

Temperate woodlands in Victoria: distribution, composition and conservation

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Prior to European settlement, temperate woodlands occupied 32% of Victoria, but by 1987 92% of woodlands had been cleared, mostly for agriculture, and much of what remains is fragmented and often degraded. The remaining woodlands contain a wide variety of ecosystems dominated by a range of tree species, and these woodlands harbour a diverse flora and many rare and threatened plant species. A distinctive woodland fauna cannot be identified due to overlaps with adjacent vegetation types, but it is clear that the fauna has been greatly affected by the widespread loss of habitat and fragmentation. Impacts were greatest on the medium-sized ground-dwelling mammals, many of which became extinct. Other faunal groups have also been impacted to various degrees. Conservation of woodlands in Victoria will require the protection of existing natural areas to prevent further degradation and loss, the management of habitats to enhance conservation values, and the long-term restoration of the ecosystem.

INTRODUCTION

BEFORE European settlement, temperate woodlands occupied large areas of northern, western and southern Victoria. Nowadays, most woodlands have been transformed to agricultural pastures and crops, and the conservation status of virtually all woodland communities is extremely poor. In this chapter, we provide an overview of the distribution, composition and conservation status of temperate woodlands in Victoria.

Most temperate woodlands in Victoria occur in flat or gently undulating landscapes on soils of moderate to high fertility. The ground stratum is generally dominated by herbaceous species (usually grasses), and relatively few species of sclerophyllous shrubs are abundant. "Typical" Australian families such as Myrtaceae, Proteaceae and Epacridaceae are poorly represented (Frood and Calder 1987; Lunt 1991; Department of Conservation and Environment 1992).

The Victorian Department of Natural Resources and Environment (DNRE) recently mapped the pre-European and present distributions of 28 "broad vegetation types" across Victoria (Department of Natural Resources and Environment 1997a). Nine of the 28 "broad vegetation types" typically form temperate woodlands (coastal grassy woodlands, sedge-rich woodlands, plains grassy woodlands, herb-rich woodlands, montane grassy woodlands, riverine grassy woodlands, rainshadow woodlands, Mallee woodlands and Wimmera mallee woodlands). In addition,

many areas mapped as grassland supported an open savannah woodland at the time of European settlement (McDougall and Kirkpatrick 1994), and shared a similar plant composition with nearby woodland ecosystems. Figure 1 shows the distribution of temperate woodlands and grasslands in Victoria, based on DNRE's map of broad vegetation types. Temperate woodlands were most widespread across northern and western Victoria, on alluvial, riverine, basaltic and coastal plains (Fig. 1).

The above circumscription of temperate woodlands excludes box-ironbark forests, which traditionally have been viewed as a distinctive ecosystem (e.g., Frankenberg 1971; Frood and Calder 1987; Conn 1993). More recently, the term "box-ironbark woodlands" has been interpreted more broadly (usually by zoologists) to include both "box-ironbark forests" on infertile auriferous soils and "box woodlands" on the adjacent agricultural plains; only the latter ecosystem is here regarded as a temperate woodland ecosystem.

Prior to European settlement, temperate woodlands occupied over 7 million ha in Victoria, 32% of the state. Grasslands and woodlands collectively occupied 9 million ha, or 40% of the state (DNRE unpubl. data, May 1997: Table 1). Today, little of the original woodland estate remains. By 1987, 92% of woodlands had been cleared (mostly for agriculture), and only 575 000 ha remained. The 1987 estimates were obtained from aerial-photo analysis of tree stands, and do not reflect the condition of the understorey,

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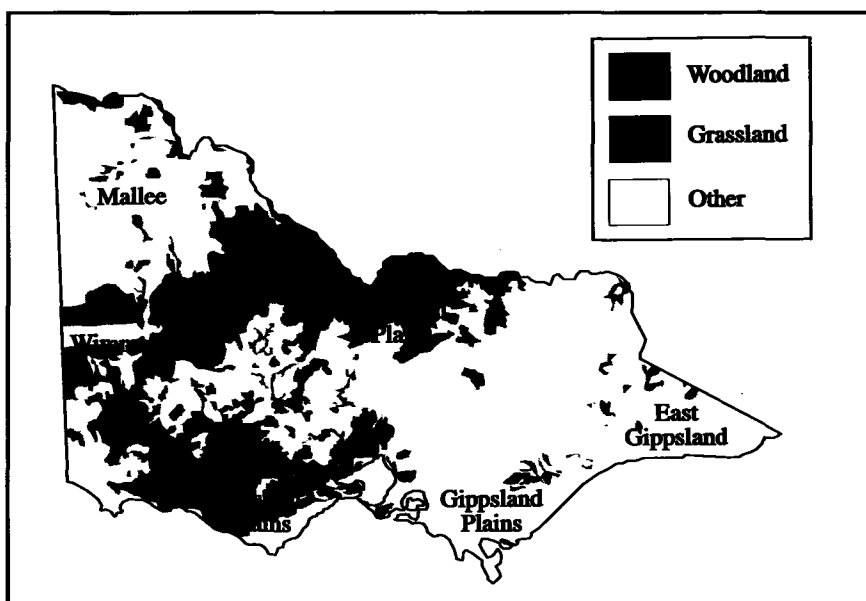


Fig. 1. Distribution of temperate woodland and grassland in Victoria at the time of European settlement. Simplified from Department of Natural Resources and Environment (1997a).

which is grossly degraded in most woodland remnants.

The amount of habitat loss since European settlement varies dramatically among the different woodland vegetation types (Table 1). However, the ecosystems which were originally the most widespread have suffered the greatest destruction (Fig. 2). This pattern reflects the wholesale conversion of woodlands on the northern and western plains to agriculture. Three of the four ecosystems which were originally the most widespread (plains grassy woodland, grassland and Wimmera mallee woodland) have fared the worst, with less than 3% remaining. At the other extreme, woodlands in eastern Victoria have fared relatively well, with over 50% of rainshadow

woodland and montane grassy woodland remaining. Again, remnants of both ecosystems are often extremely degraded, especially by stock and rabbit grazing (e.g., Clayton-Greene and Ashton 1990). Based on these figures, riverine grassy woodlands now account for 34% of the remaining temperate woodland estate in Victoria (Table 1).

In most regions, most indigenous vegetation has been lost, and pastures and crops with few native species and a high exotic cover, prevails. Thus, the traditional "habitat fragmentation"

Table 1. Area of Victoria occupied by temperate woodland broad vegetation types, in 1750 (before European settlement) and in 1987.

Broad vegetation type	Area (1 000s ha)	
	1750	1987
Plains grassy woodland	4 140	124
Riverine grassy woodland	997	201
Wimmera mallee woodland	862	2
Herb-rich woodland	691	68
Mallee woodland	224	61
Coastal grassy woodland	173	35
Rainshadow woodland	77	43
Montane grassy woodland	59	39
Sedge-rich woodland	26	2
Grassland	1 882	8
TOTAL	9 133	584

Source: Flora Section, Department of Natural Resources and Environment, and Natural Resource Systems, May 1997.

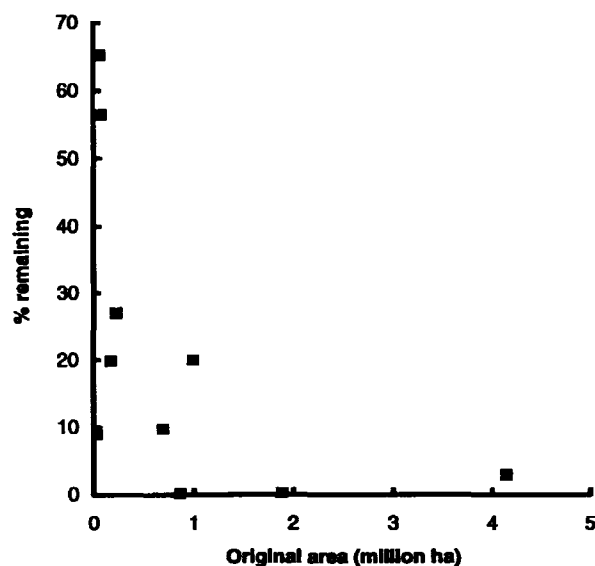


Fig. 2. Original area of broad woodland vegetation types versus the percentage remaining in 1987. Source: Flora Section, Department of Natural Resources and Environment, and Natural Resource Systems, May 1997.

model is generally more applicable than the "habitat variegation" model, which has recently been developed in the New England Tablelands in New South Wales (McIntyre and Barrett 1992). Without doubt, the most widespread woodland landscapes in northern and western Victoria are highly fragmented, not variegated. Within this fragmented landscape, a "habitat segregation" model has received considerable attention from Victorian botanists. Under this model, sites managed in different ways (e.g., burning and grazing exclusion *vs* grazing and fire exclusion) often conserve different portions of the original regional species pool (Lunt 1995, 1997; Foreman 1997). The segregation model focuses only on the best quality remnants, rather than the entire landscape, but emphasizes the divergent effects of different management regimes on native plant species. It is probably a more useful predictor for plant distributions than for larger vertebrate fauna, since it assumes that management history is a more critical component of plant composition than landscape issues such as remnant size, shape or connectivity, as has been found elsewhere (Kirkpatrick and Gilfedder 1995; Prober and Thiele 1995). It is worth noting, however, that management history can have important local effects on resources required by certain animals, such as tree hollows (Bennett *et al.* 1994), and in this way can influence the composition and distributional pattern of the fauna.

FLORA OF TEMPERATE WOODLANDS

Ecosystem descriptions

A wide variety of distinctive woodland ecosystems occurs in Victoria (Table 2), and the following descriptions are adapted from Frood and Calder (1987), Department of Conservation and Environment (1992) and Conn (1993). In semi-arid, northwestern Victoria, Slender Cypress Pine *Callitris preissii* and Buloke *Allocasuarina luehmannii* formed woodlands on sandy lunettes (Table 2). Before European settlement, the ground layer was probably dominated by perennial Spear-grasses (*Stipa* species) but the community has usually been heavily grazed, and introduced species, mostly annuals, now dominate the ground layer at most sites. Black Box *Eucalyptus largiflorens*, Buloke *Allocasuarina luehmannii* and Bull Mallee *Eucalyptus behriana* originally formed extensive woodlands on the Wimmera plains. Only scattered remnants of these vegetation types now exist. The original ground-layer is thought to have been dominated by Kangaroo Grass *Themeda triandra*, Common Wallaby-grass *Danthonia caespitosa* and Spear-grasses *Stipa* species (Morcom and Westbrooke 1998).

The original vegetation of the Northern Plains has been extensively modified by agriculture, as in the Wimmera, and only small remnants now occur. River Red Gum *Eucalyptus camaldulensis* was the original dominant in

Table 2. Common (or once-common) dominant tree species in temperate woodlands in Victoria.

Scientific name	Common name	MAL	WIM	NP	WE	GIP	EA
<i>Alectryon oleifolius</i>	Cattle-Bush	x					
<i>Allocasuarina luehmannii</i>	Buloke	x	x	x	x		
<i>Allocasuarina verticillata</i>	Drooping She-oak				x	x	
<i>Banksia marginata</i>	Silver Banksia				x	x	
<i>Callitris glaucophylla</i>	White Cypress Pine	x					x
<i>Callitris preissii</i>	Slender Cypress Pine	x					
<i>Casuarina pauper</i>	Belah	x					
<i>Eucalyptus albens</i>	White Box			x			x
<i>Eucalyptus behriana</i>	Bull Mallee		x				
<i>Eucalyptus blakelyi</i>	Blakely's Red Gum			x			
<i>Eucalyptus bridgesiana</i>	Apple Box					x	
<i>Eucalyptus camaldulensis</i>	River Red Gum	x	x	x	x	x	
<i>Eucalyptus camphora</i>	Mountain Swamp Gum						x
<i>Eucalyptus largiflorens</i>	Black Box	x	x	x			
<i>Eucalyptus leucoxylon</i>	Yellow Gum	x	x		x		
<i>Eucalyptus melliodora</i>	Yellow Box			x	x	x	
<i>Eucalyptus microcarpa</i>	Grey Box		x	x			
<i>Eucalyptus ovata</i>	Swamp Gum				x	x	
<i>Eucalyptus pauciflora</i>	Snow Gum				x	x	x
<i>Eucalyptus rubida</i>	Candlebark				x	x	x
<i>Eucalyptus stellulata</i>	Black Sallee						x
<i>Eucalyptus tereticornis</i>	Forest Red Gum					x	
<i>Eucalyptus viminalis</i>	Manna Gum				x	x	

Regions: MAL = mallee, WIM = Wimmera, NP = northern plains, WE = western plains, GIP = lowland Gippsland, EA = montane eastern Victoria. These six regions are simplified from the 16 "natural regions" identified by Conn (1993). MAL = Conn's Murray Mallee and Lowan Mallee regions; WIM = Wimmera region; NP = Riverina and northern Midlands regions; WE includes Wannon, Grampians and Victorian Volcanic Plain regions; GIP = Gippsland Plain, and EA = parts of East Gippsland natural region (includes rainshadow woodlands).

regularly flooded, riverine areas. The understorey in elevated, irregularly flooded areas was dominated by Kangaroo Grass *Themeda triandra*, Wallaby-grasses *Danthonia* species, Spear-grasses *Stipa* species and Windmill Grass *Chloris truncata*. Considerable uncertainty exists on the original dominant grasses throughout most of northern Victoria, owing to the extremely rapid, and virtually complete, elimination of C4 grasses such as Kangaroo Grass (Moore 1953; Robinson and Mann 1996; Morcom and Westbrooke 1998). In the west of the region, *E. largiflorens* was dominant in woodlands on the drier margins of the River Red Gum woodlands, with Kangaroo Grass *Themeda triandra*, Wallaby-grasses *Danthonia* species and Spear-grasses *Stipa* species and a variety of chenopod shrubs in the ground layer. Extensive woodlands of Grey Box *Eucalyptus microcarpa* occurred across much of the Northern Plains, often with White Cypress Pine *Callitris glaucophylla*, Buloke *Allocasuarina luehmannii* and, at times, Yellow Box *Eucalyptus melliodora*. White Box *Eucalyptus albens* was often dominant in the east. The ground layer of relatively undisturbed remnants is usually dominated by Wallaby-grasses *Danthonia* species and Spear-grasses *Stipa* species, although Kangaroo Grass *Themeda triandra* is likely to have dominated in many areas before grazing by European stock.

Much of western Victoria supported open grasslands and grassy woodlands (Fig. 3) dominated by a variety of species, including River Red Gum *Eucalyptus camaldulensis*, Manna Gum *E. viminalis*, Yellow Box *E. melliodora*, Swamp Gum *E. ovata*, Grey Box *E. microcarpa*, Drooping She-oak *Allocasuarina verticillata* and a tree form of Silver Banksia *Banksia marginata*. The latter species has disappeared from vast areas in which it was originally a co-dominant. Kangaroo Grass *Themeda triandra* again dominated the ground layer in most well-drained areas, with Tussock-grass *Poa labillardieri* in poorly drained sites.

The lowland plains of eastern Victoria supported grassy woodlands dominated by Manna Gum *Eucalyptus viminalis*, Black She-oak *Allocasuarina littoralis* and, in some places, Snow Gum *Eucalyptus pauciflora*. Forest Red Gum *Eucalyptus tereticornis* formed extensive woodlands and open forests on the lowland Gippsland plain. Regular burning by Aboriginals may have helped maintain an open woodland structure in many lowland coastal areas, and there are many instances of tree and shrub invasion since European settlement. Small, but distinctive, outliers of grassy woodland occur on fertile soils in inter-montane basins in montane eastern

Victoria, for example at Buchan, Omeo, Delatite and Wulgulmerang. The dominant eucalypts included Snow Gum *Eucalyptus pauciflora*, Candlebark *E. rubida*, Yellow Box *E. melliodora* and Mountain Swamp Gum *E. camphora*. The ground layer was originally dominated by Kangaroo Grass *Themeda triandra* and Tussock-grasses *Poa* species. Many of these woodlands are similar in composition to woodlands on the Southern Tablelands of New South Wales.

Plant diversity

There are no published estimates of plant species diversity in temperate woodlands in Victoria. However, unpublished quadrat data held by the Victorian Department of Natural Resources and Environment, supplemented by recent species lists (Lunt 1992; McDougall and Kirkpatrick 1994; Robinson and Mann 1996), include nearly 1 000 native plant species. This data set includes many grassland quadrats, but as virtually all native grassland species also occur (or occurred) in woodlands (McDougall 1994), the figure remains a valid estimate for plant diversity in grassy woodlands. Assuming that an extra 100 species (if not more) might be added from more exhaustive surveys, then the total native plant diversity of Victorian temperate woodlands might be tentatively estimated as at least 1 100 species, which is 33% of the 3 289 native plant taxa recorded from Victoria (Ross 1996).

Whilst considerable, this figure is not especially high for an ecosystem that once occupied 40% of the state. By contrast, a similar number of species (almost one-third of Victorian native plant species) occur in the 167 000 ha Grampians National Park in western Victoria (Calder 1987). The relatively low plant species diversity across grassy woodlands in Victoria probably reflects the environmental uniformity of most woodland habitats, and low species turnover between sites in most woodland regions. Most woodland species were widespread before habitat destruction, and few local endemics are known to occur (Scarlett and Parsons 1993; Prober 1996).

Despite a relatively low regional plant diversity, small-scale plant richness is extremely high in some woodlands. Up to 45 vascular plant species have been recorded from a single square metre, and 93 species from 128 m², in woodlands in south-west Victoria (Lunt 1990). At this scale, these woodlands are among the richest terrestrial plant communities in the world. Small-scale richness in these woodlands is comparable to that of species-rich kwongan vegetation in south-west Western Australia

(Lamont *et al.* 1984) and chalk grasslands in Europe (Lloyd *et al.* 1971; During and Willems 1984, see also Chapter 7).

Rare and threatened plant species

The status of threatened plant species in Victorian temperate woodlands has been comprehensively reviewed (Scarlett and Parsons 1982, 1993; Department of Conservation and Environment 1992; Lunt 1992). Scarlett and Parsons (1993) calculated the number of rare and threatened plant species in all major biomes in Victoria, including "grasslands, grassy woodlands and open forests of the fertile lowlands", which is largely synonymous with "temperate woodlands" as defined here. These lowland grassy ecosystems contained 48 nationally rare or threatened plant species (Table 3), about half the number in the biome with the most rare or threatened species ("shrubby open-forests of the ranges, heathlands and shrubby open forests of the coastal plains", with 97 species), but similar to that of alpine and sub-alpine communities (47 species). However, lowland grassy ecosystems contained many more nationally endangered plant species than all other ecosystems (16 cf. 8 in shrubby open forests and one in the alps). Lowland grassy ecosystems contained 142 of 688 species (21%) which were rare or threatened in Victoria (regardless of their status elsewhere in Australia), and again included the greatest number of plant species which were endangered in Victoria: 33 endangered species compared to 31 in the Mallee, and 14 in shrubby open forests (Table 3). Other reviews (Department of Conservation and Environment 1992; Lunt 1992) showed essentially the same patterns:

temperate woodlands contain a relatively small proportion of the total number of rare and threatened plant species in Victoria, but a sizeable proportion of those most at risk of extinction in Victoria, the endangered species.

Most rare and threatened species in temperate woodlands had a wide range (and presumably large total populations) prior to European settlement (Scarlett and Parsons 1982, 1993). Their present rarity is a function of habitat destruction and unsuitable management (especially grazing) in surviving remnants. Despite the large number of threatened species in these ecosystems, few have received specific ecological attention. Button Wrinklewort *Rutidosis leptorrhynchoides* is a notable exception, being perhaps the most studied endangered plant species in south-eastern Australia (Gray 1979; Scarlett and Parsons 1990; Leeton and Fripp 1991; Morgan 1995a,b, 1997, 1999; Young *et al.* 1999).

The Victorian *Flora and Fauna Guarantee Act* (1988) allows listing of threatened species and communities. Threatened communities are defined at a finer resolution than the "broad vegetation types" listed above. By June 1997, just one woodland community was listed under the Act: Forest Red Gum Grassy Woodland (in Gippsland). The paucity of listed woodland communities reflects the difficulty of nominating communities for listing (which requires data usually inaccessible to the public, such as detailed floristic descriptions), rather than the true conservation status of woodland communities (Fig. 4). No Action Statements for woodland communities have appeared to date. Many threatened species in temperate woodlands are listed under the Act, and

Table 3. Numbers of rare and threatened plant taxa in major ecosystems in Victoria.

Ecosystem type	Conservation status					Total
	X	E	V	R	K	
<i>Taxa rare or threatened throughout Australia</i>						
Fertile lowlands	3	16	19	5	5	48
Shrubby forests	5	8	22	59	3	97
Tall wet forests	—	—	2	5	1	8
Alpine	1	1	7	34	4	47
Mallee	—	1	9	5	4	19
Other	—	—	3	2	1	6
<i>Taxa rare or threatened in Victoria (but not necessarily in other states)</i>						
Fertile lowlands	9	33	54	43	3	142
Shrubby forests	9	14	81	142	7	253
Tall wet forests	—	5	19	26	—	50
Alpine	6	4	24	66	1	101
Mallee	7	31	70	80	2	190
Other	3	3	10	22	—	38

Threat codes: X = extinct, E = endangered, V = vulnerable, R = rare, K = poorly known. *Ecosystem types:* fertile lowlands = grasslands, grassy woodlands and open-forests of the fertile lowlands; shrubby forests = shrubby open-forests of the ranges, heathlands and shrubby open-forests of the coastal plains; tall wet forests = tall open-forests and closed-forests (rainforests); alpine = alpine and sub-alpine communities. Data from Tables 10.3 and 10.4 in Scarlett and Parsons (1993).

Action Statements have been published for woodland species such as Hairy-pod Wattle *Acacia glandulicarpa* (Venn 1996), Hairy Anchor Plant *Discaria pubescens* (Humphries 1993), Wedge Diuris *Diuris dendrobioides* (Johnson 1992, as *D. cuneata*), Small Psoralea *Psoralea parva* (Muir 1991), Austral Toad-flax *Thesium australe* (Scarlett *et al.* 1994), and others.

FAUNA OF TEMPERATE WOODLANDS

In parallel with the extensive destruction and modification to temperate woodland vegetation in Victoria (Table 1), the fauna of this ecosystem has also experienced enormous change over the past 150 years. Information concerning the occurrence and distribution of the vertebrate fauna of temperate woodlands in Victoria is available from four main sources.

- Historical records and reports from early settlers (e.g., Dawson 1881; Curr 1883), from naturalists, and from specimen records in museums. Because most of the changes to vegetation (and hence to faunal habitats) occurred prior to systematic faunal surveys, these historical records are invaluable in reconstructing faunal assemblages and in assessing changes that have occurred (e.g., Seebeck 1984; Bennett *et al.* 1989, 1998; Robinson 1993).
- Regional faunal surveys carried out primarily on public land to obtain information

relevant to land use planning by the former Land Conservation Council (e.g., Land Conservation Council 1981, 1983). Regional faunal surveys have provided data for the Western Plains (Emison *et al.* 1975, 1978), Northern Plains (Bennett *et al.* 1998), Mallee (Emison and Bren 1989; Robertson *et al.* 1989), Wimmera (Menkhorst and Beardsell 1982), Gippsland Plains (Norris *et al.* 1983) and East Gippsland (Land Conservation Council 1985).

Fig. 3 (right): Herb-rich grassy woodland at Langi Ghiran State Park in western Victoria. Dominant trees are *Eucalyptus camaldulensis* River Red Gum and *Eucalyptus melliodora* Yellow Box. Species richness of native plants is very high at the small-scale: at this site, 79 plant species were recorded from a single 16 m² plot. Photo: Ian Lunt.

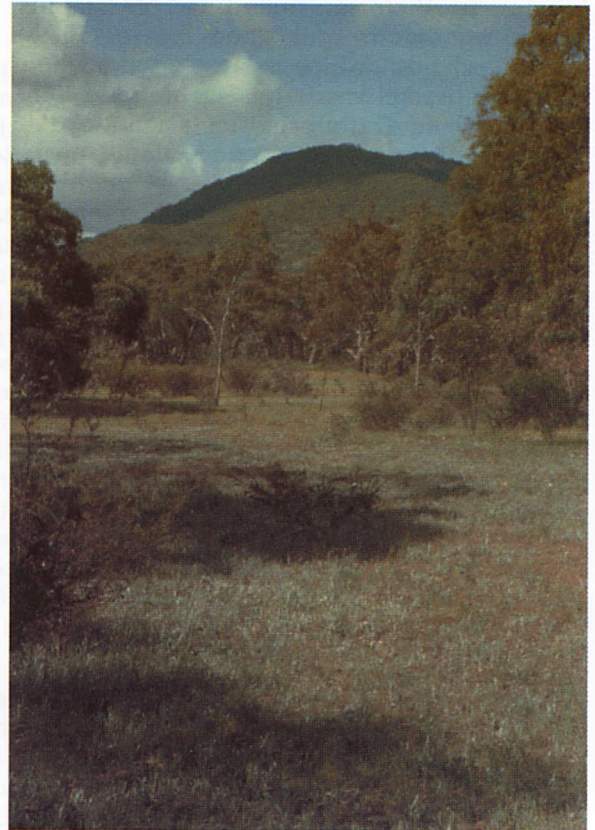


Fig. 4 (left): The only known, intact remnant of *Allocasuarina verticillata* Drooping She-oak woodland on the Lowland Gippsland Plains in eastern Victoria; a 0.4 ha rail-line remnant at West Sale. Flowers include *Burchardia umbellata* Milkmaids (white), *Bulbine bulbosa* Bulbine Lily and *Chrysocephalum apiculatum* Common Everlasting (yellow). Photo: Ian Lunt.

- Faunal surveys and reviews of existing data for local areas, for selected faunal groups, or for environmental features of interest (e.g., Menkhorst and Gilmore 1979; Bennett 1982; Chesterfield *et al.* 1984; Middleton 1984; Seebeck 1984; Hadden and Westbrook 1996; Robinson and Mann 1996).
- Surveys and ecological studies of threatened species that occur in temperate woodlands, such as the Superb Parrot *Polytelis swainsonii* (Webster and Ahern 1992), Bush Stone-curlew *Burhinus magnirostris* (Johnson and Baker-Gabb 1994), Grey-crowned Babbler *Pomatostomus temporalis* (D. Robinson *et al.*, in prep), Squirrel Glider *Petaurus norfolcensis* (Menkhorst *et al.* 1988), and Striped Legless Lizard *Delma impar* (Coulson 1990).

There is now an extensive data base of distributional records of vertebrate wildlife from temperate woodlands upon which land managers and the community can draw. However, while there is reasonable knowledge of the distributional patterns of many vertebrate species (although data are limited for private land that comprises the majority of the former temperate woodlands), there is little detailed knowledge of the ecology of most species or of the processes that influence their present distribution and abundance.

Composition of the woodland fauna

Temperate woodlands span a broad range of elevations, rainfall zones and floristic compositions, and consequently represent a wide range of habitats for fauna. Woodlands of *Casuarina* and *Allocasuarina* in the dry north-west, for example, have a fauna dominated by species associated with the Eyrean zoogeographic region of the inland, while montane eucalypt woodlands in the ranges have a fauna with strong Bassian affinities (Emison 1982). Thus, faunal assemblages in temperate woodlands display much variation in composition and there is no single woodland fauna. In most areas, the faunal assemblage overlaps substantially with that of adjacent vegetation types (such as mallee, dry forests, moist forests), as well as including some characteristically woodland species.

The faunal component most distinctively associated with woodlands in Victoria are those species whose distribution is centred on the extensive woodland habitats of the Western Plains, Northern Plains, and Wimmera. Discussion of woodland fauna in this chapter primarily relates to temperate woodlands in these regions, rather than that in southern coastal or highland regions (e.g., montane woodlands, rainshadow woodland). First, there

is a suite of species whose distribution in Victoria extends (or formerly extended) in a broad zone across the inland side of the Great Dividing Range. Examples include the Yellow-footed Antechinus *Antechinus flavipes*, Squirrel Glider *Petaurus norfolcensis*, Brush-tailed Phascogale *Phascogale tapoatafa*, Diamond Firetail *Stagonopleura guttata*, Bush Stone-curlew, Superb Parrot, Turquoise Parrot *Neophema pulchella*, Fuscous Honeyeater *Lichenostomus fuscus*, Black-chinned Honeyeater *Melithreptus gularis*, Woodland Blind Snake *Ramphotyphlops proximus*, Dwyer's Snake *Unechis dwyeri*, Olive Legless Lizard *Delma inornata* and Sloane's Froglet *Ranidella sloanei* (for distributional maps see Emison *et al.* 1991; Coventry and Robertson 1991; Hero *et al.* 1991; Menkhorst 1995).

A second group of woodland species in Victoria are those that occur (or formerly occurred) more widely in inland Australia, but in Victoria are primarily associated with dry woodlands in the north. These include species such as the Red-tailed Phascogale *Phascogale calura*, Pig-footed Bandicoot *Chaeropus ecaudatus*, Bridled Nail-tail Wallaby *Onychogalea fraenata*, Apostlebird *Struthidae cinerea*, Cockatiel *Nymphicus hollandicus*, Red-capped Robin *Petroica goodenovii*, Curl Snake *Suta suta*, Hooded Scalyfoot *Pygopus nigriceps* and Boulenger's Skink *Morethia boulengeri*.

Although not an integral part of the woodland fauna, it is notable that the Western, Northern and Wimmera Plains also support many species that favour wetland habitats. The flat plains generally have limited drainage and so numerous seasonal wetlands occur in low-lying areas and depressions within the woodland ecosystem (Corrick 1995). Adjoining aquatic and terrestrial environments are important for frog species, and also for birds such as herons, egrets, ibis, and kingfishers that feed in wetlands and roost or nest in woodlands. A number of these wetlands are significant nesting areas for waterbirds; for example, those in the riparian floodplains of Barmah and Gunbower forests for colonial waterbirds, and shallow freshwater marshes of the open plains for the Brolga *Grus rubicundis* (Land Conservation Council 1983; Chesterfield *et al.* 1984; Corrick 1995).

The structure of temperate woodlands and their climatic regime are two attributes that influence the composition of the fauna. Temperate woodlands frequently have an open canopy of large-crowned mature trees, and a relatively open ground layer dominated by grasses and herbs with scattered shrubs. Tree hollows in mature trees provide important nesting sites for a suite of obligate

hollow-using species. Parrots and cockatoos (Families Psittacidae and Cacatuidae), a notably conspicuous and diverse group in temperate woodlands, use tree hollows for nesting and a number of these species forage in the ground layer for seed-bearing grasses and forbs, culms and bulbs. The Sulphur-crested Cockatoo *Cacatua galerita*, Long-billed Corella *Cacatua tenuirostris*, Galah *Cacatua roseicapilla*, Eastern Rosella *Platycercus eximius* and Red-rumped Parrot *Psephotus haematonotus*, are common in most woodland regions (Emison *et al.* 1991) while, in the drier north-west, woodlands provide nesting areas for the Mallee Ringneck *Barnardius barnardi*, Blue Bonnet *Northiella haematogaster*, Mulga Parrot *Psephotus varius* and Major Mitchell's Cockatoo *Cacatua leadbeateri* (Land Conservation Council 1987; Emison and Bren 1989). Riverine woodlands are also important nesting areas for these families, especially for the threatened Superb Parrot and Regent Parrot *Polytelis anthopeplus*, which move between woodlands and nearby foraging habitats during the breeding season (Burbidge 1985; Webster and Ahern 1992).

The open ground layer of temperate woodlands provides foraging habitat for other seed-eating species (e.g., Diamond Firetail, Peaceful Dove *Geopelia striata*, Budgerigar *Melopsittacus undulatum*, Crested Pigeon *Ocyphaps lophotes*), as well as numerous ground-foraging birds that feed on invertebrates (e.g., Red-capped Robin, Hooded Robin, White-winged Chough *Corcorax melanoramphos*, Apostlebird, Restless Flycatcher *Myiagra inquieta*, Yellow-rumped Thornbill *Acanthiza chrysorrhoa*, Australian Magpie *Gymnorina tibicen*).

The most widespread woodlands occur in drier, warmer parts of the state, climatic conditions that are favourable to reptiles. There is a trend of increasing species richness and taxonomic diversity of reptiles towards the warmer north-west of Victoria (Brown and Bennett 1995). Thus, temperate woodlands generally support diverse assemblages of reptiles, with a greater abundance and richness in dry woodlands of the Wimmera and Mallee regions. Families such as geckoes (Gekkonidae), legless lizards (Pygopodidae) and blind snakes (Ramphotyphlopidae) are poorly, or not represented, in mesic forested regions of southern Victoria, but are a more prominent component of the fauna in warm dry woodland habitats (e.g., Brown and Bennett 1995; Hadden and Westbrooke 1996).

The geographic location and climate of temperate woodlands make them an attractive destination for migratory birds. The less-marked seasonal climate of the woodlands

contributes to a more reliable year-round supply of food than in the forested ranges where colder winter conditions contribute to seasonal food shortages (Nix 1976). This encourages winter migration of forest birds such as the Golden Whistler *Pachycephala pectoralis*, Crimson Rosella *Platycercus elegans*, White-naped Honeyeater *Melithreptus lunatus*, Pied Currawong *Strepera graculina* and Flame Robin *Petroica phoenicea* to the woodlands of the plains. In spring and summer, the woodland avifauna is swelled by breeding migrants from northern Australia, such as Rufous Whistler *Pachycephala rufiventris*, Horsfield's Bronze-Cuckoo *Chrysococcyx basalis*, Tree Martin *Hirundo nigricans* and Sacred Kingfisher *Todiramphus sanctus*, and in some years by an unusually large influx of inland species such as the Budgerigar, Cockatiel, Black Honeyeater *Certhionyx niger* and White-browed Woodswallow *Artamus superciliosus*, depending on climatic conditions in inland Australia. An additional group of migratory birds move to and from woodland habitats in response to the flowering patterns of eucalypts. Seasonal fluxes of nectarivorous birds track heavy flowering of Grey Box *E. microcarpa*, White Box *E. albens* and Yellow Box *E. melliodora* on the plains, and also the prominent flowering of ironbarks and other eucalypts in adjacent Box-Ironbark forests (e.g., MacNally and McGoldrick 1997).

Conservation status and historical changes to the fauna

It is not possible to remove 92% of temperate woodlands (Table 1) without having profound effects on the biota. Not surprisingly, there have been major changes to the fauna, including global extinction of species, decline and loss at the regional scale, and impoverishment and simplification of faunal assemblages in many localities (e.g., Seebeck 1984; Environment Conservation Council 1997; Bennett *et al.* 1998). Indeed, temperate woodlands now have a greater number of extinct, endangered, vulnerable or rare species than any other broad ecosystem (aquatic, coastal, forests, mallee) in Victoria (Department of Conservation and Environment 1992). The decline in, and change to, the fauna is most severe in areas formerly occupied by plains grassy woodland and grasslands on the Western, Northern and Wimmera Plains. In contrast, relatively little change has occurred to the fauna of temperate woodlands associated with the highlands of southern Victoria (e.g., rainshadow woodland, montane woodland) where much habitat remains intact (Table 1). The loss of fauna in temperate woodlands is not unique to Victoria, but is an issue of great concern throughout southern

Australia (Robinson 1993; Barrett *et al.* 1994; Saunders and Ingram 1995; Robinson and Traill 1996; Bennett and Ford 1997).

Mammals

The mammalian fauna of temperate woodlands has been massively altered by habitat changes over the last 150 years. The effects have been particularly severe on medium-sized (0.1–5 kg) ground-dwelling mammals, such as wallabies, rat-kangaroos, bandicoots, quolls and rodents, which have all but disappeared (e.g., Bennett *et al.* 1989, 1998). At least 14 of the 19 species of mammals known to be extinct in Victoria (Conservation and Natural Resources 1995) are believed to have regularly occurred in woodland habitats. Four are now globally extinct (Eastern Hare-wallaby *Lagorchestes leporides*, Lesser Stick-nest Rat *Leporillus apicalis*, Pig-footed Bandicoot *Chaeropus ecaudatus* and White-footed Rabbit-rat *Conilurus albipes*), while the others, such as Bridled Nail-tail Wallaby *Onychogalea fraenata*, Rufous Bettong *Aepyprymnus rufescens*, Red-tailed Phascogale *Phascogale calura* and Eastern Quoll *Dasyurus viverrinus*, persist in greatly reduced ranges in other states (Menkhorst 1995). It is difficult for present-day observers to appreciate the diversity and composition of the terrestrial mammal fauna recorded by the first European explorers and settlers in these woodlands (Dawson 1881; Curr 1883; Seebeck 1984; Bennett *et al.* 1989, 1998).

Few of the native ground-dwelling mammals that remain are common. Even widespread species such as the Eastern Grey Kangaroo *Macropus giganteus*, Short-beaked Echidna *Tachyglossus aculeatus* and Common Wombat *Vombatus ursinus*, are now scarce or absent from numerous districts in the former woodland ecosystem (Menkhorst 1995). One species, the Eastern Barred Bandicoot *Perameles gunnii*, is the focus of an intensive recovery effort that is using captive breeding, re-introductions and habitat management to restore its status in the wild (Humphries and Seebeck 1995). Arboreal mammals have generally fared better, but two typically woodland species, the Brush-tailed Phascogale and Squirrel Glider, are regarded as threatened in Victoria and face daunting conservation problems due to the paucity of remaining woodland habitat (Environment Conservation Council 1997). Bats are the group most resilient to habitat change, and now make up a large proportion of the extant mammal fauna (e.g., 45% of mammal species in the Northern Plain). Their mobility allows them to move between disjunct areas of habitat to gain access to resources for feeding and breeding, and thus to maintain

populations even in greatly disturbed environments (Lumsden *et al.* 1995).

Birds

Birds are the most diverse and visible group of vertebrates in temperate woodlands. There have been extensive changes in the status of birds but, unlike mammals, there have not been wholesale extinctions of species. However, at least 38% (20/53) of bird species listed as extinct, endangered, vulnerable or rare in Victoria (Conservation and Natural Resources 1995) regularly occur in woodland ecosystems.

Several types of changes to the woodland avifauna can be recognized. First, there has been a major reduction in the geographic range of certain species as they have gradually disappeared from areas where they once occurred. The Grey-crowned Babbler, for example, was formerly widespread in temperate woodlands of the plains, but has successively disappeared from the Western Plains and much of the Wimmera and Mallee areas, and now persists in substantial numbers only in limited areas on the Northern Plains where there are highly connected systems of remnant habitat (Davidson and Robinson 1992; Robinson *et al.*, in prep.). Similar range reductions are evident (and appear to be ongoing) for other species such as the Bush Stone-curlew, Superb Parrot and Regent Honeyeater (Menkhorst 1994; Webster and Baker-Gabb 1994).

Second, there is an ongoing decline in the relative abundance and status of numerous woodland-dependent species throughout their range in temperate woodlands of southern Australia (Robinson 1993; Saunders and Ingram 1995; Robinson and Traill 1996). This is evident from changes in the relative abundance of species in comparison with historical records for various districts, a decreased frequency of reports from local areas, and "gaps" in the distribution of species where heavy clearing of woodlands has occurred. Many of the woodland-dependent species believed to be declining (e.g., Gilbert's Whistler *Pachycephala inornata*, Diamond Firetail, Hooded Robin, Buff-rumped Thornbill *Acanthiza reguloides*, Varied Sitella *Daphoenositta chrysoptera*, Black-chinned Honeyeater *Meliphreptus gularis*) are not yet regarded as threatened on a statewide basis, but in terms of persistence in temperate woodland regions, these are serious concerns (Robinson 1993; Bennett and Ford 1997).

Third, the extensive clearing of woodlands has enhanced opportunities for birds of open habitats and those tolerant of highly-disturbed habitats, allowing them to expand their range

and increase in abundance. Cleared, open farmland is generally dominated by a handful of common species such as Australian Magpie, Australian Raven *Corvus coronoides*, Willie Wagtail *Rhipidura leucophrys*, Galah, Richard's Pipit *Anthus novaeseelandiae*, and introduced species such as the Common Starling *Sturnis vulgaris* and European Goldfinch *Carduelis carduelis*. Even common woodland birds are scarce unless fragments of woodland have been retained. In many areas where patchy tree cover is retained amongst farmland, the Noisy Miner *Manorina melanocephala* has become abundant (Loyn 1985; Grey *et al.* 1997). This aggressive native honeyeater actively excludes small insectivorous species from the habitats it occupies (Grey *et al.* 1997). Together with the decline of woodland-dependent species, the overall result has been an impoverishment and simplification of the woodland avifauna in many rural districts.

Reptiles

Reptiles are the most poorly surveyed and least-known group of vertebrates in temperate woodlands. Further, there are few baseline historical data with which to compare present patterns of occurrence. There is no evidence that any woodland reptiles have become extinct in Victoria, but present patterns suggest that loss of woodland habitats has greatly altered the distributional pattern of many species (Environment Conservation Council 1997). Some 38% of reptiles regarded as threatened in Victoria (Conservation and Natural Resources 1995) have much or all of their distribution in woodland and grassland ecosystems. While a few species are able to persist in highly disturbed environments (e.g., Boulenger's Skink, Blotched Bluetongue *Tiliqua nigrolutea*, Grass Skink *Pseudemoia entrecasteauxii*), most species of reptiles are now patchily distributed with isolated populations centred on localized areas with suitable microhabitats for refuge, feeding and breeding (Bennett *et al.* 1998). Open grassy farmland, now the dominant vegetation type in the former woodland ecosystem, supports few or no reptiles, and disturbed woodland remnants among farmland may also be poor habitat. A recent survey in the Northern Plains (Brown and Bennett 1995), for example, recorded no reptiles at a third of sites (65/193) in woodland fragments of varying size, shape and tree species composition.

Amphibians

Most species of frogs are closely associated with streams or wetlands of various types, rather than woodland habitats *per se*. Frogs need moisture to breed successfully and so

the availability of water, the soil type, and access to microhabitats such as logs, rocks or exfoliating bark that provide refuge from desiccation, are likely to be more important influences on these species than the structure or composition of woodland vegetation. Most species appear to be capable of persisting in modified woodland environments, and some species in cleared farmland, where these requirements for moisture and shelter are met. Artificial water sources associated with agriculture, such as farm dams and irrigation channels, are extensively used by common species of frogs (e.g., Common Froglet *Ranidella signifera*, Spotted Marsh Frog *Limnodynastes tasmaniensis*) and may support high density populations (Bennett *et al.* 1998).

Two species of frogs regarded as threatened in Victoria (Conservation and Natural Resources 1995), the Giant Bullfrog *Limnodynastes interioris* and Barking Marsh Frog *Limnodynastes fletcheri* occur in the woodland ecosystem (20% of listed threatened amphibians). Their occurrence in northern Victoria forms the southern part of a more extensive range in inland New South Wales (Hero *et al.* 1991).

OUTLOOK FOR TEMPERATE WOODLANDS IN VICTORIA

Conservation of the flora and fauna of temperate woodlands in Victoria poses a formidable challenge because this ecosystem has already experienced profound change. Remaining natural areas are mostly distributed as fragments amongst intensively settled rural lands and occur as thousands of patches in farmland, as strips along roadsides, streams and rail reserves, and as occasional small conservation reserves. Many woodland fragments are on private land or areas of public land that frequently are licensed to private landholders (e.g., stream frontages, unused roads, bushland reserves). In some areas, remnant woodlands are virtually the only public land, leading to land use conflicts and probable future losses of biodiversity. The biodiversity values of woodland remnants are threatened by a wide array of processes. Some of these threats, such as rising saline water tables, weed invasions, tree dieback, and stock grazing operate at the landscape scale, while others, such as fertilizer drift, roadworks, quarrying, cropping, pasture improvement, grazing by native herbivores, inappropriate burning regimes, soil disturbance, ploughing, grading, rubbish dumping and recreational damage, are usually localized in effect (Lunt 1991; Department of Conservation and Environment 1992; Robinson and Traill 1996).

Three broad elements are particularly important considerations in the future conservation of the biota of temperate woodlands: protection of existing natural areas to prevent further degradation and loss; management of habitats to enhance conservation values; and long-term restoration of the ecosystem.

First, protection of existing natural and semi-natural habitats is essential to minimize further decline in the status of plant and animal populations. Planning controls in Victoria have reduced the rate of tree clearing in the state but, because so little remains, broadscale clearing is rarely a major issue in temperate woodlands. Rather, incremental clearing, hectare by hectare, and gradual deterioration of woodland habitats and loss of species by degrading processes, are the main ways in which temperate woodlands continue to decline. There is a need for new approaches and strategies for conservation of woodland habitats. The traditional approach of achieving representative conservation through reservation of large areas of public land as parks and reserves is not now possible. Because most remnant woodlands in Victoria are in landscapes that are managed primarily for purposes *other* than nature conservation, strategies to conserve woodlands must be multi-faceted and incorporate education, extension, community input, and research, as well as the traditional approach of surveys and reservation (e.g., Prober and Thiele 1993; Ross 1995; Binning 1997).

Second, active management is required to ensure that remaining habitats achieve their potential for conservation. A particular challenge in this regard is to arrest further modification and degradation of habitats that so easily occurs through oversight, neglect, or perpetuation of land use practices that are not ecologically sustainable. Obvious examples include: excessive grazing by stock leading to loss of native plants and lack of regeneration, excessive firewood collection, invasion and spread of weeds, altered nutrient levels, and loss of mature trees. Often, processes such as understorey clearance, addition of fertilizers, alteration to drainage patterns, gross soil disturbance and damage from recreational use, pose the most immediate threats for many remnants and species. Many of these processes are avoidable, although not necessarily easy to alter. Little work has been undertaken on ranking threats to woodland remnants, either in terms of ubiquity, potential damage or irreversibility, and so assessment of the relative importance of various threatening activities is largely observational.

The woodland fauna depends upon sympathetic on-site management to maintain habitat components and required resources (e.g., diverse ground and litter layer, logs, shrubs, large trees with hollows). However, management of temperate woodlands for fauna must also adopt a landscape and regional perspective in order to strategically maintain systems of habitat. To maintain viable populations, many species require much greater areas of habitat than are available in single isolated woodlands, while other species (notably bats and some birds) regularly move between a number of woodland patches to obtain necessary resources. Consequently, effective conservation of the woodland fauna generally requires extensive interconnected systems of habitat throughout the landscape (Bennett *et al.* 1998).

Last, because so much change has already occurred, there is a need for long-term strategic, and visionary, restoration of the temperate woodland ecosystem. In recent years, a number of strategies have appeared in Victoria from government agencies (e.g., Department of Conservation and Environment 1992) and non-government bodies (e.g., Robinson and Traill 1996), and a range of important initiatives is under way. These include, for example, ongoing support for protection and restoration of natural habitats by landholders through the Land for Wildlife Scheme (Platt and Ahern 1995), a major review of resources and land use on public land in box and ironbark forests and woodlands across central Victoria (Environment Conservation Council 1997), and numerous local actions to protect and expand habitats of threatened species such as the Superb Parrot (Raven 1995) and Brolga (McIntyre 1995). The recent publication of a biodiversity strategy for Victoria (Department of Natural Resources and Environment 1997a, 1997b, 1997c) outlines a broad direction for conservation and identifies a further range of initiatives that have the potential to make a major contribution to conservation of temperate woodlands in the state.

The time frame for restoration will, of necessity, be long — decades and centuries rather than years. There is growing community support for an integrated approach to sustainable land management in rural environments, in which nature conservation and productive use of land for agriculture are both viewed as important and complementary goals. However, if restoration of the temperate woodland ecosystem is to be achieved, it requires a sustained political will and enhanced commitment of resources to implement conservation strategies that do more than simply slow the tide of decline.

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