



**The effects of fire on woody plant encroachment are exacerbated by succession of trees of decreased palatability**

**Gordijn P.J., Rice E., & Ward D.**

The ingression of woody plants into savannas and grasslands has become a global concern!

(Scholes & Archer, 1997; Britz & Ward, 2007).

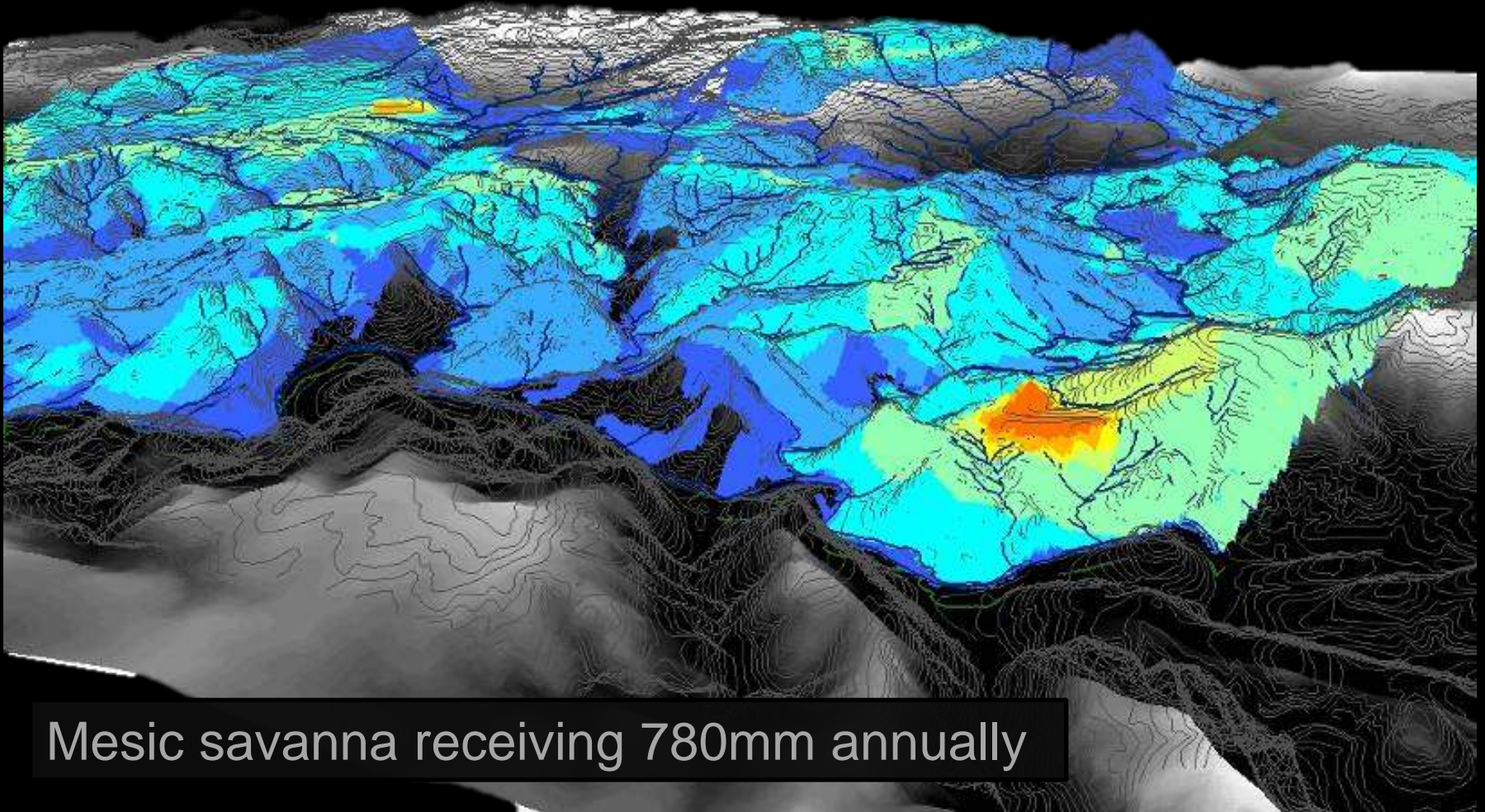


The increase of woody plants has been primarily attributed to heavy **grazing**, but more recently to the increase of atmospheric **CO<sub>2</sub>** (Bond & Midgley, 2000; Ward 2004; Wigley et al. 2010).



# Fire in Ithala Game Reserve (IGR)

Fire frequency map



# Methods

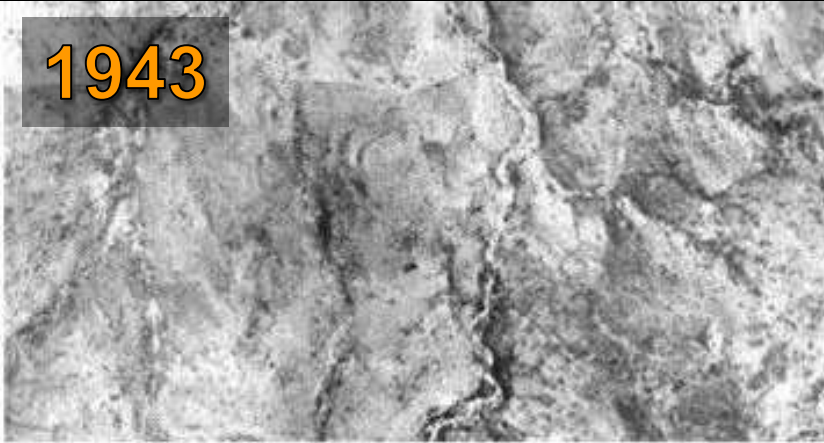


- We used long-term observations collected over 30 years to assess changes in woody vegetation in Ithala Game Reserve (IGR), South Africa.
- Textural analysis of aerial photographs was used to detect changes in woody vegetation, from 1943 to 2007 in IGR.
- Sampled woody veg in areas with different fire frequencies.
- Daily rainfall data from 1905 to 2009 were used in a time-series analysis to determine if rainfall patterns have changed.

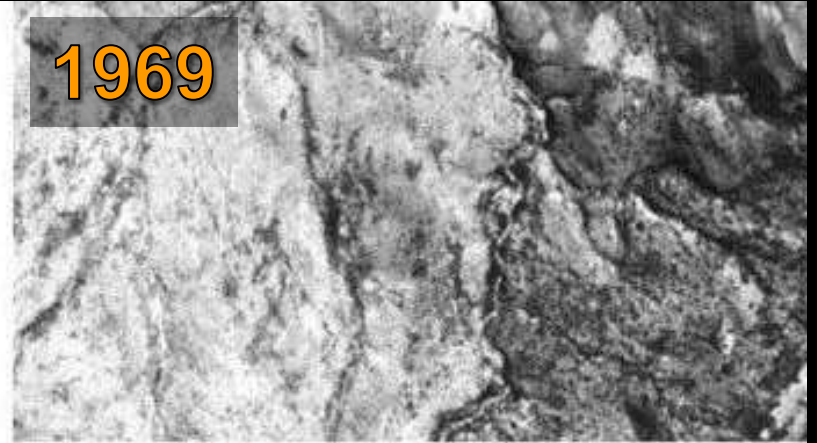


# Textural Analysis of historic aerial photographs

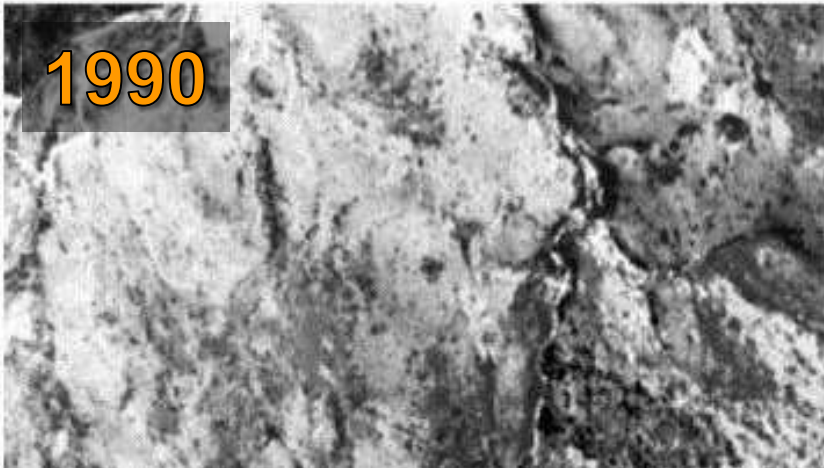
1943



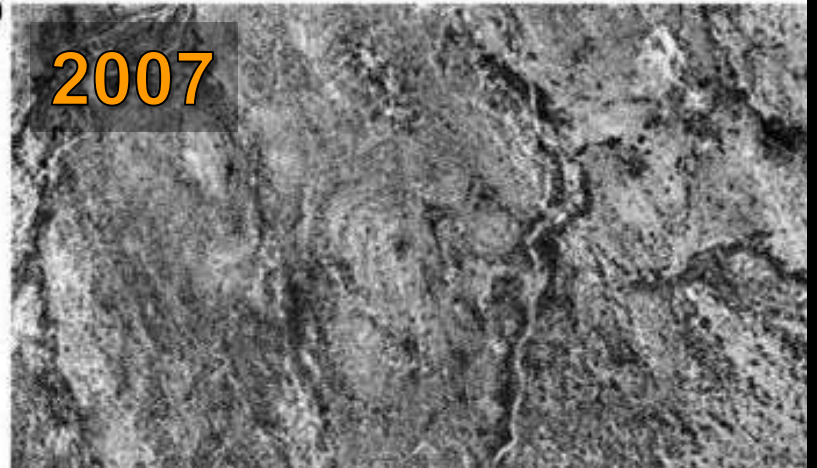
1969



1990



2007

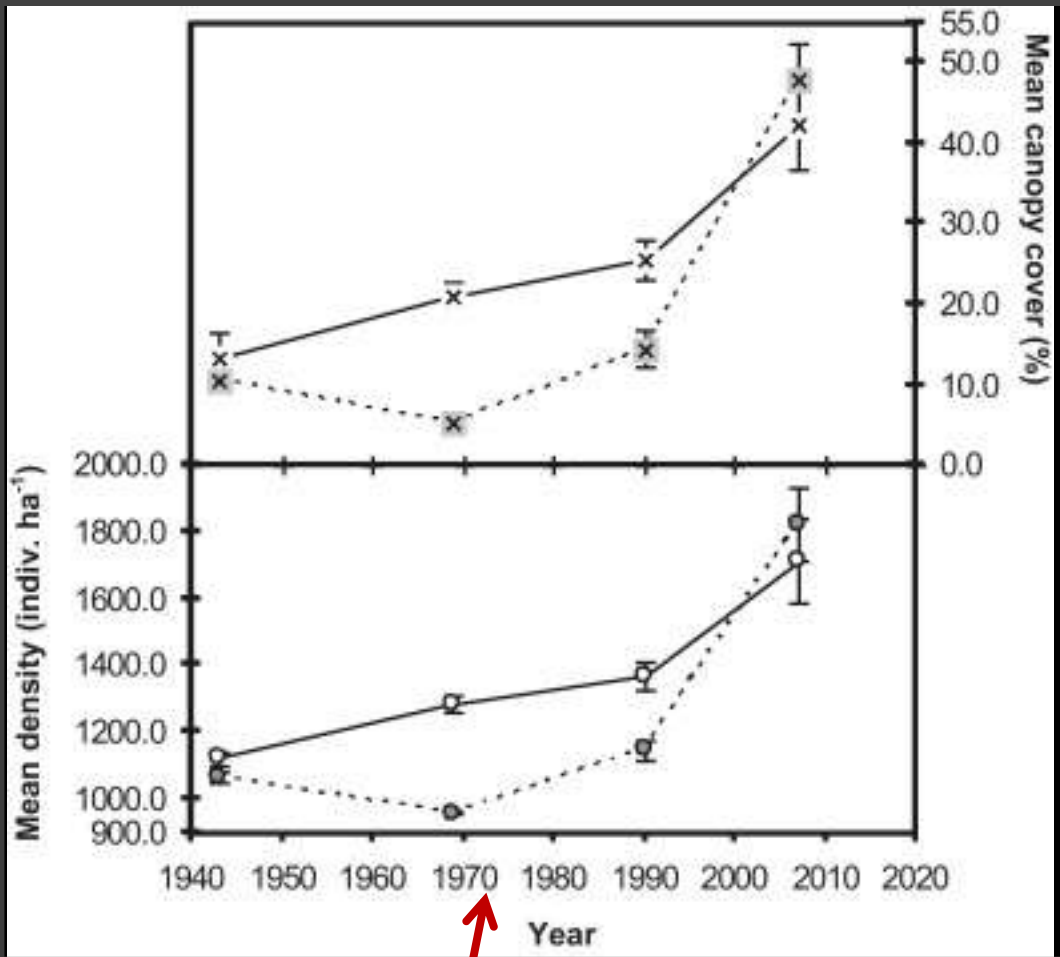


# Changes in tree density since 1943 (aerial photography)

Fire frequencies:

----- lines =  
from biennial to zero  
from 1985 to 2007.

———— = ~biennial.



Reserve declared in 1972

# Results (cont<sup>d</sup>)

- Tree cover and density increased significantly by 32.5% and 657.9 indiv ha<sup>-1</sup> respectively, over 64 years.
- Before the proclamation of IGR in 1972, increases in woody vegetation from 1943 were non-significant (determined by aerial photography).



# Zululand Tree Project

Fire

No Fire

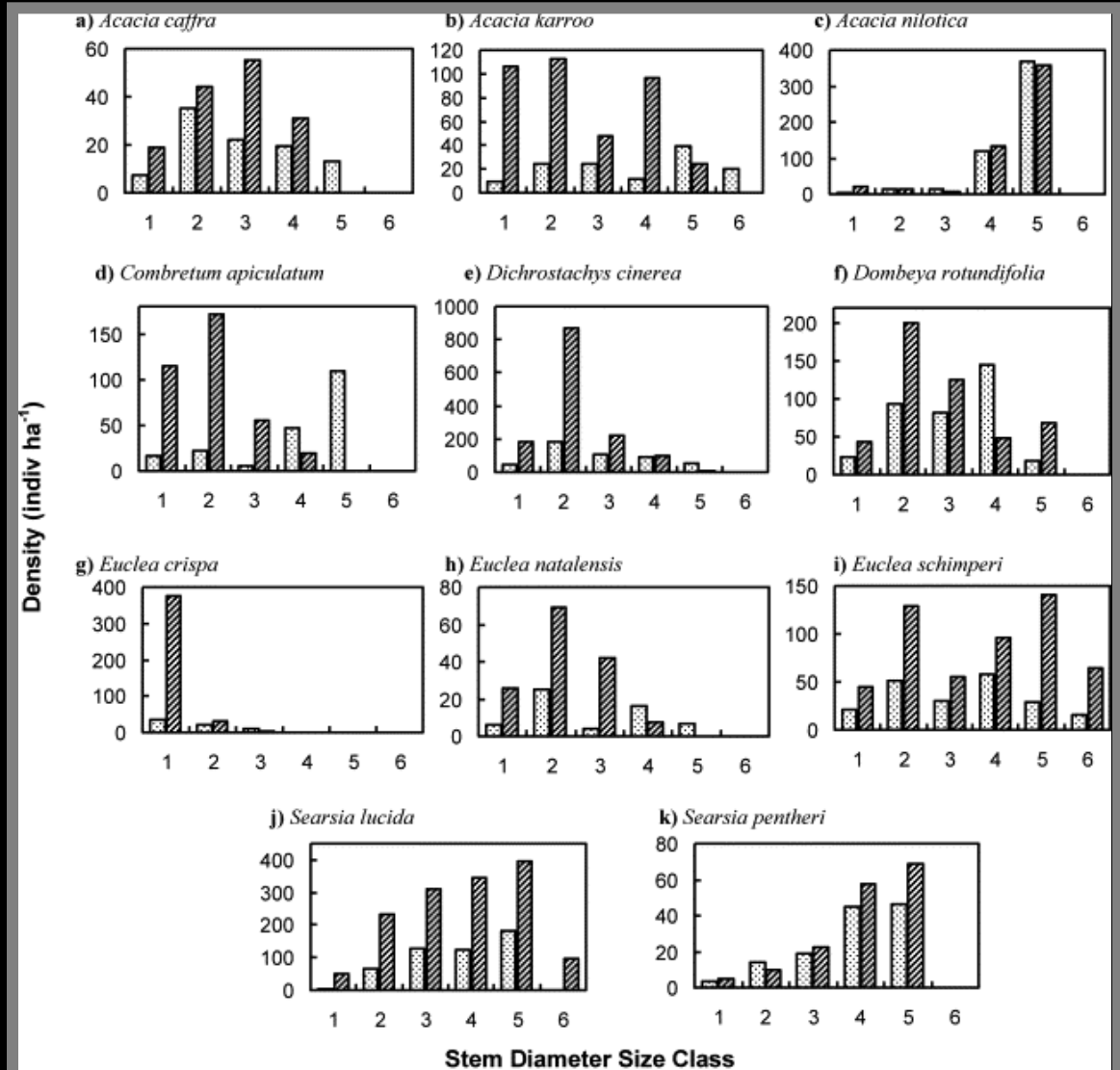




# Change in tree densities

2000 (light columns) → 2009 (dark columns)

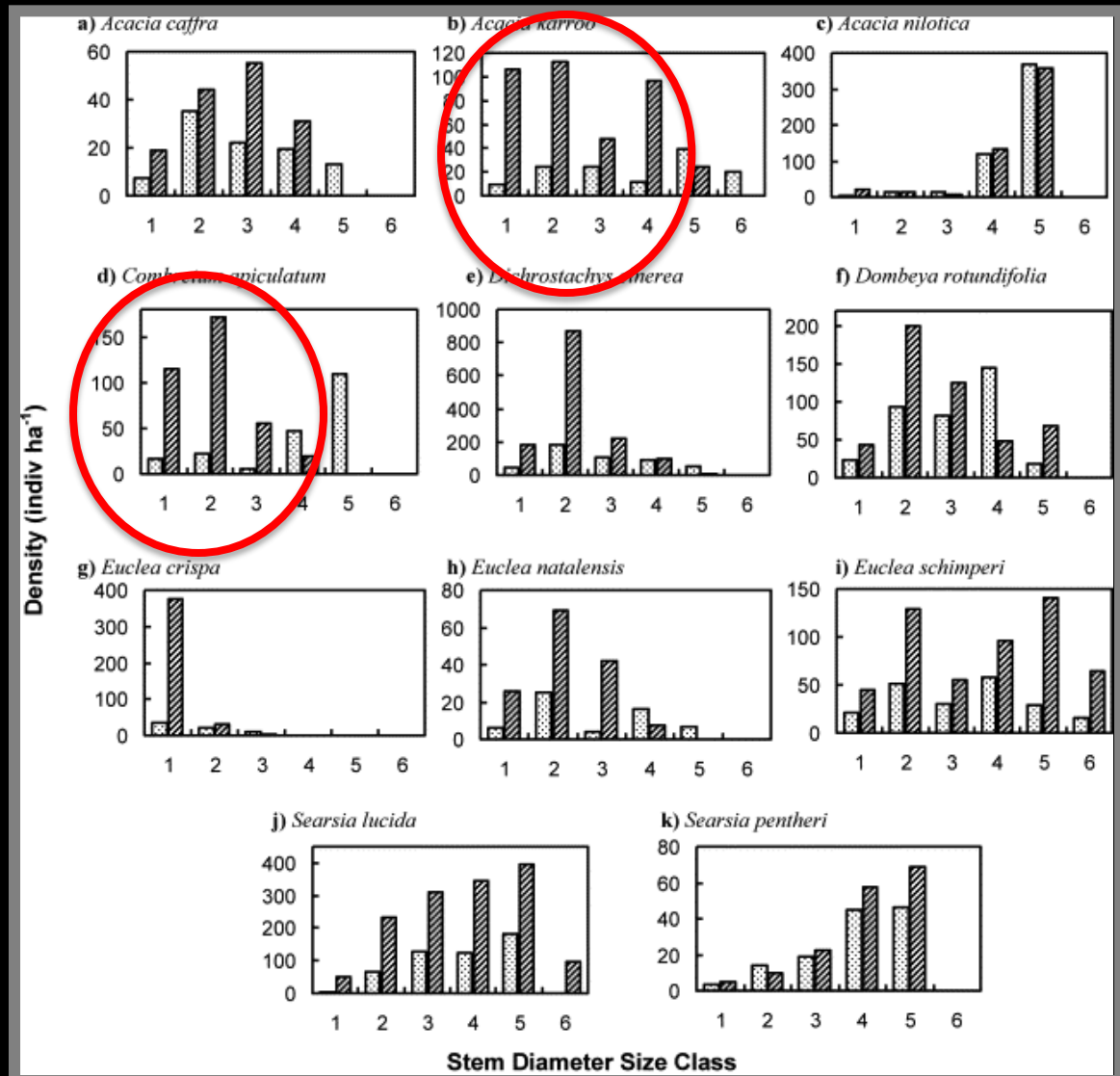
Some species increased in density due to **recruitment** while others **increased in size** or canopy cover



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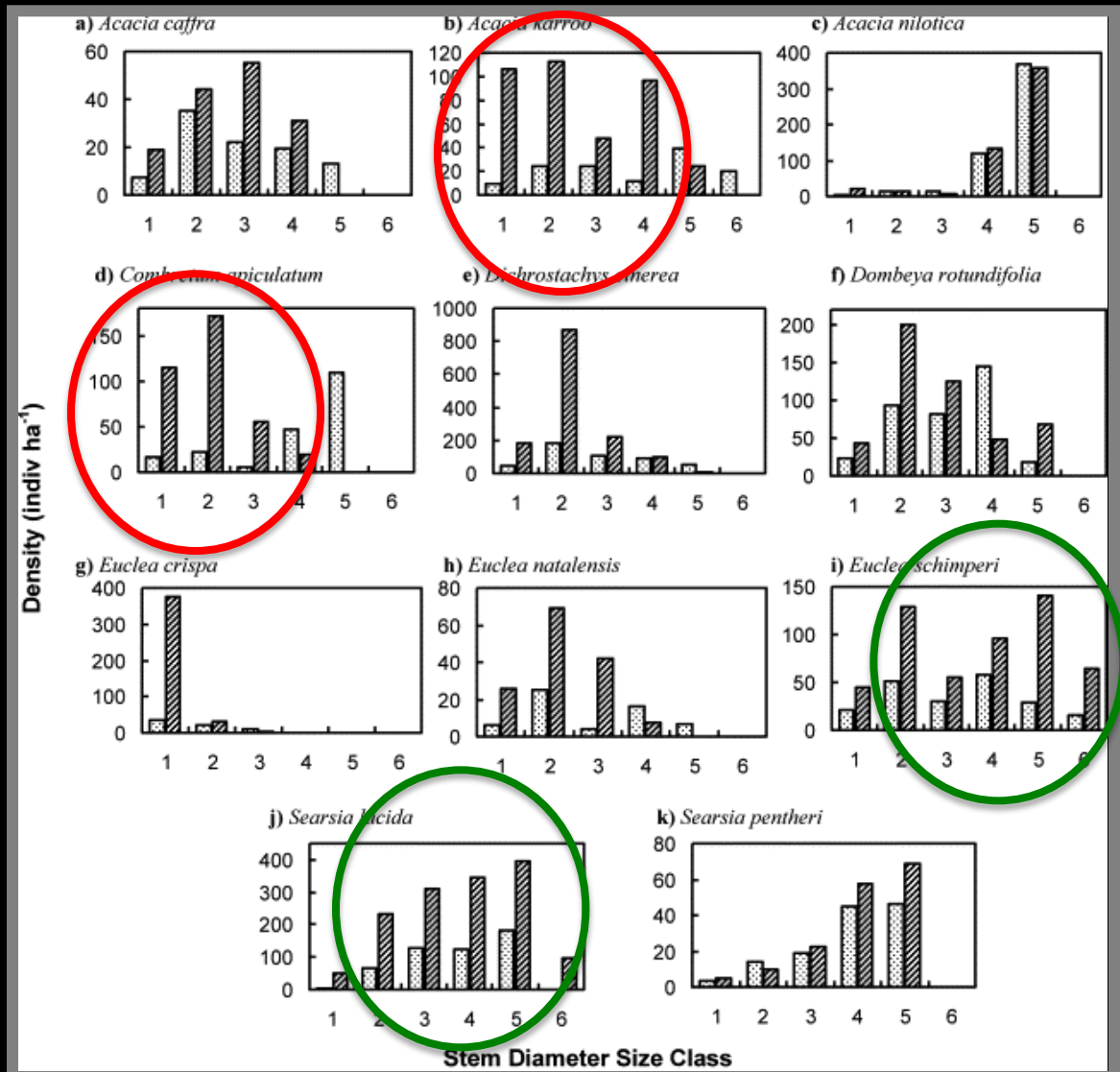
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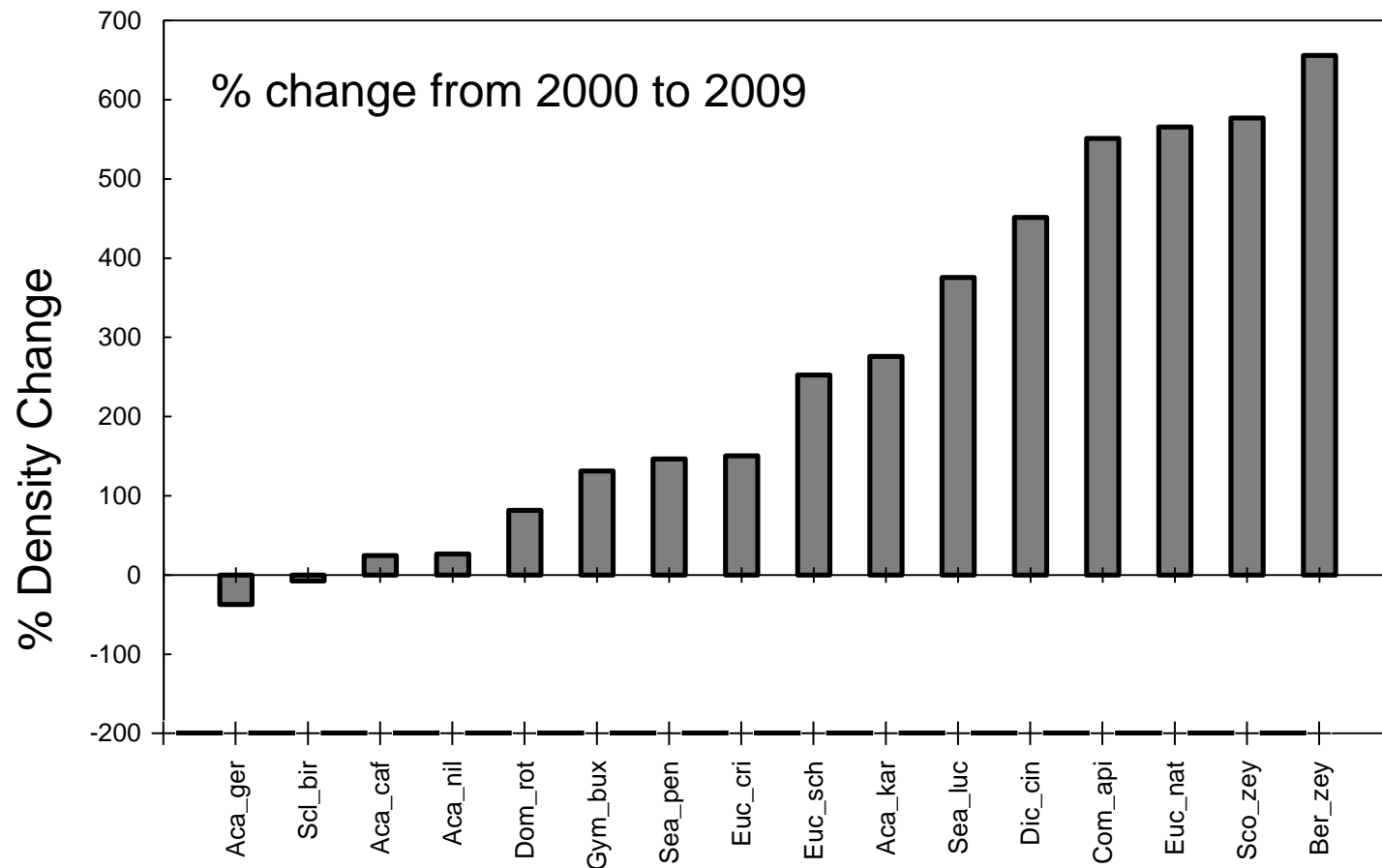
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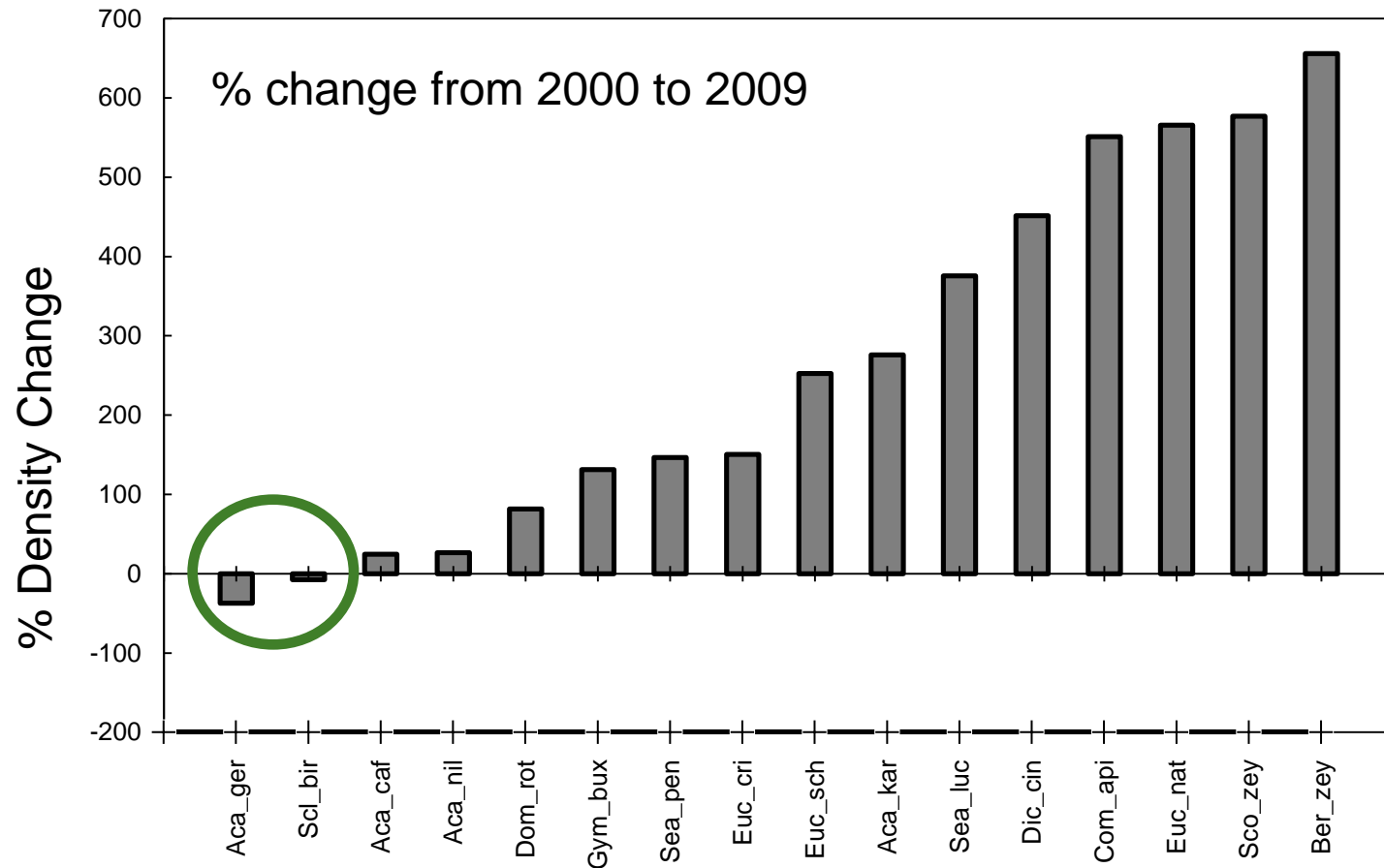
In the Nghubu loop area of Ithala G.R. there were large changes in densities of palatable (*mostly declined*) and unpalatable species (*increased*).



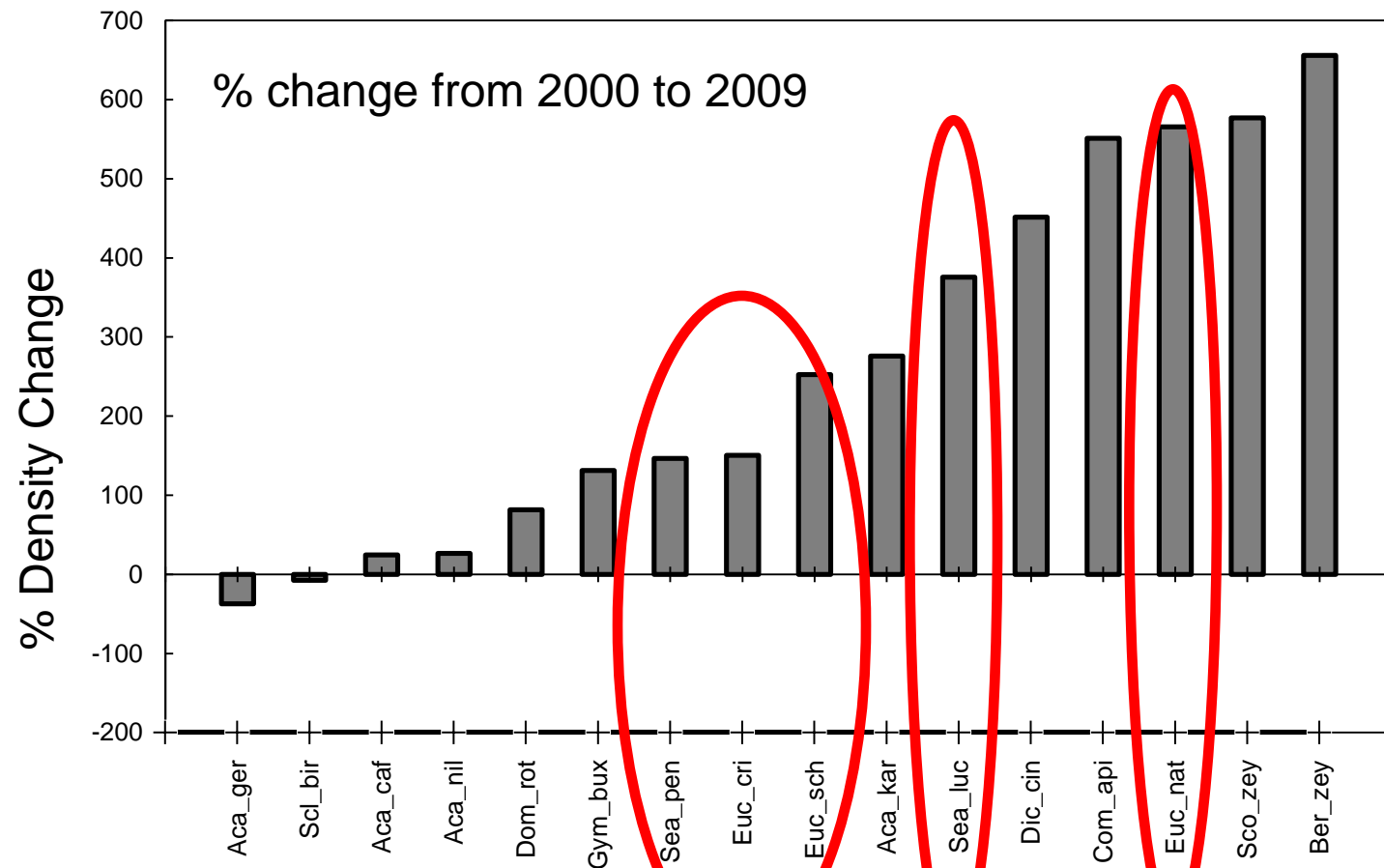
# Local extinction / decrease of some **palatable** species

e.g. *Acacia davyi*, *Aloe marlothii*

(Bond & Loffell, 2001; Wiseman *et al.* 2004; Photo-point monitoring)

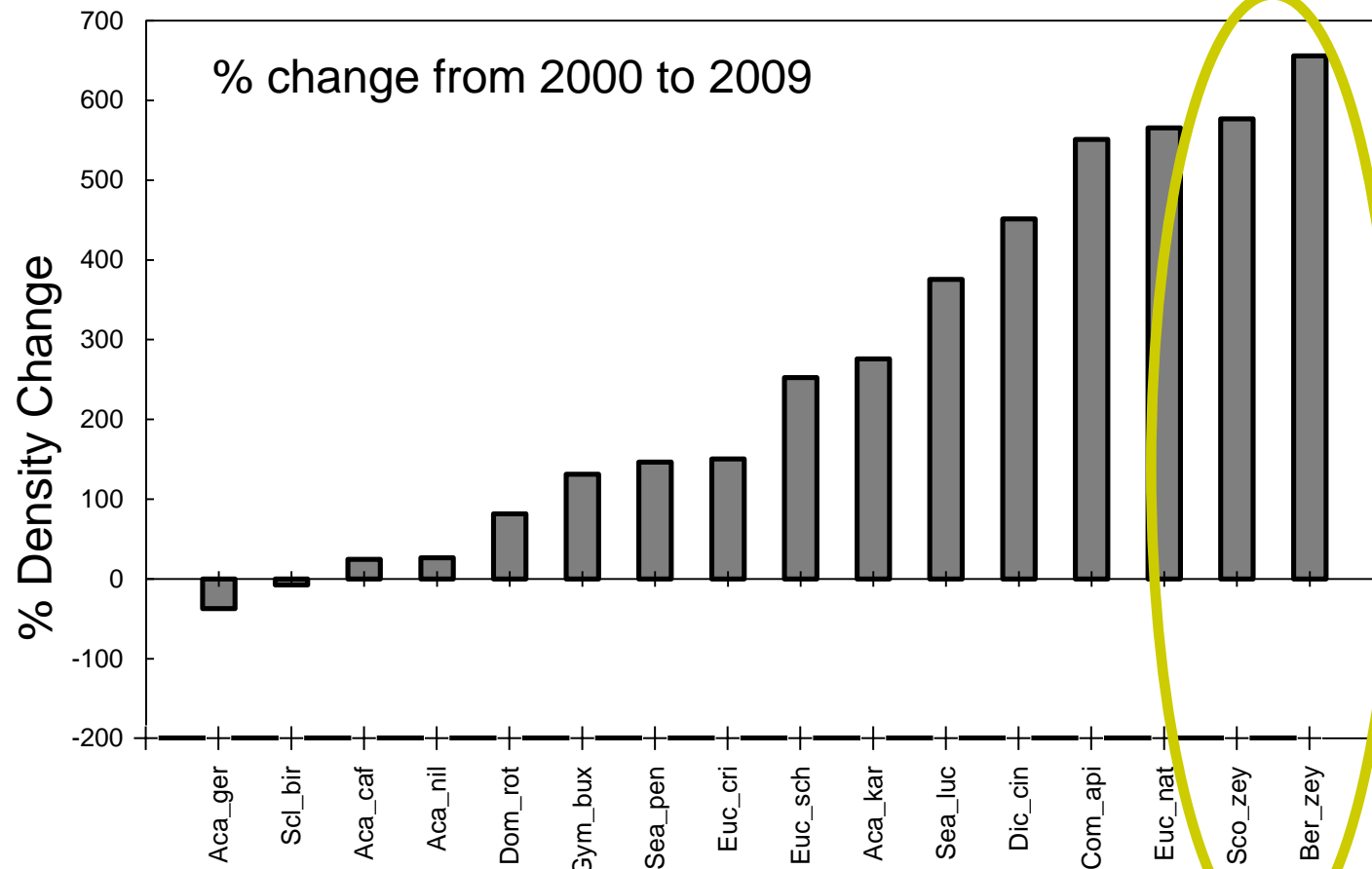


# Increase in **unpalatable** species (evergreen macrophyllous species) (Wiseman *et al.* 2004; Photo-point monitoring)






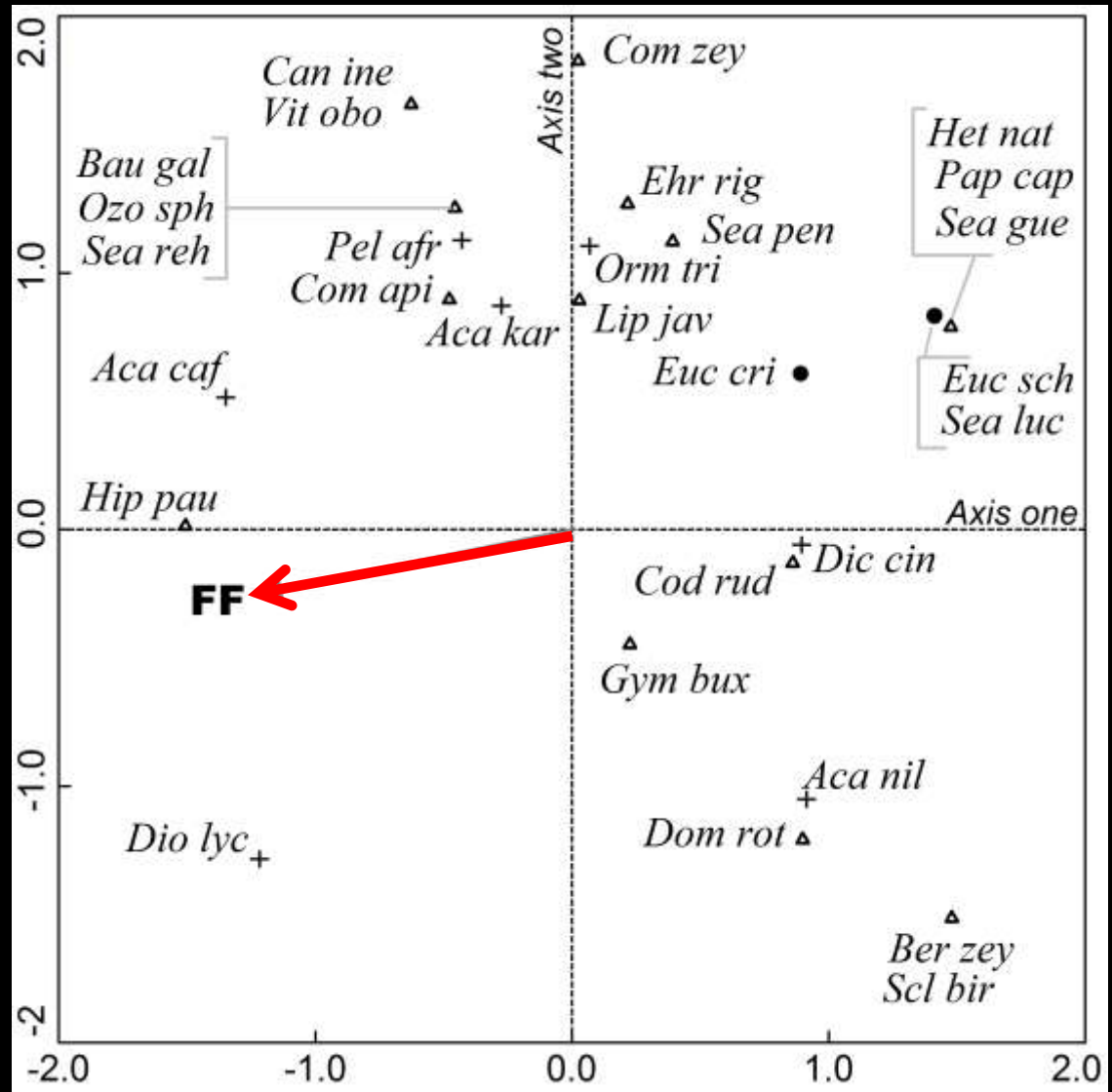


# Increase in **recruitment of forest / thicket** species (Wiseman *et al.* 2004; Photo-point monitoring)






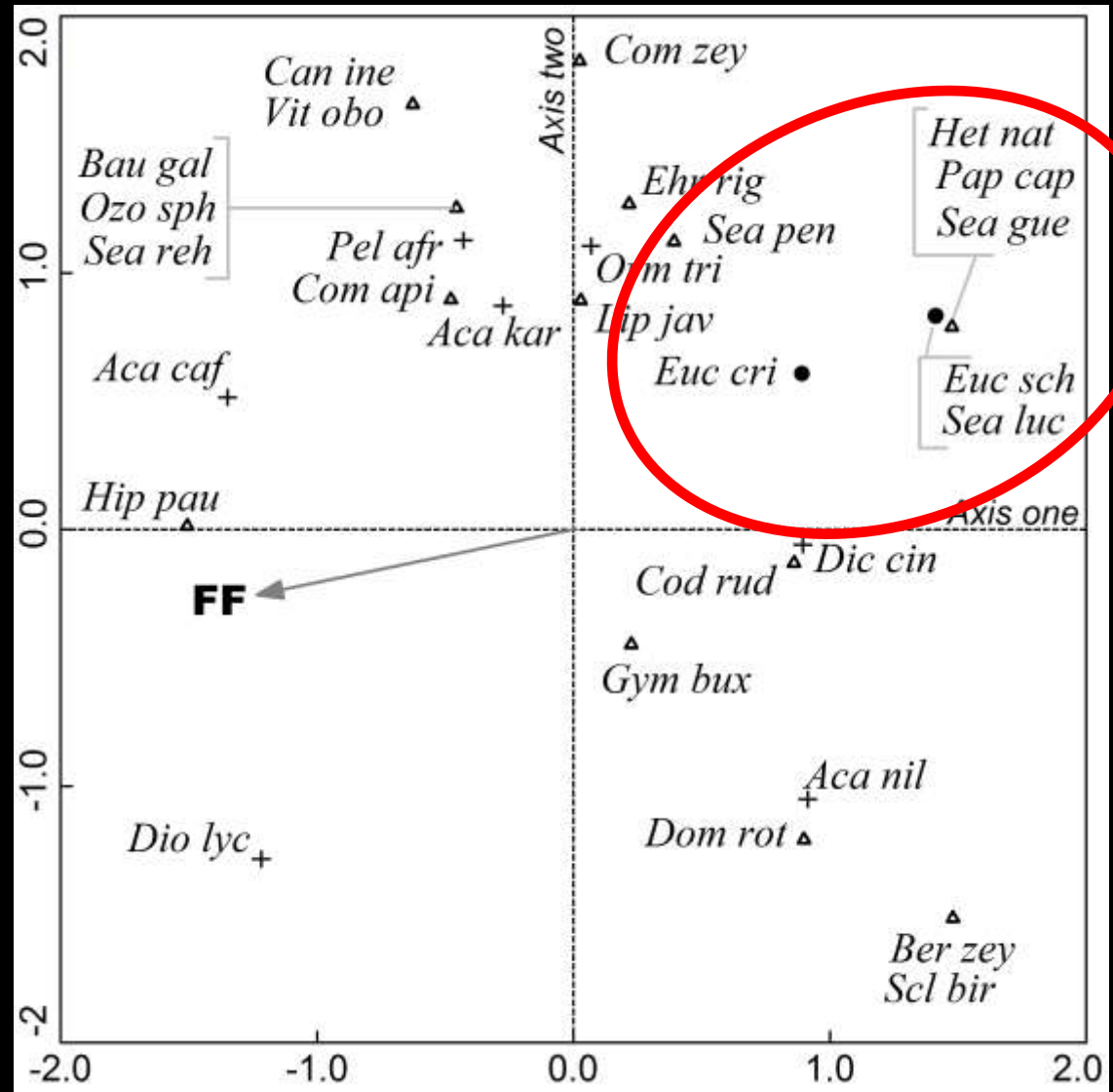
# CCA: Fire frequency – species composition

-  = deciduous macrophyllous
-  = deciduous microphyllous
-  = evergreen macrophyllous



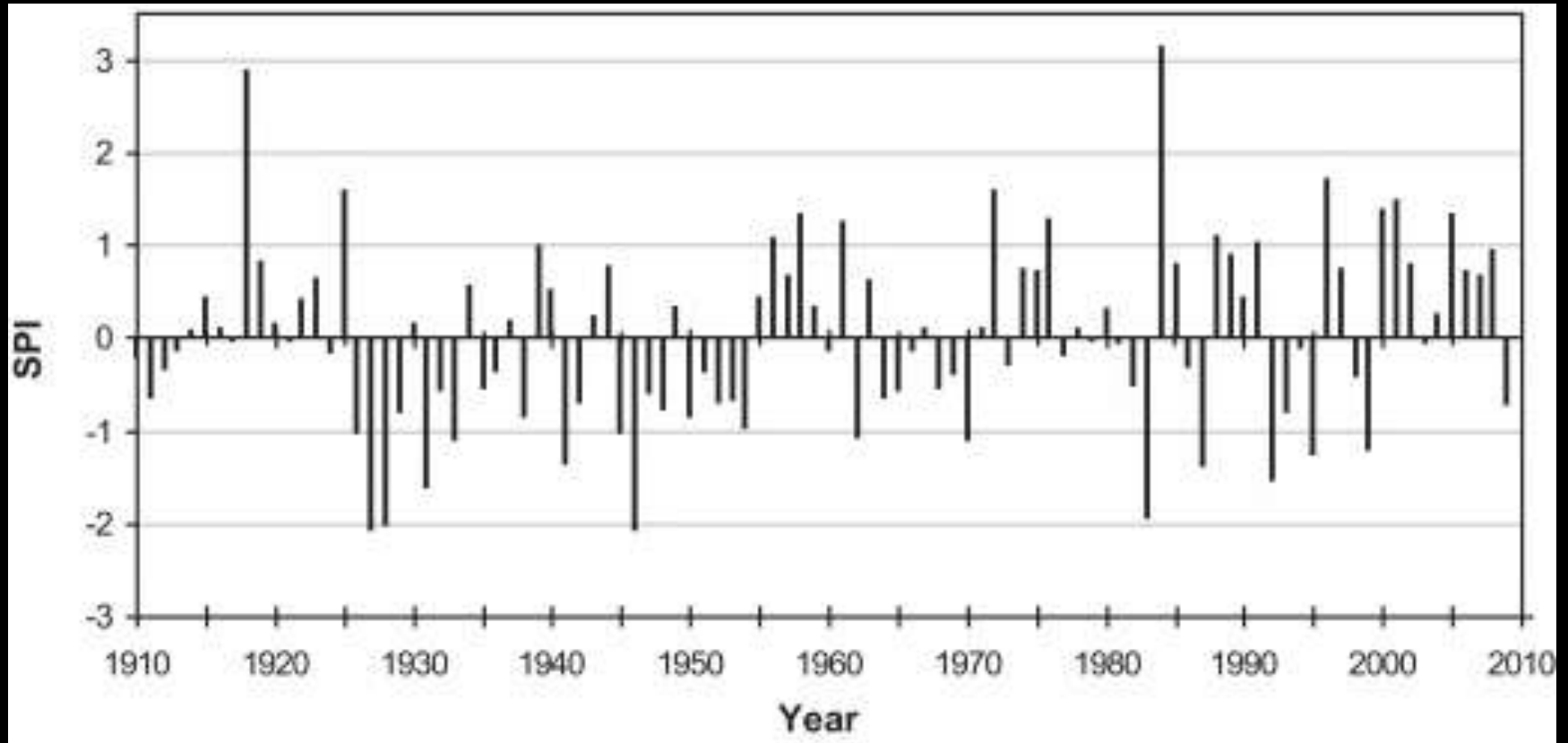
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# Deviations in annual rainfall from mean (790 mm)



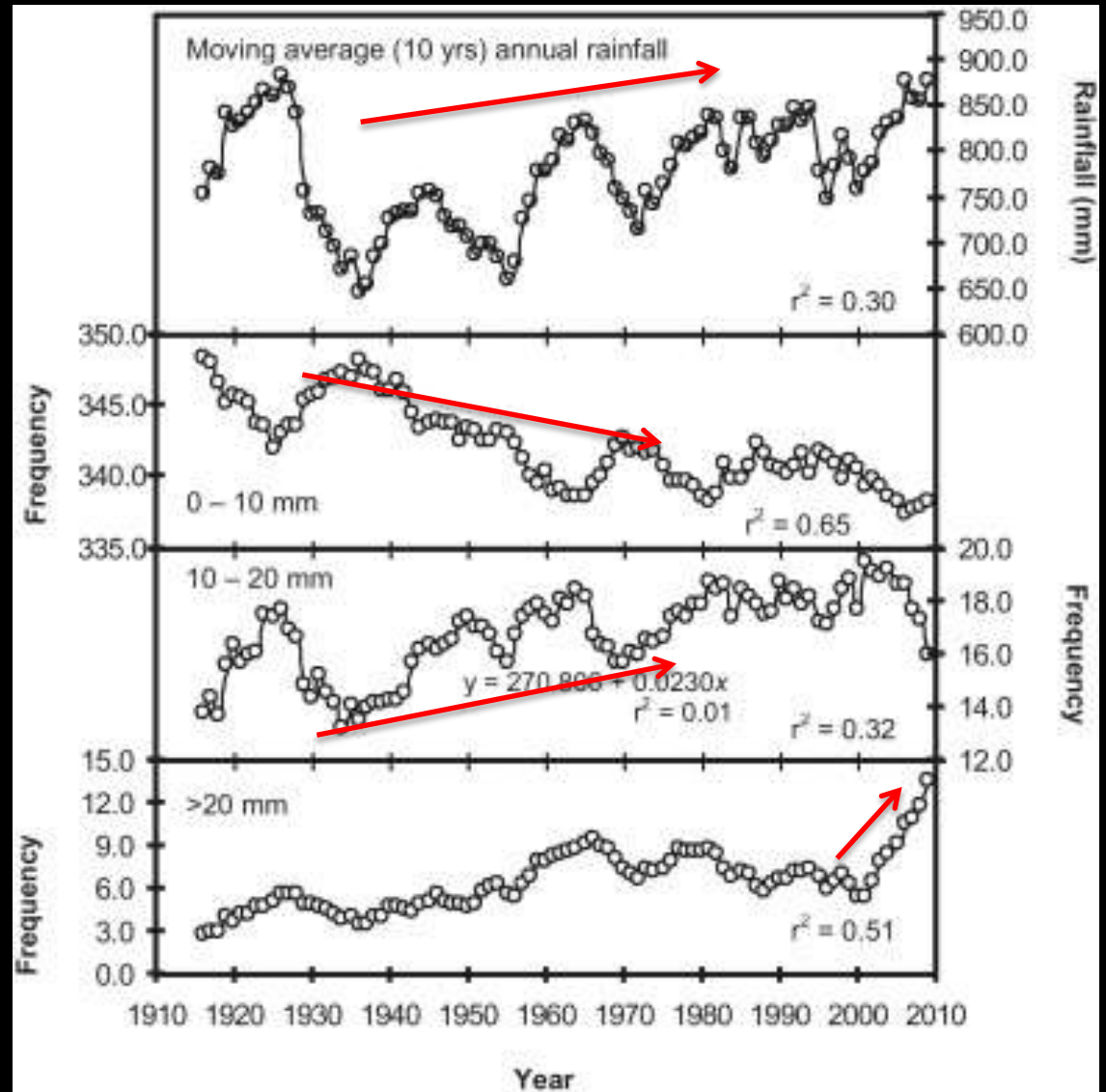
# Shifting rainfall patterns in IGR

Moving average 10yrs

0 – 10 mm events

10 – 20 mm events

> 20 mm events





# Discussion

The background image shows a savanna landscape. In the foreground, there is a steep, eroded bank of reddish-brown soil. Several large, gnarled tree roots are exposed, hanging down from the top of the bank. The trees themselves are mostly without leaves, showing a dry, brownish-yellow color. In the background, there are more trees with some green foliage under a clear blue sky.

The increase in the mean average and intensity of rainfall events

➡ may explain the increase in woody vegetation from 1943 to 2009

Grasses restrict the absorbance of soil moisture by woody plants.

- Riginos, 2009
- Knoop & Walker, 1985



# Discussion



The background image shows a savanna landscape with trees and a cross-section of the soil profile. The top part shows the ground surface with trees and grass. The middle part shows a cross-section of the soil profile with roots and moisture. The bottom part shows a cross-section of the soil profile with roots and moisture. The image is divided into three horizontal sections by dashed lines. The top section shows the ground surface with trees and grass. The middle section shows a cross-section of the soil profile with roots and moisture. The bottom section shows a cross-section of the soil profile with roots and moisture.

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# Discussion



The increase in the mean average and intensity of rainfall events

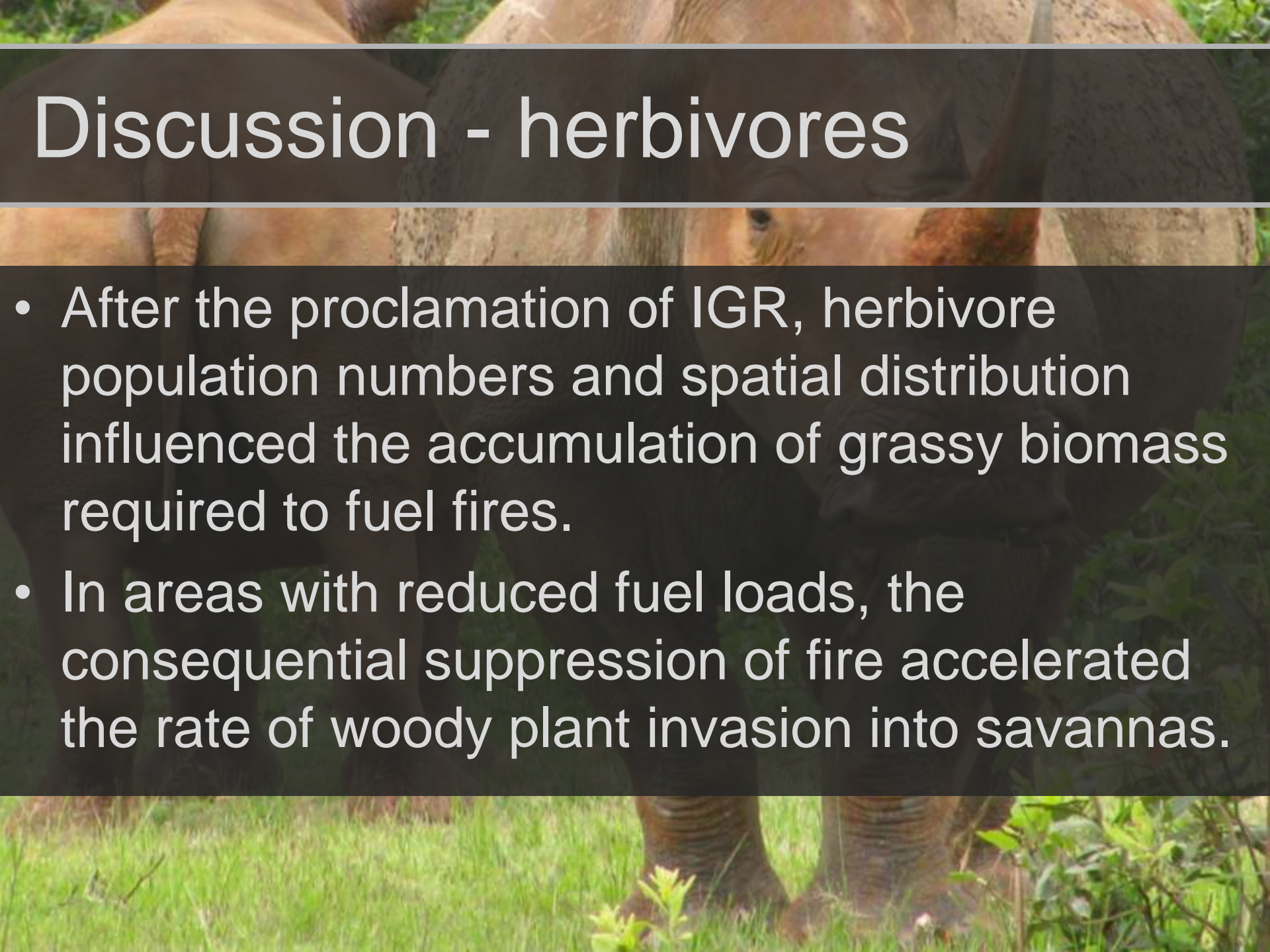
➡ may explain the increase in woody vegetation from 1943 to 2009

Infiltration increases.

More available to woody plants.

- Riginos, 2009
- Knoop & Walker, 1985



The background of the slide is a photograph of elephants in a savanna. The top half shows the heads and shoulders of several elephants, with one's eye clearly visible. The bottom half shows the lower legs and feet of elephants standing in tall green grass. The text is overlaid on a dark, semi-transparent band across the middle.

# Discussion - herbivores

- After the proclamation of IGR, herbivore population numbers and spatial distribution influenced the accumulation of grassy biomass required to fuel fires.
- In areas with reduced fuel loads, the consequential suppression of fire accelerated the rate of woody plant invasion into savannas.

# Discussion



No grazing



Heavy grazing



# Summary - herbivores

- Increase in woody vegetation coincided with:
  - ↓ in **palatable** (e.g. *Acacia gerrardii* and *Acacia davyi*) and an
  - ↑ **unpalatable** / forest thicket woody spp.

Palatable tree species such as *Acacia davyi* have gone locally extinct in IGR.



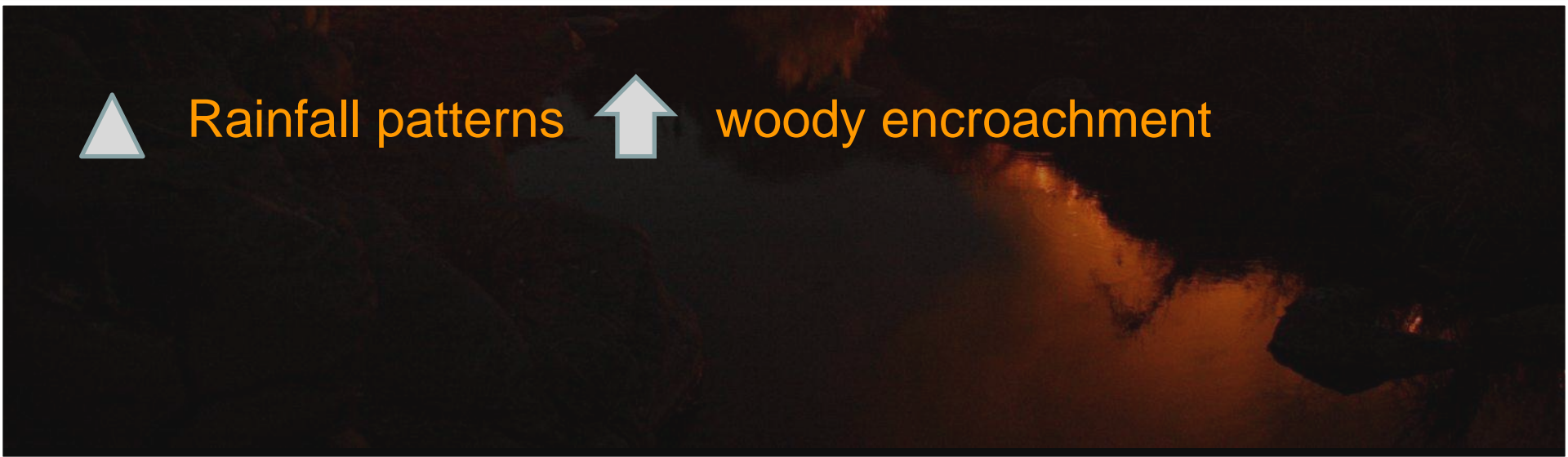
# Conclusions



Rainfall patterns



woody encroachment



# Conclusions





# Conclusions

▲ Rainfall **AND** ▲ Herbivores **AND**

▲ Savanna thicket / Forest species **AND**

↓ Fire  ▲ Woody encroachment



# The End

## Acknowledgements

