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Conserving large old trees as small natural features

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ABSTRACT

In many ecosystems globally, large old trees occur as single, spatially isolated individual trees or as small groups of scattered trees and can therefore be considered to be small natural features. Despite being constrained spatially, individual large old trees and small stands of such trees nevertheless play numerous critical ecological roles (e.g. in carbon storage and provision of wildlife habitat). The protection and management of large old trees as small natural features is essential to maintain these roles and will often require targeted fine-scale conservation strategies. Such strategies can include bans on cutting trees above a certain size, micro-fencing to control threats associated with livestock grazing, and buffers comprised of other vegetation to limit the impacts of fire and chemical sprays. Effective conservation to mitigate the effects of factors threatening large old trees will often demand ecosystem-specific responses. This is because the drivers of loss will often manifest in ecosystem-specific ways. Three general principles will likely apply in almost all cases: (1) Protect existing individual large old trees; (2) Reduce rates of adult mortality. This is because adult mortality is a key part of the life cycle of large old trees; increased adult mortality can lead to population crashes; and (3) Ensure there are sufficient recruits of trees of varying ages to replace existing large old trees as they eventually die.

1. Introduction

Small natural features (SNFs) are parts of ecosystems that make a disproportionately substantial contribution to ecological processes and/or biodiversity relative to their small size (Hunter, this issue). Large old trees qualify as SNFs in many ecosystems worldwide. These include wood production forests subject to extensive or intensive human modification such as repeated logging and where large old trees can be uncommon or even rare and are often confined to relatively small areas (Linder and Östlund, 1998) (Fig. 1). Similarly, large old trees are SNFs in many non-forested ecosystems such as savannas, deserts, and heavily disturbed agricultural and urban environments in which large old trees can occur as small groups of scattered trees (Manning et al., 2006) or single isolated trees (Carpaneto et al., 2010; Moga et al., 2016) (Fig. 2).

Although large old trees can be spatially constrained and limited in abundance in many ecosystems, they can nevertheless play numerous ecological roles. Moreover, their protection can demand targeted fine-scale conservation strategies, often at the individual tree level. The primary focus of this paper is on large old trees as SNFs with a particular emphasis on conservation strategies designed to protect existing individual large old trees, maintain the array of roles played by these trees, and recruit new cohorts of trees to avoid discontinuities in abundance. First, some of the ecological roles of large old trees are outlined to provide ecological context to discussions of fine-scale conservation strategies. This is followed by a discussion of some of the many factors threatening populations of large old trees. The final sections of the paper outline ways to conserve individual large old trees and small stands of such trees with an emphasis on the management of large old trees as small natural features.

2. Key ecological roles of large old trees as small natural features

Large old trees play many ecological roles either not filled or only partially filled by small young trees, large young trees, medium sized and intermediate-aged trees, or small old trees. These include roles in ecosystem processes such as hydrological regimes, carbon storage and nutrient cycling, micro- and meso-climatic regimes, and providing habitat for an enormous array of plant and animal species (Lindenmayer and Laurance, 2016) (Fig. 3). Some important features of large old trees such as the presence of deep and extensive root networks, large cavities, large buttresses, large lateral branches, extensive canopies, prolific flowering, and extensive seed set are not characteristic of small sized or younger aged trees (Ashton, 1975; Brokaw and Lent, 1999; Gibbons and Lindenmayer, 2002; Lindenmayer and Laurance, 2016). Thus, large old trees are truly keystone structures (sensu Tews et al., 2004) in terms of their disproportionate contribution to a wide range of ecological processes and their disproportionate value for biodiversity (Manning et al., 2006).

Large old trees can continue to have important ecological roles when they occur in small clusters of trees or as individual trees. For example,

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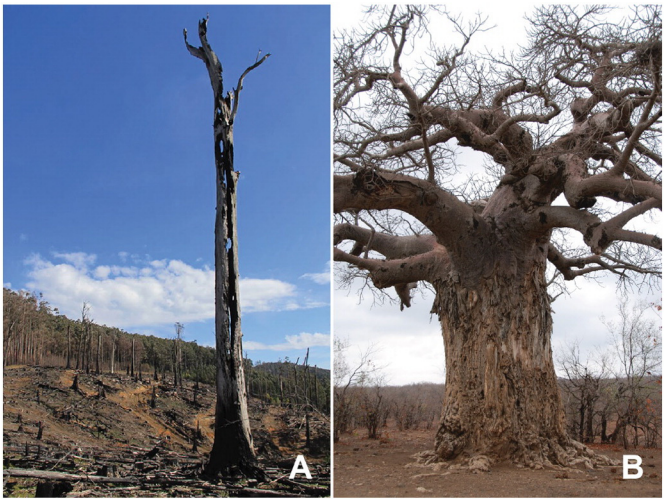

Fig. 1. Single large old trees in: A. logged Mountain Ash forests in the Central Highlands of Victoria; B. baobab tree in the tropical savannas of Kruger National Park, South Africa. Photos: (A) L. McBurney; (B) D. Lindenmayer.

they can have profound impacts on local microclimatic conditions, soil moisture and soil nutrient levels (Dean et al., 1999; Voight et al., 2015). Individual large old trees can be a small proportion of the number of stems in a given stand or area of vegetation, but nevertheless a significant contributor to the total amount of carbon stored (Slik et al., 2013). Individual large old trees can be reproductively dominant trees in an area through contributing a disproportionate numbers of germinants to new cohorts of plant recruits (Wenk and Falster, 2015). Hence, they can act as nodes of regeneration (Fischer et al., 2009). Individual large old trees and small stands of such trees can act as living "micro-hotspots" with levels of species richness and individual species abundance substantially greater than the surrounding environment. Indeed, many species of animals occur in a given area only because of the presence of large old trees (Kavanagh and Turner, 1994; Lindenmayer et al., 2014b). Several studies have shown that patterns of nesting, denning and other social behaviour by cavity-dependent animals are dramatically altered when populations of large old trees are reduced and/or

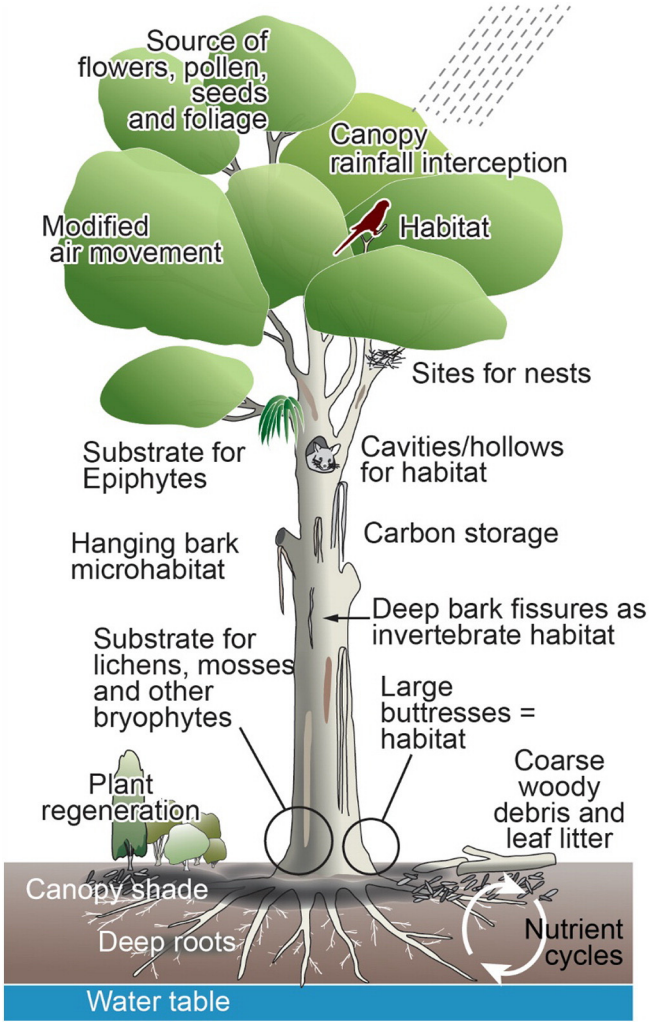

Fig. 3. Schematic representation of a subset of the array of ecological roles played by large old trees.

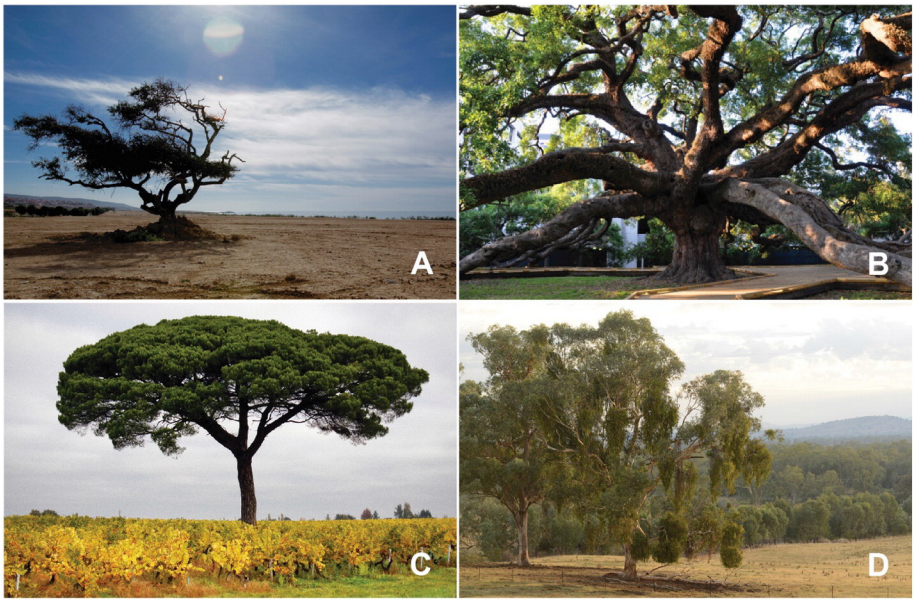

Fig. 2. Individual large old trees in non-forested environments in: A. an agricultural environment in Morocco; B. an urban streetscape in USA; C. cropping land in rural France; D. a grazing environment in Australia. Photos: (A) E Dekker (Creative Commons); (B) J Willamor (Creative Commons); (C) Ands78 (Creative Commons); (D) D Blair.

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