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3

PRIORITISING CONSERVATION IN TEMPERATE WOODLANDS

Philip Gibbons

1. Conservation priorities for woodlands should be set according to the difference between: (i) the likely improvement over time with conservation actions; and (ii) the potential loss over the same time without additional conservation actions.
2. Lesson #1 means that setting priorities for woodland conservation requires a better understanding of the gains likely to be achieved in woodlands with different conservation actions.
3. Lesson #1 also means that setting priorities for woodland conservation requires a better understanding of the trajectory of woodlands under the status quo.
4. High quality, or relatively unmodified, woodlands are not necessarily the highest priority for conservation actions.
5. Planting trees in cleared areas should not be a priority for woodland conservation.
6. Mitigating threats posed by human population growth and agricultural intensification represent higher priorities for woodland conservation than mitigating the effects of climate change.

Introduction

Given that the resources for woodland conservation are limited, where should our conservation priorities lie? A focus of my work has been to develop tools to assess proposals for developing woodlands and prioritise conservation investment in woodlands. My field work has focused on various woodland communities (Yellow Box *Eucalyptus melliodora*, Blakely's Red Gum *E. blakelyi*, Grey Box *E. microcarpa*, Poplar Box *E. populnea*, Coolibah *E. coolabah* and Mugga Ironbark *E. sideroxylon*) throughout the wheat–sheep belt of New South Wales (see map on next page). My findings and decision support tools, however, are applied across temperate woodlands and other ecosystems in several states of Australia.

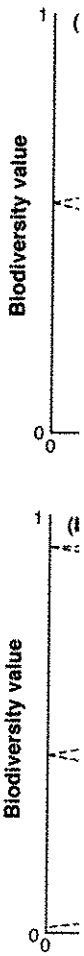
Lessons

1. Conservation priorities for woodlands should be set according to the difference between: (i) the likely improvement over time with conservation actions; and (ii) the potential loss over the same time without additional conservation actions

In 1976 Jared Diamond wrote, 'the question is not which refuge system contains more total species, but which contains more species doomed to extinction in the absence of refuges' (Diamond 1976). Diamond was telling us that our conservation priorities are not necessarily the sites with the highest biodiversity values, but those sites likely to lose the greatest biodiversity values without intervention – a message that is prominent in the systematic conservation planning literature (Pressey and Bottrill 2008). If we accept that conservation priorities in our temperate woodlands should be set according to the difference between (i) the likely improvement over time with conservation actions and (ii) the potential loss over the same time without additional conservation actions (see Figure 3.1a), then this changes the types of temperate woodlands that we should conserve urgently and the data we need to make these decisions.

2. Setting priorities for woodland conservation requires a better understanding of the trajectory of woodlands with different conservation actions

The model for prioritising conservation actions in Figure 3.1a requires an understanding of the amount of improvement in biodiversity we are likely to get when employing conservation actions in temperate woodlands. In a workshop I recently attended, however, there was little consensus among field staff on appropriate conservation actions for the woodland sites we visited. This is not surprising because the efficacy of management actions can vary from site to site. McIntyre and Lavorel (2007) identified several barriers that can inhibit restoration in



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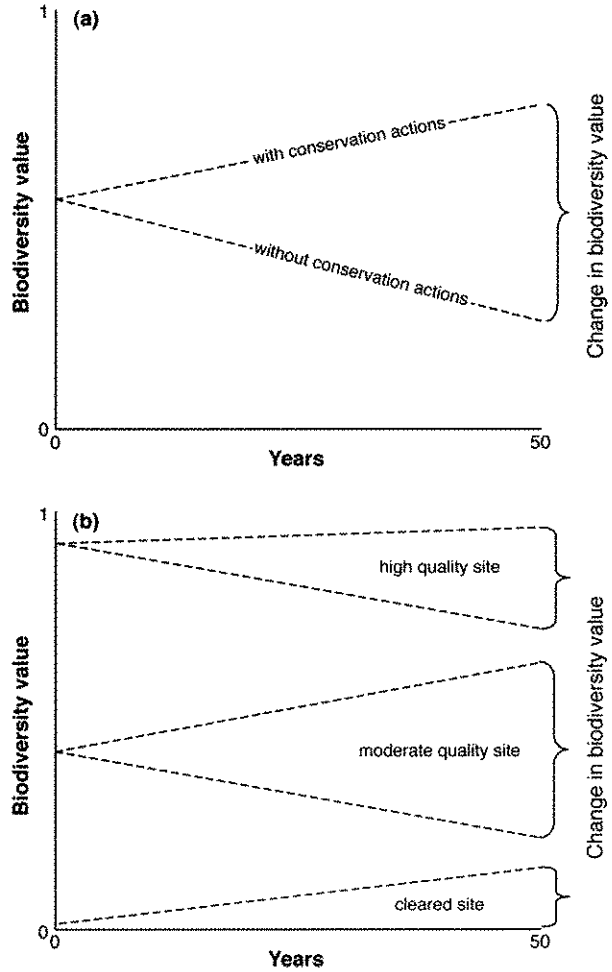

Figure 3.1 Conservation priorities for woodlands should be based on the difference between biodiversity values with and without conservation actions over time (a), which has implications for the types of sites that become priorities for conservation (b).

woodland ecosystems depending on land-use history. This model was supported by Briggs *et al.* (2008) who found little effect of two commonly funded conservation actions (fencing and grazing management) on exotic cover and the regeneration of some tree species.

Where there is uncertainty about the efficacy of management actions in temperate woodlands, then investors should monitor all funded activities and apply the principles of adaptive management to them. There have been efforts to improve monitoring after conservation actions in temperate woodlands (e.g. the Federal Government's Environmental Stewardship Program); however, monitoring programs cannot provide us with information about the efficacy of conservation actions unless there is consistent recording of management inputs (e.g. days grazed) as well as biodiversity outcomes (e.g. plant species richness) (Zerger *et al.* 2009). This is a key omission in many monitoring programs. To apply the principles of adaptive management effectively also means that a degree of flexibility must be maintained throughout any conservation program. That is, management actions should not be set in concrete from the

outset so that modifications and adjustments can occur if monitoring indicates that the objectives are not being met.

3. Setting priorities for woodland conservation requires a better understanding of the trajectory of woodlands under the status quo

The model for prioritising conservation actions in Figure 3.1a also requires an understanding of likely changes in the extent and condition of temperate woodlands on a site without additional investment. Several threats (e.g. invasion of exotic plants, lack of regeneration, salinity) and permitted activities under law (e.g. firewood collection, grazing) can potentially erode woodland condition and extent over time. Conversely, stronger native vegetation laws afford increased protection to remnant vegetation.

One of the reasons that we don't know how damaging or effective these threats and laws are is because woodlands are not monitored effectively across broad scales. This is because synoptic satellite sensors such as Landsat (which is the most common satellite used for mapping land cover change in Australia [e.g. National Carbon Accounting System]) do not have the spatial resolution to detect significant areas of temperate woodlands. Classifications based on Landsat imagery can only typically detect trees where the canopy is relatively dense (see Figure 3.2). Several intact temperate woodland stands, however, including those dominated by White Box, Poplar Box and Coolibah have, on average, a sparse canopy cover (<20%) (Gibbons *et al.* 2008). Further, vegetation layers produced from synoptic satellite sensors such as Landsat do not consistently detect small or narrow, linear remnants (Figure 3.2). This is a serious issue because scattered trees and small remnants represent a large proportion of extant temperate woodlands (Gibbons and Boak 2002) and are often under greater threat from land clearing (Gibbons *et al.* 2009), tree mortality (Gibbons *et al.* 2008), a lack of natural tree regeneration (Weinberg *et al.* in review) and salinity (Seddon *et al.* 2007) than larger remnants. Thus, existing mapping is unlikely to be sensitive to changes in the extent of temperate woodlands brought about by these threats. There are existing satellite sensors that can be used to effectively map temperate woodlands (Levin *et al.* 2009), but these are still too expensive to purchase at a scale and frequency that is required to monitor temperate woodlands at regular intervals across large areas.

4. High quality, or relatively unmodified, woodlands are not necessarily the highest priority for conservation actions

If we accept the logic in Figure 3.1, then high quality remnants are not necessarily a high priority for conservation. This is for two principal reasons. First, high quality remnants have little capacity for improvement with management relative to remnants of moderate to poor quality that have not been fertilised (McIntyre and Lavorel 2007) (see Figure 3.1b). Second, high quality remnants are not necessarily under a high degree of threat relative to moderate to poor quality remnants. High quality woodland remnants can no longer be cleared for agricultural production under revised land clearing laws in several states of Australia, although this is not necessarily the case in peri-urban areas. Many intact remnants are grazed intermittently and overstorey regeneration is typically sufficient where such conditions exist. This contrasts with moderate to poor quality woodland remnants which represent the majority of our remaining woodlands. Clearing and agricultural intensification are not necessarily excluded in moderate to poor quality remnants under existing legislation, grazing by livestock is often continuous and regeneration is often absent; that is, poor to moderate quality remnants are often at a higher risk of decline and ultimate loss under the status quo than high quality remnants. For example, in central-western NSW, Weinberg *et al.* (in review) found that around half of all remnants – principally small, modified remnants – contained no

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Figure 3.2 Broadscale mapping of tree cover from Landsat imagery (grey) overlaid with very high-resolution satellite imagery (Ikonos) illustrating that temperate woodland vegetation that occurs with a sparse canopy cover, in small patches, or in a narrow linear configuration is poorly mapped and therefore poorly monitored across broad scales in Australia. (Includes material © 2002 Space Imaging LLC, distributed by Raytheon Australia)

regeneration. Investing in high quality remnants would do nothing to address the regeneration crisis in this landscape. Investing public funds in high quality remnants can also undermine the existing legal requirement, or duty of care, in many areas that requires land managers to mitigate threats to remnant vegetation.

5. Planting trees in cleared areas should not be a priority for woodland conservation

If we accept the logic in Figure 3.1b, then plantings – and planting corridors in particular – should not be a focus of woodland conservation. This is for two reasons. The first is that plantings that are established on totally cleared sites can only achieve a modest biodiversity gain relative to effective interventions on sites that are in moderate condition and under considerable threat. Plantings can form part of successful interventions on modified sites, however. Second, a planting that is in a narrow corridor does not afford additional benefits because studies consistently indicate that the amount and quality of habitat is more important to biota than its configuration (e.g. Radford *et al.* 2005; Turner 2005). Conservation efforts in temperate woodlands should focus on stabilising and increasing the extent and condition of our existing temperate woodlands rather than planting new vegetation on highly modified sites for relatively modest biodiversity benefit.

6. Mitigating threats posed by human population growth and agricultural intensification represent higher priorities for woodland conservation than mitigating the effects of climate change

While climate change is an obvious emerging threat, I argue that there are two more immediate threats to temperate woodlands. Elevated residential property prices and continuing strong population growth in Australia (projected 55% increase by 2050, Population Reference Bureau 2009) are creating strong demand for urban growth in cities and regional centres throughout parts of Australia. The urban footprint of several expanding population centres (e.g. Melbourne, Albury, Canberra and Sydney) is encroaching upon woodland communities listed as threatened. An emerging shortage of global food production is spawning intensification of agricultural production which can be detrimental to native woodlands. Intensive grazing by livestock, broadscale use of fertiliser and cultivation are particularly damaging to temperate woodlands. In central-western NSW, Ozolins *et al.* (2001) observed a 25% increase in cultivation from the 1960s to the 1990s. We must address the issues of human population growth and agricultural intensification to protect remaining temperate woodlands effectively from these emerging threats and ensure our remaining temperate woodlands are functional, resilient ecosystems. This also happens to be the best way to prepare our temperate woodlands for the impacts of climate change (Steffen *et al.* 2009).

Conclusions

I began this chapter with the question: Where should our conservation priorities lie in temperate woodlands? The answer is in places where we stand to achieve greatest gains in biodiversity values. These will be areas that contain important values that are under threat and where these threats can be mitigated confidently with management. These are not necessarily sites in the best condition. To support these decisions, we need a greater understanding of the efficacy of different management actions for conserving temperate woodlands. We also need a greater understanding of the trajectory of our temperate woodlands under the existing suite of threats (which we know to include exotic plant invasion, grazing, fertiliser application, the lack of regeneration and tree mortality) and regulations that aim to mitigate some of these. We also need to consider emerging threats, particularly clearing for urban expansion and agricultural intensification.

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Bio

Phil Gibbons began his career in the late 1980s working in the wood production forests of East Gippsland, Victoria and southern NSW. He completed a PhD on hollow-dependent fauna in 1999 and has subsequently focused on applied research that has included carbon storage in Australian vegetation, the conservation value of paddock trees and methods for rapid biodiversity assessment. He has published two books and approximately 50 peer reviewed articles. His work informs codes of forest practice, land clearing regulations and incentive programs across Australia. He is currently a Senior Research Fellow at the Australian National University.

References

Briggs, S.V., Taws,
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Journal of Bot
Cunningham, R.E
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Diamond, J.M. (19
Science **193**, 1(
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Botany **55**, 533
Steffen, W., Burbic
Smith, M. and
Publishing: Me
Turner, I.M. (2005
Ecology, Evolut
Weinberg, A., Gibl
regeneration in
Zerger, A., Freude
structured veg
Restoration **10**,

References

Briggs, S.V., Taws, N.M., Seddon, J.A. and Vanzella, B. (2008). Condition of fenced and unfenced remnant vegetation in inland catchments in south-eastern Australia. *Australian Journal of Botany* **56**, 590–599.

Cunningham, R.B., Lindenmayer, D.B., Crane, M., Michael, D., MacGregor, C., Montague-Drake, R. and Fischer, J. (2008). The combined effects of remnant vegetation and tree planting on farmland birds. *Conservation Biology* **22**, 742–752.

Diamond, J.M. (1976). Island biogeography and conservation: strategy and limitations. *Science* **193**, 1027–1029.

Gibbons, P. and Boak, M. (2002). The value of paddock trees for regional conservation in an agricultural landscape. *Ecological Management and Restoration* **3**, 205–210.

Gibbons, P., Briggs, S.V., Ayers, D.A., Doyle, S., Seddon, J., McElhinny, C., Jones, N., Sims, R. and Doody, S.J. (2008). Rapidly quantifying reference conditions in modified landscapes. *Biological Conservation* **141**, 2483–2493.

Gibbons, P., Briggs, S.V., Ayers, D.A., Seddon, J.A., Doyle, S.J., Cosier, P., McElhinny, C., Pelly, V. and Roberts, K. (2009). An operational method to assess impacts of land clearing on terrestrial biodiversity. *Ecological Indicators* **9**, 26–40.

Gibbons, P., Lindenmayer, D.B., Fischer, J., Manning, A.D., Weinberg, A., Seddon, J., Ryan, P. and Barrett, G. (2008). The future of scattered trees in agricultural landscapes. *Conservation Biology* **22**, 1309–1319.

Levin, N., McAlpine, C., Phinn, S., Price, B., Pullar, D., Kavanagh, R.P. and Law, B.S. (2009). Mapping forest patches and scattered trees from SPOT images and testing their ecological importance for woodland birds in a fragmented agricultural landscape. *International Journal of Remote Sensing* **30**, 3147–3169.

McIntyre, S. and Lavorel, S. (2007). A conceptual model of land use effects on the structure and function of herbaceous vegetation. *Agriculture Ecosystems & Environment* **119**, 11–21.

Ozolins, A., Brack, C. and Freudenberger, D. (2001). Abundance and decline of isolated trees in the agricultural landscapes of Central New South Wales. *Pacific Conservation Biology* **7**, 195–203.

Population Reference Bureau (2009). 'World Population Data Sheet 2009.' Population Reference Bureau: Washington, D.C.

Pressey, R.L. and Bottrill, M. (2008). Opportunism, threats and the evolution of systematic conservation planning. *Conservation Biology* **22**, 1340–1345.

Radford, J.Q., Bennett, A.F. and Cheers, G.J. (2005). Landscape-level thresholds of habitat cover for woodland-dependent birds. *Biological Conservation* **124**, 317–337.

Seddon, J.A., Zerger, A., Doyle, S.J. and Briggs, S.V. (2007). The extent of dryland salinity in remnant woodland and forest within an agricultural landscape. *Australian Journal of Botany* **55**, 533–540.

Steffen, W., Burbidge, A., Hughes, L., Kitching, R., Lindenmayer, D., Musgrave, W., Stafford Smith, M. and Werner, P. (2009). *Australia's Biodiversity and Climate Change*. CSIRO Publishing: Melbourne.

Turner, I.M. (2005). Landscape ecology: what is the state of the science? *Annual Reviews of Ecology, Evolution and Systematics* **36**, 319–344.

Weinberg, A., Gibbons, P., Briggs, S.V. and Bonser, S. (in review) Broadscale failure of tree regeneration in an agricultural landscape.

Zerger, A., Freudenberger, D., Thackway, R., Wall, D. and Cawsey, M. (2009). *VegTrack*: a structured vegetation restoration activity database. *Ecological Management and Restoration* **10**, 136–144.