

The vegetation of Kinchega National Park, western New South Wales

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The vegetation of Kinchega National Park (latitude 32°18'–32°40'S and longitude 142°10'–142°25'E) in far western New South Wales was assessed using intensive quadrat sampling and mapped using extensive ground truthing and interpretation of aerial photographs and Landsat Thematic Mapper satellite images. Three hundred and fifty two species of vascular plants were recorded from this survey, which, together with other records indicates the presence of 503 species from 69 families including 100 (20%) exotic species. Fifteen vegetation communities were identified and mapped, the most widespread being *Maireana* species low open-shrubland, *Acacia victoriae* open-shrubland and *Eucalyptus largiflorens* open-woodland. The Park also contains a number of rare or threatened species and vegetation communities. One hundred and fifty years of grazing by introduced herbivores coupled with the impact of a modified hydrological regime has resulted in degradation of many of these communities.

Introduction

Kinchega National Park (latitude 32°18'–32°40'S and longitude 142°10'–142°25'E) is located in far western New South Wales 110 km south-east of Broken Hill (Fig. 1). The Park covers an area of approximately 44 000 ha. It largely encompasses Lakes Menindee and Cawndilla, which form a major part of the Murray Darling Basin Commission's Menindee Lakes Storage Scheme. About half the bed of Lake Menindee and all of the bed of Lake Cawndilla are managed by the NSW National Parks and Wildlife Service as part of the Park. The Department of Land and Water Conservation, which is responsible for the Menindee Lakes Scheme, retains the right to flood and drain Lakes Menindee and Cawndilla as part of its operations (NPWS 1999a).

History of the area

The Paakantji Aboriginal people travelled the length of the Darling River from Wilcannia through Menindee towards Wentworth. The large number of middens and stone relics encountered today is evidence of their strong ties to the river (H. Johnston, NSW Parks and Wildlife Service, Buronga, pers. comm.). With the development of pastoral leases in the 1850s, Aboriginal people were moved from their traditional homes to government missions at Menindee, Ivanhoe and Lake Cargelligo. The first Europeans to visit the area followed the Darling River in search of pasture for sheep. The Burke and Wills and Charles Sturt exploration parties both camped at Kinchega. Kinchega National Park was once part of the Kinchega-Kars pastoral lease held by the

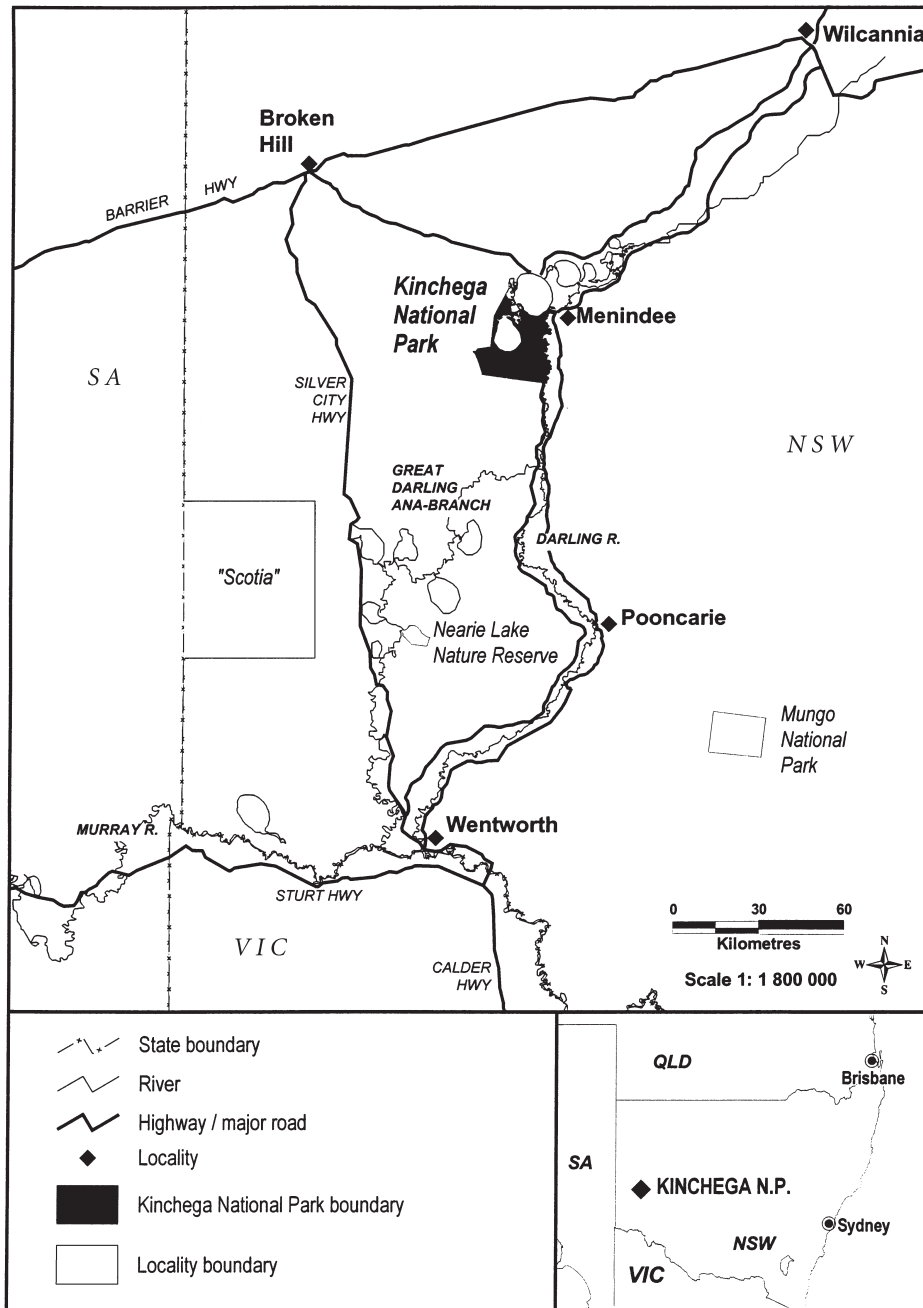


Fig. 1. Location of Kincheha National Park.

Hughes family from early 1870. The property once extended from Menindee to Broken Hill and covered an area of over 800 000 ha. The Park was established in 1967 to protect the cultural and biological features of land systems associated with the overflow lakes of the Darling River.

Climate

The climate is classified as cool semi-arid (Dick 1975), the area being within climatic zone 1B for NSW (Edwards 1979). Temperatures are high in summer and mild in winter with average daily maximum of 34°C in January and 17°C in July and average daily minimum of 19°C in January and 5°C in July. The mean annual rainfall is approximately 244 mm and annual potential evaporation is 2335 mm. The seasonal distribution of rainfall is even but annual variation is high (Clewett et al. 1994).

Geology and geomorphology

The study area lies within the Murray Basin geological province and consists of Quaternary material, with little rock outcropping (Lawrie & Stanley 1980). The lakes and dry lakebeds are underlain by lacustrine deposits of the Coonambidgal Formation and the surrounding areas consist of unconsolidated red-brown siliceous silty sand, calcareous silty clay and sandy clay of the Woorinen Formation. Associated with the floodplain of the Darling River are fluvio-lacustrine deposits of the Shepparton Formation (Brodie 1994). Four broad land systems are present (Walker 1991):

1. The lake system of deep grey cracking clays with partially stabilised sandy lunettes.
2. Alluvial plains of the Darling and Ana-branch with associated dunes and red sandy plains.
3. Partly scalded sandplains of sandy loam to sandy solonised soils.
4. Dunefields of east-west trending dunes and swales of sandy red earths and calcareous red earths.

Previous studies

The most complete study of the vegetation of far western NSW is that by Beadle (1945, 1948) who included the study area as saltbush formation. More recently the National Herbarium of New South Wales, Sydney, has undertaken mapping of the vegetation of areas to the south at 1: 250 000 scale. Reports on Ana Branch-Mildura (Fox 1991), Balranald-Swan Hill (Scott 1992) and Pooncarie map sheets (Porteners 1997) have been published. A study of the vegetation of the Willandra Lakes World Heritage Area was undertaken for the New South Wales Department of Planning and Environment (Rice 1987). Detailed surveys and vegetation maps for Mallee Cliffs National Park (Morcom & Westbrooke 1990), Mungo National Park (Westbrooke & Miller 1996), Nearie Lake Nature Reserve (Westbrooke et al. 1997) and the Scotia Country (Westbrooke et al. 1998) to the south have also been published. Auld (1990, 1993, 1995a, 1995b, 1995c) has studied the ecology of tree and shrub species in the Park and Robertson (1987, 1988) investigated the effect of rainfall on ground vegetation, but no systematic survey of the vegetation of the Park has been undertaken.

Methods

Following preliminary survey, 171 × 0.09 ha (30 m × 30 m) quadrats were sampled. All vascular plant species occurring were recorded, as was a cover abundance value, modified from Braun-Blanquet (1928) for each species. Quadrats were subjectively located following the method of Gullan (1978). This ensured that all communities were sampled and provided data on floristic variability within them. Communities were generally sampled in proportion to the area they covered. However, since many quadrats were located along transects wherever community type was observed to change, those with a discontinuous distribution may have been over-sampled. Sampling was undertaken in December 1996 and December 1997, both surveys following above average spring rains. Data from the quadrats were analysed via a computer-based numerical classification procedure coupled with a hand sorting procedure of the type outlined in Gullan (1978). A species list was compiled incorporating all vascular plant species recorded from sampled quadrats, species recorded following opportunistic collection and other records from the Park (NPWS 1999b, R. Parsons, La Trobe University, pers comm.). Further restricted and/or interesting communities recorded during the field work but not evident from the numeric classification were added to the final classification to provide 15 vegetation communities. For each community, mean species richness, total species richness and number of exotic species as a proportion of the total number of species recorded from quadrats were calculated (Table 1).

During surveys, ground truthing was undertaken by driven and walked transects. Information from these was used in conjunction with study of colour aerial photographs (Central Mapping Authority 1995) and Landsat Thematic Mapper satellite image data (Scene 96–83) to produce a vegetation map at 1: 100 000 scale. The mapped vegetation communities were defined by floristic and structural characteristics (Specht 1970). Nine communities from the vegetation classification could be mapped at this scale. Additional vegetation types of restricted occurrence, e.g. those dominated by *Acacia loderi*, *Acacia ligulata* and *Acacia carneorum* were located as points on the map. The classified image was transferred to the MapInfo Geographic Information System (MapInfo Corporation, Troy, New York) database for final production of the vegetation map.

Results

Vegetation

The vegetation of the study area consists predominantly of riverine woodlands of *Eucalyptus largiflorens* and *Eucalyptus camaldulensis* around the lake system and on the floodplains of the Darling River and Great Ana-branch, with arid woodlands and shrublands on the sandplains and dunefields. Fifteen communities were recognised. While several of these are of limited distribution they add significantly to the conservation values of the Park. The approximate area occupied by each community, the sampling intensity, mean species richness, total species richness and mean % weediness of these communities are given in Table 1.

Table 1. Area, sampling intensity, species richness and weediness of plant communities of Kinchega National Park.

Community	Area (ha)	Mean species richness	Total species richness	Mean % exotic species	No. of quadrats
<i>Eucalyptus camaldulensis</i> open-woodland	815	26	128	27	18
<i>Eucalyptus largiflorens</i> open-woodland	16 765	22	184	23	31
<i>Casuarina pauper/Alectryon oleifolius</i> low open-woodland	2415	16	79	13	16
<i>Acacia aneura</i> tall open-shrubland	< 5	22	22	14	1
<i>Acacia loderi</i> tall open-shrubland	< 5	17	44	9	4
<i>Acacia ligulata</i> open-shrubland	153	11	25	25	6
<i>Acacia carneorum</i> open-shrubland	< 5	13	29	14	4
<i>Acacia victoriae</i> subsp. <i>victoriae</i> open-shrubland	1512	19	76	16	7
<i>Senna/Dodonaea/Eremophila</i> open-shrubland	1768	27	77	7	10
<i>Atriplex nummularia</i> open-shrubland	154	13	42	11	5
<i>Maireana pyramidata</i> low open-shrubland	16 462	18	116	14	31
<i>Chenopodium nitrariaceum</i> open-shrubland	667	19	65	14	5
<i>Scleroleana</i> spp./ <i>Atriplex</i> spp. low open-shrubland	1642	18	109	14	15
<i>Zygochloa paradoxa</i> hummock grassland	72	21	67	17	6
Herbland	417	20	120	26	12

All vegetation communities are described below, grouped according to structural attributes. The distribution of vegetation types is shown on the vegetation map.

1. Woodlands

1a *Eucalyptus camaldulensis* open-woodland

Eucalyptus camaldulensis open-woodland (10 metres tall) occurs on heavy soils along the Darling River and in a generally narrow band around the overflow lakes. *Eucalyptus largiflorens* is frequently associated and the native shrubs *Einadia nutans*, *Enchylaena tomentosa* and *Muehlenbeckia florulenta* are common components of the understorey. The exotic herbs *Carrichtera annua*, *Centaurea melitensis* and *Sisymbrium erysimoides* are frequent in the ground layer (Fig. 2).



Fig. 2. *Eucalyptus camaldulensis* open-woodland occurs as a narrow strip along the Darling River.

1b *Eucalyptus largiflorens* open-woodland

This open-woodland (10 m tall) occurs on heavy soils on the floodplains around the Darling River and the overflow lakes. Trees are commonly infested with the mistletoe *Amyema miquelii*. *Atriplex leptocarpa*, *Chenopodium nitrariaceum*, *Einadia nutans* and *Enchylaena tomentosa* are commonly associated understory species. The exotic species *Centaurea melitensis*, *Centaureum spicatum* and *Cirsium vulgare* are frequent in the ground layer (Fig. 3).

1c *Casuarina pauper*/*Alectryon oleifolius* woodland/open-woodland

Casuarina pauper woodland/open-woodland growing to 10–12 metres tall, occurs in the form of monospecific groves or associated with *Alectryon oleifolius* subsp. *canescens*, which in places itself forms monospecific stands. *Casuarina pauper* may be host to the mistletoe *Amyema linophyllum* whereas *Alectryon oleifolius* subsp. *canescens* is commonly host to *Amyema miraculosum*. Most commonly associated understory shrubs are *Enchylaena tomentosa* and *Maireana pyramidata*. Common ground layer species include *Enneapogon avenaceus*, *Myriocephalus stuartii*, *Tetragonia moorei*, *Salsola kali* and the exotic *Schismus barbatus* (Fig. 4).

2. Acacia shrublands

2a *Acacia loderi* open-shrubland

Groves of *Acacia loderi* open-shrubland occur to 7 m on the dunefields and sandplains to the west of Lakes Menindee and Cawndilla. Commonly associated shrubs include *Enchylaena tomentosa*, *Maireana pyramidata* and *Sclerolaena obliquicuspis* (Fig. 5).



Fig. 3. *Eucalyptus largiflorens* open-woodland occurs across the floodplain of the Darling River.



Fig. 4. Degraded examples of *Casuarina pauper*/*Alectryon oleifolius* low open-woodland occur in the south-west of the Park.



Fig. 5. Isolated stands of *Acacia loderi* tall open-shrubland show no recent regeneration.



Fig. 6. Areas of *Acacia victoriae* subsp. *victoriae* open-shrubland occur in association with the Darling River floodplains.

2b *Acacia victoriae* ssp. *victoriae* open-shrubland

Acacia victoriae ssp. *victoriae* open-shrubland to 3 m occurs on sandplains in the south east of the Park. Associated shrub species include *Dodonaea viscosa* subsp. *angustissima*, *Senna artemisioides* subsp. and *Eremophila sturtii*. The ground layer is dominated by *Dissocarpus paradoxus*, *Enchylaena tomentosa*, *Calotis erinacea*, and *Vittadinia cuneata* (Fig. 6).

2c *Acacia ligulata* open-shrubland

Acacia ligulata open-shrubland occurs on low sandy rises on alluvial plains. Associated shrubs include *Enchylaena tomentosa* and the ground layer is dominated by *Enneapogon avenaceus*, *Myriocephalus sturtii* and the exotics *Schismus barbatus* and *Centaurea melitensis*.

2d *Acacia carneorum* open-shrubland

Small areas of *Acacia carneorum* open-shrubland occur on dunefields in the south west of the Park. *Enchylaena tomentosa* is the only shrub consistently associated and the ground layer consists of *Dissocarpus paradoxus*, *Myriocephalus sturtii*, *Nicotiana velutina* and *Tetragonia moorei*, *Salsola kali* with the exotic *Schismus barbatus* (Fig. 7).

2e *Acacia aneura* tall open-shrubland

Small patches of *Acacia aneura* tall open-shrubland occurs in the south west and northwest of the Park. *Sclerolaena* species and the exotic grass *Schismus barbatus* dominate the ground layer.

3. Low open shrublands**3a *Dodonaea viscosa* subsp. *angustissima*/*Senna artemisioides* subspecies *Eremophila sturtii* shrubland**

Associated with *Casuarina pauper* woodland/open-woodland and *Acacia* shrublands are extensive areas of mixed species shrubland in which *Dodonaea viscosa* subsp. *angustissima*, *Senna artemisioides* subspecies and *Eremophila sturtii* are prominent. Other associated shrubs include *Acacia victoriae* subsp. *victoriae*, *Enchylaena tomentosa* and *Maireana pentatropis*. *Stipa scabra*, *Vittadinia cuneata*, *Scleroleana obliquicuspis* and *Calotis erinacea* dominate the ground layer.

3b *Maireana pyramidata* *Maireana sedifolia* low open-shrubland

Low open-shrubland dominated by *Maireana pyramidata* is the most extensive community on more elevated areas of the alluvial plains. In a few sites it is associated with *Maireana sedifolia* or *Maireana astrotricha*. Herbs in the ground layer include the exotic *Schismus barbatus* and the natives *Chamaesyse drummondii*, *Enneapogon avenaceus*, *Lotus cruentus*, *Rhodanthe corymbifolia*, *Vittadinia cuneata* and *Stipa scabra* (Fig. 8).

3c *Atriplex nummularia* low open-shrubland

An open-shrub community dominated by *Atriplex nummularia* occurs on grey cracking clays to the west of the Cawndilla channel. Commonly associated shrub species include *Chenopodium nitrariaceum*, and *Scleroleana divaricata*. The herb layer includes *Atriplex lindleyi*, *Crassula colorata*, *Sclerochlamys brachyptera* and the exotic *Schismus barbatus* (Fig. 9).



Fig. 7. Small areas of *Acacia carneorum*, an endangered species in NSW, occur to the south of Lake Cawndilla.



Fig. 8. The most extensive community of the park is *Maireana pyramidata*/*Maireana sedifolia* low open-shrubland.

3d *Chenopodium nitrariaceum* low open-shrubland

Low open shrubland dominated by *Chenopodium nitrariaceum* occurs on the floodplain, in old billabongs of the Darling River and along the Cawndilla Channel. Associated low shrubs include *Scleroleana divaricata* and *Scleroleana muricata* var. *muricata*. There is a diverse ground layer within which the exotics *Carrichtera annua* and *Schismus barbatus* are prominent.

3f *Sclerolaena* species/*Atriplex* species low open-shrubland

A low chenopod community occurs on low-lying areas subject to inundation. Common dominants include *Atriplex angulata*, *Atriplex eardleyae*, *Sclerochlamys brachyptera*, *Scleroleana decurrens*, *Scleroleana diacantha*, *Scleroleana divaricata* and *Scleroleana stelligera*. Associated herbs include *Plantago drummondii*, *Nicotiana velutina*, *Osteocarpum acropterum*, *Brachyscome ciliaris* and the exotics *Carrichtera annua*, *Centaurea melitensis* and *Schismus barbatus* (Fig. 10).

4. Grasslands/Herblands

4a *Zygochloa paradoxa* hummock grassland

Small patches of *Zygochloa paradoxa* hummock grassland occur on the lunette of Lake Cawndilla. Associated shrubs include *Chenopodium nitrariaceum*, *Dodonaea viscosa* subsp. *angustissima*, *Enchylaena tomentosa* and *Maireana pyramidata*. The ground layer includes *Brachyscome ciliaris*, *Myriocephalus stuartii*, *Nicotiana velutina*, *Phyllanthus lacunellus*, *Pimelea trichostachya*, *Senecio quadridentatus*, *Vittadinia cuneata* and the exotic *Schismus barbatus* (Fig. 11).

4b Lakebed herbland

On some areas of the lakebeds, an annual herbland has developed. This is dominated by *Epaltes australis*, *Heliotropium curassavicum*, *Stemodia florulenta*, *Teucrium racemosum* and the exotics *Centaurea melitensis*, *Centaureum spicatum* and *Conyza bonariensis*. This community is the habitat for *Solanum karsense* which is listed as vulnerable in NSW (Schedule 2, *NSW Threatened Species Conservation Act 1995*) (Fig. 12).

The species

A total of 364 vascular plant species were recorded during this study. A further 139 species have been recorded from the Park (NPWS 1999b). Thirty-seven species from the total recorded (see Appendix 1) have not been previously recorded from South Far Western Plains Botanical subdivision (Jacobs & Pickard 1981, Jacobs & Lapinpuro 1986, Harden 1990–93, Morcom & Westbrooke 1990, Westbrooke & Miller 1996, Westbrooke et al. 1997, Westbrooke et al. 1998, Scott 1992). Of these, eleven are exotic.

Significant species

Two species recorded from the Park, *Acacia carneorum* and *Solanum karsense*, are listed vulnerable in NSW under the *NSW Threatened Species Conservation Act 1995* (TSC Act) and vulnerable in Australia under the *Environment Protection and Biodiversity*



Fig. 9. *Atriplex nummularia* open-shrubland occurs adjacent to the Darling River and Cawndilla Channel.



Fig. 10. In the south of the Park periodically flooded lakebeds support *Sclerolaena* spp./*Atriplex* spp. low open-shrubland.



Fig. 11. The small areas of *Zygochloa paradoxa* hummock grassland occur on the Lake Cawndilla lunette.



Fig. 12. Periodically inundated flats adjacent to the main lakes support a herbland community.

Conservation Act 1999 (EPBC Act). *Acacia carneorum* primarily occurs on sand ridges in inland *Acacia* and *Casuarina* shrublands and woodlands (Ayers et al. 1996), but also in alluvium along watercourses in chenopod low shrubland. Within the Park, this species is found in *Casuarina pauper/Alectryon oleifolius* woodland/open-woodland (1c) and in *Maireana pyramidata/Maireana sedifolia* low open-shrubland (3b) near Lake Cawndilla. *Solanum karsense* occurs in occasionally flooded depressions on heavy grey soils and dry lake beds as well as on open treeless plains with solonised brown soils, generally with *Eucalyptus largiflorens* and *Atriplex nummularia* (Ayers et al. 1996). Within the Park, *Solanum karsense* mainly occurs in lake beds and flood run-outs between Lake Cawndilla and the Darling River.

There are also unconfirmed Park records of two other threatened plant species — *Swainsonia pyrophila*, which is listed as vulnerable in NSW and Australia, and *Swainsona adenophylla*, which is endangered in NSW (NPWS 1999b).

Occurrence of exotic species

Of the 503 species recorded from the Park, 100 (20%) are exotics. Mean percentage occurrence of exotic species ranged from 27% in the *Eucalyptus camaldulensis* open-woodland (Fig. 13) to 7% in the mixed shrubland (Table 1). The highest levels of occurrence of exotic species were in communities subject to the greatest influence from water, i.e. the open woodlands and herblands associated with the lakebeds and major channels. This is in accord with Westbrooke (1990) who found a high negative correlation between occurrence of exotic species and distance from water in studies at Mallee Cliffs National Park and Nanya Station. A number of exotics are winter rainfall



Fig. 13. *Eucalyptus camaldulensis* open-woodland communities around lake Menindee have a high level of exotic weeds.

stimulated and thus may not have been recorded during these surveys. Three species were recorded as artificial plantings. Although not naturalised, these are of historic and cultural significance.

Discussion

Distribution of communities

The distribution and species composition of vegetation communities within Kinchega National Park is largely determined by variation in topography, landform position and soil type. *Eucalyptus* species open-woodlands are associated with grey cracking clays of the Darling River floodplains and the overflow lakes. *Maireana* species low open-shrubland occurs on the sand plains whilst *Casuarina/Alectryon* low woodland is associated with east-west dunefields in the south west of the Park. A number of other factors, notably past grazing history, have also played a role in determining the present distribution and floristic composition of the communities present.

The *Dodonaea viscosa* subsp. *angustissima* shrublands (4a) are likely to result from vegetation clearance and subsequent replacement by unpalatable species such as *Dodonaea*. Noble (1984) and Harrington et al. (1984) report an increase of *Dodonaea* species in response to grazing and the genus is also reported as an early coloniser following clearing (Beadle 1948, Onans & Parsons 1980).

The impact of water conservation measures

The most obvious effect of the modification of the water regime through the Menindee Lakes Storage Scheme is the large areas of dead *Eucalyptus largiflorens* in the bed of Lake Menindee and areas of Lake Cawndilla. Since the Scheme was established, overflow of water from the Cawndilla Channel which was then unable to drain away naturally has caused the death of a further 250 ha of *Eucalyptus largiflorens* woodland. On the western shore of Lake Menindee a large area of regeneration of *Eucalyptus largiflorens* and *Eucalyptus camaldulensis* results from a rise in the water level of the lake. The *Eucalyptus largiflorens* woodland around Emu Lake may be at risk due to the lack of regular flushing by floodwater due to a narrow pipe carrying water under the causeway near the ranger station (Mike Erny, Department of Land and Water Conservation, Dareton, pers. comm.) (Figs 14, 15).

Conservation status of plant communities

The New South Wales Scientific Committee has recently listed *Acacia loderi* Shrublands as an Endangered Ecological Community in NSW on Part 3 of Schedule 1 of the *NSW Threatened Species Conservation Act*. The Committee noted that *Acacia loderi* shrublands in NSW are largely confined to the south-west and are generally fragmented. Most remnant stands are located on pastoral leases and subject to threats including clearing and a lack of regeneration of overstorey through grazing pressure, particularly from stock and rabbits. Even within Kinchega National Park, it is recognised that rabbit grazing pressure has severely limited regeneration of *Acacia loderi* and flooding from



Fig. 14. Flooding of the lake system resulted in death of large areas of *Eucalyptus largiflorens* open-woodland.



Fig. 15. Large areas of *Eucalyptus largiflorens* open-woodland have been killed as a result of prolonged flooding from the Cawndilla Channel.

over-filling of the Menindee Lakes has resulted in destruction of several stands of the community (NSW Scientific Committee 2000).

Acacia carneorum open shrubland is severely degraded. Surviving plants of the dominant species are senescent, there is no regeneration and the conservation status of this community should be viewed with considerable concern. Auld (1992) has raised concerns regarding this community and Kinchega National Park is the only conservation reserve in which it is represented. It is important that steps are taken to protect and ensure rehabilitation of this community.

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Appendix: Vascular plant species recorded from Kinchega National Park. Nomenclature according to Harden (1990–1993).

* denotes exotic species † denotes species recorded by NPWS (1999) but not recorded in this study. ‡ denotes new records for South Far Western Plains.

V = vulnerable in Australia (EPBC Act). e = endangered in NSW (TSC Act). v = vulnerable in NSW (TSC Act).

AIZOACEAE

Disphyma crassifolium
Glinus lotoides
 **Mesembryanthemum crystallinum*
 **Mesembryanthemum nodiflorum*
 †*Mollugo cerviana*
 **Psilocalon tenue*
Tetragonia moorei
Trianthema triquetra
Zaleya galericulata

AMARANTHACEAE

†‡*Alternanthera angustifolia*
Alternanthera denticulata
Alternanthera nodiflora
 †*Amaranthus grandiflorus*
 †‡*Amaranthus macrocarpus* var. *pallidus*
 †*Ptilotus atriplicifolius*
 †*Ptilotus nobilis*
Ptilotus obovatus var. *obovatus*

AMARYLLIDACEAE

†*Calostemma purpureum*
Crinum flaccidum

ANACARDIACEAE

**Schinus areira*

ANTHERICACEAE

†*Thysanotus baueri*

APIACEAE

Daucus glochidiatus

ASCLEPIADACEAE

Marsdenia australis
Sarcostemma australe

ASPHODELACEAE

**Asphodelus fistulosus*
Bulbine alata
Bulbine bulbosa
Bulbine semibarbata

ASTERACEAE

Actinobole uliginosum
 †‡*Ambrosia confertiflora*
 †*Angianthus brachypappus*
 †*Angianthus tomentosus*
 **Aster subulatus*
Brachycome basaltica var. *gracilis*
 †*Brachycome* species B
Brachycome ciliaris var. *lanuginosa*
 †‡*Brachycome ciliocarpa*
Brachycome heterodonta
Brachycome lineariloba
Brachycome melanocarpa
 †‡*Calendula arvensis*
Calotis ancyrocarpa
Calotis cymbacantha
Calotis erinacea
Calotis hispidula
 †*Calotis plumulifera*
Calotis scabiosifolia var. *scabiosifolia*
 †*Calotis scapigera*
 **Carduus tenuiflorus*
 **Carthamus lanatus*
 **Centaurea melitensis*
Centipeda cunninghamii
Centipeda thespidioides
 **Chrysanthemoides monilifera*
 †*Chrysocephalum apiculatum*
Chthonocephalus pseudevax
 **Cirsium vulgare*
 **Conyza bonariensis*
 †‡*Cotula bipinnata*
 † *Craspedia haplorrhiza*
 **Dittrichia graveolens*
Eclipta platyglossa
Elachanthus pusillus
Epaltes australis
Eriochlamys behrii
Gnaphalium sphaericum
Gnephosis arachnoidea
Gnephosis tenuissima
Hedypnois rhagadioloides subsp. *cretica*
 **Helianthus annuus*

†*Hyalosperma semisterile*
 **Hypochoeris glabra*
 **Hypochoeris radicata*
Isoetopsis graminifolia
Ixiolaena leptolepis
 †*Ixiolaena tomentosa*
 **Lactuca serriola*
 †*Lemooria burkittii*
Millotia greevesii
Millotia myosotidifolia
Millotia perpusilla
Minuria cunninghamii
Minuria denticulata
Minuria leptophylla
 †*Myriocephalus pluriflorus*
Myriocephalus stuartii
Olearia muelleri
Olearia pimeleoides
 **Onopordum acaulon*
 †*Picris hieracioides*
Picris squarrosa
Podolepis capillaris
 †*Podolepis jaceoides*
Pseudognaphalium luteoalbum
Pterocaulon sphacelatum
Pycnosorus pleiocephalus
 †*Pycnosorus thompsonianus*
 **Reichardia tingitana*
Rhodanthe corymbiflora
Rhodanthe floribunda
 †*Rhodanthe microglossa*
Rhodanthe moschata
 †*Rhodanthe polygalifolia*
Rhodanthe pygmaea
 †*Rhodanthe stricta*
Rhodanthe stuartiana
 †*Rhodanthe uniflora*
Senecio cunninghamii var. *cunninghamii*
Senecio cunninghamii var. *serratus*
Senecio glossanthus
 †*Senecio gregorii*
 †*Senecio hispidulus*
Senecio lautus ssp. *dissectifolius*
 †*Senecio magnificus*
 †*Senecio murrayanus* [*Senecio tuberculatus*]
 †*Senecio platylepis*
Senecio quadridentatus
Senecio runcinifolius
 **Sonchus asper* s.l.
 **Sonchus oleraceus*

†*Urospermum picroides*
Vittadinia cuneata var. *morrisii*
 †*Vittadinia cervicularis* var. *cervicularis*
 †*Vittadinia cervicularis* var. *subcervicularis*
 †*Vittadinia eremaea*
 **Xanthium occidentale*
 **Xanthium spinosum*

AZOLLACEAE

Azolla filiculoides

BORAGINACEAE

†*Amsinckia intermedia*
 **Amsinckia calycina*
 †*Anchusa arvensis*
 **Echium plantagineum*
Heliotropium curassavicum
 **Heliotropium europaeum*
 **Heliotropium supinum*
Omphalolappula concava
Plagiobothrys plurisepalus

BRASSICACEAE

**Alyssum linifolium*
 †*Arabidella procumbens*
Arabidella trisecta
 †*Blennodia canescens*
 **Brassica tournefortii*
 **Carrichtera annua*
Geococcus pusillus
 †*Harmsiodoxa blennodioides*
 †*Harmsiodoxa brevipes*
Lepidium fasciculatum
Lepidium papillosum
 †*Lepidium phlebopetalum*
Lepidium pseudohyssopifolium
 †*Lepidium sagittulatum*
 †*Phlegmatospermum cochlearinum*
 **Raphanus raphanistrum*
 †*Rapistrum rugosum*
 **Rorippa palustris*
 **Sisymbrium erysimoides*
 **Sisymbrium irio*
 **Sisymbrium orientale*
Stenopetalum lineare

CACTACEAE

**Opuntia stricta*

CAMPANULACEAE

Wahlenbergia communis s.l.
Wahlenbergia fluminalis

Wahlenbergia gracilentia s.l.

+*Wahlenbergia graniticola*

Wahlenbergia sp.

CARYOPHYLLACEAE

**Silene gallica*

**Spergularia diandra*

**Spergularia rubra*

CASUARINACEAE

Casuarina pauper

CHENOPODIACEAE

Atriplex angulata

Atriplex conduplicata

Atriplex eardleyae

Atriplex holocarpa

Atriplex leptocarpa

Atriplex limbata

Atriplex lindleyi

Atriplex nummularia

Atriplex pseudocampanulata

Atriplex pumilio

Atriplex spongiosa

Atriplex stipitata

Atriplex suberecta

Atriplex velutinella

Chenopodium cristatum

Chenopodium curvispicatum

Chenopodium desertorum

Chenopodium melanocarpum

**Chenopodium murale*

Chenopodium nitrariaceum

Chenopodium pumilio

+**Chenopodium truncatum*

Dissocarpus biflorus

Dissocarpus paradoxus

Einadia nutans ssp. *nutans*

Enchylaena tomentosa

Halosarcia pergranulata

Maireana aphylla

Maireana appressa

♦*Maireana astrotricha*

Maireana brevifolia

Maireana coronata

Maireana decalvans

Maireana georgei

Maireana integra

Maireana pentatropis

Maireana pyramidata

Maireana sedifolia

Maireana sclerolaenoides

Maireana tomentosa

Maireana turbinata

Malacocera tricornis

Neobassia proceriflora

Osteocarpum acropterum var. *acropterum*

Osteocarpum acropterum var. *deminuta*

Pachycornia triandra

Rhagodia spinescens

Salsola kali

Scleroblitum atriplicinum

Sclerochlamys brachyptera

Sclerolaena bicornis var. *bicornis*

Sclerolaena calcarata

Sclerolaena decurrens

Sclerolaena diacantha

Sclerolaena divaricata

Sclerolaena intricata

Sclerolaena lanicuspis

Sclerolaena muricata var. *muricata*

Sclerolaena muricata var. *villosa*

Sclerolaena obliquicuspis

Sclerolaena patenticuspis

Sclerolaena stelligera

Sclerolaena tricuspis

♦*Sclerolaena uniflora*

Sclerolaena ventricosa

Sclerostegia tenuis

CONVOLVULACEAE

Convolvulus erubescens

Cressa cretica

♦**Cuscuta campestris*

CRASSULACEAE

Crassula colorata

♦*Crassula sieberana*

CUCURBITACEAE

**Citrullus lanatus*

**Cucumis myriocarpus*

Zehneria micrantha

CUPRESSACEAE

Callitris glaucophylla

CUSCUTACEAE

**Cuscuta campestris*

CYPERACEAE

♦*Bolboschoenus caldwellii*

Cyperus gymnocaulos

Cyperus pygmaeus
 †*Cyperus squarrosus*
 †*Eleocharis acuta*
 †*Eleocharis pallens*
 †*Fimbristylis dichotoma*

ELATINACEAE

††*Bergia ammanioides*
 †*Bergia trimera*

EUPHORBIACEAE

Chamaesyce drummondii
Euphorbia eremophila
 ††*Euphorbia parvicaruncula*
 †**Euphorbia pepus*
 †*Euphorbia planiticola*
Euphorbia stevenii
Phyllanthus lacunarius
Phyllanthus lacunellus
 **Ricinus communis*
 † *Sauropus trachyspermus*

FABACEAE

(CAESALPINIOIDEAE)

†*Lysiphyllum gilvum*
Senna artemisioides nothosubsp. *artemisioides*
Senna artemisioides nothosubsp. *coriacea*
Senna artemisioides nothosubsp. *sturtii*
Senna artemisioides subsp. *filifolia*
Senna artemisioides subsp. *petiolaris*

(FABOIDEAE)

†*Crotalaria eremaea* subsp. *eremaea*
 †*Glycine canescens*
 †*Glycyrrhiza acanthocarpa*
Lotus cruentus
 **Medicago minima*
 **Medicago polymorpha*
 **Melilotus indicus*
Psoralea australasica
 †*Psoralea cinerea*
Psoralea pallida
Psoralea patens
 †*Sesbania cannabina*
 e†*Swainsona adenophylla*
Swainsona formosa
Swainsona greyana
 †*Swainsona laxa*
Swainsona microphylla
 † *Swainsona phacoides*
 †*Swainsona procumbens*

Swainsona purpurea
 Vv†*Swainsona pyrophila*
Templetonia egena
 ††*Tephrosia sphaerospora*
 †*Trigonella suavissima*
 **Vicia monantha* subsp. *monantha*

(MIMOSACEAE)

Acacia aneura
Acacia brachystachya
Acacia burkittii
 Vv *Acacia carneorum* (formerly *carnei*)
Acacia colletioides
Acacia ligulata
Acacia loderi
Acacia oswaldii
 †*Acacia salicina*
Acacia stenophylla
 †*Acacia tetragonophylla*
Acacia victoriae subsp. *victoriae*

FRANKENIACEAE

Frankenia connata

GENTIANACEAE

**Centaurium spicatum*

GERANIACEAE

**Erodium cicutarium*
Erodium crinitum
 †*Erodium cygnorum* subsp. *glandulosum*

GOODENIACEAE

†*Goodenia cycloptera*
 †*Goodenia fascicularis*
Goodenia glauca
Goodenia heteromera
Goodenia pinnatifida
Goodenia pusilliflora

GYROSTEMONACEAE

†*Codonocarpus cotinifolius*

HALORAGACEAE

†*Haloragis aspera*
Haloragis glauca
 ††*Haloragis heterophylla*
Myriophyllum verrucosum

JUNCEAE

†*Juncus aridicola*

JUNCAGINACEAE

Triglochin calcitrapum
Triglochin centrocarpum

LAMIACEAE

**Marrubium vulgare*
Mentha australis
+**Mentha diemenica*
**Salvia verbenaca*
Teucrium racemosum

LILIACEAE

♦*Dianella longifolia* var. *porracea*

LORANTHACEAE

Amyema linophyllum
Amyema miquelii
Amyema miraculosum
Amyema quandang var. *bancroftii*
Lysiana exocarpi subsp. *exocarpi*

MALVACEAE

+**Abutilon malvifolium*
♦*Abutilon otocarpum*
+**Abutilon oxycarpum*
♦**Abutilon theophrasti*
♦*Hibiscus brachysiphonius*
♦*Hibiscus krichauffianus*
♦*Lavatera plebeia*
**Malva parviflora*
+**Malva verticillata*
♦*Malvastrum americanum*
♦*Sida ammophila*
Sida corrugata
+*Sida cunninghamii*
♦*Sida fibulifera*
Sida intricata
♦*Sida petrophila*
Sida trichopoda

MARSILEACEAE

Marsilea drummondii

MYOPORACEAE

Eremophila bignoniiflora
Eremophila deserti
Eremophila divaricata
Eremophila glabra
Eremophila longifolia
Eremophila maculata
Eremophila polyclada
Eremophila sturtii

Myoporum montanum

Myoporum platycarpum subsp. *platycarpum*

MYRTACEAE

Eucalyptus camaldulensis
Eucalyptus coolabah
Eucalyptus largiflorens
♦*Eucalyptus socialis*

NYCTAGINACEAE

Boerhavia dominii

OLEACEAE

Jasminum lineare

ONAGRACEAE

+*Epilobium hirtigerum*
+*Ludwigia peploides* subsp. *montevidensis*
**Oenothera stricta*

OPHIOGLOSSACEAE

♦*Ophioglossum polyphyllum*

OXALIDACEAE

Oxalis perennans

PAPAVERACEAE

**Argemone ochroleuca* subsp. *ochroleuca*

PITTIOSPORACEAE

Pittosporum phylliraeoides

PLANTAGINACEAE

Plantago cunninghamii
Plantago drummondii
Plantago turrifera
Plantago varia

POACEAE

Agrostis avenacea var. *avenacea*
♦**Alopecurus geniculatus*
♦*Aristida holathera* var. *holathera*
♦ *Aristida contorta*
**Arundo donax*
Austrodanthonia caespitosa
Austrodanthonia eriantha
Austrodanthonia setacea
♦*Austrostipa nitida*
♦*Austrostipa nodosa*
Austrostipa scabra subsp. *scabra*
Bromus arenarius
♦**Bromus cartharticus*
**Bromus diandrus*

- **Bromus rubens*
Cenchrus longispinus
 +**Chloris gayana*
Chloris truncata
 +**Cymbopogon ambiguus*
Cynodon dactylon
 **Dactyloctenium radulans*
 **Dichanthium sericeum*
 **Digitaria divaricatissima*
 **Diplachne fusca*
 +**Echinochloa crus-galli*
 **Echinochloa lacunaria*
Enneapogon avenaceus
 **Enneapogon cylindricus*
Eragrostis australasica
 **Eragrostis cilianensis*
Eragrostis dielsii
Eragrostis falcata
 **Eragrostis parviflora*
 **Eragrostis setifolia*
 **Eriochloa australiensis*
 +**Eriochloa crebra*
 **Eriochloa pseudoacrotricha*
 **Hordeum leporinum*
 **Homopholis proluta* [*Panicum prolutum*]
 **Lamarckia aurea*
 **Panicum decompositum*
 **Paractaenum novae-hollandiae*
 **Parapholis incurva*
Paspalidium jubiflorum
 **Phalaris paradoxa*
 **Phyllostachys nigra*
 +**Poa annua*
 **Poa fordeana*
 +**Poa pratensis*
 +**Polypogon monspeliensis*
Pseudoraphis spinescens
 +**Rostraria cristata*
 **Rostraria pumila*
 **Schismus barbatus*
Sporobolus mitchellii
 **Tragus australianus*
 **Triodia scariosa* subsp. *scariosa*
 **Tripogon loliiformis*
Triraphis mollis
 **Vulpia myuros*
Zygochloa paradoxa
- POLYGONACEAE
 **Acetosa vesicaria*
- **Emex australis*
Muehlenbeckia florulenta
Muehlenbeckia horrida
Persicaria lapathifolia
 + **Persicaria prostrata*
Polygonum aviculare
Polygonum plebeium
Rumex brownii
 **Rumex crispus*
Rumex crystallinus
Rumex tenax
- PORTULACACEAE
Calandrinia eremaea
 **Calandrinia volubilis*
Portulaca oleracea
- PRIMULACEAE
 **Anagallis arvensis*
- PROTEACEAE
Hakea leucoptera
Hakea tephrosperma
- RANUNCULACEAE
Myosurus minimus var. *australis*
Ranunculus pentandrus var. *platycarpus*
 **Ranunculus pumilo* var. *pumilo*
- ROSACEAE
 +**Potentilla supina*
- RUBIACEAE
 **Synaptantha tillaeacea*
- SALICACEAE
 +**Salix babylonica*
- SANTALACEAE
Exocarpos aphyllus
Santalum acuminatum
- SAPINDACEAE
Alectryon oleifolius subsp. *canescens*
Dodonaea viscosa subsp. *angustissima*
- SCROPHULARIACEAE
 **Limosella australis*
 **Limosella curdieana*
 +**Mimulus prostratus*
 +**Misopates orontium*
Stemodia florulenta
 +**Veronica peregrina*

SOLANACEAE

- ♦**Datura innoxia*
- **Lycium ferocissimum*
- **Nicotiana glauca*
- Nicotiana velutina*
- Solanum coactiliferum*
- Solanum esuriale*
- Vv *Solanum karsense*
- ♦*Solanum lacunarium*
- **Solanum nigrum*

STERCULIACEAE

- +♦*Gilesia biniflora*

TAMARICACEAE

- **Tamarix aphylla*

THYMELAEACEAE

- Pimelea microcephala*
- Pimelea simplex*
- Pimelea trichostachya*

TYPHACEAE

- Typha domingensis*

URTICACEAE

- **Urtica urens*

VERBENACEAE

- **Verbena africana*
- **Verbena officinalis*
- **Verbena supina*

ZYGOPHYLLACEAE

- **Tribulus terrestris*
- Zygophyllum ammophilum*
- Zygophyllum aurantiacum*
- Zygophyllum eremaeum*
- Zygophyllum iodocarpum*
- Zygophyllum simile*