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Effects of road age on the structure of roadside vegetation in south-eastern Australia

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ABSTRACT

In many agricultural landscapes, roadside (or road verge) environments provide important refuge for threatened native species and ecosystems, and are often selected as benchmark sites to guide restoration activities. However few studies have investigated potential temporal variability in roadside vegetation conditions. In this paper we used archived cadastral maps to determine road age and examine potential variability in roadside vegetation structures in a typical rural landscape in south-eastern Australia. We found significant differences in the density of mature trees for road segments in different road-age categories. The oldest roads (<1870s) were characterized by having the greatest density of large hollow-bearing *Eucalyptus* trees, but few native conifer trees or shrubs. Roads surveyed when broad-scale clearing commenced (1870–1879), and not the oldest roads, were found to be more intact in terms of the density of large pre-settlement trees, range of tree stem-size classes and overall shrub diversity. By contrast, the youngest roads (post-1900s) had the greatest number of native conifer trees, but few shrubs or large *Eucalyptus* trees. As a result, roads of different ages had different densities of hollow-bearing trees, which is discussed in terms of past land-use legacies. These results have important implications for selecting roadsides as benchmark sites for restoration activities, and highlight the critical importance of roadsides to conserving native biota in agricultural landscapes.

1. Introduction

Roads are a human legacy on the landscape (Lugo and Gucinski, 2000). As a result of their history of anthropogenic disturbances, the structure and composition of roadside environments is often far from uniform (Bennett, 1991). There is increasing recognition that in most agricultural and other human modified landscapes, current plant distributions and structures are best predicted by land-use history (Cousins and Eriksson, 2001; de Blois et al., 2001), where patch age has been found to be an important predictor of ecosystem conditions (e.g. Bossuyt and Hermy, 2001; Ross et al., 2002; Deckers et al., 2005). Indeed, many present-day plant populations may owe their existence to past anthropogenic disturbance processes (Foster and Motzkin, 1998; Lunt and Spooner, 2005). Ecosystems often take centuries to recover or respond to past modifying events, and so time lags may also exist between observed vegetation patterns and future conditions (Foster, 2000; Lindborg and Eriksson, 2004). Therefore knowledge of the historic development of roads is critical to understanding the condition of present-day roadside environments.

In many fragmented agricultural landscapes of south-eastern Australia, roadside environments provide important refuge for native species and remnant ecosystems (Bennett, 1991; Schabel and Eldridge, 2001). Past clearing for agriculture has resulted in extensive fragmentation of previous native ecosystems, where only small remnant patches remain – mostly in road reserves (Benson, 1991; Yates and Hobbs, 1997). Road reserves are narrow corridors of public land set aside in the late 19th century for future road transportation needs. Rather fortuitously, the survey of road reserves in Australia has (indirectly) provided refuge for native ecosystems, which now exist as a vast network of mostly linear tracts of native vegetation (Hobbs and Saunders, 1994; Spooner, 2005a). As such, the historic use and critical importance of roadside environments to conserving native biota in Australian agricultural landscapes share many commonalties to rural road networks and field margins in Europe and elsewhere (Pauwels and Gulinck, 2000; Le Cœur et al., 2002; Marshall and Moonen, 2002).

Road reserves in Australia have many important environmental (e.g. seed source for revegetation activities), recreational, aesthetic

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and cultural heritage values. They are often selected as benchmark sites to guide restoration activities, due to their perceived levels of naturalness or 'intactness' (i.e. in terms of large, hollow-bearing trees and shrub diversity; Oliver et al., 2002). However identification of roadsides as benchmark sites for restoration is problematic. Such references to 'old' or 'intact' roads imply some sort of temporal dichotomy, where past human impacts are condensed into one discrete event e.g. clearing of the landscape. Although some modifying events in agricultural landscapes can be rapid at a small scale, at a regional scale they are often slower, continuing processes (MacDonald et al., 1990). Similarly, the survey of road reserves was not a single event, but often took decades to complete (Marshall, 1999). So it is short-sighted to presume that roadside ecosystems are representative of the historical condition of a site (Fensham, 1989).

To date the temporal scale of roadside structures and compositions has received little attention. In one of few studies of this kind, Olander et al. (1998) described how older roads have different ecosystem compositions and structures to younger roads as a result of recovery from past disturbances. Potential temporal variability in roadside vegetation conditions has important implications for conservation management and restoration activities in agricultural landscapes, both in Australia and elsewhere. In this paper we examine the effect of road age on the structure of *Eucalyptus* woodlands in road reserves in southern New South Wales, Australia, to address the following questions: (1) Do roads of different age classes have different densities and size-class structures of dominant trees? (2) Are there species differences in stem densities between roads of different ages? (3) Is road age a stronger predictor of tree size structures than other patch and road attributes? (4) Which roadsides should be used to reliably benchmark pre-European settlement conditions?

2. Methods

2.1. Study area

The study area covered some 365 km^2 and was located in the Lockhart shire municipality (35°S, 146°E), a local government area in southern NSW, Australia (Fig. 1). The area has a cool temperate climate, with mean annual rainfall ranging from 450 to 600 mm. The agricultural landscape is comprised of relatively flat, intensively managed land dominated by cereal crops and sheep grazing pasture. Agricultural development has resulted in the clearing of over 85% of native vegetation, and most patches of intact native vegetation occur along roadsides. Native vegetation consists of *Eucalyptus* woodlands dominated by *Eucalyptus microcarpa* Maiden (Grey box), *E. melliodora* A. Cunn. ex Schauer (Yellow box), *E. blakelyi* Maiden (Blakely's Red-gum), *E. albens* Benth. (White box), and the native conifer *Callitris glaucophylla* J. Thompson and L. Johnson (White cypress-pine) (Moore, 1953). Study area *Eucalyptus* species are fire tolerant facultative seeders, with capacity to resprout from roots or lignotubers after disturbance. In contrast, the native conifer *C. glaucophylla* is a fire sensitive obligate seeder, which requires good autumn rains in low competition environments for successful regeneration (Lindsay, 1948; Moore, 1953; Lacey, 1972)

The Lockhart Shire road network is over 1600 km: 28% bitumen sealed roads, 47% gravel constructed roads, and 25% graded earth tracks, and is a typical rural area in south-eastern Australia. The Lockhart road network was mapped using ESRI Arcview GIS, based on maps provided by the Lockhart shire council and previous roadside vegetation surveys (Bull, 1997). Roads were divided into road segments; which were identified as (1) sections of roads from one intersection to the next, or (2) to a point on the road where vegetation conditions had markedly changed (in terms of

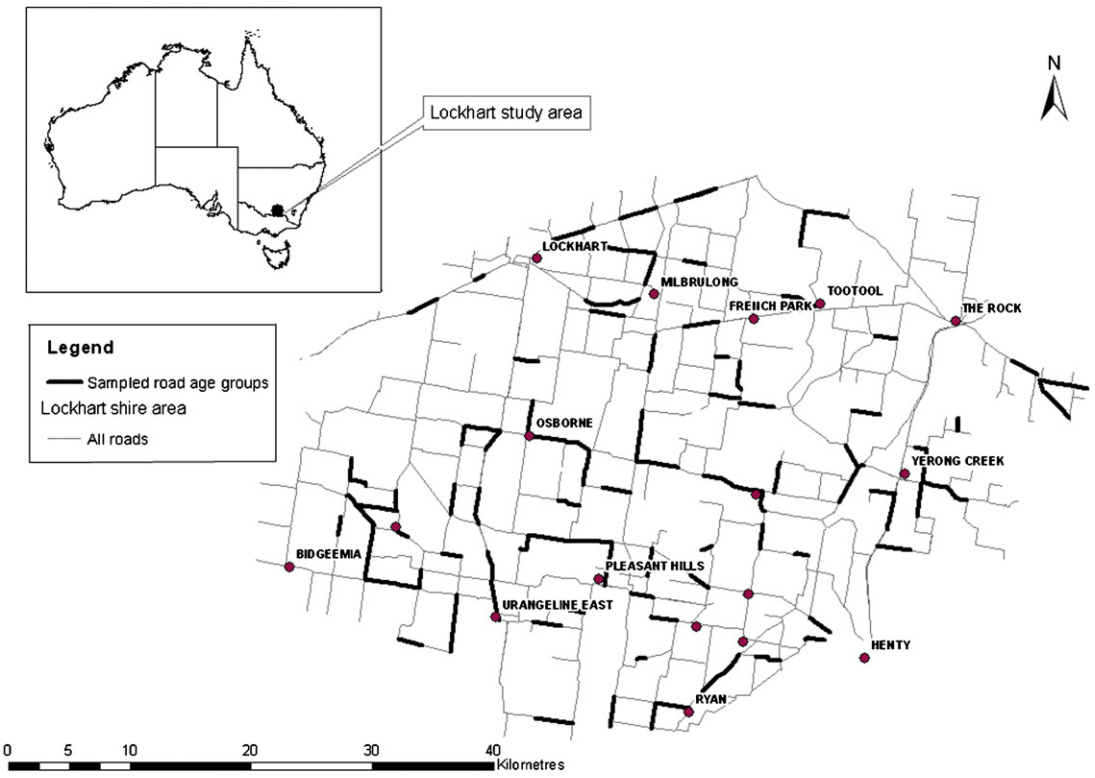

Fig. 1. Location of the Lockhart study area in southern NSW, Australia, showing 100 randomly selected road segments (all age groups combined for clarity).