

2 The Lowland Grassy Woodland Mosaic

2.1

Background

2.1.1 Temperate Eucalypt Woodlands of South-eastern Australia

In south-eastern Australia, temperate eucalypt woodlands once formed a relatively continuous vegetation crescent from about 27°S in southern Queensland to the lower south-east of South Australia with a narrow strip north and south of Adelaide. These woodlands were the culmination of a long evolution through the Tertiary period (3–65 million years BP) by which time the ancient continent of Gondwana had broken up and Australia was drifting north. During the Tertiary, vast changes occurred in Australian climate and soils, and the evolving eucalypts supplanted rainforests over much of the continent (Beadle 1981).

The temperate eucalypt woodlands in south-eastern Australia are bounded on the west by semi-arid shrub woodlands and mallee, and on the east and south by dry sclerophyll forests. These woodlands occurred as part of a mosaic, merging with treeless grasslands on valley bottoms and broad plains at lower elevations, and with dry sclerophyll forests on the upper slopes of hills and ridges (Moore 1970; Yates and Hobbs 2000; Environment ACT 2002). In the southern ACT and south-eastern NSW, lower elevation temperate woodland (referred to hereinafter as 'lowland woodland') grades into woodland of the mountain foothills and dry hill slopes, dry sclerophyll forest and sub-alpine woodland (Moore 1970; NCDC 1984; Landsberg 2000).

The Australian pastoral industry began in the early 1800s when access was gained to the temperate eucalypt woodlands across the Great Dividing Range in NSW. Because of the wide spacing of the trees and the high proportion of grass it was possible to stock many of the woodlands without initially felling or ringbarking the trees (Moore 1970). Subsequent intensification of rural use, in particular the

development of agriculture on the relatively fertile woodland soils, conversion to exotic pasture, and the growth of towns and infrastructure resulted in widespread clearing and fragmentation of temperate eucalypt woodlands. In the woodland remnants the former tall, warm season, perennial tussock grass understorey has usually been partly or wholly replaced by short, cool season, perennial native grasses in lightly grazed areas or mainly exotic grass and herb species where grazing levels are high (Prober and Thiele 1995). Adjacent natural temperate grassland areas have been similarly affected (Environment ACT 2002).

Because of the high level of clearing (estimated at up to 95% in mixed farming areas in NSW to the north-west of the ACT) it is not possible to accurately ascertain the floristic composition of the pre-European temperate eucalypt woodlands, nor of the understorey, that together comprise the ecological community (Prober 1996). However, available evidence suggests the floristic composition was influenced by climate, soil type, topography, hydrology, biotic interactions such as grazing, and large-scale disturbances such as fire, windstorms, floods and droughts (Yates and Hobbs 2000). The woodlands were affected by climatic drying and probably an increased incidence of fire during the latter part of the Pleistocene (Hobbs 2002).

These well-established eucalypt woodlands were the home of Aboriginal people for possibly 50 000 years and there is no doubt that they burnt the vegetation. The precise effects of this are unclear, but the available evidence does not support the hypothesis that Aboriginal burning caused the evolutionary diversification of the Australian biota (Bowman 1998). Aboriginal burning followed millions of years of evolutionary adaptation in which lightning-generated fire probably played a significant part. At the time of European settlement, eucalypt woodlands were not simplified park-like landscapes. They contained a wide diversity of plant species and a great diversity of animal species that relied upon a complexity of

habitat; for example, Prober (1996) recorded 375 plant species (including trees) in relatively undisturbed grassy White Box woodland remnants across New South Wales.

The distribution of temperate woodland remnants reflects the preferential clearing of the most fertile soils in plains, lower slopes and stream valleys. Woodlands that remain are generally located in more marginal areas such as rocky sites, upper slopes, poorer soils and flood plains subject to periodic inundation (Bennett 1993).

2.1.2 Temperate Woodland: ACT Regional Context

Temperate woodland in the ACT region occurs within the 'South Eastern Highlands Region' as defined in the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell 1995). This bioregion includes about 80% of the ACT, the tablelands and western slopes of south-eastern NSW (to north of Bathurst) and extends into Victoria. The alpine areas of Victoria, NSW and the ACT form a separate bioregion.

In the easterly part of this bioregion, the dominant tree species of lowland woodland are usually Yellow Box (*Eucalyptus melliodora*) and/or Blakely's Red Gum

(*E. blakelyi*) with Apple Box (*E. bridgesiana*) as a frequent associate or co-dominant. This Yellow Box–Red Gum grassy woodland extends from south of the ACT, north-east to Goulburn, north-west almost to Young, north to Orange and past Bathurst (AUSLIG 1990). To the west of the ACT, the community forms mosaics with the White Box (*E. albens*) dominated woodlands more typical of slightly drier sites of the western slopes (Figure 2.1). Within the Grassy White Box Woodland, Yellow Box and Blakely's Red Gum may become locally dominant along non-permanent watercourses or on deeper soils in valleys (NSW NPWS 2002).

In temperate grassy woodland, a more or less continuous stratum, in which mid-height tussock grasses are prominent, usually dominates the understorey. Structurally and floristically, this stratum probably closely resembles the natural temperate grassland that was adjacent to the woodland prior to European settlement. Shrubs and sub-shrubs may also be present and form a discontinuous middle stratum (Costin 1954; Landsberg 2000). The pre-European floristic composition of the understorey is poorly known, however, because grazing spread through most of the woodland 150 years ago resulting in introduction of exotic species and changes in or elimination of some native species.

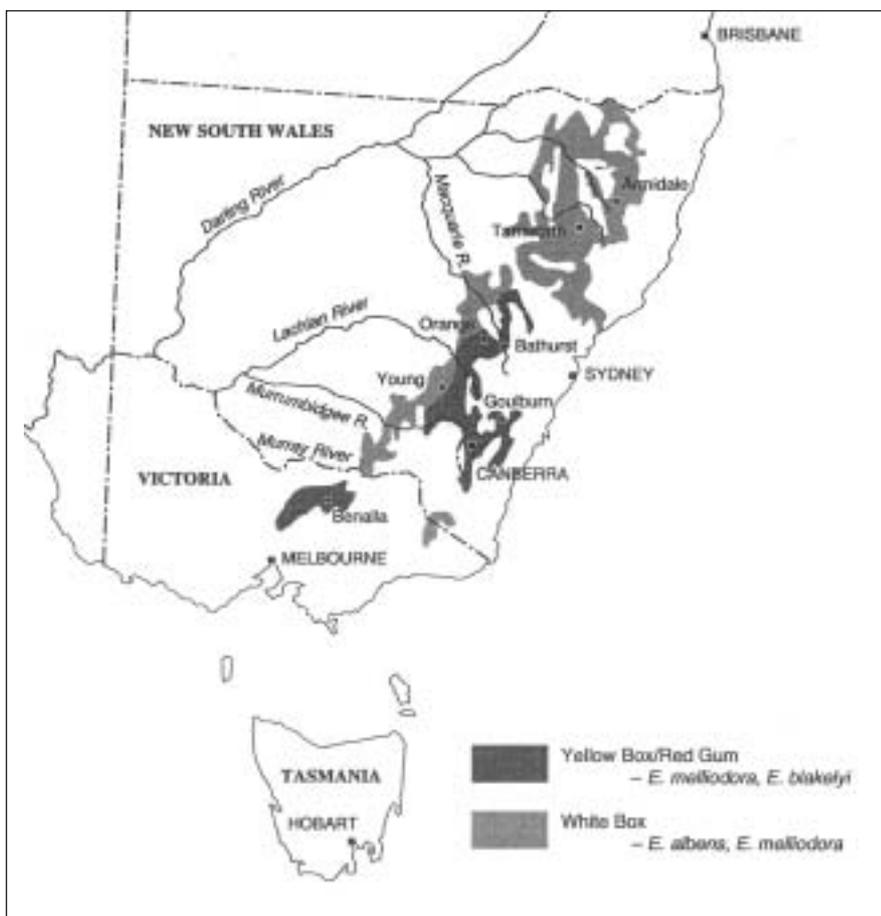


Figure 2.1
Estimated Pre-European Distribution of Temperate Woodland Dominated by Yellow Box, Blakely's Red Gum and White Box in South-eastern Australia (from AUSLIG 1990). Map from Landsberg 2000.

2.2

Woodlands in the ACT Region

2.2.1 Woodland Types in the ACT Region

Landsberg (2000) defined five major woodland types in the ACT region. Arranged altitudinally they are: subalpine, mountain foothills, dry hillslopes, low hills and plains, and river fringes. This *Lowland Woodland Conservation Strategy* includes grassy woodland of the low hills and plains and other box woodlands of the mountain foothills and the dry hillslopes where they intergrade with Yellow Box–Red Gum grassy woodland (Table 2.1). Recent work based on analysis of the data from the Southern Region Comprehensive Regional Assessment study (Thomas *et al.* 2000) has defined ecological communities in the south-east region of New South Wales and the ACT. These communities are listed in full in the ACT State of the Environment Report 2003 (ACT SOE 2003). Types of ecological communities derived from this analysis are used in sections 2.2.1.1 to 2.2.1.4 below.

Table 2.1: ACT Woodlands: Inclusion in Lowland Woodland Conservation Strategy

| Woodland type (after Landsberg 2000) | |
|--------------------------------------|--|
| Subalpine | <ul style="list-style-type: none"> Fully protected in Namadgi National Park (see s. 2.2.1.3 for ecological communities) |
| Mountain foothills | <ul style="list-style-type: none"> (a) Tablelands Dry Shrubby Box Woodland adjacent to Yellow Box–Red Gum Grassy Woodland |
| | <ul style="list-style-type: none"> (b) Remainder of the box woodland mainly protected in Namadgi National Park |
| Dry hillslopes | <ul style="list-style-type: none"> (a) Tablelands Dry Shrubby Box Woodland adjacent to Yellow Box–Red Gum Grassy Woodland |
| | <ul style="list-style-type: none"> (b) Tablelands Brittle Gum Dry Forest—significant proportion in Canberra Nature Park |
| Low hills and plains | <ul style="list-style-type: none"> (a) Tablelands and Slopes Yellow Box–Red Gum Grassy Woodland |
| | <ul style="list-style-type: none"> (b) Tablelands Valley Snow Gum Grassy Woodland |
| River fringes | <ul style="list-style-type: none"> Mainly protected in river corridor Nature Reserves (see s. 2.2.1.4 for ecological communities) |

ⁿ Woodland included in *Lowland Woodland Conservation Strategy*

- Woodland or other vegetation community not included in *Lowland Woodland Conservation Strategy*

2.2.1.1 Woodland on Low Hills and Plains (Lowland Woodland)

Lowland woodland includes Yellow Box–Red Gum Grassy Woodland (endangered ecological community) and low elevation Snow Gum Grassy Woodland. These are included in the *Lowland Woodland Conservation Strategy*.

- Tablelands and Slopes Yellow Box–Red Gum Grassy Woodland (Yellow Box (*Eucalyptus melliodora*), Blakely's Red Gum (*E. blakelyi*), Apple Box (*E. bridgesiana*)).
- Tablelands Valley Snow Gum Grassy Woodland (Snow Gum (*E. pauciflora*), Candle Bark (*E. rubida*)).

These two lowland woodland communities are readily recognised by their characteristic eucalypt species. Their distribution is closely related to altitude, topography and aspect. The core community is the endangered Yellow Box–Red Gum Grassy Woodland that is generally found on the middle and lower slopes of hills (600–900 m) and in gently undulating topography not very susceptible to cold-air drainage. Annual rainfall is in the range of 400–800 mm.

At lower elevations, Tablelands and Slopes Yellow Box–Red Gum Grassy Woodland intergrades with Tablelands Valley Snow Gum Grassy Woodland and Natural Temperate Grassland. At higher elevations and on more rocky sites, it intergrades with Tablelands Dry Shrubby Box Woodland and Tablelands Brittle Gum Dry Forest (Figure 2.2).

2.2.1.2 Woodland on Dry Hill Slopes and Mountain Foothills

Tablelands Dry Shrubby Box Woodland is included in the *Lowland Woodland Conservation Strategy* where it intergrades with Tablelands and Slopes Yellow Box–Red Gum Grassy Woodland.

- Tablelands Dry Shrubby Box Woodland (Bundy (*E. goniocalyx*)–Mealy Bundy (*E. nortonii*)–Red Box (*E. polyanthemos*)–Apple Box (*E. bridgesiana*)–Broad-leaved Peppermint (*E. dives*))
- Tablelands Brittle Gum Dry Forest (Red Stringybark (*E. macrorhyncha*)–Scribbly Gum (*E. rossii*)–Brittle Gum (*E. mannifera*))

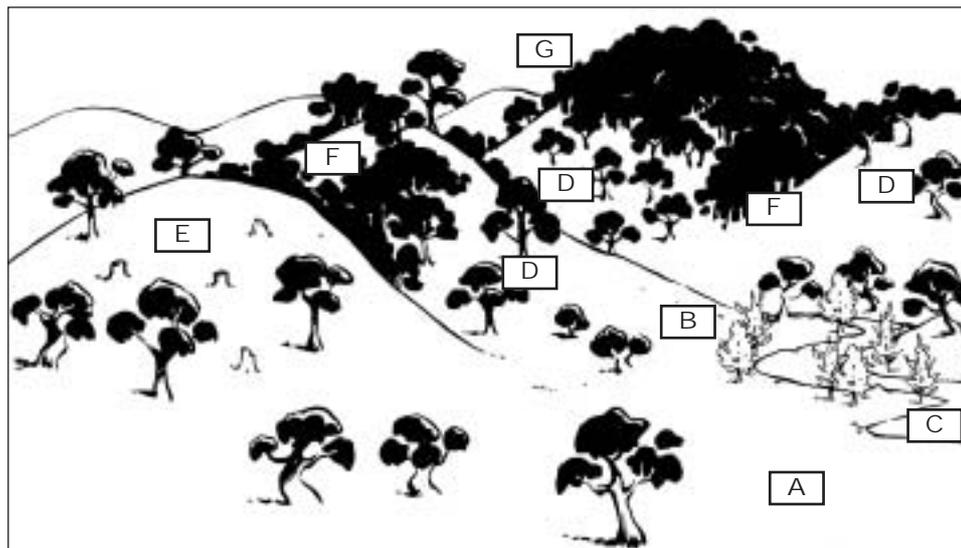
These two communities occupy the higher elevations on hillslopes and mountain foothills above the Yellow Box–Red Gum woodland but intergrade where they meet (see Figure 2.2).

Tablelands Dry Shrubby Box Woodland is most often found at higher elevations on the cooler moister

Figure 2.2

Landscape Distribution of Lowland Ecological Communities in the ACT.

- A: Natural Temperate Grassland
- B: Tablelands Valley Snow Gum Grassy Woodland
- C: Riparian Woodland
- D: Yellow Box–Red Gum Grassy Woodland
- E: Secondary Grassland (Yellow Box–Red Gum)
- F: Tablelands Dry Shrubby Box Woodlands
- G: Tablelands Brittle Gum Dry Forest



hillslopes and mountain foothills. It occurs extensively in the southern ACT, in the sub-montane stream valleys and hillslopes flanking the Murrumbidgee River at elevations generally from 700 m to over 1200 m (NCDC 1984). Tablelands Dry Shrubby Box Woodland also occurs on lower exposed slopes where it intergrades with Yellow Box–Red Gum Grassy Woodland and has a similar structure and understorey floristic composition.

It has been estimated that about half of this community has been cleared but the remainder is now mainly protected in Namadgi National Park. It was extensively used for grazing in the past and exotic weeds are common in the understorey (Landsberg 2000).

Tablelands Brittle Gum Dry Forest occupies steep, rocky and dry sites often with poorly developed soils. The community grades into Yellow Box–Red Gum woodland at lower elevations and often consists of three strata: a sparsely continuous tree stratum, a discontinuous but well developed shrub stratum, and a discontinuous herbaceous stratum (Costin 1954). These areas had limited grazing value but were often cut over for firewood, fencing and rough construction timbers. In this process they may have been opened up to the extent that the tree stratum resembles the structure of downslope lowland woodland. With the cessation of rough grazing and woodcutting, regeneration is occurring. In the ACT extensive areas were cleared for pine plantations.

It is estimated that about 30% of the pre-1750 extent of these communities remains in the ACT and adjacent part of NSW (Landsberg 2000). The communities occur in a fragmented pattern on hills and ridges with a significant proportion now included in Canberra Nature Park.

2.2.1.3 Sub-Alpine and Alpine Woodland (Not Included in *Lowland Woodland Conservation Strategy*)

- Alpine White Sallee Woodland (Snow Gum (*E. pauciflora*)–Alpine Snow Gum (*E. pauciflora* ssp. *niphophila*))
- Sub-alpine White Sallee Woodland (Snow Gum (*E. pauciflora*)–Sub-Alpine Snow Gum (*E. pauciflora* ssp. *debeuzevillii*))
- Montane Frost Hollow Snow Gum Woodland (Snow Gum (*E. pauciflora*)–Black Sallee (*E. stellulata*)–Mountain Swamp Gum (*E. camphora*))

These woodlands occur in the higher country in the western and southern parts of the ACT. They occur in broad open flats, often with impeded drainage, or more-freely draining, exposed saddles along high mountain ridges often interspersed with treeless areas. The understorey is dominated by native tussock grasses with a wide diversity of herbs (Costin 1954; NCDC 1984). There has been very little clearing of Snow Gum woodlands at higher altitude but there has been some clearing and thinning of Black Sallee and Mountain Swamp Gum in valleys that were previously grazed (Landsberg 2000). Studies by Pryor (1939) and Banks (1981, 1989) showed a greatly increased fire frequency for the higher altitude sub-alpine woodlands from about 1860 as prospectors and pastoralists began moving through the area en route to the Kiandra goldfields. Frequent (almost annual) burning continued until 1960 resulting in a profusion of leguminous shrubs and dense Snow Gum regeneration.

Sub-alpine woodlands in the ACT are now fully protected in Namadji National Park but remain fire prone. Large areas were severely burnt in the bushfires in January 2003. Based on past fire history, Snow Gum woodlands are expected to regenerate, however, the fire response of Black Sallee is not well known (Carey *et al.* 2003).

2.2.1.4 River-Fringing Woodlands (Not Included in *Lowland Woodland Conservation Strategy*)

- Slopes and Tablelands Riparian She-oak Woodland (*Casuarina cunninghamiana* community)
- Tablelands Riparian Ribbon Gum Woodland (*E. viminalis* riparian community)

The community dominated by Riparian She-oak is frequently found in pure stands in narrow belts along watercourses in eastern Australia (see Figure 2.2). Typically, it is associated with sandy and shingle terraces between normal water levels and the maximum flood height. In the ACT, Riparian She-oak woodlands extend along much of the Murrumbidgee River, some of its tributaries and the lower Molonglo River where they are mainly protected in river corridor nature reserves. South of the Tharwa area where the river banks are higher and shingle terraces absent, Ribbon Gum (*E. viminalis*) occurred in the riparian zone but has been mostly cleared. River-fringing woodlands will be included in a conservation strategy for aquatic and riparian ecosystems (expected to be prepared in 2004–5).

2.3

Changes to Woodland Since European Settlement and Ongoing Threats

2.3.1 Changes to Woodland Since European Settlement

Following European settlement, a number of factors have been responsible for removal of woodland and modification of its structure and floristics in the ACT and region:

- **Large scale clearing for pastoralism and agriculture:** Clearing, selective clearing and ringbarking for pastoralism and cropping, as occurred in much of the NSW box – gum woodlands was not as extensive in the ACT. Leasehold tenure (often short-term) discouraged investment in intensive pasture improvement that

was widely adopted elsewhere from the 1950s. However, clearing to the level of individual paddock trees was reasonably common and is evident in the present rural landscape. Removal and death of these large old trees in the foreseeable future and lack of regeneration will result in a largely treeless landscape.

- **Urban development:** Historical photographs show that the early development of central Canberra occurred on a mostly treeless plain with tree clearing and thinning evident on the adjoining hill slopes (Seddon 1977). The treeless plain comprised low elevation ecological communities, in particular, Natural Temperate Grassland and riparian communities, and at slightly higher elevations, cleared or partly cleared woodland areas. Clearing of woodland remnants occurred as the city expanded into the Belconnen, Tuggeranong and Gungahlin areas.
- **Grazing:** Grazing by livestock has had a major impact throughout the box–gum woodlands beginning with the first pastoral expansion early in the 19th century. Grazing has reduced the height, cover and biomass of the grassy stratum, with the taller native grasses often being replaced by lower growing species of grasses and forbs (Costin 1954; Moore 1966; AUSLIG 1990). Diversity of native forbs and subsidiary grasses declines significantly with grazing, and abundance of annual weeds increases (Prober and Thiele 1995). There is often a paucity of tree regeneration in grazed stands as sheep and cattle find seedlings palatable and soil compaction under remaining trees hinders germination (Landsberg *et al.* 1990; Spooner *et al.* 2002). The impact of grazing depends upon a number of factors, particularly stocking rates, level of pasture improvement, supplementary stock feeding which introduces weeds, and the extent of protection of riparian zones and remnant patches of woodland. Most ACT lowland woodland areas were grazed in the past and show varying levels of retention and regeneration of the tree cover and native understorey.
- **Deliberate or incidental introduction of exotic pasture plants:** Exotic pastures are extensive throughout the region, with widespread introduction of grasses such as Phalaris (*Phalaris aquatica*) and Cocksfoot (*Dactylis glomerata*) and many clovers, usually in conjunction with the application of superphosphate. The degree of structural change depends on the species introduced, the amount of fertiliser applied and the

extent of cultivation. Modification is most extreme when the mid-height native tussock is replaced by dense sown pasture that is dominated by exotic sward-forming grasses and legumes (Costin 1954; Moore 1966; AUSLIG 1990). Some introduced grasses have become major invasive plants of grassy woodland and Natural Temperate Grassland, especially African Love Grass (*Eragrostis curvula*). This species appears to have been introduced to Australia by accident prior to 1900, but has been imported for experimental assessment several times since then (Parsons and Cuthbertson 1992).

- **Introduction of other exotic plant species:** Many other plant species have also been introduced deliberately or accidentally and have become weeds, often replacing native species in their habitat. Naturalized species have spread into woodland areas and this process continues. Some examples include St Johns Wort (*Hypericum perforatum*), annual and perennial exotic grasses including bromes, Serrated Tussock (*Nasella trichotoma*), Chilean Needle Grass (*N. neesiana*), and woody weeds that have escaped from urban plantings including Cotoneaster (*Cotoneaster* spp.), Firethorns (*Pyracantha* spp.) and Hawthorn (*Crataegus monogyna*).
- **Response to disturbance:** In some grassy woodlands of low pastoral value, particularly those in which Apple Box is prominent, partial tree clearing has been followed by dense regrowth. This consists mainly of eucalypt saplings and a secondary shrub layer dominated by species of Acacia, Cassinia and Kunzea (Costin 1954). Such structural changes do not appear to have followed clearing of the usually topographically lower Yellow Box–Red Gum Grassy Woodland community but they do occur where grazing has been withdrawn for various periods and tree and shrub species have readily regenerated. Shrub understorey seems to persist on rocky ridges that may carry this woodland community. Where there has been complete removal of trees, the consequent thicket of shrubs, particularly Burgan (*Kunzea ericoides*) effectively prevents tree regeneration (Kirschbaum and Williams 1991).

2.3.2 Ongoing Threats to Woodland

A range of threats on a scale from continental (climate change) to a particular site (e.g. inappropriate mowing or grazing regimes) have been identified for natural ecosystems in the ACT region by Fallding (2002, p.

34). Many of these are relevant to woodland. Further loss of woodland and threats to the integrity of the ecological community derive, in particular, from:

- **Urban and infrastructure development:** Threats to remaining woodland areas from urban and infrastructure development are of two types: direct loss of woodland, and deleterious impacts on the natural integrity of woodland from adjacent urban areas. Recognition of the values of lowland woodland in recent years has reduced the loss to urban development in the ACT. While some woodland areas have been sold for development (e.g. East O'Malley), other areas originally destined for urban development (e.g. parts of Mulligans Flat and Gooroo) have been added to the reserve system. There are significant long term urban edge threats which include predation and disturbance by cats and dogs, removal of bush rock and fallen timber by local residents and for fire hazard fuel reduction, dumping of garden waste, planting out into reserves from adjacent backyards and spread of invasive pest plants (e.g. Chilean Needle Grass and St John's Wort). Urban edge threats can be lessened at the planning stage (e.g. by allowing adequate buffers and not permitting housing on the outer edge of perimeter roads), and by effective management of reserves involving the local community.
- **Grazing:** Grazing by sheep, cattle and horses affects woodland understorey and tree regeneration and therefore has a major bearing on habitat quality and long term perpetuation of the woodland. While the impact of grazing depends upon a number of factors, levels of grazing which result in understorey simplification, loss of native species and lack of tree regeneration remain a threat to lowland woodland. Secondary effects of grazing can be high levels of soil compaction and nutrient enrichment. These changes, and loss of propagules of native species mean that even when grazing is removed, restoration is proving difficult to achieve (Prober *et al.* 2002a, 2002b; Spooner *et al.* 2002). In reviewing the factors affecting regeneration of box woodland in the Central Tablelands of New South Wales, Windsor (2000) concluded that the impacts of grazing are severe on remnant vegetation and appear to be a major factor inhibiting regeneration. This is supported by the results of experimental fencing of woodland sites from grazing, though fencing alone may be insufficient for the complete restoration of the woodland community, depending upon past management of the site (Spooner *et al.* 2002).

- **Dieback:** Many of the remaining woodland trees suffer dieback, with Blakely's Red Gum particularly affected in the ACT. Dieback has many interacting causes but grazing is pivotal. The immediate cause is usually very high rates of defoliation by insects, but the build up of insect populations is due to nutrient enrichment of canopies related to pasture improvement and fertiliser application for grazing (Landsberg 2000). Decline in insectivorous woodland birds exacerbates the problem. In healthy eucalypt woodland, birds will consume 50% of the insects present (approximately 30kg/ha/yr) while gliders, bats, spiders and other insects will consume a large proportion of the remainder (NSW NPWS n.d.).
- **Firewood and other timber cutting, 'tidying up':** Standing old and dead trees and fallen logs and branches are significant faunal habitat. Box–gum woodland has been a staple source for the firewood trade and considerable volumes are sourced from woodland remnants on private land on the Southern Tablelands and Central Slopes of NSW. Collection of hardwood for commercial purposes and from areas of Public Land managed as Canberra Nature Park is not permitted in the ACT. Under the Nature Conservation Act 1980, rural lessees may use timber on their properties for firewood but are not permitted to sell it. Firewood collection is no longer a significant threat to woodland in the ACT. However, there may be local habitat effects due to removal of fallen timber by residents in urban areas adjoining reserves and for fire hazard fuel reduction.
- **Weed invasion:** Weeds are a major threat to woodland remnants. Significant groups of weeds include: annual grasses (e.g. Wild Oats (*Avena* spp.)); annual and biennial herbs (e.g. Paterson's Curse (*Echium plantagineum*)); perennial grasses (e.g. African Lovegrass (*Eragrostis curvula*), Serrated Tussock (*Nassella trichotoma*); perennial herbs (e.g. St John's Wort (*Hypericum perforatum*)); woody weeds (e.g. Briar Rose (*Rosa rubiginosa*)) and invasive native plants (e.g. Cootamundra Wattle (*Acacia baileyana*)) (NSW NPWS 2002). It should be noted, however, that in some woodland areas with degraded understorey, introduced woody weeds may be important to small birds and mammals for shelter, nest sites and food.
- **Fire:** There is no doubt that woodlands were subject to burning prior to European settlement and continued to be burnt as a means of promoting pasture growth, or by natural, arsonist

or accidental ignitions. ACT woodlands are vulnerable to wildfire in hot, dry, windy summer conditions. However, burning for management purposes is now extremely rare in eastern Australia and fuel management is more often achieved by stock grazing rather than burning (Lunt 1995; Hobbs 2002). It is not possible to extrapolate from presumed burning regimes in the continuous woodland prior to European settlement to the fragmented remnants today. Limited studies suggest local plant extinctions may be possible under both very frequent and infrequent fire regimes (Hobbs 2002).

- **Introduced pests and changes in native species abundance:** Woodland fragments are vulnerable to the effects of introduced species from the surrounding rural and/or urban matrix, as well as the effects of native species which thrive in highly modified landscapes. Feral herbivores such as rabbits and hares contribute to the negative impacts of grazing (Costin 1954) while foxes and cats are a threat to the woodland fauna. The introduced Common Mynah (*Acridotheres tristis*) and Starling (*Sturnus vulgaris*) may compete with native species for woodland nest sites. Fragmentation of woodland in the rural landscape and consequent disruption of ecological processes has resulted in significant changes in animal species composition. In the case of birds, fragments are often dominated by a core of widely distributed, abundant and often aggressive species which are tolerant of habitat change or have benefited from the changed rural landscape (Majer *et al.* 2000). There is evidence also that patterns of predation have changed and these effects are more acute the smaller the remnants are (Major *et al.* 1996, Fulton and Ford 2001). Introduced invertebrates, including the European Honey Bee and European Wasp, also threaten native species such as hollow nesting birds and some insects.

2.3.3 Changes to Lowland Woodland in the ACT Region: pre-1750 to present

The estimated distribution and composition of pre-1750 grassy woodlands serve as a baseline to consider subsequent destruction and modification. These woodlands were the result of responses to environmental conditions through evolutionary time and more recently Aboriginal occupation, though the effects of the latter, mainly through burning, remain subject to debate (Bowman 1998; Hobbs 2002). There was a rich diversity of species in grassy woodland but the precise composition remains uncertain. In areas

that retain a high native component, pre-European dominants may have been different to present species. Massive changes to the grassy woodland landscape since European settlement have resulted in most of it being destroyed or modified to varying degrees, while a very small amount has survived in a largely unmodified form.

The estimated pre-European distribution of temperate eucalypt woodlands dominated by Yellow Box, Blakely's Red Gum and White Box is shown in Figure 2.1. The Yellow Box–Blakely's Red Gum ecological community had an extensive distribution outside the current ACT boundaries. There is no evidence that White Box occurred widely in the ACT. Estimated features of the pre-1750 lowland box–gum woodland are outlined in Table 2.2.

Recent studies have attempted to document the extent of removal of woodland in the south-eastern temperate woodland zone and the fragmentation of the remnants that remain. The remaining extent of the community varies regionally. Based on remote sensing of woody vegetation it is estimated for New South Wales that the endangered White Box–Yellow Box–Blakely's Red Gum Woodland has been reduced to less than 1% of its pre-European extent in the Central Lachlan region (Austin *et al.* 2000), less than 4% in the southwest slopes and Southern Tablelands (Thomas *et al.* 2000), and less than 7% in the Holbrook area (Gibbons and Boak 2000). There is a scarcity of patches over 10 ha in size. Less than 200 ha in 14 sites (0.01%) of the pre-European extent of the Grassy White Box Woodland may remain close to its original condition (Thiele and Prober 2000).

The magnitude of the reduction in the Yellow Box–Red Gum grassy woodland in and around the ACT is illustrated in the Australian Terrestrial Biodiversity Assessment compiled by the National Land and Water Audit (2002). For that part of the South Eastern Highlands region that includes the ACT and surrounding sub-region, the once widespread woodland has been reduced from an estimated 295 000 ha to 25 200 ha (about 8.5% of the original). In the ACT and NSW Southern Tablelands area covered by the report of Fallding (2002) box–gum woodland is estimated to have covered 23% of the region in 1750 and 9% in 2000.

Across its distribution in NSW, the White Box–Yellow Box–Blakely's Red Gum Woodland has been reduced to less than 5% of its estimated pre–1750 area (Thomas *et al.* 2000) and is declared an Endangered Ecological Community under the *Threatened Species Conservation Act 1995* (NSW).

Opportunities to conserve woodland remnants on rural land in New South Wales through reservation are constrained by the general rarity of remnants, as well as the freehold system of rural land tenure. Land acquisition is prohibitively expensive. Crown lands are limited to relatively small areas in travelling stock reserves and other land. In this context, off-reserve mechanisms such as Conservation Management Networks have a particularly valuable role to play in grassy woodland conservation (see s. 5.9.9).

2.3.4 Changes to Lowland Woodland in the ACT: Pre-1750 to Present

In the period since European settlement of the Southern Tablelands of which the ACT is a part, the former zone of more or less continuous lowland woodland has been reduced to fragments of varying sizes and ecological condition. These were prime pastoral and agricultural lands and it is not surprising that the woodland cover has been so extensively removed and modified. The establishment of the Australian Capital Territory in 1911 brought Commonwealth control of all land in the ACT, which then could only be held under lease (rather than freehold). There were also planning policies and controls that placed constraints on land use (Frawley 1991). One result was that some of the ACT rural lands held on short-term leases were not subject to intensive pasture improvement from the 1950s and retained significant components of their native vegetation cover. Mulligans Flat Nature Reserve at Gungahlin is an example of such an area. Urban development of Canberra, however, occurred across the lowland areas affecting both the remaining woodland and native grassland and remains a threat.

Remnants of lowland woodland now range from single trees or small groups of trees in rural and urban areas, to largely unmodified ecological communities with a species rich understorey of native tussock grasses, herbs and scattered shrubs. There are extensive areas where some tree cover remains but the native understorey has been destroyed or modified to varying degrees. Other areas (secondary grassland) have had all or most of the trees removed but retain the grassy understorey.

In the ACT while the remaining lowland woodland area is not large, a much higher proportion is relatively intact than is the case nationally or in NSW. In terms of size, connectivity, diversity and habitat for threatened species, ACT remnants of lowland woodland are exceptional, especially the presence of larger patches (over 100 ha) in good condition.

Table 2.2: Estimated Features of the pre-1750 Lowland Box–Gum Woodland

| Feature | Description |
|--|---|
| Distribution of grassy woodland | Sub-humid southeastern Australia, inland of the Great Dividing Range with distribution determined broadly by climatic factors inter-related, at more detailed level, with soils, topography, geology and local climate influences. |
| Tree cover | Tree canopy projective foliage cover 10-30% (crown cover density 20-50%) Less than 10% (crown cover density 2-20%) on lower slopes adjacent to frost hollows. Related to disturbance and regeneration, a mosaic varying from dense cover to grassland. |
| Tree species in upper stratum | <p>Tablelands and Slopes Yellow Box–Red Gum Grassy Woodland (ACT and NSW) DOMINANTS: Yellow Box (<i>E. melliodora</i>), Blakely's Red Gum (<i>E. blakelyi</i>) ASSOCIATES: Apple Box (<i>E. bridgesiana</i>), Brittle Gum (<i>E. mannifera</i>), Scribbly Gum (<i>E. rossii</i>), Red Stringybark (<i>E. macrorhyncha</i>), <i>Acacia dealbata</i>, <i>A. mearnsii</i>, <i>A. implexa</i>, <i>Exocarpos cupressiformis</i>.</p> <p>Tablelands Dry Shrubby Box Woodland (ACT and NSW) DOMINANTS: Mealy Bundy (<i>E. nortonii</i>), Bundy (<i>E. goniocalyx</i>), Red Box (<i>E. polyanthemos</i>), Broad-leaved peppermint (<i>E. dives</i>). ASSOCIATES: Apple Box (<i>E. bridgesiana</i>), Brittle Gum (<i>E. mannifera</i>), Scribbly Gum (<i>E. rossii</i>), Red Stringybark (<i>E. macrorhyncha</i>), Drooping She-oak (<i>Allocasuarina verticillata</i>), Kurrajong (<i>Brachychiton populneus</i>).</p> <p>Tablelands Valley Snow Gum Grassy Woodland (ACT and NSW) DOMINANTS: Snow Gum (<i>E. pauciflora</i>), Candlebark (<i>E. rubida</i>) ASSOCIATES: Yellow Box (<i>E. melliodora</i>), Blakely's Red Gum (<i>E. blakelyi</i>) and Apple Box (<i>E. bridgesiana</i>) <i>Acacia dealbata</i>, <i>A. melanoxylon</i>.</p> <p>South-west Slopes White Box Woodland (NSW) DOMINANT: White Box (<i>E. albens</i>) ASSOCIATES: Yellow Box (<i>E. melliodora</i>), Blakely's Red Gum (<i>E. blakelyi</i>), also Apple Box (<i>E. bridgesiana</i>), Brittle Gum (<i>E. mannifera</i>), Candlebark (<i>E. rubida</i>), Red Stringybark (<i>E. macrorhyncha</i>), Grey Box (<i>E. microcarpa</i>), <i>A. mearnsii</i>, <i>A. implexa</i>, <i>Exocarpos cupressiformis</i>, Kurrajong (<i>Brachychiton populneus</i>), Rough-barked Apple (<i>Angophora floribunda</i>) (north).</p> |
| Ground cover | Ground cover dominated by native tussock grasses and forbs from a wide diversity of families and genera including orchids, lilies and daisies. In ACT Yellow Box–Red Gum grassy woodland, groundcover was structurally and floristically similar to adjacent natural temperate grassland. ACT: Spear grasses (<i>Austrostipa</i> spp.), Kangaroo Grass (<i>Themeda triandra</i>)*, Red-leg Grass (<i>Bothriochloa macra</i>), wallaby grasses (<i>Austrodanthonia</i> spp.), Tussock Grass (<i>Poa sieberiana</i>). NSW: Kangaroo Grass (<i>Themeda triandra</i>) and Tussock Grass (<i>Poa sieberiana</i>). Queensland Bluegrass (<i>Dichanthium sericeum</i>) and Barbed Wire Grass (<i>Cymbopogon refractus</i>) (north). |
| Middle stratum | Uncertain. Some shrubs and sub-shrubs (less than 0.5m in height) likely to have been present but not continuous. Taller shrubs not common. Shrub growth found further up-slope in box woodlands, sclerophyll forest, on shallow soils and as primary colonisers in disturbed areas e.g. burnt areas that may later revert to grassland in absence of short time scale further disturbance. |
| Disturbances | Southeastern woodland zone is subject to climatic variability—extremes of temperature, drought, flood rains and destructive windstorms. Zone would have been subject to fire (lightning strike and Aboriginal burning from possibly 50 000 years BP) but balance between natural/human induced events, periodicity and effects uncertain. |
| Habitat | Rich habitat with highly diverse flora and fauna. Box–gum woodland occurred at moister, lower elevations on more fertile soils. Trees grew large and developed hollows of all sizes providing habitat for birds, bats and arboreal mammals. Availability of nutrients and water resulted in trees having relatively reliable nectar flows and foliage growth—valuable resources for invertebrates, nectar-feeding and insectivorous birds and bats. The grassy understorey, shrub patches, rocky outcrops and fallen timber provided habitat for mammals, reptiles, birds and invertebrates. |

* also known as *Themeda australis*

Woodland surveys of the ACT show that 10 865 ha of the Yellow Box – Red Gum grassy woodland community remain in a partially or moderately modified form, (Table 6.3) (for an explanation of terms, see Table 2.3). This is 34% of the estimated pre-1750 occurrence in the ACT of 32 000 ha (J. Landsberg in ACT Government 1999a). About 13 100 ha of other types of lowland woodland also remain in a partially or moderately modified form. There are another 5955 ha of Yellow Box – Red Gum grassy woodland remnants (19% of the pre-European occurrence) that have been reduced to Yellow Box and or Red Gum trees over either exotic pasture or highly degraded understorey. In addition, 7075 ha of other types of lowland woodland remain in this highly modified form (Table 6.3).

These categories are not discrete; there is a continuum from partially modified lowland woodland to former woodland with no native understorey or to secondary grassland where the trees have been totally or mostly removed. Woodland areas that do not meet the criteria for the endangered ecological community may have important conservation and social values and therefore the *Strategy* gives attention to protection measures for these other types of remnants, particularly as habitat for wildlife.

2.4

Classifying the Remaining Lowland Woodland

2.4.1 A Typology of Woodland Landscapes

As noted previously, there is a continuum from lowland woodland remnants that appear largely intact (similar to their estimated pre-1750 state though there are likely to be changes in component species) to extensive areas where there is no vestige of the previous woodland cover. For the purposes of this *Strategy*, the remaining lowland woodland in the ACT has been classified in relation to its assessed degree of modification since European settlement; the corollary of this is the degree to which it retains its natural integrity.

A means of conceptualising human modification of woodland landscapes has been presented by McIntyre and Hobbs (1999) (see also McIvor and McIntyre 2002). At a regional scale, they propose a typology of landscapes depending upon the proportion of habitat retained in an area:

(a) intact landscape (>90% *retained* habitat);

- (b) variegated landscape (60–90% *retained* habitat);
- (c) fragmented landscape (10–60% *retained* habitat); and
- (d) relictual landscape (<10% *retained* habitat).

At a second level, the scheme considers the degree of modification imposed on remaining habitats and defines four levels of modification and related habitat states:

- (f) unmodified *retained* habitat (e.g. reserves, stock routes);
- (g) modified *retained* habitat (e.g. cleared native pasture, grazed woodlands);
- (h) highly modified *retained* habitat (e.g. fertilised natural pastures); and
- (i) destroyed habitat (e.g. crops, sown pastures).

As it is unlikely that any woodland areas fully retain their pre-1750 characteristics, the unmodified category above effectively refers to areas that are *largely* unmodified. The pattern of modification of remaining habitat may take the form of gradients between habitat states or may be sharply defined, as that between urban development and reserves.

In each of the landscape types (intact to relictual), retained habitat is a mix of habitat states. All combinations of habitat destruction and modification gradients are theoretically possible, but remaining woodland habitats tend to become more highly modified with increasing levels of destruction around them (i.e. where there is no buffer, or where modification gradients are short). This means that in relictual landscapes, for example, remaining woodland fragments are more likely to be highly modified habitat and be under intense pressure from the effects of surrounding land uses. Conversely, the retained habitat in variegated and intact landscapes is likely to have a higher proportion of modified and unmodified habitat. This provides a guide to regeneration and restoration activities. Because effective habitat restoration is extremely difficult, a first priority should always be to maintain the least modified habitat available (McIntyre and Hobbs 1999).

In the above typology, the ACT contains lowland woodland landscapes that range from the relictual to the variegated. Intact woodland landscapes are no longer found in the ACT or Southern Tablelands. Remnants of lowland woodland form a patchy distribution with highly variable retained habitat (unmodified to highly modified) as well as areas of destroyed habitat within patches. Urbanisation, as has occurred across the low elevation parts of the ACT,

results in fragmentation and sharp habitat boundaries, as areas of completely destroyed habitat adjoin largely unmodified areas which may be placed in reserves.

2.5

Description of the Categories of Lowland Woodland in the ACT

The scheme presented by McIntyre and Hobbs (1999) has been used as the conceptual basis for categorising ACT lowland woodland, but has been adapted to ACT circumstances for the purposes of the *Strategy*. In the *Strategy*, pre-1750 unmodified woodland provides a baseline against which to compare progressive levels of modification (Table 2.3). The typical landscape location of these woodland categories in the ACT is shown in Figure 2.4.

To understand the changes that agricultural and pastoral activities have made on grassy woodlands, it is useful to consider the tree layer and ground layer separately (McIvor and McIntyre 2002). Where both of these layers have been removed, grassy woodland and its habitat have been destroyed. In the surviving remnants of grassy woodland, modification of either layer is variable. There is a continuum in each layer, from highly intact vegetation to complete removal, and there may be no correspondence at a particular time between the tree and grass layers in their respective levels of modification.

A woodland community is defined as one that contains characteristic flora and fauna species, with a structure that usually contains up to 50% crown cover density (30% projective foliage cover). Because of the degree of modification that has occurred to lowland woodland, the following additional characteristics are also taken into account:

- remaining diversity of species;
- extent of native cover in the groundlayer;
- the ability of the understorey and overstorey to respond to assisted natural regeneration; and
- the presence of propagules of native species that provide a basis for natural regeneration.

The categories in Table 2.3 show progressive levels of modification of both the tree cover and the understorey from the pre-1750 unmodified base, to the situation where all traces of the original woodland community have been removed from the landscape. Based on the features identified above, Yellow Box–Red Gum Grassy Woodland that is partially or moderately modified (containing trees or secondary grassland) is

classified in the ACT as the ecological community, which has been declared under the *Nature Conservation Act 1980*. Substantially modified and severely modified woodland is not classified as this ecological community, as it is considered that it no longer contains the elements necessary to perpetuate the community through natural regeneration.

While six discrete levels are identified in this section and in Table 2.3 the condition of sites may to some extent merge from one level to another. In addition, under appropriate management changes may occur in species diversity and abundance of some species such that a site may be regarded as having the characteristics and/or condition of another level. A description of each level follows.

2.5.1 Unmodified Lowland Woodland (Pre-1750 Composition and Structure)

Estimation of the features of the pre-1750 lowland woodland (Table 2.2) provides a base against which to consider the type and extent of subsequent modification.

DISTRIBUTION AND EXTENT

Lowland woodland was formerly widely distributed in the ACT on deeper soils on the middle and lower slopes of hills. It occurred mainly in the altitude range 600 to 800 m, but ranged from about 450 m up to 1000 m. It is likely that very little or no such unmodified woodland remains in the ACT or surrounding region, as most remnants have suffered at least some degree of disturbance or invasion by exotic species.

FLORISTICS

Floral diversity was a feature of lowland woodland. While the composition of such unmodified woodlands is unknown, they are likely to have contained a diversity of native grasses and forbs, including lilies, orchids and many other species (see Table 2.2).

FAUNA

Lowland woodland contained a highly diverse fauna related to tree cover and understorey habitat.

2.5.2 Partially Modified Lowland Woodland

Partially modified lowland woodland comprises what are considered to be relatively intact remnants of the pre-European ecological community. These are areas of high natural integrity. Domestic stock may have grazed these woodlands, but probably only lightly and infrequently.

DISTRIBUTION AND EXTENT

As shown in Figure 2.3, the distribution of partially modified lowland woodland in the ACT is a mosaic with woodland that has been more modified. The largest areas of partially modified woodland are in the north-east (Ainslie–Majura, Mulligans Flat–Gooroo), the south-west (Naas Valley, Tharwa, Castle Hill, Lambrigg and parts of the Bullen Range).

FLORISTICS

Partially modified lowland woodland typically contains a relatively complete age range of trees (dead trees, large old trees with hollows, trees in middle stages of growth, saplings and seedling growth) and species that are not commonly found in more disturbed areas. Understorey species include Billy Buttons (*Craspedia variabilis*), Rice Flower (*Pimelea linifolia*) and lilies including Nodding Chocolate Lily (*Dichopogon fimbriatus*). Some common annual and perennial weed species are likely to be present.

FAUNA

These woodlands provide habitat for many animals, including birds, bats, reptiles, ground dwelling and arboreal mammals, and invertebrates. The hollows developed in older tree trunks and branches, together with fallen wood, provide essential shelter for many of these species. In the better quality stands, structural complexity is created by the presence of tree hollows, trees of different ages, standing dead trees and a variable shrub and grassy understorey which provide nesting sites, shelter and food resources for fauna.

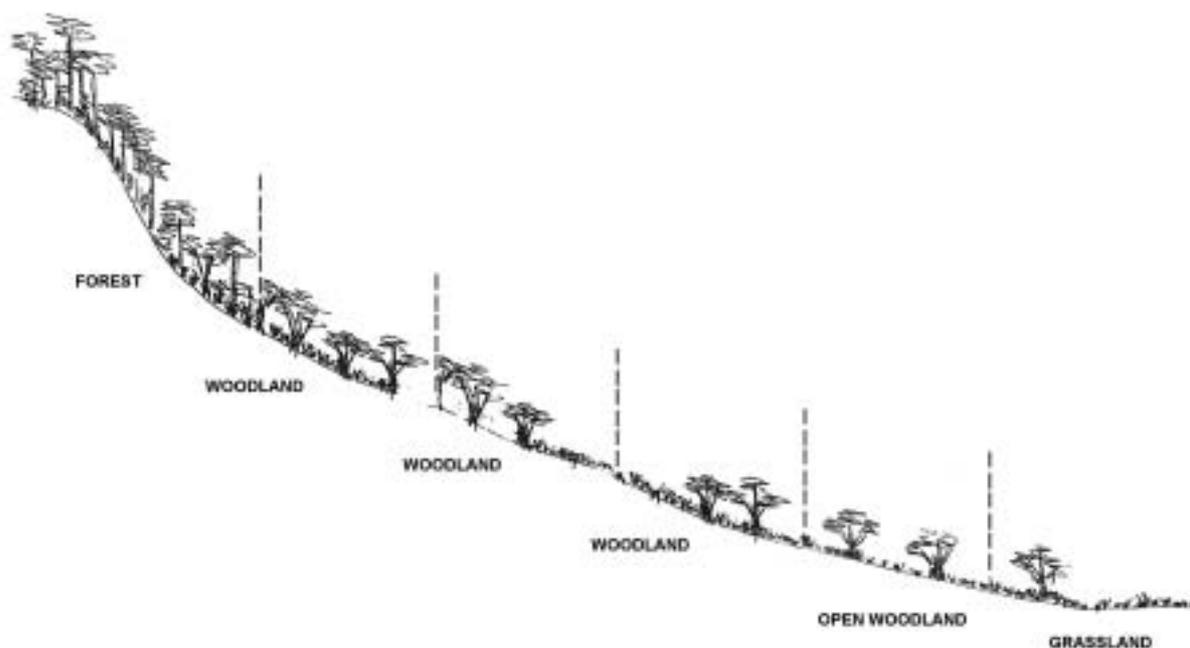
2.5.3 Moderately Modified Lowland Woodland

Moderately modified lowland woodland may superficially resemble partially modified lowland woodland but is grassy woodland in which land uses, particularly grazing, have resulted in the loss of a significant component of the native understorey and

Table 2.3: ACT Lowland Woodland: Habitat States and Woodland Categories

| Degree of modification <small>(Adapted from McIntyre and Hobbs 1999)</small> | Trees <small>(Percentages refer to crown cover density (see s. 1.3 & Glossary))</small> | Groundlayer <small>(Predominant cover, may also contain small patches of more or less disturbed vegetation)</small> | Woodland category <small>(Yellow Box–Red Gum Grassy Woodland Endangered Ecological Community: greater than 40% of crown cover is or was likely to have been Yellow Box and/or Blakely's Red Gum)</small> | |
|---|--|--|---|----|
| Unmodified <small>(pre-1750 composition and structure)</small> | 2–50% tree cover | Only native cover, reflecting biological diversity prior to European settlement | Lowland Woodland (includes Yellow Box–Red Gum grassy woodland) (s. 2.5.1) | ↓ |
| (Largely) Unmodified | 2–50% tree cover | High diversity and cover of native species, including disturbance sensitive species and/or moderately sensitive species | Partially Modified Lowland Woodland (includes Yellow Box–Red Gum grassy woodland) (s. 2.5.2) | ↓ |
| Modified | 2–50% tree cover | Moderate diversity and cover of native species, including disturbance tolerant species (but excluding sensitive and moderately sensitive species) | Moderately Modified Lowland Woodland (includes Yellow Box–Red Gum grassy woodland) (s. 2.5.3) | ↓↑ |
| | Less than 2% tree cover (trees cleared) | Moderate diversity and cover of native species, including disturbance sensitive and/or disturbance tolerant species. | Moderately Modified Lowland Woodland—Secondary Grassland (includes Yellow Box–Red Gum grassy woodland) (s. 2.5.4) | ↓↑ |
| Highly modified | 2–50% tree cover | Low to very low diversity of native species (mostly disturbance tolerant native grasses), usually with a high cover of exotice perennial species and annual exotices | Substantially Modified lowland woodland (s. 2.5.5) | ↓ |
| Highly modified | Single trees or small clumps | Minimal or no diversity and cover of native species. Pasture species, perennial exotices and annual exotices. | Severely Modified Lowland Woodland–Paddock trees (s. 2.5.6) | ↓↑ |
| Destroyed | No trees | Exotic pasture, urban or other development | Not applicable | |

↓↑ Areas of woodland may change categories depending upon land use, management and disturbance factors.



| | Partially and moderately modified lowland woodland | Substantially modified lowland woodland | Moderately modified lowland woodland–Secondary Grassland | Severely modified lowland woodland–Paddock trees | Moderately modified lowland woodland | Native Grassland |
|--|--|---|--|--|--|-----------------------------|
| Endangered ecological community | Yellow Box–Red Gum Grassy Woodland | | Yellow Box–Red Gum Grassy Woodland | | | Natural Temperate Grassland |
| Other woodland types | Dry Shrubby Box woodland | Groups of Yellow Box/Red Gum trees where understory has been 'lost' | | Single trees in exotic/mixed pasture | Valley Snow Gum grassy woodland low elevation fringe community | |

Figure 2.4 Schematic Diagram: Categories of ACT Lowland Woodland and Typical Landscape Location

led to other changes in the composition of understorey native species. These areas have not been subject to widespread pasture improvement. There may have also been impacts on the tree cover but not sufficient to change their essential woodland character. These areas are included in the endangered ecological community because they retain their tree cover, and the native understorey component remains high. There is potential through regeneration and restoration to recover their natural integrity.

DISTRIBUTION AND EXTENT

Moderately modified lowland woodland has the same distribution pattern as partially modified lowland woodland. Large areas of moderately modified woodland occur in Gungahlin, the Majura valley, Callum Brae–Jerrabomberra, and the Naas valley.

FLORISTICS

Past disturbance to the tree cover and varying regeneration, depending upon land use, may result in disjunct age classes (e.g. large old trees and extensive sapling growth). These areas are characterised by disturbance tolerant species in the understorey e.g. Common Everlasting (*Chrysocephalum apiculatum*), Australian Bindweed (*Convolvulus erubescens*). Remnants of the Snow Gum grassy woodland (low elevation fringe community) occur in some locations (north and central Gungahlin and west Belconnen). Some common annual and perennial weed species are likely to be present.

FAUNA

These areas provide similar fauna habitat to partially modified lowland woodland except that the loss of habitat complexity may reduce the suitability of the habitat for some species.

2.5.4 Moderately Modified Lowland Woodland—Secondary Grassland

Secondary grassland is an ecological community that develops when the tree canopy cover of grassy woodland (or forest) is removed or suffers dieback and natural regeneration is prevented (Benson 1996). The understorey, however, remains relatively intact, with disturbance tolerant and/or disturbance sensitive species present. These areas are included in the endangered ecological community as assisted regeneration and revegetation can be used to restore the tree diversity.

DISTRIBUTION AND EXTENT

Extensive areas of secondary grassland are scattered throughout the lowland woodland zone in the ACT. They are found on hillslopes beyond the normal extent of natural temperate grassland, which they superficially resemble. Examples of secondary grassland are at Kama (Belconnen), Gooroo (Gungahlin), Conder Section 4 (Tuggeranong).

FLORISTICS

Species composition in these sites is often very similar to natural grasslands, but they also contain shrubs and herbaceous species more characteristic of the former woodland community. They are invaded to varying degrees by annual and perennial exotic grass and herbaceous weeds.

FAUNA

Secondary grasslands contribute to habitat diversity and provide browsing areas for macropods. Species composition is similar to natural temperate grassland intermixed with woodland species where grassland adjoins woodland.

2.5.5 Substantially Modified Lowland Woodland

There are extensive, fragmented woodland remnants where the native understorey has been destroyed or so highly modified that the remnants no longer represent the ecological community. In these areas the vegetation has been reduced to woodland trees over highly degraded native understorey, exotic perennial and annual species, and areas of bare ground, especially in dry periods. Native species diversity is low, ecological functionality reduced, and resilience to weeds and other disturbance is limited. Native understorey is typically disturbance tolerant native grasses with few or no native forbs. However, the tree cover may still be valuable habitat particularly for birds. Regeneration of trees in these areas is often minimal

or non-existent being highly dependent upon management. Tree seedlings are particularly attractive to sheep and cattle (Jacobs 1955; Landsberg 2000) and may also be suppressed by a dense exotic understorey.

DISTRIBUTION AND EXTENT

These woodland patches have a similar distribution to the grassy woodland ecological community as a whole but are frequently located at lower elevations on the hillslopes and adjacent plains (Figure 2.4) where they have important habitat values (see s. 4.6.8 and s. 4.7). They have been more intensively grazed and may have undergone pasture improvement with exotic species. Some areas have been cultivated for crops and later allowed to regenerate.

FLORISTICS

The upper stratum contains eucalypt trees and associated species typically without a complete range of age classes. Selective removal of species may have occurred in the past e.g. cutting of Yellow Box for firewood. The native component in the understorey it is most likely to be speargrasses (*Austrostipa* spp.), wallaby grasses (*Danthonia* spp.) or Red Grass (*Bothriochloa macra*), which are more tolerant of grazing. Typically there is a high component of perennial exotic grasses and forbs, annual exotic grasses and herbaceous and woody weeds.

FAUNA

These areas continue to provide important animal habitat. However, their habitat value for reptiles, frogs and some bird species is reduced if they are heavily grazed and fallen logs and branches are removed. Their value as bird habitat in the ACT is well documented e.g. parts of Callum Brae Woodland, Newline Quarry area south of Canberra International Airport.

2.5.6 Severely Modified Lowland Woodland—Paddock Trees

'Paddock trees' are characteristic of grazed and cultivated land in the temperate eucalypt woodland zone. They are the only remnants of the tree and understorey cover extensively cleared from the 1800s. With grazing and cultivation there is lack of tree recruitment. This, together with natural senescence, ongoing clearing, woodcutting and dieback is resulting in the progressive decline of these paddock trees (Landsberg *et al.* 1990; Gibbons and Boak 2000; Ozolins *et al.* 2001).

DISTRIBUTION AND EXTENT

Across extensive areas of the ACT, the last vestiges of grassy woodland are solitary trees or small groups of woodland tree species. These are found in the rural landscape and throughout the Canberra urban area, mostly in urban open space, road reserves and other easements. A typical example of the rural landscape with paddock trees and minimal regeneration is west of the Canberra urban area in the Bulgar Creek catchment, south of the Cotter Road. Where grazing has been removed or is applied selectively, regeneration in a copse pattern is evident around mature seed trees. This can be seen in areas such as the footslopes of Isaacs Ridge (west of Mugga Lane) and parts of Mulligans Flat Nature Reserve.

There is a similar scatter of remnant trees throughout the urban area. While most of these are on Public Land, some are located on private leases, both residential and institutional. Many of these are magnificent large mature trees and some Yellow Box trees have been dated to over 300 years old (Banks 1997). These trees typically have an understorey of mown introduced dry grassland or lawn grasses and there is no recruitment. The age of the trees and safety concerns in urban areas means that trees are being slowly removed from the urban landscape. Examples of such trees can be found in the grounds of CSIRO Black Mountain (Clunies Ross Street) and the Australian National University, the village of Hall, and throughout most Canberra suburbs.

FLORISTICS

Trees are often large and very old, with minimal regeneration evident. Introduced pasture species, perennial and annual grasses and weeds, or crops usually wholly or largely replace the understorey.

FAUNA

Paddock trees have habitat value for species that feed on pollen, nectar, seed and invertebrates or nest in hollows (Gibbons and Boak 2000; Ozolins *et al.* 2001; Gibbons and Lindenmayer 2002; NSW NPWS *et al.* 2002). They also assist species such as woodland birds move between larger remnants (Fischer 2000). Urban trees have similar value and contribute to the diversity of the Canberra 'urban forest'.

Distribution of woodland vegetation in the ACT

Figure 2.3.

