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Ageing long-unburnt Gimlet woodlands

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Background

Establishing the time since disturbance is a significant challenge in studies of temporal changes in ecosystem composition and function in infrequently-disturbed communities. Individual fire events, for example, can have effects lasting for centuries. Dating fires that occurred prior to those documented in contemporary sources (e.g. historical records or remotely-sensed imagery) is not a trivial problem, as many ecological processes, such as hollow formation, operate over long time scales. Estimates of the actual time since fire of long-unburnt vegetation can be made through dendrochronology (measuring stem growth rings), or establishing relationships between plant size and age.

Eucalyptus salubris (gimlet) is a fire-killed tree widespread across the globally-significant Great Western Woodlands (GWW). We aimed to characterize the relationship between Gimlet tree rings, plant age and plant size. The woodlands of the GWW are typically fire sensitive and are at risk from inappropriate fire regimes. Uncertainty concerning the age of long-unburnt woodlands, and hence the scale over which temporal changes in woodland dynamics occur, currently constrains understanding as to whether the recent fire regime represents a significant long-term threat to mature woodland ecosystems.

Gimlets (*Eucalyptus salubris*) are killed when burnt and recruit en-mass post fire (left) from seed released from a canopy-stored seed bank. Satellite imagery can be used to determine the age of woodlands regenerating post-fire for periods up to ~ 40 years ago (centre), but what age post-fire are the iconic woodlands characterised by large, widely-spaced trees that typify the Great Western Woodlands (right)?

Findings

- Growth ring counts strongly reflected the age of plants of known age (range 3-40 years old).
- Growth rings could be used to age plants up to approximately 100 years old. Most gimlets older than this had developed hollow cores, truncating the growth ring record.
- Trunk diameter at the base adequately reflected plant age (derived from satellite images and growth ring counts) (Figure 1). Model based on both a linear relationship between trunk size and age, and a non-linear relationship of declining growth rates with age (square-root of time), performed well over the range of trunk sizes that were dated. For trunks larger than this, there is greater uncertainty over their age when estimated from trunk size.
- Local tree growth increment records suggest that the linear relationship underestimates true stand age. However, in the non-linear model, small increases in trunk diameter in large plants can lead to large changes in estimated age.

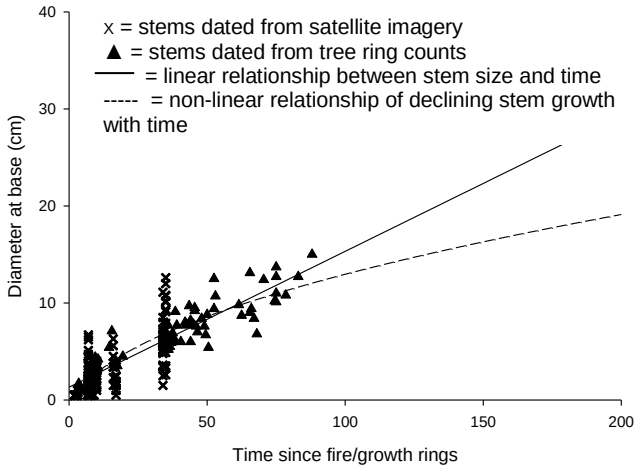

Figure 1. Relationship between years since fire and diameter at the base in gimlet. The large effect of choice of model form on estimated times since fire of long-unburnt sites illustrates increasing uncertainty of age estimates with increasing plant size.

Trunk section of gimlet, showing visible growth rings

- Under the assumption that the time since fire of the long-unburnt gimlet stands sampled in this study reflects the distribution of times since fire across the GWW more broadly, the estimated age-class distribution of gimlet woodlands in the GWW was determined. (Figure 2).

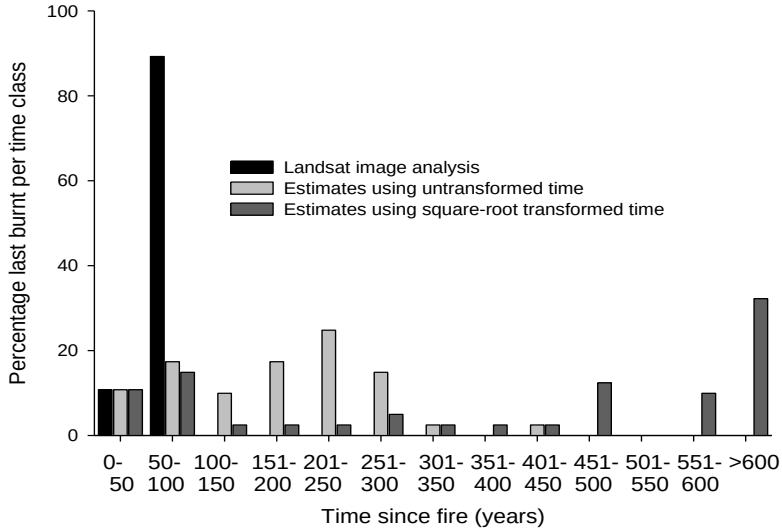

Figure 2. Comparison of gimlet woodland age-class distributions for the western half of the Great Western Woodlands generated from: (i) analysis of satellite imagery (note that the vegetation in the 51-100 year band is more accurately considered > 50 years old, without an upper bound, but with no resolution of age classes beyond 50 years post-fire); (ii) a linear relationship between trunk size and time; and (iii) a non-linear relationship between trunk size and time.

Management Implications

- Diameter at the base can be used to estimate the post-fire age of gimlet stands in the GWW, although the uncertainty of age estimates increases with plant size/age. Age-class distributions generated from these size-age relationships illustrate a considerably greater diversity of vegetation ages in gimlet woodlands than that able to be generated from analysis of satellite imagery, as satellite imagery substantially truncates maximum ages.
- Actual age-class distributions can be compared with a variety of theoretical distributions to determine the type and scale of fire management interventions that may facilitate improved conservation of mature woodland ecosystems.

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GREAT WESTERN WOODLANDS