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Abstract: 1. Prevent further losses: so little temperate woodland remains in most regions that all remnants must be conserved and degrading processes avoided.2. Promote diverse solutions: diverse policy and management approaches are needed to capture the wide mix of woodland conditions, land tenures and management objectives.3. Protect small patches: all else being equal, bigger patches are better, but small remnants are critical, as remnants containing high-quality understoreys are typically small. 4. Adopt ecological management: many woodlands on productive soils require regular burning, crash grazing or slashing to promote plant diversity.5. Restore degraded woodlands: degraded woodlands need to be revegetated and restored to promote plant diversity, control weeds and achieve sustainable woodland landscapes. 6. Reduce soil nutrients: a continuing restoration challenge is to develop techniques to reduce elevated soil nutrient levels, as weeds out-compete native plants on disturbed and fertilised soils.7. Manage for climate change: conserve networks of diverse patches, especially interconnected, little-disturbed remnants on unfertilised soils, as these have the greatest potential to support native plants and resist exotic invasion.8. Coordinate and support individual efforts: this vision must be coordinated and supported through a national system of management networks and stewardship schemes.
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Eight steps to conserve diverse understoreys in grassy woodlands

Ian D. Lunt, Suzanne M. Prober and Kevin R. Thiele

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8. Coordinate and support individual efforts: this vision must be coordinated and supported through a national system of management networks and stewardship schemes.

Introduction

For over 20 years we have been fortunate to work in some of Australia’s most beautiful ecosystems: remnant grassy woodlands and grasslands in the wheat–sheep belt. Our research has focused on one of the most sensitive components of woodland biodiversity – the native understorey plants, especially the grasses and vibrant wildflowers that make woodlands so spectacular. In the most diverse woodlands, one can find up to 45 different plant species in a single square metre (Lunt 1990). Our research includes woodlands in southern Queensland, New South Wales, the ACT and Victoria (see map below), particularly threatened woodlands dominated by White Box (Eucalyptus albens), Yellow Box (Eucalyptus melliodora), Grey Box (Eucalyptus microcarpa) and Red Gums (E. camaldulensis and E. tereticornis).

We have learnt how woodlands have changed since European settlement, how they have been affected by activities such as burning and livestock grazing, and we are beginning to learn how to restore functional, diverse understoreys (e.g. Prober and Thiele 1995; Lunt 1997; Prober et al. 2002, 2005, 2007; Lunt et al. 2006; Prober and Lunt 2009). These insights have been gained from complementary research approaches, including historical studies, regional and cross-regional surveys (of species, vegetation
structure, genetics and soils), and many short and long-term experiments, the longest of which has now run for 16 years. The following eight points represent the major lessons we have distilled from our work.

Lessons

1. **Prevent further losses: so little temperate woodland remains in most regions that all remnants must be conserved and degrading processes avoided**

Many temperate woodlands have been cleared for agriculture and most remnants are small, isolated and degraded. For example, less than 1% of endangered White Box–Yellow Box–Red Gum woodlands remain in good condition, and most surviving remnants are heavily degraded. Considerable progress has been made over the past 20 years in listing endangered ecosystems, creating new reserves, promoting off-reserve conservation networks and raising public awareness. However, woodlands continue to be lost through a ‘death by a thousand cuts’, as paddock trees, native pastures, roadside strips and remnants are destroyed and degraded for other land uses (Prober et al. 2001). Activities such as intensification of fertilisation and livestock grazing, tree clearing and firewood collection continue to degrade many areas. As in other systems, woodlands are easy to degrade but hard to restore. Our threatened woodlands cannot survive this attrition; all woodland remnants must be conserved and degrading processes avoided.

2. **Promote diverse solutions: diverse policy and management approaches are needed to capture the wide mix of woodland conditions, land tenures and management objectives**

Every patch of woodland in agricultural landscapes has been altered by past management. Remnants with different management histories support different species and processes, and require different management goals and interventions; for example, some patches are valuable for understorey diversity and others for hollow-bearing trees (Lunt and Spooner 2005). It is rare for all biological attributes to be well represented within a single patch. These patterns are reflected in different land tenures (cemeteries, roadsides, travelling stock reserves, scenic reserves, grazed pastures, private woodlots, home and back paddocks), which have been managed for different purposes by many people with differing outcomes (Prober and Thiele 1995; Prober et al. 2001). All of these land tenures and histories are needed to make an effective conservation network. Woodlands cannot be conserved on public land alone, and cannot be conserved by a single policy or management approach. Diverse policy and management approaches are needed to capture the wide mix of woodland conditions and management objectives.

3. **Protect small patches: all else being equal, bigger patches are better, but small remnants are critical, as remnants containing high-quality understoreys are typically small**

Big, interconnected remnants are essential for sustainable conservation of woodland landscapes. But not all remnants are the same, and for small understorey plants, past disturbance and management are stronger drivers of species’ occurrences and population sizes than are spatial attributes such as patch size or connectivity (Prober and Thiele 1995). Typically, only small remnants (such as those in some cemeteries) have escaped degradation through livestock grazing and nutrient enrichment. These can support large, genetically diverse populations of declining species (Lunt 1994; Prober et al. 1998) and thus make a critical contribution to woodland conservation. Small patches are not the same as small populations. We need to protect small patches and develop ways to boost small populations.

4. **Adopt ecological management: many woodlands on productive soils require regular burning, crash grazing or slashing to promote plant diversity**

Some (but not all) woodlands require regular management such as burning, crash grazing or slashing to maintain plant diversity and vigorous growth of native grasses. This is most relevant in productive sites
with few trees, where large dominant grasses such as Kangaroo Grass (Themeda australis) can rapidly out-compete smaller plants (Lunt and Morgan 2002; Prober et al. 2007). Many native woodland plants do not form persistent seed banks in the soil, so if existing plants die after mismanagement, the species may disappear completely from a site (Lunt and Morgan 2002). Fire is a preferred management tool in sites that have historically been burnt (e.g. many cemetery, road or rail easements, Prober et al. 2007), but other methods such as short-duration livestock grazing and slashing are useful in many places (Lunt et al. 2007). Management goals should be clearly articulated, and effects monitored to ensure that goals are being met.

5. Restore degraded woodlands: degraded woodlands need to be revegetated and restored to promote plant diversity, control weeds and achieve sustainable woodland landscapes

The enormous scale of woodland destruction and degradation means that merely conserving the few surviving remnants is not good enough. Restoration and revegetation are critical for promoting plant diversity, controlling weeds and achieving sustainable woodland landscapes (Prober and Thiele 2005). Since woodlands contain few tree species but many ground layer plants, effort must be given to restoring diverse ground-layer species, not just planting trees and shrubs. Trees and shrubs benefit many fauna but tree planting has little (if any) benefit for ground-layer plants (Munro et al. 2009). Progress has been made in restoring dominant grasses through weed and seedbank management (e.g. Prober et al. 2005), but new strategies are needed to restore diverse understoreys over large areas (e.g. Gibson-Roy 2007).

6. Reduce soil nutrients: a continuing restoration challenge is to develop techniques to reduce elevated soil nutrient levels, as weeds out-compete native plants on disturbed and fertilised soils

A key constraint on restoration outcomes is elevated soil nutrient levels, often arising from fertilisation, livestock grazing or soil disturbance. High levels of soil nitrate or phosphorus promote ubiquitous fast-growing exotic plants which out-compete native plants, preventing sustainable restoration outcomes (Prober et al. 2005; Dorrough et al. 2006). Recently we have found that restored swards of Themeda australis can effectively reduce soil nitrate and control exotic annuals, hence re-establishing this natural grassland dominant is an important way to restore degraded understoreys (Prober and Lunt 2009). It is not known, however, whether Themeda or other native species can fulfill this function in sites with extremely high nutrient levels. Given the enormous areas across which fertilisers have been added to woodland landscapes (either deliberately or through drift from adjacent paddocks), a continuing restoration challenge is to develop practical techniques to reduce soil nutrient levels over large areas.

7. Manage for climate change: conserve networks of diverse patches, especially interconnected, little-disturbed remnants on unfertilised soils, as these have the greatest potential to support native plants and resist exotic invasion

Woodland structure, composition and function will change in unforeseen ways as climate continues to change. The aim of woodland conservation should not be to preserve current ecological conditions, let alone relics of pre-European ecosystems. Instead, it should be to actively conserve diverse, resilient, dynamic ecosystems (Dunlop and Brown 2008). The high degree of fragmentation and degradation in woodland ecosystems makes this goal challenging. The most practical way to achieve this may be to conserve (and where possible create) networks of little-disturbed sites on unfertilised soils, as these areas have the greatest potential to support diverse native understoreys and resist exotic invasion (Prober et al. 2002). Travelling stock reserve networks are critical in this regard.
Woodland conservation depends on diverse efforts by many individuals. Every woodland remnant and every on-ground action to restore woodland landscapes contributes to a greater conservation vision. Some new ‘off-reserve’ conservation models, such as Conservation Management Networks, Natural Resource Management councils and the box-gum woodland stewardship program have already been established to coordinate and support the plethora of on-ground actions being undertaken. These programs require ongoing development and integration, to support landholders at the local level and to ensure we achieve the best possible outcomes from the collective effort at bioregional and national scales (e.g. Prober et al. 2001; Fitzsimons and Wescott 2005).

Conclusions

When we began our research, conservation attention in Australia was focused on ecosystems such as rainforests and tall wet forests; few people were interested in declining species in fragmented woodlands. Over the last two decades, huge progress has been made in understanding woodland ecology, developing management options and policies, and raising community awareness. We now often have a good understanding of what we need to do, but we don’t always know how to do it, especially at the large scales required. Just as woodland decline can be characterised as a ‘death by a thousand cuts’, woodland restoration will be achieved by a thousand small actions, not one grand symbolic gesture or research breakthrough. This may seem frustrating, but the scale of the issue means that progress will be slow even if we can multiply our efforts 10-fold. Consequently, we must highlight successes, however small they may appear, rather than focus on declines; otherwise we risk disenchanting the communities (and funding and government agencies) who have the greatest potential to enact widespread change. At the same time, we must remain vigilant that ground is not lost. In this light, proposals to sell parts of the travelling stock reserve network are destined to be condemned by future generations. Such short-sighted agendas must be vigorously opposed.

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Bios

Ian Lunt lectures in vegetation ecology and ecosystem management at Charles Sturt University in Albury, NSW. His research documents how disturbances such as grazing and burning regimes affect biodiversity in fragmented native grasslands and grassy woodlands in south-east Australia. His work has helped managers to: (a) understand historical influences on natural ecosystems (‘how did we get here?’), (b) refine present management regimes (‘how do we stay afloat?’), and (c) develop restoration methods for the future (‘how can we get ahead?’). Ian provides expert advice to many government committees in Victoria and New South Wales, and regularly writes extension articles for the broader community.

Suzanne Prober is a plant ecologist at CSIRO Sustainable Ecosystems in Perth, and has worked for many years in temperate eucalypt woodlands of southern Australia. Her research is centred on understanding and restoring ecological function and diversity in woodlands and other ecological communities of
fragmented agricultural landscapes, with a focus on plant-soil interactions, weed invasion, fire ecology and native grasses. She has been closely involved in the development of novel policy initiatives for conserving and restoring fragmented and degraded temperate woodlands. Current projects focus on understanding and restoring ecological resistance and resilience in woodlands and shrublands under climate change.

Kevin Thiele is a plant taxonomist and systematist and is the Curator of the Western Australian Herbarium, part of the Department of Environment and Conservation in Perth. He has worked on the systematics, taxonomy and phylogenetics of diverse groups including Banksia, Viola and the family Rhamnaceae. With Suzanne Prober, he has contributed to ecological research seeking to understand the conservation needs of grassy woodland communities and to develop a policy framework that can meet those needs. In his role at the Western Australian Herbarium, he is involved in conservation assessment and planning for Western Australian plants, algae and fungi.

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