



Ancient trees and the protection of biodiversity and cultural heritage

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Abstract: Ancient large trees are keystone structures and organisms in many ecosystems globally. They have numerous critical ecological roles and often an important part of human culture and religious practice. Despite the ecological and cultural importance of large old trees, populations of them are declining in many ecosystems - both in natural environments and human-modified environments. In some cases, young individuals of a given species that may eventually become large and old might be common, but the large old life stage of that species might be rare and declining. Given that some species of large old trees can live for more than 1000 years, novel and often highly targeted conservation strategies are needed to better protect them. Approaches to achieve such ambitious long-term conservation strategies will demand a robust and enduring combination of monitoring programs, focused actions from the scientific and citizen science communities, and strong legislation for effective protection and conservation. The combination of strategies is critical not only for the protection of existing large old trees, but also to ensure the recruitment of new cohorts of such trees in the future.

Key words: large old trees; conservation; long-term protection.

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1. INTRODUCTION

Large old trees are the largest organisms on the planet. They are also among the longest lived. I have long had a passion for large old trees, starting from when I was five years old - although perhaps I did not know it then. Our neighbours had a giant exotic Oak (*Quercus* spp) in the backyard of their house. It was by far the tallest tree in the suburb and likely planted 120 years earlier - at the time the

city of Melbourne was just being established. I spent many hours climbing that tree. When my parents sold their house, the buyers also bought the neighbour's house - so they could have access to the tree and protect it. The tree is still there and just as majestic as it was 60 years ago. My first real (properly paid) job commenced in 1983, and since then trees became a key part of my life. I was employed as a field Research Assistant measuring large old trees; this was the start of a project that we maintain

to this day (e.g. see Lindenmayer et al., 2024). I measured several thousand huge old Mountain Ash trees - some approaching 100 metres tall and exceeding 14 metres in circumference. The work is documenting rates of collapse and changes in the condition of Mountain Ash trees (Lindenmayer et al., 2024) - the world's tallest flowering plant (Williams et al., 2023).

An increasing body of work is highlighting the many key ecological and cultural roles of large old trees (Lindenmayer & Laurance, 2017). They are critical for: (1) supporting large amounts of biodiversity (Paillet et al., 2018), (2) storing vast amounts of carbon (Lutz et al., 2013), (3) regulating hydrological processes (Vertessy et al., 2001), (4) influencing key aspects of fire regimes (Cruz et al., 2012), and (5) underpinning agricultural production in agricultural landscapes (such as providing shelter for livestock) (Masters et al., 2023). Large old trees also have numerous biocultural values such as in religion; Buddha received enlightenment under a sacred Fig tree, and the ancient Olive trees of Jerusalem's Garden of Gethsemane are revered in Christianity. Iconic large trees are now commonly found around temples and churches as well as in cemeteries (Huang et al., 2025). Of course, large old trees feature in paintings, books, films and are part of almost all ancient and modern cultures globally (Blicharska & Mikusinski, 2014).

As important as large trees are to life on earth and human culture, populations of them are declining in many parts of the world (Lutz et al., 2009), not only in forests but also in savannas (Setterfield et al., 2010), and farmlands (Jacobsen et al., 2023; Brandt et al., 2024). As an example, up to 15 billion large old trees have been cleared from the agricultural landscapes of inland Australia in the past 120 years (Walker et al., 1993) - and the loss is continuing there (Maron & Fitzsimons, 2007). Similarly, hundreds of millions of large old trees

are being lost from the agricultural landscapes in India (Brandt et al., 2024). Many of the largest old trees are dying in Africa (Patrut et al., 2018); and large old trees are being cleared from Orchard Meadows in Germany as a result of urban expansion (Plieninger et al., 2015).

In many cases we are not seeing the extinction of a species - but rather the extinction of a critical life history stage (very old trees) of that species. For instance, in the tall, wet Mountain Ash forests of south-eastern Australia - the risks of recurrent wildfire that kills large old trees but stimulates the germination and regeneration of that same species - means that large old trees and associated old growth forest might never again develop. Essentially, whole landscapes will be trapped at a young stage, unlikely ever to mature and become old growth supporting numerous large old trees (Lindenmayer et al., 2022).

2. CONSERVATION STRATEGIES

Focussed and often highly targeted conservation strategies are essential to better conserve remaining populations of large old trees. Such strategies will need to be extremely long term as individuals can persist longer than many civilizations - over 2000 years in some cases (Liu et al., 2022) - so non-standard conservation practices of protection are needed over massive timeframes. This has many implications; first, there needs to be well developed cross-generational communication about informed conservation policy and practices, second, the consequences of poor decisions (such as to clear trees) must be made clear; that is, bad policy enacted now will potentially still be having negative ramifications in 1000+ years time.

A further important conservation issue is that not only do existing large old trees need protection, but also the recruitment of new co-

horts of trees must be facilitated. This demands a reduction in the number and magnitude of stressors that threaten large old trees. A further challenge is that the climatic conditions under which trees germinated 200-2000 years ago might be very different to those which exist now (Lindenmayer & Laurance, 2017). Such changes may require assisted translocations (Hoegh-Guldberg et al., 2008) to establish seedlings in places that might be climate-suitable for a given species in the future.

Novel partnerships will be needed to promote the conservation of large old trees. For example, conservationists must collaborate with religious leaders as remaining individuals and small populations of some species of large old trees occur in churches and temples - such as the Buddhist temples of China (Huang et al., 2025). These partnerships might be most successful where common interests can be found across different philosophies, world views and approaches - science and religion - to yield better protection outcomes.

3. CONCLUDING COMMENTS

Despite the ecological and cultural importance of large old trees and the fact that they have been extensively studied in many places, there is still much to be learnt about them. Surprisingly, much remains unknown about the long-term trajectories of populations of many species of large old trees. Some of that understanding will need to come from long-term monitoring - but over time scales that will exceed the lifetimes of many generations of people. How to achieve this is unclear, but there is a role for citizen scientists in helping to find, identify, document, monitor, and protect large old trees. Important programs to do this occur in the United Kingdom, Romania and Norway, among many other nations. A

key issue with citizen science programs is the need for field data collection to be guided by a robust scientific framework to ensure the data collection is meaningful. These, and many other challenges, mean that we need more people - scientists, citizens scientists, land managers, and policy makers - to bring together their collective wisdom and insights to tackle the problems and challenges of conserving large old trees.

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