The natural vegetation of north-western New South Wales: notes to accompany the 1:1 000 000 vegetation map sheet

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Pickard, John[1] and Norris, E.H.[2] (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1994. The natural vegetation of north-western New South Wales: notes to accompany the 1:1 000 000 vegetation map sheet. Cunninghamia *3 (3): 423–464.* The pre-settlement vegetation of the north-western quarter of New South Wales (latitude 29–33° S, longitude 141–147° E) is interpreted and mapped at the Australian continental scale of 1:1 000 000. The area (approximately 26.6 million ha) represents 28% of the State and is mostly within the Western Division. The map shows 41 plant communities, defined by structure and characteristic species, and 28 mosaic communities. Brief descriptions are provided in the text. Vegetation is predominantly controlled by climatic and edaphic factors. The area covers much of semi-arid and arid New South Wales. Potential problems in vegetation management and conservation options are discussed.

Dedication

We dedicate this paper and map to Professor Noel Beadle in recognition of the outstanding value of his 1948 Vegetation and pastures of western New South Wales. *For almost half a century his map and book have been essential and invaluable references for anyone working in semi-arid New South Wales. His fundamental contribution to understanding the landscapes of western New South Wales has never been fully recognised. On a more personal level, some 30 years ago, the work evoked images that stimulated Pickard to become a vegetation ecologist — a decision and a career never regretted. This dedication is our acknowledgement of our respect and admiration of an Australian scientist and his work.*

Introduction

Vegetation maps provide an inventory of plant communities and their locations, extent and geographical distribution in the landscape. They help in the understanding of plant community distribution on the basis of various features of the landscape, as well as acting as a reference for measuring changes and rates of change in vegetation over time. They also provide important scientific base-information for land use planning and range management.

In this study the pre-settlement, natural vegetation of north-western New South Wales has been interpreted and mapped at the Australian Continental Scale (1:1 000 000) and the vegetation communities, defined by structure and characteristic species, described. It deals with over one quarter of the area of New South Wales and complements the maps of Boyland (1984) and Neldner (1984) for Queensland, and Specht (1972) for South Australia.

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Map area

The 1:1 000 000 map area covers the north-western quarter of New South Wales, bounded in the north by the Queensland–New South Wales border (latitude 29° 00'S), in the west by the South Australia–New South Wales border (longitude 141° 00'E) in the south by latitude 33° 00'S, and in the east by longitude 147° 00'E (Fig. 1). The area lies mostly within the Western Division of New South Wales and is approximately 26.6 million hectares (ha) in extent representing 28% of the State. The area is largely within the North-western Plains and North Far-western Plains botanical subdivisions. The map covers sixteen 1:250 000 maps.

Major rivers within the map include the Darling, Paroo, Warrego and Culgoa Rivers and their associated tributaries and distributaries (Fig. 1).

Resident population distribution within the area is largely confined to major centres, in particular the city of Broken Hill with an estimated 52% of the population (Australian

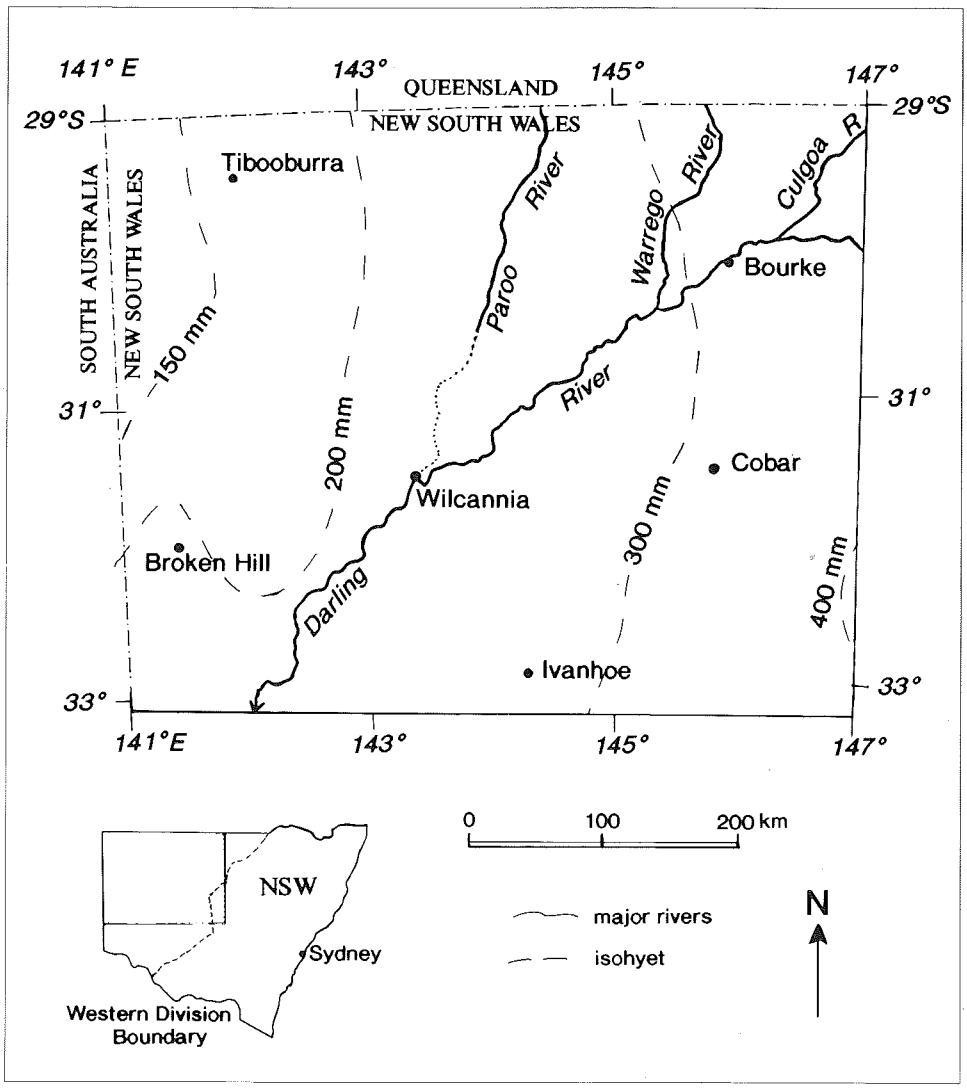


Figure 1. Map area showing main towns, rivers and rainfall isohyets.

Bureau of Statistics 1991). The Shires of Cobar and Bourke have 14% and 10% respectively. Population numbers between towns are very low and widely scattered.

Climate

The map area covers much of semi-arid and arid New South Wales. Long-term mean annual rainfall decreases from east (400 mm) to west (150 mm in the far north-west corner) (Fig. 1), with reliability decreasing from east to west (Fig. 2). Over the long term, rainfall is summer dominant for the northern areas, falling by way of convective storms, and winter dominant in the south associated with cold fronts of lower intensity (Johns, Tongway & Pickup 1984). The north-west corner experiences a fairly even spread of rainfall throughout the year. Variability is greatest in the far north-west corner, but rainfall is highly variable over the whole area and prolonged periods of low rainfall and occasional floods are characteristic.

Rainfall patterns over decades may be recognised, though records for most of the area are barely 100 years old. Despite the massive and well-publicised droughts of the late 1890s (Royal Commission 1901), the period prior to 1910 was generally wetter than from 1911 to 1947 (Gentilli 1971). Since then, rainfall has been substantially higher and with a marked increase in the amount of summer rainfall (Pittock 1981). Within any one of these periods, individual years may be wetter or drier, but the decadal pattern occurs across all of the mapped area.

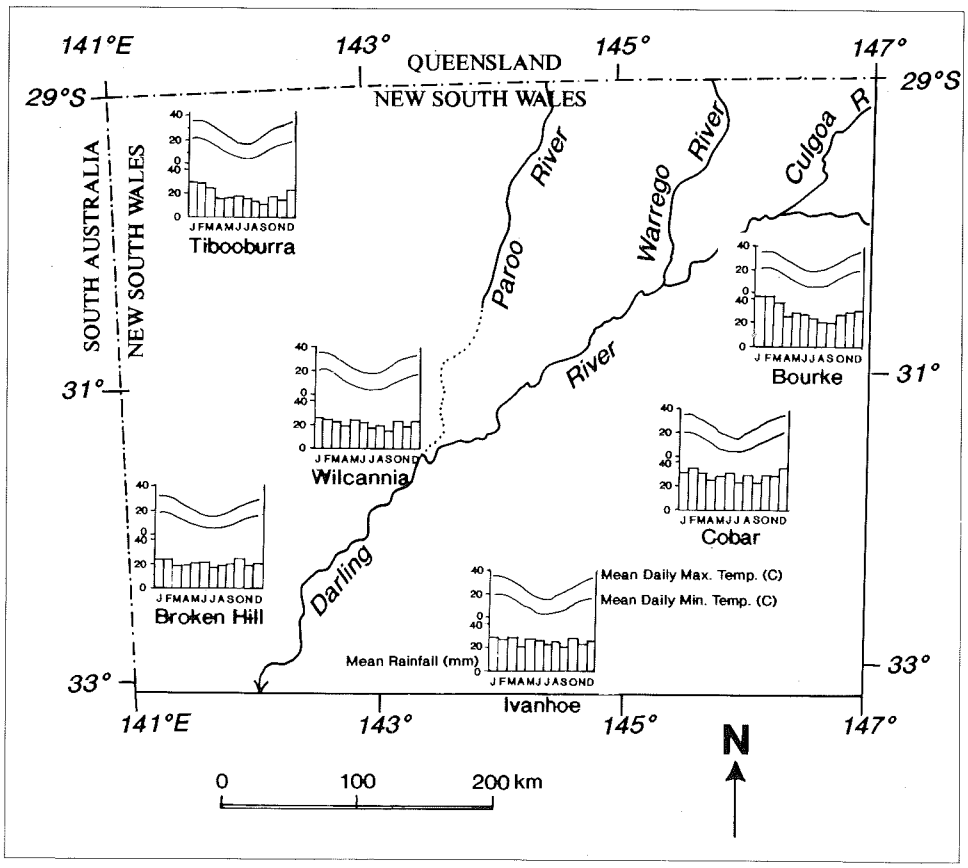


Figure 2. Monthly rainfall and temperature for major centres.

Temperatures are hot in summer and mild in winter. Figure 2 displays long-term mean monthly maximum and minimum temperatures for particular stations within the area. Major departures from maximum temperatures may occur for short periods and are not uncommon, with temperatures exceeding 40° C during December to February and exceeding 35° C during October to March (Bureau of Meteorology 1988). Available data indicate that evaporation increases from south to north and from east to west, being highest in the far north-west corner (Cunningham et al. 1981). In all months mean evaporation exceeds mean rainfall (Dalton 1988).

Frosts are common in many areas; most occur in the period May–June to August–September.

In the late 19th and early 20th centuries, massive dust storms were a common feature of western NSW (Royal Commission 1901). However, more recently, they have been less frequent. From 1957 to 1984, dust storms occurred once per two years to twice per year over most of the map area. In the southern section bordering the extensive mallee of south-western New South Wales, dust storms were more frequent in 1957 to 1984, averaging two to five per year (McTainsh et al. 1989).

Geology

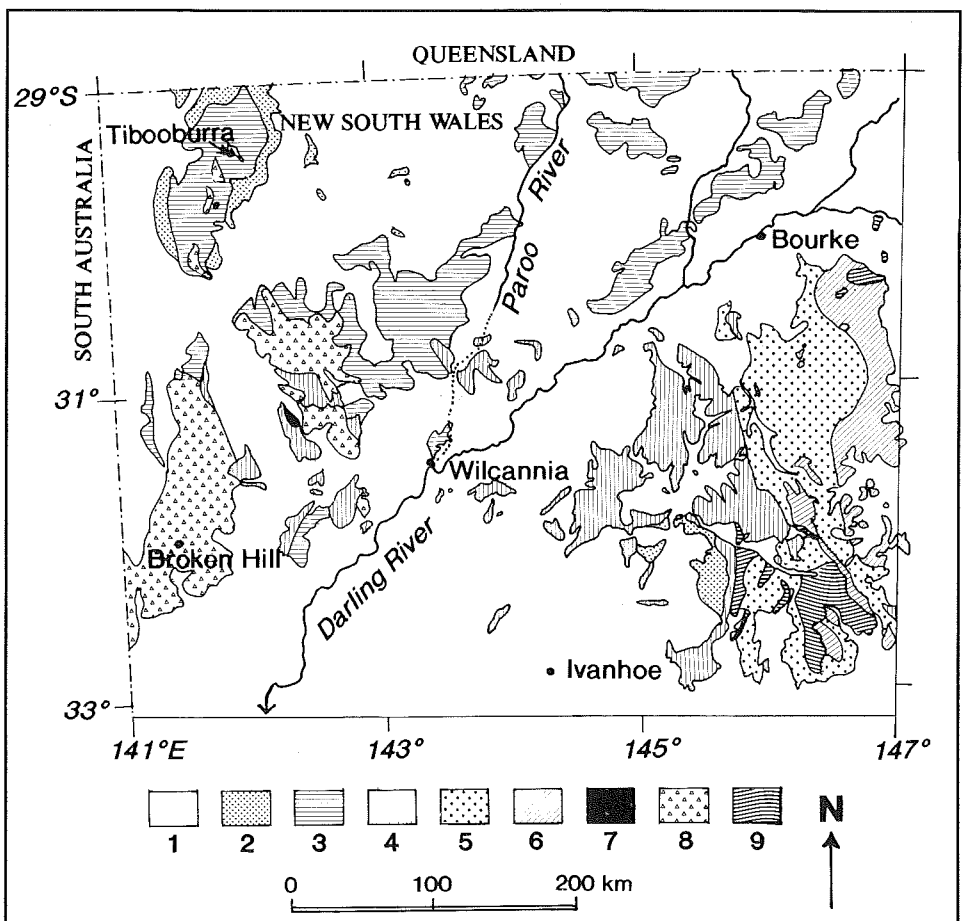
The geology of the map area, summarised in Figure 3, is a complex mosaic of geological units representing rock formations of various ages overlain by more recent sediments.

The North Western Fold Belt comprises the outcrop areas of Broken Hill and the Barrier Range, the ranges in the Mootwingee area and parts of the Grey Range in the Milparinka–Tibooburra area. Most of these outcrops are Pre-Cambrian in age and consist of conglomerate, sandstone, shale, limestone, tillite, schist, gneiss, amphibolite, pegmatites and gabbro (Packham 1969; Geological Survey of NSW 1972; Cunningham et al. 1981). Small areas of Devonian sandstones, quartzites, acid lavas and chert outcrop, as well as Cretaceous sandstones, siltstones and shale. Tertiary sedimentary deposits (silcrete) are common in the Milparinka–Tibooburra area, where the oldest formations of granites, phyllites and schist can be found.

Rocks of the Central and Southern Highland Fold Belt are younger; the oldest comprise Ordovician sandstones, siltstones, chert, quartzite, limestone, tuff, andesite, slate and greywacke. Devonian and Silurian sediments and volcanics are common in the region, as well as Silurian–Devonian granites and granodiorites.

The Great Artesian Basin comprises mainly Quaternary alluvial material along the major river systems, particularly along plains in the Brewarrina district. Quaternary sands of mostly aeolian origin can be found in the western sections of the Basin. North of the Darling River are extensive areas of Cretaceous sandstones, siltstones, claystone and shale; marine shales outcropping in the White Cliffs area are the source of opal. In the deeper parts of the Basin towards the Queensland border more sandy lacustrine beds overlie sandstone and shale sequences.

In the main, the Murray Basin is a Permian–Tertiary sedimentary basin containing thick sequences of Eocene marine sediments. Reworking of the sediments since the Tertiary has resulted in a covering of Quaternary sediments of fluvial and aeolian origin (National Parks & Wildlife Service 1982). Few rock outcrops are present but include the Devonian Manara Hills north-west of Ivanhoe, and the Darnick Range south-west of Darnick.



1: QUATERNARY gravel, sand, silt, clay;

2: TERTIARY conglomerate, sandstone, silstone, claystone, gravel, sand, silt, clay;

3: CRETACEOUS sandstone, silstone, claystone, shale, coal;

4: DEVONIAN conglomerate, sandstone, mudstone, arkose, quartzite, tuff, limestone, chert, acid to basic lavas, porphyry;

5: SILURIAN conglomerate, sandstone, mudstone, quartzite, slate, tuff, limestone, lavas and porphyry;

6: ORDOVICIAN sandstone, siltstone, chert, quartzite, tuff, andesite, slate and greywacke;

7: CAMBRIAN conglomerate, sandstone, shale, limestone, chert, lava;

8: PRECAMBRIAN conglomerate, sandstone, shale, limestone, tillite, schist, gneiss, amphibolite, pegmatite, gabbro;

9: PRECAMBRIAN–IGNEOUS granite, adamellite, granodiorite, porphyry, monzonite, andesite.

Figure 3. General geology of map area (after Packham 1969).

Geomorphology

There are two main landform types in the map area — erosional and depositional. The erosional landforms comprise only a small percentage of the area compared to the predominantly depositional environment, where wind and water have distributed and continue to distribute sediments (Cunningham et al. 1981).

Relief is dominated by the Barrier and Grey Ranges and the mesa country around White Cliffs and Mootwingee. Mt Robe (474m) in the Barrier Range is the highest point west of the Darling River. In the eastern part of the map the most extensive erosional surface is the Cobar Pediplain (Lawrie 1976), with the isolated McCullochs Range east of Wilcannia being the westerly extension of this. Approximately 80 km south of Cobar lie the Tarran Hills (508m) which represent the highest elevation in the Western Division. In other areas relief is provided by smaller ranges and isolated hills such as the Manara Hills north-west of Ivanhoe and Thoolabool Range south-west of Louth.

Much of the map area consists of level to undulating plains 70–250 m above sea level. The north-west corner is characterised by densely spaced linear sand ridges which have formed on the deepest sands. Large areas of scattered linear sand dunes can also be found south-east of Broken Hill (Australian Water Resources Council 1972). Level sand plains are common in more northerly areas (National Parks & Wildlife Service 1982).

A large proportion of the map area is drained by the Darling River through-drainage system and associated rivers. Associated with the Darling River catchment are extensive alluvial floodplains dissected by a complex network of channels and lakes which only carry water during floods. The far north-west corner of the area forms part of the extensive inland channel country where waters flow south-west and drain into Lake Frome in South Australia.

Soils

Details regarding soil types of the map area have been well documented (Stannard 1962; James 1960; Mabbutt 1973; Lawrie 1976, 1991; Cunningham et al. 1981; Soil Conservation Service various dates). Broadly, nine major soil types occur throughout the map area. Lithosols (skeletal soils), brown gibber soils and red earths are associated with areas of relief, red-brown earths and grey and brown clays are associated with alluvial plains, whilst desert loams, solonised brown soils, calcareous red earths and dune sands are associated with the aeolian plains.

History of settlement

Aboriginal occupation

Recent archaeological studies suggest that Aborigines have occupied western New South Wales for at least 40 000 years (Bowler 1971, Allen 1980). During this time the climate, flora and fauna have changed substantially and the distribution of occupation over time is in part due to the availability of food and other resources, in particular fresh water (National Parks & Wildlife Service 1982).

The Aborigines may have largely altered the ecosystems in which they lived by the use of fire to aid their hunting and gathering and through their use of local resources generally. However, unlike the Europeans, it seems likely that the Aborigines had a

kinship with the land (Pickard 1990b). From accounts by the early explorers (Mitchell 1838; Sturt 1849), Aboriginal occupation in the recent past seems to have been centred on the major river systems, and the drier country away from permanent water sources was used opportunistically when seasonal or heavy rains permitted hunting in more favoured areas. However, Aborigines overcame the lack of permanent water in the drier areas, since it has been found that occupation on a regular basis away from rivers was quite common (Harris 1989).

European Occupation

After the early exploring expeditions, initial settlement on lands east of the Darling River was slow, due to Government policy aimed at controlling land occupancy within the 19 counties of the 'Limits of Location'. However, squatters gradually spread out onto adjoining lands and the pressure for land settlement was such that in 1836 by Act of Council, it was decided to allow squatters to graze their stock, paying an annual fee of 10 pounds (King 1957). By 1850 the frontages of the Darling River up to Wilcannia had been occupied (National Parks & Wildlife Service 1982). Most of the land east of the River had also been taken up but settlement was limited by lack of permanent water; the land could only be used opportunistically after rains.

Land west of the Darling River was settled later, mainly associated with the more reliable sources of water such as the Darling River and smaller, often ephemeral, supplies along local drainage areas, for example in the Barrier Range (Mabbutt 1973). The discovery of the vast artesian water supply and the subsequent sinking of bores and construction of wells paved the way for a greater settlement in drier areas and by the end of the 19th century the majority of the map area was settled.

Land use

Arid and semi-arid rangelands of western New South Wales have now been grazed for between 110–140 years (Cunningham & Milthorpe 1981, Pickard in press a). During this time there have been various irreversible soil and vegetation changes.

The squatters brought in large numbers of domestic stock. Cattle predominated at first but were later replaced by sheep (Cunningham et al. 1981) with wool production becoming the major industry. Mining assisted in opening up many areas away from permanent water, particularly during the gold boom of the 1850s. Broken Hill and Cobar remain today as viable centres through mining for silver, lead and zinc, whilst opals are mined at Lightning Ridge and White Cliffs.

Currently, the main land use is pastoral with sheep remaining the most numerous domestic animal. Cattle numbers fluctuate in response to price and market availability. Some of the large feral goat population is periodically trapped and sold for meat and for introduction into mohair-producing flocks (Cunningham et al. 1981). Dryland cropping is undertaken during favourable times particularly along the eastern edges of the map area, and on some of the dry lakebeds such as Lake Tandou.

Less than 3% of the map area is conserved in National Parks, Nature Reserves and Historic Sites managed by the National Parks & Wildlife Service. The Forestry Commission of NSW has a Forest Preserve and some Timber Reserves in the eastern section of the map sheet.

Land tenure

Lands to the eastern edge of the map sheet and lying outside the Western Division are mostly held under freehold title. However, most of the map area lies within the Western Division and is predominantly held under leasehold tenure; the bulk of this is held under perpetual lease (Condon 1976). A large proportion of these holdings are held as Western Lands Leases through the Western Lands Act of 1901. Western Lands Leases may be for grazing and agriculture, town residential blocks and business sites (Western Lands Commission 1990). A very few other holdings remain under the Crown Lands Act.

Leasehold land allows restrictions to be placed on the term of the lease as well as some control over land use — for example, control of land use for a specific purpose such as pastoralism, control of the intensity of use (limiting stock numbers), setting conditions for the control of noxious plants and animals, encouraging land improvements, and the right of the Crown to minerals (Western Lands Commission 1990).

Review of vegetation and studies

Charles Sturt during his 1844–46 exploration of the interior of the continent first described the vegetation and collected plant material (Sturt 1849). Cambage (1900a, 1900b) made notes on plant species and habitats in the Bourke to Cobar and Cobar to the Bogan River above Nyngan. Turner (1903, 1905) described plant species of the Darling and north-western New South Wales regions. Haviland (1911, 1913) described species and their habitats from the Cobar country, including a map with place names and localities and MacGillivray (1923) described plant species whilst travelling north through the Barrier and Grey Ranges. Collins (1923, 1924) produced the first detailed discussions on the flora and ecology of the Grey Ranges, discussing predominant vegetation types and habitats, associated species, and annual flora.

Beadle (1948) published the first vegetation map of western NSW and his 1:1 024 000 scale map (1" = 16 miles) and its accompanying memoir have remained the standard reference to the vegetation ever since. Although produced before the advent of air photos and under rather difficult conditions (Beadle 1981a), it is remarkably accurate. The detailed notes of the memoir are mandatory reading for the serious student of the vegetation of western NSW. An interesting account of Beadle's first trip to the west in 1939 is given in Beadle (1981b).

A vegetation map of the Paroo–Upper Darling region was compiled by James (1960) as part of his erosion survey of that region. Stannard (1963) carried out similar work in the central East–Darling region. Morris (1939) discussed plant regeneration at Broken Hill and west Darling region plants (Morris 1966); Milthorpe (1972) and Burrell (1973) described vegetation in the Fowlers Gap–Calindary area north of Broken Hill.

Vegetation studies in adjacent areas include those of Specht (1972) for South Australia and Dawson and Boyland (1974) and Boyland (1974) for Queensland. More recent studies include those of Cunningham et al. (1981), Cunningham & Milthorpe (1981), Beadle (1981a), Soil Conservation Service of NSW (various dates), and include Dalton 1988; Irons & Quinlan 1988; Iwaszkiewicz & Semple 1988), Boyland (1984), Neldner (1984), Fox (1991), Milthorpe (1991), Porteners (1993), Scott (1992), Walker (1991) and Wade (1992). Extensive bibliographies list research papers and publications dealing with a range of subjects relating to the Western Division (Moore 1986; Semple & Irons 1989; Parson 1990, 1991).

Methods

Mapping procedure was based primarily on the reinterpretation of existing 1:250 000 scale geological maps of the area, as a strong relationship between geological type and vegetation type became apparent from early fieldwork. Preliminary maps at 1:250 000 scale were field-checked over many seasons from 1971 to 1978 using extensive ground traverses on most public roads and many station tracks in the area (Fig. 4). This was carried out by Pickard during his employment as plant ecologist with the Royal Botanic Gardens. At this stage, the maps included many vegetation units smaller than 2 km across. These individual maps were photo-reduced to 1:1 000 000 scale and the vegetation was compiled onto a single base map. During this transfer, very small units were omitted, and the boundaries simplified somewhat. Some boundaries needed modification where they crossed borders of the compilation sheets, but this was usually minor. Further field checking followed. Specific areas were also checked using existing Land System maps published by the Soil Conservation Service of NSW, Landsat satellite images, and occasionally, air photos.

Such a procedure is appropriate in large semi-arid and arid areas such as this where maps are to be published at 1: 1 000 000 scale. Beard pioneered this rapid technique in his vegetation maps of Western Australia (e.g. Beard 1974, Beard & Webb 1974). The basis of the technique is that geological maps are prepared by interpreting air

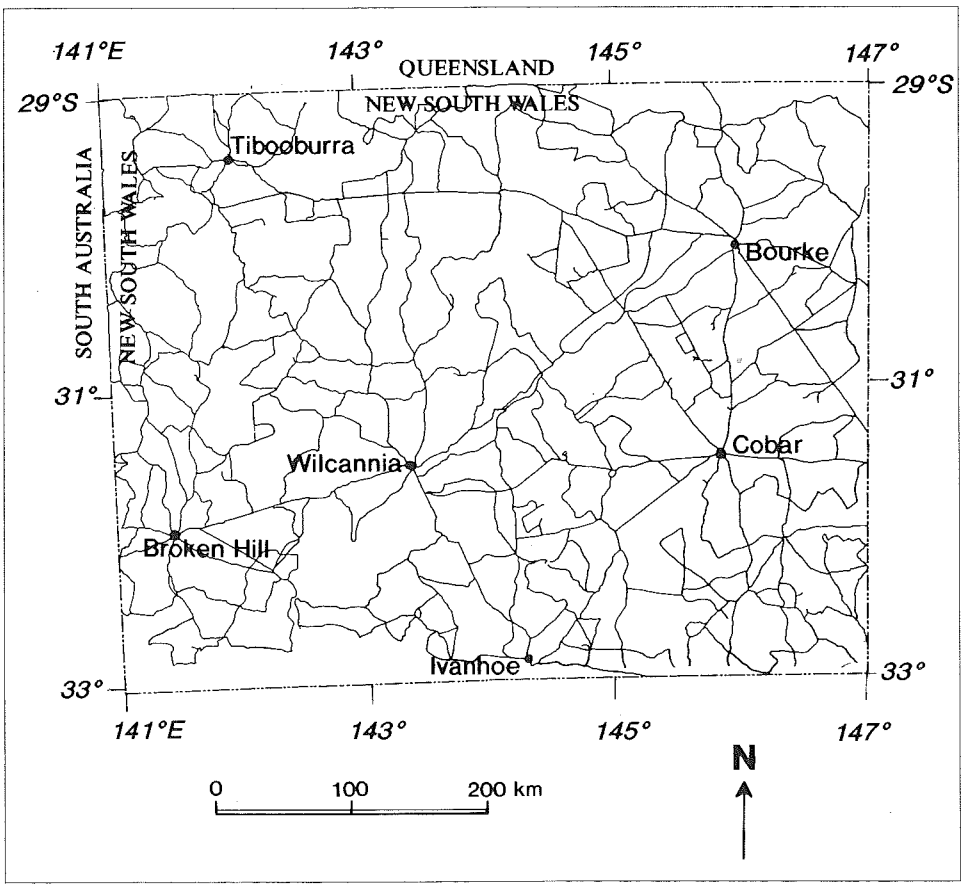


Figure 4. Extent of vehicular traverses of map area during field work.

photo patterns which include vegetation. Despite Beadle's (1948) earlier conclusion, it is clear that one of the primary controls of vegetation in western NSW is geology.

The accuracy of the technique has been compared with that of vegetation maps produced by direct air photo interpretation. Pickard & Boyland (1981) compared a draft of the present map and an adjoining 1:500 000 scale vegetation map in Queensland. The Queensland map was prepared by interpreting stereo pairs of 1:80 000 scale air photos, compiling land systems at 1:250 000 before final vegetation mapping at 1:500 000. There were very few boundaries displaced on the border by more than 5 km, and most of these could be reconciled by slightly expanding the definitions of the vegetation units.

Such adjustments recognise the subjectivity inherent in vegetation mapping (Pickard 1983). Within a single map sheet, the units should be consistently conceived, described and mapped. However, there will be greater or lesser inconsistencies between mappers. This does not present major problems because, as Pickard & Boyland (1981) showed, differences are readily reconciled for continent-wide standardisation.

Draft copies of the map have been widely available over the last decade. However, there has been little feedback on the accuracy of the map. While this may suggest that the users were all satisfied with the map, a more likely explanation is inertia, and the perceived difficulty in writing to report a problem. Publication of the map has been in response to the continuing need for information on the vegetation of western New South Wales and the Western Division. The draft map, prepared by Pickard, has been redrawn and some corrections made by Norris in consultation with Pickard.

Using the map

Cartographic printing limits the smallest area that can be depicted on a map to about 3 mm across. This represents 3 km at the 1: 1 000 000 scale. In other words, the map is unable to resolve or display different communities or variation finer that 3 km. This has important consequences for both preparing and using the map.

Since the smallest unit shown on this map is about 3 mm across, representing 3 km on the ground, any vegetation community, no matter how distinct, that is smaller than this will not be shown. Thus a small rocky hill may support a very distinctive and easily recognised community of *Eucalyptus vicina*. However, because the hill is only 1.5 km across, it is simply not mapped as different from the surrounding *Eucalyptus populnea* subsp. *bimbil* woodland. This does not mean that the map is inaccurate — it simply reflects the limitations of scale inherent in cartography. Therefore, attempts to digitise the map and subsequently enlarge portions to, say 1:250 000 will not improve the accuracy.

Vegetation overview

Although the vegetation cover shown on the map is presented as the pre-settlement distribution, it is largely based on present-day conditions, with extrapolation into areas that have been completely or partially changed. This is to meet the map's purpose as a baseline description for the whole area. The descriptions, however, reflect present-day conditions and concentrate on major perennial species. Regrettably there are little data on the ephemeral component of the vegetation or of the changes that have been incurred because of stock and rabbit grazing. Norris prepared the descrip-

tions of the map units using a range of references, including Pickard's field notes and in consultation with him. References to other sources of information on the vegetation are given where possible. Botanical names follow Harden (1990–1993), though it has not always been possible to determine all subspecies. For example, subspecies of *Alectryon oleifolius* and *Senna artemesioides* are only given where certainly known.

General description

Much of the western area of the map sheet supports small trees of Mulga, *Acacia aneura*, with dense stands occurring between the Darling River and the Cobar–Byrock district. Elsewhere, Mulga forms open-woodlands with its density decreasing westward as aridity increases. To the east and south-east it merges with Bimble Box (also known as Poplar Box), *Eucalyptus populnea* and other woodlands, while to the south with shrublands predominantly of *Atriplex, Maireana, Casuarina pauper* and Mallee (*Eucalyptus socialis, Eucalyptus dumosa*).

Climatic and edaphic factors are the major controls on vegetation growth in the region and these have been discussed elsewhere (Beadle 1948; Cunningham et al. 1981; Eldridge 1988; Milthorpe 1991). Other factors such as topography, fire, flood, drought and management are also important for plant growth and survival.

Plant communities

There are 41 plant communities recognised and mapped (Table 1) and a further 28 mosaic communities also recognised.

Map unit 1

Callitris glaucophylla open-forest

(White Cypress Pine)

Geographic distribution: Generally extends from Queensland to Victoria on sandy areas throughout western New South Wales and also occurs in South Australia, Western Australia and the Northern Territory. In New South Wales communities are widespread, and mapped west of the Noonthorangee Range, north of Mootwingee and north-west and south-west of Cobar. Two other smaller areas are mapped east of Milparinka and east of Menindee.

Landforms: Gently undulating to rolling topography, but not in depressions.

Soils: Predominantly sandy, often infertile with a pH ranging from 5–7.4. On shallow stony soils in the eastern area of its range it is replaced by Black Cypress Pine, *Callitris endlicheri*.

Structure: Where it forms dense stands, *Callitris glaucophylla* suppresses herbaceous ground cover, its own litter forming a thin layer so that the ground is almost free of small plants. It is very fire-sensitive and is susceptible to grazing by stock and rabbits.

Map unit 2

Callitris glaucophylla – Eucalyptus intertexta open-forest

(White Cypress Pine–Red Box)

Geographic distribution: Widespread in the south-eastern corner of the map sheet, and also for a small area east of Byrock.

Landforms: Level to undulating country and low gravelly rises.

Soils: Red-brown clay loams, sandy loams and gravelly soils in elevated positions.

Structure: These communities form extensive open-forests, 20–24 m in height.

Canopy species: *Grevillea striata*, *Brachychiton populneus* and *Acacia excelsa*.

Other species: The understorey is commonly shrubby and includes *Eremophila mitchellii*, *Geijera parviflora*, *Alectryon oleifolius*, *Apophyllum anomalum*, *Senna artemisioides* (various subspp.), *Dodonaea viscosa* subsp. *angustissima* and *Eremophila longifolia*.

The herbaceous layer, although sparse, is dominated by *Aristida jerichoensis* var. *subspinulifera*, *Eragrostis*

Table 1. Plant communities and map units recognised and described for the vegetation map of north-western New South Wales

Open forest	1 *Callitris glaucophylla*
	2 *Callitris glaucophylla–Eucalyptus intertexta*
	3 *Eucalyptus ochrophloia*
	4 *Eucalyptus coolabah* subsp. *coolabah*
Woodland	5 *Eucalyptus populnea* subsp. *bimbil*
	6 *Eucalyptus populnea* subsp. *bimbil–Callitris glaucophylla*
	7 *Eucalyptus populnea* subsp. *bimbil–Eucalyptus intertexta*
	8 *Eucalyptus intertexta–Acacia aneura*
	9 *Eucalyptus melanophloia–Triodia mitchellii* var. *breviloba*
	10 *Eucalyptus microcarpa* (narrow-leaved race)
	11 *Eucalyptus camaldulensis*
	12 *Acacia excelsa*
Open woodland	13 *Eucalyptus* aff. *terminalis–Eucalyptus populnea* subsp. *bimbil*
Low open forest	14 *Callitris glaucophylla*
	15 *Eucalyptus largiflorens*
	16 *Acacia cambagei*
	17 *Acacia harpophylla*
Low woodland	18 *Casuarina pauper–Alectryon oleifolius* subsp. *canescens*
	19 *Eucalyptus* aff. *terminalis–Atalaya hemiglauca*
Tall shrubland	20 *Eucalyptus socialis* (sandplain)
	21 *Eucalyptus socialis* (rocky hills)
	22 *Eucalyptus vicina*
	23 *Eucalyptus gillii*
	24 *Acacia aneura* (sandplain)
	25 *Acacia aneura* (rocky hills)
	26 *Acacia aneura–Acacia ligulata*
	27 *Acacia aneura–Acacia tetragonophylla*
	28 *Acacia aneura–Acacia excelsa–Geijera parviflora*
	29 *Acacia loderi*
	30 *Acacia clivicola*
Shrubland	31 *Acacia ramulosa*
	32 *Acacia cana*
	33 *Atriplex nummularia*
Dwarf open scrub	34 *Atriplex vesicaria* (downs and ranges)
	35 *Atriplex vesicaria* (floodplains)
	36 *Maireana pyramidata*
	37 *Maireana sedifolia*
Herbland	38 *Eragrostis australasica–Muehlenbeckia florulenta*
Grassland	39 *Astrebla lappacea* (floodplains)
	40 *Astrebla* spp. (downs)
Salt lakes	41 Salt lake communities

lacunaria, and *Stipa* spp. Other perennial and annual species may include *Digitaria brownii*, *Enteropogon acicularis*, *Sclerolaena diacantha*, *Chenopodium* spp., *Calotis cuneifolia*, and *Sida cunninghamii*.

Map unit 3

Eucalyptus ochrophloia open-forest

(Yapunyah)

Geographic distribution: Restricted to the Paroo River (and adjacent lower reaches of adjacent Purnanga and Dingo Creeks) and channels of Cuttaburra Creek.

Landforms: Floodplains and associated channels, pans and sandy rises.

Soils: Brown clays, red texture-contrast soils, gravel and stony beds of streams.

Structure: Variable low open-forest to woodland, in essentially monotypic stands (Fig. 5). Variable amounts of *Muehlenbeckia florulenta* and *Eragrostis australasica* forming dense herbland along channels. Some patches of tall shrubs (for example *Acacia stenophylla*).

Canopy species: Generally only *Eucalyptus ochrophloia*, but on fringes a range of other trees: *E. coolabah* subsp. *coolabah*–*E. coolabah* subsp. *arida* (see notes in Map unit 4), *E. camaldulensis*, *E. populnea* subsp. *bimbil* and *E. largiflorens*.

Other species: A wide range of shrubs occupy slightly lower (wetter) and higher (drier) sites in a bewildering manner: *Maireana aphylla*, *Acacia victoriae*, *A. stenophylla*, *Eremophila bignoniiflora*, *E. polyclada*, *E. maculata*. Herbs include *Muehlenbeckia florulenta*, *Sclerolaena muricata*, and many other annual *Sclerolaena* species and annual *Atriplex* species as well as a number of ephemeral species occurring after floods. Many grass species: *Eragrostis australasica*, *E. setifolia*, *Astrebla lappacea*, *Paspalidium jubiflorum*, *Leptochloa digitata*, *Dichanthium sericeum* and *Digitaria ammophila*.

Merges with: Other northern floodplain communities, especially *Eragrostis australasica*–*Muehlenbeckia florulenta* herbland, *Eucalyptus populnea* low open-forest, *Maireana pyramidata* low open-shrubland, as well as dryland communities.

Map unit 4

Eucalyptus coolabah subsp. *coolabah* open-forest

(Coolibah)

Geographic distribution: Floodplains of the Darling River and its tributaries upstream of Wilcannia, and especially upstream of Louth.

Landforms: Quaternary alluvium with more recent rises of sandier sediment (small source-bordering dunes), various depressions in the plains.

Soils: Grey cracking clays and grey self-mulching clays

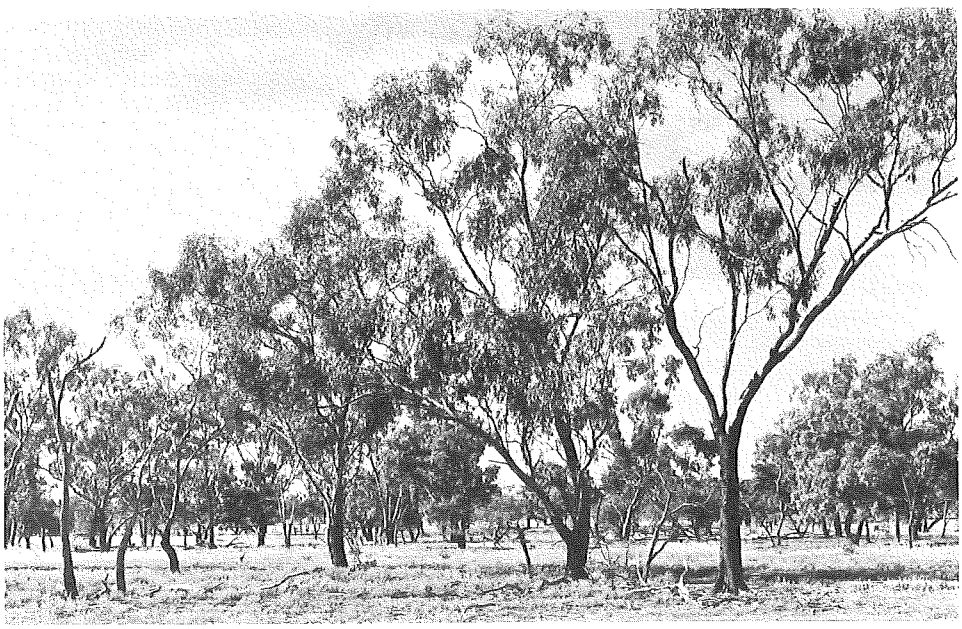


Figure 5. ***Eucalyptus ochrophloia*** **open-forest (Map unit 3). Cuttaburra Creek.**

with gilgais and crab-holes, sandy soils on rises.

Structure: As mapped here, the community includes a wide range of structural forms, ranging from open woodland dominated by *E. coolabah* to ephemeral herbland with no single dominant. Shrub layer may be present. The extensive plains are most often essentially treeless, but are mapped here for convenience.

Canopy species: *E. coolabah*, *E. largiflorens*, *E. camaldulensis*, *Casuarina pauper*/*C. cristata*. Two subspecies are recognised in the map area: subsp. *coolabah* is common throughout on heavier soils, while subsp. *arida* is confined to the the far north-western corner, usually in sandy or gravelly creek lines in stony or sandy desert country.

Other species: Shrubs: *Acacia victoriae*, *A. stenophylla*, *Atalaya hemiglauca*, *Eremophila bignoniiflora*, *Atriplex nummularia*, *Chenopodium nitrariaceum*, *Rhagodia spinescens*, dense *Dodonaea viscosa* subsp. *angustissima* on sandy rises. Herbs dominated by various annual chenopods together with a wide range of season-specific ephemerals (including grasses).

Merges with: Other southern floodplain communities (*Eucalyptus camaldulensis* open-forest, *E. largiflorens* low open-forest and *Eragrostis australasica–Muehlenbeckia florulenta* herbland and dryland communities (*Maireana pyramidata* (sandplain) low open-shrubland, *Atalaya hemiglauca* open-woodland).

Map unit 5

Eucalyptus populnea subsp. *bimbil* woodland

(Bimble Box or Poplar Box)

Geographic distribution: Communities dominated by Bimble Box form extensive woodlands through parts of the map area, particularly in the eastern areas south of Bourke and around Cobar. Here they occur on plains and gentle slopes, often in seasonal drainage lines. Further west in lower rainfall areas, the community becomes more restricted to drainage lines and near White Cliffs is found essentially as a riparian community only. Some extensive stands occur in closed depressions forming "Bimble Box swamps", which are seasonally inundated. (Beetson et al. 1980.)

Landforms: Extensive slopes and low ridges, floodplains coming off stony downs, from 0.2 to 3 km wide, with incised channels, and various higher sandier patches.

Soils: Variable mixture of unconsolidated creek sediments (clay to silt to gravel), brown clays and texture-contrast soils.

Structure: The structure of Bimble Box communities varies with soil type. On moderately fertile loamy soils and heavy clays a two-layered tree-grass structure predominates. At its maximum development communities on these sites may approach low open-forest to 10 m or more high. On lighter-textured, more sandy soils, there is frequently a variable understorey of shrubs — *Callitris glaucophylla* is often codominant.

Canopy species: Dependent on soil type: red earths support *Acacia excelsa*, *Geijera parviflora* and *Alectryon oleifolius*. Lighter soils also have *Callitris glaucophylla*, heavy clay soils in depressions have *Casuarina cristata* and *Acacia harpophylla*. *Eucalyptus microcarpa* may also be present as an associated species in alluvial and clay soils on plains and gentle slopes in the south-east of the map area.

Other species: Various shrubs including *Acacia victoriae*, *Eremophila longifolia*, *Maireana pyramidata*, *M. aphylla*, *A. tetragonophylla* and *A. aneura*. Frequently invaded by woody weeds, especially *E. sturtii* and *E. mitchellii*. Grasses and forbs are very variable, the main species being *Eragrostis setifolia*, and annual *Sclerolaena* species.

Merges with: Other floodplain communities except *Eucalyptus coolabah* open-woodland; *Maireana pyramidata* low open-shrubland (creeks); low open-woodland and low open-woodland–tall open-shrubland communities dominated by *Casuarina pauper–Alectryon oleifolius* and other species. Forms a boundary community between creeks entering the western side of the Paroo River. Forms mosaics with *Callitris glaucophylla* (Map unit 5/1) and *Acacia excelsa* (Map unit 5/12) adjacent to the Paroo River and Cuttaburra Creek.

Map unit 6

Eucalyptus populnea subsp. *bimbil–Acacia aneura–Acacia* spp. woodland

(Bimble Box–Mulga–Acacia)

Geographic distribution: These communities are widespread on the plains country south of Bourke, and are mapped for this area.

Landforms: Level to undulating plains.

Soils: Deep calcareous to acid loamy to sandy red earths.

Structure: Tree cover varies, ranging from an open structure to quite dense stands.

Canopy species: Associated species include *Acacia excelsa*, *Eucalyptus intertexta*, *E.* aff. *terminalis*, *Eremophila mitchellii*, *Apophyllum anomalum*.

Other species: *Senna artemisioides*, *Dodonaea viscosa* subsp. *angustissima* and *Eremophila sturtii*. Ground covers include *Aristida* spp., *Eragrostis eriopoda*, *Chloris truncata* and other perennial grasses and forbs.

Map unit 7

Eucalyptus populnea subsp. *bimbil*–*E. intertexta* woodland

(Bimble Box–Red Box)

Geographic distribution: These communities form extensive woodlands south-east of Bourke and east and north-east of Cobar.

Landforms: Relatively hilly topography.

Soils: Shallow skeletal soils having a light texture.

Structure: They form predominantly a shrub woodland with understorey species including *Geijera parvifolia*, *Senna artemisioides*, *Alectryon oleifolium* and *Eremophila mitchellii*. Other minor species of less importance include *Apophyllum anomalum*, *Senna artemesioides*, *Dodonaea viscosa* subsp. *angustissima* and *Eremophila longifolia*. Interspersed within these communites is *Eucalyptus viridis* which occurs on more shallow soils and slight rises.

As rain decreases *E. intertexta* becomes more dominant over *E. populnea* subsp. *bimbil*, especially on stony ridges and hills.

These communities sometimes grow in a mosaic with *Callitris glaucophylla* (Map unit 7/1).

Map unit 8

Eucalyptus intertexta–*Acacia aneura* woodland

(Red Box–Mulga)

Geographic distribution: These communities are mapped for a region on the western fringe of the Cobar pediplain north-west of Cobar.

Landforms: Low gravelly rises and ridge crests with sandstone or quartzite rock outcrops. They can also be found in rocky drainage lines.

Soils: Red earths, which may sometimes be quite shallow, and in the more hilly areas soils are skeletal.

Structure: *Acacia aneura* predominate in the intermediate areas between the scattered stands of *Eucalyptus intertexta*, standing 10–15 m in height.

Canopy species: Associated species include *Acacia excelsa*, *Atalaya hemiglauca*, *Geijera parviflora*, *Grevillea striata*, *Alectryon oleifolius* and *Brachychiton populneus*. *Callitris glaucophylla* is almost entirely absent.

Other species: Shrubs may include *Pittosporum phylliraeoides*, *Senna* spp., *Eremophila* spp. (including *E. mitchellii*). The herbaceous layer may include *Aristida jerichoensis* var. *subspinulifera*, *Aristida contorta*, *Eragrostis eriopoda*, *Tripogon loliiformis*, *Monachather paradoxa*, *Thyridolepis mitchelliana*, *Paspalidium constrictum*, *Sclerolaena* spp. and *Sida* spp.

Map unit 9

Eucalyptus melanophloia–*Triodia mitchellii* var. *breviloba* woodland

(Silver-leaved Ironbark–Buck Spinifex)

Geographic distribution: These communities are mapped for two localised areas north-west of Brewarrina. *Eucalyptus melanophloia* is more common in country to the east of the map sheet area.

Landforms: Sandplains and dunefields

Soils: Variable, range from deep sandy red earths to texture-contrast soils with a light clay B-horizon.

Structure: *Eucalyptus melanophloia* grows to a height of 7–10 m and commonly forms savannah woodlands with *Triodia mitchellii* var. *breviloba* (Fig. 6).

Canopy and other species: Associated species occurring within these communities are not common but may include *Acacia murrayana*, *Grevillea albiflora*, *G. juncifolia*, *Micromyrtus ciliata*, and *Keraudrenia integrifolia*. Grasses and forbs may include *Eragrostis eriopoda* and *Calandrinia balonensis*.

Map unit 10

Eucalyptus microcarpa (narrow-leaved race) woodland

(Western Grey Box)

Geographic distribution: *Eucalyptus microcarpa* communities are mapped for a small area around, and east, of Bobadah representing a westerly extension of its more easterly distribution in the State.

Landforms Generally gentle slopes and plains.

Soils: Mainly red earths and red-brown earths.

Structure: Woodland, *E. microcarpa* is a medium-sized tree attaining 20 m in height.

Canopy species: *E. microcarpa* (narrow-leaved race; this species forms an extensive intermediate, with good breeding populations between *E. microcarpa* and *E. pilligaensis*). Associated species include *Callitris glaucophylla*, *Eucalyptus viridis* and *E. populnea* subsp. *bimbil*.

Other species: Shrubs include *Acacia deanei*, *A. oswaldii*, *Hakea leucoptera*, *Pittosporum phylliraeoides* and *Eremophila longifolia*. Perennial pasture species may include *Danthonia caespitosa*, *Aristida jerichoensis* var. *subspinulifera*, *Paspalidium constrictum* and other annuals and perennial forbs.

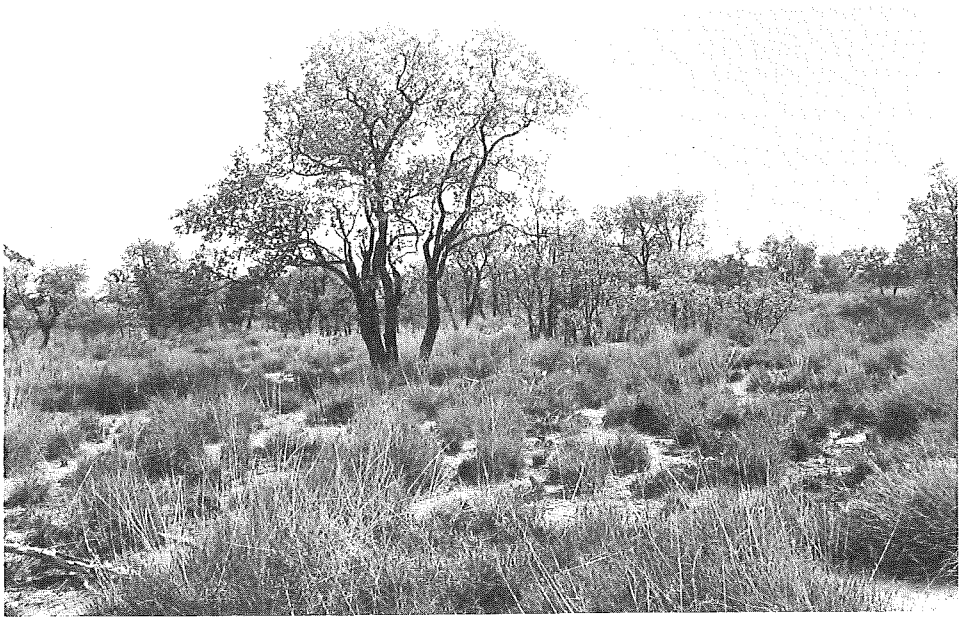


Figure 6. ***Eucalyptus melanophloia–Triodia mitchellii*** **woodland (Map unit 9).**

Map unit 11

Eucalyptus camaldulensis woodland

(River Red Gum)

Geographic distribution: Along all perennial rivers and large creeks flowing in the map area. Also along major creek channels with intermittent flow.

Landforms: Meandering incised river channels and nearby levee banks; incised channels in ephemeral streams, rocky creek beds.

Soils: Generally grey cracking clays, but also any other soils in creek bottoms.

Structure: At its maximum development along the banks of the major rivers (Darling and Lachlan) this community forms a forest of trees up to 30 m high. More typically, it is an open-forest, and frequently low woodland. There is usually only one tree layer, and occasionally a tall shrub layer of, for example, *Acacia stenophylla* with much shorter *Chenopodium nitrariaceum* or *Rhagodia spinescens*. *Muehlenbeckia florulenta* commonly occurs as dense to open thickets where there are large gaps in the tree canopy.

Where the community occurs in channels on broad creeks, it is usually restricted to the active and not-long inactive channels. Whenever a new channel is formed, it is quickly colonised by a single or double row of *E. camaldulensis*. Whether these ever survive to form open-forest is a function of the stability of the landforms. In Wannara Creek near White Cliffs, channels have migrated > 100 m in the past 100 years (Pickard1994) and all the *E. camaldulensis* in traces of the oldest channels are long dead. Short-lived channels frequently show lines of dying *E. camaldulensis*, e.g. channels of Wannara Creek below "Arrowbar" homestead.

Canopy species: *Eucalyptus camaldulensis*, with variable amounts of *E. populnea* subsp. *bimbil* and *E. coolabah* depending on the site. (*E. camaldulensis* in the Barrier Range to Tibooburra area is a distinct taxon, L.A.S. Johnson pers. comm.)

Other species: *Acacia stenophylla*, *Chenopodium nitrariaceum*, *Rhagodia spinescens*, *Muehlenbeckia florulenta* and a wide range of ephemerals after floods.

Merges with: All other flood plain communities. This community sometimes grows in a mosaic with *Eucalyptus populnea* subsp. *bimbil* (Map unit 5) east of White Cliffs, and *E. largiflorens* (Map unit 15) along the Darling River.

Map unit 12

Acacia excelsa woodland

(Ironwood)

Geographic distribution: *Acacia excelsa* communities are scattered and are mapped for the north-eastern portion around Louth, north of Louth, and north-west to north-east of Bourke.

Landforms: Level to undulating country on well-watered drainage flats, and may also be found on

sandplains and sand ridges.

Soils: Variable. In the Bourke district these communities grow on deep sands and are commonly associated with *Callitris glaucophylla*. On solonised brown soils and red earths *A. excelsa* grows with *A. homalophylla*, *A. aneura*, *Eremophila mitchellii*, *Grevillea striata*, *Hakea tephrosperma* and *H. leucoptera*.

Structure/Canopy species: *A. excelsa* can occur in almost pure stands, 10 m high or more, or it may intergrade with other species such as *E. populnea –Callitris glaucophylla*, *A. aneura* and *E. intertexta*.

Other species: May include *Pittosporum phylliraeoides*, *Apophyllum anomalum*, *Senna artemisioides*, *Dodonaea viscosa* subsp. *angustissima*, *Olearia pimelioides*. Groundcovers may include *Eragrostis eriopoda*, *Aristida jerichoensis* var. *subspinulifera*, *Dichanthium sericeum*, *Aristida contorta* and *Sclerolaena diacantha*. *Acacia excelsa* is an important drought-fodder species.

Acacia excelsa grows in a mosaic jointly with *Eucalyptus populnea* subsp. *bimbil* (Map unit 5) and *Callitris glaucophylla* (Map unit 1), ie. 12/5/1, having a limited distribution north of Bourke and north and north-east of Enngonia; with *Casuarina cristata–Alectryon oleifolius* (Map unit 18) in the Enngonia district; and with *Acacia aneura* (Map unit 24) north-east of Wanaaring and adjacent to the Paroo River and Cuttaburra Creek.

Map unit 13

Eucalyptus aff. *terminalis–E. populnea* subsp. *bimbil* open woodland

(Inland Bloodwood–Bimble Box)

Geographic distribution: This uncommon community is mapped for an area north-west of Wanaaring and west of the Paroo River towards the New South Wales–Queensland border in country largely dominated by *Acacia aneura* tall shrubland (Map unit 24).

Landforms: The landscape is characterised by extensive, slightly undulating sandplains.

Soils: Typically light-textured soils such as deep sandy to sandy loam red earths.

Canopy species: Associated species may include *Grevillea striata* and *Hakea ivoryi*.

Other species: Shrub species include *Senna artemisioides* and *Dodonaea* spp. The herbaceous layer may include *Aristida* spp., *Enneapogon avenaceus* and *Thyridolepis mitchelliana*.

Map unit 14

Callitris glaucophylla low open-forest

Geographic distribution: Scattered distribution over the south-eastern corner of the map sheet and adjacent to communities dominated by *Eucalyptus socialis* (Map unit 20), *E. vicina* (Map unit 22) and *Callitris glaucophylla–E. intertexta* (Map unit 2).

Landforms: Rocky hills and ranges. Here, *Callitris glaucophylla* grows well up the slopes.

Soils: Sandy to loamy lithosols which become deeper and better developed downslope.

Canopy species: *Callitris glaucophylla* (Fig. 7); associated species may include *Acacia doratoxylon*, *Eucalyptus intertexta*, *E. populnea* subsp. *bimbil*, *Myoporum mitchellii* and *Brachychiton populneus*.

Other species: Shrub species may include *Acacia decora*, *Senna artemisioides*, and scattered *Pandorea pandorana*. The herbaceous layer may be dominated by *Stipa* spp., *Aristida* spp., *Amphipogon caricinus* and other grasses and forbs.

Map unit 15

Eucalyptus largiflorens low open-forest

(Black Box)

Geographic distribution: Widespread as a fringing community along creeks, around lakes and in depressions of various sizes from Tibooburra to White Cliffs and along the Darling River floodplain downstream of Wilcannia. Immediately upstream of Wilcannia both *Eucalyptus largiflorens* and *E. coolabah* subsp. *coolabah* may occur but on different sites. Futher upstream, *E. coolabah* open-forest (Map unit 4) predominates.

Landforms: Intermittently flowing billabongs and anabranches adjacent to Darling River; floodplains generally, seasonally flooded internal drainage basins.

Soils: Variable; grey cracking clays with and without extensive areas of crabholes, some texture-contrast soils.

Structure: Extremely variable. At its maximum development an open-forest but more generally low open-forest and even open-woodland. Trees are typically bent, and often occur as a single line around the contour of a previous high flood line. Various shrubs (especially *Chenopodium nitrariaceum* and *Acacia stenophylla*) and herbs occur forming discontinuous lower layers.

Forms complex mixtures with *Eragrostis australasica–Muehlenbeckia florulenta* herbland on floodplains of Paroo River, and with *Eucalyptus coolabah* on the floodplains of the Darling River.

Canopy species: *E. largiflorens*, *E. populnea* subsp. *bimbil*, *E. coolabah*, *Casuarina pauper*, *Grevillea striata*.

Figure 7. *Callitris glaucophylla* low open-forest (Map unit 14). Approximately 40 km north-west of Condobolin (32° 47′ S 146° 59′ E).

Other species: Dense to open stands of *Muehlenbeckia florulenta*, *Acacia stenophylla*, *Chenopodium nitrariaceum*, various *Sclerolaena* species and a range of grasses (e.g. *Eragrostis setifolia*, *Sporobolus mitchellii* and *Eragrostis australasica*). Slightly higher areas on sandier soils with annual *Sclerolaena* and *Atriplex* species, and *Enneapogon avenaceus* under *Myoporum montanum* and *Dodonaea viscosa* subsp. *angustissima*. Some *Acacia victoriae*.

Merges with: All other floodplain communities; and with communities of sandplains. Sometimes forms a mosaic with *Acacia aneura* tall shrubland (Map unit 24), *Atriplex vesicaria* shrubland (Map unit 35), and *Eragrostis australasica–Muehlenbeckia florulenta* (Map unit 38) where there is a mix of suitable soils and landforms.

Map unit 16

Acacia cambagei low open-forest

(Gidgee)

Geographic distribution: Large areas between the Paroo and Culgoa Rivers, north of Louth and Bourke, and replaces Brigalow, *Acacia harpophylla* as rainfall decreases to below 550 mm per year.

Landforms: Areas subjected to irregular flooding, such as along the edges of watercourses and drainage channels.

Soils: Variable, include brown and reddish-brown clays and duplex soils on the floodplains, and desert loams along creeks.

Structure: *Acacia cambagei* characteristically forms pure stands to 10 m in height with dense interlacing canopies, or can occur in more open formations.

Canopy species: *Acacia harpophylla*, *Casuarina pauper*, *Apophyllum anomalum*, *Eremophila mitchellii*, *Flindersia maculosa*, *Acacia aneura*, *Atalaya hemiglauca*, *Grevillea striata* and *Alectryon oleifolius*.

Other species: Shrub species may include *Atriplex nummularia*, *Rhagodia spinescens*, *Enchylaena tomentosa* and *Maireana pyramidata*. Herbaceous species may include *Paspalidium jubiflorum*, *Enteropogon acicularis*, *Digitaria* spp., *Eulalia aurea*, *Leptochloa digitata* and *Dichanthium sericeum*. Annual *Atriplex* spp. and *Sclerolaena* spp. may also be present.

The flowers and damp leaves of *Acacia cambagei* give off an offensive more-or-less faecal odour.

Merges with: Floodplain communities, and *Acacia excelsa*, *A. aneura* and *A. harpophylla* communities.

Acacia cambagei sometimes grows in a mosaic with *Eucalyptus populnea* subsp. *bimbil–Callitris glaucophylla* (Map units 5 and 1), *Eucalyptus camaldulensis* (Map unit 11), and *Casuarina pauper–Alectryon oleifolius* subsp. *canescens* (Map unit 18).

Figure 8. Low open-forest of Brigalow, *Acacia harpophylla* (Map unit 17) (29° 08′ S 146° 33′ E).

Map unit 17

Acacia harpophylla low open-forest

(Brigalow)

Geographic distribution: Scattered occurrences of *Acacia harpophylla* communities are mapped for three localities north-east of Bourke.

Landforms: The landscape is of low-relief sandplains and sandhills. Rarely found on hills and ridges.

Soils: Soils are predominantly red clays, often with gilgai development, alluvial clays subject to flooding, and red earths with sandy clay loam topsoils.

Structure: *Acacia harpophylla* suckers easily from roots and often forms dense monospecific stands to 10–15 m in height (Fig. 8). For detailed descriptions of the structure and floristics see Isbell (1962), Pulsford (1984), Bailey (1984), Johnson (1984) and Wade (1992).

Canopy species: *Acacia harpophylla* can grow in association with *A. cambagei* and *Casuarina cristata*, and occasionally with *Callitris glaucophylla* and *A. pendula*.

Other species: The understorey usually comprises few, if any, shrubs, but may include *Dodonaea viscosa* subsp. *angustissima* and *Eremophila longifolia*. The sparse groundcover may comprise *Atriplex* spp., *Sclerolaena* spp., *Stipa* spp. and *Eragrostis eriopoda* and other grasses and forbs.

Merges with: *Acacia cambagei* and *A. excelsa* communities.

Map unit 18

Casuarina pauper–Alectryon oleifolius subsp. *canescens* low woodland

(Belah–Rosewood)

Geographic distribution: Extensive communites over a wide area of the centre of the map from Broken Hill to west of Bourke, especially south of the Darling River towards Ivanhoe. (Some intergradation of *Casuarina pauper* with *C. cristata* occurs in the area from Bourke to west of Condobolin. *C. pauper* occurs through far western New South Wales, whilst *C. cristata* occurs further east).

Landforms: Generally on undulating sandplains with low relief.

Soils: Calcareous red earths and red earths.

Structure: Varies from parkland with clumps of open-woodland separated by very open areas, to dense scrubs and woodlands, and open forests with trees only 4–5 m apart. Consequently density of trees is highly site specific (Fig 9).

Canopy species: *Casuarina pauper*, *Alectryon oleifolius*, *Flindersia maculosa*, *Acacia aneura*. Pure stands of both dominants are common. Reynolds (1985) recognises two subspecies of *Alectryon oleifolius* in the map area. Subspecies *canescens* usually grows on sand dunes, sandy ridges and hills in the west. Subspecies *elongatus* is more common in open forests, usually on heavy soils, in the east of the mapped area.

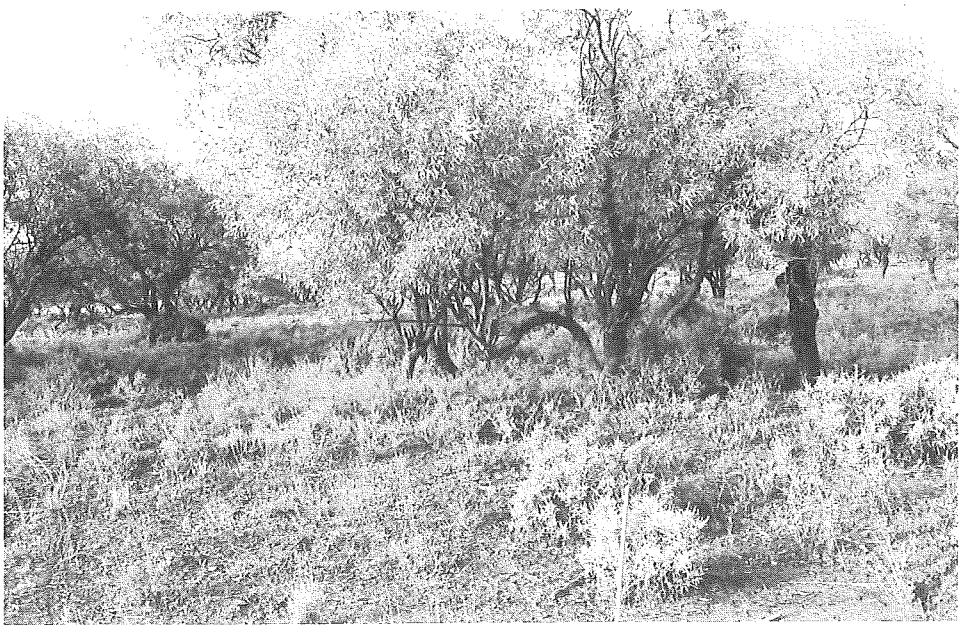


Figure 9. Belah–Rosewood, *Casuarina pauper–Alectryon oleifolius* subsp. *canescens* low woodland (Map unit 18) (32° 19′ S 143° 30′ E).

A major variant of this community occurs in the Wilcannia–White Cliffs area. Here *Casuarina pauper–Alectryon oleifolius* subsp. *canescens–Flindersia maculosa–Acacia aneura* low open-woodland–tall open-shrubland occurs on two distinct site types: loam and gibbers, and sand plain and dunes. The former is restricted to hillslopes and plateaus formed on Cretaceous sediments, and adjacent downslope areas with desert loams and skeletal lithosols, generally with gibbers at surface. The latter occurs on low relief undulating sandplains, with and without extensive areas of sand dunes and swales with calcareous red earths, red sandy earths and deep sands.

The structure of both communities is extremely variable and changes rapidly over short distances from woodland (generally in parkland mosaic of denser and more open phases) to tall open-shrubland. On the hilly gibber sites there is frequently an extensive understorey of *Maireana pyramidata* and/or *Atriplex vesicaria*. The sandy sites now often support dense stands of "woody weeds".

Other species: Dense stands of *Eremophila sturtii* and *Dodonaea viscosa* subsp. *angustissima* (both "woody weeds"), *Apophyllum anomalum*, and some invasion by *Senna artemisioides*, *Acacia cana*, *Maireana pyramidata*, *Atriplex vesicaria*, *Eremophila serrulata*, *E. longifolia*, *Rhagodia spinescens*, *Acacia tetragonophylla*. Grasses include extensive areas of *Astrebla lappacea* on clayey sites, but on sandier sites *Eragrostis setifolia*, *Stipa nitida* and *Enneapogon avenaceus* are more common. *Eragrostis setifolia* is particularly abundant in run-on areas. *Stipa nitida* is particularly obvious after winter rainfall. Herbs are variable and are generally dominated by *Sclerolaena* spp., and various ephemerals.

Merges with: All other communities of gibber slopes and Cretaceous hills, and sandplains; especially *Acacia aneura* tall shrubland, *Maireana pyramidata* shrubland, *Atriplex vesicaria* shrubland, *Eucalyptus socialis* tall shrubland.

This community sometimes grows in a mosaic with *Acacia excelsa* (Map unit 12), *A. aneura* (Map unit 24), and with *Atriplex vesicaria* (Map unit 34).

Map unit 19

Eucalyptus aff. *terminalis–Atalaya hemiglauca* low woodland

(Inland Bloodwood–Whitewood)

This community is mapped for a small area south of Tibooburra. Reaching 6 m in height, the community is commonly found on crests, low rises and stony ridges. The soils comprise gravelly red loams to sandy soils. *Eucalyptus* aff. *terminalis* is to be named *Corymbia tumescens* (L.A.S. Johnson, pers. comm.).

Map unit 20

Eucalyptus socialis tall shrubland

(Red Mallee on sandplain)

Geographic distribution: Extensive areas in south of map area, east of Roto, but extending north to Cobar and west to Wilcannia. Isolated stands are known from north of Bourke and Wilcannia.

Landforms: Gently undulating sandplain.

Soils: Calcareous red earths, with abundant calcareous nodules close to surface.

Structure: Typically a shrubland of mallee individuals from 1.5–5 m tall depending on time since the last wildfire (Fig. 10). Plants have multiple stems arising from an underground lignotuber. Some stands are commonly described as "bull mallee": very large individuals with only a few stems, but each of these up to 10 m high, forming woodland. This is typical of mallee stands which have not been burnt for many years. Wildfire kills the above-ground stems, but new stems sprout from the lignotuber. Smaller shrubs vary locally from few to very abundant. For detailed descriptions of the structure and floristics of mallee vegetation see Hill (1989), Noble (1982, 1984), and Noble *et al.* (1990).

Canopy species: *Eucalyptus socialis, E. dumosa.*

Other species: A very wide range of small shrubs, and herbs. The most abundant are *Melaleuca uncinata*, *Olearia* spp., *Alectryon oleifolius* and various grasses, especially *Triodia scariosa*.

Merges with: *Casuarina pauper–Alectryon oleifolius* low open-woodland, *Maireana pyramidata* low open-shrubland.

This community sometimes grows in a mosaic with *Casuarina pauper–Alectryon oleifolius* subsp. *canescens* (Map unit 18).

Map unit 21

Eucalyptus socialis tall shrubland

(Red Mallee on rocky hills)

Geographic distribution: Scattered occurrences south and south-east of Cobar.

Landforms: These communities of *Eucalyptus socialis* occur on stony rises, low ridges and rocky hills.

Soils: Usually shallow loamy to gravelly soils.

Structure: Typical mallee shrubland 1.5–5 m tall.

Canopy species: *Eucalyptus socialis;* Associated species may include *E. populnea* subsp. *bimbil*, *E. intertexta*, *E. viridis; and Casuarina pauper–Alectryon oleifolius* and *Acacia aneura* communities.

Other species: The generally sparse understorey includes *Enchylaena tomentosa*, *Sclerolaena* spp., *Atriplex* spp., and other annual and perennial forbs and grasses.

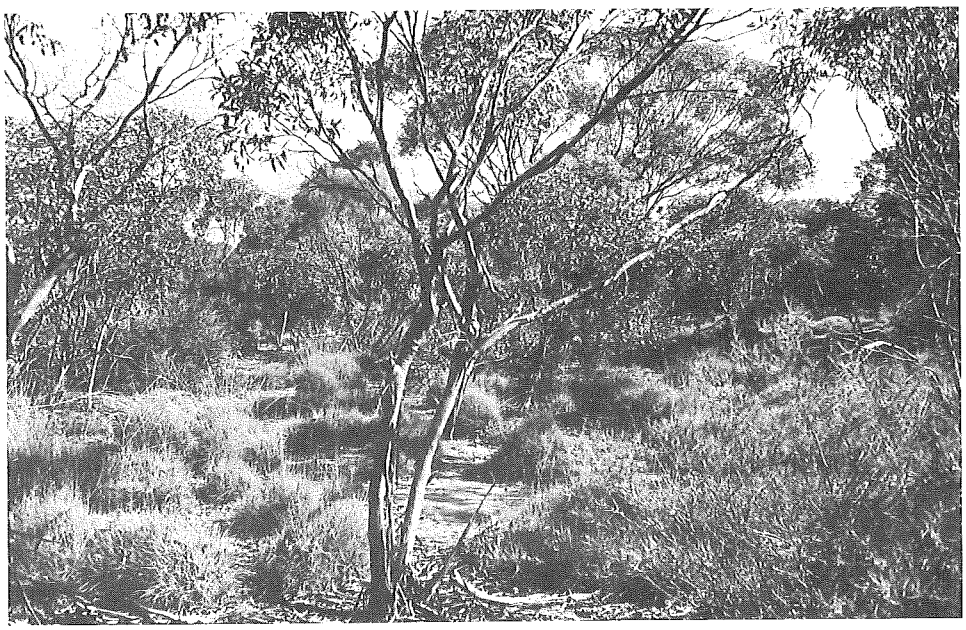


Figure 10. *Eucalyptus socialis* tall shrubland (Map unit 20). Approximately 35 km south-east of Mt Hope (32° 57′ S 146° 08′ E).

Map unit 22
Eucalyptus vicina tall shrubland

Geographic distribution: Country around Mt Hope, the Tarran Hills, Mootwingee and the hilly areas north-west of Ivanhoe.

Landforms: Ridge tops and ridge slopes.

Soils: Skeletal well-drained soils overlying sandstone, granite, quartzite or shale.

Structure: Moderate to open tall shrubland, usually found as the dominant species ocurring with *Eucalyptus sideroxylon* and *Callitris glaucophylla*. In many cases the understorey is an open to dense scrub of *Acacia doratoxylon*, although it does form open stands devoid of shrub species.

Canopy species: *Eucalyptus vicina, E. morrisii, Eucalyptus sideroxylon, Callitris glaucophylla*.

Other species: When shrubs are present in the understorey, species of *Prostanthera, Cassinia* and *Eriostemon* are common. Ground covers of *Helichrysum bracteatum* and species of *Wahlenbergia, Thyridolepis, Danthonia* and *Stipa* are usually present.

Map unit 23
Eucalyptus gillii tall shrubland
(Curly Mallee)

Geographic distribution: Main occurrence is in the Flinders Ranges in South Australia, but occurs in disjunct outliers in the northern sections of the Barrier Range, north of Broken Hill.

Landforms: Mainly in rocky terrain of weathered limestone or highly calcareous sandstone.

Soils: Calcareous skeletal, usually red-stained sandy soils.

Structure: Sparsely to moderately spaced trees in small clumps, 3–4 m high surrounded by *Acacia aneura* or forming continuous stands.

Canopy species: Associated species may include *Myoporum platycarpum* and *Eremophila alternifolia*.

Other species: Shrubs include *Maireana pyramidata, M. sedifolia* and *Atriplex vesicaria*. Ground covers include *Sclerolaena obliquicuspis* and *Zygophyllum apiculatum* beneath the canopy area, whilst the intercanopy area can be dominated by *Stipa nitida, S. trichophylla, Sclerolaena* spp. annual chenopods including *Osteocarpum acropterum, Atriplex angulata* and *A. lindleyi*. Annual grasses can also be found. Ground cover is rarely abundant after good rains.

Map unit 24
Acacia aneura tall shrubland
(Mulga on sandplain)

Geographic distribution: Extensive areas west of the Darling River and north of Wilcannia, extending to the borders (see also Sattler 1986).

Landforms: Undulating sand plain with some dunefields (especially on western side of Peery Lake and channels of Paroo River).

Soils: Calcareous red earths and deep red dune sands.

Structure: Individual stands vary from dense scrubs to open-woodlands but more typically the community forms tall shrubland of *Acacia aneura*. In the Wilcannia region there are extensive areas of dead *A. aneura*. These are currently being investigated. Many of the dead individuals have been dead for many decades. The cause of such widespread death seems to be a combination of wildfire and perhaps stress from a drought acting on old individuals in a single cohort. In marked contrast, Mulga communities near Bourke are often extremely dense with abundant regeneration and no areas of dead individuals.

Locally on deep sand adjacent to the Peery Hills east of White Cliffs a variant community dominated by *Grevillea striata* and *Eucalyptus intertexta* occurs. This open-woodland is of variable height and density, sometines with a dense shrub layer over a good cover of perennial grasses.

Canopy species: *Acacia aneura, Casuarina pauper, A. ligulata, Alectryon oleifolius* and *Flindersia maculosa*.

Other species: Shrubs: *Senna artemisioides, Eremophila sturtii, Dodonaea viscosa* subsp. *angustissima* (all three are "woody weeds"), *Myoporum montanum, Eremophila longifolia, Acacia ligulata, A. victoriae, Alectryon oleifolius, Maireana pyramidata, Rhagodia spinescens, Eremophila longifolia*. Grasses and forbs: *Aristida jerichoensis, A.contorta, Eragrostis eriopoda, Enneapogon avenaceus, Sclerolaena* spp. with *Themeda australis* and *Cymbopogon ambigua* in small creek lines.

Merges with: Other sandplain communities in the south: *Casuarina pauper–Flindersia maculosa–Alectryon oleifolius–Acacia aneura* low open-woodland–tall open shrubland. This community sometimes grows in a mosaic with *Eucalyptus populnea* subsp. *bimbil* (Map unit 5), *E. largiflorens* (Map unit 15), *Acacia cambagei* (Map unit 16), and *Eragrostis australasica–Muehlenbeckia florulenta* (Map unit 38).

Map unit 25

Acacia aneura tall shrubland

(Mulga on rocky hills)

Geographic distribution: Extensive distribution on hills and ranges over a wide area west of the Darling River around the Paroo River and Cuttaburra Creek.

Landforms: Plateaus, scarps and mesas on Cretaceous sediments.

Soils: Lithosols and desert loams, frequently with abundant gibber lag.

Structure: Moderate to open stands of *A. aneura* with extensive open areas of grassland and low open shrubland.

Canopy species: *Acacia aneura*, *Casuarina pauper*, *Flindersia maculosa*, *Atalaya hemiglauca*. On some sites the community becomes almost monotypic *A. hemiglauca* woodland.

Other species: The most common associated species are *Acacia tetragonophylla*, *Eremophila duttonii*, *E. latrobei*, *Prostanthera striatiflora*, *Ptilotus* spp., *Dodonaea viscosa* subsp. *angustissima*, *Maireana pyramidata*, *M. tomentosa*, *Pittosporum phylliraeoides*, *Senna artemisioides*, *E. sturtii*, *Apophyllum anomalum*, *Enneapogon avenaceus*, *Atriplex* spp., and *Sclerolaena* spp. Locally there are stands of *Acacia clivicola* and *A. brachystachya* on tops of scarps and mesas. Herbs include *Ergrostis parviflora* and other chenopods. Grasses are variable: *Astrebla lappacea*, *Enneapogon avenaceus*, *Aristida* spp., and *Thyriodolepis mitchelliana*.

Merges with: *Astrebla lappacea* grassland on plateaus; on slopes with *Maireana pyramidata* low open-shrubland and *Casuarina pauper–Flindersia maculosa–Alectryon oleifolius–Acacia aneura* low open-woodland–tall open-shrubland.

Map unit 26

Acacia aneura–Acacia ligulata tall shrubland

(Mulga–Sandhill Wattle)

Geographic distribution: This community occupies a relatively large area in the far north-west of the map sheet.

Landforms: Predominates on the deep sands of the sand ridges or dune crests replacing *Acacia aneura* (Map unit 24) on the adjacent sandplain country to the east.

Soils: Usually deep neutral to alkaline sands or cemented calcareous sands.

Structure: Tree cover comprises scattered *Acacia aneura* and isolated or clumped *A. ligulata*.

Canopy species: Associated species may include *Hakea leucoptera*, *H. tephrosperma*, *Alectryon oleifolius*, *Casuarina pauper* and *Grevillea stenobotrya*.

Other species: Associated shrubs may include *Senna artemisioides*, *Dodonaea viscosa* subsp. *angustissima* and *Eremophila sturtii*. The ground storey is sparse, and variable depending on whether the soil surface is stable or unstable. Where soils are stable species may include *Enneapogon avenaceus*, *Dactyloctenium radulans*, *Aristida contorta*, *Triraphis mollis*, *Dissocarpus paradoxa*, *Sclerolaena bicornis*, *S. diacantha*, *Helipterum floribundum*, and *Ptilotus polystachyus* var. *polystachyus*. Where soils are unstable species may include *Ptilotus polystachyus* var. *polystachyus*, *Trachymene glaucifolia*, *Eriachne aristidea*, *Eragrostis dielsii* var. *dielsii*, *Salsola kali* (mostly var. *strobilifera*), *Convolvulus erubescens*, *Calotis erinacea* and *Myriocephalus stuartii*.

Merges with: This community sometimes grows in a mosaic with *Eragrostis australasica–Muehlenbeckia florulenta* (Map unit 38).

Map unit 27

Acacia aneura–Acacia tetragonophylla tall shrubland

(Mulga–Dead Finish)

Geographic distribution: Widespread and scattered community on rocky hills and ridges, such as the Barrier Ranges, where it is most common and extensive, the Grey Range, Scopes Range east of Broken Hill and mesas east of White Cliffs. Also occurs on both sides of the Darling River north-west of Wilcannia, and on parts of the Cobar pediplain.

Landforms: Steep to moderate slopes on hills of Devonian sandstone, rocky cliffs, abundant outcropping sandstone.

Soils: Skeletal lithosols, some desert loams. Local patches of aeolian sediment.

Structure: Open-shrubland of rather small and stunted bushes of *Acacia aneura* and *A. tetragonophylla* with extensive open areas. Also extensive areas of dead shrubs. Cause of death may be wildfire or stress from droughts.

Canopy species: *Acacia aneura*, *Atalaya hemiglauca*, *Casuarina pauper*, *Acacia tetragonophylla*, *Grevillea striata*.

Other species: Various herbs including *Ptilotus* spp., and grasses, especially *Enneapogon avenaceus* and *Aristida contorta*.

Merges with: All communities at base of the hills, especially where sediment has accumulated on slopes of hills.

Map unit 28

Acacia aneura–A. excelsa–Geijera parviflora tall shrubland

(Mulga–Ironwood–Wilga)

Geographic distribution: Extensive areas of the Cobar Pediplain and surrounds.

Soils: Sandy to loamy skeletal soils.

Canopy species: *Acacia aneura*, *A. excelsa*, *Geijera parviflora*.

Merges with: Interspersed with *Eucalyptus populnea* subsp. *bimbil* woodland (Map unit 5) and *Callitris glaucophylla* open-forest (Map unit 1), and forms an indistinct boundary on its eastern range with *E. populnea–E. intertexta* woodland (Map unit 7).

Map unit 29

Acacia loderi tall shrubland

(Nelia)

Geographic distribution: Extensive stands between Broken Hill and Wilcannia, but isolated stands beyond (Fig. 11). In 240–280 mm rainfall zone.

Landforms: Undulating sandplain with minor drainage channels, low relief.

Soils: Calcareous red earths.

Structure: Open-shrubland of individual shrubs to small tree, usually with several major trunks arising close to ground.

Canopy species: *Acacia loderi*, *Casuarina pauper*, *Flindersia maculosa*. Over much of its distribution there is relatively little regeneration of *A. loderi*. This may be due to a combination of grazing by stock and death of young individuals by wildfire. Large old individuals are particularly susceptible to killing by fire. Litter of bark, twigs, branches and wind-blown plant material accumulated at the base of the plants burns during fires, killing the plants even though the canopy is barely scorched.

Other species: *Acacia aneura*, *Maireana pyramidata*, *Eremophila sturtii*, various grasses, especially *Stipa* ssp.

Merges with: Surrounding community of *Casuarina pauper–Alectryon oleifolius* open-woodland.

Map unit 30

Acacia clivicola tall shrubland

(Bastard Mulga)

Geographic distribution: Cootaurundee Range west of White Cliffs, and various mesas in the Warwick Hills east of White Cliffs.

Landforms: In the White Cliffs area it occurs on the crest of sandstone ranges and mesas and on plateaus of Cretaceous sediments, stony surface with considerable outcrop of bedrock (Fig 12). On the Queensland border it occurs on extensive sandplains.

Figure 11. ***Acacia loderi*** **tall shrubland (Map unit 29). Approximately 120 km north of Ivanhoe (32° 08′ S 144° 08′ E).**

Figure 12. ***Acacia clivicola*** **tall shrubland (Map unit 30). Crest of Cootaurundee Range, 12 km east of Wertago (30° 56′ S 142° 37′ E).**

Soils: Skeletal lithosols, and red sandy loams.

Structure: Variable shrubland of low and twisted, often multistemmed shrubs. Variable understorey of shrubs and herbs.

Canopy species: *Acacia clivicola*, *A. aneura*, *A. ramulosa*.

Other species: *Maireana pyramidata* and various grasses *Aristida* spp., *Thyridolepis mitchelliana* and *Digitaria* spp. Forbs include *Sida* spp. and *Abutilon* spp.

Merges with: All adjacent communities in these ranges, and on the sandplains.

Map unit 31

Acacia ramulosa shrubland

(Horse Mulga)

Geographic distribution: Ranges and hills west of Brewarrina, and especially west of Wilcannia.

Landforms: Rounded hills, particularly with exposed bedrock of Devonian sandstone, gentle slopes. Also on sand dunes.

Soils: Shallow lithosols, calcareous red earths.

Structure: Typical shrubland of multistemmed shrubs, very bushy and spreading individuals, occasional emergent small trees, variable understorey of low shrubs and herbs (Fig 13).

Canopy species: *Acacia ramulosa*, *A. aneura*, *A. brachystachya*, *Casuarina pauper*, *Flindersia maculosa*.

Other species: *Maireana pyramidata*, various other perennial chenopods.

Merges with: Adjacent communities, especially *Acacia aneura–A. tetragonophylla* open-shrubland, *Casuarina pauper–Alectryon oleifolius* open-woodland. *Acacia ramulosa* Shrubland is often found on small rocky hills within *Eucalyptus populnea* subsp. *bimbil*, *Eucalyptus intertexta* and *Acacia aneura* communities.

Map unit 32

Acacia cana shrubland

(Cabbage-tree Wattle)

Geographic distribution: Communities are scattered and are mapped for the north-west of the region, particularly in the White Cliffs area.

Landforms: Broad sandy watercourse areas and adjacent low rises.

Soils: Red earths or brown gibber soils on creek floodplains, and hardsetting, scalded red soils, and lighter-textured soils on rises.

Structure: Shrubland to 4 m forming dense pure stands or widely scattered trees.

Canopy species: *Acacia aneura*, *Flindersia maculosa*, *Casuarina pauper*, and *Alectryon oleifolius*. *Acacia cana* sometimes replaces *A. cambagei* along shallow watercourses.

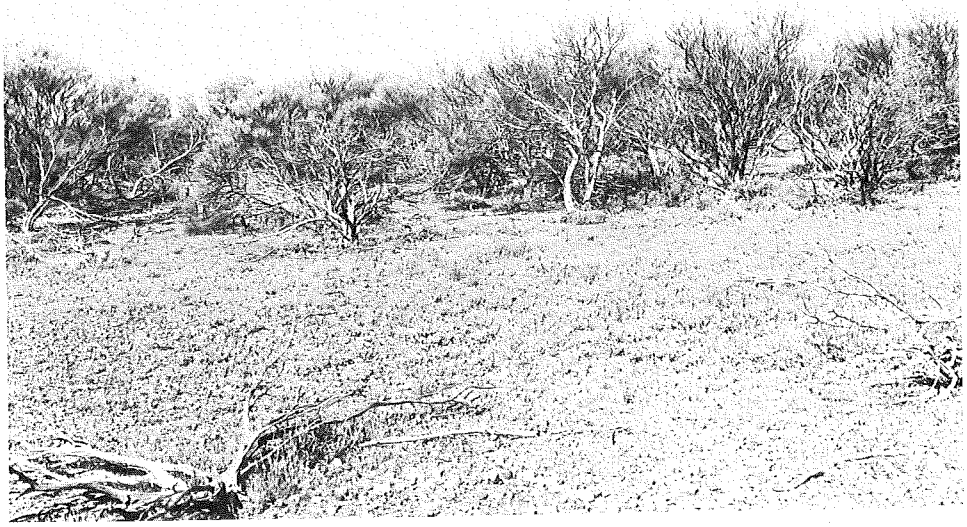


Figure 13. *Acacia ramulosa* shrubland (Map unit 31). The Dolo Hills, approximately 80 km west of Wilcannia (31° 43′ S 142° 43′ E).

Other species: Shrub species within these communities include *Eremophila sturtii*, *E. maculata*, *Dodonaea viscosa* subsp. *angustissima*, and *Senna* spp. Ground covers may include *Chloris truncata*, *Eragrostis dielsii*, *E. parviflora*, *Triraphis mollis*, and *Dactyloctenium radulans*, and species of *Atriplex* and *Sclerolaena*.

Map unit 33

Atriplex nummularia shrubland

(Old Man Saltbush)

Geographic distribution: Floodplain of Darling River close to junction with Paroo River, and in southernmost sections of Paroo River; north of Clifton Bore in the Bulloo Overflow.

Landforms: Alluvial plains, periodically flooded; sandy rises adjacent to floodplains.

Soils: Grey clays and texture contrast soils.

Structure: Open-shrubland to shrubland up to 2.5 m high with variable grass and forb layer after floods. Some anecdotal evidence suggests that many of the *Atriplex nummularia* communities in the map area are the results of natural spread from deliberate plantings in suitable habitats. However, some survey plans from the 1880s near Wilcanna have the annotation 'Giant Saltbush', indicating that *A. nummularia* was present at the time (Fig. 14).

Atriplex nummularia occurs as an understorey in *Eucalyptus coolabah*, *E. largiflorens* and *Acacia pendula* communities. Formerly it formed extensive stands in *A. pendula* but these have now been destroyed. It also forms localised stands along drainage lines and in depressions throughout *Atriplex vesicaria* shrublands.

Canopy species: *Atriplex nummularia*, *Eragrostis australasica*, *Muehlenbeckia florulenta*, *Chenopodium nitrariaceum*.

Other species: *Sclerolaena muricata*, annual *Atriplex* spp., various ephemerals.

Merges with: *Eragrostis australasica–Muehlenbeckia florulenta* Herbland, *Eucalyptus coolabah* open-woodland.

Map unit 34

Atriplex vesicaria dwarf open-scrub

(Bladder Saltbush on downs and ranges)

Geographic distribution: Widespread in the north-west of map area from Wilcannia to both South Australian and Queensland borders.

Landforms: Broad undulating stony plains, often on plateaus, and on stony ranges.

Soils: Brown desert loams with extensive lags of silcrete gibbers, gilgai brown clays; skeletal lithosols.

Structure: Moderate to sparse *Atriplex vesicaria* forming dwarf open-scrub with open inter-bush areas. On strongly gilgaied sites, *Astrebla lappacea* and various herbs usually occur in the depression

and *Atriplex vesicaria* on the rises. On rocky ranges, the inter-bush areas are frequently occupied by various herbs and low shrubs.

Canopy species: Vary with the site and habitat. Downs often have *Atriplex vesicaria*, *Maireana pyramidata* (especially in sandier soils in drainage lines), and *Astrebla lappacea*. Ranges and rocky sites often have *Atripex vesicaria*, *Maireana pyramidata* with scattered emergent *Acacia aneura* and *Casuarina pauper*. Low open woodland of *Acacia cana* on sandier rises and in creeks.

Other species: Wide range of herbs and grasses, especially *Astrebla lappacea*. In some areas, scattered *Sarcostemma australe* and *Sclerostegia* spp. occur. Ground cover species on downs are usually short-lived perennial grasses, especially *Enneapogon* spp., *Triraphis mollis*, *Sporobolus actinocladus*, *Dichanthium sericeum*, and the more long-lived perennial *Eragrostis setifolia*. Common forbs include *Sclerolaena brachyptera*, *S. eriantha* and *S. ventricosa*.

Merges with: *Astrebla lappacea* grassland, communities dominated by combinations of *Acacia aneura* and *Casuarina pauper* on gibber uplands; communites dominated by *Acacia aneura* on ranges.

Map unit 35
Atriplex vesicaria dwarf open-scrub
(Bladder Saltbush on floodplains)

Geographic distribution: Widespread in the north and north-east of the mapped area, for example in floodplains of the Darling and Bogan Rivers, and Cuttaburra Creek.

Landforms: Floodplains and low-lying areas.

Soils: Typically grey and brown cracking clays, and shallow-surfaced-red brown earths.

Structure: Moderate *Atriplex vesicaria* forming a dwarf open-scrub (Fig. 15).

Canopy species: *Maireana pyramidata*, *Maireana aphylla* and *Nitraria billardieri* may be present and *Atriplex nummularia* may also form localised patches. These communities are mainly treeless but may have a tree cover of *Eucalyptus coolabah* subsp. *coolabah* or *Acacia pendula*.

Other species: Between *Atriplex vesicaria* bushes are forbs and grasses of varying quantity depending on the season.

Atriplex vesicaria shrubland sometimes grows in a mosaic with *Astrebla lappacea* (Map unit 39) and after a series of years of summer-dominated rainfall, *Astrebla lappacea* can become more prominent.

Figure 14. *Atriplex nummularia* shrubland (Map unit 33). Near Wilcannia (31° 35′ S 143° 23′ E).

Figure 15. *Atriplex vesicaria* dwarf open-scrub (Map unit 35). Between Conoble and Trida.

Map unit 36

Maireana pyramidata dwarf open-scrub

(Black Bluebush on sandy loam texture contrast soils)

Geographic distribution: Widespread in the Broken Hill–Wilcannia–White Cliffs area.

Landform: Extensive undulating sandplains with aeolian reworking and usually with a texture contrast, higher areas on floodplains of Darling River. Also on broad sandy creeks and lower stony slopes of rises.

Soils: Texture-contrast soils, red desert loams in creeks and on edges of rises.

Structure: Dense to sparse and extensive areas of *Maireana pyramidata*. Locally there may be numerous small bushes which indicate post-World War II establishment of new plants. There may be emergent small trees, and invasion by "woody weeds" forming dense thickets.

Canopy species: *Maireana pyramidata*, emergents include *Casuarina pauper*, *Atalaya hemiglauca*, *Acacia aneura* and *Flindersia maculosa*. *M. astrotricha* is commonly mixed with *M. pyramidata* and becomes more common on shallower soils. *M. aphylla* may be locally co-dominant, especially in broad drainage lines.

Other species: Shrubs: *Senna artemisioides*, *Dodonaea viscosa* subsp. *angustissima*, *Eremophila sturtii*. Locally *Acacia victoriae* may be abundant. Locally there may be extensive invasion by *Lycium ferocissimum* and *Solanum glaucum*.

Interbush areas support a variety of forbs and grasses. Forbs: *Sclerolaena* spp., *Brachycome* spp., *Calotis* spp., *Helichrysum* spp., *Helipterum* spp. and *Medicago* spp. Grasses: *Stipa nitida*, *Enneapogon avenaceus*, *Eragrostis setifolia*, *Danthonia caespitosa*, *Aristida* spp., *Vulpia* spp., and *Bromus* spp. Annual species of *Atriplex* and *Sclerolaena* (especially *S. muricata*), *Eragrostis parviflora*.

Merges with: Other communities of sandplains (especially *Casuarina pauper–Alectryon oleifolius*) and *Atriplex vesicaria* on more clayey soils.

Map unit 37

Maireana pyramidata dwarf open-scrub

(Blackbush on loams and gibbers)

Geographic distribution: In the Barrier Ranges north of Broken Hill, and in the Noonthorangee Range west of White Cliffs.

Landforms: Rocky rises and ridges, extensive undulating plains of gibbers, adjoining slopes and associated broad drainage lines.

Soils: Self-mulching brown clays and red desert loams usually highly calcareous, often skeletal lithosols.

Structure: Dense to sparse low shrubs to 1.5 m high, frequently with emergent small trees.

Canopy species: *Maireana pyramidata*, *M. astrotricha* (especially near rock outcrops), *Atriplex vesicaria* ssp. *calcicola*, emergent *Casuarina pauper* and *Flindersia maculosa*.

Other species: *Astrebla lappacea*, and various annual *Sclerolaena* spp.

Merges with: Adjoining *Astrebla lappacea* grassland, and communities dominated by combinations of *Casuarina pauper* and *Flindersia maculosa* on gibber plains and slopes.

Map unit 38

Eragrostis australasica–Muehlenbeckia florulenta herbland

(Canegrass–Lignum)

Geographic distribution: Widespread across entire map area, always associated with drainage lines and depressions: for example, these areas include and are mapped for the Bulloo River overflow country, extensive areas along the Paroo River and associated tributaries, scattered occurrences south of Wilcannia and isolated patches near the Warrego River.

Landforms: Seasonally flooded alluvial plains with associated channels and depressions, seasonally flooded run-on areas and internally draining basins within sandplains.

Soils: Grey clays, sometimes self-mulching.

Structure: Dense to open herbland to 3 m tall, but often only 1 m tall. Height depends partially on flood frequency and also on previous management. May be emergent small trees and shrubs.

Eragrostis australasica forms dense almost impenetrable tussock grasslands to 2 m high. Plants are frequently partially submerged with water. During long droughts, the plants gradually die, becoming grey in colour and leaving persistent culms. Individuals of *Muehlenbeckia florulenta*, Lignum, grow 2–3 m tall, but are often much smaller. They form more or less globular, tangled bushes which may be isolated or contiguous. In the latter case, they may form almost impenetrable thickets.

Canopy species: *Eragrostis australasica*, *Muehlenbeckia florulenta*, *Atriplex nummularia*. Emergents *E. largiflorens*, *A. stenophylla*, and *E. ochrophloia*.

Other species: Various shrubs including *Eremophila bignoniiflora*, *Acacia salicina*, *Chenopodium nitrariaceum*, *C. auricomum*, and *Atriplex nummularia*. The rare grasses *Uranthoecium truncatum* and *Eriochloa australiensis* grow in pans with Canegrass–Lignum herbland when the pans are full of water.

Ground cover is normally dependent on the length of time since the depression held water. Various herbs colonise the depressions following the receding water: *Sclerolaena* spp., annual *Atriplex* spp., *Osteocarpum acropterum* var. *acropterum* and the fern *Marseilia drummondii*. Other herbs include *Centipida cunninghamii*, *Minuria cunninghamii*, *Agrostis avenaceua*, *Gnaphalium luteo-album*, *Eragrostis setifolia*, *Verbena supina*, *Sclerolaena muricata* and *Diplachne fusca*. The sedges *Eleocharis pallens* and *Schoenoplectus validus* are common.

Although the dominants require regular flooding, inundation for long periods will kill *Meuhlenbeckia florulenta* and convert the community into one of annual and ephemeral herbs until the next cohort of Lignum assumes dominance. In one example on the Paroo Overflow, Lignum was killed in the 1976 flood and has still not recolonised the plain.

Merges with: All communities bordering drainage lines and depressions on gentle slopes.

Map unit 39

Astrebla lappacea grassland

(Curly Mitchell Grass on floodplains)

Geographic distribution: These perennial grassland communities are widespread along the floodplains of the northern Darling River and tributaries.

Landforms: Low-lying areas subject to periodic flooding.

Soils: Grey clay soils.

Structure/main species: *Astrebla lappacea* forms dense often monospecific stands of tussock grass to 90 cm tall with an upright tufted habit (Fig. 16). It suffers from severe disturbance such as fire, drastic overgrazing and trampling. The seeds were used by Aborigines, who ground them to produce an edible paste. Mitchell grasses are important components of native grasslands and provide drought reserves for grazing.

Other species: These communities may be interspersed with *Atriplex vesicaria–Maireana pyramidata* communities and occasionally with *Acacia victoriae*. *Maireana aphylla* and *Chenopodium auricomum* may also be present. The communities are usually treeless, although they may intergrade with *Eucalyptus largiflorens* and *E. coolabah* subsp. *coolabah* communities.

Ground cover species include *Eragrostis setifolia*, *Dichanthium sericeum*, *Iseilema membranaceum*, *Aristida anthoxanthoides*, *Chloris truncata*, *Sclerolaena biflora*, *Sclerolaena divaricata*, *Helipterum uniflorum* and *Swainsona phacoides*.

This community sometimes grows in a mosaic with *Atriplex vesicaria* (Map unit 35). After a series of years of summer-dominated rainfall, the Mitchell Grass can become more prominent.

Map unit 40

Astrebla grassland

(Mitchell Grass on downs)

Geographic distribution: Discontinuous areas from north of White Cliffs to Tibooburra.

Landforms: Extensive stony and alluvial plains, low slopes, some gilgai areas.

Soils: Soils are typically red-brown sandy loams of the stony downs country. Some self-mulching brown clays.

Structure: Tussock grassland with marked seasonal variation. Considerable spatial variation on patterned ground of gilgais and associated rises.

Canopy species: *Astrebla pectinata* is the most common species, whilst *A. lappacea*, *A. elymoides* and *A. squarrosa* also occur but in decreasing order of abundance. Emergent *Maireana aphylla*, *M. pyramidata* and *Atriplex vesicaria* can occur.

Other species: Very wide range of ephemeral and annual species occurring after seasonal rain, especially *Sclerolaena* spp. After a series of summer-dominant rainfall years the Mitchell Grass predominates, but after a series of winter-dominant rainfall years chenopods may predominate. During the chenopod phase, *Atriplex* species such as *A. angulata*, *A. leptocarpa*, *A. conduplicata* and *A. lindleyi* become more obvious together with *Sclerolaena* spp. and *Osteocarpum* spp. (S. Jacobs pers. comm.)

Merges with: Other communities occurring on low angle slopes of gibber soils.

Map unit 41

Salt lakes

Geographic distribution: Discontinuously north and west from Cobar.

Landforms: Large and small lakes which retain water for long periods when filled, e.g. > 12–15 months (Fig. 17).

Soils: Varies from saline clays, which are often puffy as a result of high salt levels, to cracking clays with extensive crabholes.

Structure: The bases of depressions are generally bare. The margins have extremely variable communities depending on salinity, slope and period since last inundation. These are mainly seasonal herbland strand communities that follow the receding water line.

Canopy species: Extremely variable.

Other species: Characteristic species include *Heliotropium curassavicum*, *Mimulus repens*, *Morgania floribunda*, *Bergia ammanioides*, *Glinus ammannioides* and *Swainsona* spp. Some saline areas may have perennial shrubs of *Halosarcia* spp. and *Sclerostegia* spp. (S. Jacobs pers. comm.).

Merges with: *Eragrostis australasica–Muehlenbeckia florulenta* herbland and other communities of alluvial plains.

Figure 16. *Astrebla lappacea* grassland (Map unit 39). 30 km north-east of Tilpa (30° 22′ S 144° 15′ E).

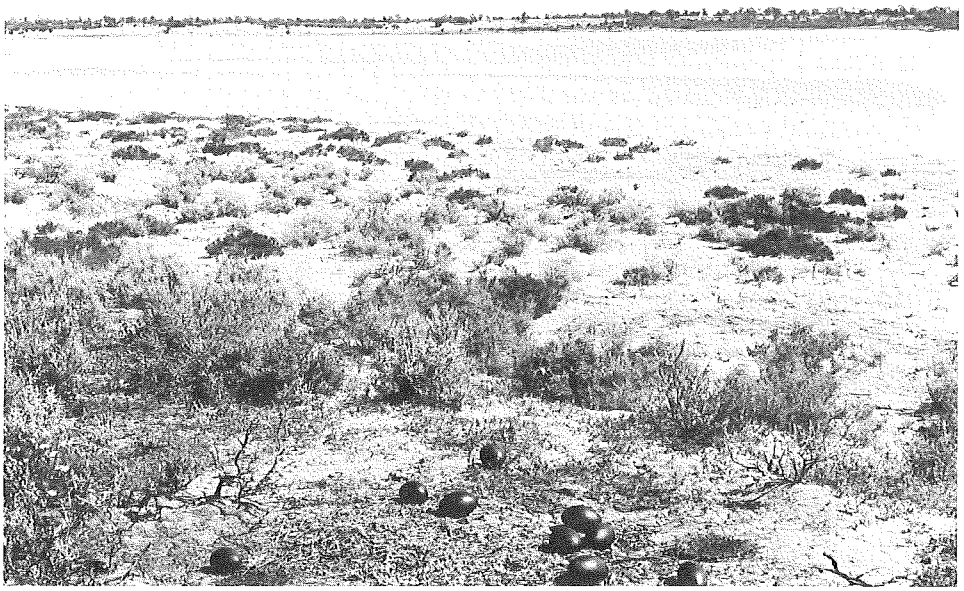


Figure 17. Salt lake communities (Map unit 41). The Salt Lake, approximately 100 km south of Tibooburra (30° 07′ S 142° 05′ E).

Artesian mound springs and *Eriocaulon carsonii*

By far the most unusual and rare habitats in the map area are the artesian mound springs on the eastern and western sides of Peery Lake east of White Cliffs. These springs are still flowing despite drawdown in artesian waters caused by a century of overuse and waste. The western springs are now unique in NSW because they have the only known population of the sedge *Eriocaulon carsonii*. This species is restricted to a single mound on the western side of Peery Lake. Nearby are numerous other apparently similar mounds which do not support the plant. The springs have been heavily used for European management for over 100 years and are heavily grazed by domestic and feral stock. At least one spring was tapped for a permanent water supply, but this is now derelict. The mound with *E. carsonii* is submerged by the waters of Peery Lake for up to 18 months, apparently without harm (Pickard 1992 a, b, c, d).

Management proposals in Pickard (1992 b) include fencing off the springs with stainless steel wire and posts to minimise damage to the fence from rusting when the lake is full, and sinking a new bore to replace the springs as a water source. Another recommendation suggests research into propagation of the plant. The recommended program involves the grazier as an integral component of the plan.

A survey of all mound springs in the Western Division (Pickard 1992 d) indicates that very few are suitable habitat for introducing *E. carsonii*. Indeed, there is no evidence that the plant ever occurred on any other spring except the now extinct Wee Watta Spring north-west of Tilpa.

Conservation areas

Since European settlement virtually all of the Western Division has been subjected to the trampling of hard-footed stock or feral animals and the grazing and browsing of these introduced herbivores (Denny 1987, Benson 1988, 1991, Mitchell 1991, Morgan & Terrey 1992, National Parks Association of NSW 1988, Pressey 1990, Pressey et al. 1990).

Most of the land in the Western Division is publicly-owned leasehold administered by the Western Lands Commission. However, some portions come under the control of the NSW National Parks & Wildlife Service and the Forestry Commission of NSW.

National Parks, Nature Reserves and Historic Sites

The National Parks and Wildlife Service of New South Wales administers three National Parks, nine Nature Reserves and two Historic Sites within the map area where adequate conservation of the plant and animal communities is ensured (Fig. 15). The total area of these (Table 2) is approximately 721,440 ha, representing 2.7% of the map area.

Forest Preserves

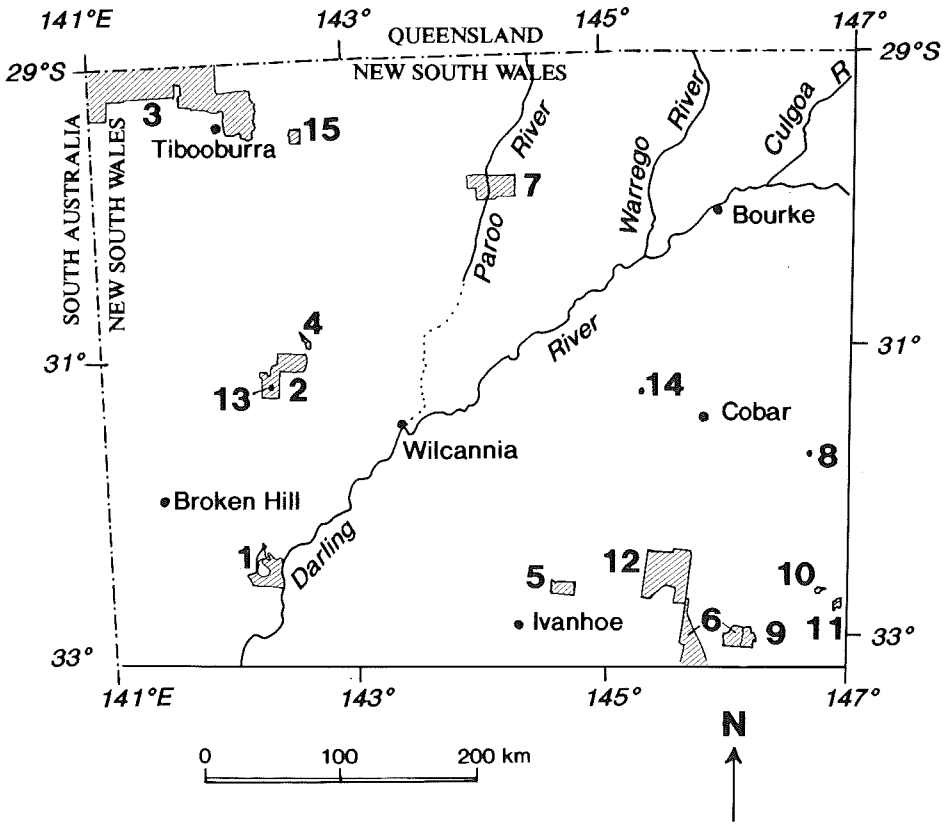
Forest Preserves are under the control of the Forestry Commission of New South Wales. The tenure of Forest Preserves has no legislative backing, whereas Flora Reserves can only be revoked by an Act of Parliament. Until Forest Preserves are established as Flora Reserves their conservation is not guaranteed.

Scrubby Mountain Forest Preserve (F.P. No. 252 in Balowra State Forest) in the Cobar district is the only Forest Preserve within the map area. It comprises sedimentary stony hills and carries *Callitris glaucophylla* associated with *Eucalyptus populnea* subsp. *bimbil*, *Eucalyptus intertexta*, *Eucalyptus sideroxylon* and *Eucalyptus microcarpa* (narrow-leaved form), plus the mallee species *Eucalyptus socialis*, *Eucalyptus dumosa*, *Eucalyptus viridis* and *Eucalyptus morrisii*. The area has had little human disturbance for a long period (Forestry Commission of NSW 1989).

Table 2. National Parks, Nature Reserves and Historic Sites within the map area (data from Property Services, NPWS, Sydney)

	Name	Area (ha)
National Parks (NP)	1. Kinchega NP	44,182
	2. Mootwingee NP	68,912
	3. Sturt NP	310,634
Nature Reserves (NR)	4. Coturaundee NR	6,688
	5. Kajuligah NR	13,660
	6. Nocoleche NR	74,000
	7. Nombinnie NR	70,000
	8. Quanda NR	854
	9. Round Hill NR	13,630
	10. Tollingo NR	3,232
	11. Woggoon NR	6,565
	12. Yathong NR	107,240
Historic Sites (HS)	13. Mootwingee HS	486
	14. Mount Grenfell HS	1,357
Total area		**721,440**

Figure 18. Location of National Parks, Nature Reserves, Historic Sites and Aboriginal Area.



National Parks 1. Kinchega; 2. Mootwingee; 3. Sturt: **Nature Reserves** 4. Coturaundee; 5. Kajuligah; 6. Nombinnie; 7. Nocoleche; 8. Quanda; 9. Round Hill; 10. Tollingo; 11. Woggoon; 12. Yathong: **Historic Sites** 13. Mootwingee; 14. Mount Grenfell. **Aboriginal Area** 15. Pindera Downs.

Potential problems in vegetation management

Grazing by domestic stock

Grazing started in the Western Division in the 1850s and has continued to the present. There is no doubt that grazing, past and present, is the single most important influence on the landscape. The magnitude of the impact cannot be overstated. Further, given that the bulk of the land is leased in perpetuity for grazing, the future of the landscape is intimately tied to future grazing management. This has important implications for conservation and is discussed further below. There is abundant evidence that current levels of grazing continue to have detrimental effects on the vegetation. Before considering the arguments advanced to support this assertion, it is necessary to briefly review changes in the vegetation, environment and management of the area. The information presented includes summarised field evidence collected between Wilcannia and White Cliffs (Pickard 1990a, 1990b, 1991a, 1991b, 1994, in press b).

The first graziers to settle the semi-arid rangelands found what they considered to be limitless feed. The only restriction to their operations was water. Once they augmented the few permanent waterholes with dams and wells, they simply kept on increasing

stock numbers. At the same time, seasons continued with good rainfall. Unfortunately, the graziers had confused high standing biomass with high productivity. The low productivity of the vegetation was unable to cope, and the enormous numbers of stock led to widespread devastation of vegetation, erosion, and siltation. At the same time, economic depression wiped out the markets for wool. The net result was both ecological and financial ruin (Royal Commission 1901). At the end of the 19th century, stock numbers had fallen from their peak, never to rise to such heights again.

For the next several decades, the landscape bore the scars of the pioneers' management: enormous scalds, dust storms, little regeneration, etc. (Holmes 1938, Beadle 1948). Seasons were generally poor, with low rainfall. The landscape and the vegetation continued in the state left by the damage of the 19th century.

After the Second World War, things changed: higher rainfall, better financial returns, more investment in improvements, more intensive management, better transport systems, and for the first time, effective control of rabbits. At the same time, the landscape began to heal: scalds reduced in number and area, dust storms receded and some regeneration occurred (Condon 1986, Palmer 1991). That these changes have occurred is not open to dispute; but the cause is, and this is quite critical to the future management of the vegetation. There are three main arguments presented to account for the changes.

The first, and the argument most favoured by graziers, is that management has improved enormously since World War II and with more watering points and fences, and with control of rabbits, grazing has less impact than previously (Palmer 1991). Even acknowledging the benefits of rabbit control, the other factors in this argument are difficult to support when all available evidence is examined (Pickard 1991c, 1994). There is still very little or no regeneration of palatable shrubs over enormous areas.

The second argument, supported only by Condon (1986), asserts that changes in legislation and administration of the land through closer settlement is the main cause. There is very little evidence to support this claim.

The third argument suggests that increased rainfall since 1947 has been the primary factor with secondary assistance from rabbit control. This accounts for the fact that stock numbers over large areas have increased since then at the same time that scalds have regenerated naturally. This would only be possible if there was more feed to support the stock (Pickard 1990a, 1994).

This debate is crucial to the future of the vegetation. The root of the disagreement lies in what is considered acceptable damage to the landscape, and what levels of stocking are acceptable. It is likely that many graziers are unaware of the more subtle changes that have taken place. Everyone can see, recognise and understand the impact of scalds and "woody weed" invasion. But how many graziers are aware that losing the top 5 cm of soil in *Acacia aneura* shrubland results in the loss of the bulk of the nutrients (Pressland et al. 1988)? A soil loss of 5 cm would not be detected by most graziers. Yet this is the magnitude of loss that probably still occurs as a consequence of grazing at currently accepted levels in the Western Division.

Although overstocking is prohibited under the Western Lands Act (s. 18D 1 v), there were numerous examples of overstocking during the 1991–1992 drought. Anecdotes relate how thousands of sheep died from starvation. This will only occur if there is no feed available: by definition, this is overgrazing. However, while this may have a severe and long-lasting impact on the soil through erosion and sedimentation, its impact on vegetation may be exaggerated (see below).

The impact of herbivores is not uniform across the semi-arid landscape. Favoured areas of high productivity are grazed more heavily. These areas probably supported the highest populations of native fauna before European settlement (Stafford Smith &

Morton 1990). The disruption and destruction of these habitats has had serious impacts on fauna (Morton 1990).

Regeneration of palatable canopy species

Traditionally it is assumed that present grazing is relatively benign compared to grazing at the end of the 19th century. Proponents of this view argue that the vegetation was devastated by vast numbers of stock to generate enormous profits for rapacious absentee owners (Palmer 1991). However, as noted above, palatable shrubs are not regenerating over most of the map area. Thus current grazing levels are too high to guarantee the long-term future of most of the vegetation (Pickard in press b). Consequently, unless there are fundamental changes in grazing regimes, it is not possible to guarantee long-term survival of the vegetation and landscape. Effects of present (and past) regimes on native fauna (both vertebrate and invertebrate) are also significant and of course relevant to vegetation and ecosystems at large.

It is crucial to realise that rainfall has essentially no influence on the outcome, and that these are not seasonal effects to be dismissed by graziers and their organisations with assertions such as: "It's the drought mate. This is good country. She always comes back after decent rain." There is abundant evidence to show that these are long-term effects over decades covering both good as well as bad seasons. Three examples will suffice here. For others, see the studies quoted in Pickard (1991c). Over at least three decades, *Acacia papyrocarpa* has only regenerated in semi-arid South Australia where seedlings are protected from both sheep and rabbits. *Casuarina pauper* and *Alectryon oleifolius* did not regenerate in south-western NSW despite heavy rains in the 1970s. The available evidence suggests that rabbits and sheep are eliminating all young plants.

Current damage to the flora and vegetation is independent of rainfall. The common link over a wide geographic range is grazing by sheep and feral animals, especially rabbits. The root cause is too many herbivores trying to survive on low-productivity land. Consequently, grazing at currently accepted and acceptable levels is the single major problem facing semi-arid Australia (Pickard in press b).

The basic issue with grazing management is simple and can be reduced to very few words: too little feed, too many mouths. Like many environmental problems, the technical aspect of the solution is trivial: reduce the number of mouths. But because of a complex web of personal, financial and political reasons, the social aspects of the solution appear intractable.

There is now increasing evidence that comparatively low stocking rates actually increase net income while encouraging land regeneration (Purvis 1986, Morrissey & O'Connor 1988). The impact of so-called 'minimal stocking rate' systems on conservation values is unknown. However, vegetation does regenerate with these systems, and as vegetation forms the basis of the food chain for most animals, the systems are worth investigating.

In any event, there is no doubt that only a financially secure grazier can afford to be worried about conservation of non-income producing components of the landscape. Therefore it is essential to quantify these impacts over a range of environments.

Currently, the solution appears to lie in 'minimal stocking rate' grazing systems that have been developed by graziers (Purvis 1986, Morrissey & O'Connor 1988). While these have been shown to generate more income for the grazier, their impact on conservation of the landscape is unknown.

"Woody weeds"

Substantial increases in numbers and density of several species have earned them the pejorative expression "woody weeds": unpalatable native shrubs (e.g. *Senna artemisioides, Dodonaea viscosa* ssp. *angustifolia, Dodonaea viscosa* ssp. *angustissima, Eremophila mitchellii, Eremophila sturtii*). It is generally accepted that these are a form of land degradation because they lower production in terms of sheep, wool, lambing percentages, and profitability (Burgess 1988). While there is some evidence that soil erosion may be higher in dense stands of "woody weeds", there is very little evidence that they are causing any problem with respect to biodiversity.

It is generally considered that "woody weeds" have increased in density because of the lack of regular fire. Domestic stock have removed all the available biomass (fuel) and thus there are now fewer fires than before European settlement (Booth 1985). Thus the plants are responding to a radically changed environment, and are a consequence of grazing. (There is growing field and experimental evidence in Texas, USA, that similar species there are responding to increased CO_2 levels in the atmosphere since the mid-19th century (Johnson et al. 1992, Mayeux et al. 1992, Bahre 1991). If this is the case, then "woody weeds" are in fact, the new vegetation of a large proportion of the semi-arid landscape.)

Environmental weeds

Many exotic plants occur in the map area, but only a relatively small number can be regarded as serious invaders. Perhaps the most serious environmental weed (Humphries 1992) is *Prosopis* spp. (Mesquite). The spiny shrub is mainly located from Broken Hill north to Packsaddle, but has also been recorded from the floodplain of the Darling River southeast of Wilcannia. However, the species occupies hundreds of square kilometres in the upper catchment of the Paroo River in Queensland. Seeds will be carried downstream by floods and will eventually spread into the lower Paroo in New South Wales. Once established, the plant forms dense impenetrable thickets in all suitable habitats. Creek lines and alluvial plains are favoured habitats. As seeds last up to 40 years in the soil, once the species occurs in an area, it is almost impossible to eradicate. *Prosopis* is (barely) controlled with herbicides and is currently listed nationally as a target for biological control.

Lycium ferocissimum (African Boxthorn) is widespread on scalded plains east of White Cliffs, near Ivanhoe and elsewhere, and often close to old watering points on sandplains. The spiny shrub spreads via seeds in bird droppings and in flood debris. Once established, it can form dense thickets, but plants are killed by prolonged droughts (e.g. 1991–1992 drought). When abundant, the plant completely changes the structure of the vegetation. Thus, low open-shrublands of *Maireana* spp. are transformed into *Lycium* Open-shrublands. *Lycium* may have some value as a nesting site for small birds which appear to find shelter from predators in the dense spiny shrubs, and even when dead, the shrubs afford considerable protection.

Xanthium spinosum (Bathurst Burr) and *Carthamus lanatus* (Saffron Thistle) are widespread roadside weeds spreading into suitable sites. *Xanthium* is generally restricted to wetter areas, such as ephemeral creeks. In favourable (wet) seasons, local populations may be extremely dense, and set abundant seed to maintain the infections. In contrast, *Carthamus* is more widespread in drier sites and has been gradually spreading in the area for the past few decades. It is most often seen as dead plants, but the seeds are very long-lived and thus, once established, the plant can quickly appear from seeds in the soil when suitable moisture conditions prevail. Currently there is virtually no systematic attempt at controlling either species. Given the relative values of the land, cost of control, and anticipated benefits from control, concerted efforts at control are unlikely.

Conservation options for future management of the vegetation

Alternative approaches to vegetation management for conservation

In the Western Division the approach of the NSW National Parks and Wildlife Service has been to acquire land with perceived high conservation values, though some land has been acquired merely because it was vacant. An important aim is to have one sample of every land system in a formal reserve. This is one of the most popular objectives of conservationists, but is probably politically unlikely (Pressey & Nicholls (1989). For this, and other cogent reasons, it is apparent that formal conservation areas need to be complemented by off-reserve conservation procedures to achieve goals of environmental conservation. Such procedures include negotiating agreements with landholders whose land covers sites deemed to be of high conservation value — for example the proposals recommended to conserve the rare *Eriocaulon carsonii* discussed above. Such negotiations could conclude with a range of measures that satisfy both the conservation objectives and the aspirations of the landholder: formal contracts, informal agreements, covenants on titles, and combinations of these. The landholder should be compensated in an appropriate manner for foregone income.

However, the implications of the findings of Pressey & Nicholls (1989) should be noted. Piecemeal attempts at reserving examples of environments are not the best approach. Instead all options for the Western Division need to be addressed as a whole. There are problems with this. When the National Parks and Wildlife Service seeks to purchase properties in the Western Division, particularly during periods of rural depression, it is perceived by remaining graziers as being opportunistic. Interestingly, other purchasers would not be regarded in this light, demonstrating a double standard among graziers. Further, potential problems caused by graziers being financially unable to maintain improvements over the past few years have been ignored by neighbours. As soon as the Service acquired any land, these would immediately jump to prominence and may be considered the fault of the Service. There are no easy solutions to these problems. They are merely the corollary of acquiring land for environmental conservation.

Currie & Hacker (1990) argue that in arid Western Australia grazing may be compatible with conservation. There is however a dearth of relevant information on the impact of different grazing systems and styles of management on the vegetation of semi-arid NSW. Some semi-arid lands in South Australia are currently managed for multiple uses; grazing, recreation, mining and conservation (Cohen 1990). Experience to date has been promising despite some initial problems. Legislation in the United States requires multiple use of Federal land for grazing, logging, recreation and conservation (Clawson 1983). In principle, each parcel is considered to determine which use should be given priority. In practice, existing grazing use is often given preference (Jacobs 1991).

Combining these arguments with those expounded earlier, it is clear that successful off-reserve conservation is predicated on both successful negotiations (every party wins and achieves their own goals), and landscape management that is sensitive to conservation objectives. In general terms it is known (and accepted by most graziers, and all agencies) that excessively heavy grazing leads to land degradation; soil erosion, vegetation structure changes, and perhaps "woody weed" invasion. What is not so widely accepted is that grazing levels that are currently considered to be safe are also causing land degradation (Pickard 1991a, c).

Before being involved in off-reserve conservation on their properties, graziers need to be convinced that they will not suffer financially. As the normal approach suggested is to lower stocking rates, this does not appear very convincing to many graziers

(Pickard in press b). However, there is now increasing evidence that comparatively low stocking rates actually increase net income while encouraging land regeneration (Purvis 1986, Morrissey & O'Connor 1988). The impact of these 'minimal stocking rate' systems on conservation values is unknown but it is essential to quantify these impacts over a range of environments.

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References

Allen, R.H. (1980) Aborigines of the western plains of New South Wales. *Parks and Wildlife* 2:33–42.

Australian Bureau of Statistics (1991) Estimated Resident Population of Statistical Local Areas, New South Wales, at 30th June, 1989 Final and 1990 Preliminary.

Australian Water Resources Council (1972) Hydrology of smooth plainlands of arid Australia. *Hydrological Series* No. 6. (Australian Government Publishing Service: Canberra).

Bahre, C.J. (1991) A *legacy of change. Historic human impact on vegetation of the Arizona borderlands.* (University of Arizona Press: Tucson).

Bailey, A. (ed.) (1984) *The brigalow belt of Australia.* (Royal Society of Queensland).

Beadle, N.C.W. (1948) *The vegetation and pastures of western New South Wales with special reference to soil erosion.* (Government Printer: Sydney).

Beadle, N.C.W. (1981a) *Vegetation of Australia.* (Cambridge University Press: Melbourne).

Beadle, N.C.W. (1981b) Forty years ago. *Cunninghamia* 1: 1-6.

Beard, J.S. (1974) *Great Victoria Desert. Vegetation Survey of Western Australia 1:1 000 000 Vegetation Series.* (University of Western Australia Press: Nedlands).

Beard, J.S. & Webb, M.J. (1974) *Great Sandy Desert. Vegetation Survey of Western Australia 1: 1 000 000 Vegetation Series.* (University of Western Australia Press: Nedlands).

Beetson, G.R., Walker, P.J., Purdie, R. & Pickard, J. (1980) Plant communities of the poplar box (*Eucalyptus populnea)* lands of eastern Australia. *Australian Rangeland Journal* 2(1): 1–16.

Benson, J.S. (1988) Conservation of flora in western New South Wales. *National Parks Journal* 32(3): 16–22.

Benson, J.S. (1991) The effect of 200 years of European settlement on the vegetation and flora of New South Wales. *Cunninghamia* 2(3): 343–370.

Booth, C.A. (1985) *Woody weeds: their ecology and control.* (Soil Conservation Service of NSW: Sydney).

Boyland, D.E. (1974) Vegetation. In Western arid region land use study — part 1. *Division of Land Utilisation Tech. Bulletin No.12.* (Queensland Dept. of Primary Industries: Brisbane).
Boyland, D.E. (1984) Vegetation survey of Queensland — south-western Queensland. *Queensland Botany Bulletin* No. 4. (Queensland Dept. of Primary Industries: Brisbane).
Bowler, J.M. (1971) Pleistocene salinities and climatic change: evidence from lakes and lunettes in south-eastern Australia. In Mulvaney, D.J. & Golson, J. (eds), *Aboriginal man and environment in Australia* (ANU Press: Canberra)
Bureau of Meteorology (1988) *Climatic Averages: Australia.* (Australian Government Publishing Service: Canberra).
Burgess, D.M.N. (1988) The economics of prescribed burning for shrub control in the semi-arid woodlands of north-west New South Wales. *Australian Rangeland Journal* 10: 48–59.
Burrell, J.P. (1973) Vegetation of Fowlers Gap Station. In Lands of Fowlers Gap Station, New South Wales. J.A. Mabbutt (ed.) *University of NSW Research Series* No.3: 175–195.
Cambage, R.H. (1900a) Notes on the botany of the interior of New South Wales. I. From the Darling River at Bourke to Cobar. *Proceedings of the Linnean Society of NSW* 25: 591–604.
Cambage, R.H. (1900b) Notes on the botany of the interior of New South Wales. II. From Cobar to the Bogan River above Nyngan. *Proceedings of the Linnean Society of NSW* 25: 708–720.
Clawson, M. (1983) *The federal lands revisited.* (Resources for the Future: Washington).
Cohen, B. (1990) Reconstruction of South Australia's arid lands: the conservation option. *Proceedings of the Ecological Society of Australia* 16: 459–465.
Collins, M.I. (1923) Studies in the vegetation of arid and semi-arid New South Wales. I — the plant ecology of the Barrier District. *Proceedings of the Linnean Society of NSW* 48: 229–266.
Collins, M.I. (1924) Studies in the vegetation of arid and semi arid New South Wales. II — the botanical features of the Grey Range and its neighbourhood. *Proceedings of the Linnean Society of NSW* 49: 1–18.
Condon, R.W. (1976) History of administration of the Western Division. *Agricultural Gazette of N.S.W.* 87: 2–5.
Condon, R.W. (1986) Recovery of catastrophic erosion in western New South Wales. In Joss, P.J., Lynch, P.W. & Williams, O.B. (eds) (1986) *Rangelands: a resource under siege.* (Cambridge University Press: Cambridge).
Cunningham, G.M. & Milthorpe, P.L. (1981) The vascular plants of five exclosure sites in western New South Wales. *Cunninghamia* 1: 23–34.
Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. & Leigh, J.H. (1981) *Plants of Western New South Wales.* (Government Printer: Sydney).
Currie, P.J. & Hacker, R.B. (1990) Can pastoral grazing management satisfy endorsed conservation objectives in arid Western Australia? *Journal of Environmental Management* 30: 295–320.
Dalton, K.L. (1988) A review of information relevant to the Downs Country of far western New South Wales. *Soil Conservation Service of NSW Technical Report* No. 11.
Dawson, N.M. & Boyland, D.E. (1974). Western arid region land use study — part 1. *Division of Land Utilisation Tech. Bulletin No.12.* (Queensland Dept. of Primary Industries: Brisbane).
Denny, M. (1987) *Historical and ecological study of the effects of European settlement in inland NSW.* Report by the Nature Conservation Council of New South Wales to the Heritage Council of New South Wales.
Eldridge, D.J. (1988) Soil-landform and vegetation relations in the chenopod shrublands of western New South Wales. *Earth Science Reviews* 25: 493–499.
Forestry Commission of NSW (1989) Forest preservation in state forests of New South Wales. *Research Note* no 47.
Fox, M.D. (1991) The natural vegetation of the Ana Branch — Mildura 1: 250 000 map sheet (New South Wales). *Cunninghamia* 2(3): 443–494.
Gentilli, J. (ed) (1971) Climates of Australia and New Zealand. *World survey of climatology.* Vol 13. (Elsevier Publishing Company: Amsterdam).
Geological Survey of NSW (1972) *Geology of New South Wales.* 1:1 000 000 Map.
Groves, R.H. (ed.) (1981) *Australian vegetation.* (Cambridge University Press: Cambridge).
Harden, G.J. (ed.) (1990–1993) *Flora of New South Wales* Vols.1–4 (New South Wales University Press: Sydney).
Harris, C.R. 1989. The history of mallee land use: Aboriginal and European. In: J.C. Noble, P.J. Joss & G.K. Jones *The mallee lands — a conservation perspective.* Proceedings of the National Mallee Conference, CSIRO.
Haviland, F.E. (1911) Notes on the indigenous plants in the Cobar district. *Proceedings of the*

Linnean Society of NSW 36: 507–540.
Haviland, F.E. (1913) Notes on the indigenous plants in the Cobar district. No ii. *Proceedings of the Linnean Society of NSW* 38: 639–655.
Hill, K.D. (1989) Mallee eucalypt communities: their classification and biogeography. In: J.C. Noble & R.A Bradstock (eds) *Mediterranean landscapes in Australia — mallee ecosystems and their management*. (CSIRO Publications: East Melbourne).
Holmes, J.M. (1938) The erosion-pastoral problem of the Western Division of New South Wales. *University of Sydney Publications in Geography* 2: 1–51.
Humphries, S.E. (1992) Plant invasions: The incidence of environmental weeds in Australia. *Kowari* 2: 1–134.
Irons, N.M. & Quinlan, E.E. (1988) A review of information relevant to the Mulga rangelands of western New South Wales. *Soil Conservation Service of New South Wales Technical Report* No. 5.
Isbell, R.F. (1962) Soils and vegetation of the Brigalow Lands of Eastern Australia. *CSIRO Soils and Land Use Series* No. 43.
Iwaszkiewicz, A. & Semple, W.S. (1988) A review of information relevant to the Bimble Box-Pine and associated rangelands of western New South Wales. *Soil Conservation Service of N.S.W. Technical Report* No. 6.
Jacobs, L. (1991) *Waste of the west: public lands ranching*. (Lynn Jacobs: Tucson).
James, J.W. (1960) Erosion survey of the Paroo–Upper Darling region. Part III — Vegetation. *Journal Soil Conservation Service NSW* 16: 185-206.
Johns, G.G., Tongway, D.J. & Pickup, G. (1984) Land and water processes. In *Management of Australia's rangelands*. (CSIRO Division Wildlife and Rangelands Research: East Melbourne).
Johnson, H.B., Polley, W.P. & Mayeux, H.S. (1992) Increasing CO_2 and plant–plant interactions: effects on natural vegetation. *Vegetatio* **, 1–16.
Johnson, R.W. (1984) Flora and vegetation of the Brigalow Belt. In: A. Bailey (Ed.) *The brigalow belt of Australia*. (Royal Society of Queensland: Brisbane).
King, C.J. (1957) An outline of closer settlement in New South Wales. Part 1 — The sequence of the land laws 1788–1956. *Review of Marketing and Agricultural Economics* 25:9–29.
Lawrie, J.W. (1976) Landforms, soils and erosion. *Agricultural Gazette of New South Wales* 87(3):13–15.
Lawrie, J.W. (1991) Soils and erosion. In: P.L. Milthorpe *et al.* Lands of the north-west corner of NSW. *Soil Conservation Service of NSW. Technical Report* No.12.
Mabbutt, J.A. (1973) Historical background. In *Lands of the Fowlers Gap Station, New South Wales*. J.A. Mabbutt & M.E. Sullivan (eds) Fowlers Gap Arid Zone Research Station, Research Series No.3 (University of New South Wales: Kensington).
MacGillivray, W. (1923) A trip to the north and north-west from Broken Hill. *Victorian Naturalist* 39: 131–142.
Mayeux, H.S., Johnson, H.B. & Polley, H.W. (1992) Global change and vegetation dynamics. Chapter 7, pp. 62–74 in James, L.F., Evans, J.O., Ralphs, M.H & Child, R.D. (eds) *Noxious range weeds*. (Westview Press: Boulder).
McTainsh, G.H., Burgess, R. & Pitalbo, J.R. (1989) Aridity, drought and dust storms in Australia (1960-84). *Journal of Arid Environments* 16: 11–22.
Milthorpe, P.L. (1972) Vegetation of the Fowlers Gap–Calindary Area. In *Lands of the Fowlers Gap–Calindary Area, New South Wales*. Fowlers Gap Arid Zone Research Series No. 4. University of New South Wales.
Milthorpe, P.L. (1991) Lands of the north-west corner of New South Wales. *Soil Conservation Service of NSW Technical Report* No. 12.
Mitchell, P.B. (1991) Historical perspectives on some vegetation and soil changes in semi-arid New South Wales. *Vegetatio* 91:169–182.
Mitchell, T.L. (1838) *Three expeditions into the interior of eastern Australia* ... (T. & W. Boone: London).
Moore, C.W.E. (1986) Annotated checklist of the vascular plants in part of north-western New South Wales. *CSIRO Technical Memorandum* 84/30. (Institute of Biological Resources, Division of Water and Land Resources: Canberra).
Morcom, L. (No date) Expedition Sturt May 1988 Sturt National Park, New South Wales. Botany Group Report. Australian & New Zealand Scientific Exploration Society.
Morgan, G. & Terrey, J. (1992) *Nature conservation in western New South Wales* (National Parks Association of New South Wales Inc.: Sydney).
Morris, A. (1939) Plant regeneration in the Broken Hill district. *Australian Journal of Science* 2: 32–38.

Morris, A. (1966) *Plantlife of the West Darling*. (Barrier Field Naturalists Club).
Morrissey, J.G. and O'Connor, R.E.Y. (1988) 28 years of station management. Paper presented to 5th Biennial Conference of the Australian Rangeland Society, Longreach, Queensland.
Morton, S.R. (1990) The impact of European settlement on the vertebrate animals of arid Australia: a conceptual model. *Proceedings of the Ecological Society of Australia* 16: 201–213.
National Parks Association of NSW (1988) Nature conservation in western New South Wales. Special Issue. *National Parks Journal* 32(3).
National Parks & Wildlife Service (1982) Submission to joint select committee enquiry on the Western Division of New South Wales.
Neldner, V.J. (1984) *Vegetation survey of Queensland: South central Queensland*. Queensland Botany Bulletin No 3. (Queensland Dept of Primary Industries).
Noble, J.C. (1982) The significance of fire in the biology and evolutionary ecology of mallee *Eucalyptus* populations. In W.R. Barker & P.J.M. Greenslade (eds) *Evolution of the flora and fauna of arid Australia* (Peacock Publications: Adelaide).
Noble, J.C. (1984) Mallee. In G.N. Harrington, A.D. Wilson & M.D. Young *Management of Australia's rangelands* (CSIRO Division of Wildlife and Rangelands Research: Melbourne).
Noble, J.C., Joss, P.J. & Jones G.K. (eds) (1990) *The mallee lands — a conservation perspective*. CSIRO.
Packham, G.H. (1969) *The geology of New South Wales*. (Geological Society of Australia: Sydney).
Palmer, D. (1991) Western New South Wales — a miracle of recovery. *Australian Journal of Soil and Water Conservation* 4: 4–8.
Parson, A. (1990) Conservation and ecology of riparian communities in the Murray–Darling Basin, New South Wales. Annotated Bibliography — Preliminary version 2. (Unpubl. report National Parks & Wildlife Service: Sydney)
Parson, A. (1991) Conservation and ecology of riparian communities in the Murray–Darling Basin, New South Wales. Review Draft January 1991. (Unpubl. report National Parks & Wildlife Service: Sydney).
Pickard, J. (1983) Vegetation of Lord Howe Island. *Cunninghamia* 1(2): 133–266.
Pickard, J. (1990a) Analysis of stocking records from 1884 to 1988 during the subdivision of Momba, the largest property in semi-arid New South Wales. *Proceedings of the Ecological Society of Australia* 16: 245–253.
Pickard, J. (1990b) Attitudes and environmental use and management in the forgotten 70% of Australia. *Australian Zoologist* 26: 54–58.
Pickard, J. (1991a) Land management in semi-arid environments of New South Wales. *Vegetatio* 91: 191–208.
Pickard, J. (1991b) Quaternary studies and land rehabilitation in semi-arid New South Wales; or when is a scald not a scald? In Brierley, G. & Chappell, J.M.A. (eds) *Applied Quaternary studies*. (Department of Biogeography and Geomorphology, Australian National University: Canberra).
Pickard, J. (1991c) Sheep and rabbits: the biological chainsaws. *Search* 22: 48–50.
Pickard, J. (1992a) Recovery plan research phase. *Eriocaulon carsonii*. Final report on contract with NSW National Parks & Wildlife Service.
Pickard, J. (1992b) Conservation recovery plan, management phase. *Eriocaulon carsonii*. Final report on contract with NSW National Parks & Wildlife Service.
Pickard, J. (1992c) Conservation research statement. *Eriocaulon carsonii*. Final report on contract with NSW National Parks & Wildlife Service.
Pickard, J. (1992d) Mound springs of the Western Division of New South Wales. Graduate School of the Environment Occasional Paper, Macquarie University.
Pickard, J. (1993) Western New South Wales — increased rainfall and not a miracle leads to recovery. *Australian Journal of Soil and Water Conservation* 6(4): 4–9.
Pickard, J. (1994) Post-European changes in creeks of semi-arid rangelands, "Polpah Station", New South Wales. In Millington, A.C. & Pye, K. (eds) *Effects of environmental change in drylands*. (John Wiley: London), p. 271–283.
Pickard, J., (in press a). Do old survey plans help us discover what happened to western New South Wales when Europeans arrived? *Australian Zoologist*.
Pickard, J. (in press b) Land degradation and conservation in the semi-arid zone of Australia: grazing is the problem ... and the cure. in Moritz, C. (ed) *Conservation biology in Australia and Oceania* (Surrey Beatty: Chipping Norton).
Pickard, J. & Boyland, D.E. (1981) Comparison of three small-scale (1:1 000 000) vegetation

mapping techniques. In A.N. Gillison & D.J. Anderson (eds) *Vegetation classification in Australia*. (CSIRO: Canberra).
Pittock, A.B. (1981) Long term climatic trends in eastern Australia. pp. 23–39 in de Krantzow, D.R. & Sutton, B.G. (eds) (1981) *Cropping at the margin: potential for overuse of semi-arid lands*. Australian Institute of Agricultural Science Symposium Series No 1.
Porteners M. (1993) The natural vegetation of the Hay Plain: Booligal–Hay and Deniliquin–Bendigo 1:250 000 maps. *Cunninghamia* 3(1): 1–122.
Pressey, R.L. (1990) Clearing and conservation in the Western Division. *National Parks Journal* 34(6): 16–24.
Pressey, R.L. and Nicholls, A.O. (1989) Application of a numerical algorithm to the selection of reserves in semi-arid New South Wales. *Biological Conservation* 50: 263–278.
Pressey, R.L., Cohn, J.S. & Porter, J.L. (1990) Vascular plants with restricted distributions in the Western Division of New South Wales. *Proceedings of the Linnean Society of NSW* 112: 213–233.
Pressland, A.J., Mills, J.R. & Cummins, V.G. (1988) Landscape degradation in native pasture. In Burrows, W.H., Scanlan, J.C. & Rutherford, M.T. (eds) (1988) *Native pastures in Queensland. The resources and their management*. (Queensland Department of Primary Industries Information Series Q187023) 174–197.
Pulsford, I.F. (1984) Conservation status of Brigalow in New South Wales. In A. Bailey (ed.) *The brigalow belt of Australia*. (Royal Society of Queensland: Brisbane).
Purvis, J.R. (1986) Nurture the land: my philosophies of pastoral management in central Australia. *Australian Rangeland Journal* 8: 110–117.
Reynolds, S.T. (1985) Sapindaceae (excluding *Dodonaea* and *Diplopeltis*). Flora of Australia 25: 4–164.
Royal Commission (1901) *Royal Commission to inquire into the condition of the crown tenants of the Western Division of New South Wales*. 2 volumes (Legislative Assembly of New South Wales: Sydney).
Sattler, P.S. (ed.) 1986. *The mulga lands: Proceedings of a Symposium*. (Royal Society of Queensland: Brisbane).
Scott, J.A. (1992) The natural vegetation of the Balranald–Swan Hill area. *Cunninghamia* 2(4): 597–652.
Semple, W.S. & Irons, N.M. (1989) The Rangeland Review Program: A computerised listing of references pertaining to the rangelands and rangeland plants of western New South Wales. *Soil Conservation Service of New South Wales Technical Report* No. 19.
Soil Conservation Service of NSW (various dates) *1:250 000 Land System Series* . Sheets: Milparinka, Cobham Lake, Broken Hill, Menindee, Urisino, White Cliffs, Wilcannia, Manara, Yantabulla, Louth, Barnato, Ivanhoe, Enngonia, Bourke, Cobar, Nymagee. (NSW Central Mapping Authority: Bathurst).
Specht, R.L. (1972) *The vegetation of South Australia*. (Government Printer: Adelaide).
Stafford Smith, D.M. and Morton, S.R. (1990) A framework for the ecology of arid Australia. *Journal of Arid Environments* 18: 255–278.
Stannard, M.E. (1962) Erosion survey of the Central East-Darling region. Part II Soils. *Journal of the Soil Conservation Service of NSW* 18: 173–182.
Stannard, M.E. (1963) Erosion survey of the Central East-Darling region. Part III Vegetation. *Journal of the Soil Conservation Service of NSW* 19: 17–28.
Sturt, C. (1849) *Narrative of an expedition into Central Australia.*. Australiana Facsimile Edn no 5 (Libraries Board of South Australia: 1965).
Turner, F. (1903) Botany of the Darling, New South Wales. *Proceedings of the Linnean Society of NSW* 28: 406–442.
Turner, F. (1905) Botany of north-western New South Wales. *Proceedings of the Linnean Society of NSW* 30: 32–91.
Wade, T. (1992) *The brigalow outlier* (NSW Department of Conservation and Land Management).
Walker, P.J. (1991) Land systems of western New South Wales. *Soil Conservation Service of New South Wales Technical Report* No. 25.
Western Lands Commission (1990) *Western lands* (Western Lands Commission: Sydney).

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