Australian Government
Land & Water Australia

Dynamics in tropical eucalypt forests

This fact sheet written by John Woinarski and Brydie Hill presents the key findings from the Land & Water Australia managed project: **Defining successional patterns and biodiversity values of north Australian eucalypt forests**.

LWA project code: TRC14

Some of Australia's and indeed, the world's most extensive intact forest systems occur in tropical northern Australia. Here, tropical open forests and savanna woodlands dominated by *Eucalyptus miniata* (Darwin woollybutt) and/or *E. tetrodonta* (Darwin stringybark) extend over 450,000 km^2 or about 6% of Australia's land area.

With frequent fire and cyclone disturbance, the ecological dynamics of northern Australia's tropical forests are likely to contrast markedly with those of temperate Australia. Yet, it is these temperate forests that are largely seen as typifying Australian forest systems. For example, "old-growth" criteria are now reasonably well established in temperate forests, but there has been no consideration of comparable criteria for the tropical eucalypt forests and there is currently a pervasive belief that the very concept of "old-growth" may be inappropriate for these frequently disturbed forests.

What is "old-growth"?

Foresters, ecologists and conservationists have long recognised that there is variation in the characteristics of forests as they age. Older forests have larger trees and these are more likely to form hollows and hence support hollow-dependent animal species; they may also have more epiphytic plants (i.e. plants that grow upon or attach to other living plants), and coarse woody debris (fallen logs and other "litter") and consequently more animals associated with the decay of organic material.

They may also provide habitat for plant and animal species that are disadvantaged by disturbance or prefer the particular microclimatic conditions deriving from a relatively tall, layered and dense canopy. Some have also ascribed particular aesthetic or spiritual qualities to forests made up of large tall and very old trees. The foundation document for the delineation of old-growth forests in Australia is the "JANIS" report (*Nationally agreed criteria for the establishment of a comprehensive adequate and representative reserve system for forests in Australia*, 1997, A report by the Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-committee). This defined old-growth criteria applicable for all Australian forests, with the single proviso that:

"These criteria apply to all forested regions except those in the Northern Territory where the vast areas involved mean a different set of criteria will need to be developed."

This study has aimed to remedy this now long-standing deficiency.

***Photo**. Ground-based estimates of hollow availability in eucalypt forests were checked against actual counts derived from climbing or felling representative trees. Photo John Westaway.*

Why worry about dynamics in these forests?

One reason is that they are now the main target for broad-scale vegetation clearance in northern Australia (and possibly the environment undergoing the highest current clearing rate in Australia). Clearing is occurring to accommodate forestry plantations, horticulture, residential development and pastoral intensification. The development stage of a tropical forest (i.e. whether "old-growth" or not) is not considered in assessment of clearing applications, yet it is very obvious that some areas of these forests have large trees supporting many hollows and associated hollow-dependent fauna, whereas other areas of the same forest type are of much reduced stature.

Another reason is that there is some need to assess the conservation value and characteristics of regrowth forest, in terms of how this should be treated in (re)clearing applications, in closure conditions for rehabilitation following mining or other impermanent intensive development, and for the design of linkages in landscapes now overly cleared. Another reason is that climate change is likely to increase the frequency and/or intensity of disturbance in these forests, so we need to understand the current dynamic in order to assess the likely impact of change.

And yet another reason is that we should balance our understanding of Australian forest ecology through counterpointing the now well-known workings of temperate eucalypt forests with those of tropical eucalypt forests.

In this study, we examined a series of characteristics in these tropical eucalypt forests: the occurrence of hollows; the persistence of fallen logs; change in fauna assemblages following cyclones; and changing characteristics of fauna assemblages in regrowth vegetation. Our consideration of these different issues is linked by the themes of examining the applicability of characteristics that have been used to define "old-growth" elsewhere (e.g. hollow availability, coarse woody debris (fallen logs)) and variation in the faunal assemblage of these forests with forest age.

Conventional wisdom of the dynamics of Australia's tropical forests partly derives from, and is encapsulated in, a brief study of growth rates of eucalypt stems near Darwin, by Mucha (1979). He concluded that growth was rapid and that, because there were no large trees, "eucalypts of the Darwin region tend to be particularly short-lived ... the eucalypts of this region probably rarely reach the age of 100 years", whereas eucalypts in temperate Australia may live well over 300 years. However, Mucha's study was based on stems re-growing following clearance, and over estimates by up to 10-fold the growth rates of trees in intact forest. Large eucalypt trees in these tropical forests are instead likely to be substantially older than 100 years.

We measured tree size, forest stand attributes and hollow occurrence at 42 sites scattered across the substantial rainfall gradient occupied by *E. miniata* / *E. tetrodonta* forests in the Top End of the Northern Territory. Tree size, total forest basal area (a measure of the amount of wood per unit of area), and abundance of hollows increased substantially from lower rainfall to higher rainfall sites (Figure 1 opposite). However this relationship was disrupted at those higher rainfall (near coastal) sites that had (in this case, 33 years previously) been affected by cyclone(s), and was also significantly influenced by fire regimes.

Typical tropical open forest of northern Australia, dominated by Eucalyptus miniata *and/or* E. tetrodonta*. Photo Kym Brennan.*

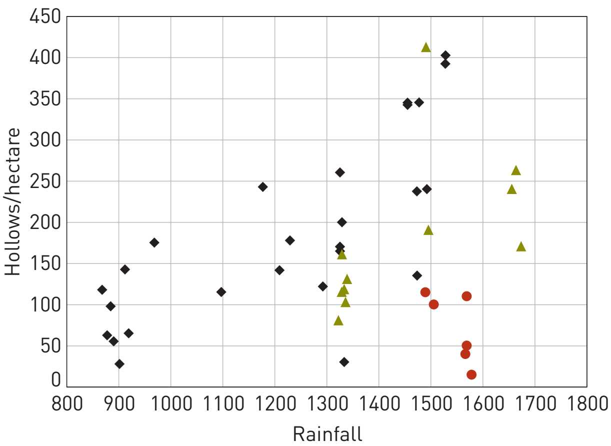


Figure 1*. The abundance of hollows in tropical eucalypt open forests generally increased from lower rainfall to higher rainfall sites. However, this relationship was substantially disrupted by greater incidence of cyclones at higher rainfall (near coastal) sites. Symbols: filled black diamond = no cyclone impact; filled red circle = 33 year regrowth after forest felling by Cyclone Tracy; green triangle = partial impact of more recent Cyclone Ingrid and/or Monica.*

Although forest basal area and tree size was substantially less than for eucalypt forests in temperate Australia, the availability of hollows in the tropical eucalypt forests was greater (especially at higher rainfall sites). This difference can be attributed to the much greater prevalence (or voraciousness) of hollow-forming termites in these tropical eucalypt forests.

Trees in these tropical eucalypt forests were more likely to develop hollows at smaller size than for trees in temperate eucalypt forests. In the tropical eucalypt forests, the first hollow accessible to vertebrate fauna is likely to be available in trees with diameter 20–25 cm, but large hollows (minimum diameter >20 cm: suitable for owls, kookaburras and possums) form only when trees are >65–75 cm diameter. Such large trees are relatively rare, comprising <0.5% of all eucalypt stems >20 cm diameter. Using growth rates to convert these diameters to tree age, these tropical eucalypt trees are unlikely to have any hollows available until they are 25–30 years old (if growth rates are based on regrowth sites) or 65–150 years old (based on growth rates from intact sites), and unlikely to have any large hollows available until they are 60–75 years old (regrowth sites) or 220–500 years old (intact sites).

We also examined the persistence of fallen logs in tropical eucalypt forest, taking the opportunity presented by the destructive Cyclone Monica to measure decay rates in many fallen logs with known time of origin. Our initial assumption was that because of the high incidence of termites, humidity and rainfall and frequent fires, logs would decay rapidly.

The dynamics of tropical eucalypt forests may be much influenced by frequent intense disturbance regimes: in this case, damage caused by Cyclone Ingrid. Photo Kym Brennan.

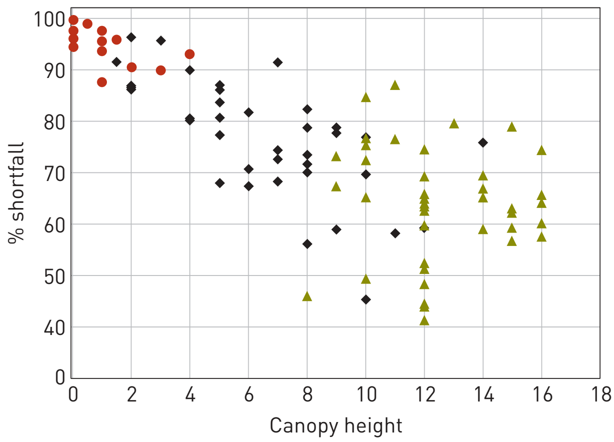


***Figure 2**. Characterisation of vertebrate fauna assemblages for cleared sites (red circles), regrowth (black diamonds) and intact forest (green triangles) across a series of sites in the Daly River region of the Northern Territory. Values shown are biodiversity shortfall relative to a reference fauna assemblage (the average abundance of all species across the set of intact forest sites). As tree sizes increase (with age) in regrowth sites, their faunal assemblage rapidly converges on that of intact forests.*

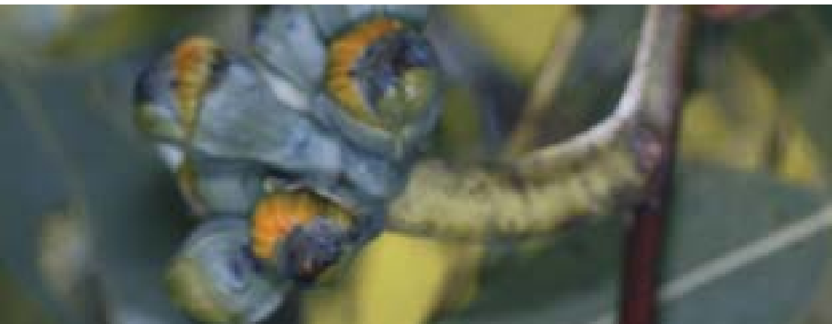
However, over the two year period examined, only three of 174 logs disappeared. Nonetheless many logs showed some decay, and the rate of this decay was related to the incidence of fire, tree species (with more decay in eucalypts than non-eucalypts), log size (greater rates of decay in larger trees) and degree of hollowness (with more decay in hollow logs).

In another component of this study, we examined the "succession" in fauna assemblages at sites ranging from cleared land through regrowth of contrasting ages to intact forests. This aspect of the study was prompted in part by current debate about the degree of regulatory protection that should be afforded regrowth vegetation. Our study found that faunal assemblages in regrowth vegetation were intermediate between those of cleared lands and intact forest sites, but that they converged relatively rapidly to the reference faunal assemblage of intact forests. When regrowth vegetation exceeded about 8 metres in height (i.e. about 20 years), their faunal assemblage was not significantly different to that of intact forest, with the notable exception of under-representation of hollow-associated species. For many species, land management factors (e.g. the incidence of fire, weeds and grazing) were more important factors governing abundance than was whether the vegetation had previously been cleared or not (i.e. was intact or regrowth).

Overall, this study provides major new insights into the dynamics of these important tropical eucalypt forests, particularly allowing comparison with the dynamics of temperate eucalypt forests. The study has important management implications. It is now possible to provide some explicit quantitative criteria for the delineation of "old-growth" in these forests (relating particularly to the incidence of larger trees, and the consequential abundance of hollows and hollow-associated fauna). For regrowth vegetation, it is now possible to justify regulatory controls; although we recommend that if there is a need for choice, it is better to (re-)clear regrowth than to clear intact forest, better to clear younger than older regrowth, and better to clear isolated regrowth than regrowth that may form connections between otherwise isolated intact forest patches.

Reference

Mucha, S.B. (1979). 'Estimation of tree ages from growth rings of eucalypts in northern Australia', *Australian Forestry*, vol. 42, pp. 13–16.



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http://www.lwa.gov.au/nativevegetation

Published by: Land & Water Australia
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Office location: L1, The Phoenix
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Product code: PN21601

Photos: Front cover and at left: Kym Brennan.
Above left: Roger Charlton
Design: Angel Ink
Print: Paragon Printers
September 2008