NYIKA-VWAZA TRUST RESEARCH STUDY REPORT

Status and Condition of Stands of *Colophospermum mopane* (mopane) in Vwaza Marsh Wildlife Reserve, Malawi

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ABSTRACT

A study to assess the status and condition of *Colophospermum mopane* (mopane) was carried out in Vwaza Marsh Wildlife Reserve, Malawi. The study examined the spatial distribution of mopane, its age/size structure as well as elephant damage. It was carried out between August and November, 2020. Three areas of mopane within the reserve were categorized and a total of 109 random plots (20× 30m each) were used to collect data. Tree height, basal area, tree density, shrub density, density of damaged plants and number of dead mopane trees were recorded within each plot. Damage was also assessed and rated depending on the intensity. A total of 2541 *C. mopane* trees were sampled and data was analyzed using SPSS version 20 for Windows (SPSS Inc, Chicago, USA). Results revealed that *C. mopane* covers approximately 12.3% of the total reserve's area, with no significant differences in all vegetation attributes of the species (height, DBH, basal area, and density), except for stocking density (P>0.036). In terms of damage, 37% of the total mopane trees assessed (n=2541) were damaged by elephants, 2% had other forms of damage, whereas 61% were not damaged. Results indicated no significant differences in the proportion of damaged trees across mopane sections of VMWR (P=0.340). Continuous monitoring of *C. mopane* populations in relation to different forms of damage is encouraged, alongside further research into the ecological dynamics of biodiversity components in the reserve within mopane woodlands.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
ANOVA	Analysis of Variance
cm	Centimeter
DBH	Diameter at Breast Height
DNWP	Department of National Parks and Wildlife
et al.	*et alii,* and others
GPS	Global Positioning System
HSD	Honestly Significant Difference
km	Kilometer
m	Meter
NEAP	National Environmental Action Plan
NVT	Nyika–Vwaza Trust (UK)
QGIS	Quantum Geographic Information System
UK	United Kingdom
UTM	Universal Transverse Mercator
VMWR	Vwaza Marsh Wildlife Reserve
WGS	World Geodetic System
USA	United States of America

1.0 INTRODUCTION

1.1 Description of the species

Colophospermum mopane (Kirk ex Benth.) Kirk ex J. Leonard (commonly known as mopane) is a leguminous broad-leafed deciduous tree or shrub in the legume family (Fabaceae), and the only species in the genus *Colophospermum* (Palgrave, 2002). Native to Africa, the species dominates over large areas of southern tropical Africa (approx. 550,500 km^2) in hot, arid, low-lying savannahs (Mapaure 1994; Timberlake, 1995, 1996). In most instances, the species exist in monospecific stands in a woodland form called mopane woodlands (Mlambo and Nyathi, 2004; Mlambo, Nyathi and Mapaure, 2005), and tends to outcompete many other tree species in such areas (Timberlake et al., 2010).

1.2 Justification of the study

Mopane woodlands have been well reported to play highly significant socio-economic and ecological roles across much of its range (Timberlake, 1995; Bruschi et al., 2017; Makhado et al., 2009, 2014; Ryan et al., 2016; Moura et al., 2017). This includes in Malawi, even though heavy utilization pressure, particularly for building materials and charcoal/firewood production, was reported as contributing to its significant decline outside of protected areas in the late 1900s within the country (Chikuni, 1996), thus warranting protection of mopane by law (Government of Malawi, 1994). The most recent assessment by the International Union for the Conservation of Nature (IUCN) confirms its populations are still considered in decline as a result of overexploitation, although site-specific information on local population sizes and trends is scant (Hills, 2019).

Vwaza Marsh Wildlife Reserve (VMWR) (Figure 1) is one of the protected areas where mopane occurs (Shorter, 1989; McShane & McShane-Caluzi, 1988). In this reserve, mopane significantly adds to biodiversity in addition to being an important wildlife habitat (McShane & McShane-Caluzi, 1988). Despite this, an information deficit has remained prominent regarding the current status and condition of mopane woodlands in the protected area, even though accelerated degradation of the woodlands (due to elephant damage and wildfires) has been increasingly reported in other protected areas (e.g. Mapaure & Ndeinoma, 2011; Simbarashe & Farai, 2015; Mapaure & Mhlanga, 2000). Therefore, this study aimed at providing information on the status and condition of mopane vis-à-vis elephant damage in VMWR. Such information is deemed essential for development of effective and sustainable management strategies for conservation of both mopane and the associated biodiversity across its range.

1.3 Objectives of the study

1.3.1 General Objective

The general objective of the study was to assess the status of *C. mopane* woodland in the Vwaza Marsh Wildlife Reserve.

1.3.2 Specific Objective

1) To determine the spatial distribution of *C. mopane* across the Vwaza Marsh Wildlife Reserve.
2) To determine the size/age structure of *C. mopane* across the Vwaza Marsh Wildlife Reserve.
3) To assess elephant damage on the *C. mopane* across the Vwaza Marsh Wildlife Reserve.

1.4 Significance of the Study

The study will provide a basis from which effective and sustainable management strategies for conservation of mopane in the reserve can be developed, such as ecological management plan for monitoring. It will also form a platform from which more advanced studies aimed at improving mopane conservation in Vwaza may be inferred and conducted.

2.0 METHODOLOGY

2.1 Study Area

Vwaza Marsh Wildlife Reserve lies in northwest Malawi along the international border with Zambia (Figure 1), spreading over 986 km^2 with a varying altitude range of 1000-1660m (McShane & McShane-Caluzi, 1988). Mean annual rainfall is about 800-1100 mm across the reserve, falling from November to April (Anon., 2016). A more detailed description of VMWR is given by McShane (1985).

Figure 1: Map of the study area.

2.2 Sampling Procedure

All areas with mopane were first mapped using ground transects and a GPS device then categorized into three sections (i.e. A = Alluvial plains/Mopane association; B = Alluvial plains/Deciduous-thicket mopane association; and C = Alluvial plains/Pediment alluvial) based on landscape classification by McShane (1984). Plot based surveys were then carried out and a total of 109 rectangular plots (20 x 30 m each) were randomly laid within all mopane sections and distributed as follows; 39 plots in section A, 36 plots in section B, and 34 plots in section C.

2.3 Data Collection

Data was collected between August and December, 2020. Using standard forest inventory techniques (West, 2015), data on tree/shrub height, diameter (measured at breast height (DBH) for plants greater than 2 m high and at 0.33 m above-ground for those less than 2 m high), number of stems per plant, number of saplings/regenerants, number of dead trees and plant damage were recorded for each plot. Data on associated species were recorded with the aid of visual field guides by Palgrave (2002) and Van Wyk & Van Wyk (1997) and verified on the Flora of Malawi database - https://www.malawiflora.com/ .

Elephant damage data: - Damage was defined as any form of vegetation utilization by elephants (Mapaure & Mhlanga, 2000). In this study, this included breaking of branches and stems, uprooting, pushing over and scarring (bark striping) of *C. mopane*. Eye observations were used to determine damage form and intensity (Mukwashi et al., 2012; Smith, 1999), and score overall elephant damage according to a 4-point scale shown on Table 1. Definitions of intensity levels (i.e. slight, moderate and severe) for each damage type as was used in the field are given in Table 2. Damage due to other agents such as fire and human induced damage was also noted and recorded as 'other damage'.

Additionally, GPS coordinates for all sampled plots were captured and are in Universal Transverse Mercator (UTM) zone 36, based on the World Geodetic System of 1984 (WGS 84) (Appendix 1).

Table 1: Scale used to record elephant browsing damage to C. mopane trees in VMWR (adapted from Walker 1976).

Damage score	Description
0	No damage
1	Slight elephant damage
2	Moderate elephant damage
3	Severe elephant damage

Table 2: Definitions of damage intensity level as used in the study

Damage type (form)	Intensity	Definition
Barking (Scarred stem)	(1) Slight	Less than 20% stem barked
	(2) Moderate	Less than 50% stem barked
	(3) Severe	Greater than 50% stem barked
Broken stem	(2) Moderate	Partial stem breaking
	(3) Severe	Complete cut
Broken branch	(1) Slight	Less than 20% canopy removed
	(2) Moderate	Less than 50% canopy removed
	(3) Severe	Greater than 50% canopy removed
Uprooting	(3) Severe	Completely fallen with roots exposed
Pushed over	(1) Slight	Above 45^0 slant angle
	(2) Moderate	Between 25^0 to 45^0 slant angle
	(2) Severe	Less than 25^0 slant angle

NB – There is no slight stem breaking as this is impossible, and also no slight or moderate uprooting.

Figure 2: During data collection in mopane woodland, VMWR.

2.4 Data Analysis

The collected data was entered, cleaned, and organised using Microsoft Office Excel 2010. For analysis, data on diameter at breast height (DBH) and height (h) of *C. mopane* was grouped into classes of <10, 10-20, 20-30, 30-40, >40 cm and <2, 2-5, 5-10, 10-15, >15 m respectively. For each plot, tree and shrub heights were averaged on the basis of woody vegetation assessment data. Diameter at breast height (DBH) data was used in calculating stem basal areas for each stem using the formula below;

⇒ Basal area (m^2/ha) = $(dbh/2)^2$ x pi

The densities of the *C. mopane* trees, shrubs, damaged trees, dead trees and saplings were calculated using the data from the physical count using the formula of Gandiwa and Kativu (2009);

⇒ Density (y/ha) = (x × 10,000 m^2) / (plot area, m^2),

Where y denotes any of the trees or shrubs and x is the recorded number of trees and shrubs, damaged trees, dead trees and saplings.

Spatial mapping was done using Quantum GIS (QGIS) map tools, and statistical analyses were carried out using the Statistical Package for Social Scientists (SPSS) version 20. A One-way analysis of variance (ANOVA) was performed to test for significant differences in age/size, and elephant damage between sections. A post hoc Tukey Honestly Significant Difference (Tukey HSD) (Tukey, 1953) test was then carried out to separate significantly different means. Finally, maps were produced using Quantum GIS version 3.8.1.

3.0 RESULTS AND DISCUSSION

3.1 Spatial Distribution of *C. mopane* in VMWR

C. mopane in Vwaza occurs in low-lying alluvial plains (within an altitudinal range of 1000-1150m), covering an area of approximately (12.3%) 121 km^2 mostly in the central and south-central areas of the reserve (Figure 3). These areas are characterized by moderately deep to deep loamy and clay soils, including grey clays as described by McShane (1984), and are waterlogged during the rains and intensively arid in the dry season. Stands of *C. mopane* which appear in fairly good condition dominate the tree flora in these areas, with a few other smaller trees, such as *Commiphora* spp., forming a sparse shrub layer. The ground cover is generally very light, with large open glades of grassland, comprising largely of *Loudetia simplex* and *Setaria* species with very little herbaceous cover (Figure 4).

Although not depicted in the recent distribution range map by Mapaure (1994) (Figure 5), the distribution of mopane in VMWR is at its most northerly occurrence in Africa, and extends into Zambia to the south-west adjoining that of Luangwa Valley (Zambia).

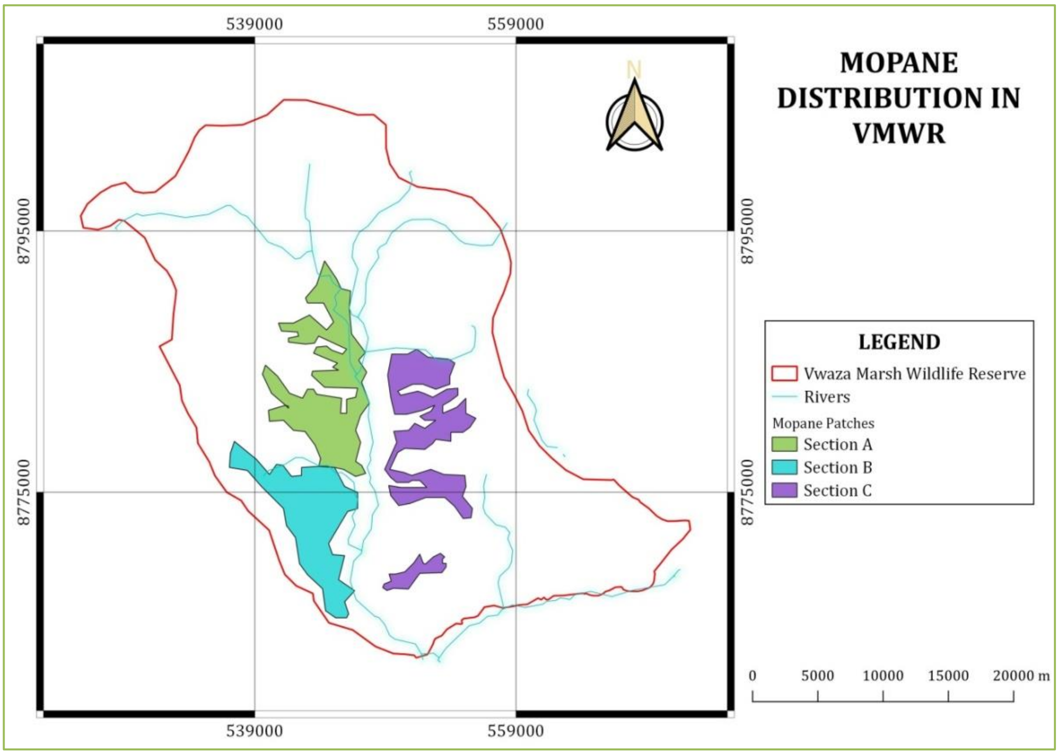


Figure 3: Main areas with C. mopane in VMWR.

Figure 4: Light ground cover with open glades of grassland in mopane woodland of VMWR (A & B).

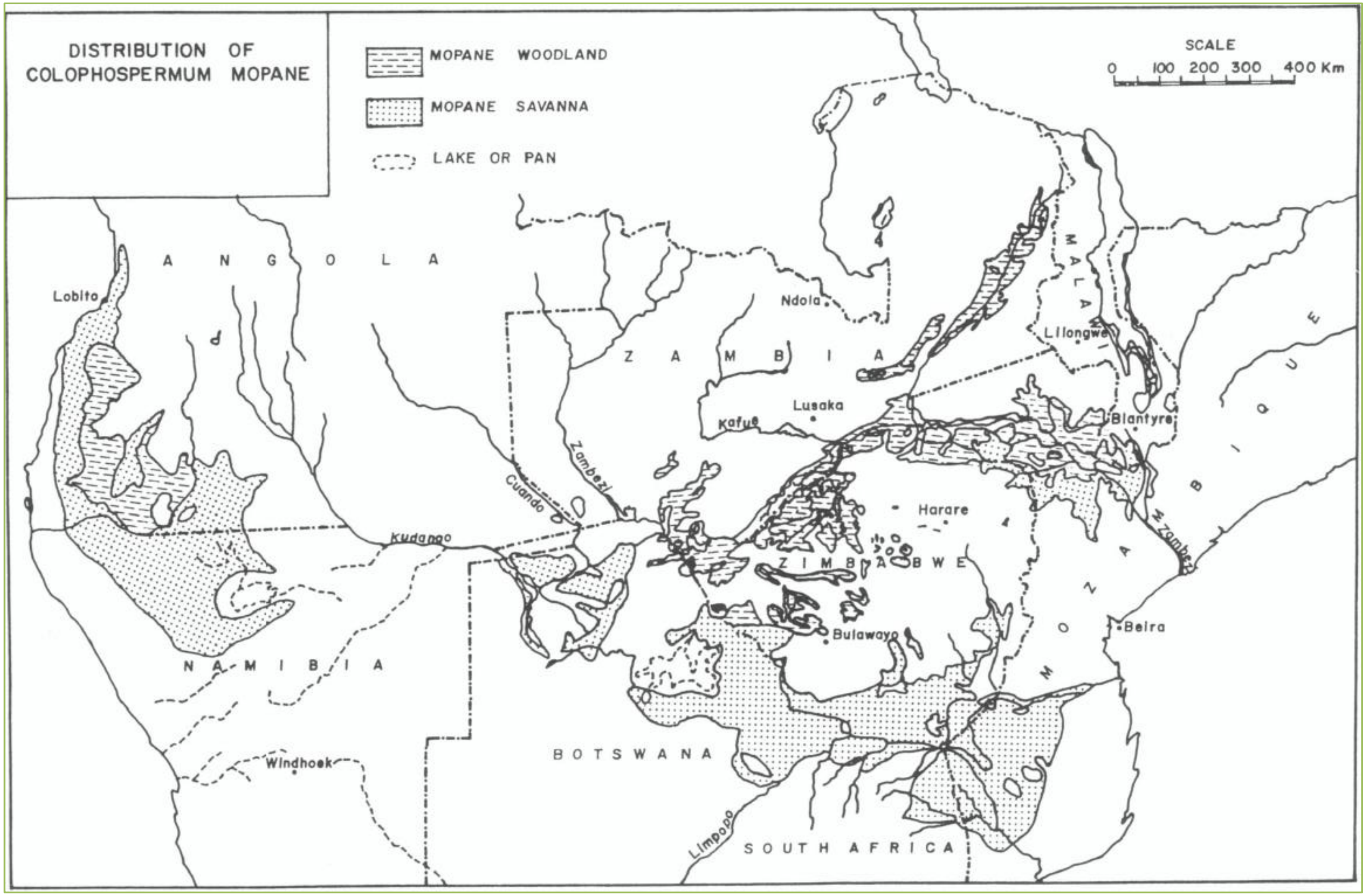


Figure 5: Natural distribution of C. mopane in southern Africa (from Mapaure, 1994).

3.2 Size/age Structure of *C. mopane* in VMWR

A total of 2541 *C. mopane* (both trees & shrubs) was assessed in 109 random sampling plots, across all the 3 sampled sections of mopane (**Table 3)**.

Table 3: Assessed mopane trees across mopane sections of VMWR.

Section	Approx. Area (km²)	No of Plots (20×30m)	Number of *C. mopane*		Total trees assessed
			Trees (>2 m high)	Shrubs (≤2 m high)	
A	49	39	809	74	**883**
B	39	36	841	75	**916**
C	33	34	701	41	**742**
Total	**131**	**109**	**2351**	**190**	**2541**

In terms of size, *C. mopane* trees were almost equally represented in all sections with evenly distributed mean proportions (7.0-7.6%) across DBH classes, except for the larger girth size which had the least proportion (Figure 6). This means that more than one size class of mopane predominates in Vwaza demonstrating a balance of age/size classes.

Mean dominant height was in the range of 12-13m, although the majority are between 8-12m with a basal area between 22 and 24 m²/ha (Table 4). All vegetative attributes of *C. mopane* did not significantly differ across sections except for stocking density (P=0.036), which was highest in section B (Table 4).

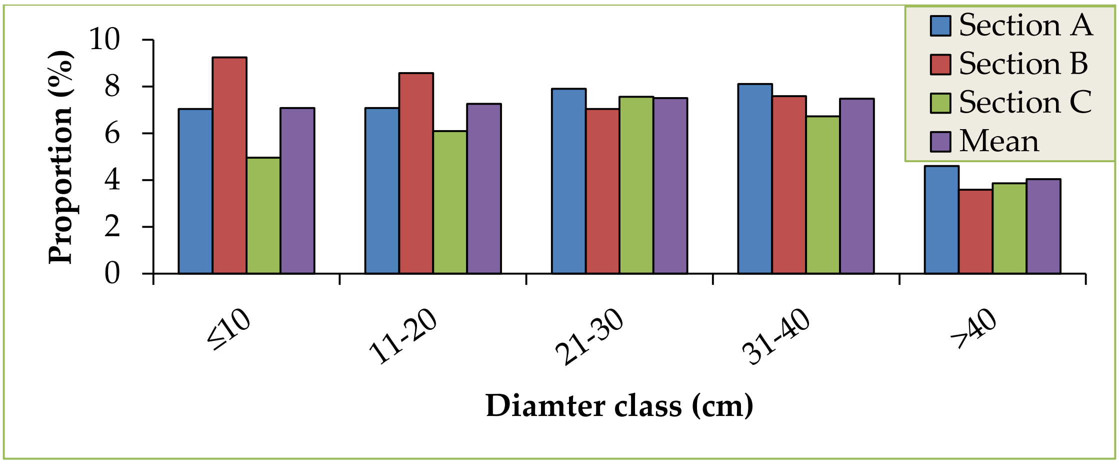


Figure 6: Percent frequency distribution of diameter class of C. mopane trees in VMWR.

Table 4: Vegetative attributes (mean ± standard error) of C. mopane in VMWR

Variable	Section A	Section B	Section C	P-value
Dominant height (m)	12.54(±0.19)	12.41(±0.16)	12.35(±0.16)	0.720
Basal area (m²/ha)	23.58(±1.42)	23.04(±1.28)	22.08(±1.06)	0.935
Stocking density (m²/ha)	377(±12)[b]	424(±23)[a]	364(±12)[b]	0.036
Sapling[1] density (m²/ha)	153(±15)	196(±78)	103(±16)	0.384
Density of dead trees (m²/ha)	26.54(±5.08)	23.64(±4.80)	18.21(±4.13)	0.457

NB – Values (mean ± standard error) with different letter-superscripts within stocking density variable row denote significant differences.

In the field, the common phenomenon of mopane occurring in several physiognomic forms ranging from short mopane, medium mopane to tall mopane, with an even-sized appearance of stands was evident (Figure 7). Although it is commonly reported that even-sized appearance generally demonstrates episodic or cohort recruitment across mopane woodlands (Timberlake, 1995; Ghazoul, 2006), this was not supported in this study as results showed no evidence of that as more than one age/size class predominates (see Figure 6). Further scientific studies are therefore required to elucidate the concept of episodic or cohort recruitment in mopane woodlands (i.e. whether even-size stands of mopane are even-aged, and whether recruitment is episodic).

In terms of physiognomy, edaphic factors are reported to largely control mopane physiognomy, i.e. shrub versus tall tree forms (Dye & Walker, 1980; Lewis, 1991; Timberlake, 1995; Mantlana, 2002; Mlambo, 2006).

Figure 7: Physiognomic forms of C. mopane in VMWR: (A) shrub mopane, (B) medium mopane, (C) tall mopane.

[1] Sapling is defined as a seedling that has survived the dry season and enters the second growing season as a sapling (**Wigley et al., 2020**), and not exceeding 0.5 m high.

Saplings (0.5 m high) were common though patchily distributed, indicating good seed production and germination/regeneration. This is most likely due to the occurrence of a high proportion of large mopane trees (>4 m) as there is unlikely a seed supply limitation when trees exceed 4 m in height (Caughley, 1976; Lewis, 1991).

In addition, a high incidence (over 60%) of coppicing of damaged mopane trees (especially those with broken stems) and saplings was also noted with almost no mortality observed. This also is an indicative of good natural regeneration after disturbances which include periodic drought, frost, fires and vertebrate damage (Stevens et al., 2021). Repeated disturbances, however, result in the disturbed trees experiencing shifts in height and architecture (Caughley, 1976; Kennedy & Potgieter, 2003; Stevens et al., 2018; Styles & Skinner, 2000; Whitecross et al., 2012) thereby modifying woodland structure by preventing recruitment into taller size classes (e.g. Figure 12 in section 3.3).

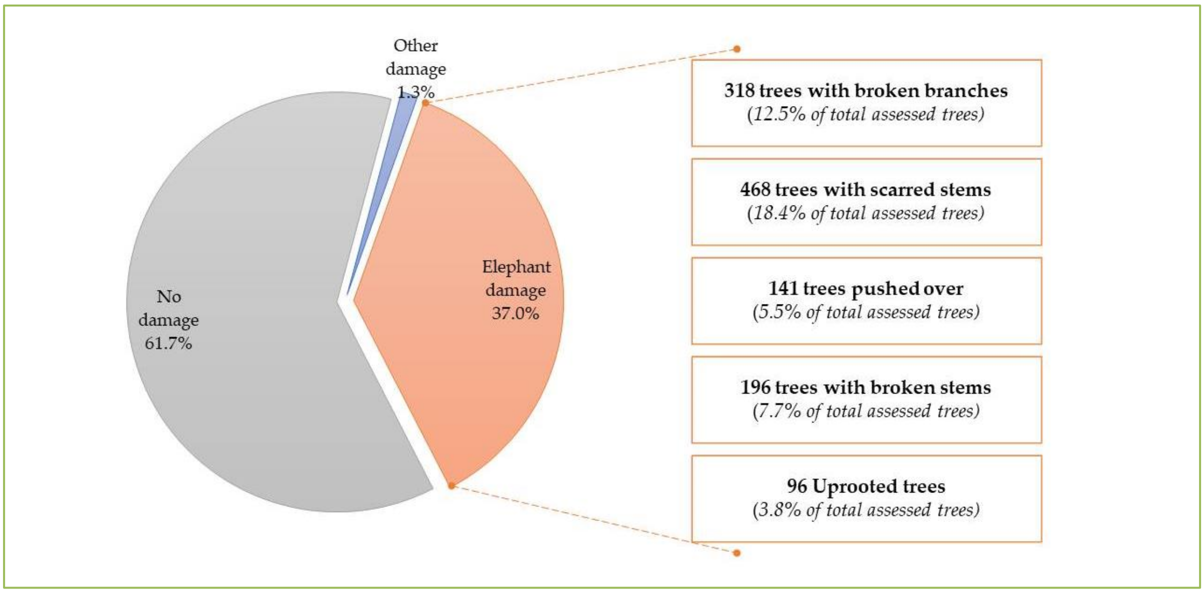
Other associated species; - A total of 31 species associated with *C. mopane* were recorded (Appendix 2). The most common (occurred in >80% of total plots) included; *Albizia harveyii*, *Acacia nigrescens, Canthium frangula, Cissus gracilis, Combretum apiculatum*, *Commiphora caerulea, Commiphora mollis, Dalbergia melanoxylon*, *Dichrostachys cinerea, Diplorhynchus condylocarpon*, *Grewia bicolor, Grewia monticola, Lannea schimperi*, *Rhus longipes, Vachellia nilotica, Xerophyta retinervis, Ximenia Americana,* and *Ziziphus mucronata.* Consequently, mopane (the most dominant species) and the other species listed above could be treated as key species for classifying the vegetation of mopane woodland in Vwaza.

Figure 8: Some of the mopane associated species; (A) Vachellia nilotica, (B) Xerophyta retinervis, (C) Sansevieria sp.

3.3 Elephant damage

As shown in Figure 9, 37% of the total mopane trees assessed (n=2541) were damaged by elephants, 2% had other forms of damage (including human induced felling and fires), whereas 61% were not damaged. There was no significant difference in the density of damaged mopane trees across all mopane sections of VMWR (P=0.340), and the level of damage was uniform (Figure 10).

Although 37% damage seems quite high (i.e. more than a third of trees damaged), it was considered low seeing as majority (20.6%) were slightly damaged whilst moderately and severely damaged trees were at 7.6% and 8.8% respectively.



NB – Total % damage type ≠ total % trees damaged due to damage overlaps.

Figure 9: Elephant damage to C. mopane species in VMWR.

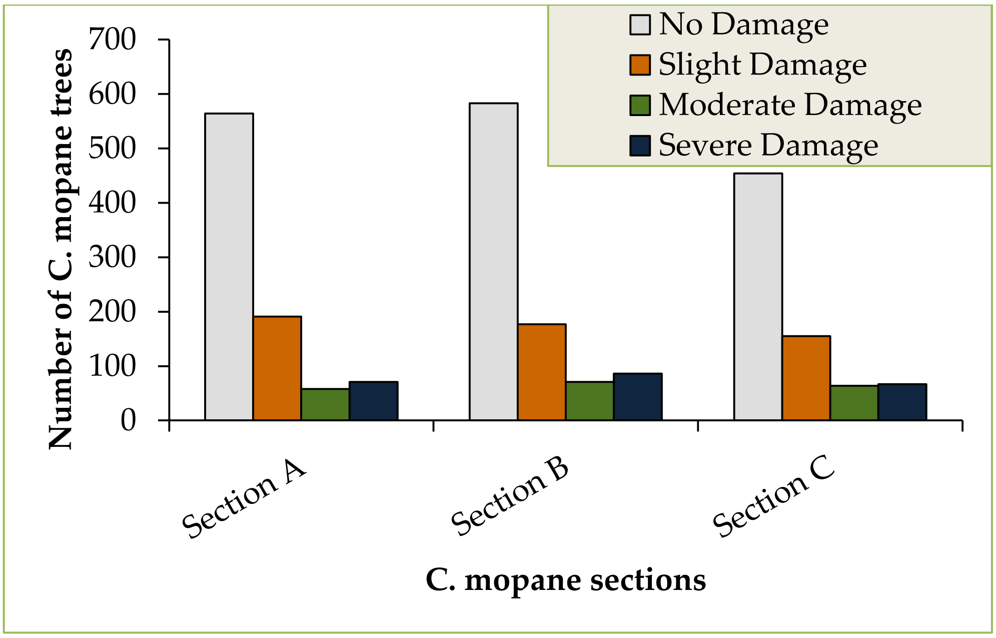


Figure 10: Elephant damage level of C. mopane in VMWR.

C. mopane species of less than 30 cm girth were the most affected while those above 30 cm girth were the least affected (Figure 11), and the damage distribution was patchy with few localized dwarfed *C. mopane* (1.5–2 m). This supports the notion that the form of elephant damage and the level of plant's vulnerability to elephants depend on the size of the tree (Smallie & O'Connor, 2000; Ihwagi et al., 2009; Gandiwa et al 2012). Furthermore, as dwarf mopane (Figure 12) is a result of continuous/ or excessive browsing, especially by elephants (Timberlake, 1995), its rarity also adds credence to the generally low level of elephant damage to mopane woodlands in VMWR.

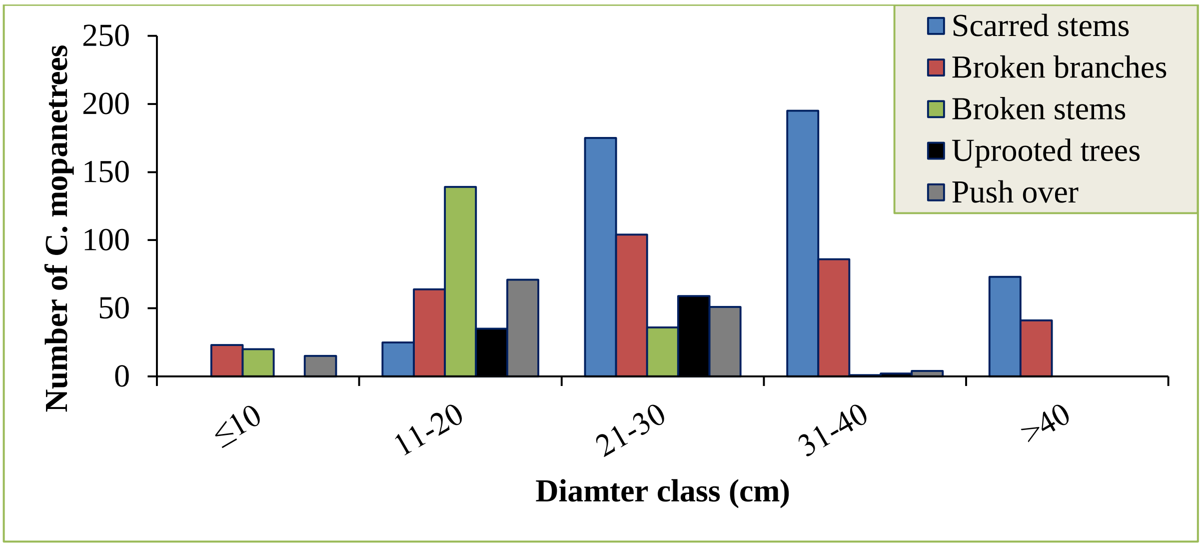


Figure 11: Distribution of elephant damage to C. mopane species by diameter class.

Figure 12: Mopane shrubs resulting from continuous browsing by elephants.

Presence of forking (below 2 m), also an indication of damage to the terminal part of the plant while it was still young (Caughley 1976), was apparent but was not quantified as elephants are not the only agents that could damage the plants at that early stage. Other herbivores such as buffalo, impala etc. and top-kill by fires as well could have contributed to the effects (Lewis, 1991; Timberlake, 1995; Stevens et al, 2021).

The low elephant damage to mopane in Vwaza could be attributed to low elephant density which is currently estimated at no more than $0.25/km^2$ as compared to the reserve's desired density of approximately $0.8(\pm0.1)/km^2$ (Anon., 2016). However, while it is likely that relationship between elephant density and damage is exponential (Anderson & Walker, 1974), the size of the elephant range, the patterns of elephant distribution, the distribution of permanent surface water, floristic and physiognomic composition of the vegetation and elephant occupancy of different habitats will all influence the pattern and scale of elephant damage (Timberlake & Childes, 2004).

For instance, seasonal site elephant occupancy appeared to have contributed to low elephant damage on *C. mopane* seeing as elephants rarely visit the mopane woodlands during the dry season (McShane, 1984; Sichinga, 2020, personal observation), the time that elephants have been observed to heavily utilise mopane (Lagendjik et al., 2005; Ben--Shahar & Macdonald, 2002; Dekker & Smit, 1996). This was confirmed by the absence of fresh damage during the dry season of the study period.

Reasons as to why elephants rarely visit mopane woodland are yet to be known. However, scarcity of permanent surface water in mopane sites during the dry season in VMWR could be one of the reasons as surface water availability has a strong influence on elephant movements (Shannon et al, 2009; Smit et al., 2007). However, further investigations into elephant seasonal - site occupancy/movements within the reserve would explain this better.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The study reveals that mopane woodlands in Malawi's Vwaza marsh Wildlife Reserve occupy approximately 12.27% (121 km^2) of the total reserve area. In its current local range, the woodlands occur in all physiognomic forms, with an almost even distribution in height and diameter classes across *C. mopane* clusters indicating a good balance between age/size classes. *C. mopane* saplings are common, as is the incidence of coppicing and presence of large (>4 m height) mopane seed trees signifying good seed production and regeneration. The extent and intensity of elephant damage is generally low (37%), with scarring and broken branches the most common. Other forms of damage were as low as 2%.

For conservation, continuous monitoring of *C. mopane* populations is strongly encouraged to keep in check the damage levels arising from both natural as well as anthropogenic sources. However, further investigation into the ecological dynamics and relationships of mopane with fauna in VMWR are recommended.

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6.0 APPENDICES

Appendix 1: Coordinates for all sampled plots in UTM zone 36, WGS 84.

Section A			
Plot Number	Latitude	Longitude	Altitude
1	546224	8783798	1067
2	545948	8782491	1088
3	546851	8782448	1109
4	547060	8780344	1111
5	547150	8780151	1110
6	547526	8778989	1110
7	545671	8785075	1058
8	544719	8788821	1108
9	544647	8788640	1113
10	546135	8780156	
11	545960	8781690	
12	544719	8788821	1108
13	544647	8788640	1113
14	546070	8779169	
15	545021	8778643	
16	544759	8780128	
17	545109	8781439	
18	544060	8781349	
19	543187	8780478	
20	542051	8781172	
21	536960	8777919	
22	538091	8778623	
23	541686	8773188	
24	541460	8772389	
25	546866	8776062	
26	547717	8776914	
27	546145	8776176	
28	543590	8779010	
29	544114	8778224	
30	545162	8778814	
31	545752	8780190	
32	543066	8780910	
33	542148	8781697	
34	541428	8781566	
35	544765	8786328	
36	543408	8788414	
37	543056	8791250	

38	542352	8790375	
39	546601	8785335	
Section B			
1	551598	8784216	1102
2	551541	8784275	1121
3	551368	8784253	1124
4	551327	8784078	1129
5	551289	8783901	1130
6	551403	8783809	1135
7	551479	8783527	1140
8	551378	8783272	1141
9	551144	8782993	1139
10	550821	8783020	1136
11	550593	8783091	1134
12	550156	8783478	1128
13	549843	8783712	1127
14	549465	8783977	1125
15	549116	8784474	1126
16	549568	8785062	1129
17	552205	8774504	1111
18	551866	8774914	1122
19	551515	8775044	1126
20	551320	8775261	1127
21	551091	8775527	1127
22	549385	8785210	1085
23	549128	8780740	1102
24	550102	8785240	1113
25	550713	8785000	1129
26	550613	8780740	
27	548469	8785115	
28	548558	8785476	
29	548891	8785729	
30	549200	8785749	
31	551837	8780391	
32	549680	8785624	
33	549900	8785845	
34	552448	8781002	
35	549888	8785504	
36	549906	8784945	
Section C			
1	544158	8767037	1042

2	544311	8767127	1044
3	544509	8767624	1060
4	543981	8767326	1094
5	547078	8769495	1097
6	544592	8769738	1092
7	544464	8770103	1099
8	544154	8770341	1112
9	543759	8769857	1104
10	543259	8770347	1103
11	540865	8771970	1113
12	548438	8774018	1113
13	548442	8733899	1111
14	548346	8773459	1104
15	548143	8772994	1100
16	548104	8772044	1100
17	547941	8771639	1098
18	547895	8770537	1100
19	547584	8770149	1100
20	542225	8770605	1116
21	542616	8772037	
22	547066	8770528	
23	544904	8771735	
24	541711	8771484	
25	540605	8773294	1103
26	539424	8774676	
27	540102	8774400	
28	538594	8775028	1098
29	537312	8776134	1136
30	537480	8777058	1114
31	546538	8769925	
32	546689	8772389	
33	547443	8773570	
34	546814	8774953	

Appendix 2: Other species associated with *C. mopane* in VMWR.

1	*Acacia nigrescens* Oliv. *[Senegalia nigrescens]*
2	*Acacia nilotica* (L) Del. subsp. *kraussiana* (Benth.) Brenan *[Vachellia nilotica]*
3	*Adansonia digitata* L.
4	*Albizia harveyii* E. Four.
5	*Balanites aegyptiaca (L.) Delile*
6	*Bauhinia petersiana* Bolle.
7	*Canthium frangula* S. Moore
8	*Cassia abbreviata* Oliver
9	*Cayratia gracilis* (Guill. & Perr.) Suesseng *[Cissus gracilis* Guill. & Perr.*]*
10	*Combretum apiculatum* Sonder
11	*Combretum molle* G. Don.
12	*Commiphora africana* (A. Rich.) Engl.
13	*Commiphora edulis (Klotsch) Engl*
14	*Dalbergia melanoxylon* Guill. & Baker
15	*Dichrostachys cinerea* (L.) Wight & Arn. subsp. *africana* Brenan & Brummitt.
16	*Diplorhynchus condylocarpon* (Muell. Arg.) Pichon
17	*Euphorbia ingens* Boiss. *[E. candelabrum]*
18	*Friesodielsia obovata* (Benth.) Verdc. *[Popowia obovata]*
19	*Gardenia resiniflua* Hiern
20	*Grewia monticola* Sonder
21	*Lannea schimperi* (A. Rich.) Engl.
22	*Philenoptera violacea* (Klotze) Schrire
23	*Rhus longispina Engl.*
24	*Sansevieria* sp.
25	*Sclerocarya birrea* (A.Rich.) Hochst.
26	*Sterculia africana* (Lour.) Fiori
27	*Vangueria infausta* Burch
28	*Xerophyta retinervis* Baker *[Vellozia retinervis* Baker*]*
29	*Ximenia americana* L.
30	*Zanthoxylum chalybeum* Engl.
31	*Ziziphus mucronata* Willd.

NB: Synonyms are placed in square brackets