

# Structural and compositional change caused by extreme elephant impact in the Linyanti woodland, northern Botswana over 16 years



**Gabi Teren; Norman Owen-Smith; Barend Erasmus**  
 School of Animal, Plant and Environmental Sciences, University of the Witwatersrand  
 Gabi.Teren@gmail.com

## INTRODUCTION

The Linyanti Woodland on the border of northern Botswana and Namibia's Caprivi Strip is subject to the highest elephant densities in the world (estimated at >20 elephants/km<sup>2</sup> during the dry season compression).

These concentrations of elephants have been cited as the cause of the disappearance of large canopy trees (mainly *Acacia erioloba* and *A. nigrescens*), prevalent in the 1960's.

Following on from previous studies and aerial photographs from 1992 and 2001 and a current 2008 aerial survey, this study aims to evaluate the consequences for structural and compositional diversity of the woodland, by focusing on dynamics over large spatial and long temporal scales.

## METHODS

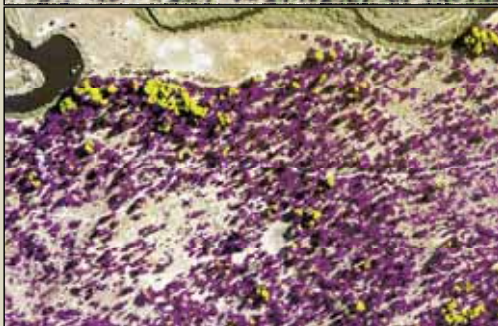
Vegetation transects conducted in areas of high and low tree mortality identified from the aerial photographs, to compare vegetation composition with two previous studies (Wackernagel, 1993 and Bell, 2001).

GIS and OBIA (Object-based Image Analysis) of high resolution (1:10 000) aerial photographs to determine spatial distribution and changes of patches of shrubs, canopy woodland and dead canopy trees.

## STRUCTURAL CHANGES

Object Based Image Analysis (OBIA) using Definiens® Developer.

Canopy Cover from this portion of the 2001 aerial photograph is extracted using an object segmentation based on properties of the RGB (Red, Green, Blue) and IHS (Intensity, Hue, Saturation) bands. This results in the purple canopy cover classification. The DEM (Digital Elevation Model) is then used to pick out canopy trees (>10m tall) shown in yellow. This analysis is particularly successful in excluding the prevalent shadows. The method will be applied to the 1992 and 2008 aerial photographs to group canopy cover into shrubs (<3m), trees (4-9m) and canopy trees (>10m). Change detection will then evaluate patch dynamics and structural diversity changes over the 16 years. Note the high shrub densities, already apparent in 2001.



## Compositional changes

The woodland has been converted from an Acacia woodland (see shaded cells) to a shrubland dominated by a single species *Combretum mossambicense*. Most visible tree death is due to debarking by elephants (fig. 1), but some mature trees are felled by wind during severe storms. Seedlings are found but do not persist, killed by browsing or desiccation (fig. 2;3).

1993 Woodland Composition (Wackernagel, 1993)	
Tree Species (>2.5m)	% population
<i>Croton megalobotrys</i>	17
<i>Acacia erioloba</i>	14
<i>Colophospermum mopane</i>	12
<i>Acacia nigrescens</i>	11
<i>Combretum molle</i>	10
<i>Combretum imberbe</i>	4
All other species (<4% ea.)	32
TOTAL	100

2008 Woodland Composition	
Tree Species (>2.5m)	% population
<i>Combretum mossambicense</i>	58.61
<i>Croton megalobotrys</i>	13.69
<i>Philenoptera nelsii</i>	13.52
<i>Colophospermum mopane</i>	3.41
<i>Combretum hereroense</i>	1.93
<i>Combretum imberbe</i>	1.64
<i>Diospyros lyciodes</i>	1.64
<i>Diospyros mespiliformis</i>	1.07
<i>Acacia nigrescens</i>	0.94
<i>Acacia erioloba</i>	0.18
All other species (16 spp.) <1%ea.	3.37
TOTAL	100



Figure 1. Debarking on *A. nigrescens* by elephants.



Figure 2. *A. erioloba* seedling browsed by elephants.



Figure 3. Desiccated *C. imberbe* seedling

## DISCUSSION

### The loss of tall acacias

- Compositionally, the once-dominant acacias have all but disappeared, particularly *A. erioloba*.
- The 1960's prevalence of Acacias is hypothesized to be as a result of an even-aged stand established in the late 1800's when rinderpest and hunting of elephants dramatically reduced herbivore numbers. This will be evaluated by dating acacias and by pollen analysis which will determine the historical woodland composition.
- Whilst recruitment of canopy tree species is not apparent, seedlings are found throughout the area.
- Seedlings are hypothesized to be in a 'herbivore trap', exacerbated by long-term drying in northern Botswana.
- If they can 'escape' elephants during an extended period of good rainfall they may be recruited into the next size class.

### The increase in shrubs

- *Combretum mossambicense* now dominates most areas of the woodland, but is also prevalent in less elephant-impacted areas such as across the Linyanti River in the Caprivi Strip and further West in the Kwando area.
- This has led to the hypothesis that climate change, particularly carbon fertilisation effects may be responsible for the shrub encroachment.

## ACKNOWLEDGMENTS

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