PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY BIENNIAL CONFERENCE

Official publication of The Australian Rangeland Society

Form of Reference

The reference for this article should be in this general form;
Author family name, initials (year). Title. *In*: Proceedings of the nth Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).
For example:
Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite *(Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15^{th} Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

REGROWTH AND THE BENEFITS OF RETAINING TREES IN PRODUCTIVE LANDSCAPES: CASE STUDIES FROM NORTH-WEST NSW

M.T. McHenry [1,3], *B.R. Wilson* [2] *and P.L. Norman* [2]

[1] School of Environmental Sciences and Natural Resources Management, University of New England, Armidale NSW 2351. (STUDENT)
[2] NSW Department of Natural Resources, P.O. Box U245, Armidale NSW 2351
[3] Corresponding author: melinda.harrison@dnr.nsw.gov.au

ABSTRACT

Extensive agricultural modification of the North Western Slopes and Plains of NSW has resulted in conditions suitable for the establishment of dense regrowth, especially on private lands. Recent research has shown that dense regrowth of Eucalypts and other species such as White Cypress Pine (*Callitris glaucophylla*) are perceived by the community to be invasive and to impede normal farming activities. It is widely believed that such regrowth suppresses groundcover, depletes soil nutrient and water reserves and causes soil erosion. New legislation in NSW has included provisions for managing many regrowth tree species as 'invasive native scrub'.

We present new data which suggest that, contrary to the perceived problems with dense regrowth, individual trees of a variety of species contribute positively to the landscape. Increased soil nutrient status and groundcover were associated with individual trees and appropriately managed regrowth. Other benefits thought to be gained from tree retention include shading for stock, increased pasture plant diversity and increased soil stability. We suggest that the effects of trees on the landscape can be managed to maximise derived benefits. Future management of regrowth across NSW should therefore consider the benefits of retained trees as a component of the production landscape.

INTRODUCTION

Over much the South East Australian landscape, extensive modification has resulted in an overall decline in the native vegetation cover. In some regions however, agricultural management practices have created conditions that encourage vigorous regeneration of native trees and shrubs. The resultant dense regrowth stands are often mono-specific, and are commonly comprised of *Eucalyptus* spp. or White Cypress Pine.

In North West NSW, regrowth is considered by many to be a significant environmental problem. In the community, regrowth is widely perceived to be invasive and to impede farming and grazing activities due to the suppression of ground-cover and the depletion of water and nutrient availability to pasture plants. In some sections of the community, it is believed that dense regrowth causes environmental degradation and soil erosion.

In NSW, recent legislation (Native Vegetation Act 2003) seeks to put an end to 'broad-scale' clearing of native vegetation. Other than limited exemptions (for routine agricultural practices), clearing of native vegetation is only permitted where it can be demonstrated to "improve or maintain environmental outcomes". Methods to manage these regrowth stands are therefore being sought, to balance both native vegetation and production objectives.

ROLE AND FUNCTION OF REGROWTH STANDS

To do this effectively, it is first necessary to examine the role and functions of these regrowth stands in the landscape and to assess the potential benefits of retaining such vegetation in the landscape. By clarifying the role of trees with respect to soil condition, ground-storey vegetation and other landscape components, more effective methods can be developed to optimise the integration of native vegetation into production systems. In this paper we discuss a range of research findings relating to the value of trees in grazing systems.

Soils

There is now a good deal of evidence from higher rainfall areas that soil condition is profoundly affected by the presence of native trees and shrubs. There is for example, considerable evidence that, in grazed paddocks, soil nutrient concentrations and pH are significantly higher around eucalyptus trees and that this enrichment is independent of livestock camping (Wilson 2002, Wilson and Lemon 2004a, Graham *et al.* 2004). The nature and scale of this enrichment varies between species and soil types but is consistently found in association with all the trees that have been studied.

A concern which is expressed commonly in the community is that dense regrowth, and even individual trees, place a significant demand on soil nutrient (and soil water) reserves for growth and development. Contrary to this belief however, it appears that even juvenile trees have the potential to contribute to the surface soil and pasture nutrient pool. For instance, in a recent study of juvenile and mature individual White Cypress Pines on private lands in north-west NSW, a distinct pattern of nutrient enrichment was evident inside the canopy of both tree types (McHenry *et al.* 2006, unpublished). Groups of trees and woodland stands also seem to increase soil organic matter and nutrient status compared with the soils of comparable farmland (Chilcott 1998, Eldridge and Wong 2004, Wilson and Lemon 2004b, McHenry *et al.* 2006) and there would seem to be a tangible benefit from retaining trees in the system.

The mechanisms that result in these effects are not fully understood but it is believed that trees act as 'biological pumps' (Noble and Randall 1998, 1999) drawing material from deeper soil layers and depositing this at the soil surface in litter. Nutrients in the surface of soils under trees also appear to be cycled and re-used much more efficiently. Trees also intercept dust and tend to attract organisms such as birds and arboreal mammals in otherwise cleared landscapes, thus contributing a net addition of nutrient, which is deposited at the soil surface.

For inland NSW, trends are less clear. In the Cobar area for example, soils collected from a number of properties indicated that organic carbon and nitrate nitrogen were consistently higher under long established pasture than uncleared invasive trees/shrubs (Cobar Vegetation Management Committee unpublished). Conversely, data from a single property in the Walgett area showed that organic carbon and total nitrogen were higher under both dense 30 year old regrowth (approx 8000 species/ha) and open old-growth (approx 50 species/ha) *Eucalyptus coolibah* woodland than under comparable open pasture (Norman unpublished). The effect of trees on soil condition in these environments requires further investigation.

Ground cover

Given the nutrient enrichment under trees, it might be theorised that pasture species beneath tree canopies could be advantaged. There is indeed growing evidence that pasture under trees has greater palatability and nutritive value that those species found in open grazed paddocks. For example, Gibbs *et al.* (1999) demonstrated that the palatable grass species *Microlaena stipoides* was more common in abundance under tree canopies and that the less palatable

Aristida ramosa was found more extensively in open paddocks. The relative proportion of these species was related to percentage tree foliage cover. Such a result would seem to imply that pasture quality does indeed benefit from the presence of trees.

Trees also influence the extent of ground-storey and in dense regrowth stands, it has been demonstrated that growth and cover of ground-storey vegetation can be significantly reduced due to competition for water and nutrients (Williams et al. 1999, Watson and Reid 2001, Eldridge et al. 2003, McHenry *et al.* 2006). However, this is not necessarily reflected in a reduction in pasture diversity. A retrospective study of data from a number of properties in the Lightning Ridge/Walgett area showed no relationship between the composition of groundcover (at either species or group level) and over-storey density in sites with *E. coolibah* regrowth thinned to a range of densities (Norman unpublished). Similar results have been found in White Cypress Pine regrowth in NSW where no relationship existed between canopy density and ground-storey diversity. The diversity of vegetation under White Cypress regrowth appears to instead be correlated more with factors such as rainfall, soil type or land use history (Thompson and Eldridge 2005, McHenry *et al.* 2006).

In many circumstances, the loss of groundcover under regrowth is greatly increased under the added influence of grazing and other activities (Freudenberger et al. 1997, McHenry *et al.* 2006) and can be associated with land degradation (e.g. erosion). For instance, a loss of groundcover and poor soil structure were noted beneath the canopies of individual White Cypress Pine trees at sites where the grazing intensity was high, and tree cover was low. Conversely, at sites where grazing intensity was low and a range of trees were available for shade and shelter, there was no significant difference in the cover of ground storey vegetation beneath the tree canopy versus out in the paddock (McHenry *et al.* 2006). As such, it would appear that appropriate management of trees can result in adequate ground-storey vegetation cover. Such management therefore has the potential to balance the benefits and dis-benefits of retained trees and to optimise production and environmental benefits.

Water Use

Water competition between different components of the vegetation cover is often cited as a potential negative impact of native trees and shrub cover in production paddocks. However, trees can have both positive and negative effects from a water use perspective (Reid and Landsberg 1999) and, again, the overall effect on the water cycle is not fully understood. Trees do intercept a significant quantity rainfall due to their large canopies (Wu *et al.* 2001). However, the extent to which trees compete with grasses for the water that reaches the ground is not so clear. Some evidence suggests that trees and grasses compete for water from the same soil depths (Tunstall and Webb 1981, Harrington *et al.*1984, Chilcott 1998) while others (e.g. Johns 1981) suggest that trees and shrubs utilise water from quite different soil depths.

Competition for moisture with groundcover vegetation varies with maturity and species of trees. Eucalypt seedlings, with their very small seeds, are particularly vulnerable to moisture competition from established vegetation and typically require a level of disturbance to groundcover vegetation (e.g. fire or flood) for regeneration to be successful. Other larger seeded species (e.g. White Cypress Pine) require high rainfall events for germination, but are better able to tolerate early moisture stress, due to the rapid growth of extensive modified root systems which allow the plant to exploit a number of zones in the soil profile (McHenry, unpublished). Many species in arid and semi-arid environments, such as mature eucalypts and White Cypress Pine have well-developed lateral and taproot systems, which have the potential to exploit surface soil water inputs from rain or permanent water deep in the soil profile depending on the conditions (Evans and Ehleringer 2004). This has significant implications for the extent to which they are able to survive extended drought and compete for moisture with sub-canopy vegetation. For instance, in times of low rainfall, trees are able to survive by accessing permanent water. By retaining higher humidity gradients than surrounding pasture plants, tree canopies also have the potential to protect underlying grasses and forbs.

Other work has also demonstrated the benefits of trees in increasing or maintaining soil infiltration capacity beneath their canopies (Eldridge and Freudenberger 2005). This enhances water movement into the soil and minimises surface wash and consequent erosion. Trees also intercept atmospheric moisture and contribute this to the soil surface where otherwise it would be lost. Some trees have also been demonstrated to have a hydraulic lift function (Caldwell and Richards 1989, Dawson 1993), where water collected deep in the soil is made available to drier soil layers. Trees in landscapes prone to salt movement also have considerable value and are known to reduce the effects of deep-drainage and water table recharge in association with a vigorous ground-cover. The water balance is therefore likely to be moderated by native vegetation, reducing the intensity of extreme moisture events.

MANAGEMENT OPTIONS FOR REGROWTH

A typical response in the community to regrowth is to clear, burn, or otherwise remove the regenerating plants in order to return the land to open pasture or other agricultural practice. However, where the original seed source is still present, clearing can in many circumstances simply expose the soil surface to further re-colonisation. Successful approaches to the management of regrowth should therefore be sensitive to the nature of the landscape in question and the behaviour of the regrowth species. An alternative management approach is the thinning of regrowth stands sufficient to restore a ground-storey vegetation cover and thereby optimise the production benefits and environmental services delivered by the trees. Alongside management of the trees and shrubs however, there is also a necessity to sensitively manage the other components of the system. In grazing systems for example, grazing duration and intensity should suit the capability of the land and soil.

CONCLUSIONS

There are many benefits that can be demonstrated resulting from the presence of trees in production landscapes including nutrient enrichment, higher organic matter status etc. However, there are also a number of potentially negative effects on production that are evident for very dense regrowth stands. The challenge for ongoing management and research is therefore to balance this range of effects to optimise the environmental and production benefits of retaining trees in the landscape. A range of techniques for the management of regrowth of a range of species are currently being investigated by the NSW Department Natural Resources in collaboration with University of New England.

REFERENCES

Caldwell, M.M. and Richards, J.H. (1989). Hydraulic lift: water efflux from upper roots improves effectiveness of water uptake by deep roots. *Oecologia* 79, 1–5.

Chilcott, C. (1998). The initial impacts of reforestation and deforestation on herbaceous species, litter decomposition, soil biota and nutrients in native temperate pastures on the Northern Tablelands, NSW. PhD thesis, University of New England.

Dawson, T.E. (1993). Hydraulic lift and water use by plants: implications for water balance, performance and plant–plant interactions. *Oecologia* 95, 565–574.

Eldridge, D., Wilson, B.R. and Oliver, I. (2003). 'Regrowth and Soil Erosion in the Semi-Arid Woodlands of New South Wales'. NSW Department of Land and Water Conservation, Sydney.

Eldridge, D.J. and Wong, V.N.L. (2004). Clumped and isolated trees influence soil nutrient levels in an Australian temperate box woodland. *Plant Soil* 270, 331-342.

Eldridge, D.J. and Freudenberger, D. (2005). Ecosystem wicks: Woodland trees enhance water infiltration in a fragmented agricultural landscape in eastern Australia. *Aust Ecol,* 30 (3), 336-347(12).

Evans, R.D., Ehleringer, J.R. (1994) Water and nitrogen dynamics in an arid woodland. *Oecologia* 99, 233-242.

Freudenberger, D., Hodgkinson, K.H. and Noble, J.C. (1997). Causes and consequences of landscape dysfunction in rangelands. *In*: Landscape Ecology: Function and Management (Eds J. Ludwig, D. Tongway, D. Freudenberger, J. Noble, and K. Hodgkinson), CSIRO, Melbourne.

Gibbs, L., Reid, N. and Whalley, R.D.B. (1999) Relationships between tree cover and grass dominance in a grazed temperate stringybark (*Eucalyptus laevopinea*) open-forest. *Aust J Bot.* 47, 49-60.

Graham, S., Wilson, B.R., and Reid, N. (2004) 'Scattered paddock trees, litter chemistry and surface soil properties in pastures of the New England Tablelands, NSW'. *Aust. J. Soil Res.* 42, 905-912.

Harrington, G.N., Friedel, M.H., Hodgkinson, K.H. and Noble, J.C. (1984). Vegetation ecology and management. *In*: Management of Australia's Rangelands (Eds G.N. Harrington, A.D. Wilson, and M.D. Young), CSIRO, East Melbourne.

Johns, G.G. (1981). Hydrological processes and herbage production in shrub invaded poplar box (*Eucalyptus populnea*) woodlands. *Aust. Rangel. J.* 3, 45–55.

McHenry MT, Wilson BR, Lemon JM, Donnelly DE and Growns, IG (2006) soil and vegetation response to thinning White Cypress Pine (Callitris glaucophylla) on the North Western Slopes of NSW, Australia. *Plant Soil*, online first DOI 10.1007/s11104-006-9011-9.

Noble, A.D. and Randall, P.J. (1998). How trees affect soils. RIRDC, Canberra.

Noble, A.D. and Randall P.J. (1999). The impact of trees and fodder shrubs on soil acidification. RIRDC, Canberra.

Reid, N. and Landsberg, J. (1999). Tree decline in agricultural landscapes: what we stand to lose. *In*: Temperate Eucalypt Woodlands in Australia: Biology, Conservation and Restoration (Eds R.J. Hobbs and C.J. Yates), Surrey Beatty and Sons, Chipping Norton, pp. 127–166.

Thompson, W. and Eldridge, D.J. (2005). Plant cover and composition in relation to density of *Callitris glaucophylla* (white cypress pine) along a rainfall gradient in eastern Australia Aust. J. Bot., 53 (6), 545 – 554.

Tunstall, B.R. and Webb, A.A. (1981). Effects of land use on the solodic soils of the poplar box (*Eucalyptus populnea*) lands. *Aust. Rangel. J.* 3, 5–11.

Watson, C. and Reid, N. (2001). Herbage response to thinning in Eucalyptus regrowth. *Nat. Res. Mgt.* 4, 16–21.

Wilson, B.R. (2002) 'The influence of scattered paddock trees on surface soil properties: A study on the Northern Tablelands of NSW. *Ecol. Mgt. Restor.,* 3 (3), 213-221.

Wilson, B.R. and Lemon, J. (2004). *'Native Grassland Soils: How do they compare?'* Grassland Society of NSW, 19th Annual Conference, Gunnedah, NSW, 27th-29th July, 2004.

Wilson, B.R. and Lemon, J. (2004). Scattered native trees and soil heterogeneity in grazing land on the Northern Tablelands of NSW. In: Proceedings of "SuperSoil 2004: Human impact and management of soils", Joint Annual Conference of the Australian and New Zealand Soil Science Societies, Sydney, December 5-9, 2004.

Wu, X.B., Redeker, E.J. and Thurow, T.L. (2001). Vegetation and water yield dynamics in an Edwards Plateau watershed. *J. Range Mgt.* 54, 98–105.

Williams, D.G., Wallace, P., McKeon, G.M., Hall, W., Katjiua, M. and Abel, N. (1999). Effects of Trees on Native Pasture Production on the Southern Tablelands. A report for the RIRDC/LWRRDC/FWPRDC Joint Venture Agroforestry Program. RIRDC Publication No 99/165, Canberra.