucalypt species, R5 *Acacia pendula* (Myall) Shrublands; P6 *Callitris glaucophylla* (White Cypress Pine) Woodlands; and P11 *Flindersia maculosa* (Leopardwood) Open Shrublands (Fig. 14).

Extent of remaining native vegetation and rate of clearing during the study

At the beginning of the survey in the 1980s 1 324 000 ha (32%) was mapped as native woody vegetation (the study area is approximately 4 177 500 ha). Considerable land cover change occurred during the course of the study. Bedward et al. (2001) documented 129 865 ha of clearing. Clearing from the 1980s to 2000 resulted in a reduction of nearly 10% of the total extent of vegetation originally mapped (Table 14). Only 32% of the total area mapped was considered to have native woody vegetation cover at the beginning of the study, by 2000 this had been reduced by 3% to 29% (Table 14). This is a conservative estimate of clearing, it does not include remnants of less than 10 ha, and scattered paddock trees or the decline in native woody vegetation cover resulting from selective thinning. It does not take into account 'natural' tree loss such as senescence of mature trees, windthrow and dieback.

The clearing is not evenly distributed geographically across the study area or floristically across the vegetation units (Fig. 5). Five map units (P16 Simple Box Woodlands, U2 Red Box, Poplar Box and Pine Woodlands, P13 Grey Box Woodlands, P14 Red Box Poplar Box and Pine Woodlands and P7 Belah and Poplar Box Woodlands) have been cleared above the average for native woody vegetation as a whole. Poplar Box dominates four of these units, with P16 Simple Poplar Box Woodlands in the west reduced by 17% since the beginning of the study (Table 14). Map units already greatly depleted have been further reduced during this time, for example R5 Myall Woodlands have been reduced by 10% and H7 Mallee On Rolling Hills reduced by 9%.

Table 14. Decrease of native woody vegetation cover (1980s and 2000)

Map Unit		1980s (ha)	2000 (ha)	Decreases (ha)	% of 1980s
R1	*Eucalyptus camaldulensis* Forests and Woodlands	92 483	88 319	4 164	5%
R3	*Eucalyptus largiflorens* Woodlands	74 569	69 379	5 190	7%
R5	*Acacia pendula* Woodlands	25 701	23 043	2 658	10%
P1	*Eucalyptus socialis – Eucalyptus dumosa* Mallee Woodlands on Plains	19 675	18 757	918	5%
P4	*Eucalyptus populnea* Woodlands	290 823	266 140	24 683	8%
P6	*Callitris glaucophylla* Woodlands	19 892	19 629	263	1%
P7	*Casuarina cristata – Eucalyptus populnea* Woodlands	39 335	34 568	4 767	12%
P11	*Flindersia maculosa* Open Shrublands	190	190	0	0%
P12	Woodlands on Jurassic Sandstone	21 331	20 418	913	4%
P13	*Eucalyptus microcarpa* Woodlands	69 165	59 963	9 202	13%
P14	*Eucalyptus intertexta – Eucalyptus populnea – Callitris glaucophylla* Woodlands	267 313	234 381	32 932	12%
P15	*Eucalyptus chloroclada – Callitris glaucophylla – Eucalyptus populnea* Woodlands	16 899	15 592	1 307	8%
P16	Simple *Eucalyptus populnea* Woodlands	163 283	134 428	28 855	18%
U1	*Eucalyptus intertexta – Eucalyptus populnea, Callitris glaucophylla – Eucalyptus viridis* Woodlands	33 838	30 994	2 844	8%
U2	*Eucalyptus intertexta – Eucalyptus populnea – Callitris glaucophylla* Woodlands on Granite Hillslopes	20 232	17 239	2 993	15%
U3	*Eucalyptus dwyeri* Low Open Woodland on Granite Crests	10 021	9 195	826	8%
H1	*Eucalyptus dwyeri – Eucalyptus sideroxylon – Eucalyptus viridis* Woodlands	89 774	87 005	2 769	3%
H2	*Eucalyptus viridis* Woodlands	21 891	20 893	998	5%
H6	*Eucalyptus morrisii* Open Woodlands	6 625	6 602	23	0%
H7	*Eucalyptus dumosa – Eucalyptus socialis* Mallee Woodlands on Rolling Hills	38 208	34 665	3 543	9%
H8	*Eucalyptus dealbata* Woodlands on Basalt Hills	282	282	0	0%
H9	*Eucalyptus dwyeri* Open Woodland on Granite Hills	432	415	17	4%
	Total	1 321 962	1 192 097	129 865	10%

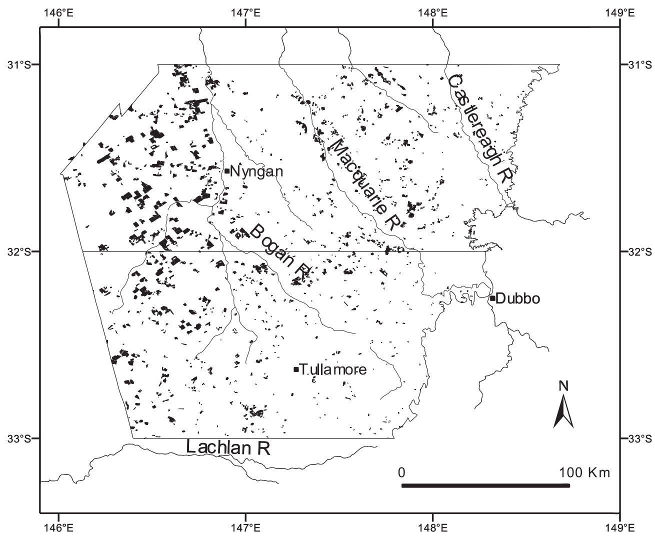

Fig. 5. Shaded areas represent the location of clearing events recorded from visual interpretation of Landsat TM imagery up to 2000.

Clearing events need to be considered in the context of the surrounding vegetation. Large sections of clearing occurred in the west of the study area (Fig. 5) and have a striking visual impact. The proportional loss of vegetation associated with smaller clearing events in the east can be demonstrated by an analysis of the proportion of clearing within a 10 kilometre radius. Where little vegetation remains, a clearing event of a small number of hectares causes a large proportional loss in the vegetation in the immediate vicinity (Fig. 6) (Bedward et al. 2001).

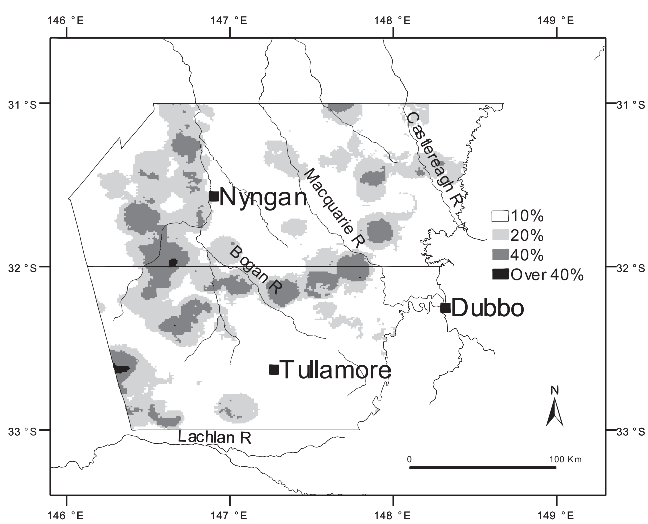

Fig. 6. Proportional loss of vegetation across the study area. Darker shade represents highest proportional loss. Note eastern section where clearing events are small but proportional loss is large.

Discussion

Quantitative techniques for mapping vegetation

The floristic assemblages have been derived using traditional mapping techniques and a number of quantitative techniques. Quantitative analyses were used to define the floristic classification, determine characteristic species for map units, select a classification from alternative classifications, explore consistency of classification groups where sites were distinguished in the photo patterns on non-floristic differences, and test the adequacy of sampling on public land compared to sampling across all tenure. The approach used to identify specific quantitative differences between alternative classifications allowed us to test assumptions that are frequently made about exotic and infrequently occurring species in floristic data sets.

The ANOSIM algorithm (Clarke 1993) was used to explore the consistency of sites within one classification group that had been separated on the differences in landform and vegetation structure in the aerial photographs. The technique provided quantitative support for qualitative patterns recognised within a classification group, in this case the qualitative patterns were landform and structure associated with mallee woodlands. These floristically very similar map units are cleared at strikingly different rates over time (Table 14). Initially (P1) Mallee Woodlands on Plains was cleared more rapidly than (H7) Mallee Woodlands on Rolling Hills, the trend in recent times has been reversed (Table 14).

The technique used to provide a quantitative comparison between two sampling regimes provided objective support that the original site data, sampled on public land only, was an adequate representation of the floristic diversity of the native woody vegetation within a subset of the study area.

Each of these techniques relies on quantitative site data and assists in explaining the relationships between the qualitative patterns recognised from API and the patterns based on quantitative floristic information. These techniques are useful in the part they play assisting to define the vegetation in the study area but more importantly offer insights into the way in which quantitative data may be explored to gain a more complete understanding of patterns in vegetation.

Map units within the landscape

The woodlands, forests and shrublands of the area are represented by 22 map units mapped at 1:250 000 scale, down to at least 10 ha in size, where canopy cover is greater than 5%. The remaining native woody vegetation within the highly modified agricultural landscape is a mosaic of isolated remnants sometimes linked by road, river, shelter-belt and wind-break corridors. As a result of agricultural activity some map units are greatly reduced from their original extent. The map units on the most fertile soils, with gentle relief and close to river systems have been preferentially cleared. R5 Myall Woodlands, R3 Black Box Woodlands and P4 Poplar Box Woodlands had all been highly depleted at the start of the study and have continued to decline.

is currently not viable to clear for cropping, such as steep slopes, poor soils, or restricted land use tenures. As changes in agricultural practices or demands for increased productivity are placed on the landscape, this remaining vegetation is vulnerable to clearing.

Vegetation and environmental associations

The distribution of the natural vegetation is related to landform, substrate, rainfall and position in the landscape. *Eucalyptus populnea* (Poplar Box) is the dominant woodland over a vast area between 300 mm to the 500 mm isohyet (Beadle 1981). The distribution of *Eucalyptus populnea* in these maps reflects trends previously noted (Biddiscombe 1963, Beadle 1948), dominating the plains in the west and north of the study area and declining in the east. As the rainfall gradient increases from west to east, *Eucalyptus largiflorens* (Black Box) is replaced by *Eucalyptus populnea*, which is in turn replaced by *Eucalyptus pilligaensis* (Pilliga Box) and *Eucalyptus microcarpa* (Grey Box).

A change in soil type also has a major effect on the distribution of vegetation. *Acacia pendula*, *Eucalyptus largiflorens* and *Casuarina cristata* are associated with clay soils, while *Eucalyptus microcarpa* is associated with duplex soils with high gravel content. Webb et al. (1980) linked the decline in *Eucalyptus populnea* abundance from west to east to the major soil groups. Our mapping supports the suggestion by Webb et al. (1980) that the distribution of *Eucalyptus populnea* is not based on a gradient of fertility levels between soils, but linked to the variation in the ability of different soils to hold water. This can be observed in the west of the study area, which has low rainfall and high evaporation potential. Here *Eucalyptus populnea* is associated with massive earths and is more likely to occur in a lower position in the landscape, where water availability is greater, than in the more elevated parts. Conversely in the east, where rainfall is higher, *Eucalyptus populnea* is associated with duplex and clay soils in a higher position in the landscape. It is also reflected by the change from P16 Simple Box Woodlands to P14 Red Box, Poplar Box and Pine Woodlands and U1 Red Box, Poplar Box, Pine and Green Mallee.

In some instances it has been argued that vegetation change over time is a direct reflection of land management practices and has little to do with environmental conditions. Harrington et al. (1981) suggested large Eucalypt trees are crucial to the distribution of shrubs and documented an increase in shrub distribution with a decrease in density of *Eucalyptus populnea*.

In *Eucalyptus populnea* woodlands where the density of *Eucalyptus populnea* has been reduced, Hodgkinson et al. (1980) found the soil seed banks showed low numbers of seed of formerly common grass species, but high numbers of shrub seeds. They found no species present in the soil seed-bank that were not present in the above ground floristic community. Lunt (1997) also found that the soil seed banks of anthropogenic native grasslands and grassy forest remnants reflected the above ground flora. These changes in the residual soil seed bank will limit attempts to restore woodland to a predominantly grassy understorey by change in management practices alone. It is likely that the re-introduction of many species, particularly palatable species, will be necessary for rehabilitation of remnants (Lunt 1997). The changes in structure and floristics of *Eucalyptus populnea* communities identified by Beeston et al. (1980) and Lunt (1997) are still being examined (Prober et al. 2001, Prober et al. 2002), particularly in relation to change in floristic composition, the simplification of vegetation structure and soil nutrient cycling.

The *Eucalyptus populnea* Woodlands can be described as a continuum, with species assemblages at the extremities of the distribution distinctly different in both an east-west and north-south direction. On the floodplain in the south *Eucalyptus populnea* is associated with *Eucalyptus largiflorens* while in the north *Eucalyptus populnea* is associated with *Eucalyptus coolibah.* In the east *Eucalyptus populnea* is associated with *Eucalyptus microcarpa* – *Eucalyptus pilligaensis* and in the west *Eucalyptus populnea* is associated with *Eucalyptus intertexta*. The site data separated some *Eucalyptus populnea* associations with well defined classification groups in the dendrogram but the differentiation between all *Eucalyptus populnea* associations is not definitive, and the perception that *Eucalyptus populnea* Woodlands are distinctly different in the east compared to the west (Beckers, Knop, Dykes pers. com.) was not strongly supported. Subtle differences in topography, soils and hydrology make it difficult to separate all the *Eucalyptus populnea* alliances at the 1:250 000 scale.

Change in vegetation cover

The reduction in the area occupied by temperate eucalypt woodlands is not a recent event. Compared with historical descriptions by Oxley (1818), Sturt (1828, 1829) and Mitchell (1846), Denny (1992) noted a large reduction in the amount of vegetation cover in the region. While present tree species composition is similar to the first European descriptions, there has been an obvious decrease in the density and area covered by the original vegetation associated with extensive land clearing for cropping and grazing activities. Wells et al. (1984) indicates up to 45 per cent of the forests and woodlands in this area have been severely modified since settlement and Walker et al. (1993) have estimated 14 billion trees have been removed from the Murray Darling Basin. Using extinct and threatened plant species data, Burgman (2002) reports that the primary cause for range contraction, population reduction and extinction in Australian vascular flora is due to land clearing for agriculture.

Recent legislative measures to constrain and manage clearing such as *State Environmental Planing Policy 46* 1996 and the *Native Vegetation Conservation Act*, 1997 and the listing of clearing as a threatening process at the national and state level (Environment Protection and Biodiversity Conservation Amendment (Wildlife Protection) Act 2001, NSW Scientific Committee 2002)) indicates the serious nature of the decline in native woody vegetation.

Land clearing rates have not slowed overall in Australia since the early 1990s (Burgman 2002). New clearing, progressive expansion of existing cropped areas into adjacent remnants, fragmentation of larger remnants, and vegetation permanently inundated by off-river storage (Sivertsen 1995) are all evident in the study area. Native woody vegetation occupied only 1 324 000 ha (32 %) of the study area examined in 1980s. Since that time, native woody vegetation cover has declined by 129 000 ha or10 %. In 2000 native woody vegetation occupied 1 194 000 ha (29 %) of the area mapped (Table 14). Thirty five percent (45 000 ha) of all clearing recorded in this study occurred between 1998 and 2000.

Beeston et al. (1980) indicate that development pressures are greatest along the eastern limit of the distribution of *Eucalyptus populnea* (Poplar Box) Woodlands. These assertions are supported by the limited distribution and fragmented or relictual (McIntyre & Hobbs 1999) nature of remnant vegetation in the eastern section of the study area, and by the high levels of clearing recorded in the P4 Poplar Box Woodlands, (24 683 ha) during the course of this study (Table 14).

P16 Simple Poplar Box Woodlands in the west of the study area are still relatively un-fragmented and could be described as variegated in their spatial pattern (McIntyre & Hobbs 1999). However, the largest proportion of clearing occurred within this unit and a distinct shift in land management practice can be observed where 18 % (28 855 ha) of the original extent have been removed since 1987. Similarly, the extensive and relatively un-fragmented P14 Red Box, Poplar Box and Pine Woodlands were cleared heavily, 32 932 ha or 12 % of the original extent since the 1980s, 2 % higher than the average for the entire study area (Table 14). Small, localised clearing events as allowed under the *Native Vegetation Conservation Act* exemptions, for example, may have major consequences for the persistence of native flora and fauna by reducing habitats to unsuitable size (van dee Rae & Bennett 2001) or preventing species movement by increasing distances to adjacent remnants (Law & Chidel 2002).

Although clearing is the most obvious cause for tree decline, other processes such as thinning for pasture improvement, dieback, windthrow, fire, salinity and rising water table, lack of regeneration due to feral and domestic grazers, inappropriate conditions for seedling establishment, and invasion by weeds all contribute to the underlying decline (Saunders et al. 1991). In this fragmented and degraded condition, with altered biotic and abiotic processes, medium to long term persistence of these woodlands in the landscape is uncertain (Prober & Thiele 1993, Prober et al. 2001).

The continuing reduction in native woody vegetation cover means that fewer options for conservation and sustainable agricultural practices are left, as the remaining options for vegetation management are used up in each clearing event. A review by Saunders et al. (1991) indicated that conservation of regional biotas depends entirely on the retention and management of remnants. The ecological implications resulting from the reduction of native woody vegetation cover include loss of habitat for flora and fauna species (which is considered the biggest current threat to biodiversity, WCMC 1992), increased runoff from rainfall, increased soil erosion, reduced extraction of groundwater (Walker et al. 1993) hence possible increase in groundwater levels, increased dryland salinity, decreased water quality, increased land degradation, uncertainty of persistence in the landscape of flora and fauna species, and decreased productivity in the major agricultural centre of NSW.

Despite national efforts such as One Billion Trees, Farming for the Future, 14 years of Landcare, and millions of dollars of Natural Heritage Trust Funding, *State Environmental Planning Policy Number 46* (1996) and *The Native Vegetation Conservation Act* (1997), common box woodland species are not adequately protected in dedicated conservation networks and continue to decline (Prober et al. 2001). The plight of temperate eucalypt woodlands of central NSW requires immediate attention.

Conservation status of the vegetation and implications for management

Four of the 22 vegetation units are represented in conservation reserves. These are: 9480 ha (50%) of P1 Mallee Woodlands on Plains; 345 ha (0.002%) of P16 Simple Poplar Box Woodlands; 290 ha (0.001%) of P14 Red Box, Poplar Box and White Cypress Pine Woodlands; and 70 ha (<0.001%) of H1 Dwyer's Red Gum, Ironbark and Green Mallee Woodlands. Although up to 50% of the current vegetation is in a conservation reserve for P1 Mallee Woodlands, mallee has been considerably reduced from its original extent. These reserves are not considered to adequately represent the diversity of these vegetation units and they clearly do not comprehensively represent the diversity of vegetation in the study area.

Acacia pendula (Myall) Woodlands R5, limited in distribution, fragmented, and threatened by clearing, grazing and altered water regime (Benson 1991, Specht et al. 1995), is not represented in the conservation network. Despite the increased clearing pressure on Box Woodlands no sites within the study area are protected under the Grassy Box Woodland Conservation Management Network and Grassy Poplar (Bimble) Box Woodlands have no representation in the Network at all (Prober et al. 2001). Beeston et al. stated in 1980 that the conservation of *Eucalyptus populnea* and allied communities was poor and that there was an urgent need for adequate sampling and conservation of the variation in both the species and communities. This action is even more important today, as the changes in community structure and the contraction of these communities is occurring at a higher rate than the contraction of native vegetation on the whole.

Existing conservation reserves in the study area are small and becoming more isolated as clearing continues. Quanda Nature Reserve (one of three small reserves in the area) is situated on an unusual geological intrusion with mainly mallee and some Poplar Box and Grey Box. It is not representative of the vegetation of the floodplains or the rolling hills surrounding this area. A large-scale clearing event in 2000 removed nearby vegetation corridors and effectively isolated the Nature Reserve from vegetation to the north. Similarly Tollingo and Woggoon Nature Reserves are of limited extent, represent mainly mallee vegetation associated with the plains and are surrounded by agricultural activity.

These small conservation reserves do not adequately represent the native vegetation of the study area. They exist as islands in a sea of agriculture, not as part of a matrix of compatible land use as is more common of reserves on the east coast of Australia. They are more susceptible to the degrading processes characteristic of fragmented ecosystems including changes in microclimate (influxes of radiation, wind, water and nutrients), degree of isolation (time since isolation, distance to other remnants, degree of connectivity, changes in the surrounding landscape), increased fertility from runoff, mobilisation of salts, changed fire regime, and lack of recruitment due to grazing pressure (Saunders et al. 1991). Their long-term persistence in the landscape is questionable (Landsberg & Wylie 1991).

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Appendix 1.

Map unit descriptions for the remnant vegetation of the Cobar–Nyngan–Gilgandra and Nymagee–Narromine–Dubbo 1:250 000 vegetation map sheets

22 Map Units have been identified, 18 occur on the Cobar–Nyngan–Gilgandra vegetation sheet and 16 on the Nymagee–Narromine–Dubbo 1:250 000 vegetation sheet. Each map unit is described as follows:

Name: Map Unit Code and Title

Area: The extent of the map unit in 2000

Sites: Number of formal sites used to derive the description

Landforms: Most frequently occurring Morphological Terrain Types

Soils: Main soil types based on field observations, not from formal profile descriptions

Geology: Geological formations interpreted from: Cobar 1:250 000 Metallogenic (1994) and Geological (1969) map sheet; Nyngan 1:250 000 Geological map sheet (1996); Gilgandra 1:250 000 Geological map sheet (1968); Nymagee 1:250 000 Geological map sheet (1968); Narromine 1:250 000 Geological map sheet (1972) and Dubbo 1:250 000 Geological map sheet (1971)

Structure: Main vegetation structural types following Walker & Hopkins (1990)

Species: Dominant and characteristic species listed by relevant stratum, trees, low trees, tall shrubs, shrubs, herbs and grasses

Comments: general descriptions and variation expected

Species table: Group C/A = the mean Cover/Abundance for the species in the sites within the classification group (50 percentile).
Group freq %: the percentage of the species in the sites within the classification group of the map unit.
Non-group C/A = the mean Cover/Abundance of the species in the sites outside the classification group (50 percentile).
Non-Group freq %: the percentage of the species in the sites outside the classification group.
Diagnostic (positive and negative) and characteristic (constant) species are listed (see Table 9).

Communities described as:

Riparian and floodplain remnants

R1 *Eucalyptus camaldulensis* (River Red Gum) Forests and Woodlands

R3 *Eucalyptus largiflorens* (Black Box) Woodlands

R5 *Acacia pendula* (Myall) Woodlands

Undulating Peneplain remnants

P1 *Eucalyptus socialis, Eucalyptus dumosa* Mallee Woodlands on Plains

P4 *Eucalyptus populnea* (Poplar Box) Woodlands

P6 *Callitris glaucophylla* (White Cypress Pine) Woodlands

P7 *Casuarina cristata* (Belah) – *Eucalyptus populnea* (Poplar Box) Woodlands

P11 *Flindersia maculosa* (Leopardwood) Open Shrublands

P12 Woodlands on Jurassic Sandstone

P13 *Eucalyptus microcarpa* (Grey Box) Woodlands

P14 *Eucalyptus intertexta* (Red Box), *Eucalyptus populnea* (Poplar Box) and *Callitris glaucophylla* (Pine) Woodlands

P15 *Eucalyptus chloroclada* (Dirty Red Gum), *Callitris glaucophylla* (Pine) and *Eucalyptus populnea* (Poplar Box) Woodlands

P16 Simple *Eucalyptus populnea* (Poplar Box) Woodlands

Remnants on undulating rises

U1 *Eucalyptus intertexta* (Red Box), *Eucalyptus populnea* (Poplar Box), *Callitris glaucophylla* (Pine) and *Eucalyptus viridis* (Green Mallee) Woodlands

U2 *Eucalyptus intertexta* (Red Box), *Eucalyptus populnea* (Poplar Box) and *Callitris glaucophylla* (Pine) Woodlands on Granite Hillslopes

U3 *Eucalyptus dwyeri* (Dwyer's Red Gum) Low Open Woodland on Granite Crests

Hill and ridge remnants

H2 *Eucalyptus viridis* (Green Mallee) Woodlands

H6 *Eucalyptus morrisii* (Grey Mallee) Open Woodlands

H7 *Eucalyptus dumosa – Eucalyptus socialis* Mallee Woodlands on Rolling Hills

H8 *Eucalyptus dealbata* (Tumbled Down Red Gum) Woodlands on basalt hills

H9 *Eucalyptus dwyeri* (Dwyer's Red Gum) Open Woodland on Granite Hills

Riparian and floodplain remnants (R)

R1 *Eucalyptus camaldulensis* (River Red Gum) Forests and Woodlands

Area: 88 319 ha **Sites:** 42

Landforms: Banks, channels, depressions, cowals and backplains of the Bogan, Macquarie and Castlereagh Rivers. Banks of major tributaries in the Cobar and Pilliga peneplains.

Soils: Grey cracking clays, polygenetic alluvial soils.

Geology: Unconsolidated Quaternary alluvials. Note that these alluvials overlay the Ordovician fine grained quartzose metasediments of the Girilambone geological group in the Cobar peneplain and the Jurassic Pilliga sandstone in the Pilliga peneplain region.

Structure: Tall to Very Tall Open Forests and Mid-high to Tall Open Woodlands.

Trees: *Eucalyptus camaldulensis,* occasionally *Eucalyptus largiflorens.* Low Trees: *Acacia salicina, Acacia stenophylla.* Shrubs: *Bursaria spinosa, Glycyrrhiza acanthocarpa, Muehlenbeckia florulenta.* Herbs and Rushes: *Carex appressa, Cyperus gymnocaulos, Eleocharis pallens, Eleocharis plana, Glycine tabacina, Juncus radula, Marsilea drummondii.* Grasses: *Austrodanthonia caespitosa, Eulalia aurea, Phragmites australis, Austrostipa ramosissima, Austrostipa verticillata.*

Comments: Typically dominated by *Eucalyptus camaldulensis* primarily confined to the banks and channels of the major river systems, on perennial streams, in depressions and around cowals and also on intermittent streams in the west of the area. Forests grade into Mid-high and Tall Open Woodlands on the marshes, cowals and open depressions of the Bogan and Macquarie River system. An example of an extensive area of Mid-high Open River Red Gum Woodland spreading from the confines of the river channel is found 25 kms north of Warren.

The low trees *Acacia stenophylla* (River Cooba) and *Acacia salicina* (Cooba) commonly occur in the upper strata. Along the Bogan River, Bulbodney and Crowie Creeks of the Narromine map sheet, *Eucalyptus largiflorens* commonly co-dominates. On sandier soils, particularly in the eastern part of study area (Narromine, Peak Hill, Dubbo, Gilgandra and Tenandra 1:100 000 sheets), along upper tributaries of the Castlereagh and Macquarie River and Coolbaggie Creek, *Eucalyptus conica* (Fuzzy Box), *Eucalyptus melliodora* (Yellow Box) and *Callitris glaucophylla* (White Cypress Pine) occasionally occur with River Red Gum.

The understorey is characterised by a patchy shrub layer, which is frequently absent, and a ground layer of herbs and grass species, often exotics, that vary considerably between sites.

	Fidelity	Group		Non-group	
Species	**class**	**C/A**	**freq %**	**C/A**	**freq %**
Callitris glaucophylla	negative	4	9	4	5
Acacia salicina	positive	2	12	0	0
Bursaria spinosa	positive	1	3	0	0
Carex appressa	positive	4	9	0	0
Cyperus gymnocaulos	positive	6	6	0	0
Austrodanthonia caespitosa	positive	4	3	0	0
Eleocharis plana	positive	4	9	0	0
Eucalyptus camaldulensis	positive	6	97	4	4
Eulalia aurea	positive	4	3	0	0
Glycine tabacina	positive	1	6	0	0
Glycyrrhiza acanthocarpa	positive	5	6	0	0
Juncus radula	positive	4	6	0	0
Phragmites australis	positive	6	6	0	0
Austrostipa ramosissima	positive	4	3	0	0
Austrostipa verticillata	positive	4	3	0	0

Fig. 7. R1 *Eucalyptus camaldulensis* (River Red Gum) Forests and Woodlands, Gunning Bar Creek

Fig. 8. R3 *Eucalyptus largiflorens* (Black Box) Woodlands

R3 *Eucalyptus largiflorens* (Black Box) Woodlands

Area: 69 379 ha **Sites:** 26

Landforms: Floodplains**,** banks, depressions, cowals and flats of the Bogan-Macquarie floodplain.

Soils: Mainly grey cracking clays, minor red and red-brown earths.

Geology: Quaternary alluvium.

Structure: Mid-high Open Forests, Mid-high Woodlands and Mid-high Open Woodlands.

Trees: *Eucalyptus largiflorens,* occasionally *Eucalyptus camaldulensis, Eucalyptus populnea, Casuarina cristata.* Low Trees: *Acacia stenophylla.* Tall Shrubs: *Geijera parviflora, Apophyllum anomalum.* Shrubs: *Atriplex semibaccata, Einadia nutans* subsp. *nutans, Lysiana subfalcata* subsp. *subfalcata, Rhagodia spinescens, Sclerolaena tricuspis, Muehlenbeckia florulenta, Solanum esuriale.* Herbs and Rushes: *Calotis scapigera, Marsilea drummondii, Minuria integerrima, Modiola caroliniana, Oxalis chnoodes, Tribulus terrestris, Eleocharis pusilla.* Grasses: *Enteropogon acicularis, Leptochloa digitata, Thyridolepis mitchelliana.*

Comments: Characterised by Mid-high Open Woodlands of *Eucalyptus largiflorens* and most commonly found on grey cracking clays of the broad floodplain of the Bogan-Macquarie system and north of the Lachlan River (Narromine 1:250 000 map-sheet). Mid-high Woodlands and Mid-high Open Woodlands dominated by *Eucalyptus largiflorens* occur along the banks of the Bogan River and on the slow draining flats, depressions and seasonally flooded low-lying areas (Nyngan 1:250 000 map sheet). Black Box Woodlands are generally absent in the study area east of the Macquarie River except along Marthaguy and Back Creeks.

Along the Bogan River, R3 Black Box Woodlands integrades with R1 River Red Gum Forests. *Eucalyptus camaldulensis* and *Acacia stenophylla* occasionally occur in the overstorey. Away from the main river channels, and on slightly higher ground where the soils grade between grey cracking clays and red earths, a floodplain mosaic comprising minor areas of *Eucalyptus populnea* and *Casuarina cristata* occurs within this unit.

Typically the understorey is composed of scattered low trees and tall shrubs such as *Geijera parviflora* and *Apophyllum anomalum.* Generally a low shrub layer is lacking. Where it is present, chenopods usually dominate, however in those areas subject to periodic inundation, the shrub *Muehlenbeckia florulenta,* may occur. The ground layer may be sparse or absent and is often dependent on seasonal influences.

Species	**Fidelity class**	**Group C/A**	**Group freq %**	**Non-group C/A**	**Non-group freq %**
Callitris glaucophylla	negative	0	0	4	54
Atriplex semibaccata	positive	4	7	0	0
Calotis scapigera	positive	1	3	0	0
Einadia nutans subsp. *nutans*	positive	3	59	2	35
Eleocharis pusilla	positive	3	3	0	0
Eucalyptus largiflorens	positive	5	100	4	2
Lysiana subfalcata	positive	1	3	0	0
Minuria integerrima	positive	2	10	0	0
Modiola caroliniana	positive	4	3	0	0
Rhagodia spinescens	positive	3	52	2	14
Sclerolaena tricuspis	positive	1	7	0	0

Fig. 9. R5 *Acacia pendula* (Myall) Woodlands

R5 *Acacia pendula* (Myall) Woodlands

Area: 23 043 ha **Sites:** 14

Landforms: Flats of the alluvial plains subject to gilgai development and extending to the flats of the Pilliga peneplain.

Soils: Grey and brown clays, rarely on deeper red and brown earths

Geology: Quaternary alluvium.

Structure: Mid-high Woodland and Mid-high Open Woodland. Minor Low Open Woodlands.

Low Trees: *Acacia pendula.* Tall Shrubs: *Geijera parviflora, Apophyllum anomalum.* Shrubs: *Atriplex vesicaria, Lasiopetalum baueri, Maireana aphylla, Einadia nutans* subsp. *nutans, Rhagodia spinescens, Sclerolaena muricata, Amyema quandang.* Herbs: *Brachycome curvicarpa.* Grasses: *Austrodanthonia linkii* var. *linkii, Digitaria divaricatissima, Enteropogon acicularis, Paspalidium gracile, Austrostipa aristiglumis.*

Comments: Occurs as small stands scattered across the flats of the alluvial floodplain of the Bogan and Macquarie Rivers and Boggy Cowal, or isolated remnants in roadside reserves, or pockets amongst taller woodlands. Myall Woodlands most frequently occur on the heavy grey and brown clay gilgais, occasionally on the red and brown earths of the flats of the Pilliga peneplain. Canopy is characteristically monospecific though eucalypts and tall shrubs such as *Geijera parviflora* and *Apophyllum anomalum* may occur with *Acacia pendula* where it is adjacent to Poplar Box or Black Box Woodlands.

Understorey characterised by many species of low chenopod shrubs and grasses. *Amyema quandang* is a common stem parasite of *Acacia pendula.* [Myall Woodlands are difficult to distinguish from pasture and grasslands on API, and may be more common than is indicated by the mapping.]

Species	**Fidelity class**	**Group C/A**	**Group freq %**	**Non-group C/A**	**Non-group freq %**
Callitris glaucophylla	negative	0	0	4	51
Acacia pendula	positive	5	100	0	0
Amyema quandang	positive	2	56	0	0
Brachycome curvicarpa	positive	3	33	0	0
Einadia nutans subsp. *nutans*	positive	3	89	2	24
Lasiopetalum baueri	positive	1	11	0	0
Rhagodia spinescens	positive	3	67	3	14
Sclerolaena muricata	positive	2	78	2	9

Fig. 10. P1 *Eucalyptus socialis, Eucalyptus dumosa* (Mallee) Woodlands on Plains

Undulating Peneplain remnants (P)

P1 *Eucalyptus socialis, Eucalyptus dumosa* (Mallee) Woodlands on Plains

Area: 18 757 ha **Sites:** 13

Landforms: Flats very low hills in the east of the Cobar peneplain on Nymagee and Cobar map sheets. **Soils:** Red Earths

Geology: Mainly confined to Honeybugle Ordovician basic intrusion on Cobar map sheet, but also occurs on very low rises of the peneplain around Quanda Nature Reserve on Ordovician sediments.

Structure: Dense, generally even height Very Tall to Extremely Tall Closed Mallee Forest.

Trees: *Eucalyptus socialis* (Pointed Mallee), *Eucalyptus dumosa* (Congoo), *Eucalyptus leptophylla* (Narrow-leafed Red Mallee), *Eucalyptus sideroxylon* (Mugga Ironbark), *Eucalyptus microcarpa* (Mallee Grey Box) *Eucalyptus viridis, Brachychiton populneus, Callitris glaucophylla, Eucalyptus intertexta.* Tall Shrubs: *Acacia deanei* subsp. *paucijuga, Acacia buxifolia* subsp. *buxifolia, Acacia hakeoides, Acacia tetragonophylla, Eremophila deserti, Hakea leucoptera, Eremophila longifolia, Geijera parviflora.* Shrubs: *Pimelea microcephala, Bertya cunninghamii, Cassinia laevis, Choretrum glomeratum, Bossiaea walkeri, Senna artemisioides* subsp. *zygophylla, Eremophila glabra, Olearia pimeleoides, Sclerolaena bicornis* var. *horrida;* Herbs: *Solanum ellipticum, Solanum ferocissimum.* Grasses: *Dianella revoluta, Lomandra effusa, Austrostipa scabra, Triodia scariosa* subsp. *scariosa.*

Comments: *Eucalyptus viridis* (Green Mallee) is an occasional co-dominant on gravelly soils. *Brachychiton populneus* (Kurrajong), *Eucalyptus intertexta* (Red Box) and *Callitris glaucophylla* (White Cypress Pine) may also be found as isolated trees. Understorey typically composed of *Acacia* species, *Geijera parviflora* and *Eremophila longifolia* in the upper shrub layer with the grass *Triodia scariosa* subsp. *scariosa* and herbs being characteristic of the ground layer. [This map unit is similar to H7 Mallee Woodlands on Rolling Hills in floristic composition, but P1 Mallee Woodlands on Plains are more diverse and display a taller structure, and generally occur lower in the landscape.]

Occurrences within Tollingo, Woggoon and Quanda Nature Reserves represents the largest eastern-most remnants of this vegetation type (Porteners 1998, 2001). It has been extensively cleared and outside of Nature Reserves all that remains of this once extensive map unit are narrow fragmented remnants along the roadsides.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Acacia deanei subsp. *paucijuga*	positive	2	100	4	1
Acacia hakeoides	positive	1	50	1	6
Acacia buxifolia subsp. *buxifolia*	positive	1	33	0	0
Bertya cunninghamii	positive	4	66	4	3
Callitris glaucophylla	positive	4	83	2	27
Cassinia laevis	positive	1	83	1	1
Choretrum glomeratum	positive	1	16	0	0
Dianella revoluta	positive	3	50	3	2
Eremophila glabra	positive	2	66	1	4
Eucalyptus socialis	positive	5	50	4	10
Eucalyptus sideroxylon	positive	4	50	4	13
Lomandra effusa	positive	1	66	3	1
Phebalium glandulosum subsp. *glandulosum*	positive	4	33	0	0
Pimelea microcephala	positive	1	33	0	0
Sclerolaena bicornis var. *horrida*	positive	1	50	2	1
Senna artemisioides subsp. *zygophylla*	positive	1	50	3	1
Austrostipa scabra	positive	2	100	4	10

Fig. 11. P4 *Eucalyptus populnea* (Poplar Box) Woodlands

P4 *Eucalyptus populnea* (Poplar Box) Woodlands

Area: 266 140 ha **Sites:** 76

Landforms: Flats and some open depressions of the backplains, floodplains and low footslopes of the peneplain.

Soils: Red, red-brown and yellow earths and grey, brown and red clays.

Geology: Quaternary colluvial and alluvial derivation.

Structure: Mid-high to Tall Woodlands and Open Woodlands.

Trees: *Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii.* Low Trees: *Alectryon oleifolius, Capparis mitchellii, Acacia colletioides, Acacia salicina.* Tall Shrubs: *Geijera parviflora, Eremophila mitchellii, Eucalyptus glabra, Apophyllum anomalum, Hakea leucoptera.* Shrubs: *Bertya cunninghamii, Einadia nutans* subsp. *nutans, Rhagodia spinescens, Sclerolaena* spp., *Maireana decalvans.* Herbs and Rushes: *Brunoniella australis, Calotis* spp., *Cheilanthes sieberi* subsp. *sieberi, Dichondra repens, Pelargonium australe, Eleocharis* spp., *Carex appressa;* Grasses: *Austrostipa scabra, Cymbopogon obtectus, Enteropogon acicularis, Aristida* spp.

Comments: *Eucalyptus populnea* (Poplar Box) Woodlands are the most commonly occurring and widespread remnant types in the study area. They have been categorised into P4 Poplar Box Woodland and P16 Simple Poplar Box Woodland map units and account for 30% of all vegetation mapped. The distinction between these units is based on a slight difference in floristic composition, examination of air photo patterns and field observations. Within the P4 Poplar Box Woodland map unit a number of different associations are recognised and described. Their subtle differences in structure and composition in the field made it impractical to classify them as separate map units given the scale of the aerial photography interpreted the amount of available site data, and the scale of the final map. P4 Poplar Box Woodland may occur as small isolated stands and narrow, linear corridors along road and property boundaries and as wind breaks. Where land use and management has had minimal impact, expansive Tall Woodlands and Tall Open Woodlands are found.

A typical Poplar Box Woodland remnant is dominated by *Eucalyptus populnea* (Poplar Box) with the relative dominance of associated overstorey and understorey species changing with the degree of impact of past and current land use practices and local variations in environmental conditions. The upper layer of the understorey is commonly composed of scattered low trees such as *Alectryon oleifolius* and *Capparis mitchellii* occurring with tall shrubs including *Geijera parviflora, Eremophila mitchellii* and *Apophyllum anomalum*. The lower shrub layer is typically dominated by chenopods and the ground layer is generally characterised by herbs and grasses.

From east to west of the range of associations can be noted at the local level, but are not represented in the maps. From the Pilliga Peneplain west to the Castlereagh River P4 Poplar Box Woodlands occur on the sandier, quartzose-dominated soils and grade into P12 Woodlands on Jurassic Sandstone. Here *Eucalyptus pilligaensis, Eucalyptus microcarpa, Eucalyptus conica,* and *Casuarina cristata* occur as associated overstorey species. On the yellow earths of the banks and raised flats of the Castlereagh River, *Eucalyptus populnea, Callitris glaucophylla,* and *Eucalyptus melanophloia* can occur with *Eucalyptus camaldulensis*.

West of the Castlereagh where the Macquarie River floodplain rises gently, the red and yellow earths of Quaternary Carrabear formation support Tall Woodlands and Tall Open Woodlands of *Eucalyptus populnea* with *Callitris glaucophylla* and *Allocasuarina luehmannii*. Remnants adjacent to P15 *Eucalyptus chloroclada* (Dirty Gum), Pine and Poplar Box Woodlands, *Eucalyptus chloroclada* and *Callitris glaucophylla* may co-dominant with *Eucalyptus populnea*. P4 Poplar Box woodlands adjacent to and east of the Bogan river, on soils with higher fertility, *Eucalyptus microcarpa* (Grey Box) may dominate. In the zone of transition from the Macquarie River floodplain to the Bogan River floodplains and backplains, alluvial red and yellow earths and some grey clays support Tall Open Woodlands of *Eucalyptus populnea* with occasional *Casuarina cristata* and *Allocasuarina luehmannii* (Tullamore and Dandaloo 1:100 000 sheets). From the elevated flats of the Bogan River backplain west to the Cobar peneplaiin, P4 Poplar Box Woodlands grade into P16 Simple Poplar Box Woodland, where *Eucalyptus populnea* is associated with *Callitris glaucophylla, Casuarina cristata* and *Eucalyptus intertexta.*

	Fidelity	Group		Non-group	
Species	**class**	**C/A**	**freq %**	**C/A**	**freq %**
Callitris glaucophylla	constant	4	88	4	51
Acacia colletioides	positive	4	13	0	0
Acacia salicina	positive	5	38	0	0
Alectryon oleifolius	positive	3	57	1	14
Aristida behriana	positive	1	26	0	0
Aristida jerichoensis	positive	3	19	0	0
Aristida leichhardtiana	positive	2	19	0	0
Bertya cunninghamii	positive	4	26	0	0
Brunoniella australis	positive	2	25	0	0
Bursaria spinosa	positive	1	1	0	0
Calotis cuneata	positive	1	1	0	0
Calotis lappulacea	positive	2	50	3	4
Calotis scapigera	positive	3	2	0	0
Carex appressa	positive	3	2	0	0
Cheilanthes sieberi subsp. *sieberi*	positive	2	50	2	5
Cymbopogon obtectus	positive	1	2	0	0
Dichondra repens	positive	2	25	0	0
Einadia nutans subsp. *nutans*	positive	2	65	3	37
Eleocharis pallens	positive	3	2	0	0
Eleocharis plana	positive	3	6	0	0
Eleocharis pusilla	positive	3	2	0	0
Enneapogon polyphyllus	positive	2	26	0	0
Enteropogon acicularis	positive	3	55	3	34
Eragrostis megalosperma	positive	3	2	0	0
Eremophila glabra	positive	3	2	0	0
Eremophila mitchellii	positive	3	51	2	26
Eriochloa pseudoacrotricha	positive	4	2	0	0
Eucalyptus populnea	constant	5	98	4	56
Eucalyptus melliodora	positive	6	2	4	1
Geijera parviflora	positive	3	67	3	42
Juncus radula	positive	1	2	0	0
Lysiana subfalcata	positive	4	2	0	0
Muehlenbeckia florulenta	positive	4	77	0	0
Pelargonium australe	positive	3	2	0	0
Rhagodia spinescens	positive	3	50	2	8
Rhynchosia minima	positive	1	2	0	0
Sclerolaena tricuspis	positive	2	58	0	0
Vittadinia dissecta var. *hirta*	positive	4	14	0	0

Fig. 12.
P6 *Callitris glaucophylla* (White Cypress Pine) Woodlands, adjacent to Meryula State Forest

P6 *Callitris glaucophylla* (White Cypress Pine) Woodlands

Area: 19 629 ha **Sites:** 17

Landforms: Flats, low rises and aeolian dunes of the alluvial plain. Low slopes and flats of the peneplains.

Soils: Sandy red and yellow earths

Geology: Quaternary alluvials and residuals.

Structure: Tall Open Woodland and Tall Woodland. Minor Mid-high Open Woodland.

Trees: *Callitris glaucophylla*. Tall Shrubs: *Dodonaea viscosa*. Shrubs: *Einadia nutans* subsp. *nutans, Rhagodia spinescens.* Herbs: *Calotis cuneifolia, Cheilanthes austrotenuifolia*. Grasses: *Enteropogon acicularis, Austrostipa scabra*.

Comments: Occurs on red earths of the Cobar peneplain, the alluvial plains of the major rivers and the sandy red and yellow earths of the Pilliga peneplain. Characterised by a predominance of mature *Callitris glaucophylla* (White Cypress Pine) in the tallest stratum, or by a dense, uniform, regrowth layer of *Callitris glaucophylla* in the mid stratum, with a sparse understorey. In State Forests typically occurs as large stands of Tall Open Woodlands or Tall Woodlands with eucalypt species as isolated emergent trees, having been thinned in the past. On the low slopes and flats of the Cobar peneplain, overstorey species *Eucalyptus populnea* and *Eucalyptus intertexta* are infrequently interspersed. The distinctive airphoto pattern of the canopy and lack of species recorded in the understorey and ground layer has influenced the classification of this map unit.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Callitris glaucophylla	constant	6	100	4	62
Eucalyptus populnea	negative	2	4	4	72
Geijera parviflora	negative	1	8	3	52
Einadia nutans subsp. *nutans*	positive	3	87	2	42
Enteropogon acicularis	positive	3	75	3	38

Fig. 13. P7 *Casuarina cristata* (Belah) and *Eucalyptus populnea* (Poplar Box) Open Woodlands

P7 *Casuarina cristata* (Belah) – *Eucalyptus populnea* (Poplar Box) Woodlands

Area: 34 568 ha **Sites:** 16

Landforms: Flats and depressions of the floodplains.

Soils: Red Earth, grey and brown clays.

Geology: Quaternary alluvium.

Structure: Mid-high Open Woodlands

Trees: *Casuarina cristata, Allocasuarina luehmannii, Eucalyptus populnea.* Low Trees: *Acacia salicina.* Tall shrubs: *Geijera parviflora, Eremophila mitchellii, Alectryon oleifolius, Apophyllum anomalum.* Shrubs: *Muehlenbeckia florulenta. Lysiana subfalcata, Rhagodia spinescens, Sclerolaena birchii, Sclerolaena muricata, Einadia nutans* subsp. *nutans.* Herbs: *Oxalis chnoodes, Calotis cuneata, Calotis scapigera, Calotis lappulacea, Marsilea drummondii, Pelargonium australe, Rhynchosia minima.* Grasses: *Aristida jerichoensis, Aristida leichhardtiana, Cymbopogon obtectus, Enteropogon acicularis, Eriochloa pseudoacrotricha, Austrostipa scabra, Carex appressa, Eleocharis pallens, Eleocharis pusilla, Eleocharis plana, Juncus radula.*

Comments: Occurs in the eastern third of the study area on a range of topographical sequences; on the banks of intermittent and perennial creeks, on the flats and depressions of the alluvial plains and backplains of the major river systems. In favourable situations these woodlands may occur beyond the backplains in the zone of transition between the floodplain and peneplain.

Typically a Tall Woodland to Tall Open Woodland with *Casuarina cristata (*Belah) commonly the dominant canopy species. *Eucalyptus populnea* frequently occurs with *Casuarina cristata* on the red and brown earths and sandy clays of the flats of the alluvial plains and in depressions that may be subject to periodic inundation. Away from the main channels towards the backplains where fine, sandy, yellow and red earths occur, *Casuarina cristata* declines in dominance and species such as *Allocasuarina luehmannii* (Bulloak), and *Eucalyptus populnea* become more common. The relative distribution and abundance of these species is related to local variations in environmental conditions, such as, soil type, soil moisture and microtopography.

Geijera parviflora is a common understorey species in remnants. Scattered *Alectryon oleifolius* also occurs, often as a result of having been left as fodder trees following thinning or clearing of the surrounding vegetation. The lower shrub layer and ground cover varies between remnants but usually consists of unpalatable chenopods and grasses. Lignum is common in the understorey on the Dandaloo and Tottenham 1:100 000 sheets (Nyngan 1:250 000). Surrounding the Bay of Biscay Swamp, between the Bogan River and Narromine, *Casuarina cristata* and *Eucalyptus microcarpa (*Grey Box) occur on Red Brown Earths. *Casuarina cristata* with both Poplar Box and Grey Box are less restricted, occurring throughout the flats of the Bogan River on Yellow, Red and Red Brown Earths, as well as the Grey and Brown Clays near Dandaloo. Localised pure stands of *Casuarina cristata* are usually associated with intermittent drainage lines.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Eucalyptus populnea	constant	5	98	4	56
Callitris glaucophylla	negative	0	0	4	67
Acacia salicina	positive	5	38	0	0
Aristida jerichoensis	positive	3	1	0	0
Aristida leichhardtiana	positive	2	1	0	0
Calotis cuneata	positive	1	1	0	0
Calotis scapigera	positive	3	1	0	0
Carex appressa	positive	3	1	0	0
Casuarina cristata	positive	5	69	2	06
Cymbopogon obtectus	positive	1	1	0	0
Eleocharis pallens	positive	3	1	0	0
Eleocharis plana	positive	3	6	0	0
Eleocharis pusilla	positive	3	1	0	0
Eriochloa pseudoacrotricha	positive	4	1	0	0
Geijera parviflora	positive	4	84	2	45
Juncus radula	positive	1	1	0	0
Lysiana subfalcata	positive	4	1	0	0
Muehlenbeckia florulenta	positive	4	7	0	0
Oxalis chnoodes	positive	2	53	2	24
Pelargonium australe	positive	3	1	0	0
Rhagodia spinescens	positive	3	50	2	7
Rhynchosia minima	positive	1	1	0	0

Fig. 14. P11 *Flindersia maculosa* (Leopardwood) Open Shrublands

P11 *Flindersia maculosa* (Leopardwood) Open Shrublands

Area: 190 ha **Sites:** 1

Landforms: Flats on alluvial plains.

Soils: Red and grey clays

Geology: Quaternary alluvium.

Structure: Mid-high Sparse Shrublands to Low Open Woodlands.

Low Trees: *Flindersia maculosa.* Tall Shrubs: *Apophyllum anomalum, Atalaya hemiglauca, Geijera parviflora, Capparis mitchellii.* Shrubs: *Rhagodia spinescens, Sclerolaena muricata, Einadia nutans* subsp. *nutans, Lysiana subfalcata, Lasiopetalum baueri.*

Comments: Occurs in small areas on red and grey clays of the flats of the alluvial plains. A sparse shrub layer includes scattered tall shrubs *Geijera parviflora* and *Apophyllum anomalum*. The stem parasite *Lysiana subfalcata* may be found growing on the overstorey species. Beadle (1948) notes that on the red soils of slightly elevated areas, low scrub of the perennial saltbushes *Atriplex nummularia* and *Atriplex vesicaria* was once supported and surrounded by a zone of *Flindersia maculosa*. Given the present degraded nature of this remnant, it is possible that some of the larger trees have been removed in the past and grazing pressure on the palatable saltbush species has produced the current vegetation mapped today.

Remnants of this map unit are not common in the study area and are often difficult to distinguish on the high level aerial photography. More extensive areas of P11 *Flindersia maculosa* (Leopardwood) Open Shrublands occur further north on the Bourke and Walgett 1:250 000 sheets.

Fig. 15. P12 *Eucalyptus microcarpa, Eucalyptus sideroxylon* Woodlands on Jurassic Sandstone

P12 Woodlands on Jurassic Sandstone

Area: 20 418 ha **Sites:** 27

Landforms: Flats, broad drainage lines and gently undulating rises of the Pilliga Peneplain.

Soils: Yellow Earths, sandy Red and Red Brown Earths and Lithosols

Geology: Jurassic Pilliga Sandstone.

Structure: Mid-high to Tall Open Woodlands and Woodlands.

Trees: *Eucalyptus populnea* subsp. *bimbil, Eucalyptus crebra, Eucalyptus sideroxylon, Eucalyptus microcarpa, Eucalyptus pilligaensis, Eucalyptus viridis, Eucalyptus dwyeri, Eucalyptus chloroclada, Eucalyptus melliodora, Callitris glaucophylla.* Low Trees: *Allocasuarina luehmannii.* Tall Shrubs: *Acacia havilandiorum, Acacia hakeoides, Acacia tindaleae, Geijera parviflora.* Shrubs: *Acacia cardiophylla, Acacia triptera, Cassinia* species, *Dillwynia juniperina, Dodonaea viscosa, Melaleuca uncinata, Melichrus urceolatus.* Herbs: *Cheilanthes austrotenuifolia, Chrysocephalum apiculatum, Einadia nutans* subsp. *nutans, Hibbertia sericea, Lomandra collina.* Grasses: *Enteropogon acicularis, Eragrostis lacunaria.*

Comments: Occurs on low undulating hills and flats and broad drainage lines of the Pilliga peneplain in the east and south-east of the area, in some areas extending to the apron of colluvial material eroded from the Pilliga sandstone.

This map unit represents a diverse complex of vegetation varying spatially in structure and floristic composition. *Eucalyptus chloroclada, Eucalyptus pilligaensis, Eucalyptus sideroxylon, Callitris glaucophylla* and *Allocasuarina luehmannii* (Bulloak) are some of the more dominant canopy species with a dense shrub layer of *Acacias* occurring in some woodlands at the western limits of the outcropping Pilliga peneplain on the Bundemar 1:100 000 map sheet. On the main extent of the Pilliga peneplain, Grey Boxes, *Eucalyptus pilligaensis, Eucalyptus microcarpa* and *Eucalyptus conica*, Ironbarks *Eucalyptus crebra, Eucalyptus sideroxylon* and *Eucalyptus melanophloia*, Red Gums *Eucalyptus dwyeri, Eucalyptus chloroclada* and Pine *Callitris glaucophylla* predominate. The understorey is equally diverse, with a large *Acacia* component. Genera common to coastal and tableland communities are also a feature of the P12 Woodlands on Jurassic Sandstone; including *Dillwynia juniperina, Hibbertia sericea* and *Hibbertia obtusifolia, Melaleuca uncinata* and *Melaleuca densispicata* and *Melichrus urceolatus.* A wide range of grass species were recorded including: *Aristida calycina, Aristida jerichoensis* var. *jerichoensis, Aristida muricata, Aristida ramosa* var. *speciosa, Austrodanthonia linkii var. fulva, Austrostipa aristiglumis, Austrostipa scabra* var. *scabra, Paspalidium constrictum, Themeda australis, Thyridolepis mitchelliana*, however their frequency was too low to list them as characteristic species.

Of note is an area on the Bundemar 1:100 000 map sheet to the west of the peneplain near 'Ferndale Stud Park', where, on the raised flats surrounding a large cowal, there is vegetation that closely resembles that which commonly occurs to the east on the Jurassic peneplain sediments. Also of note was a small homogeneous stand of *Acacia harpophylla* (Brigalow) near the property 'Pine View'. The only other occurrence of this species in the study area is in the very north of the Gulargambone 1:100 000 map sheet near 'Fairfield', some distance from the Pilliga sediments. *Angophora floribunda* and *Eucalyptus conica* (Fuzzy Box), occur on banks of streams in the Coolbaggie creek system.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Eucalyptus populnea	constant	1	50	4	66
Acacia cardiophylla	positive	3	66	0	0
Acacia hakeoides	positive	4	50	1	6
Acacia havilandiorum	positive	1	100	3	2
Acacia lineata	positive	3	83	4	3
Acacia tindaleae	positive	4	100	0	0
Acacia triptera	positive	7	66	3	2
Allocasuarina luehmannii	positive	1	66	2	2
Amyema miquelii	positive	1	66	1	3
Callitris glaucophylla	positive	1	66	2	29
Cassinia quinquefaria	positive	1	17	0	0
Dillwynia juniperina	positive	2	66	0	0
Einadia nutans subsp. *nutans*	positive	3	87	2	42
Enteropogon acicularis	positive	4	50	3	22
Eragrostis lacunaria	positive	4	67	4	2
Eucalyptus crebra	positive	3	16	0	0
Eucalyptus dwyeri	positive	3	67	4	14
Eucalyptus microcarpa	positive	4	96	3	7
Eucalyptus sideroxylon	positive	5	100	4	11
Eucalyptus viridis	positive	4	67	5	9
Hibbertia sericea	positive	2	33	0	0
Melaleuca uncinata	positive	7	100	0	0

Fig. 16.
P13 *Eucalyptus microcarpa* (Grey Box) Woodlands

P13 *Eucalyptus microcarpa* (Grey Box) Woodlands

Area: 59 963 ha **Sites:** 21

Landforms: Slopes and low rises of the hills and the peneplains. Relief to 15 m

Soils: Red Earths.

Geology: Quaternary eluvial sediments that overlay many different geological substrates.

Structure: Mid-High to Tall Open Woodlands

Trees: *Eucalyptus microcarpa, Callitris glaucophylla, Eucalyptus populnea*. Tall shrubs: *Acacia lineata, Acacia pravifolia.* Shrubs: *Cassinia aculeata, Cassinia uncata, Eremophila debilis, Eremophila deserti, Dillwynia juniperina, Melichrus urceolatus, Dodonaea viscosa sens lat, Asperula conferta*. Grasses: *Amphipogon caricinus, Enteropogon acicularis, Austrostipa setacea, Dianella revoluta.*

Comments: Occur in the central and western part of the area on rolling country of the Nymagee 1:250 000 sheet; and on footslopes and rolling country of the Narromine 1:250 000 sheet (Boona Mount, Tottenham and Tullamore 1:100 000 sheets). *Eucalyptus microcarpa* (Grey Box) and occasionally *Eucalyptus populnea* are the dominant canopy species. The understorey has a diverse range of shrubs and a grassy ground layer is generally present, with *Enteropogon acicularis*, and *Austrostipa setacea* commonly occurring. The vine *Parsonsia eucalyptophylla* occurs scrambling through the ground layer. The understorey ranges from dense to sparse due to changes in local environmental factors, but may also have a localised and distinct 'patch-work' pattern resulting from land use. In these areas, White Cypress Pine regeneration is common. Grey Box also becomes a more frequent component of P4 Poplar Box Woodlands adjacent to and immediately to the east of the Bogan River.

Where the outcrops of substrates occur, *Eucalyptus microcarpa* Woodlands frequently give way to other plant communities. Common to the crests and shallow, gravelly soils are H2 Green Mallee Woodlands or H1 Dwyer's Red Gum, Ironbark and Green Mallee Woodlands. This pattern, of rolling plains of P13 Grey Box Woodlands interspersed with crests of H2 Green Mallee and hills with H1 Dwyer's Red Gum, Ironbark and Green Mallee Woodlands, is characteristic of the western half of the Narromine 1:250 000 sheet and parts of the northern half of the Nymagee 1:250 000 sheet.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Callitris glaucophylla	constant	4	54	4	65
Eucalyptus populnea	negative	1	17	4	71
Acacia lineata	positive	3	8	0	0
Acacia pravifolia	positive	2	4	0	0
Amphipogon caricinus	positive	4	4	0	0
Asperula conferta	positive	2	4	0	0
Austrostipa setacea	positive	5	4	0	0
Dianella revoluta	positive	2	4	0	0
Dodonaea viscosa subsp. *spatulata*	positive	1	4	0	0
Enteropogon acicularis	positive	4	63	3	37
Eremophila debilis	positive	3	8	0	0
Eremophila deserti	positive	1	4	0	0
Eucalyptus microcarpa	positive	4	96	3	7

Fig. 17.
P14 *Eucalyptus intertexta, Eucalyptus populnea* and *Callitris glaucophylla* (Red Box, Poplar Box and Pine) Woodlands

P14 *Eucalyptus intertexta* (Red Box), *Eucalyptus populnea* (Poplar Box) and *Callitris glaucophylla* (Pine) Woodlands

Area: 234 381 ha **Sites:** 33

Landforms: Undulating rises, slopes, flats and open depressions of the Cobar peneplain. Relief to 15 m.

Soils: Red earths and quartzose dominated coarse-grained quaternary colluvial and alluvial deposits overlying Ordovician sedimentary bedding and some Devonian volcanics.

Geology: Coarse-grained quaternary colluvial and alluvial deposits overlying Ordovician sedimentary bedding and some Devonian volcanics.

Structure: Tall Woodlands to Tall Open Woodlands. Minor Very Tall Mallee Woodlands.

Trees: *Eucalyptus intertexta, Callitris glaucophylla, Eucalyptus populnea*. Tall Shrubs: *Eremophila mitchellii, Geijera parviflora.* Shrubs: *Dodonaea lobulata, Dodonaea viscosa, Acacia decora, Lycium australe, Senna artemisioides* subsp. *filifolia, Sclerolaena muricata.* Herbs: *Cheilanthes austrotenuifolia, Solanum ellipticum, Solanum ferocissimum, Ptilotus obovatus.* Grasses: *Aristida jerichoensis* var. *jerichoensis, Enteropogon acicularis.*

Comments: P14 Woodlands characterise the slopes of the far north-west of the area extending west from the Bogan River to the undulating rises of the peneplain and occupy the flats in between. They occur on the deeper red earths of the flats and open depressions. Further up slope from the flats, on the more gravelly rises and low crests, *Eucalyptus intertexta* (Red Box) becomes a major component of these woodlands. On some of the coarser grained quartzose dominated soils at the crests of the undulations, may be localised stands of *Eucalyptus viridis* (Green mallee). *Geijera parviflora* and *Eremophila mitchellii* form an open understorey that is occasionally dense particularly where nutrients and moisture accumulate on the flats and in open depressions.

P14 Woodlands are similar to U1 Red Box, Poplar Box, Pine and Green Mallee Woodlands and P13 Grey Box Woodlands. P14 Red Box, Poplar Box, and Pine Woodlands differs from U1 in that it occurs slightly lower in the landscape and extends further east on the undulating rises and open depressions of the Cobar peneplain. P14 Woodlands are associated with the gentler more undulating landforms than the steeper more abrupt rises of P13 Grey Box Woodlands and differ from U1 and P13 in that *Eucalyptus intertexta* is one of the major canopy species especially on the more gravelly rises and rocky drainage lines.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Callitris glaucophylla	constant	4	73	4	63
Eucalyptus populnea	negative	4	40	4	67
Dodonaea lobulata	positive	6	13	0	0
Eremophila mitchellii	positive	2	53	3	31
Eucalyptus intertexta	positive	4	100	3	56
Geijera parviflora	positive	2	87	3	45
Hibbertia riparia	positive	1	67	0	0
Lycium australe	positive	2	13	0	0
Ptilotus obovatus	positive	2	13	0	0
Solanum ellipticum	positive	1	67	0	0

Fig. 18. P15 *Eucalyptus chloroclada* (Dirty Red Gum), Pine and Poplar Box Woodlands

P15 *Eucalyptus chloroclada* (Dirty Red Gum), *Callitris glaucophylla* (Pine) and *Eucalyptus populnea* (Poplar Box) Woodlands

Area: 15 592 ha **Sites:** 5

Landforms: Flats and gently undulating belts and sandy lenses of the meander plain and flats to low gentle rises of the western apron of the Pilliga peneplain.

Soils: Sandy Yellow Earths and Light Red Loams

Geology: Quaternary meander plain of the Carrabear Formation.

Structure: Mid-high to Tall Woodlands.

Trees: *Eucalyptus chloroclada, Callitris glaucophylla, Eucalyptus populnea* subsp. *bimbil, Allocasuarina luehmannii.* Low Trees: *Alectryon oleifolius.* Tall Shrubs: *Hakea leucoptera, Apophyllum anomalum.* Shrubs: *Dodonaea viscosa, Sclerolaena bicornis, Einadia nutans* subsp. *nutans.* Herbs: *Calotis lappulacea, Caloti cuneifolia, Cheilanthes austrotenuifolia;* Grasses *Enteropogon acicularis, Austrostipa aristiglumis, Paspalidium constrictum, Aristida jerichoensis* var. *jerichoensis.*

Comments: This map unit is associated with the lateral sandy lenses of The Monkey Scrub, the alluvial meander plain of the Carrabear Formation. A smaller occurrence can be found further south on the sandy red earths of the western apron of the Pilliga peneplain on the Bundemar 1:100 000 map sheet.

Eucalyptus chloroclada (Dirty Gum) and *Callitris glaucophylla* (White Cypress Pine) usually co-dominate, other species such as *Eucalyptus populnea* (Poplar Box), and *Allocasuarina luehmannii* (Buloke) occur frequently. Scattered *Brachychiton populneus* (Kurrajong) has been observed in Warrie State Forest at the south-eastern extent of The Monkey Scrub and *Eucalyptus sideroxylon* (Mugga Ironbark) has also been observed in this map unit situated within the Pilliga peneplain. The low trees *Alstonia constricta* and *Atalaya hemiglauca* are commonly scattered throughout this community with tall shrubs such as *Hakea leucoptera* and *Acacia* species forming the upper shrub layer of the understorey. In remnants on the Pilliga peneplain, *Acacia ixiophylla* is common in the understorey with dense monospecific stands of this species observed on the low slopes. The lower shrub layer is often absent and only scattered herbs and grasses were recorded in the ground layer at the time of the survey. The current extent of this map unit is restricted to a chain of State Forests, that at the time of survey were heavily grazed.

Characteristic species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Callitris glaucophylla	constant	6	100	4	63
Eucalyptus populnea	constant	1	50	4	66
Einadia nutans subsp. *nutans*	positive	3	86	2	42
Enteropogon acicularis	positive	3	75	3	38
Eucalyptus chloroclada	positive	4	25	4	5

Fig. 19. P16 Simple *Eucalyptus populnea* (Poplar Box) Woodlands

P16 Simple *Eucalyptus populnea* (Poplar Box) Woodlands

Area: 134 428 ha **Sites:** 29

Landforms: Flats and drainage depressions of the plains and rises of the Cobar peneplain.

Soils: Red earths and occasional red clay soils

Geology: Quaternary colluvial and alluvial derivation over the Ordovician Girilambone Beds.

Structure: Mid-high to Tall Woodlands and Open Woodlands.

Trees: *Eucalyptus populnea, Callitris glaucophylla.* Low Trees: *Alectryon oleifolius.* Tall Shrubs: *Acacia aneura* var. *latifolia, Acacia colletioides.* Shrubs: *Bertya cunninghamii, Bursaria spinosa, Eremophila glabra, Eucalyptus mitchellii, Einadia nutans* subsp. *nutans, Maireana microphylla.* Herbs: *Solanum quadriloculatum, Stackhousia viminea, Wahlenbergia luteola, Oxalis chnoodes, Cheilanthes austrotenuifolia.* Grasses: *Aristida behriana, Enneapogon polyphyllus, Eragrostis megalosperma, Triodia scariosa* subsp. *scariosa, Enteropogon acicularis.*

Comments: Woodlands dominated by Poplar Box occur across the study area and have been separated into two units P16 Simple Poplar Box Woodlands and P4 Poplar Box Woodlands (see above). *Eucalyptus populnea* and *Callitris glaucophylla* with a grassy understorey and a patchy, open shrub layer characterise P16 Woodlands.

The distinction between the two Poplar Box units is based on slight differences in the floristic composition, structure, underlying geology and topographic location. It was difficult to determine the boundaries of this map unit from API consistently; the east-west boundary is not as abrupt as indicated on the maps but has an area of transition between the Cobar Peneplain colluvial apron and the Bogan River.

P16 Woodlands range from the low slopes, broad drainage lines and low undulations of the Cobar peneplain in the west, to the slightly elevated flats of the alluvial meander plains of the Bogan River in the east. The shape and size of the remnants have the same variation as P4 Poplar Box Woodland in the east but P16 Woodlands occupy a smaller area (134,428 ha in 530 remnants, median remnant size 37 ha) than the more extensive P4 Woodlands. The remnants can occur as small isolated stands and narrow, linear corridors along road and property boundaries or as expansive Tall Woodlands and Tall Open Woodlands where land use and management has left the vegetation relatively intact.

P16 Simple Poplar Box Woodlands exhibit variation in the landscape. On the flats and low gentle rises of the Cobar peneplain, Mid-high to Tall Open Woodlands of *Eucalyptus populnea* and *Callitris glaucophylla* occur on the Quaternary red earths. Associated overstorey species include *Eucalyptus intertexta* (Red Box) and *Brachychiton populneus* (Kurrajong), with the former infrequently occurring as a co-dominant on the slopes of the more gentle rises. The understorey varies with seasonal influences and the relative level of disturbance caused by grazing. On the lower flats and in drainage depressions, the remnants are denser Mid-high Woodlands of *Eucalyptus populnea* and *Callitris glaucophylla*. In the drainage lines *Casuarina cristata* (Belah) may co-dominate. In the south east of the Simple Poplar Box Woodlands distribution *Eucalyptus microcarpa* (Grey Box) may occur on the gentle, gravelier crests. *Eucalyptus largiflorens* (Black Box) occurs occasionally, particularly in the alluvial outwash areas near Fountain Dale on the Nymagee 1:250 000.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Callitris glaucophylla	constant	4	88	4	51
Acacia aneura var. *latifolia*	positive	6	1	0	0
Acacia colletioides	positive	4	1	0	0
Aristida behriana	positive	1	3	0	0
Bertya cunninghamii	positive	4	3	0	0
Bursaria spinosa	positive	1	1	0	0
Einadia nutans subsp. *nutans*	positive	1	1	0	0
Enneapogon polyphyllus	positive	2	3	0	0
Eragrostis megalosperma	positive	3	3	0	0
Eremophila glabra	positive	3	3	0	0
Eucalyptus populnea	positive	5	100	4	48
Solanum quadriloculatum	positive	3	3	0	0
Stackhousia viminea	positive	2	3	0	0
Triodia scariosa subsp. *scariosa*	positive	2	1	0	0
Wahlenbergia luteola	positive	1	1	0	0

Remnants on undulating rises (U)

U1 *Eucalyptus intertexta* (Red Box), *Eucalyptus populnea* (Poplar Box), *Callitris glaucophylla* (Pine) and *Eucalyptus viridis* (Green Mallee) Woodlands

Area: 30 994 ha **Sites:** 3

Landforms: Low crests and slopes of rounded ridges of the Cobar peneplain. Relief to 30 m.

Soils: Red to red-brown earths and gravelly quartzites.

Geology: Ordovician sedimentaries and Devonian sedimentary beds and volcanics.

Fig. 20. U1 *Eucalyptus intertexta, Eucalyptus populnea, Callitris glaucophylla* and *Eucalyptus viridis* (Red Box, Poplar Box, Pine and Green Mallee) Woodlands

Structure: Mid-high to Tall Open Woodlands and Very Tall to Extremely Tall Mallee Woodlands

Trees: *Eucalyptus intertexta, E. populnea, E. viridis, Callitris glaucophylla.* Tall Shrubs: *Eremophila mitchellii, Geijera parviflora.* Shrubs: *Dodonaea viscosa* subsp. *angustissima, Acacia decora, Capparis mitchellii, Senna* sp. Grasses: *Themeda australis.*

Comments: This map unit is predominantly associated with the rolling hills and lower crests of the Cobar peneplain west of Girilambone (Cobar 1:250 000) and extends into the Western Division. The mallee *Eucalyptus viridis* is most commonly found on low crests where shallow gravelly quartzites and light red earths occur. On the upper and mid-slopes where deeper red and red-brown earths occur, *Eucalyptus intertexta* dominates as Mid-high to Tall Open Woodlands. *Eucalyptus populnea* and *Callitris glaucophylla* are often scattered within these woodlands and may be co-dominant in some areas. *Eremophila mitchellii* and *Geijera parviflora* commonly form an open understorey with the lower shrub layer consisting of *Acacia decora, Capparis mitchellii* and *Senna* sp. *Themeda australis* forms good grass cover where grazing has been minimal and seasonal conditions have been favourable. On the mid and lower slopes, deep colluvial and eluvial red earths are Tall Woodlands of *Eucalyptus populnea* with occasional *Eucalyptus intertexta* and *Callitris glaucophylla*. The understorey is similar to that of the mid and upper slopes but may be locally dense in minor depressions where nutrients and moisture accumulate, and where thinning of the vegetation has been minimal. There is no table of characteristic species available for this map unit.

U2 *Eucalyptus intertexta* (Red Box), *Eucalyptus populnea* (Poplar Box) and *Callitris glaucophylla* (Pine) Woodlands on Granite Hillslopes

Area: 17 239 ha **Sites:** 3

Landforms: Slopes and swales of rolling granite country west of Black Range.

Soils: Red Earths on Quaternary eluvial sediments.

Geology: Silurian grey granite.

Structure: Low Open Woodlands

Trees: *Eucalyptus intertexta, Eucalyptus populnea, Callitris glaucophylla, Brachychiton populneus*. Tall shrubs: *Eremophila mitchellii, Acacia homalophylla*. Low shrubs: *Sclerolaena bicornis*. Grasses: *Enteropogon acicularis*.

Comments: Occurs on rolling granite country in the far west of the area (Nymagee 1:250 000), part of a much larger granite belt, extending into the Western Division. Found on the Bobadah and

Gindoono 1:100 000 map sheets west and south from the property of Balowra and Nangerybone State Forest, down to the Tarran Hills. The rolling country on granite is steeper than the rolling country of the nearby peneplain, with relief up to 30 m. These Low Open Woodlands of *Eucalyptus intertexta* with *Eucalyptus populnea* are characterised by a very sparse understorey. Scattered shrubs may include *Sclerolaena bicornis* and *Acacia homalophylla* (Yarran), while small trees of *Eremophila mitchellii* (Budda) also occur. Scattered patches of *Enteropogon acicularis* occur on the ground.

U2 Low Open Woodlands occur between patches of outcropping substrate, the level of outcropping is less than the adjacent U3 (Dwyer's Red Gum Low Open Woodlands on Granite Hill crests). There is no table of species available for this map unit.

U3 *Eucalyptus dwyeri* (Dwyer's Red Gum) Low Open Woodland on Granite Crests

Area: 9 195 ha **Sites:** 1

Landforms: Upper slopes and crests of the rolling granite country west of Black Range.

Soils: Lithosols

Geology: Silurian grey granite

Structure: Low Open Woodlands

Species: Trees *Eucalyptus dwyeri, Callitris glaucophylla, Brachychiton populneus;* Shrubs *Acacia decora*; Herbs *Cheilanthes austrotenuifolia, Goodenia cycloptera;* Grasses *Enteropogon acicularis.*

Comments: Occurs on the exposed granite outcrops in association with U2 Red Box, Poplar Box and Pine Woodlands (Nymagee 1:250 000). The vegetation of the granite crests has a barren character about it, accentuated by bare slabs of granite with lone *Eucalyptus dwyeri* growing in the crevices. The understorey is equally sparse, with isolated occurrences of species such as *Acacia decora*, *Goodenia cycloptera, Enteropogon acicularis* and *Cheilanthes austrotenuifolia*. The soils are fragile and prone to erosion.

Fig. 21. H1 *Eucalyptus dwyeri, Eucalyptus sideroxylon* and *Eucalyptus viridis* (Dwyer's Red Gum, Ironbark and Green Mallee) Woodlands, note *Eucalyptus sideroxylon* in foreground

Hill and ridge remnants (H)

H1 *Eucalyptus dwyeri* (Dwyer's Red Gum), *Eucalyptus sideroxylon* (Ironbark) and *Eucalyptus viridis* (Green Mallee) Woodlands

Area: 87 005 ha **Sites**: 54

Landforms: Slopes, ridges and crests of Hills and Low Rises.

Soils: Predominantly gravelly to sandy Red Earths, with Red-Brown Earths, Yellow Earths, and Lithosols.

Geology: Ordovician sediments, Silurian conglomerate, sandstone, chert, Devonian sediments, granite, limestone and a small patch of Tertiary basalt.

Structure: Mid High Woodlands to Open Woodlands

Trees: *Eucalyptus dwyeri*, *Eucalyptus sideroxylon*, *Eucalyptus viridis, Eucalyptus crebra, Callitris glaucophylla, Allocasuarina luehmannii.* Shrubs: *Acacia doratoxylon, Acacia hakeoides, Acacia lineata, Acacia difformis.* Low Shrubs: *Acacia triptera, Calytrix tetragona, Cassinia aculeata, Daviesia genistifolia, Dodonaea viscosa, Hibbertia sericea, Kunzea ambigua, Melichrus urceolatus, Olearia tenuifolia, Phyllanthus hirtellus.* Herbs: *Goodenia glabra, Goodenia ovata, Bracteantha bracteata, Bracteantha viscosa, Ptilotus atriplicifolius* var. *atriplicifolius, Cheilanthes austrotenuifolia, Cheilanthes lasiophylla.* Grasses: *Aristida leichhardtiana, Aristida ramosa var. scaberula, Cymbopogon refractus, Enneapogon nigricans, Eragrostis lacunaria, Eulalia aurea, Fimbristylis dichotoma, Scirpus fluviatilis, Lomandra glauca.*

Comments: Occurs high up off the plains on the hills, ridges and slopes (usually greater than 250 m ASL) on shallow gravelly soils and make up some of the largest remnants of the study area as these landforms are unfavourable for agriculture. In the west the woodlands of the hills are a simple association of *Eucalyptus dwyeri* and *Callitris glaucophylla*. Further east they become more diverse, with *Eucalyptus sideroxylon* on the slopes and *Eucalyptus viridis* occurring with *Eucalyptus dwyeri* and Callitris *glaucophylla* on the crests. Given the large geographic range, other tree species may be locally common. *Eucalyptus intertexta* is scattered over low, rocky and gravelly rises on the ridges and slopes of hills in the central-eastern part of the area (Tullamore 1:100 000 sheet), *Eucalyptus microcarpa* and *Eucalyptus populnea* may occur on the lower slopes where the soils are slightly loamier. In the east, *Allocasuarina luehmannii* sometimes occurs on the sandier soils. On an outcrop of Jurassic conglomerate and fine sandstone just east of the Boona Mountains, tall woodland of *Eucalyptus sideroxylon* occurs over a dense thicket of *Kunzea*. *Exocarpos cupressiformis* and *Callitris endlicheri* also occur here.

The understorey of the H1 woodlands has a strong representation of Acacias. *Acacia doratoxylon* is the most dominant species, although *Acacia hakeoides, Acacia lineata* and *Acacia triptera* are also common. The ground layer is generally open with a variety of grasses and herbs occurring.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Eucalyptus populnea	negative	1	11	4	68
Acacia difformis	positive	3	11	0	0
Acacia doratoxylon	positive	3	73	2	3
Acacia hakeoides	positive	4	50	1	7
Acacia lineata	positive	3	83	4	3
Acacia triptera	positive	4	11	0	0
Allocasuarina luehmannii	positive	1	67	2	2
Aristida leichhardtiana	positive	2	4	0	0
Aristida ramosa var. *scaberula*	positive	3	11	0	0
Bracteantha bracteata	positive	2	4	0	0
Bracteantha viscosa	positive	2	8	0	0
Callitris glaucophylla	positive	2	73	2	22
Calytrix tetragona	positive	3	15	0	0
Cassinia aculeata	positive	2	12	0	0
Chamaesyce drummondii	positive	1	11	0	0
Cheilanthes austrotenuifolia	positive	3	54	3	9
Cheilanthes lasiophylla	positive	3	22	0	0
Cymbopogon refractus	positive	2	4	0	0
Daviesia genistifolia	positive	2	11	0	0
Dodonaea viscosa	positive	1	8	0	0
Enneapogon nigricans	positive	2	11	0	0
Eragrostis lacunaria	positive	4	67	4	3

Eriachne mucronata	positive	2	11	0	0
Eucalyptus crebra	positive	3	17	0	0
Eucalyptus dwyeri	positive	4	81	4	3
Eucalyptus sideroxylon	positive	4	50	4	8
Eucalyptus viridis	positive	6	100	2	2
Eulalia aurea	positive	2	11	0	0
Fimbristylis dichotoma	positive	3	11	0	0
Goodenia glabra	positive	2	4	0	0
Goodenia ovata	positive	1	4	0	0
Hibbertia sericea	positive	1	11	0	0
Kunzea ambigua	positive	5	15	0	0
Lomandra glauca	positive	3	4	0	0
Olearia tenuifolia	positive	3	11	0	0
Panicum effusum	positive	2	4	0	0
Phyllanthus hirtellus	positive	3	8	0	0
Platysace lanceolata	positive	2	11	0	0
Ptilotus atriplicifolius var. *atriplicifolius*	positive	3	4	0	0
Scirpus fluviatilis	positive	1	11	0	0

Fig. 22. H2 *Eucalyptus viridis* (Green Mallee) Woodlands

H2 *Eucalyptus viridis* (Green Mallee) Woodlands

Area: 20 893 ha **Sites:** 7

Landforms: Crests and gentle hillslopes.

Soils: Gravelly Red and Yellow Earths and Lithosols.

Geology: Ordovician sediments, Silurian conglomerate and sandstone.

Structure: Mid High Open Mallee Woodlands.

Trees: *Eucalyptus viridis, Eucalyptus dwyeri, Eucalyptus sideroxylon, Callitris glaucophylla*. Tall Shrubs: *Acacia doratoxylon*. Shrubs: *Acacia difformis, Acacia amblygona, Cassinia aculeate, Dodonaea* viscosa, *Olearia tenuifolia, Melichrus erubescens, Calytrix tetragona.* Herbs: *Cheilanthes austrotenuifolia*. Grasses: *Aristida calycina, Thyridolepis mitchelliana, Enteropogon acicularis*.

Comments: H2 Woodlands are characteristic of crests and hilltops in the south western half of the area (on the Gindoono, Bobadah, Tottenham and Boona Mount 1:100 000 sheets). *Eucalyptus dwyeri* is commonly scattered throughout, becoming more frequent towards the eastern part of the distribution of this map unit (on the Tottenham & Boona Mount sheets). In the far south-west, *Eucalyptus intertexta* occurs on saddles between the crests. Dominant shrubs in the understorey include *Acacia doratoxylon, Acacia difformis, Acacia amblygona, Cassinia* and *Dodonaea* species. The ground layer is sparse and dominated by grasses.

A mosaic of H2 Woodlands on the shallow, gravelly soils on the crests and P13 Grey Box Woodlands on Red Earths of the slopes and flats of the rolling country is characteristic.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Acacia amblygona	positive	3	14	0	0
Acacia difformis	positive	2	7	0	0
Acacia doratoxylon	positive	3	73	2	30
Aristida calycina	positive	2	7	0	0
Callitris glaucophylla	positive	3	50	2	28
Calytrix tetragona	positive	3	15	0	0
Cassinia aculeata	positive	2	11	0	0
Cheilanthes austrotenuifolia	positive	3	54	3	9
Dodonaea viscosa	positive	1	7	0	0
Eucalyptus dwyeri	positive	4	80	4	3
Eucalyptus sideroxylon	positive	4	50	4	8
Eucalyptus viridis	positive	6	100	2	2
Olearia tenuifolia	positive	3	14	0	0

Fig. 23. H6 *Eucalyptus morrisii* (Grey Mallee) Open Woodlands

H6 *Eucalyptus morrisii* (Grey Mallee) Open Woodlands

Area: 6 602 ha **Sites:** 4

Landforms: High steep hills and outcropping linear ridges of the Cobar peneplain. Relief to 100 m.

Soils: Shallow stony and sandy lithosols becoming deeper, better developed gravelly red earths down slope.

Geology: Whinfell Chert and massive white quartzites of the Ordovician Girilambone Group and the early Devonian volcanics of the Kopyje Group.

Structure: Tall to Very Tall Open Mallee Woodland and Mid-high Open Woodland.

Trees: *Eucalyptus morrisii*, occasionally *Eucalyptus viridis, Eucalyptus intertexta, Eucalyptus socialis, Callitris glaucophylla.* Low Trees: *Acacia aneura, Acacia burrowii, Acacia doratoxylon, Alectryon oleifolius.* Tall Shrubs: *Eremophila mitchellii.* Shrubs: *Acacia deanei, Acacia decora, Acacia hakeoides, Beyeria viscosa, Cassinia laevis, Prostanthera ringens*. Herbs: *Cheilanthes sieberi* subsp. *sieberi*. Grasses: *Themeda australis.* Vines: *Pandorea pandorana*.

Comments: Grow on the lithosols and skeletal soils on the crests of the high, steep, hills and ridgelines of the Cobar peneplain. *Eucalyptus morrisii* (Grey Mallee) is common in the overstorey in these areas with *Eucalyptus viridis* an occasional co-dominant. Scattered low trees and a patchy shrub layer with a variety of *Acacia* species are characteristic of the understorey.

Downslope from the high hill crests and ridgelines, the lithosols and skeletal soils grade into the more developed gravelly eluvial red earths. The vegetation here changes from the being dominated by H6 Grey Mallee Woodlands to Mid-high Open Woodlands of *Eucalyptus intertexta* (Red Box), *Eucalyptus populnea* (Poplar Box) and *Callitris* *glaucophylla* (Pine) with mallee species occasionally interspersed. The understorey of this map unit is generally open with scattered *Alectryon oleifolius* and *Eremophila mitchellii* in the upper layer and shrubs such as *Einadia nutans* subsp. *nutans, Dodonaea viscosa* and *Cassinia laevis* in the lower layer. The ground layer is patchy, with few herbaceous or grass species recorded in the sites.

H6 Grey Mallee Open Woodlands are confined to the Coolabah and Canbelago 1:100 000 map sheets (Cobar 1:250 000). Small occurrences occur on the outcrops known as 'Trig Hill' and 'The Brothers' just west of Girilambone.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Cheilanthes sieberi subsp. *sieberi*	positive	4	100	2	5
Eucalyptus morrisii	positive	4	100	0	0
Pandorea pandorana	positive	2	100	2	3

Fig. 24. H 7 Mallee Woodlands on rolling hills

H7 *Eucalyptus dumosa – Eucalyptus socialis* Mallee Woodlands on rolling hills

Area: 34 665 ha **Sites:** 14

Landforms: Rolling hills, ridges and crests of the Cobar peneplain. Relief to 50 m.

Soils: Red Earths, Red-Brown Earths and minor gravelly Red Earths

Geology: Ordovician metasediments and some Devonian volcanics. Including the Whinfell cherts along ridges in the west of the study area.

Structure: Very Tall to Extremely Tall Open to Closed Mallee Forest.

Trees: *Eucalyptus dumosa, Eucalyptus socialis, Eucalyptus viridis.* Low Trees: *Callitris verrucosa.* Tall Shrubs: *Acacia aneura* var. *latifolia, Acacia tetragonophylla, Eremophila mitchellii, Geijera parviflora.* Shrubs: *Bertya cunninghamii, Bossiaea walkeri, Dodonaea viscosa* subsp. *cuneata, Dodonaea boroniifolia, Eutaxia microphylla, Einadia nutans* subsp. *nutans, Eremophila glabra, Olearia pimeleoides, Senna artemisioides* subsp. *filifolia.* Herbs: *Calotis cuneata, Marsdenia australis, Solanum parvifolium,* Grasses *Digitaria hystrichoides.*

Comments: Occur mainly on slopes, ridges and hill crests of the Cobar peneplain. *Eucalyptus socialis* (Pointed Mallee) and *Eucalyptus dumosa* (Congoo) dominate on the deeper red earths with *Eucalyptus viridis* (Green Mallee) becoming more prevalent as the soils become increasingly gravelly at the crests of the hills. It is typically dense Mallee Forest; generally more variable in height than P1 Mallee Woodlands further east on the flats of the peneplain. The understorey is variable and often reflects the density of the overstorey and past management practices. *Triodia scariosa* subsp. *scariosa* is noticeably absent from the understorey.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Callitris glaucophylla	negative	2	26	4	51
Acacia amblygona	positive	3	14	0	0
Acacia aneura var. *latifolia*	positive	1	5	0	0
Acacia difformis	positive	2	7	0	0
Acacia tetragonophylla	positive	3	11	0	0
Aristida calycina	positive	2	7	0	0
Callitris verrucosa	positive	5	5	0	0
Calotis cuneata	positive	1	5	0	0
Digitaria hystrichoides	positive	2	5	0	0
Dodonaea boroniifolia	positive	2	5	0	0
Eremophila mitchellii	positive	2	79	2	6
Eucalyptus dumosa	positive	4	94	3	2
Eucalyptus socialis	positive	4	84	5	3
Eucalyptus viridis	positive	6	100	2	2
Eutaxia microphylla	positive	2	11	0	0
Geijera parviflora	positive	2	68	2	2
Halgania cyanea	positive	2	16	0	0
Marsdenia australis	positive	3	11	0	0
Olearia tenuifolia	positive	3	14	0	0
Solanum parvifolium	positive	2	5	0	0

Fig. 25. H8 *Eucalyptus dealbata* (Tumble-down Red Gum) Woodlands on Basalt Hills

H8 *Eucalyptus dealbata* (Tumbled Down Red Gum) Woodlands on basalt hills

Area: 282 ha **Sites:** 2

Landforms: Outcropping hills in the east of the study area. Relief to approximately 100 m.

Soils: Basaltic Clay Lithosols with some outcropping

Geology: Tertiary Basalt.

Structure: Low to Mid-high Open Woodland.

Trees: *Eucalyptus dealbata, Casuarina cristata.* Low Trees: *Atalaya hemiglauca, Alectryon oleifolius, Alstonia constricta, Owenia acidula.* Tall Shrubs: *Geijera parviflora.* Shrubs: *Canthium oleifolium, Lycium ferocissimum.* Herbs: *Malva parviflora, Medicago truncatula, Oxalis chnoodes, Rumex brownii.* Grasses: *Eleusine indica.*

Comments: Occurs on the outcropping basaltic hills in the east of the area. Structure varies with aspect, landuse and grazing pressure. The low trees *Atalaya hemiglauca, Alectryon oleifolius, Alstonia constricta* and *Owenia acidula* commonly occur on the upper and lower slopes. *Eucalyptus dealbata* occurs on on the north-east facing slopes of Tenandra Hill, while mature *Casuarina cristata* occurs on Magometon Hill. As with H9 Woodland on Granite Hills further west, the lower shrub and ground layers contains a mix of woody shrubs, grasses and herbs, influenced by grazing, herbicide spraying and the degree of outcropping.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Alectryon oleifolius	positive	5	100	1	3
Alstonia constricta	positive	2	100	3	3
Atalaya hemiglauca	positive	4	100	2	1
Canthium oleifolium	positive	2	100	1	1
Geijera parviflora	positive	2	100	2	3
Oxalis chnoodes	positive	2	100	2	2
Rumex brownii	positive	1	100	3	1

Fig. 26. H9 *Eucalyptus dwyeri* (Dwyer's Red Gum) Open Woodlands on Granite Hills. Note outcropping.

H9 *Eucalyptus dwyeri* (Dwyer's Red Gum) Open Woodland on granite hills

Area: 415 ha

Landforms: Rounded outcropping hills on the Macquarie River floodplain. Relief to approximately 80 m.

Soils: Lithosols with some outcropping

Geology: Mount Foster Monzonite, part of the early Devonian intrusives of the Lachlan Fold Belt.

Structure: Low to Mid-high Open Woodland.

Trees: *Eucalyptus dwyeri*, occasional *Eucalyptus populnea*, and *Brachychiton populneus.* Low Trees: *Alstonia constricta, Alectryon oleifolius.* Shrubs: *Sclerolaena birchii.* Herbs: *Cheilanthes sieberi* subsp. *sieberi, Cheilanthes distans, Chamaesyce drummondii, Calostemma purpureum, Calotis lappulacea, Chrysocephalum apiculatum, Fimbristylis dichotoma, Glycine canescens, Goodenia fascicularis, Isotoma axillaris, Lepidium pseudohyssopifolium, Mimulus prostratus, Mimulus repens, Oxalis chnoodes, Pelargonium australe, Rhynchosia minima, Rostellularia adscendens* subsp. *adscendens* var. *adscendens, Sida corrugata, Solanum esuriale, Trachymene incisa* subsp. *corrugata, Wahlenbergia communis.* Vines: *Pandorea pandorana, Jasminum lineare;* Grasses *Cymbopogon obtectus, Digitaria brownii, Enneapogon nigricans, Eriachne mucronata, Austrostipa scabra, Themeda australis.*

Comments: Occurs on the granitic intrusives of Mt Foster and Mt Harris on the Mt Harris 1:100 000 map sheet (Nyngan 1:250 000). Typically very open, low woodland with scattered occurrences of *Eucalyptus dwyeri* (in both tree and mallee form), *Eucalyptus populnea, Brachychiton populneus* and the low trees *Alstonia constricta, Atalaya hemiglauca* and *Alectryon oleifolius*. Shrubs are generally scattered with the ground layer a diverse array of herbs and grasses. A limited number of formal sites were collected from this map unit due to its restricted distribution and lack of access from public land. The lower shrub and ground layers may be dominated by a diverse mix of woody shrubs, grasses and herbs, influenced by grazing, herbicide spraying and the degree of outcropping.

Species	Fidelity class	Group C/A	Group freq %	Non-group C/A	Non-group freq %
Callitris glaucophylla	negative	0	0	4	50
Alstonia constricta	positive	3	100	4	13
Calostemma purpureum	positive	3	67	3	25
Calotis lappulacea	positive	2	67	3	4
Chamaesyce drummondii	positive	1	67	2	3
Cheilanthes distans	positive	3	67	0	0
Cheilanthes sieberi subsp. *sieberi*	positive	2	100	2	4
Chrysocephalum apiculatum	positive	1	67	2	1
Cymbopogon obtectus	positive	1	67	0	0
Digitaria brownii	positive	1	33	0	0
Enneapogon nigricans	positive	1	33	0	0
Eriachne mucronata	positive	5	67	0	0
Eucalyptus dwyeri	positive	4	67	4	15
Fimbristylis dichotoma	positive	1	33	0	0
Glycine canescens	positive	2	33	0	0
Goodenia fascicularis	positive	4	67	1	2
Isotoma axillaris	positive	1	67	0	0
Jasminum lineare	positive	1	33	0	0
Lepidium pseudohyssopifolium	positive	1	67	2	1
Mimulus prostratus	positive	1	100	0	0
Mimulus repens	positive	1	33	0	0
Oxalis chnoodes	positive	3	100	2	14
Pandorea pandorana	positive	4	67	2	2
Pelargonium australe	positive	2	67	0	0
Rhynchosia minima	positive	1	33	0	0
Rostellularia adscendens subsp. *adscendens* var. *adscendens*	positive	1	33	0	0
Sclerolaena birchii	positive	1	67	4	2
Sida corrugata	positive	2	33	0	0
Solanum esuriale	positive	3	100	2	6
Austrostipa scabra	positive	4	67	2	13
Themeda australis	positive	1	33	0	0
Trachymene incisa subsp. *corrugata*	positive	2	67	0	0

Null, not mapped as native woody vegetation

Areas identified on the maps as not native woody vegetation consist of four categories; **exotic vegetation, highly modified native vegetation, no vegetation and native vegetation difficult to be accurately identified on high level API.** Exotic vegetation is land that is highly modified, under crop production and areas where current land management activity will not allow vegetation to revert to a natural state, for example plantations, crops, orchards. Highly modified native vegetation occurs where native species composition and density is low. The area is usually dominated by exotic species, this is often as a result of intensive thinning, tilling and grazing. The area was not under cultivation at the time of the survey or ground truthing. Areas where no vegetation is present due to natural or management induced physical conditions include barrens, scars, scalds, tilled or ploughed earth and off river storage. Native vegetation difficult to accurately identify on high level air photos comprise patches of native vegetation less than 10 hectares in size and vegetation types such as Lignum, Myall, Chenopod Shrublands, wetlands and naturally treeless plains (grasslands) that are difficult to discern on photographs of a scale less than 1:50 000.