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Assessing ecosystem function of restoration plantings in south-eastern Australia

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ABSTRACT

We used the Landscape Function Analysis (LFA) (sensu Tongway and Hindley, 2004) to assess the development of ecosystem function in revegetation, particularly in relation to the basic ecological functions of soil stability, water infiltration and nutrient cycling. We compared these three LFA indices between two types of revegetation plantings, remnants, and cleared agricultural land (paddocks), in an agricultural landscape in south-eastern Australia. We differentiated between 'woodlot plantings' (planted with overstorey eucalypts only) and 'ecological plantings' (planted with many indigenous species of trees and shrubs). Remnant and paddock sites indicated the goal and starting point of restoration, respectively. Sites in remnant vegetation scored highest for all three functional attributes, whereas paddocks had high scores for soil stability, but low scores for water infiltration and nutrient cycling. Contrary to our expectations, soil stability, water infiltration and nutrient cycling did not differ between ecological plantings and woodlot plantings, and increased with age of planting (2–26 years) only for the nutrient cycling index. Although LFA provided an overview of some key functional differences between site types, it may be too coarse as a tool to measure restoration success. Specifically, the three functions considered by the LFA were strongly influenced by a single variable relating to perennial vegetation cover, but were essentially unaffected by more subtle differences between site types, such as quantity of leaf litter or cover of grasses. We also caution that Landscape Function Analysis derives surrogates of very basic functional attributes which may not be sufficiently sensitive to accurately reflect more complex ecological functions such as habitat provision for wildlife.

1. Introduction

Quantifying the ecosystem function of landscapes or sites is a major challenge, especially in a restoration context (Bengtsson, 1998). A critical measure of successful restoration is that a restored site is functioning adequately (Society for Ecological Restoration International Science and Policy Working Group, 2004; Ruiz-Jaen and Aide, 2005a,b). However, despite the general recognition of the importance of restoring ecosystem function, practical methods for determining function in relation to restoration success are often lacking (Bengtsson, 1998).

Ecological function has been defined in many ways. At the most basic level, function relates to the flows of water and nutrients through a site (Bengtsson, 1998; Srivastava and Vellend, 2005). At a higher level, and often at larger spatial scales, there are more complex ecological functions such as (for revegetation plantings) lowering of water tables to prevent or reduce salinity (Hatton and Nulsen, 1999; Stirzaker et al., 2002), reducing wind and water erosion (Bird et al., 1992), improving stream-bank stabilisation and water quality (Vought et al., 1995), and providing habitat and connectivity for plants and animals (Rosenberg et al., 1997; Munro et al., 2007, 2009b). Other measures of ecological function include the productivity or rate of biomass accumulation of a site (Henry et al., 2001; Erskine et al., 2006; Foster et al., 2007), species interactions across functional traits and trophic levels (Palmer et al., 1997; Walker et al., 1999), pollination processes (Balvanera et al., 2005), and carbon storage (Balvanera et al., 2005; Kanowski and Catterall, 2010).

These many and varied definitions of function make a single, broadly applicable tool for measuring ecosystem function difficult to identify. A limited number of studies in restoration have measured specific individual functions, such as species functional groups (Lomov et al., 2009), or nitrogen accumulation (Davidson et al., 2007; Amazonas et al., 2011), but rapid plot-level indicators of overall ecosystem function were rare (Herrick et al., 2006). Indeed, we found only one index-based tool for the rapid assessment of ecosystem function, the Landscape Function Analysis (Tongway and Hindley, 2004).

Landscape Function Analysis is a rapid assessment technique that has been used in the assessment of ecological functions in rehabilitation and restoration sites throughout the world. Initially developed by Tongway and Hindley (2004) to monitor the

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