

Local vs. landscape effects of bush encroachment on the herbaceous layer

A landscape photograph showing a road curving through a savanna area with scattered trees and a dirt path. In the background, there are hills and a small town. A road sign is visible on the right side of the road.

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Bush encroachment – widespread and of concern:

- Reduced herbaceous production
- Irreversible switch from savanna to thicket / forest





NB to understand how trees affect the herbaceous layer:

- Net outcome of different processes
- Effect of tree density – more than the sum of single trees?
- Feedbacks on fire spread and grazers

This study:

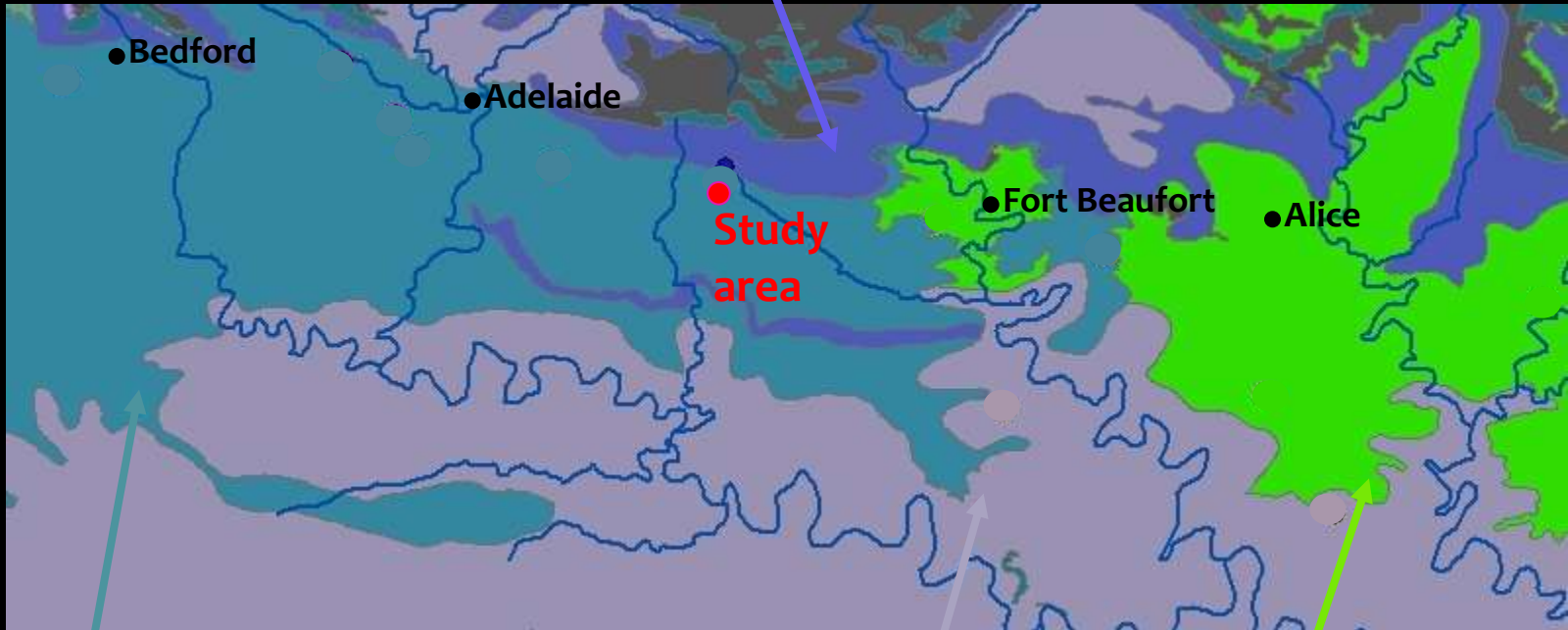
Sub-canopy vs. inter-canopy at different stand-wide tree density:

- Light availability
- Basal cover and composition of herbaceous layer

Do the effects of trees at low density (~ 20 % cover) scale up predictably when tree cover increases?

Study Area

East Cape Escarpment Thicket



Bedford Dry Grassland

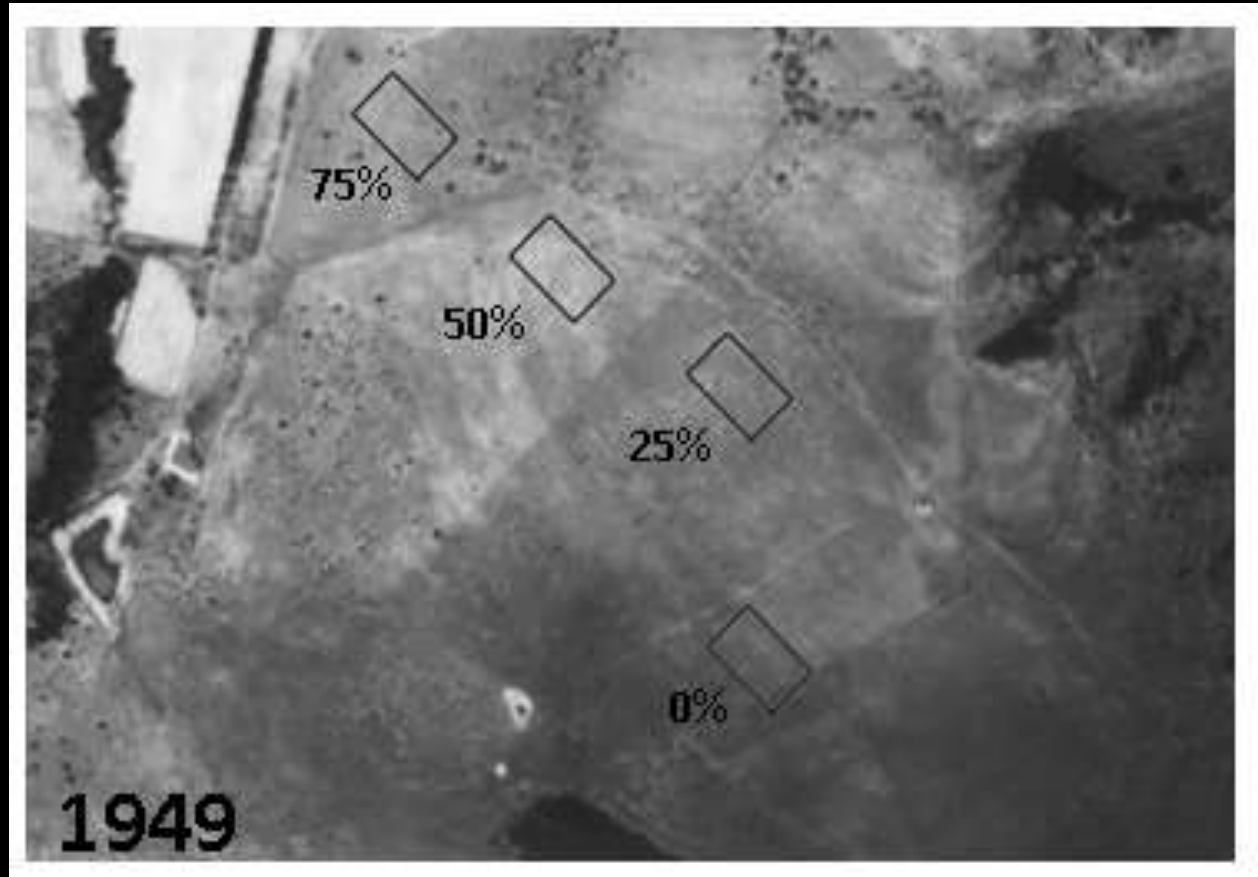
Great Fish Thicket

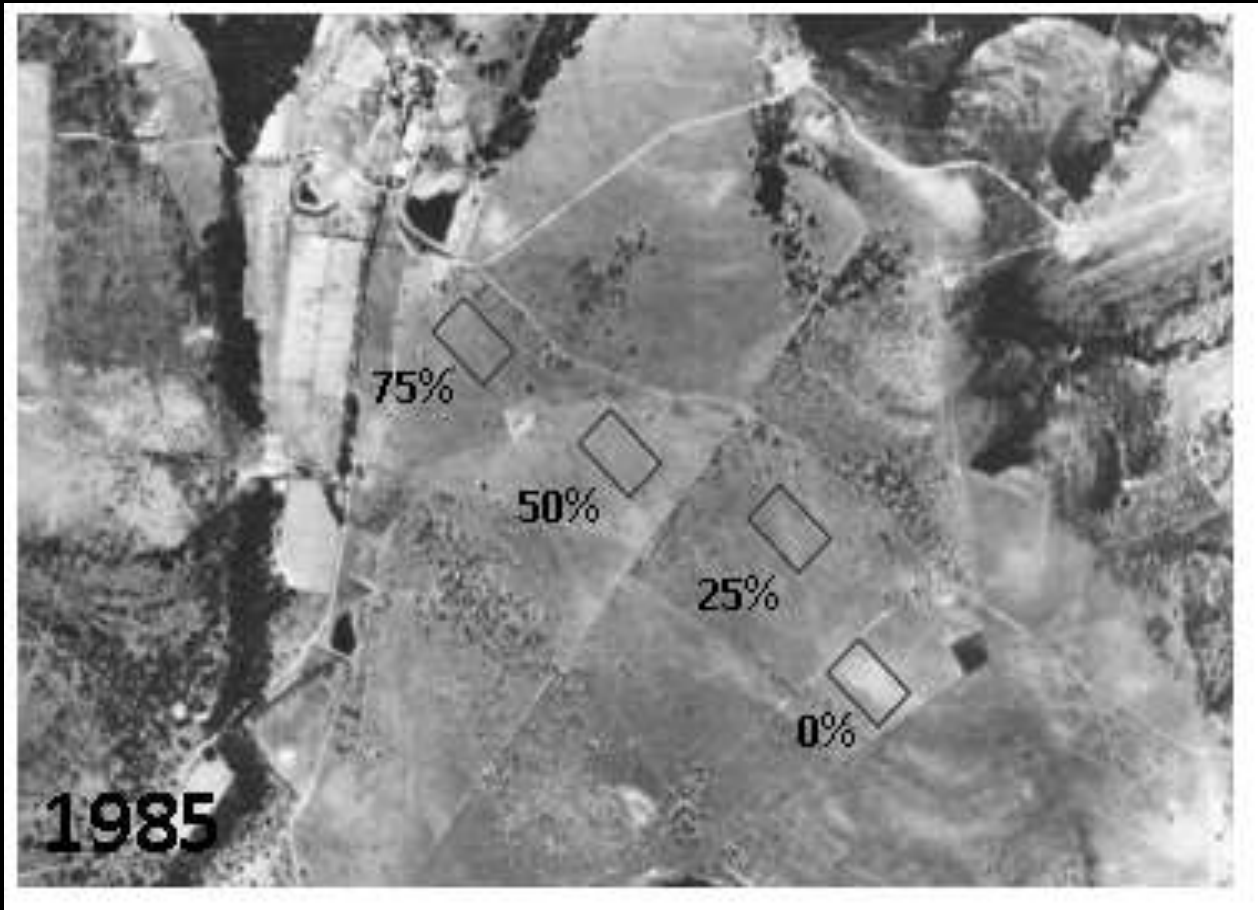
Bisho Thornveld

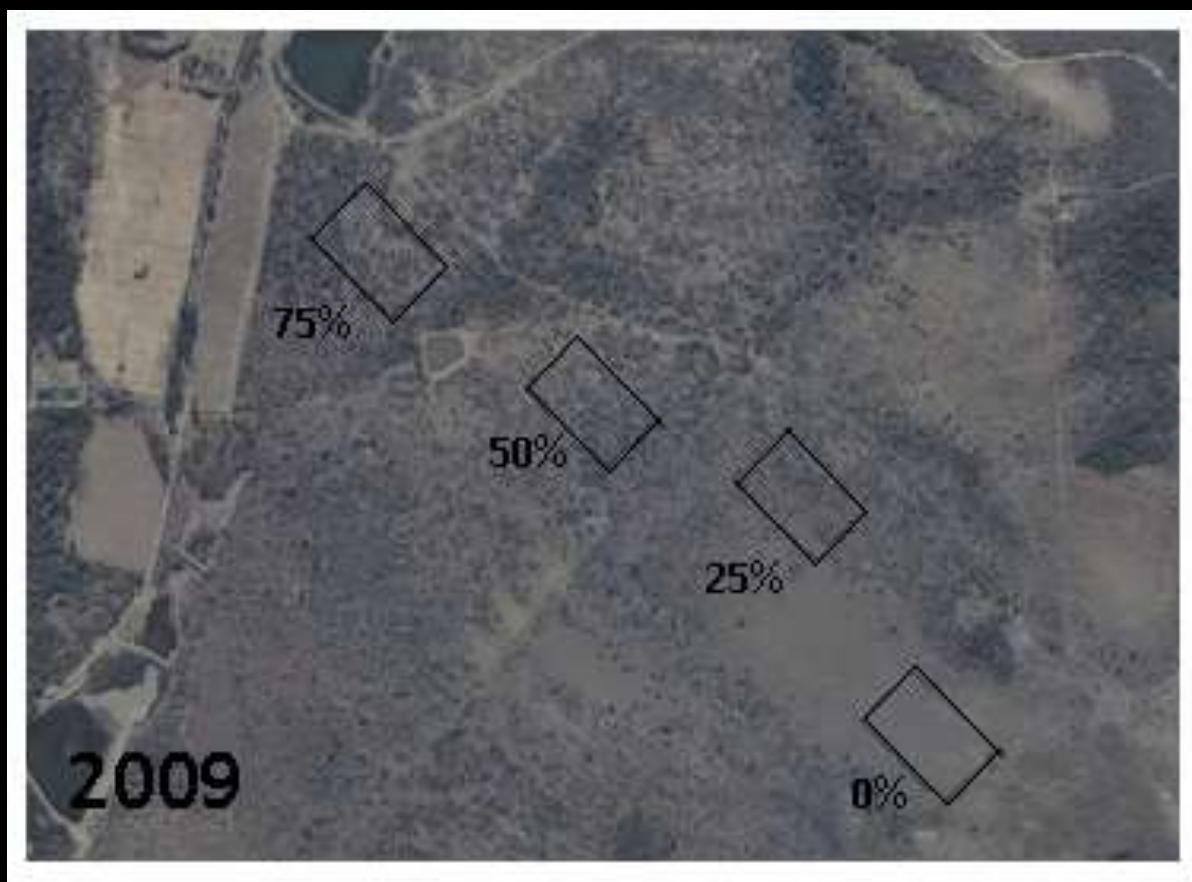
Sampling sites:

1949: < 5 % tree cover

2009: 0 %, 25 %, 50 % and 75 % tree canopy cover



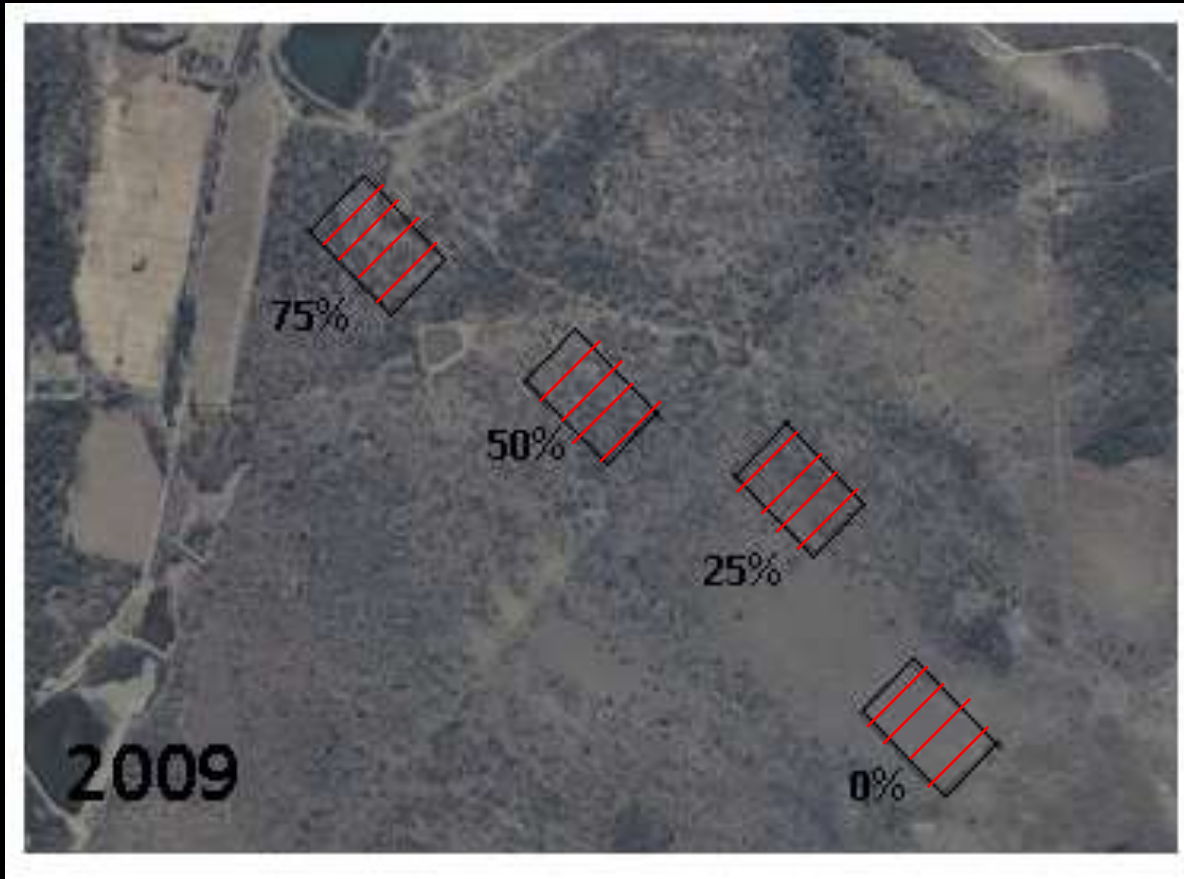




Sampling procedure

Four fixed 50-m transects per level of canopy cover.
Recorded the following at sampling points every metre:

- Sub- or intercanopy
- Light transmittance
- Herbaceous cover and composition



At paired sub- and intercanopy sites at each level of encroachment:

- Biomass production

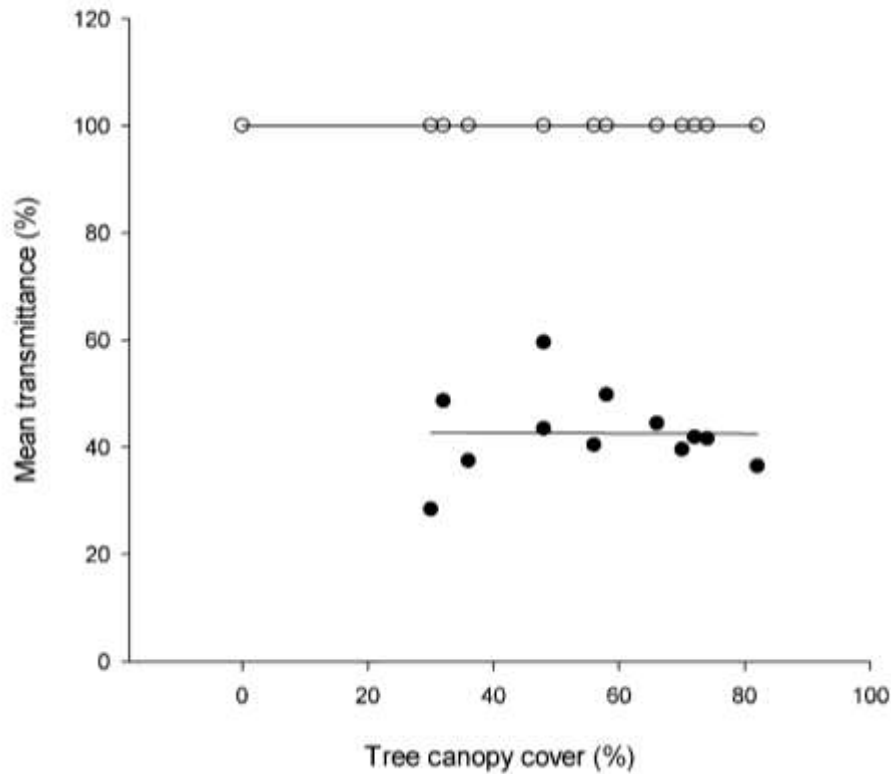
Light transmittance:

Subcanopy vs. intercanopy at different tree densities*

- sub-canopy
- inter-canopy

Ceptometer

(c) Sub-canopy: $R^2 = 0.00093$ (n.s)



* Each data point = mean values for one transect

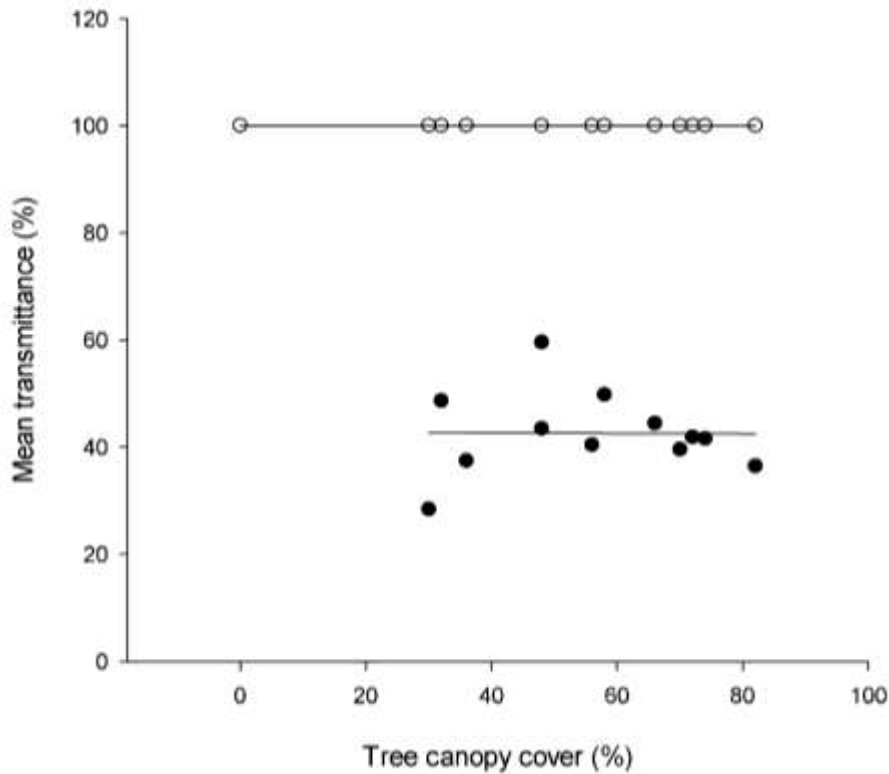
Light transmittance:

Subcanopy vs. intercanopy at different tree densities*

- sub-canopy
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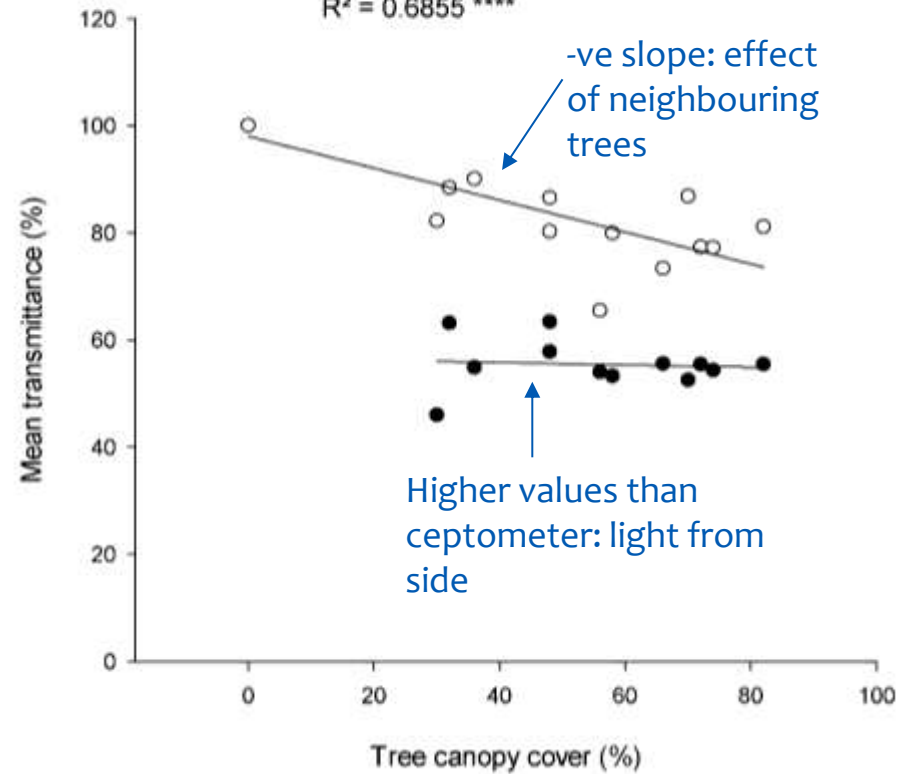
Ceptometer

(c) Sub-canopy: $R^2 = 0.00093$ (n.s)



Hemispherical camera

Sub-canopy: $R^2 = 0.0071$ (n.s)
Inter-canopy: $y = -0.2979x + 98.022$
 $R^2 = 0.6855$ ****



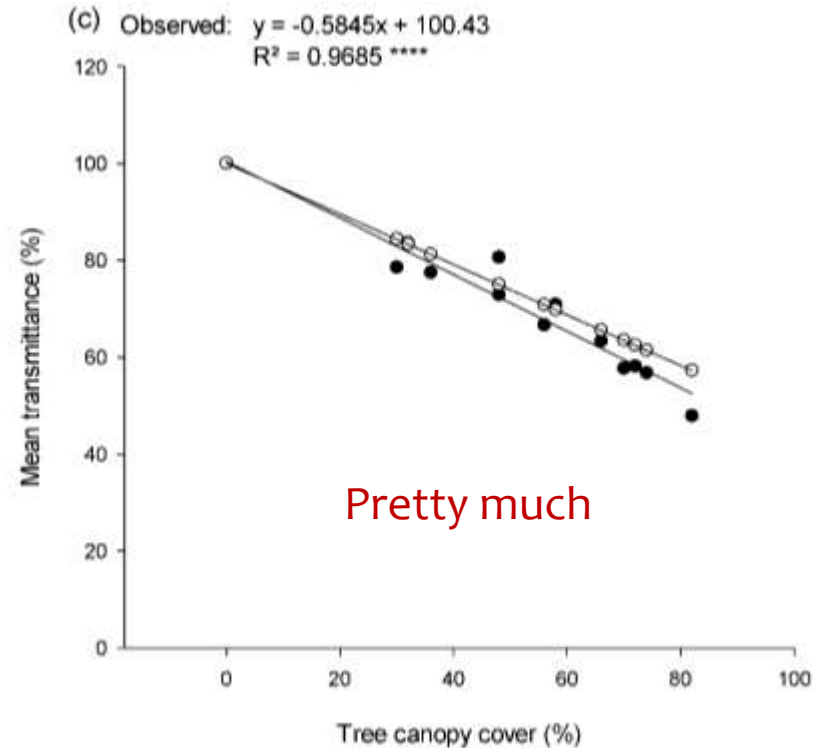
* Each data point = mean values for one transect

Does single tree effect scale up to stand level?

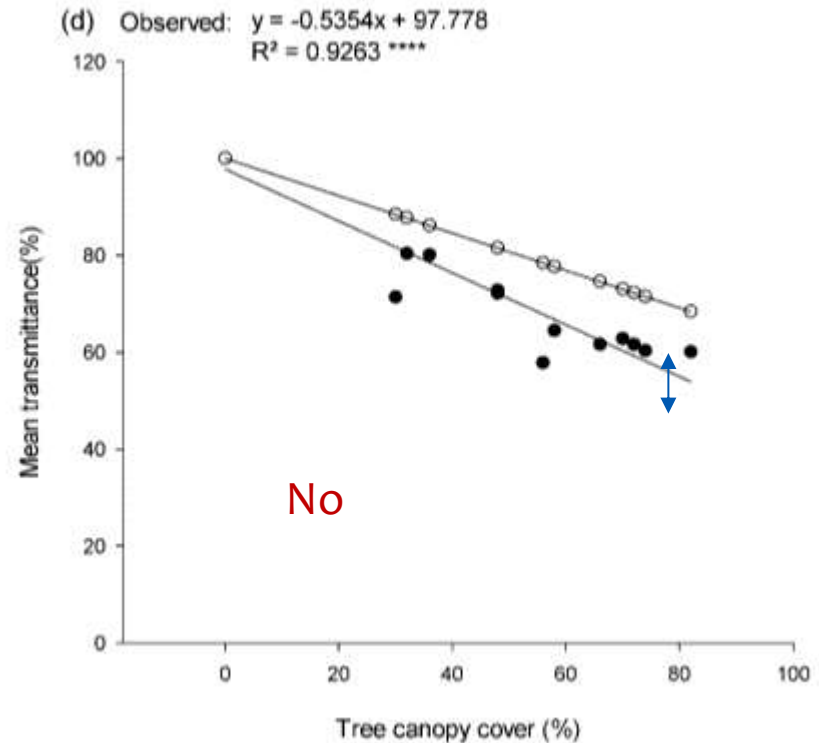
Depends on how transmittance is measured!

● observed
○ expected

Ceptometer



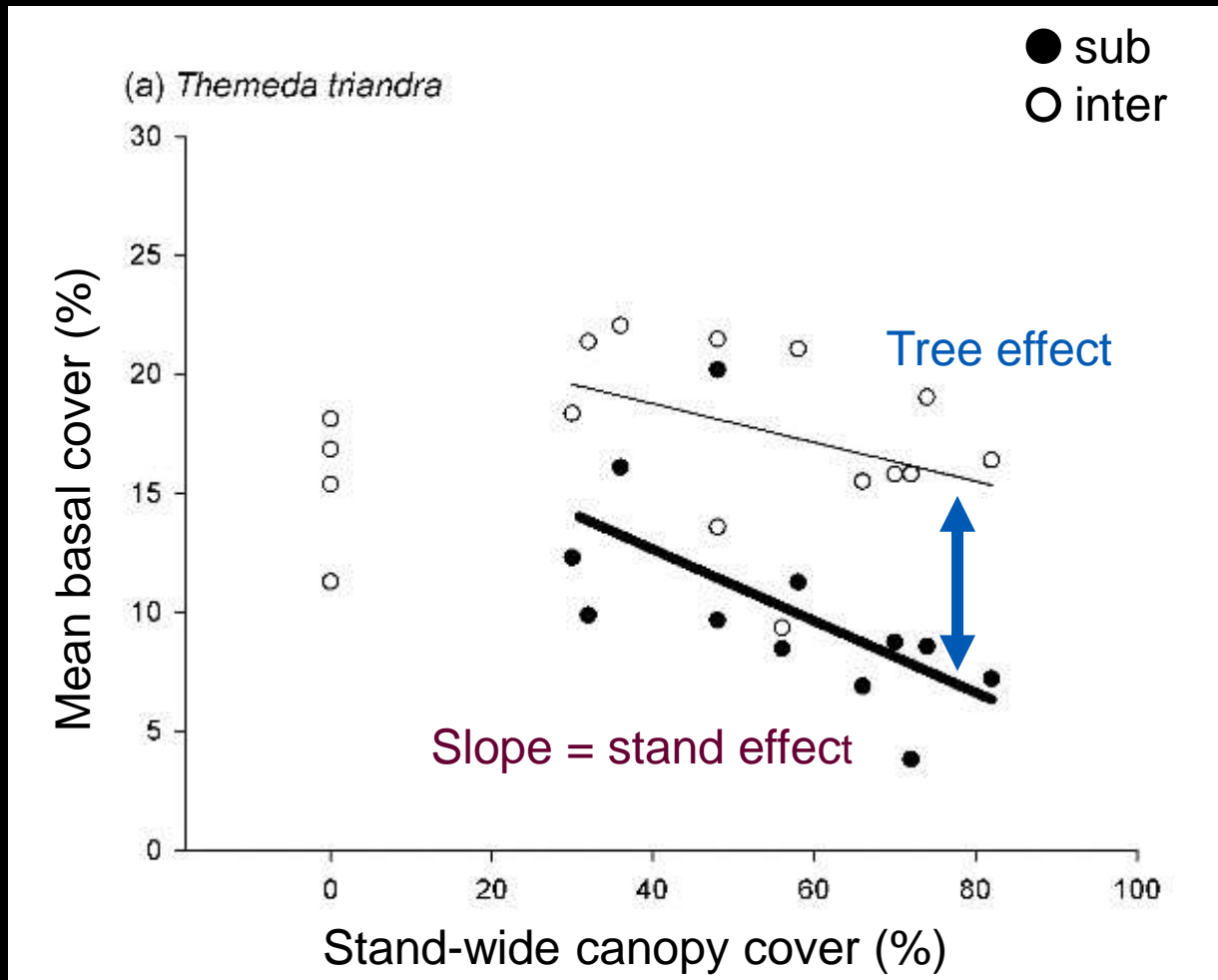
Hemispherical camera



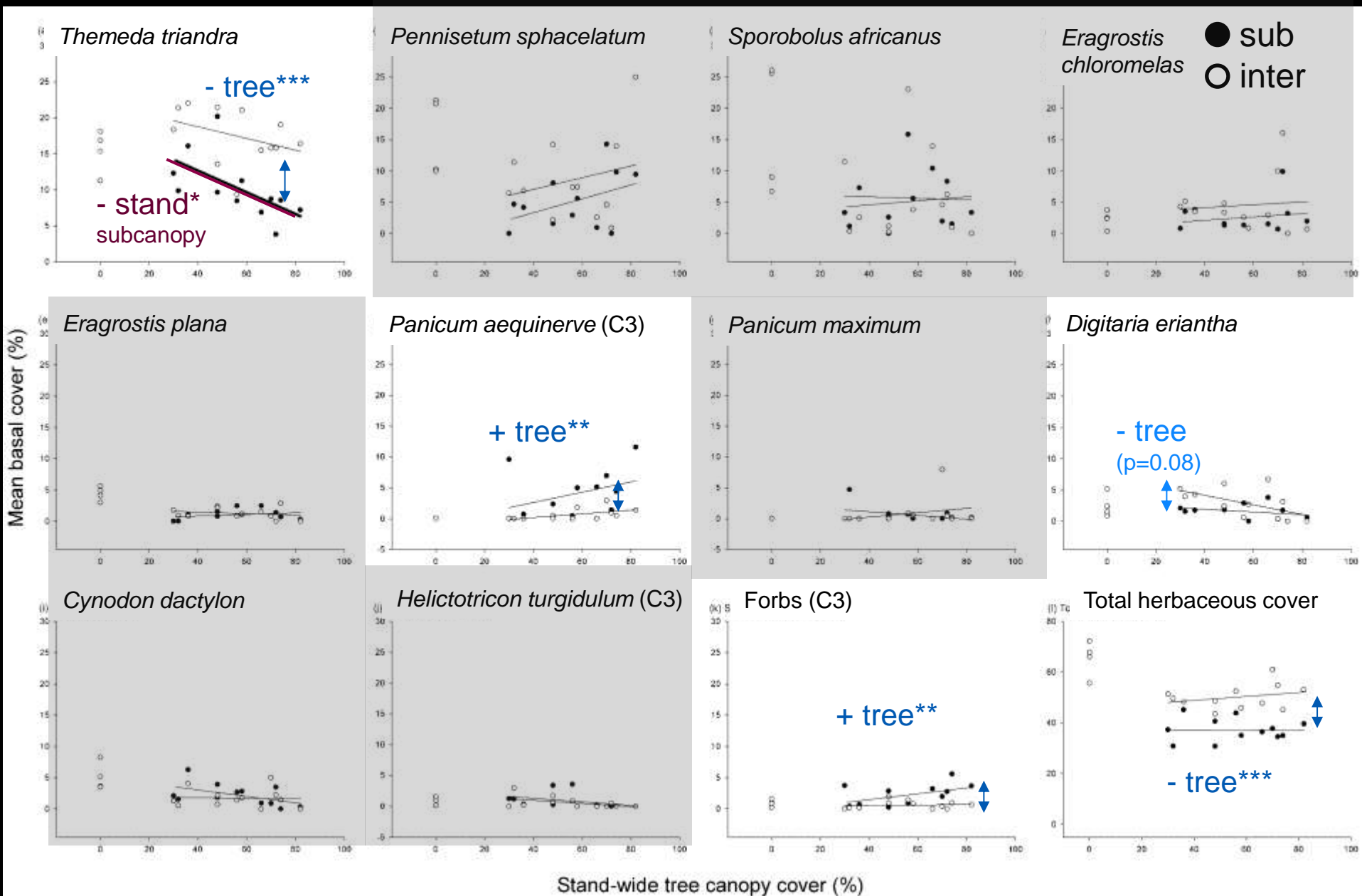
Expected: Calculated from sub- and inter-canopy values at lowest tree density and % of transect falling within sub- and inter-canopy

Observed: Mean transmittance (all 50 transect points)

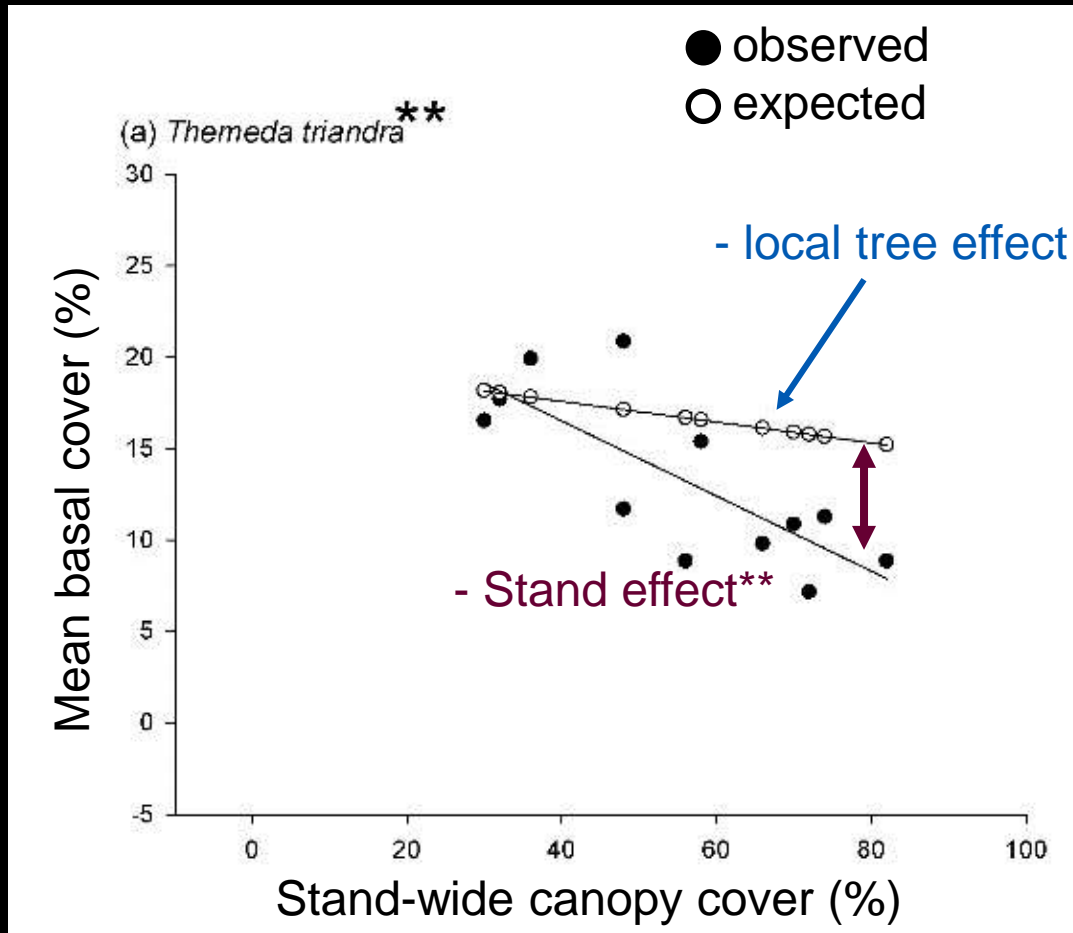
Basal cover and composition: local tree and stand density effects



Basal cover and composition: local tree and stand density effects



Does local tree effect scale up as predicted from local tree effect?

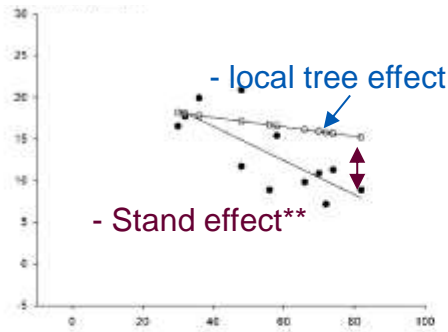


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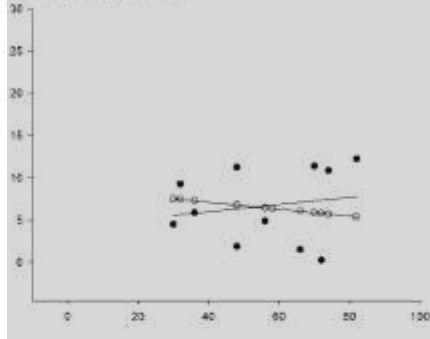
Observed: Mean basal cover (all 50 transect points)

Does local tree effect scale up as predicted from local tree effect?

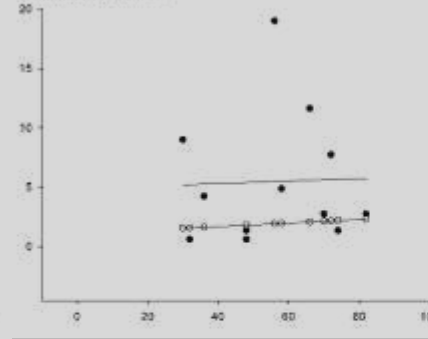
Themeda triandra



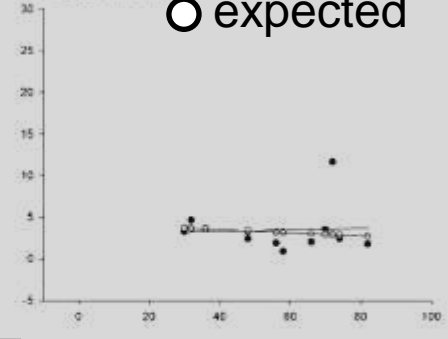
(b) *Pennisetum subcapitatum*



(c) *Sporobolus africanus*

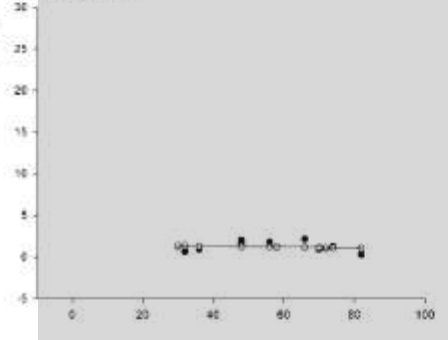


(d) *Eragrostis chlorimelas*

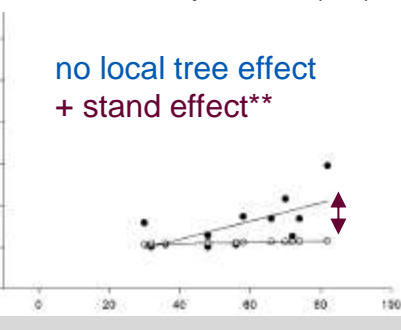


● observed
○ expected

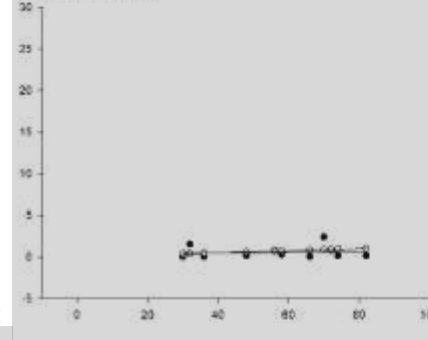
(e) *Eragrostis plana*



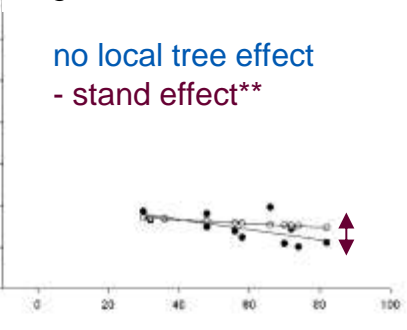
(f) *Panicum aequinerve* (C3)



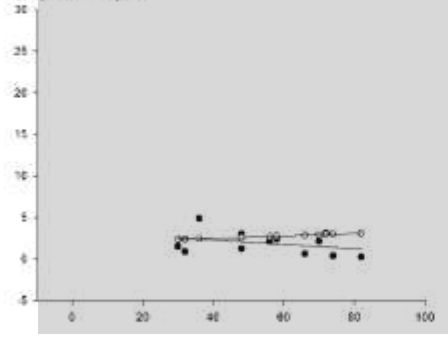
(g) *Panicum maximum*



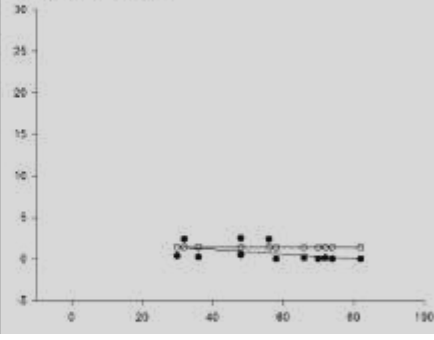
(h) *Digitaria eriantha*



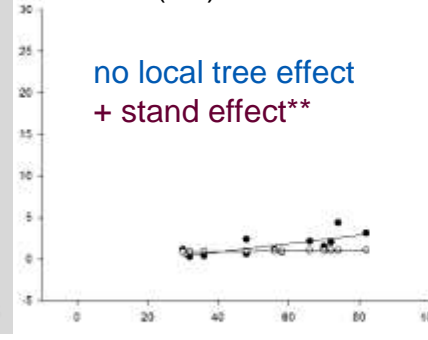
(i) *Cynodon dactylon*



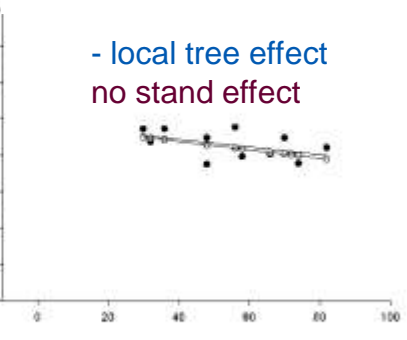
(j) *Helictotrichon furgidulum*



(k) Forbs (C3)



(l) Total herbaceous cover

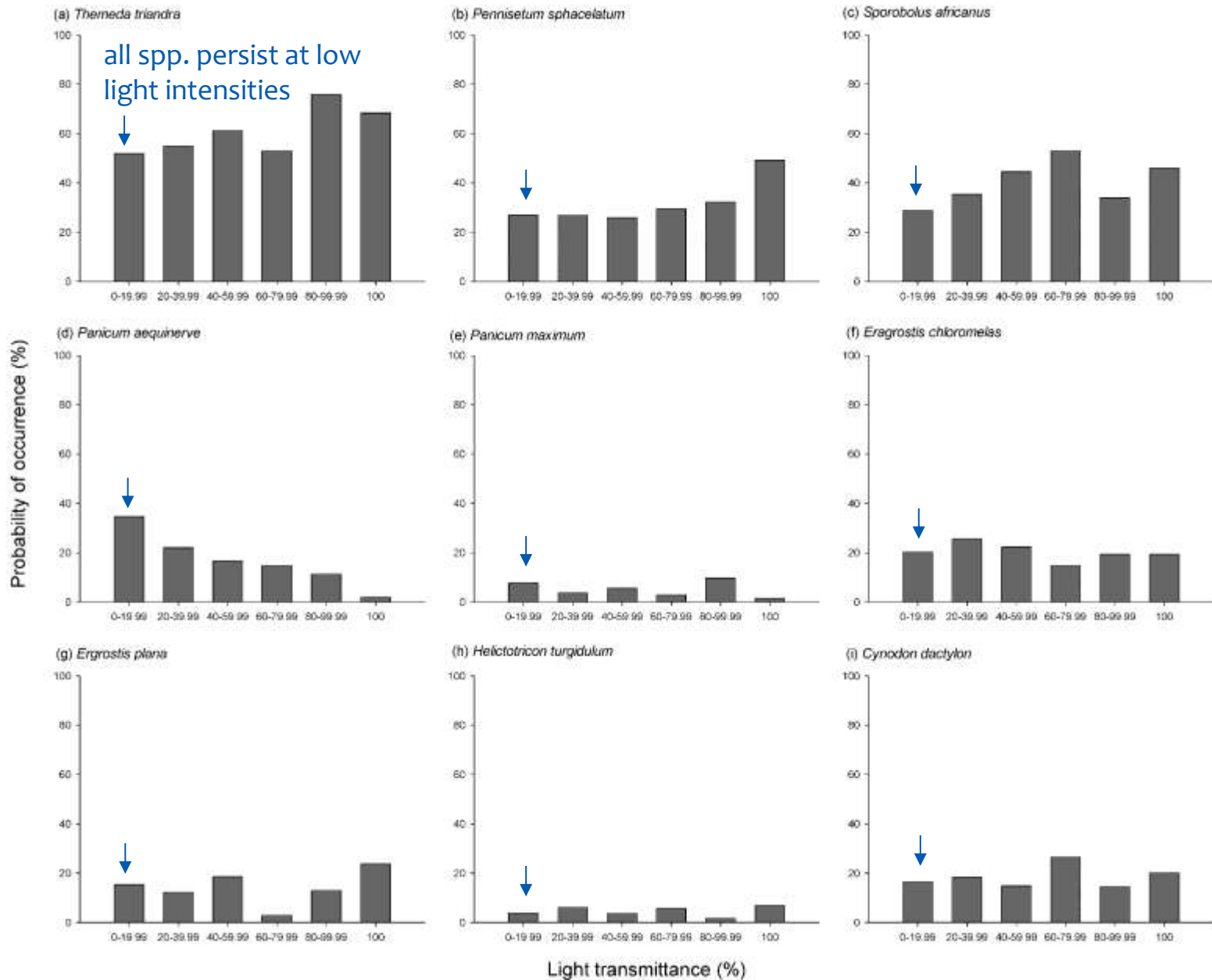


Stand-wide tree canopy cover (%)

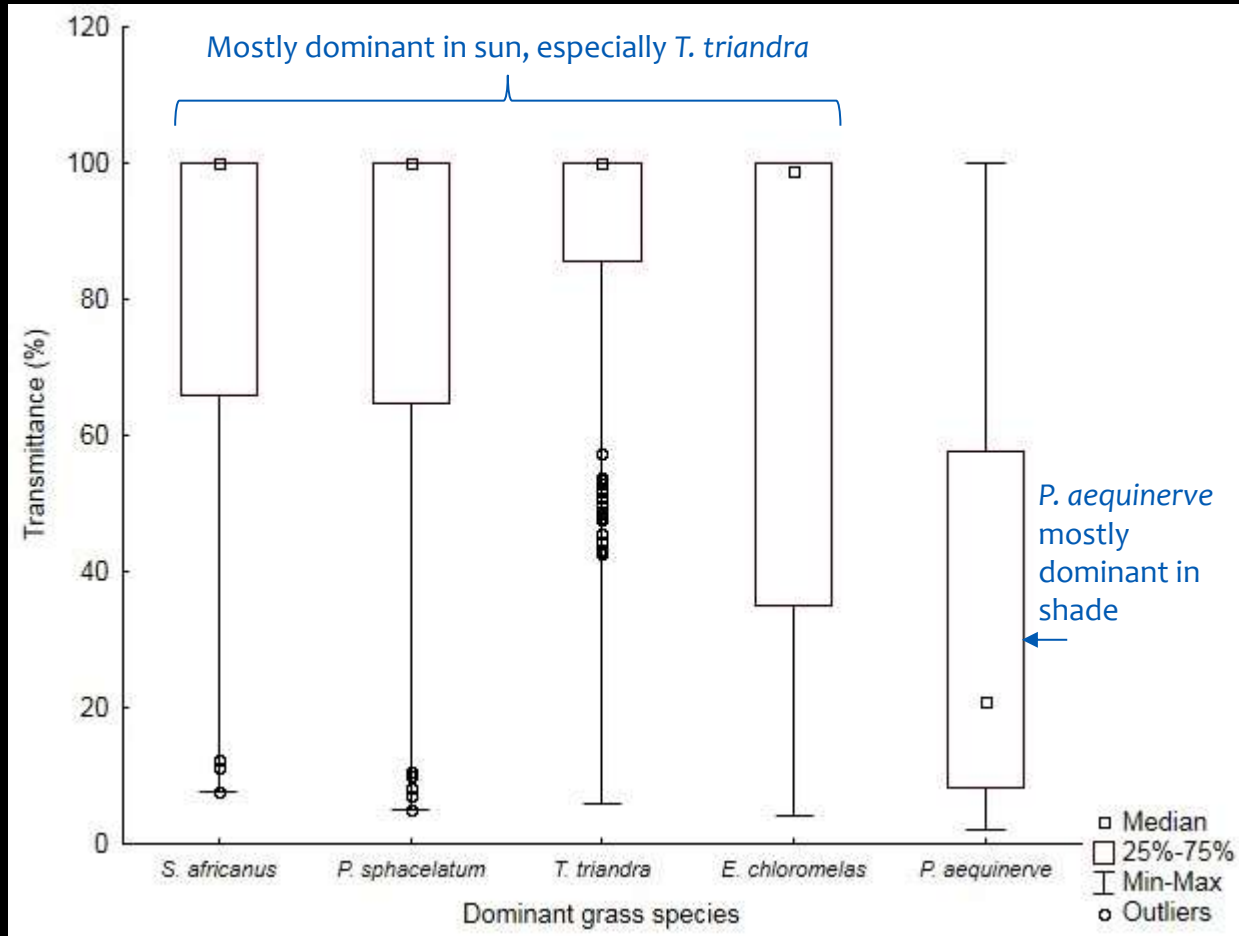
Expected: Calculated from sub- and inter-canopy values at lowest tree density and % of transect falling within sub- and inter-canopy

Observed: Mean basal cover (all 50 transect points)

Probability of occurrence at different % transmittance



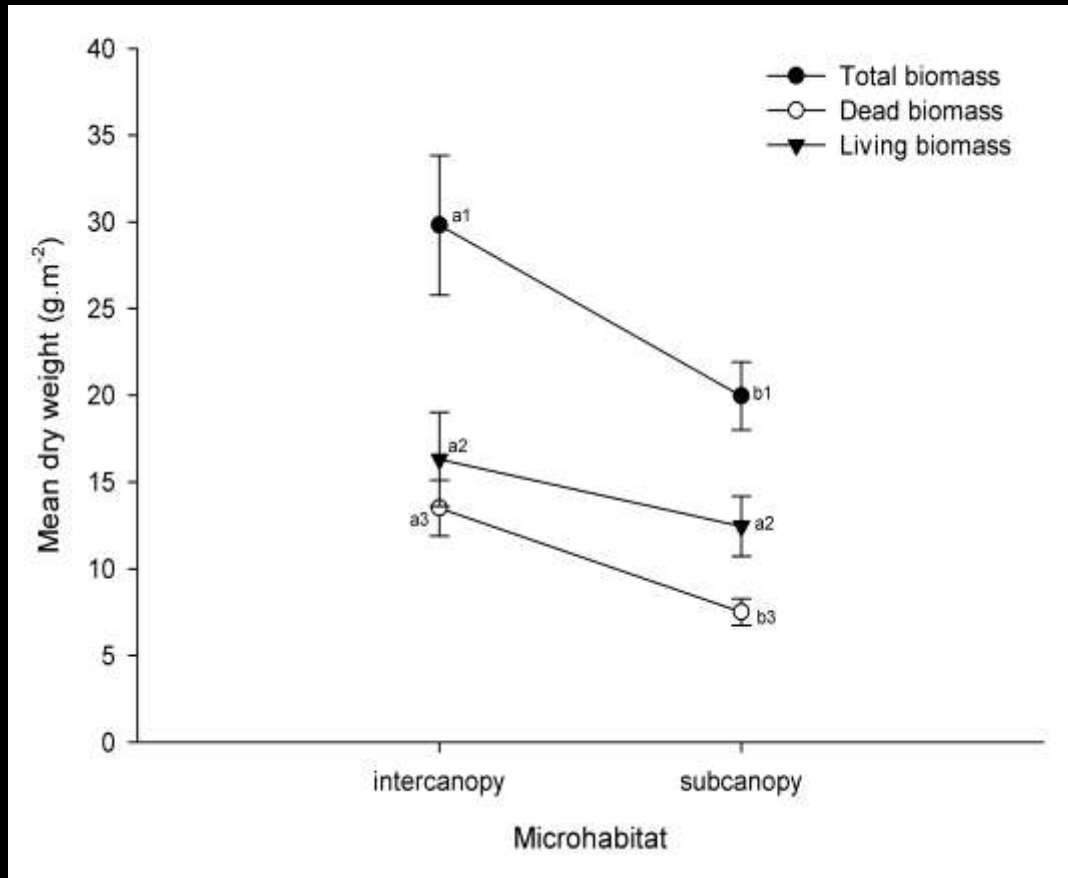
But... at what light transmittance are different grass spp dominant*?



* Dominant = most abundant sp. at transect point

Biomass production:

Higher in the inter-canopy.



Conclusions

Light transmittance is lower under canopies but the effect does not scale up linearly (effect of neighbouring trees).

At the study site, even sun-loving grass spp. persist in the shade, but at reduced abundance – notably *T. triandra*.

Overall effect is reduced basal cover and biomass production at high tree cover.

All this at conservative stocking rates – effect at higher SR?

Consequences for fire spread and herbivory?



Soil moisture

Recorded the day after three rainfall events – effect of interception:

15 mm – subcanopy < intercanopy

22 mm, 27 mm: no difference

Effect only below ~ 20 mm of rain

Soil moisture

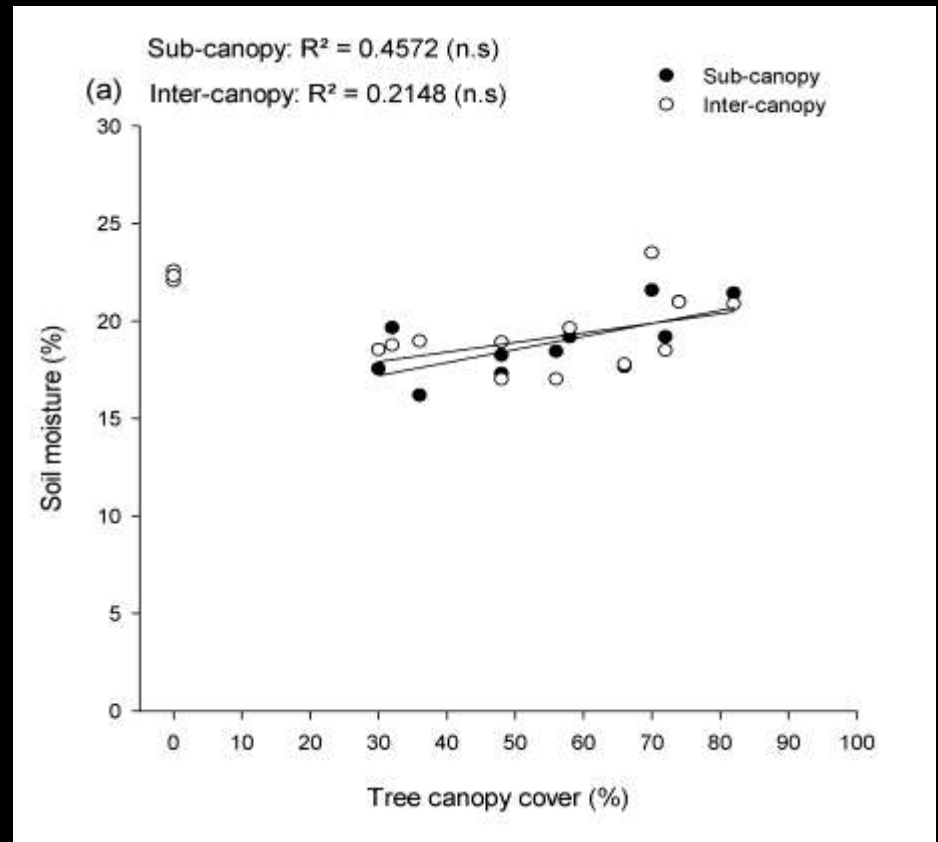
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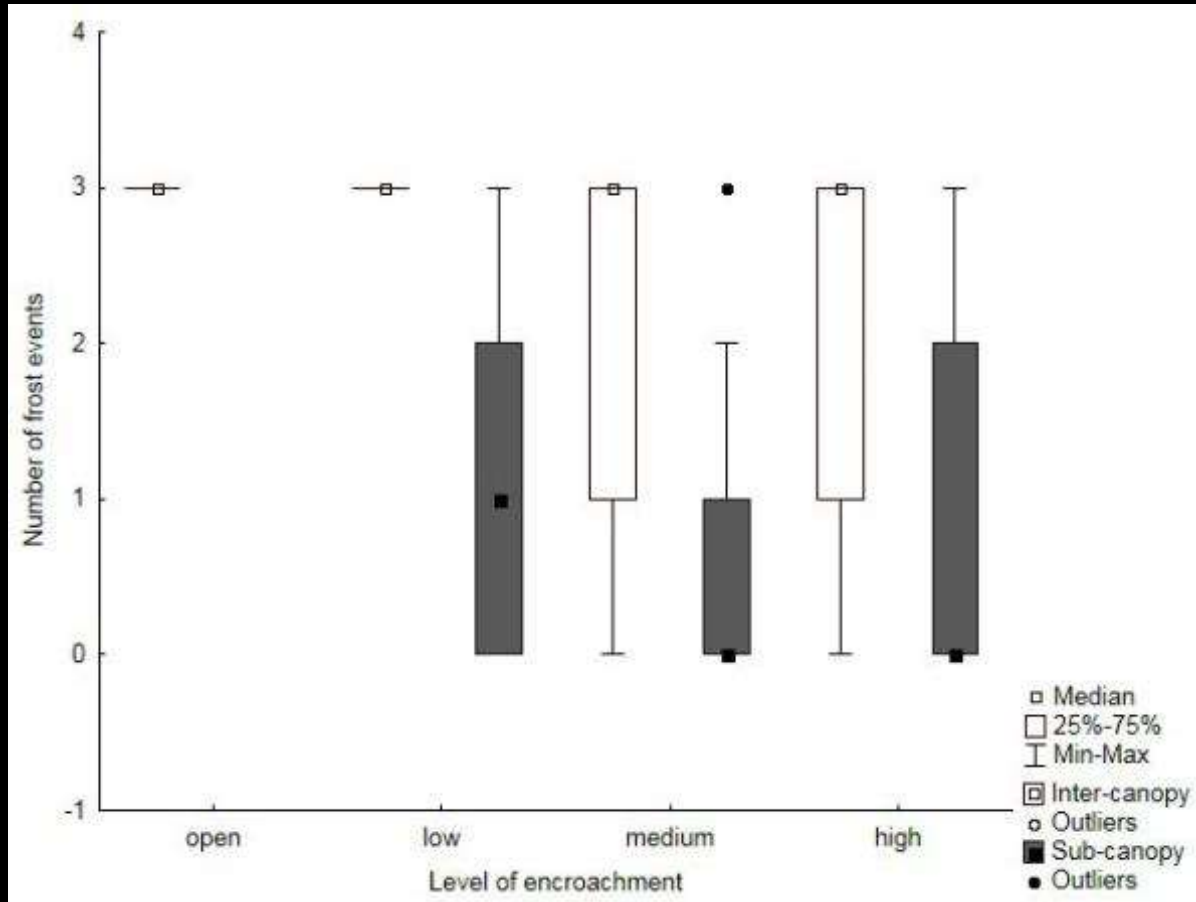
Effect only below ~ 20 mm of rain

No effect of tree density



Data points: means of transect points after 22 mm of rain

Frost occurrence



Number of times (out of 3 frost events) frost was recorded at each transect point.