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# Impact of Elephants (*Loxodonta Africana*) on Woody Vegetation Structure and Composition around Water Pans in Hurungwe Safari Area, Zimbabwe

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### Abstract

The ecology of African savanna and woodlands is largely influenced by wild animals especially elephants (*Loxodonta Africana*). Elephants have the potential to markedly alter vegetation structure and composition through their foraging and trampling activities. The study was set out to investigate the effects of elephants on vegetation structure and composition around major water pans in the Nyakasanga section, Hurungwe Safari Area (HSA) in Zimbabwe. The results indicate that elephants altered the woody vegetation density around the water pans as four out of five pans studied recorded 0.02 trees per m2. Elephants physiologically damage woody plants and some were left to gradually die. Our study findings suggest that *Colophospermum mopane* woodland around water pans in HSA is being degraded. HSA management should consider developing a monitoring program on woody vegetation through establishing plots and further studies need to be carried out on general recruitment of most affected woody vegetation.

**Keywords:** Composition; Elephants; Water pans; Woody; Structure; Vegetation

## Introduction

African savanna ecosystems in wild protected areas are largely influenced by wild angulates especially elephants (*Loxodonta Africana*) [1,2]. Elephants can alter vegetation structure and composition due to their selective and destructive feeding behaviour [1-4]. In Botswana, elephants were considered as the prominent factor influencing vegetation structure and composition due to their high preference for other woody species than others [2,4-6]. Water forms a key abiotic factor that affects the distribution of angulates in the savanna ecosystem especially in the dry season [1,7]. An increase in animal concentration around water sources risks the loss of woody vegetation from increased herbivory [1,3,4,7]. A survey in Hwange and Gonarezhou National Parks in Zimbabwe reported over utilisation of vegetation around permanent and ephemeral water sources [1,2,8]. Elephants are versatile herbivores, equipped with a unique nasal appendage, they can graze and browse effectively [1,3,4,9]. The trunk can coil around and pull up grass, pick up peas and tear off tree limbs. Tusks are also used for prying bark loose, digging pits and even caves in mineral earth to increase salt intake [3,4,9]. Rasp-like teeth grinds up the toughest grass, reeds, bark and branches.

Elephants seem to progressively target certain tree species in different habitats in which they forage [3-5]. The destruction of vegetation by trampling does not cause permanent vegetation damage because nothing is removed from the soil but affects the vegetation structure [10,11]. Elephants have a low impact on vegetation structure and composition; only trees vulnerable to elephant damage are those which are found in flatlands, open areas close to water than those on inclined and steep grounds [10]. Trees which grow on rocky outcrops, on steep slopes, amongst dense vegetation and in areas inaccessible to elephants are likely to persist unaffected [5,11].

## Materials and Methods

Hurungwe Safari Area-Nyakasanga section is situated in northernmost Zimbabwe between 16.1166º S and 29. 1623º E (Figure 1). The area is bounded by the Zambezi River on the North, Charara Safari area to the East and Mana Pools National Park to the West. The Zambezi escarpment marks the boundary between Nyakasanga and Makuti sections to the south [1,12]. The area falls within natural region 4 with an average annual rainfall of 650mm received between November and April as well as $20^{0}$ C and $38^{0}$ C winter and summer maximum temperatures respectively [1,12,13]. The soils vary from deep brown to reddish, medium-textured soils with pre-Cambrian granite and gneisses rocks as well as patches of clay loamy soils [1,14] The area is endowed with a wide variety of angulates, birds, fish and insects [1,12].

Purposive sampling was used to select 5 major water pans in the study area. Four plots measuring 20m x 30m (0.06ha) were cited on each pan and a total of 20 plots were studied. Global Positioning System was used to mark plots on the map and to show the direction on the pans. A measuring pole was used to measure trees' height in metres. A 100m tape measure was used to measure the woody plants' stem basal circumference. Plots measuring 20m x 30m (0.06ha) were used throughout the study, giving a total sample area of 12 000$m^2$ (12ha), and this amounted to approximately 7, 21 % of the study area. The plot size was determined after following Walker [15] method of having at least 15-20 trees inside a plot. Plots were permanently pegged on the ground on all study sites. Sample plots were located approximately 30m from the main road to exclude the road effects. Besides, sampling near the stream, rock out-crops and boundaries of woodlands were avoided to avoid bias in vegetation structure and composition from the already affected area. Plots which were on the northern and southern were lying at $180^{0}$ to each other and the same set-up was on the eastern and western plots. All woody plants were sampled on each plot and recorded. All data was collected in March 2019. Live plant stands were determined by having leaves, shoots and live barks whilst the dead ones were ascertained after observing the cracking barks, no live leaves and no live shoots.

Each plot was assessed once during the study and edges of the plots were maintained straight using a 100m tape measure and all information collected was recorded on the data collection sheet. The tree density was calculated by dividing the total area of the plot and the number of trees inside the plot. The percentage of elephant damage was calculated using a designed range scale [11]. Dead woody plant stands percentage was established by counting the total number of dead plant stands in the plot and dividing by the total number of woody plant stands (both live and dead) in that particular plot and converted to percentage values. The mean height on each plot was recorded by summing up the heights of woody plants and dividing by the total number of all the woody plant species in the plot. Woody species occurring within the study plots were identified using tree field guides [11]. Woody plants occurring along plot margins were included if at least half of the rooted system was inside the plot [11,15]. However, the methods used had a limitation in that there were no previous aerial photographs to show the comparison of changes in vegetation structure and composition. Analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 20 for Windows (IBM SPSS Inc., Chicago, USA). Descriptive statistics were used to analyse woody plant densities, tree heights and extent of tree damage by elephants around selected water pans.

## Results

Four water pans recorded a mean density of 0.02 trees per $m^2$ and only one pan had a mean density of 0.03 trees per $m^2$ Table 1.

**Table 1:** Woody plant stands density.

| Name of Study Pan | Woody Plant Stands Density |
|---|---|
| Madziva pan | 0.02 |
| Mhofu pan | 0.03 |
| Mhenza pan | 0.02 |
| Shunjuni pan | 0.02 |
| Zingane pan | 0.02 |

Elephants feeding caused insignificant changes in tree heights as three out of five pans recorded a mean height of 8 metres and the other two recorded an average of 9 metres and 10 metres (Figure 2). Elephants uprooted several trees in the studied plots and some trees were debarked and gradually dried up (Figure 3). Elephants destroyed some trees by rubbing themselves on the tree trunks, breaking the branches and stems.

All of the *Colophospermum mopane* which was at Madziva pan was damaged by elephants. *C. mopane* was found to have the highest damage from elephants from all sampled water pans (Figure 4). *Diospyros quiloensis* was least damaged by elephants and it was found at only two water points (Figure 4).

Forty-eight per cent (48%) of the trees damaged were damaged through ring debarking (Figure 5). Tree branch removal means of damage was the second means by which elephants destroyed the vegetation around the selected water pans. About 19 % of the trees were damaged through uprooting.

## Discussion

On average, undisturbed plots in protected areas can have an average of 0,03 trees per $m^2$ [15]. A deviation of 0,01 trees per $m^2$ on four pans may have been caused by elephants as they knock down trees and removed branches and tree barks which result in increased tree mortality. Fires and wood poaching are some of the factors associated with high vegetation destruction in protected areas. In the study area, fires and poaching are not a threat since the area is highly protected from fires and poaching challenges.


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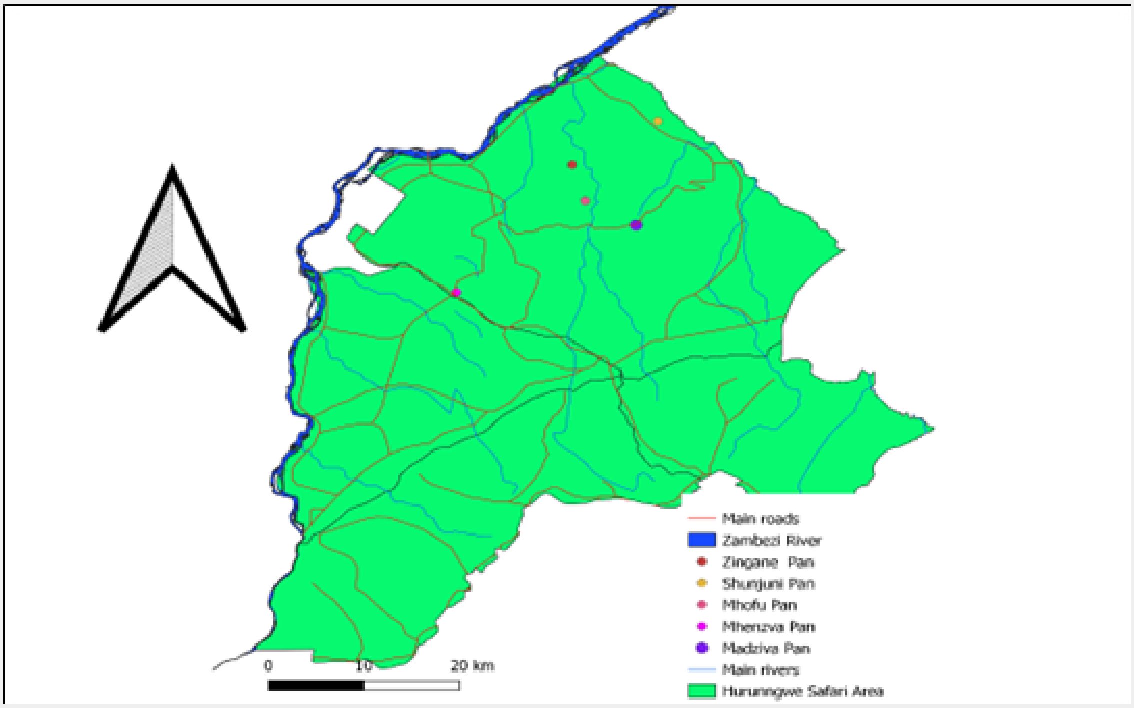


**Figure 1:** Map of Hurungwe Safari Area showing the sites of studied water pans.

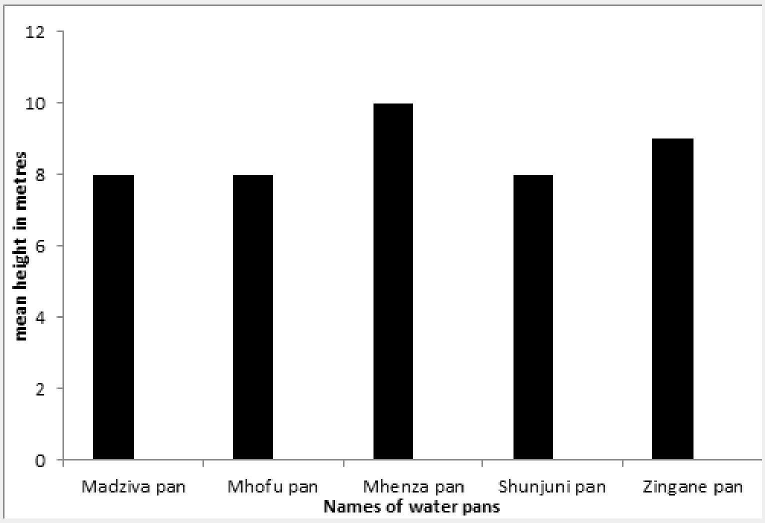


**Figure 2:** Woody plants stand mean height at different water pans.

Six metres is the maximum height at which elephants have a high chance to cause maximum damage to trees if they are standing upright [3-5]. In this regard, the studied trees recorded 2 metres extra indicating that elephants did not affected the tree heights. Structural changes are usually pronounced in the lower height strata less than 6 m resulting in individual plants having to re-grow from ground level [3,4,16]. Elephants have a selective feeding habit and this could be the reason why *Colophospermum mopane* was more severely damaged than other tree species [3,5]. Apart from that, more damage was recorded close to the water sources due to high elephant concentration. A combination of drought conditions and elephant pressure on major water points result in massive browsing, debarking and uprooting of woody vegetation [1,3,8,17]. The selective feeding nature of elephants



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may affect local tree species composition. Elephants destroyed most of the vegetation by ring debarking followed by tree branch removal. Debarking and bark utilisation by elephants could be a seasonal phenomenon [18]. Seasonal variations result in absence of grass at a certain time of the year and this may force elephants to heavily depend on browsing thus causing more destruction to woody vegetation [17,18]. Tree barks have high nutrient content and elephants feed on tree barks to supplement their nutritional requirements [16]. Feeding by uprooting trees suggests that roots contain some nutrients which attract elephants and uprooting was associated with the aggressive nature of elephants [16,18].

**Figure 3: Trees destroyed by elephants around water pans.**

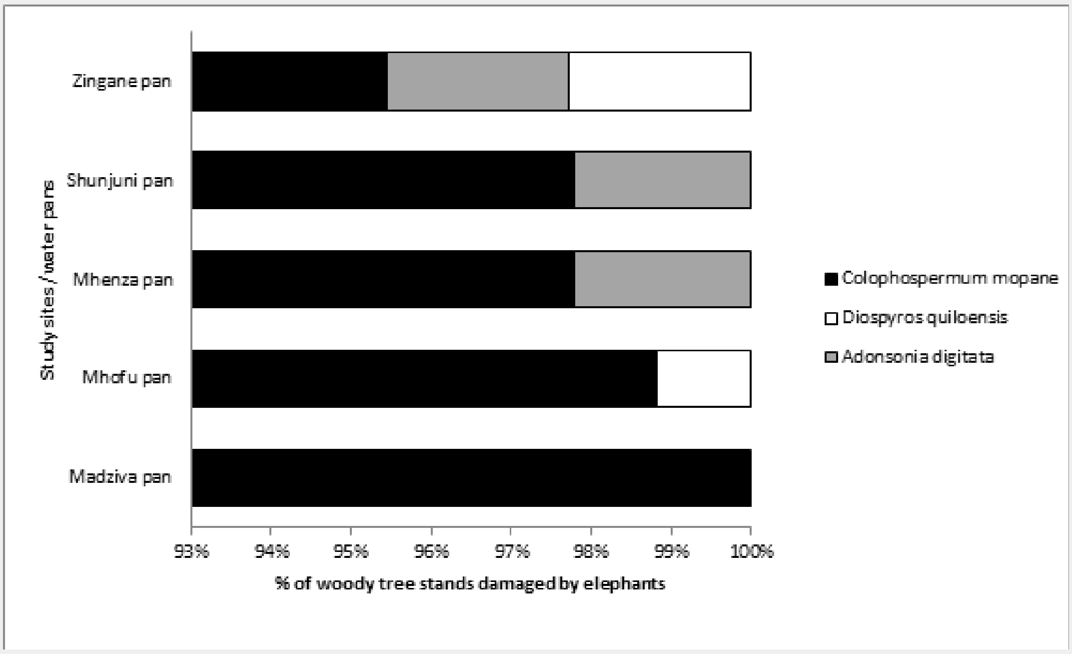


**Figure 4:** Woody plant stands species damaged by elephants around 5 water pans.


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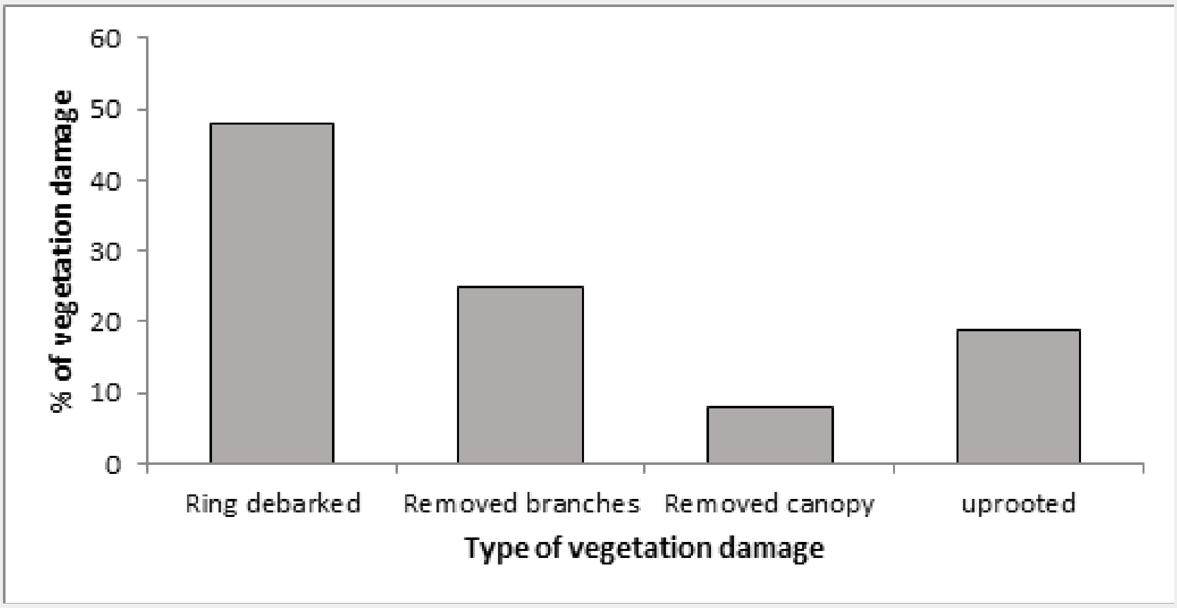


**Figure 5:** Elephant Damage classification within Nyakasanga.

## Conclusion

Elephants may have high economic and ecological value in Zimbabwe but have been noted for altering woody vegetation's structure and composition around water pans. The study shows that elephants reduced woody plant stands densities and increased the mortality rate of woody plant stands around major water pans. Elephants' selective feeding on trees could easily alter the general species diversity around the major water pans. Elephant damage was restricted to mopane trees and most serious damage was pronounced within a range of 10 metres from a water source. The study confirms that elephants do not affect the general woody plant stand height. Although elephants' feeding does not seem to affect tree height, they debarked and remove tree branches which in turn have long-term effects on vegetation growth. The study noted that most of the mortalities of woody vegetation around the major water pans were related to elephant feeding and other activities like rubbing on trees and uprooting trees. Trees mortalities were either gradual after trees were debarked and removed branches or sudden after the trees were uprooted and broken. The study recommends continued monitoring using photo panoramas at selected water points and future research should investigate the growth rate of damaged woody vegetation on specific woodlands in Zambezi valley. Management should also develop a monitoring program on woody vegetation through establishing plots and further studies need to be carried out on general recruitment of most affected woody vegetation.


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