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Exploring interactions among fire, elephants and vegetation in Miombo woodlands of Chuilexi Conservancy, Niassa Special Reserve

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Introduction

- The impact of increasing elephant density and fires on biodiversity remains a controversial issue in current research on the dynamics of the ecosystem in protected areas (Cumming & Jones, 2005).
- This study aims to explore the effects of interactions between vegetation patterns, frequency of fire and elephants in the Niassa Special Reserve. The specific objectives are: (i) to characterize vegetation in terms of floristic composition, diversity in relation to damage due to fire and elephants, (2) Estimate the frequency of acceptability of tree species by Elephants.

Methodology

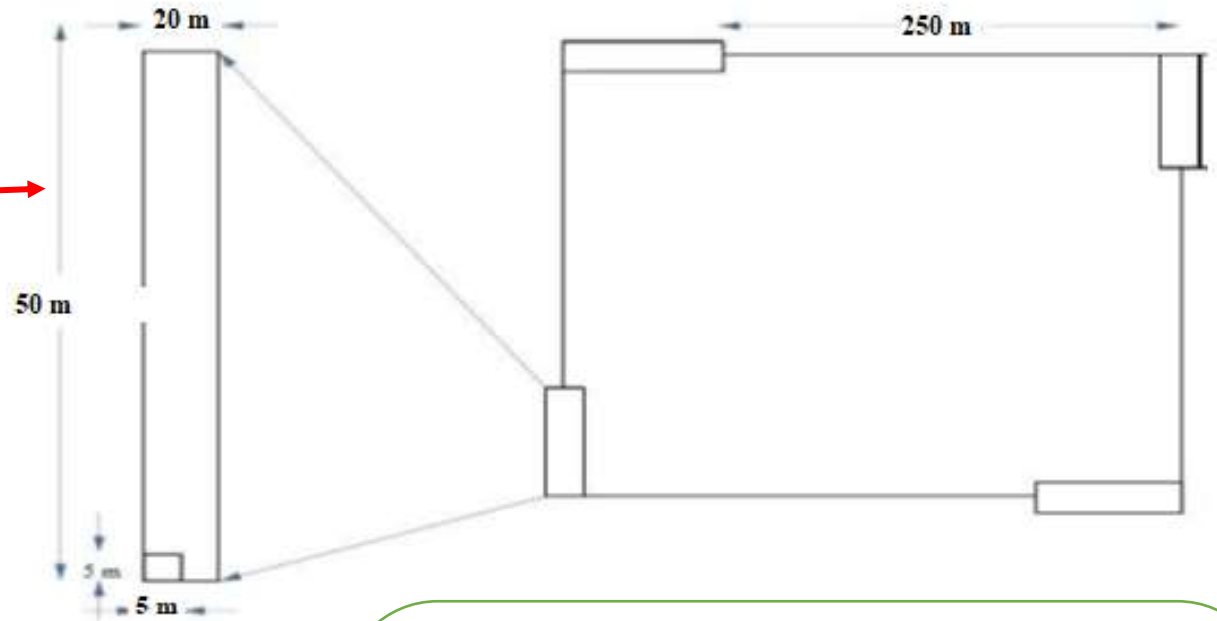
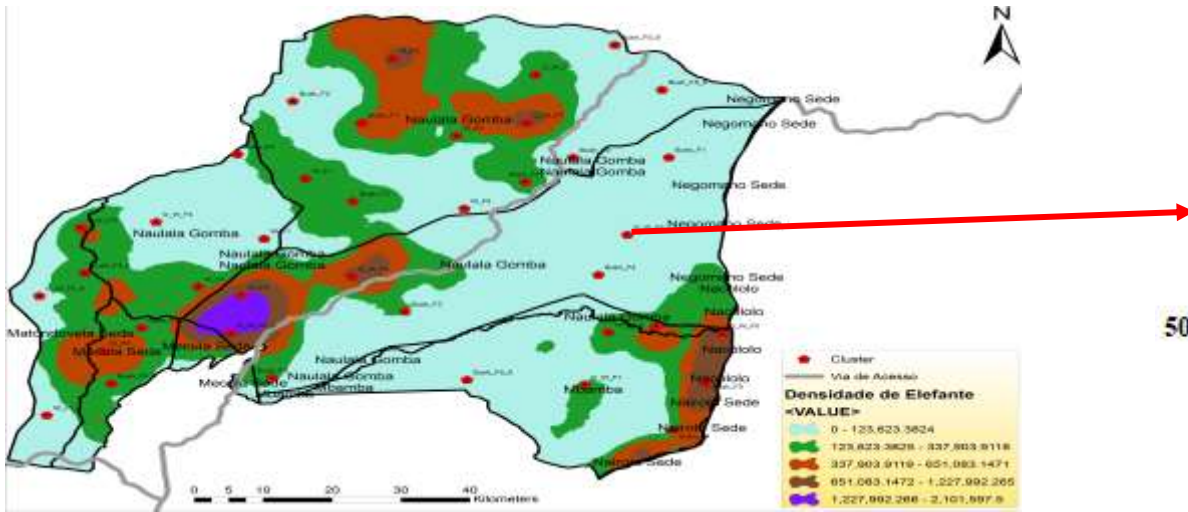


Fig.1 frequency of fires (Remote sensing) x presence of elephants (GIS database)

	Total Number of Clusters		
	Fire Frequency (2014-2019)		
Elephant presence	0-2 (Low)	3-4 (medium)	≥5 (High)
Low density	5	3	2
High density	5	4	2

In each plot:

1. Diameter at breast height for adult trees (DBH) \geq 5cm;
2. Height of adult trees
3. The identification of individual species
4. Counting and identification of natural regeneration in 5x5 m subplots

In each plot:

5. A qualitative assessment was made of the damage caused by fire and elephants to the trees. Two classes of damage were attributed: (i) fire damage: Death by fire (DF), burnt trunk more alive (TB), fallen alive due to fire (FF), (ii) damage caused by elephants: fallen with life (CE), broken branches (BB), bark partially removed (CR), uprooted but alive tree (UA), dead tree (DE).

a)



b)



c)



d)



e)



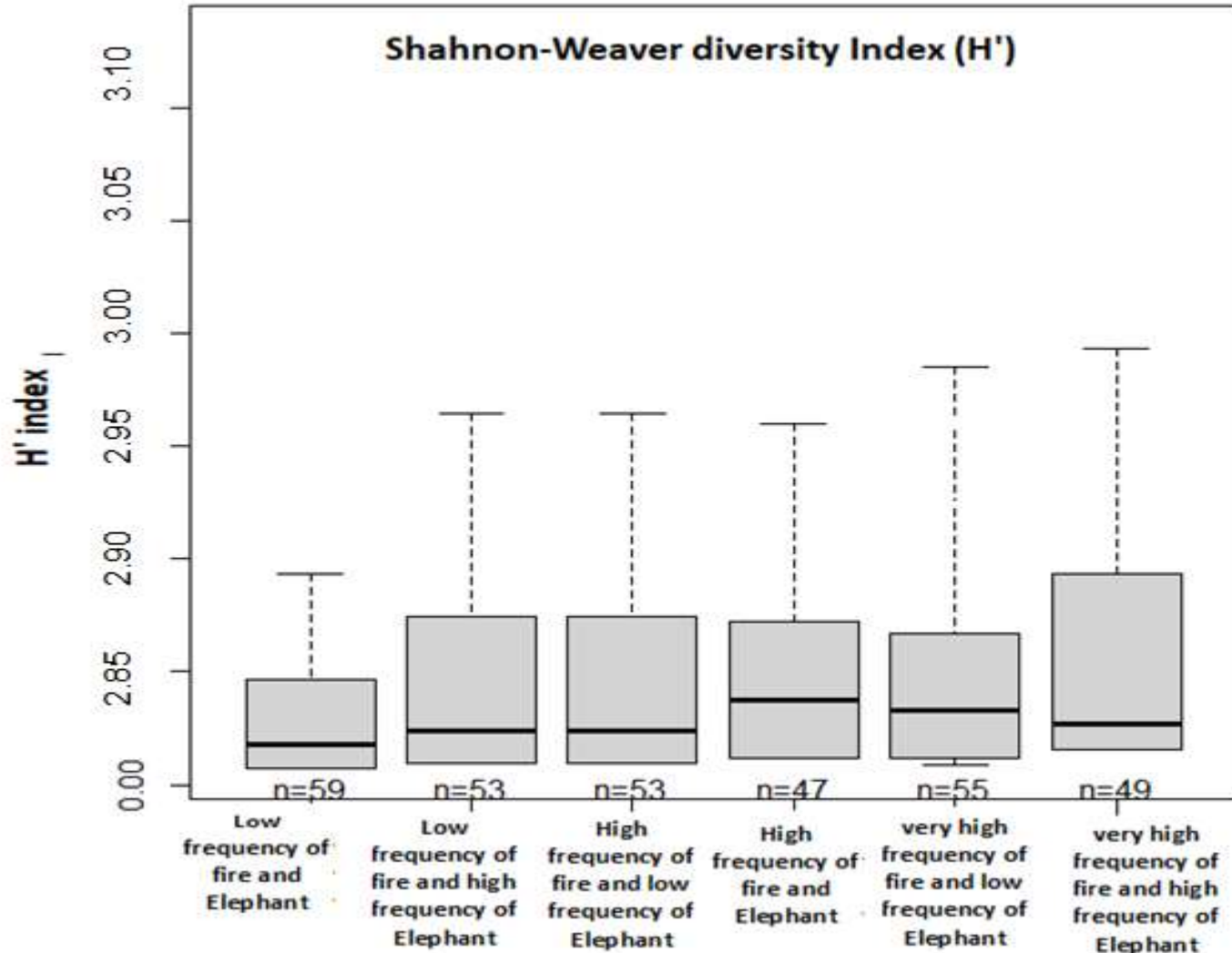
Fig. 2 a) Burnt trunk alive b) Death by fire c) Broken branches d) Uprooted but alive tree e) Dead tree

Data analysis

- For the composition and distribution of species, an important ecological index was used, the importance value index (IVI): $IVI = DR + DoR + FR$ (%)
- **Shannon-Weaver index (H')**: $H' = -\sum P_i * \ln(p_i)$
- The results of the Shannon-Wiener diversity index (H') obtained in each stratum were evaluated at a confidence level of $\alpha = 5\%$ by the Kruskal-Wallis test. To distinguish the mean values from each other, the Wilcoxon multiple comparison test was used.
- **The acceptability index** of each species was calculated by the number of clusters in which each species was damaged by elephants), divided by the number of clusters in which each species was found (Owen-Smith and Cooper, 1987; Macandza et al., 2004). Species that are found in more than 2 strata within the sampling were included for the acceptability calculation.

RESULTS

Species diversity




- 101 species were recorded
- Low FF and low elephant presence had the highest species richness (# of species).
- High FF and high elephant presence had lower richness.
- There was no significant differences in species diversity at 5% significance.

Fig. 2 Distribution of the Shannon-Weaver Diversity Index (H')

Importance value index (IVI)

Lower end

Upper end



Species	Low frequency of fire and Elephant	Low frequency of fire and high frequency of Elephant	High frequency of fire and low frequency of Elephant	High frequency of fire and Elephant	very high frequency of fire and low frequency of Elephant	very high frequency of fire and high frequency of Elephant
<i>Brachystegia boehmii</i>	27	29	-	-	-	-
<i>Combretum adenogonium</i>	34	25	-	13	-	14
<i>Diplorhynchus condylocarpon</i>	12	-	27	26	12	21
<i>Julbernardia globiflora</i>	24	23	26	29	26	15
<i>Markhamia sp.</i>	-	-	-	13	24	13
<i>Pseudolachnostylis maprouneifolia</i>	-	12	-	-	-	-
<i>Pteleopsis myrtifolia</i>	11	-	-	-	-	-
<i>Pterocarpus angolensis</i>	-	-	39	23	-	-
<i>Terminalia sericea</i>	-	-	-	-	-	19

- Low FF and low elephant presence: *Combretum adenogonium* (34%), *Brachystegia boehmii* (27%), *Julbernardia globiflora* (24%)
- Very high FF and high elephant presence: *Diplorhynchus condylocarpon* (21%; **Fire indicator sp.**), *Terminalia sericea* (19%), *Julbernardia globiflora* (15%), *Combretum adenogonium* (14%).

Richness and diversity of natural regeneration

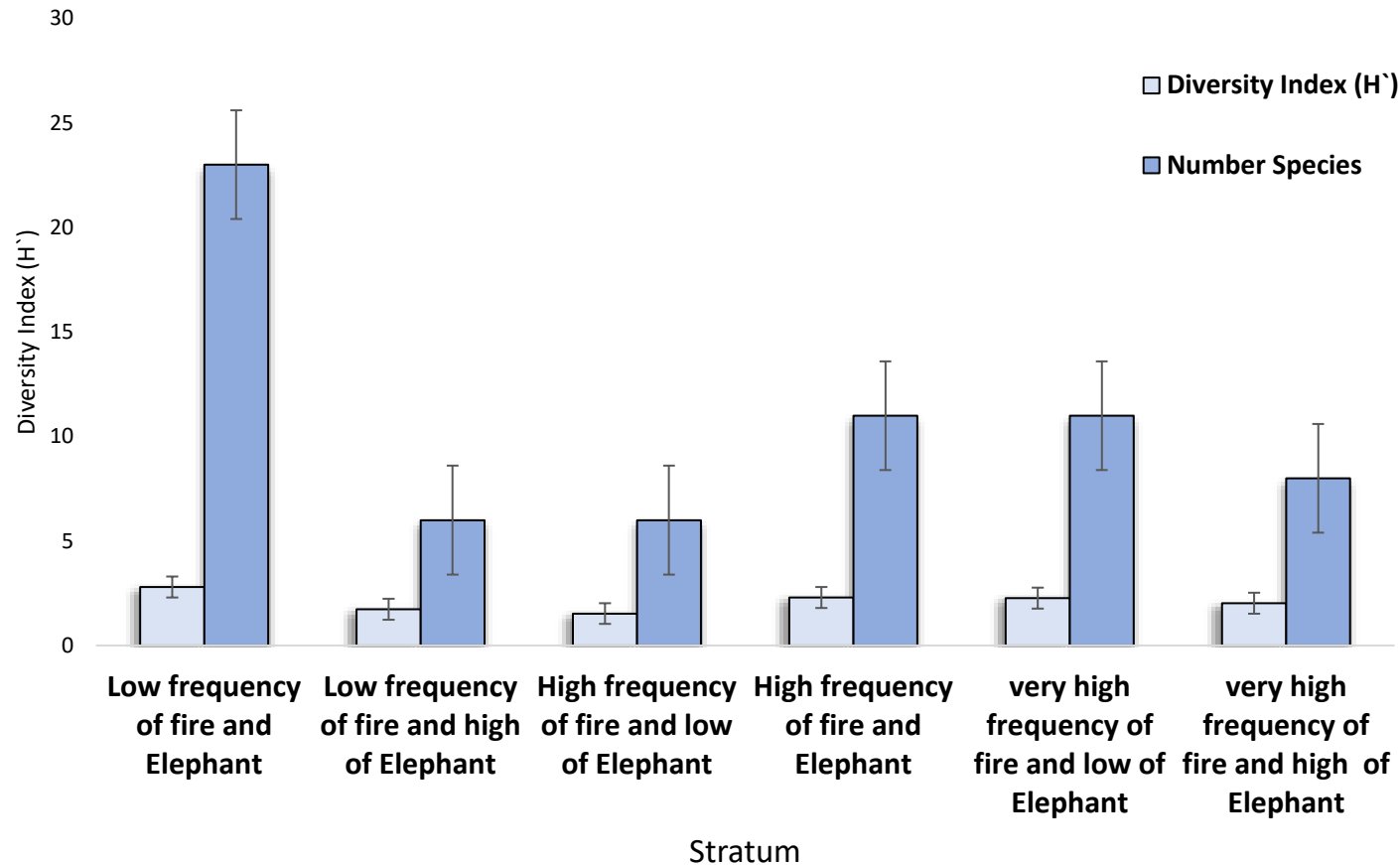


Fig. 3 Number of species and diversity in natural regeneration

- Low FF and low elephant presence show higher richness (23).
- High FF and high elephant presence has lower richness (6).
- There was no significant difference in species diversity in natural regeneration plants at a level of significance of 5%

Natural regeneration density of key miombo species

Lower end

Upper end



Species	Low frequency of fire and Elephant	Low frequency of fire and high of Elephant	High frequency of fire and low of Elephant	High frequency of fire and Elephant	very high frequency of fire and low of Elephant	very high frequency of fire and high of Elephant
<i>Diplorhynchus condylocarpon</i>	10	2	8	3	3	2
<i>Terminalia sericea</i>	4		3	1	2	2
<i>Julbernardia globiflora</i>	7	1			1	
<i>Pterocarpus angolensis</i>	3	1		2		1
<i>Brachystegia boehmii</i>	4			1	1	
<i>Diospyros kirkii</i>	2				3	1
<i>Combretum adenogonium</i>	1			1	1	1

- Low FF and low elephant presence: *Diplorhynchus condylocarpon*, *Julbernardia globiflora*, *Brachystegia boehmii*, *Terminalia sericea*, *Pterocarpus angolensis*.
- Very high FF and high elephant presence: *Combretum adenogonium*, *Diospyros kirkii*, *Diplorhynchus condylocarpon*, *Terminalia sericea*.

Assessment of fire damage and Elephants

Of the damaged individuals:

- 44% had branches broken by the Elephants
- about 3% had their trunk burned and bark partially removed due to the elephants
- 2% are fallen trees due to fires.
- Species with highest acceptability are also present in the adult and young strata.

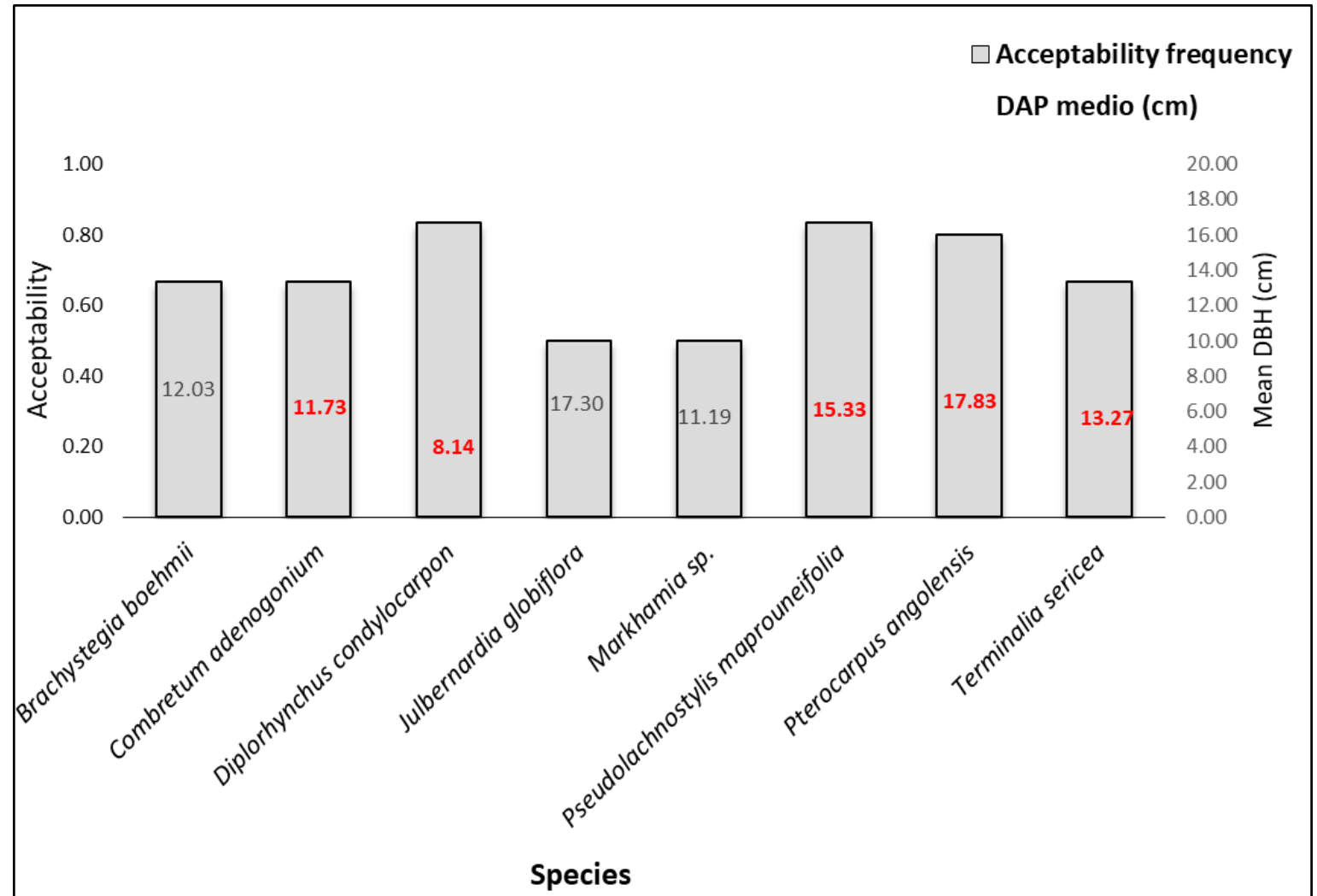


Fig. 4 Acceptability frequency of damage by elephants in relation to DBH (cm)

Preliminary conclusions

- Fire frequency and elephant presence do influence the number of species (richness) but diversity is not affected - > some kind pyrodiversity, to be explored further.
- There seem to have a change in tree species composition from low fire frequency of fire and low elephant presence (*Brachystegia boehmii*, *Julbernardia globiflora* and *Combretum adenogonium*) to high fire frequency and high elephant presence (*Diplorhynchus condylocarpon*, *Terminalia sericea*, *Julbernardia globiflora*). **Combratecea species are fire resistant.**
- This is observed also at the natural regeneration level (young cohort)
- Important miombo species are also the most preferred by elephants



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Thank You