

Are the dynamics of the eucalypt and non-eucalypt components of Australian tropical savannas coupled?

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Coupled dynamics?

Variation in the attributes of one vegetation component elicits an apparent direct response in terms of variation in the same or similar attributes of another component.

Eucalypts (*Eucalyptus* and *Corymbia*)

vs.

Non-eucalypts (Mimosaceae, Proteaceae and Sterculiaceae)

The tree composition of tropical savannas

- Eucalypts dominate tree biomass of tropical savannas
- But, only a fraction of the tree diversity.
- Eucalypts 60% of plot BA, but 34% of plot and 25% of total species richness.
- Most tree diversity derives from families other than the Myrtaceae.





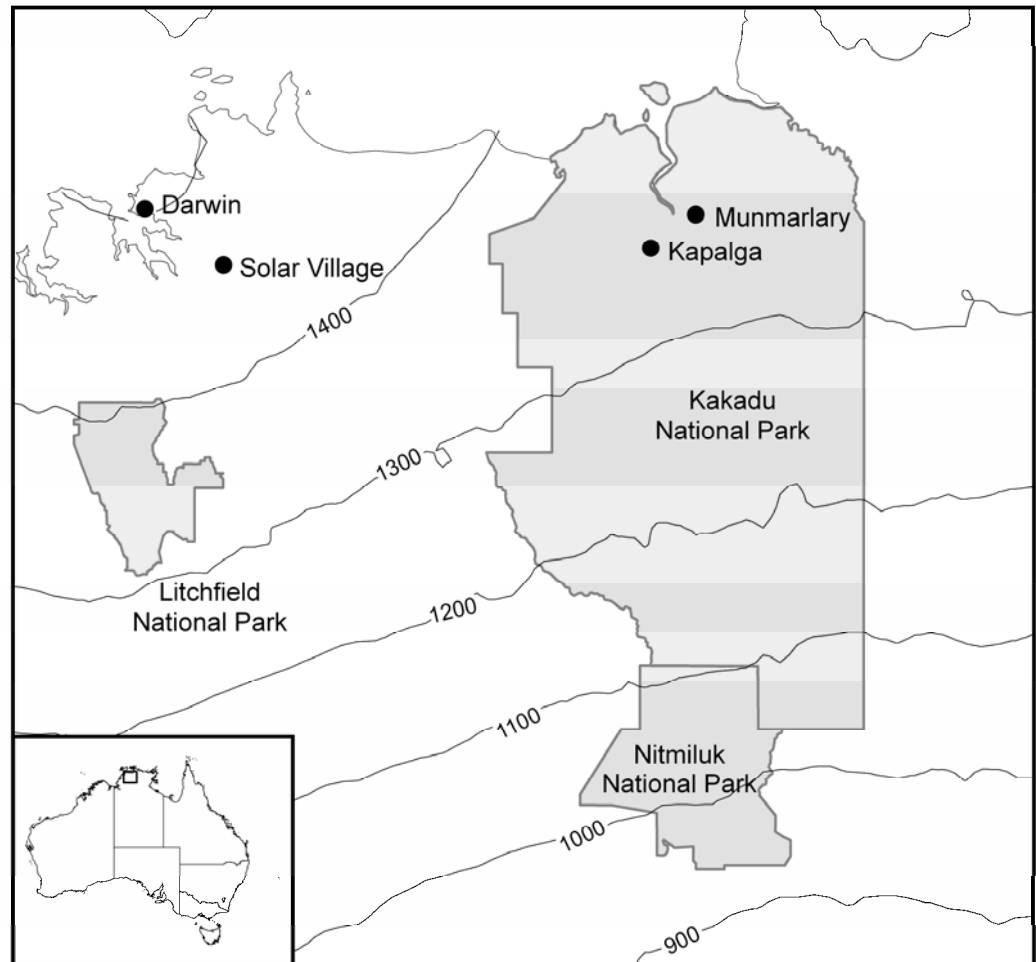
The case for uncoupled dynamics

- Eucalypts adapted to persistence - disturbances (e.g., fire) – epicormic sprouting
- Disturbance confers competitive advantage on eucalypts – component may be at carrying capacity.
- Escape from the disturbance (fire) trap - dynamics of eucalypt component potentially independent of dynamics of other components.

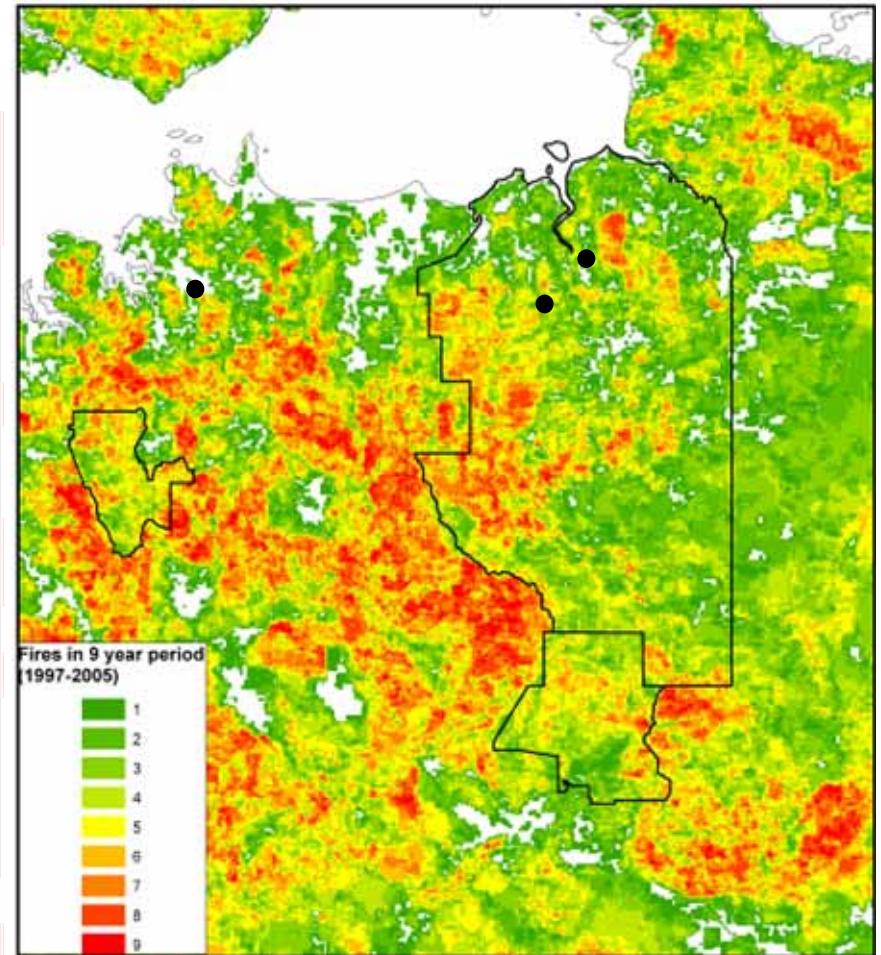
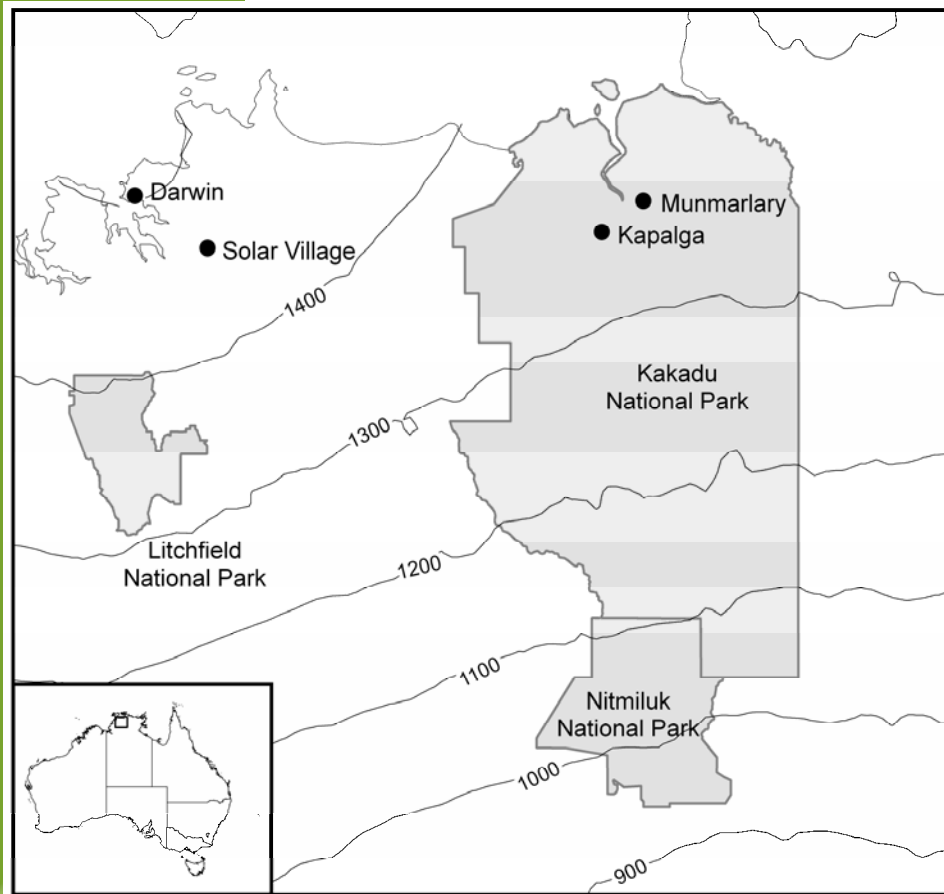


Previous research

- Sites all have high rainfall but gradient of increasing fire frequency and intensity.
- Solar Village
- Munmarlary
- Kapalga



Fire gradient



Evidence for uncoupled dynamics

Across gradient of increasing fire frequency and intensity but high rainfall:

- concomitant decline in the density of the non-eucalypt component;
- eucalypt basal area not significantly different in the burnt than unburnt plots



What happens when fire is withdrawn in a high rainfall region?



SOLAR VILLAGE

23 years without fire

- Basal area of rainforest species increased in unburnt plots
- Basal area of eucalypts did not differ significantly between fire regimes – lag effect?
- Note change to grass-savanna tree interaction
- Fire necessary for maintenance of savanna

Woinarski et al. 2004 Austral Ecology **29**, 156–176

Under low- to moderate-intensity, frequent burning regimes

MUNMARLARY

- woody vegetation dominated by mature eucalypts was structurally stable
- absence of burning for >5y, release of the non-eucalypt, woody component into the midstorey with no appreciable change to eucalypt BA
- accession of rain forest species occurred on some unburnt plots

Under high intensity, frequent burning regimes KAPALGA

- Eucalypt component structurally stable
- Relatively invariant eucalypt BA among burnt and unburnt sites
- Establishment of non-eucalypts in under- and mid-storey in some unburnt plots.



Williams *et al.* (1999) *Aust. J. Ecol.* 24: 50-59.

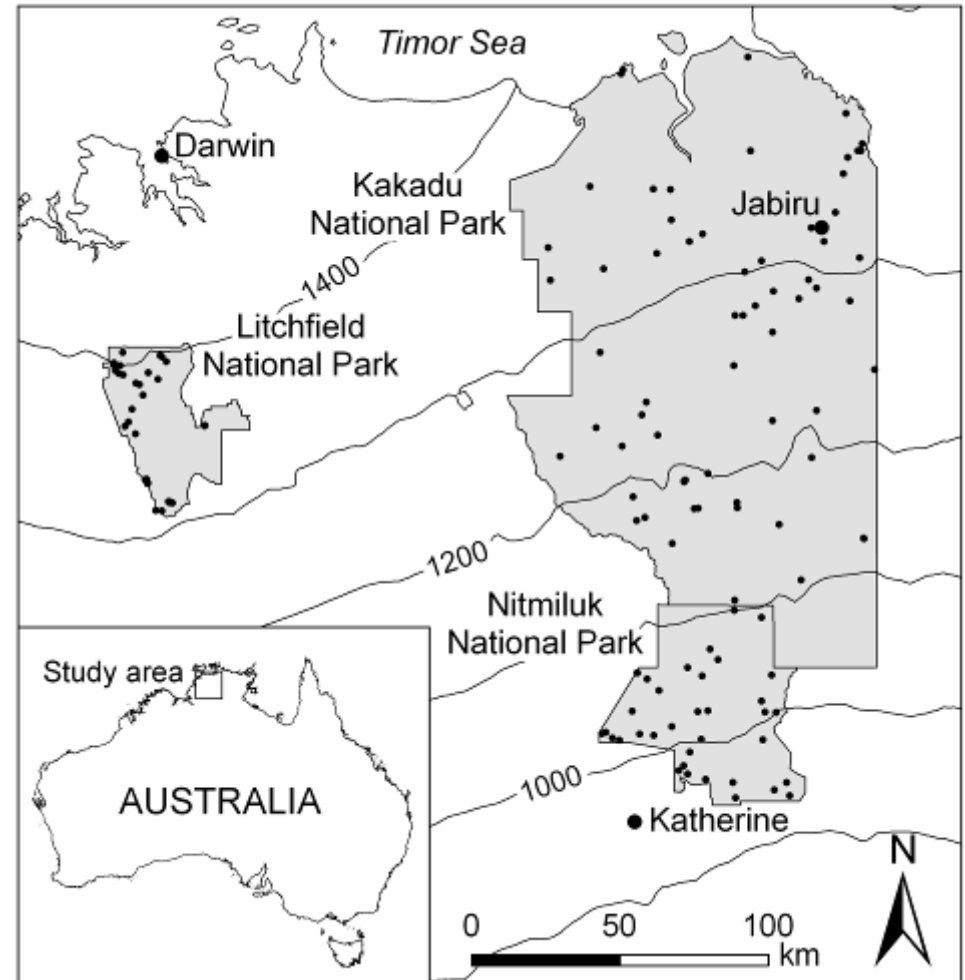
This study

Three Parks dataset

Litchfield NP,
Kakadu NP,
Nitmiluk NP

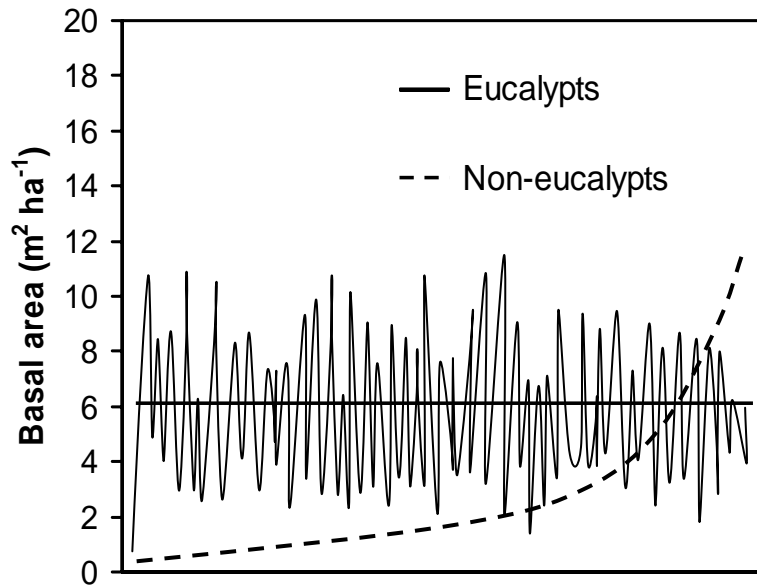
Transcends rainfall
and fire gradients

- = sample plots,
n=129



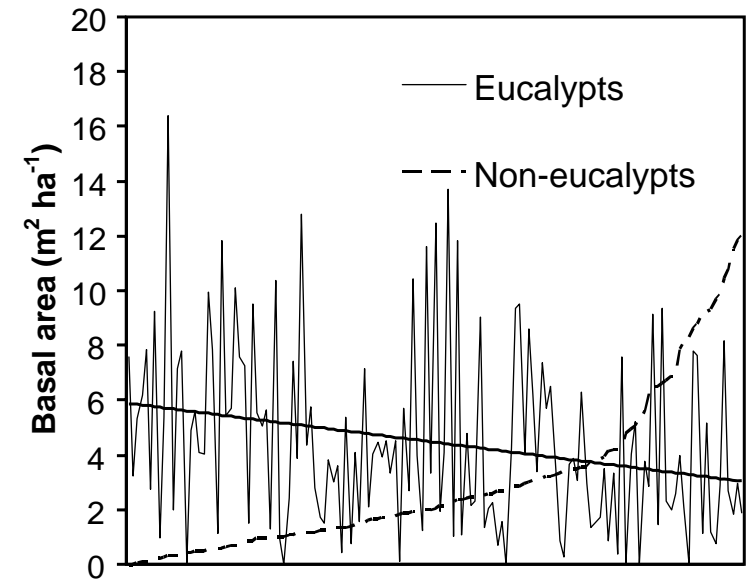
Are Euc and Neuc dynamics uncoupled?

Expected



Plots ordered by increasing non-eucalypt basal area

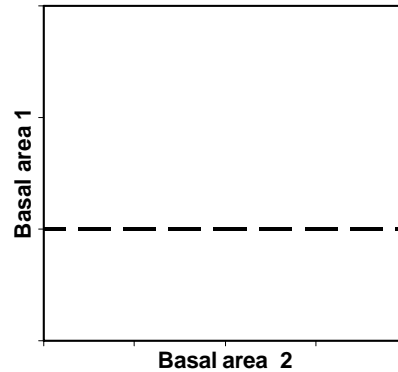
Observed



Plots ordered by increasing non-eucalypt basal area

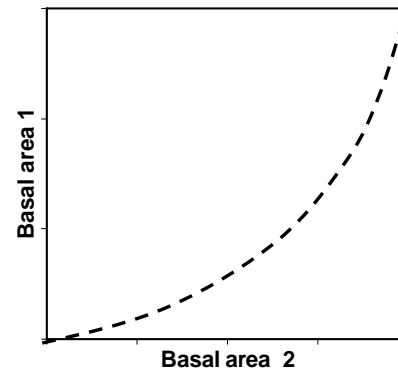
Eucalypt BA not entirely additive!

Are Euc and Neuc dynamics uncoupled?

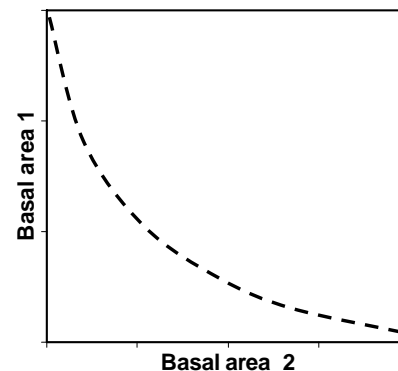


Uncoupled

BA1 independent of BA2.

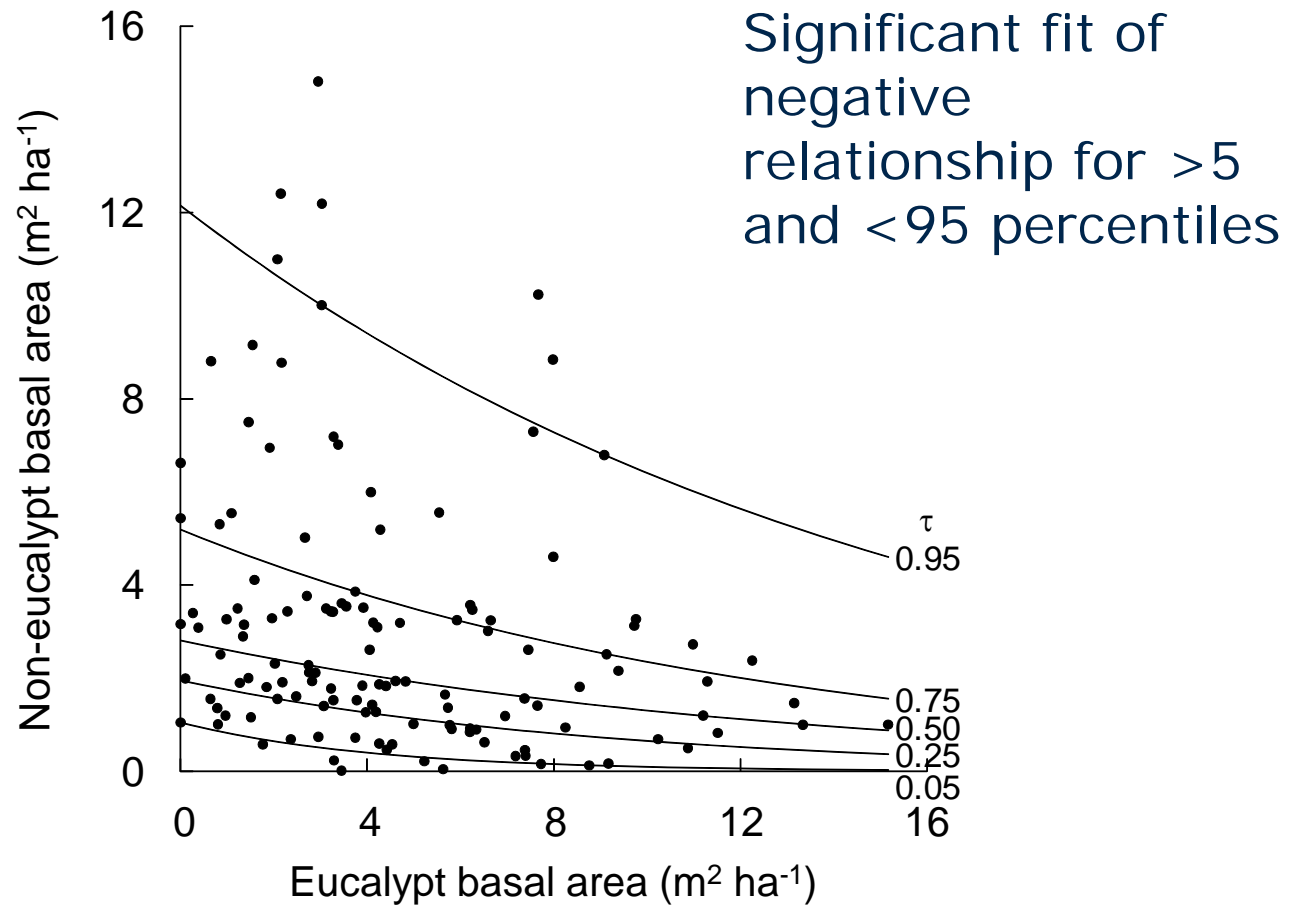


Coupled – facilitation
or similar response to common driving factor.



Coupled – competition
or different response to common driving factor.

Euc and Neuc dynamics appear to be coupled!



What drives Neuc response?

Akaike relative importance values (w_+) of predictor variables:

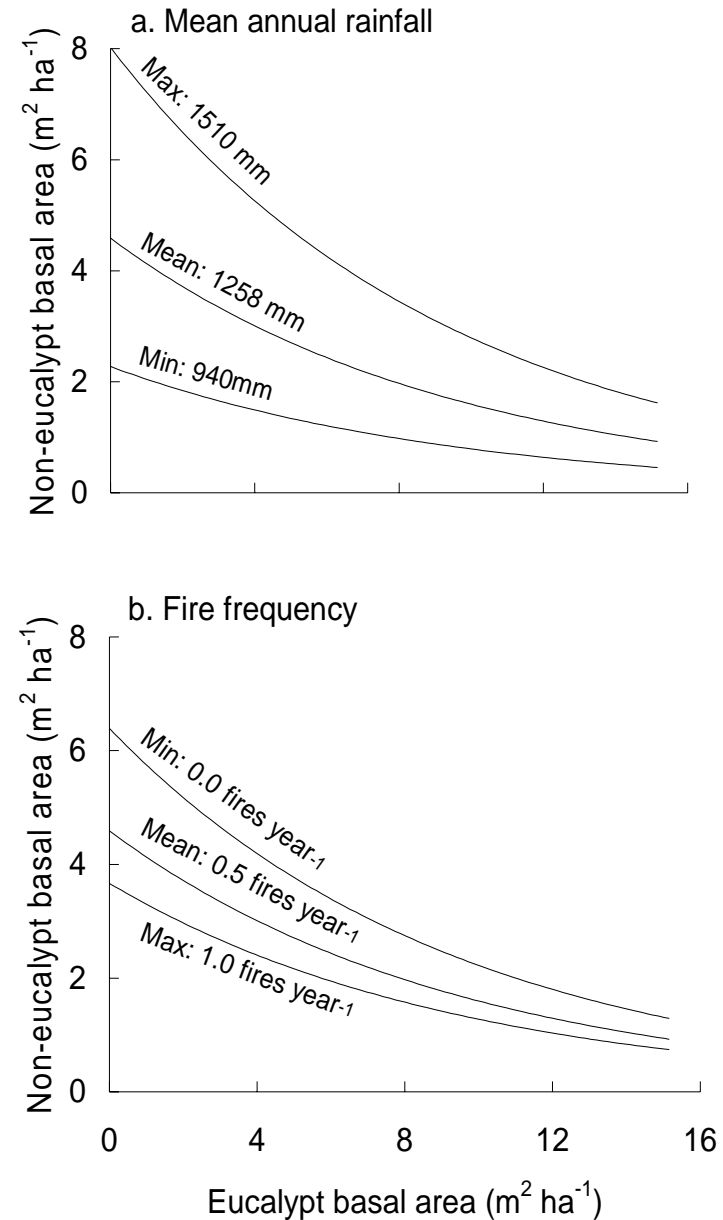
	Basal area	Species richness
Soil depth	0.28	0.54
Fire	0.80	0.34
Rainfall	1.00	1.00
Eucalypt BA	1.00	0.69

Influence of rainfall and fire

Non-eucalypt BA greater at higher rainfall and lower fire frequencies.

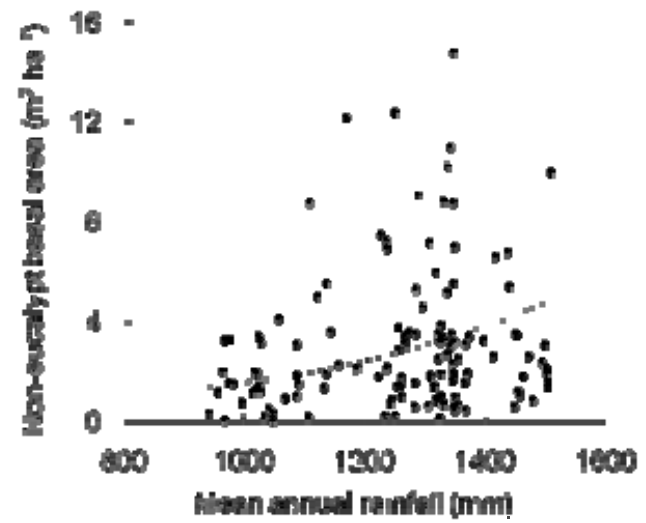
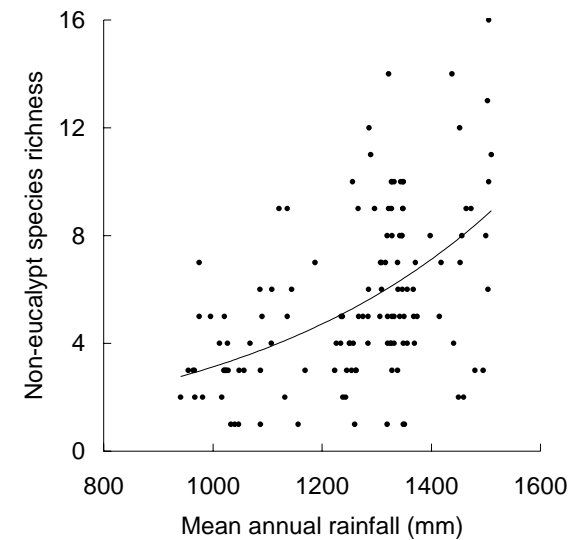
Rainfall has proportionately greater effect than fire on non-eucalypt dynamics.

Does rainfall maintain the non-eucalypt component and fire the savanna (grass-tolerant) component?



Non-eucalypts and rainfall

Rainfall accounted for 28% of the deviance in non-eucalypt species richness



Conclusions

- Dynamics of Euc and Neuc components weakly coupled.
- Eucalypts at or approaching carrying capacity across rainfall and fire gradients.
- Non-eucalypts advantaged in regions of high rainfall where fire is withdrawn and the additive eucalypt basal area in these circumstances may be a lag effect.
- Without fire, potential for alteration of savanna tree – grass interaction by accession of rainforest 'normal' trees that exclude grasses and ultimately savanna trees.
- Fire and rainfall together (amplifying feedbacks) influence savanna tree-grass interaction.
- To maintain tree diversity – infrequent (<0.2 fires y^{-1}), early dry season fires, and patch-mosaic fire regimes to maintain non-eucalypt species pool.

