Department of
Sustainability and
Environment

Literature Review

Threatened Grassy Vegetation Communities of the Goulburn Broken Catchment

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September 2006

Australian Government

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

Victoria
The Place To Be

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I. ABBREVIATIONS

DSE	Department of Sustainability and Environment
DPI	Department of Primary Industries
EVC	Ecological Vegetation Class
DEH	Department of Environment and Heritage
GBC	Goulburn Broken Catchment
FIS	Flora Information Systems
ESSS	Endangered Species Scientific Subcommittee
EPBC	Environment Protection and Biodiversity Conservation Act 1999
FFG	Flora and Fauna Guarantee Act 1988

II. PREAMBLE

The following literature review is a product of the project *'Management of threatened communities in the Goulburn Broken Catchment'*. This project is funded from the Natural Heritage Trust through the Goulburn Broken Catchment Authority.

The project aims to assist the on ground management of the communities *Northern Plains Grassland*, *Grey Box-Buloke Grassy Woodlands* and *Box-Gum Grassy Woodlands and derived Grasslands* by disseminating information to landmanagers and advisors. This project follows on from an earlier project, which identified and mapped a number of sites in the catchment.

Feedback during this project indicated that a literature review would be beneficial to assist decision-makers in better managing these communities. The intended audience includes land managers and extension staff of Parks Victoria, DSE, DPI, Committees of Management, Local Government, Landcare Groups and private landholders. The review is a summary of scientific evidence to date for these grassy vegetation communities. Relevant research papers, journals, books and reports were accessed via the Departments Library Catalogues and Databases.

In particular the following are addressed:

- How are these communities classified?
- Where are they are found?
- What flora and fauna are commonly associated?
- What are the threats which currently operate?
- What management techniques will improve existing conservation values?
- What further research is required?

The nomenclature *Box-Gum Grassy Woodlands and derived Grasslands* incorporates a number of floristic communities including *Grassy White Box Woodland*. *Grassy White Box Woodland* was the nomenclature used previously under the EPBC Act 1999 prior to this year. Occasionally this review may refer to *Grassy White Box Woodlands* rather than the new synonym.

III. EXECUTIVE SUMMARY

Grey Box-Buloke Grassy Woodlands, *Box-Gum Grassy Woodlands and derived grasslands*, and *Northern Plains Grasslands* are distinct vegetation communities[1] found in Victoria, South Australia and NSW.

These communities are under threat because very little vegetation remains and what areas that do occur are small and highly fragmented. Estimates suggest that the former extent of *Northern Plains Grassland* is 0.5%, *Grassy White Box Woodland* is 0.01% and *Grey Box-Buloke Grassy Woodlands* is <1%(Beckmann R 1996, DCNR 1992).

The conservation status of these communities is recognised in State and Federal Government Legislation. The listings are summarised as below:

- Grey Box-Buloke Grassy Woodlands - **threatened** ecological community (FFG 1988)
- Buloke Woodlands of the Victorian and Murray Darling Depression Bioregions (inc. Grey Box-Buloke Grassy Woodlands) - **endangered** ecological community (EPBC 2000)
- Northern Plains Grassland – **threatened** ecological community (FFG 1988)

[1] A community includes a group of plants (trees, shrubs, grasses and herbs) and animals found together rather than individual species alone.

- Box-Gum Woodlands and Derived Grasslands (inc. Grassy White Box Woodlands) – **endangered** ecological community (EPBC 2000)

These grassy communities are also habitat for many threatened fauna: grassy ecosystems contain 40% of the State's extinct and threatened vertebrate fauna and nearly as many birds and reptiles in the endangered and vulnerable categories, as there are in all other habitats in Victoria combined (DCNR 1992).

While most of the understorey plants exist elsewhere, as do the trees (although most are mature and there are few new saplings); what is at threat is not particular species, but an assemblage of interacting species flora and fauna that together form a unique ecosystem (Beckmann 1996).

1. INTRODUCTION

'*As I stood, the first European intruder on the sublime solitude of these verdant plains as yet untouched by flocks or herds, I felt concern of being the harbinger of mighty changes and that our steps would soon be followed by the men and animals for which it seemed to have been prepared'* (Major Mitchell 1839 in Foreman 1996).

The mighty changes Major Mitchell predicted have led to a near complete devastation of the natural grasslands and grassy woodlands of the Northern Plains of Victoria. As the trees were well spaced it was possible to introduce flocks of sheep and cattle without needing to clear the land.

These changes include:

- Introduction of grazing by sheep and cattle (hard hoofed animals) and rabbits,
- Clearing of trees and shrubs to encourage more palatable plant species,
- Cultivation for cropping and planting of exotic largely European grasses,
- Widespread application of fertilisers and herbicides,
- Irrigation of crops and pastures,
- And a cessation to many aboriginal land management practices such as the use of fire.

The affects of these changes on grassy ecosystems were initially slow and subtle but soon became rapid and significant with increasing mechanisation and intensity of agricultural practises.

Less than 1% of the grasslands and grassy woodlands former extent currently exist today, if in a highly modified state. Many of our significant grassland and grassy woodland remnants are found in cemeteries, aerodromes, rail and road reserves, rubbish tips, holding paddocks, racecourses and small public land reserves, where disturbance has been kept to a minimum (Kirkpatrick *et.al* 1996).

Grassland and Grassy Woodland researchers have identified important sites in Victoria on private and public land, which have been included on State Departmental databases (eg. FIS[2], Biosites[3]) and the National Register. The flora and fauna of these sites in many instances are well documented and are closely monitored particularly if rare or threatened species are found.

While we have some understanding of how different management techniques (burning, grazing, mowing and spraying) affect the composition and structure of grasslands and grassy woodlands, there is still much to be learnt (Lunt 1991, Foreman 1996, Prober 2005). The conservation status of these communities and associated species (flora and fauna) requires a degree of urgency for action on the part of government agencies (Foreman 1996).

[2] FIS – Flora Information System (Viridans 2005)
[3] Biosites - DSE databases of sites of biological significance (DSE 2006)

2. DESCRIPTION OF THE COMMUNITIES

2.1.Grey Box-Buloke Grassy Woodlands

Grey Box-Buloke Grassy Woodlands are described by Sluiter *et.al* (1997) as:

A tall woodland or woodland in which Grey Box (*Eucalyptus microcarpa*) may be the structural dominant over a lower tree stratum of Buloke (*Allocasuarina luehmannii*), ranging to a low open woodland dominated by Buloke with or without Grey Box as a co-dominant. A shrub layer is generally lacking although golden wattle (*Acacia pycnantha*), Sweet Bursaria (*Bursaria spinosa*) and Drooping Cassinia (*Cassinia arcuata*) are present at a number of sites. The ground layer is dominated by grasses including bristly wallaby grass (*Austrodanthonia setacea*), squirrel-tail fescue (*Vulpia bromoides*), soft brome (*Bromus hordeaceus*), windmill grass (*Chloris truncate*), common wheat grass (*Elymus scabrous*) and in some cases kangaroo grass (*Themeda triandra*) and grey tussock-grass (*Poa sieberiana*). Also present in the ground layer are taxa such as common onion-grass (*Romulea rosea*), narrow-leaf clover (*Trifolium angustifolium*), wingless bluebush (*Maireana enchylaenioides*), slender dock (*Rumex brownii*), finger rush (*Juncus subsecundus*), Woolly New Holland daisy (*Vittadinia gracilis*), common sedge (*Carex inversa*) and lemon beauty heads (*Calocephalus citreus*) (Sluiter *et.al* 1997).

In general they can be described as grassy woodlands with < 30% tree cover, with Grey Box and Buloke overstorey species present. Occassionally other trees may occur including River Red Gum, White Box, Yellow Box and occasionally White Cypress-pine.

At the EVC level the community is closely associated with the Riverina Plains Grassy Woodland (EVC 55_62), a subset of Plains Grassy Woodland of lower rainfall areas <600 mm p.a. (Berwick S 2006 *pers.comms*).

Figure 1 – Wunghnu Bushland Reserve an example of a Grey Box-Buloke Grassy Woodland.

2.2.Northern Plains Grassland

The Northern Plains Grassland is named to reflect its geographic location on a portion of the Murray Darling Basin commonly referred to as the Riverine Plain or the Northern Plain. (Bennet *et.al* 1988).

Rainfall ranges from 600mm p.a. in the East to less than 400mm p.a. in the West. This being the main driver in influencing the floristic differences found in Northern Plains Grasslands, East to West (Foreman 1996).

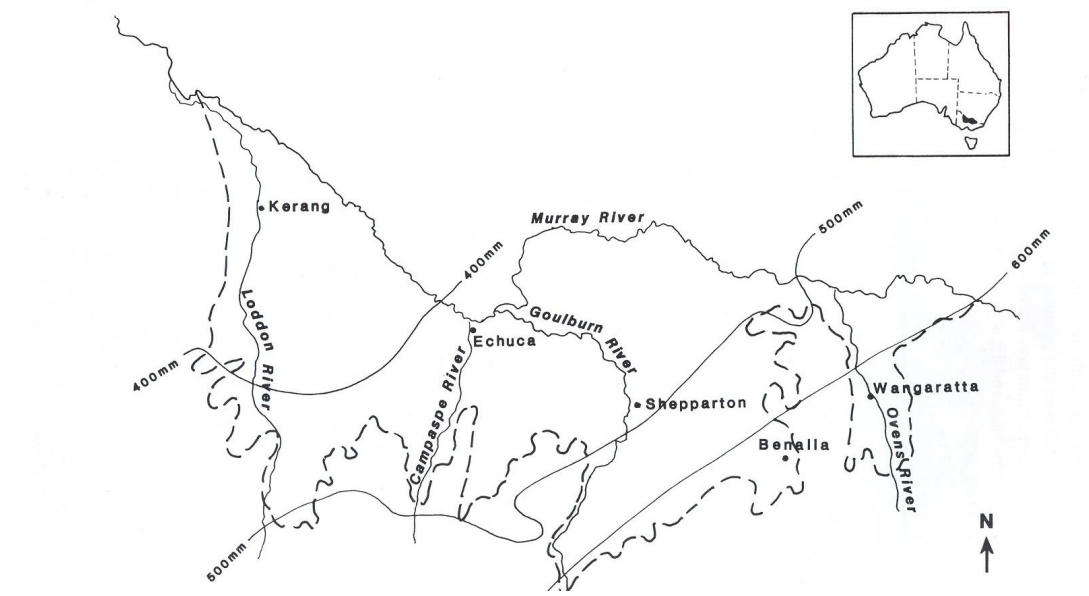


Figure 2 – The Northern Plain extends from Wangaratta in the East to Kerang in the West (Bennet *et.al* 1988)

The community is described in the *Action Statement* (DCE 2004) as:

'Northern Plains Grassland Community occurs throughout the areas of the Northern Plain (Shepparton formation) which are not subject to seasonal inundation or associated with prior stream channels. It infrequently occurs in the southern regions of the Northern Plain because particle size distribution results in better drained soils in the south which tend to support grassy woodlands. The community occurs on quaternary alluvial sediments. Soils are calcareous clay loms or clays on wetter sites. In the lower rainfall parts of the Riverina plains the present Northern Plains Grassland Community consists of a plains herbland of no particular dominance, or an open to closed tussock grassland dominated by Wallaby-grasses (*Austrodanthonia setacea* and *A. caesptiosa*), Spear-grasses (*Austrostipa scabra* and *A.gibbosa*) and Spider Grass (*Enteropogan acicularis*). This dominance tends to be the result of past grazing and disturbance events. Prior to intensive livestock grazing and cultivation, there would probably have been a greater abundance of annual and perennial herbs, shrubs and C4 grasses. It occasionally occurs as an open (grassy) shrubland dominated by a variety of species. A range of perennial herbs occupy the inter-tussock spaces. Total indigenous vascular flora richness is greater than 10 species per 100m^2, although the most species-rich areas generally exceed 20 and occasionally 30 species /100m^2'.

Foreman (1996) suggests that grasslands would have previously had a shrub component that has since disappeared because of grazing pressure. Likely species include Old Man Saltbush (*Atriplex nummularia*) and Weeping Myall (*Acacia pendula*) particularly in the more arid west of the study area (Foreman, 1996).

Figure 3 – O'Deas Rd, Tongala an example of a Northern Plains Grassland.

'Artefact', 'secondary' or 'derived grasslands' are all terms used to describe grasslands which have previously had an overstorey of trees and shrubs but have since been cleared. These areas are not natural grasslands in the true sense of the word (although they may have significant conservation values present and may be managed for these grassland values).

At the Victorian EVC level the community is closely associated with Plains Grassland (EVC 132) (Berwick S 2006 *pers.comms*).

2.3. Box-Gum Grassy Woodlands and Derived Grasslands

The following description comes from the *Grassy White Box Woodlands* recovery plan (DSE 2004b):

Grassy White Box Woodland is that woodland community where the dominant tree species is generally White Box (Eucalyptus albens) and native herbaceous species dominate the ground layer. Within this community type White Box may form mosaics with Blakely's Red Gum (Eucalyptus blakelyi) and Yellow Box (Eucalyptus melliodora). These associated species may be locally dominant along non-permanent watercourses or on deeper soils on valleys, Co-dominants may include Grey Box, Yellow Box, Red Box, Blakely's Red Gum or Drooping She-oak.

'The floristic composition of the little -disturbed GWBW understorey is usually characterised by open swards of *Themeda australis* (Kangaroo Grass) and/or *Poa sieberiana* (Snow Grass) and/or *P. labillardieri*, interspersed with a range of herbs and other grasses such as *Arthropodium spp.*, *Asperula conferta* (Common Woodruff), *Austrodanthonia spp*. (Wallaby grasses), *Austrostipa scabra* (Corkscrew Grass), *Bulbine bulbosa* (Bulbine Lily), *Bothriochloa spp*., *Cheilanthes sieberi* (Rock Fern), *Chrysocephalum apiculatum* (Common Everlastings / Yellow Buttons), *Dianella longifolia* (Pale Flax Lily), *D. revoluta* (Black-anthered Flax Lily), *Dichopogon fimbriatus* (Nodding Chocolate Lily), *Elymus scaber* (Common Wheat Grass), *Geranium retrorsum* and *G. solanderi* (Native Geraniums), *Glycine clandestina* (Twining Glycine), *G. tabacina* (Vanilla Glycine), *Goodenia pinnatifida* (Scrambled Eggs), *Hypericum gramineum* (Small St Johns Wort), *Leptorhynchos squamatus* (Scaly Buttons), *Linum marginale* (Native Flax), *Lomandra filiformis (*Spiny-headed Matrush),*Microseris lanceolata* (Yam Daisy)*, Oxalis perrenans* (Grassland Wood Sorrel) *Sorghum leiocladum* (Wild Sorghum) and *Stackhousia monogyna* (Creamy Candles). Additional species recorded in Victorian GWBW sites include: *Acacia implexa* (Lightwood), *A. rubida* (Red-stemmed Wattle), *Aristida ramosa* (Cane Wire-grass), *Austrostipa densiflora* (Dense Spear-grass), *Bursaria spinosa* (Sweet Bursaria),

*Elymus scaber (*Tall Wheat Grass) and *Pentapogon quadrifidus* (Five-awned Spear-grass). (Moore 1953a, ESSS 1998, Vic RFASC 1997, 1998; Berwick 2001).'

At the Victorian EVC level the community equates to:

- Grassy Woodland (Rainshadow),
- Grassy Woodland (Low Rises),
- Grassy Woodland (Shrubby Granitic-outwash),
- Valley Grassy Forest (part) (Vic RFASC 1997, 1998; Berwick 2001)

Figure 4 – Boxwood Reserve an example of a high quality Grassy White Box Woodland.

3. DISTRIBUTION OF THE COMMUNITIES

3.1.Grey Box- Buloke Grassy Woodland

The following discussion regarding the distribution is taken from Sluiter *et.al* 1997:

'This community is more or less distributed in a band across dry sub-humid Victoria from Jilpanger southwest of Horsham to near Rutherglen and Nagambie in Northeast Victoria. Remnant populations also exist on roadsides and private land near Melton, west of Melbourne. Localities are clustered at the present day around Dadswell Bridge in the southern Wimmera, Inglewood in the North Cental Goldfields and near Rutherglen in the Northeast although this is probably more of an artefact of the sampling program around concentrations of remnants than an indicator of disjunct populations. Sites occur on a variety of land tenures from almost exclusively private land and roadsides in Northeast Victoria and at Melton, to Flora and Fauna Reserves and National Parks in Southwest Victoria. Sites in the Goldfields District mostly occur in State Forest. The community has been substantially cleared for agriculture and is under-reserved.'

From previous mapping and assessment work in the Goulburn Broken Catchment, sites have been documented from Molka, Pranjip, Longwood, Murchison and Balmattum in the south to Wunghnu in the north. The state-wide distribution of Grey Box-Buloke Grassy Woodlands is not accurately known however, the state-wide EVC mapping for Riverina Plains Grassy Woodland does give a likely indication of the pre-1750 (extent) and existing (extant). 0.6% of the former Plains Grassy Woodland (Riverina) EVC currently remain.

The Department of Heritage and Environment have published the following map as an indication of where the *EPBC* listed community *Buloke Woodland of the Riverina and Murray Darling Depression Bioregions* may occur. Note this is far broader than the distribution of the Grey Box and Buloke Grassy Woodland community.

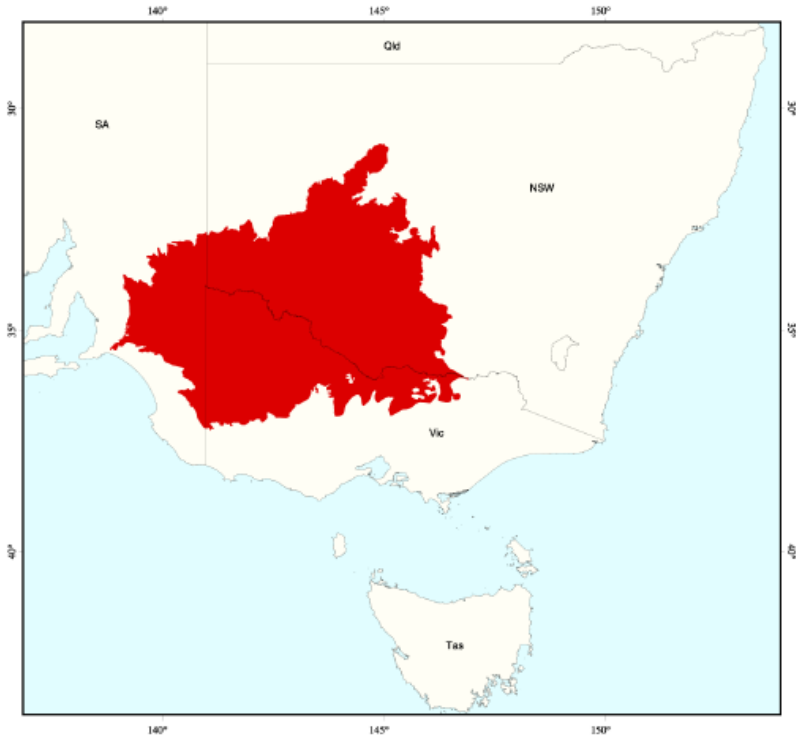


Figure 5 – Buloke Woodlands of the Victorian and Murray Darling Depression bioregions (DEH 2006)

3.2.Northern Plains Grassland

The following discussion is taken from the Action Statement (DCE 2004):

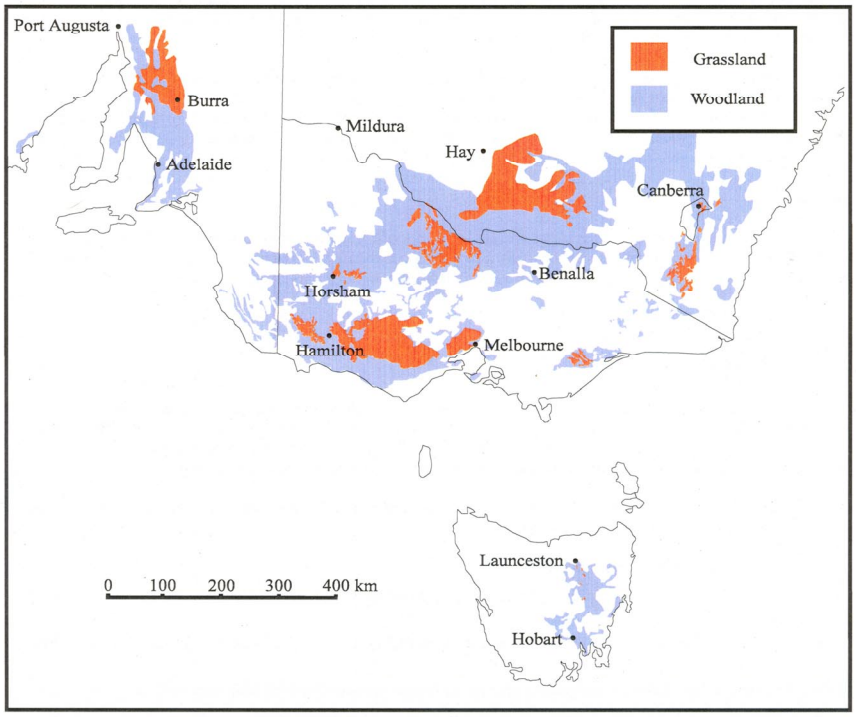
'Today this vegetation extends to the west from the Patho/Mitiamo Plains over the Loddon River at Serpentine on the Powlett Plains. It is also found to the north west of Kerang in the Bael Bael area associated with the Avoca River. To the east this community extends to Echuca, into NSW at Moama and east of the Campaspe River as far as Kyabram and Corop – although this region has not been extensively searched for remnants.Grasslands of the higher rainfall areas (up to 550mm) occur on the far eastern edge of the Riverine Plain around Wangaratta, Chiltern and areas immediately adjacent to the Warby Ranges. The soils of this region are also generally of a lighter texture and the average particle size distribution decreases further north and west (McDougal and Kirkpatrick 1996).'

This community has been nearly completely eliminated through clearing and grazing for Agriculture across the productive Northern Plain with 0.5% of the former extent existing. However small remnants do exist in the GBC largely to the North West around Echuca, on roadsides, railway lines, small reserves or wherever disturbance has been kept to a minimum (eg. Tongala, Echuca, Corop). Also areas are found infrequently on private property. Two such areas which have recently been reserved include Naringaningalook Grassland Reserve and Terrick Terrick National Park. (Terrick Terrick National Park is the largest example of Northern Plains Grassland in the state).

The state-wide EVC mapping for Plains Grassland gives a very good indication of what the distribution of this community may have been like.

Lunt *et.al* (1998) also estimates the pre-1770 distribution of grasslands and grassy woodlands, which includes the community Northern Plains Grasslands.

Figure 6 – Pre-1770 Distribution of temperate lowland grasslands and grassy woodlands of south-eastern Australia (taken from Lunt *et.al* 1998).



3.3.Box-Gum Grassy Woodlands and Derived Grasslands

The following discussion is taken from the Grassy White Box Woodland Recovery Plan (DSE 2004)[4]:

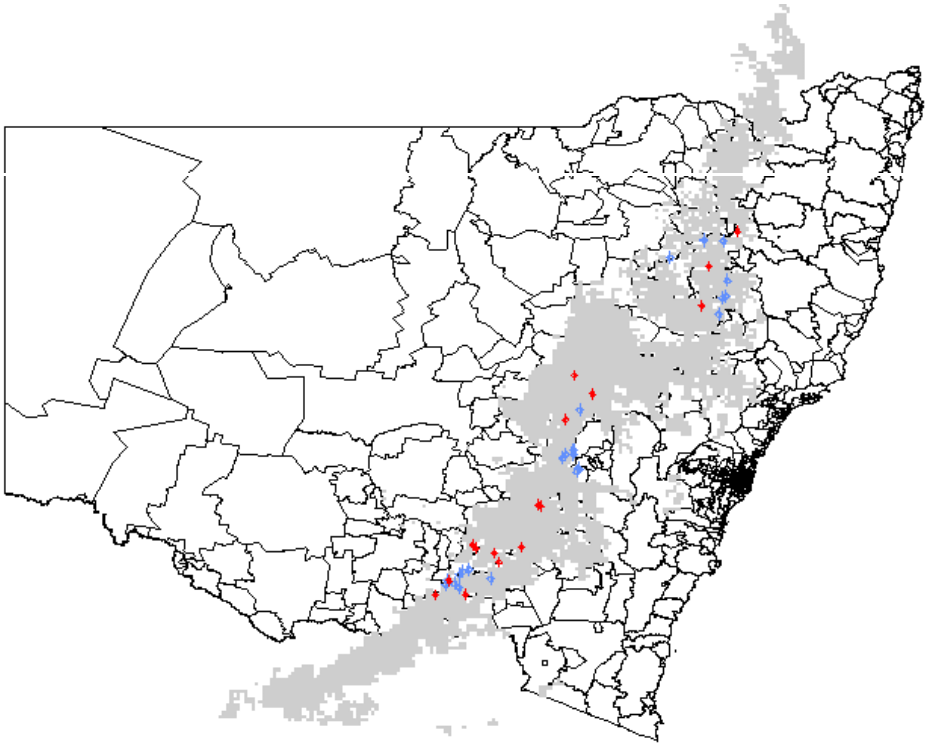
'Before they were extensively cleared, box woodlands dominated by *Eucalyptus melliodora*, *E. albens*, *E. microcarpa, E. pilligaensis* and *E. populnea* occurred in a more-or-less continuous band along the western slopes of the Great Dividing Range, from southern Queensland to central Victoria (Beadle 1981). Of these, Grassy White Box Woodland once covered several million hectares in the eastern part of the wheat-sheep belt (Prober and Thiele 1993).

The core of their distribution was the New South Wales Western Slopes and Brigalow Belt South Bioregions, but their range extended into the Nandewar Bioregion to the north-east, the Sydney Basin to the east, the South Eastern Highlands to the south-east and the Victorian Midlands and East Gippsland to the south, with minor extensions into other adjacent bioregions, and small patches in South Australia. Grassy White Box Woodland grades into shrubbier White Box communities in the South Eastern Highlands and Sydney Basin (ESSS 1998) and when soils become poorer, especially in northern NSW and Queensland. The community was once a major component of the native vegetation of the subhumid inland of south-eastern Australia, but as it occurs on relatively rich soil, it has been mostly grazed or cleared for cropping and that which still remains is usually in poor condition (ESSS 1998).'

[4] The distribution of Box-Gum Grassy Woodlands and Derived Grasslands is much wider than that of the Grassy White Box Woodlands. For further information see the DEH fact sheet re. this community.

The following predictive map is indicative of the Grassy White Box Woodland distribution (Prober 1995).

Figure 7 – Map illustrating the likely distribution of Grassy White Box Woodlands (Prober 1995)



4. SOILS

Northern Plains Grasslands, Grey Box-Buloke Grassy Woodlands and Grassy White Box Woodlands occur on relatively dry and high ground, away from zones of seasonal inundation. The soils are calcareous clay loams or clays on wetter sites (Foreman 1996, McDougall *et al*. 1994, Prober 1996).

The most common feature which differentiates grasslands (inc. Northern Plains Grasslands) and grassy woodlands (inc. Grey Box-Buloke Grassy Woodlands, Grassy White Box Woodlands) is the soil particulate size.

Grassy woodlands occur where soil particulate size is greater and soils are free draining, as in the southern and eastern regions of the Northern Plain. Indeed the poor drainage in winter and subsequent cracking of clays and clay/loam soils in summer has been suggested as a possible reason why trees are naturally absent from grasslands (Foreman 1996, Kirkpatrick *et.al* 1996).

5. LEGISLATION

As all three communities have special listings under State and Federal Government Legislation, the following is a discussion of relevant legislation.

5.1.Flora and Fauna Guarantee (FFG) Act 1988

The *Flora and Fauna Guarantee Act 1988* is the key piece of Victorian legislation for the conservation of threatened species and communities and the management of potentially threatening processes. The exemptions allowed under Sect 52.17 (Vegetation Controls) of the Victorian Planning Provisions do not apply to vegetation which is a listed vegetation community.

The flora and fauna conservation and management objectives of this legislation include:

- To guarantee that all taxa of Victoria's flora and fauna can survive, flourish and retain their potential for evolutionary development in the wild,
- To conserve Victoria's communities of flora and fauna,
- To manage potentially threatening processes,
- To ensure that any use of flora or fauna by humans is sustainable,
- To ensure that the genetic diversity of flora and fauna is maintained

- To provide programs -
  - Of community education in the conservation of flora and fauna,
  - To encourage co-operative management of flora and fauna through, amongst other things, the entering into of land management co-operative agreements under the *Conservation, Forests and Lands Act 1987,*
  - Of assisting and giving incentives to people, including landholders, to enable flora and fauna to be conserved,
  - To encourage the conserving of flora and fauna through co-operative community endeavours.

(DSE *external website* 2006)

The communities Northern Plains Grassland and Grey Box-Buloke Grassy Woodland are both listed as **threatened** ecological community of the FFG Act 1988.

Buloke (*Allocasuarina luehmannii*) is listed under the FFG Act as a **threatened** species. There are also a further 20 plus species of flora and fauna which are found in Northern Plains Grasslands, Grey Box-Buloke Grassy Woodlands and Grassy White Box Woodlands listed under this legislation (DCNR 1992).

A listing under the FFG Act 1988 allows for:

1. Management responses including :
- Action Statement MUST be prepared.
- Flora and Fauna Management Plan may be prepared.
- Public Authority Management Agreement may be entered into.

2. All flora which is part of that community are declared 'protected flora' and as such controls exist over the taking, trading, keeping, moving or processing of plants. (The *FFG Act 1988* revokes the *Wild Flowers and Native Plants Protection Act of 1958*). As such a permit is needed to 'take' protected flora on public (not private) land. Where 'take' is defined as 'to kill, injure, disturb or collect'. This includes deliberate and accidental actions such as timber harvesting, control burning, drainage, grazing, track clearing etc.

3. Critical habitat to be determined if a threat exists and no immediate solutions are available. Critical habitat includes '*the land and water environments and resources which are essential for the continued survival of a species of community'*. Exemptions under the FFG ACT 1988 do not apply to private landowners or leaseholders within a critical habitat.

4. '*Interim Control Order'* (ICO) under the FFG Act 1988 protects critical habitat of Guarantee-listed or nominated:
- taxa, on private land,
- taxa and communities on Crown Land for up to 2 years and 90 days.

An ICO can override other Acts including a planning scheme, permit or licence issued by an authority where there is a conflict.
(DCFL 1988a, DCFL 1988b)

For further information about the FFG Act 1988 go to www.dse.vic.gov.au and search under FFG Act.

5.2.EPBC Act 1999

Buloke Woodlands of the Riverina and Murray Darling Depression Bioregions and *Box-Gum Grassy Woodlands and Derived Grasslands* are listed as an **endangered community** under the EPBC Act 1999. This listing includes the communities Grey Box-Buloke Grassy Woodland and Grassy White Box Woodlands found in Victoria, New South Wales and South Australia.

The listing in the EPBC Act 1999:

1. Recognises the endangered status of the community at a national level,
2. May trigger a Commonwealth assessment and approval process,
3. And provides for a National Recovery Plan to be prepared.

If an '*action*' is '*likely*' to have a '*significant impact'* on a matter protected under Part 3 of the EPBC Act, then it must be referred to the Minister for a decision on whether an environmental impact assessment and approval is required (Kennedy 2004). An example of a referred application may be a planning permit to remove a significant area of Grey Box and Buloke vegetation (trees and understorey) for an irrigation development. Definitions of these exact terms and exceptions are found in the Act and if in doubt, contact the Department of Environment and Heritage, Canberra.

Note members of the public cannot refer someone else's action to the Minister even if it is clear that the action triggers the EPBC Act. However they can contact the Minister via DEH and request that the Minister take appropriate measures including requiring the person/s submit a referral or seek an injunction in the Federal Court to remedy or restrain the breach if it has already occurred (Kennedy L.A. 2004).

5.3. Planning and Environment Act 1987

While the FFG and EPBC Act are most relevant because of the community listings, the Planning and Environment Act 1987 also considers the conservation value of threatened species and communities and the role of vegetation more generally. The Act allows for the development of planning schemes across Victoria, which provide a consistent planning framework for the use, development and protection of land. It is these Planning Schemes which are charged with protecting these communities in the most part, through considered planning permit decisions.

Relevant sections from Clause 15.09 and Clause 52.17 are discussed below, from the Planning and Environment (PE) Act 1987. The complete clauses should be read in their entirety together with the Planning Scheme including the Municipal Strategic Statement and can be found at www.dse.vic.gov.au (Planning Schemes Online).

5.3.1. Clause 15.09 (Conservation of native flora and fauna)

The objective of this clause is '*to assist the protection and conservation of biodiversity, including native vegetation retention and provision of habitats for native plants and animals and control of pest plants and animals'*. (PE Act 1987)

This clause also links the PE Act 1987, to the FFG Act 1988 and to Victoria's Net Gain policy as defined in the Framework. Grasslands and grassy woodlands are given a particular mention as below.

Decision-making by planning and responsible authorities should:

- *'Assist the conservation of the habitats of threatened and endangered species and communities as identified under the Flora and Fauna Guarantee Act 1988, including communities under-represented in conservation reserves such as native grasslands, grassy woodlands and wetlands'*.

- *'If native vegetation is proposed to be removed as part of a land use or development proposal, planning and responsible authorities should achieve a Net Gain outcome, as defined in the Framework. This is achieved firstly, as a priority, by avoiding adverse impacts, particularly native vegetation clearance; secondly, if impacts cannot be avoided, by minimising impacts through appropriate consideration in planning processes and expert input into project design or management; and thirdly, by identifying appropriate offset actions. The criteria for determining the appropriate response and offsets are contained within the Framework'*.

5.3.2. Clause 52.17 (Native Vegetation)

The objective of this clause is '*protect and conserve native vegetation to reduce the impact of land and water degradation and provide habitat for plants and animals*'. (PE Act 1987) Note. A Victorian Government review of these exemptions is currently in progress.

A permit is required to remove, destroy or lop **all** native vegetation including native trees, shrubs, herbs and grasses, unless an exemption exists.

In particular, consideration must be given to the role of native vegetation:

- '*In areas where removal, destruction or lopping could jeopardise the integrity or long term preservation of any identified site of scientific, nature conservation or cultural significance'*.
- *'If it is rare or supports rare species of fauna or flora'*.

This permit requirement is relatively well known by land managers in woodland environments ie. Most people understand that a planning permit is required to remove trees and/or shrubs. However in grasslands the requirement for a permit is less well known, as many people are ignorant of the conservation values of native grasslands and the protection measures which exist.

Essentially land managers (private and public) can continue to manage their land as they have done in the past. However any deviation in management such as spraying, ploughing, fertilising, or burning etc. will require a planning permit (DCNR 1989).

6. POLICY FRAMEWORK

The Victorian and Federal Government have released a number of key strategies, plans and programs which affect grasslands and grassy woodland management and conservation specifically.

The most relevant of these are listed in the timeline below:

2005 Goulburn Broken Native Vegetation Management Strategy: Volume 2

- Regional Guidelines for Native Vegetation Retention Controls in the Goulburn Broken Catchment. The conservation status of Northern Plains Grasslands (Plains Grassland EVC) and Grey Box and Buloke Grassy Woodlands (Riverina Plains Grassy Woodland EVC) are listed as endangered. Estimates of the pre-1750 distribution and current distribution are included.

2003 Goulburn Broken Native Vegetation Management Strategy: Volume 1

- Strategy to protect, conserve and manage native vegetation in the Goulburn Broken Catchment.

Establishes a number of goals for native vegetation management including:

1. Maintain extent of all native vegetation types at 1999 levels in keeping with the goal of 'net gain' listed in Victoria's Biodiversity Strategy 1997.
2. Improve the quality of 90% of existing (2003) native vegetation by 2030.
3. Increase the cover of all endangered and applicable vulnerable Ecological Vegetation Classes to at least 15% of their pre-European vegetation cover by 2030.
4. Increase 2002 conservation status of 80% threatened flora and 60% threatened fauna by 2030.

- Eg 1 - Northern Plains Grasslands pre-1750 estimate is 5,374 ha therefore 15% cover equates to 806 ha. Current extant (existing) is 17ha total.

- Eg 2 - Plains Grassy Woodland pre-1750 estimate is 449,562 ha therefore 15% cover equates to 67,434 ha. Current extant (existing) is 4,240 ha total.

2002 Victoria's Native Vegetation Management – A Framework for Action

- Victoria's primary goal is to achieve 'A reversal, across the entire landscape of the long-term decline in the extent and quality of native vegetation, leading to a net gain[5]'.
- Provides a consistent and transparent way of assessing and valuing native vegetation.
- Gives likely planning permit approval decisions dependant upon conservation status eg. Vegetation of a High conservation status, planning approval should be refused (Northern Plains Grassland, Grey Box-Buloke Grassy Woodland and Grassy White Box Woodland fit into this High conservation status).

2002 Flora and Fauna Guarantee Action Statement: Central Gippsland Plains Grassland, Forest Red Gum Grassy Woodland, Northern Plains Grassland, South Gippsland Plains Grassland and Western (Basalt) Plains Grassland.

- Addresses five lowland grassland or grassy woodland communities which are listed as threatened under FFG Act 1988.
- Includes discussion of the communities, their broad description and distribution, conservation status and issues related to management.
- Management actions are divided into Statewide (DSE/DPI) and Local actions (Regional DSE and DPI Offices).

1992 DCE Draft Conservation Program for Native Grasslands and Grassy Woodlands in Victoria

- Outlines the flora, fauna, values threats, management and action required for these communities.

1987 Victoria's Biodiversity Strategy

Goals are to ensure that within Victoria:

- There is a reversal across the entire landscape of the long-term decline in the extent and quality of native vegetation leading to a net gain with the first target being no net loss by the year 2000.

[5] Net gain – where losses of native vegetation and habitat as measured by a combined quality quantity measure (habitat hectare) are reduced minimised and more than offset by commensurate gain.

- The ecological processes and the biodiversity dependent upon terrestrial, freshwater and marine environments are maintained and where necessary, restored; the present diversity of species and ecological communities and their viability is maintained or improved across each bioregion.
- There is no further preventable decline in the viability of any rare species or of any rare ecological community.
- There is an increase in the viability of threatened species and in the extent and quality of threatened ecological communities.

7. NON GOVERNMENT GROUPS

A number of non government groups are very active in grassland and grassy woodland issues. These groups bring together experience and expertise from a range of backgrounds, including scientist, researcher, field naturalist, Landcare and farming. These groups are important because they not only disseminate information effectively through existing networks but they are effective at lobbying government, including purchasing land eg. Naringaningalook Grassland and Goomalibee Grassy Woodland.

Some of these are listed below:

Victorian National Parks Association
- Independent, non-profit organisation which fosters public interest in national and state parks, flora and fauna reserves and other areas of conservation, scientific or historic value.
- Publishes newsletters, magazines and books many relating to grasslands and grassy woodlands.

Trust For Nature
- Covenants, land purchases (revolving fund), flora surveys and management advice.
- Managers of public land including Naringaningalook Grassland.
- Publish Information Sheets and publications such as *Grassy Guidelines: How to manage native grasslands and grassy woodlands on your property*.

Landcare
- May be involved in grassland and grassy woodland revegetation or rehabilitation projects.
- Support private land managers as the majority of grassland and grassy woodland sites occur on private property.

Local Government
- Responsible for roadside management and roadside management plans.
- Planning staff provide input in to planning processes such as planning permits and planning scheme reviews.
- Environment officers (depending on their charter) may provide advice on the assessment, conservation and management of grassland and grassy woodlands.

County Fire Authority
- Many significant grassland reserves particularly in Western Victoria have been maintained by volunteer CFA brigades.
- Fire plays an important role in maintaining and managing many grassland and grassy woodlands. CFA must be supported if they are to assist in the management and conservation of grasslands and grassy woodlands, including trial burns and improved training.

8. ECOLOGY OF GRASSLANDS AND GRASSY WOODLANDS

8.1.Grassy features

Grasses are an important and conspicuous component of many grassland and grassy woodlands. Therefore it is useful to understand the meaning of some commonly used terms, which are used to describe this group of plants. Also by understanding the differences between the growing conditions of grasses (exotic and native) these differences, can be exploited to increase the cover of native grasses (Morgan 1994).

Grasses can be classified as either C4 (Warm season grasses) or C3 (Cool season grasses). This refers to the metabolic pathways by which plants produce sugars, from water, sunlight and carbon dioxide. They are also referred to as warm or cool season grasses because they have different growing seasons. In general C4 grasses are active in Spring/Summer and C3 grasses are active in Autumn/Winter (Morgan 1994).

Local examples include:

- C4 or Warm season grasses eg. Kangaroo Grass (*Themeda spp*)
- C3 or Cool season grasses Spear Grasses (*Austrostipa spp*.) or Wallaby Grasses (*Austrodanthonia spp*.)

Other common terms used to describe grasses include:

Tussock grass - Many tillers each with its own roots, stems and leaves which function independently eg. *Themeda triandra (*Kangaroo Grass*).*

Stonloniferous grass - Horizontal stems above the ground eg. *Phragmites spp.(*Common Reed*)*

Rhizomatous - Horizontal stems below the ground eg. *Cynodon dactylon* (Couch Grass)

Perennial - Survives for more than one season usually three or more years eg. *Austrostipa scabra* (Rough Spear Grass. Most native grasses are perennial in nature.

Annual - Survives for one growing season usually to exploit favourable conditions and avoid adverse conditions eg. *Avena fatua* (Wild Oat).

8.2. Disturbance

Native grasslands and grassy woodlands have evolved with a degree of disturbance. Prior to European settlement macropods (kangaroos and wallabies) grazed these areas, aboriginals burnt the vegetation and dug the soil for roots and tubers. However with European settlement and development, new disturbance regimes were introduced that native plants were not adapted to, including grazing by hard hoofed animals, and wide spread cultivation. (Foreman 1996)

Some degree of disturbance is considered desirable to reduce biomass and allow spaces to develop between the grass tussocks (inter tussock spaces) (Foreman 1996). In Northern Plains Grasslands this biomass reduction is less critical than in Western Basalt Plains Grasslands due to the much slower growth rates, dominant species and the climate (Foreman 1996). Further research is required to determine exactly what types of disturbance is desirable and when exactly this should occur. The following sections discuss the most common types of disturbance used in management.

8.2.1.Grazing

Grazing of grasslands and grassy woodlands by domestic stock (sheep and cattle) can lead to significant changes in the ecology of the native vegetation. These changes are dependent on the plant species tolerance of grazing, and the duration, intensity and timing of grazing (Lunt 1991, Foreman 1996, Kirkpatrick *et.al* 1996).

The most common changes observed in grazed grasslands and grassy woodlands include:

- Tall perennial tussock grasses are replaced by annuals (usually exotic) and low growing perennial grasses (creating a mown lawn affect),
- Palatable perennial native herbs including chenopods are eliminated,
- Palatable annual native herbs are eliminated,
- Ringbarking of trees and woody shrubs,
- And regeneration of trees and woody shrubs are suppressed (McIntrye 2004).

Sheep grazing may be more destructive than cattle because of their grazing habits. Typically sheep graze more uniformly than cattle, down to soil level and select the most palatable plant species (McIntrye 2004). Cattle have the potential to *'pug'* the ground more so than sheep do if the ground is wet, which can cause damage to native plant tubers (Edmonds *per comms* 2006). Cattle farming is typically a more intensive agricultural system however, which includes fertilisation, pasture establishment, irrigation etc. For this reason if native grasslands and grassy woodlands occur on private agricultural land, it is typically found where sheep have grazed and not cattle (McIntryre 2004).

Grazing by rabbits and macropods can also affect the ecology of grasslands and grassy woodlands, if there are large numbers. Overgrazing by domestic, native or exotic animals can lead to weed invasion, localised erosion and poor regeneration of woody species (McIntrye 2004).

8.2.2. Cultivation and clearing

Cultivation, ploughing, grading or ripping etc. is perhaps the most disastrous scenario possible for native grasslands and grassy woodlands. Not only is the grassy understorey removed including the associated herbs and small shrubs but the exotic plant species are further advantaged because of an increase in soil nutrient levels. These are typically exotic annuals, which quickly establish and grow in response to an increase availability of nutrients and limited competition from native species (Stuwe 1986). Disturbance to the soil crust and the mat forming native grass roots has also been suggested, as a contributing factor in allowing annuals to invade where they were previously excluded (Scarlett 1994).

Clearing of trees and large shrubs in grassy woodlands, lead to an increase in available light and soil temperature. This may favour species that are adapted to these conditions ie. Grasses rather than herb species. Clearing of trees may also affect the soil fertility. Prober (2002) found that a soil fertility gradient existed in Grassy Woodland, where fertility was highest beneath the canopy and least amongst the open grassy areas.

While the cultivation of Buloke roots may result in suckering from the parent plant, this is not a recommended practice. It is a short-term approach, does not lead to genetic difference in a population and if conducted too close to the trunk or if too many feeder roots are severed, it may seriously harm individual trees (Macauley and Westbrooke 2003).

8.2.3. Fire

Researchers have studied the affects of fire on the plant species composition and ecology of grassland and grassy woodlands. Studies have also identified specific fire regimes for threatened plant species including members of the Pea (*Cullen sp*.) and Orchid (*Prasophyllum sp*) families (Coates and Lunt 2006, Scarlett and Parsons 1982). Virtually all published information is on the response of flora rather than fauna to fire (Lunt and Morgan 2000).

In the main grasslands and in particular the Western Basalt Plains Grassland, have been the subject of many studies examining burnt and non-burnt areas. Annual burning has been used since the 1940's in these areas, as a means of controlling the fire threat on roadsides and rail reserves (Lunt and Morgan 2000). These frequently burnt reserves are some of the highest quality, biodiverse, grassland remnants in south eastern Australia. By comparison few studies have been conducted on grasslands or grassy woodlands of the Northern Plains (Foreman 1996).

Nowadays fire has been largely replaced with increased herbicide use and ploughed firebreaks. Where it does occur it is typically on small, narrow rail and road easements, which have historically been burnt and on previously grazed (rarely burnt) paddocks, which are now being burnt to maintain grassland diversity by conservation agencies (Lunt and Morgan 2000).

There is much conjecture about the effects of burning and burning in different seasons. Spring burning has been suggested as a possible mechanism to deplete annual exotic species in invaded grasslands by reducing their flowering and seed set (Stuwe 1986, McDougall 1989). Perennial species are able to re-shoot from tubers and are more able to recover from fire, than annuals that depend on seed for regeneration either on site or dispersed from offsite. Over several years, repeated spring burning may exhaust seed supplies and deplete these species from the community. By contrast autumn fire regimes may help to promote exotic annual grasses by providing competition-free sites for establishment (Lunt and Morgan 2000).

Foreman (1996) has conducted the most relevant studies of fire ecology on the Northern Plains. He found that burning dramatically reduced the cover and abundance of annuals (exotic and native) while perennials had only a minor reduction in cover and abundance. Infrequent burning may therefore have application as a conservation management tool for reducing the abundance and richness of weeds. However Foreman 1996 recommends a continued conservative grazing regime at Terrick Terrick Grassland, until further research is conducted.

Grassy Woodlands require a slightly different approach to grasslands as frequent burning will inhibit regeneration of some tree and shrub species and may eliminate those, which reproduce only from seed. Barlow (1998) recommends a mosaic approach to burning at a frequency of no less than six to seven years, to allow for regeneration, refuge and diversity of habitat for wildlife. Macauley and Westbrooke (2003) recommended a burning frequency of no more than ten years, in Buloke Woodlands of the Wimmera. Sluiter *et. al* (1997) reported that wildfire at Wyperfield National Park had 'eliminated and diminished the quality of Buloke woodlands'.

Clearly fire is a complex issue and further research is required before any specific recommendations can be made regarding the appropriate regimes for the communities *Northern Plains Grassland, Grey Box-Buloke Grassy Woodland* and *Grassy White Box Woodlands*.

8.2.4.Mowing

Little research has been undertaken on the effects of mowing or slashing on grasslands and grassy woodlands of the Northern Plain (Lunt 1991). As a general rule mowing is probably less favourable in native grasslands than burning (Kirkpatrick *et al* 1988). McDougall (1989) found that *Themeda* grasslands were quite tolerant of mowing and that annual or biennial mowing may be preferable to no biomass management at all. Barlow (1998) suggests that mowing can be used in weedy situations to hinder the seed-set of weeds and to favour the potential seed-set of native plants. If this strategy is employed then care should be taken to remove the spent grass by collecting, baling or raking the cut grass and removing it. Lodder *et. al* (1986) recommends that grasslands and grassy woodlands should not be mown, less than 10cm in high, in order to permit the survival of native herbs.

8.3.Regeneration of overstorey species

Buloke trees can be male, female or in some rare instances both. The female trees have cones and the male trees produce long catkins of red coloured pollen. Regeneration of Buloke trees tends to be rainfall dependant, typically in years with an early autumn break and above average rainfall. Successful germination and seedling survival requires cooler than average summer temperatures and regular rainfall to sustain its growth (DNRE 1998). Suckering is also a means of vegetative regeneration. This is often observed in roadside table drains where graders have disturbed the roots and water collects (Castle 1989).

Grey Box and White Box appear to be not so dependant on seasonal constraints and regeneration can be continuous throughout the year if conditions are suitable. (Todd 2005)

9. HABITAT AND FAUNA VALUES

Grassy ecosystems contain 40% of the state's extinct and threatened vertebrate fauna. Nearly as many birds and reptiles are in the endangered and vulnerable categories, as there are in all other habitats in Victoria combined (VNPA 2000). Needless to say, conservation of these communities including Northern Plains Grassland, Grassy White Box Woodlands and Grey Box-Buloke Grassy Woodlands is very important to protect our native fauna threatened or otherwise.

No specific fauna associations of these communities are known with the exception of the Plains-wanderer (*Pedionomus torquatus*) and the Striped-legless lizard (*Delma impar*), which are nearly always found in grasslands and occasionally grassy woodland environments. Both these threatened fauna species have become 'flag-ship species' for grassland conservation efforts.

The fauna of grasslands and grassy woodlands can be broadly divided into the following vertebrate and invertebrate groups:

Mammals

At least six mammals are known to have vanished from the Northern Plains since European settlement (Bennet *et. al* 1998). Among these include the Eastern Quoll (*Dasyurus viverrinus*), Rufous *Bettong (Aepyprymnus rufescens*), Eastern Hare-wallaby (*Lagorchestes leporides*), Red Kangaroo (*Macropus rufus)*, Bridled Nailtail Wallaby (*Onychogalea fraenata*) and Dingo (*Canis lupus dingo*) (Bennet *et. al* 1998). Medium size terrestrial mammals appear to be the most adversely affected group. This depletion has been largely brought about by the introduction of the Red Fox, Feral Cat and significant losses of habitat, as land was settled and developed for agriculture (Bennet *et. al* 1998).

Today the most familiar and obvious animals of grasslands and grassy woodlands are the large mammals the macropods (Kangaroos and Wallabies). In addition to these the large-medium sized arboreal mammals have persisted in treed grassy environments such as the Brush-tailed Phascogale (*Phascogale tapaotafa*), and Squirrel Glider (*Petaurus norfolcensis*) (Bennet *et. al* 1998).

Small mammals are made up nearly entirely of the bat species with the exception of the Yellow Footed Antechnius (*Antechinus flavipes*) and the Fat-tailed Dunnart (*Sminthopsis crassicaudata*)(Bennet *et. al* 1998). Of the bats there is no historical information to suggest any regional extinctions over the past 150 years. Most are still widespread and relatively common if there overall numbers have declined (Bennet *et. al* 1998). The Large-footed Myotis (*Myotis adversus*) and the Greater Long-eared Bat (*Nyctophilus timoriensis*), while rare and vulnerable respectively, do not depend solely on grasslands or grassy woodlands (Bennet *et. al* 1998).

Figure 8- Fat–tailed Dunnart (*Sminthopsis crassicaudata)*

The Fat-tailed Dunnart is a small mouse-sized marsupial that occurs in grassland and grassy woodlands throughout inland Australia. Distinguished from the house mouse by its large beady eyes, large ears and short fat tail, where it stores fat reserves in its tail as an energy source. It makes small nests under rocks, fallen timber or old posts for daytime shelter and at night it forages for worms crickets, beetles, spiders and other invertebrates. Most records of this species are from unimproved pastures and native grasslands in farmland in the northwest eg. Patho Plains (Bennet *et.al* 1998).

Birds

The composition of the bird fauna is dynamic in these communities as birds move between vegetation types and to and from the Goulburn Broken Catchment as a whole. There is also substantial overlap between the birds of grasslands and grassy woodlands on the Northern Plains and those of the forests and woodlands of temperate south-eastern Australia (Bennet *et. al* 1988).

Those species closely associated with grasslands and grassy woodlands include: Banded Lapwings, Grey-crowned Babbler, Bush-stone Curlew, Plains-wanderer, Brown Songlark, Inland Dotterel, Singing Bushlark and Stubble Quail (Bennet *et.al* 1988).

Figure 9 - Plains-wanderer (*Pedionomus torquatus*)

The Plains-wanderer is a rare, shy ground-dwelling bird resembling a tall, slender quail. Once widespread across grasslands and grassy woodland, it is now nearly exclusively found in North-west Victoria particularly on the Patho Plains. The Plains-wanderer has survived only in the occasional unimproved paddocks, that are now left across its former range (VNPA 2000).

Reptiles

Forty-eight species are known from the Northern Plains, representing nine families: tortoises, dragons, geckoes, legless lizards, skinks, goannas, pythons, blind snakes and snakes. The legless lizards preferred habitat is native tussock grasslands although it has been found occasionally in other vegetation types such as Box-Ironbark Forest (Smith, S *pers.comms*, Bennet *et.al* 1988).

Figure 10 - Tree Goanna (*Varanus varius*)

The Tree Goanna sometimes called the Lace Monitor, is a large arboreal lizard of an average length of 1.5 metres. Absent from either grasslands or irrigation areas where few trees occur, it uses live and dead trees for basking, foraging and shelter (in hollows). They are a carnivorous predator and scavenger that forage over a large area and will eat insects, vertebrates (eggs and nestlings of tree-nesting birds) as well as carrion (Bennet *et. al* 1998). This species was observed in a number of locations in the Goulburn Broken Catchment including Wunghnu Bushland Reserve.

10. THREATS

Very little vegetation of Northern Plains Grasslands, Grey Box-Buloke Grassy Woodlands and Grassy White Box Woodlands exists today and what does exist is poorly reserved (Lunt 1991, Prober and Thiele 1995).

The following are threats, which are common to all three vegetation communities: Northern Plains Grassland, Grey Box-Buloke Grassy Woodland and Grassy White Box Woodland.

1. **Soil disturbance**
   Cultivating, ploughing, ripping, grading or scrapping the soil is harmful to grasslands and grassy woodlands. Hobbs and Atkins (1988), Stuwe (1986) and Foreman (1996) have demonstrated that soil disturbance greatly favours the establishment of introduced species and causes a rapid often complete removal of native vegetation and replacement by introduced species. It is particularly disastrous for grasslands as all structural components are affected, not just the understorey as in grassy woodlands.

2. **Grazing**
   Grasslands and grassy woodlands can tolerate and are adapted to light periodic grazing. Light periodic grazing is often a recommended management practice of Northern Plains grasslands and grassy woodlands to reduce the biomass of perennial native grasses eg. *Terrick Terrick Grasslands National Park* (Foreman 1996). However as grazing intensity increases the diversity of native species typically declines and become dominated by exotic species (Prober and Thiele 1995). The structure of the vegetation and the composition of species may change and the remnant may be more prone to weed invasion (DSE 2004b).

3. **Clearing**
   Clearing of trees, shrubs, herbs and native grasses require a Local Government Planning permit, unless an exemption exists (DCNR 1989). However areas of grassland and grassy woodland continue to be cleared despite the conservation efforts of government and non-government agencies, community and individuals. It is difficult to estimate the extent of loss occurring in these vegetation communities, because no proper monitoring of permitted or unauthorised clearing occurs. Estimates suggest that up to half of the Northern Plains Grassland sites recorded as part of the *Plains Wanderer Statewide Assessment* may have been destroyed (Marshall Deanna *pers.comms* 2006).

4. **Ground timber collection**
   Ground timber is essential to provide habitat for native fauna including the threatened Bush-Stone Curlew (*Burhinus grallarius*) and plays an important role in recycling nutrients (DCNR 1991). It is commonly collected from grassy woodlands such as roadsides for firewood or to ‘clean-up’ in cropping paddocks or pastures.

5. **Invasion by weeds**
   The term weed is used here to define any plant exotic or native, which is not part of the vegetation community. Weeds compete with desirable species and can lead to a decline of diversity and regenerative capacity of native species (DCE 2004b). Weeds can be spread by machinery, vehicles, people and animals. They exist at virtually every grassland and grassy woodland site surveyed by Foreman (1996) across the Northern Plain. A weed control program is necessary to maintain or improve the value of remnants in the long term particularly at priority sites. Lunt (1991) suggests that they rarely pose a serious threat to grasslands *per se,* rather the exotic weeds particularly annual grasses are evidence of prior disturbance, such as ploughing. Appendix 5 lists common weeds of grasslands and grassy woodlands.

6. **Inappropriate planting**
   Grasslands and grassy woodlands are particularly susceptible to inappropriate planting of trees and shrubs because trees and shrubs are naturally sparse or absent. The understanding of this fact can lead to inappropriate planting by individuals or groups. As occurred at O’Deas Rd, Tongala in the GBC where trees and shrubs were planted in a Northern Plains Grassland area. Methods of planting may also include deep ripping and cultivating the soil, which can further degrade a remnant (DCNR 1991).

7. **Trampling**
   Native grasses and herbs are particularly susceptible to trampling by heavy vehicles and machinery. Lunt (1987) found that the native grass Kangaroo Grass (*Themeda triandra*) was eliminated after one drive over soft wet ground.

8. **Inappropriate use of herbicides**
   While herbicides have a role in managing weeds in grasslands and grassy woodlands (Morgan 1989), they pose a threat if used inappropriately and indiscriminately. Herbicide use has largely replaced fire nowadays in controlling fuel loads and fire hazards, on roadsides and rail reserves (DSE 2004b).

9. **Increased soil nutrient status**
   Most Australian plants are poorly adapted to low soil nutrient levels including the vegetation of grasslands and grassy woodlands. Increased soil nutrient status from fertiliser application, run-off or fertiliser drift from neighbouring agricultural land or stock camps, result in a more favourable environment for weeds, loss of native understorey species and dieback in overstorey species (Windsor 1999).

10. **Fire**
    The issue of fire is very complex in that an absence of burning may be threatening the conservation values at grasslands and grassy woodlands (DCNR 1992, DSE 2004b). Research on grasslands of Western Victoria support the role of fire in reducing the biomass and maintaining the diversity of native species (Lunt 1990). However because little research has been conducted on grasslands and grassy woodlands of the Northern Plain this suggestion is more difficult to confirm (Foreman 1996). The absence of fire is significant for the management of many rare species, such as Purple *Diuris (Diuris punctata var.punctata*) and Gaping Leek-orchid (*Prasophyllum correctum*) that depend on fire to stimulate flowering (DPI 2003).

11. **Wildflower harvesting**
    Wildflowers have been periodically harvested for commercial use from grasslands and grassy woodlands across the Northern Plains. This occurs with a permit or license issued under the FFG Act by the Department of Sustainability and Environment. Drumsticks (*Pycnosorus globulus*) in particular are highly sought after and have been harvested from private land and roadsides in the north west of the region in the past (DSE 2004a).

12. **Habitat fragmentation and size**
    The fragmented and small size of many grasslands and grassy woodlands is a threat to the flora and fauna that occur and to the viability of these vegetation communities as a whole. It is generally accepted that habitat fragmentation leads to a reduced species diversity within remnants through inbreeding and altered ecosystem processes (Hobbs 1993). Smaller remnants have a higher edge-to-area ratio and are therefore more susceptible to degradation arising from management practices in the surrounding agricultural land (Saunders *et al.* 1991). The small size of many grasslands and grassy woodlands on roadsides, rail reserves, cemeteries, conservation reserves and on private property, also make them more susceptible to accidental and episodic events, such as runaway fires, wayward grader drivers etc.

13. **Lack of knowledge**
    A number of researchers Lunt (1991), Foreman (1996), Morgan (1994) and Prober (1995) have highlighted the need for greater research. This research needs to be practical and transferable to enable land managers to apply specific management regimes to these vegetation communities.

11. MANAGEMENT

Before deciding on any management regime for grasslands and grassy woodlands, the following are important questions to consider:

- What is the management goal?
- What species are present and how will they react to any planned action?
- How has the site been managed in the past?
- What threats are present on site?
- Do I need to change the way the site has been managed in the past?
- How am I going to monitor the affects of my actions? (Barlow 1998)

While lack of knowledge is a real threat as discussed earlier, the following general recommendations can be made. These are applicable to Northern Plains Grassland, Grey Box-Buloke Grassy Woodlands and Grassy White Box Woodlands. The principles of 'adaptive management' should be applied when managing these areas, recognising that site specifics and available resources will dictate the degree to which these management guidelines are relevant at each site.

1. Continue past management

If a good quality remnant of either a grassland or grassy woodland exists and has survived under a certain management regime (eg. frequent fuel reduction burning or light grazing by stock) then it is best to continue that regime with only minor modifications. Before adopting a new regime consider a trial treatment with careful monitoring of the affects. Detailed botanical assessments including species presence, diversity, abundance and structure are necessary to monitor the change in floristics over time. Photo points are also beneficial to quickly assess general trends at a site (DSE 2004a, Barlow 1998).

2. Grazing by livestock

Light and periodic grazing by livestock during Summer and Autumn in grasslands and grassy woodlands is generally not detrimental and may be beneficial to reduce the biomass and maintain species diversity (Foreman 1996). In Northern Plains Grassland, Foreman (1996) advocates a continuation of a 'conservative' grazing regime where there is a history of grazing eg. *Terrick Terrick National Park*.

In most instances woodlands however require little to no grazing (Barlow 1998). Prober and Thiele (1995) found that the 'little grazed' remnants had the best representative understorey of the pre-European Grassy White Box Woodland. Any grazing therefore requires careful monitoring, to ensure that there is adequate recruitment of woody species and that the richness of native plants is not in jeopardy. Grazing may be required to reduce the biomass of exotic and native grasses ie. 'crash grazing'. If permissible stock should be excluded in Spring to allow natives to set seed (particularly those short-lived native annual species) and in Winter to avoid pugging when wet (Barlow 1998).

3. Natural regeneration

Natural regeneration may be an effective means of increasing the size of a patch of grassland or grassy woodland; however the success depends largely on the prior history of management (Prober and Thiele 2005). Grassy woodlands and grasslands can establish once livestock is removed, if there is a sufficient seed bank present in the soil and/or adjacent seed source. Typically these areas have had a moderate farming history i.e. little cultivation, fertilizer application, irrigation etc. Studies by Onans and Parsons (1980) in Mallee woodlands showed that natural regeneration can be very slow (up to 50 years) and may result in a non-natural suite of vegetation. Therefore this method requires careful monitoring and potential active management and intervention, including thinning of overstorey or supplementary planting.

4. Weed management

A thorough understanding of the ecology of the flora found in these communities (including the seasonality of seed germination, active growth and reproduction) is necessary, when timing any weed control treatments (Lunt 1991). Weeds in these vegetation communities are all pervasive. Foreman (1996) found no sites of grasslands or grassy woodland on the Northern Plains where weeds were totally absent. Techniques therefore that encourage the competitiveness of native species over exotics rather than total eradication should be encouraged. Techniques may include: mechanical pulling of weeds, manipulation of fire regimes, scalping, mulching and herbicide application. In most instances more than one technique will need to be employed as part of a total weed management strategy.

The use of herbicide application in grasslands and grassy woodlands requires further study before these treatments can be broadly recommended. Results can be unpredictable as in Cole *et.al* (2004), where they found that Kangaroo Grass or *Themeda*, which is normally resistant to *Simazine* was not resistant.

Its cover and density was significantly reduced. As in all aspects of grassland and grassy woodland management, the manager should use caution when changing the existing regime.

The intactness of the understorey is also an important consideration, as some weed management techniques (such as scalping) involve the complete removal of all vegetation, native and exotic. Cole *et.al* 2004 found that scalping combined with soil disturbance best promoted Kangaroo Grass or *Themeda* establishment in Grassy White Box Woodlands. This form of weed management is best employed in areas where little native understorey exists.

Manipulation of fire and grazing regimes in conjunction with herbicide control is probably the most likely method for the broad-scale control of weeds in grasslands and grassy woodlands. Davies (1997) gives a good review of studies relating to weed management in these environments including chemical herbicide use.

5. Burning

Annual spring burning has been recommended as a means to control the seeds of annual weeds (Adair 1995, Foreman 1996). However there is still considerable conjecture about the effectiveness of this strategy, as has been discussed previously. If the grassland or grassy woodland does not have a history of burning then field-testing using mosaic burns should be conducted carefully with adequate monitoring thereafter. Fires at too high a frequency will inhibit the regeneration of woody species (Barlow 1998).

Autumn burning is recommended by Prober and Thiele (1995) for Grassy White Box Woodland every 4-6 years to maintain the floristic diversity in remnants.

6. Minimise soil disturbance

Minimising soil disturbance as much as possible will prevent the invasion and spread of weeds and maintain the structure and diversity of native plant species in grasslands and grassy woodlands.

7. Revegetation

Where native seed banks have been depleted or there are no alternative seed sources, revegetation may be required to restore some of the original species (Yates and Hobbs 1997). Important considerations include the method of planting, plant species and local provenance (DNRE 2001). Plantings should try to achieve as near natural a composition and planting density as possible and while recognising that some form of seed-bed preparation is necessary, this should be limited to areas which have been previously disturbed (Yates and Hobbs 1997).

Revegetation may also be a necessary requirement to protect rare grassland or grassy woodland species eg. Plover Daisies (*Leiocarpa spp*) have been reintroduced to the *Naring Grassland Reserve* as a means of conserving the species.

8. Soil nitrate depletion

In most degraded remnants, soil nitrates rise to high levels over the Summer and Autumn, encouraging lush growth of annual exotics as they germinate in Autumn (Prober and Thiele 2005). Experiments have shown that applying sugar to the soil can suppress soil nitrates, reduce the vigour of annual exotics and enhance the establishment of desirable natives. This increase in the carbon:nitrogen ratio causes soil microbes to flourish which use up any available nitrogen. Field trials used 0.5kg sugar per m^3 at 3-monthly intervals but further studies are required to determine the effective minimum rates of carbon application for different types of remnants (Prober and Thiele 2005).

9. Restore the landscape

To ensure the conservation of these communities efforts are required at the landscape and patch level (DCNR 1992, DSE 2004a, DSE 2004b). Tools including the *Landscape Context Tool* can assist in determining where and how much vegetation should be protected and enhanced (Wilson and Terweda 2005).

Some general points can be made regarding these communities.

- Protect and enhance existing areas first (rather than recreate habitat).
- Enlarge existing areas.
- Buffer narrow strips eg. roadsides or rail reserves from edge affects by revegetating with local species.
- Link isolated patches to assist flora and fauna dispersal and movement.
- Develop a landscape plan for restoration and revegetation works for these communities to achieve the most from available resources.

10. Improve stakeholder awareness and understanding

Poor stakeholder awareness and understanding of these vegetation communities is a significant impediment to there conservation. Education and extension programs must highlight the values of these vegetation communities, their tenuous state and the obligations which exist under current State and Federal Laws.

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APPENDIX 1: RARE AND THREATENED FLORA OF GRASSLANDS AND GRASSY WOODLANDS

Family	Scientific Name	Common Name	Conservation status	Listed FFG Act	Listed EPBC Act
Apiaceae	*Eryngium paludosum*	Long Erygium	v		
Asteraceae	*Stemmacantha australis*	Austral Cornflower	x		
Asteraceae	*Senecio georgianus*	Grey Groundsel	Xx		
Asteraceae	*Brachyscome chrysolglossa*	Yellow-tongue Daisy	v	Yes	
Asteraceae	*Brachyscome curvicarpa*	Curved-fruit Daisy	e		
Asteraceae	*Brachyscome debilis*	Weak Daisy	v		
Asteraceae	*Brachyscome gracilis*	Dookie Daisy	v	Yes	
Asteraceae	*Helipterum molle*	Soft Sunray	v		
Asteraceae	*Leptorhynchos panaetioides*	Wooly Buttons	r		
Casuarinaceae	*Allocasuarina luehmannii*	Buloke	d	Yes	
Chenopodiaceae	*Slerolaena napiformis*	Turnip Bassia	e		
Chenopodiaceae	*Maireana cheelii*	Chariot Wheels	v	Yes	Yes
Chenopodiaceae	*Maireana excavata*	Bottle Bluebush	v		
Chenopodiaceae	*Maireana humillima*	Dwarf Bluebush	r		
Cyperaceae	*Callitris glaucophylla*	White Cypress-pine	d		
Fabaceae	*Cullen parvum*	Small Psoralea	e	Yes	
Fabaceae	*Swainsona plagiotropis*	Red Swainson-pea	e	Yes	
Fabaceae	*Swainsona murrayana*	Murray Swainson-pea	e	Yes	
Fabaceae	*Templetonia stenophylla*	Leafy Templetonia	d		
Fabaceae	*Euphrasia scabra*	Rough Eyebright	e	Yes	
Fabaceae	*Lotus cruentus*	Red Bird's-foot Trefoil	d		
Loranthaceae	*Amyema linophylla subsp orientale*	Buloke Mistletoe	v	Yes	
Mimosaceae	*Acacia oswaldii*	Umbrella Wattle	d		
Mimosaceae	*Acacia decora*	Western Silver Wattle	v		
Mimosaceae	*Acacia omalophylla*	Yarran Wattle	e	Yes	
Myoporaceae	*Myoporum montanum*	Waterbush	r		
Myoporaceae	*Myoporum deserti*	Turkey Bush	d		
Myrtaceae	*Hakea tephrosperma*	Hooked Needlewood	d		
Ophioglossaceae	*Botrychium australe*	Austral Moonwort	v		
Orchidaceae	*Prasophyllum suaveolens*	Fragrant Leek Orchid	e	Yes	
Orchidaceae	*Prasophyllum hygrophilum*	Swamp Leek Orchid (Nagambie)	e	Yes	Yes
Orchidaceae	*Diuris cuneata*	Wedge Diuris	v		
Orchidaceae	*Diuris punctata*	Purple Diuris	v	Yes	
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	v		
Poaceae	*Danthonia ricardsonii*	Straw Wallaby-grass	v		
Poaceae	*Eragrostis facata*	Sickle Love-grass	r		
Poaceae	*Panicum bisulcatum*	Black-seed Panic	e		
Poaceae	*Panicum decompositum*	Australian Millet	r		
Poaceae	*Sporobolus creber*	Rat-tail Grass	r		

Poaceae	*Amphibromus pithogastris*	Swollen Swamp Wallaby-grass	e	Yes	
Thymelaeaceae	*Pimelea spinescens subsp. spinescens*	Spiny Rice-flower	v		

Source: DCNR 1992 and Cullen *et.al* 2005

X State extinct
e State endangered
v State vulnerable
r State rare
d State depleted
X Nationally extinct

APPENDIX 2: RARE AND THREATENED FAUNA OF GRASSLANDS AND GRASSY WOODLANDS

Fauna Group	Scientific Name	Common Name	Conservation status	Listed FFG Act	Listed EPBC Act
Bird	*Calyptorhynchus magnificus magnificus*	Red-tailed Black Cockatoo	e	Yes	
Bird	*Xanthomyza phyrgia*	Regent Honeyeater	e	Yes	
Bird	*Chlamydera maculata*	Spotted Bowerbird	e	Yes	
Bird	*Falco hypoleucos*	Grey Falcon	v	Yes	
Bird	*Pedionomus torquatus*	Plains-wanderer	v	Yes	
Bird	*Burhinus magnirostris*	Bush Thick-knee	v	Yes	
Bird	*Polytelis swainsonii*	Superb Parrot	v	Yes	
Bird	*Lathamus discolor*	Swift Parrot	v	Yes	
Bird	*Pomatostomus temporalis*	Grey-crowned Babbler	v	Yes	
Bird	*Climacteris affinis*	White-browed Treecreeper	v	Yes	
Bird	Falco subniger	Black Falcon	r		
Bird	*Cacatua leadbeateri*	Pink Cockatoo	r		
Bird	*Neophema pulchella*	Turquoise Parrot	r		
Bird	*Ninox connivens*	Barking Owl	r	Yes	
Bird	*Tyto novaehollandiae*	Masked Owl	r	Yes	
Bird	*Coracina maxima*	Ground Cuckoo-shrike	r		
Bird	*Grantiella picta*	Painted Honeyeater	r		
Bird	*Morethia adelaidensis*	Apostlebird			
Bird	**Haliaeetus leucogaster*	White-bellied Sea-Eagle	r	Yes	
Bird	**Grus rubicundus*	Brolga	r		
Bird	**Ninox strenua*	Powerful Owl	r	Yes	
Bird	**Polytelis anthopeplus*	Regent Parrot	r	Yes	
Bird	**Lophoictinia isura*	Square-tailed Kite	v		
Bird	*Ardeotis australis	Australian Bustard	e		
Frog	*Limnodynastes interioris*	Giant Bullfrog	v	Yes	
Invertebrate	*Paralucia pyrodiscus lucida*	Eltham Copper Butterfly	v	Yes	
Mammal	*Dasyurus viverrinus*	Eastern Quoll	e		
Mammal	*Perameles gunniii*	Eastern Barred Bandicoot	e	Yes	
Mammal	*Sminthopsis murina*	Common Dunnart	r		
Mammal	*Phascogale tapoatafa*	Brush-tailed Phascogale	r	Yes	
Mammal	*Petaurus norfolcensis*	Squirrel Glider	r	Yes	
Mammal	**Dasyurus maculatus*	Tiger Quoll	v	Yes	Yes
Mammal	**Macropus robustus*	Common Wallaroo	r	Yes	
Mammal	**Myotis adversus*	Large-footed Myotis	r		
Mammal	**Nyctophilus timoriensis*	Greater Long-eared Bat	r		
Reptile	*Rhynchoedura ornata*	Beaked Gecko	e		
Reptile	*Delma impar*	Striped Legless lizard	v	Yes	
Reptile	*Pygopus nigriceps*	Hooded Scaly-foot	e		
Reptile	*Tympanocryptis lineata pinguicolla*	Southern Lined Earless Dragon	e	Yes	
Reptile	*Furina diadema*	Red-naped Snake	e	Yes	
Reptile	*Morelia spilota variegata*	Carpet Python	v	Yes	
Reptile	*Vermicella annulata*	Bandy Bandy	v		
Reptile	*Ramphotyphlops proximus*	Woodland Blind Snake			
Reptile	**Tympanocrptis lineata lineata*	Lined Earless Dragon	v	Yes	
Reptile	*Varanus varius*	Tree Goanna	r	Yes	
Reptile	**Lerista muelleri*	Muellers Skink	r	Yes	
Reptile	**Demansia psammophis*	Yellow-faced Whip Snake	r		
Reptile	**Pseudonaja nuchalis*	Western Brown Snake	r		
Reptile	**Suta Suta*	Curl Snake	r		

*Note: Includes fauna primarily of other habitats, but which also occur in native grassland and grassy woodland.

Source: DCNR 1992 and CNR 1995

e State endangered
v State vulnerable
r State rare
d State depleted

APPENDIX 3: PLANTS CHARACTERISTIC OF NORTHERN PLAINS GRASSLANDS

Family	Scientific Name	Common Name
Anthericaceae	*Arthropodium spp*	Vanilla Lillies
Asphodelaceae	*Bulbine bulbosa*	Bulbine Lily
Asteraceae	*Leptorhynchos squamatus*	Scaly Buttons
Asteraceae	*Rhodanthe corymbiflora*	Paper Sunray
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting
Asteraceae	*Calocephalus sonderi*	Pale Beauty-heads
Asteraceae	*Ptilotus exaltatus*	Lambs-tails
Asteraceae	*Calotis scabiosifolia*	Rough Burr-daisy
Asteraceae	*Pyncosorus globosus*	Billy Buttons
Asteraceae	*Isoetopsis graminfolia*	Grass Cushion
Asteraceae	*Triptilodiscus pygmaeus*	Common Sunray
Asteraceae	*Eriochlamys behrii*	Wooly Mantle
Asteraceae	*Leiocarpa panaetioides*	Wooly Buttons
Asteraceae	*Goodenia pusilliflora*	Small-flowered Goodenia
Chenopodaceae	*Maireana enchylaeniodes*	Wingless Blue-bush
Chenopodaceae	*Maireana pentagona*	Slender Bluebush
Chenopodaceae	*Maireana excavata*	Bottle Bluebush
Chenopodaceae	*Maireana humillima*	Dwarf Bluebush
Chenopodaceae	*Maireana decalvans*	Common Bluebush
Chenopodaceae	*Maireana rohrlachii*	Rohrlachs Bluebush
Chenopodaceae	*Maireana aphylla*	Leafless Bluebush
Chenopodaceae	*Atriplex semibaccatta*	Creeping Saltbush
Colchicaceae	*Wurmbea latifolia*	Broad-leaf Early Nancy
Convolvulaceae	*Convovulus erubescens*	Pink Bindweed
Fabaceae	*Swainsona plagiotropis*	Red Swainson Pea
Malvaceae	*Sida corrugata*	Variable Sida
Oxalidaceae	*Oxalis perennans*	Grassland Wood-sorrel
Plantaginaceae	*Plantago guadichaudii*	Narrow-leaf Plantain
Poaceae	*Austrodanthonia setacea*	Wallaby Grass
Poaceae	*Austrodanthonia caespitosa*	Wallaby Grass
Poaceae	*Austrostipa scabra*	Spear Grass
Poaceae	*Austrostipa gibbosa*	Spear Grass
Poaceae	*Enteropogan acicularis*	Spider Grass
Stylidiaceae	*Levenhookia dubia*	Hairy Stylewort

Source: DSE 2004a

APPENDIX 4: PLANTS CHARACTERISTIC OF GREY BOX AND BULOKE GRASSY WOODLANDS

Family	Scientific Name	Common Name
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting
Asteraceae	*Cassinia arcuata*	Drooping Cassinia
Asteraceae	*Vittadinia gracilis*	Wooly New Holland Daisy
Asteraceae	*Calocephalus citreus*	Lemon Beauty-heads
Casuarinaceae	*Allocasuarina luehmannii*	Buloke
Chenopodaceae	*Enchylaena tomentosa*	Ruby Saltbush
Chenopodaceae	*Einadia hastata*	Saloop
Chenopodaceae	*Maireana enchylaenoides*	Wingless Bluebush
Chenopodaceae	*Einadia nutans*	Nodding Saltbush
Convovulaceae	*Dichondra repens*	Kidney-weed
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine
Cyperaceae	*Carex inversa*	Knob Sedge
Fabaceae	*Eutaxia microphylla*	Common Eutaxia
Juncaceae	*Juncus subsecundus*	Finger Rush
Loranthaceae	*Amyema linophyllum*	Buloke Mistletoe
Mimosaceae	*Acacia acinacea*	Gold dust Wattle
Myrtaceae	*Eucalyptus microcarpa*	Grey Box
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum
Myrtaceae	*Eucalyptus melliodora*	Yellow Box
Myrtaceae	*Eucalyptus albens*	White Box
Phormiaceae	*Dianella revoluta*	Black-anther Flax Lily
Pittosporaceae	*Bursaria spinosa*	Sweet Bursaria
Poaceae	*Austrodanthonia setacea*	Bristly Wallaby-grass
Poaceae	*Austrostipa scabra*	Rough Spear-grass
Poaceae	*Austrodanthonia caespitosa*	Wallaby Grass
Poaceae	*Chloris truncata*	Windmill Grass
Poaceae	*Elymus scabrus*	Common Wheat-grass
Poaceae	*Poa sieberiana*	Grey Tussock-grass
Poaceae	*Themeda triandra*	Kangaroo Grass
Polygonaceae	*Rumex brownii*	Slender Dock

Source: Sluiter I, Minchin P and Jaensch S (1997)

APPENDIX 5: EXOTIC PLANT SPECIES OF GRASSLANDS AND GRASSY WOODLANDS

Family	Scientific Name	Common Name
Asteraceae	**Hypochoeris glabra*	Smooth Cat's Ear
Asteraceae	**Arctotheca calendula*	Cape weed
Asteraceae	**Cirsium vulgare*	Spear Thistle
Fabaceae	**Trifolium spp.*	Clovers
Gentianaceae	**Centaurium tenuiflorum*	Centaury
Geraniaceae	**Erodium botrys*	Big Herons-bill
Iridaceae	**Romulea spp.*	Onion weed
Plantaginaceae	**Plantago lanceolata*	Ribwort
Plantaginaceae	**Plantago coronopus*	Bucks Horn Plantain
Poaceae	**Lolium rigidum*	Annual Rye-grasss
Poaceae	**Bromus hordeaceus*	Soft Brome
Poaceae	**Aira*	Silvery Hair Grass
Poaceae	**Briza spp*	Quaking Grass
Poaceae	*Phalaris spp	Canary Grass
Poaceae	**Vulpia bromoides*	Squirrel-tail Fescue
Poaceae	**Avena fatua*	Wild Oats

Source: DCNR 1992