ELEPHANTS AS AGENTS OF TREE DAMAGE AND FOREST DYNAMICS IN BWINDI IMPENETRABLE NATIONAL PARK

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INTRODUCTION

- The population of elephants (*Loxodonta africana*, Blumenbach) in Bwindi has been estimated to be 20 (Butynski, 1986), 22 (Babaasa, 1994) and 40 – 50 (Plumptre *et al*., 2008)
- Little information is available to show interaction of elephants and vegetation
- Elephant activity is localised around Mubwindi swamp and its environs
- Elephants and other mega herbivores are key stone species influential in shaping ecosystems (Bond and Loffel, 2001)
- This study set out to document elephant impacts on trees and to evaluate the associated ecological implications.

RESEARCH PROBLEM

- Elephant damage was evident along trails

a) Toppling

b) Bark stripping

c) Branch breakage

d) Trampling

OBJECTIVES

- **Main objective**: Determine the impact of elephants on trees of BINP
- **Specific objectives**

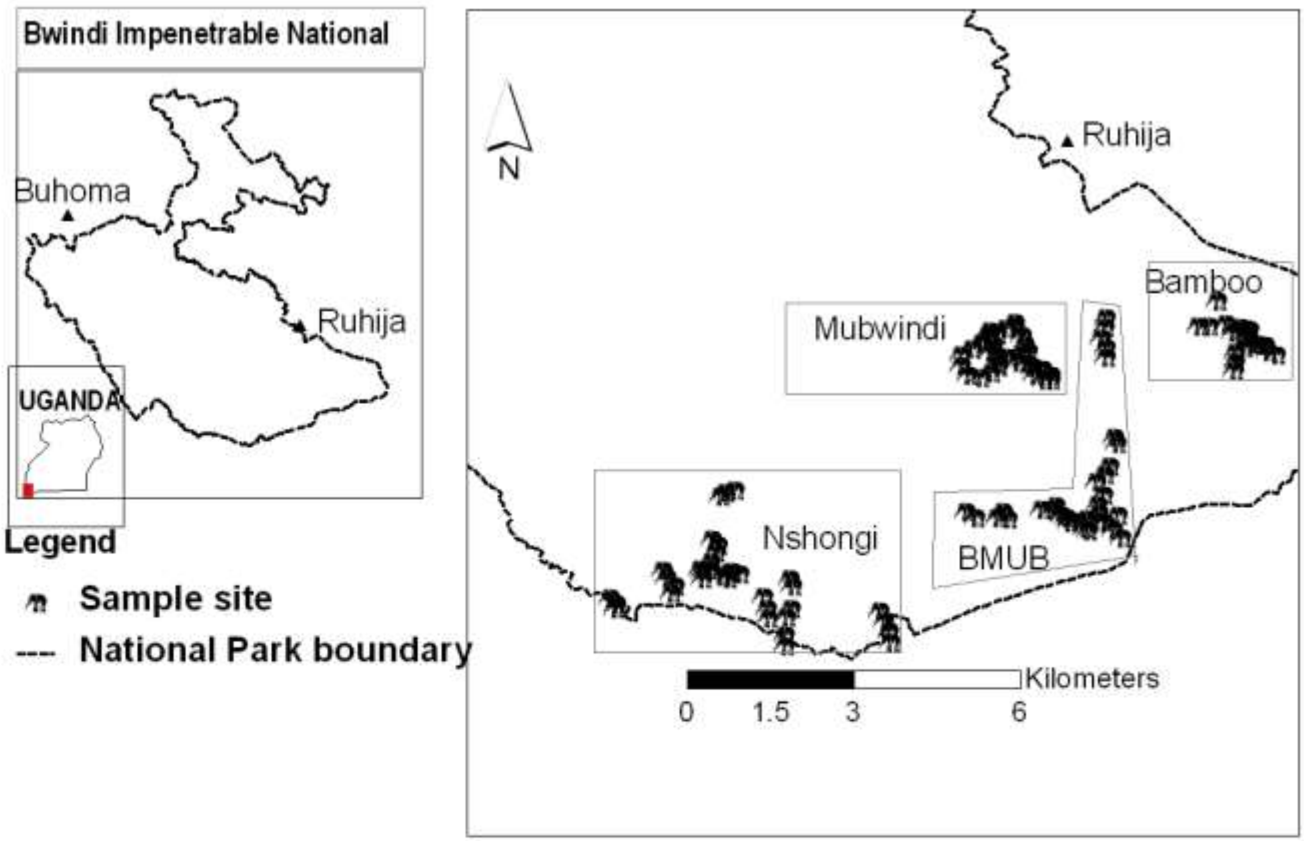
(1) To find out how different types of elephant damage vary across tree species and size classes

(2) To determine how elephant impacts vary among sites

(3) To evaluate factors influencing elephant impacts across sites

STUDY AREA: BWINDI IMPENETRABLE NATIONAL PARK

- Field work was conducted in four study sites located in the southern sector of the park



METHODS

- Sampling plots (80 m^2) were replicated every 200 m along fresh elephant trails

a)Laying a plot

b) measuring dbh

c) Area trampled

d) Seed in dung

ANALYSIS

- The data were analysed using Minitab 15 and R 2.6.0.

- Chi-square tests were used to find out differences in relative counts of elephant damage among species, size classes and sites (Sokal & Rohlf, 1996).

- Preference ratio (PR) of each tree species and size class was calculated for each impact type as described by Viljoen (1989):

  PR =PU/PA, where, PU = percent utilization, PA = percent availability.

- GLM test was performed to determine the variation of elephant impacts according to percentage of damaged stems in the plot with respect to nearest distance to forest edge, distance to closest water source, stem abundance, tree cover, altitude, terrain slope and basal area

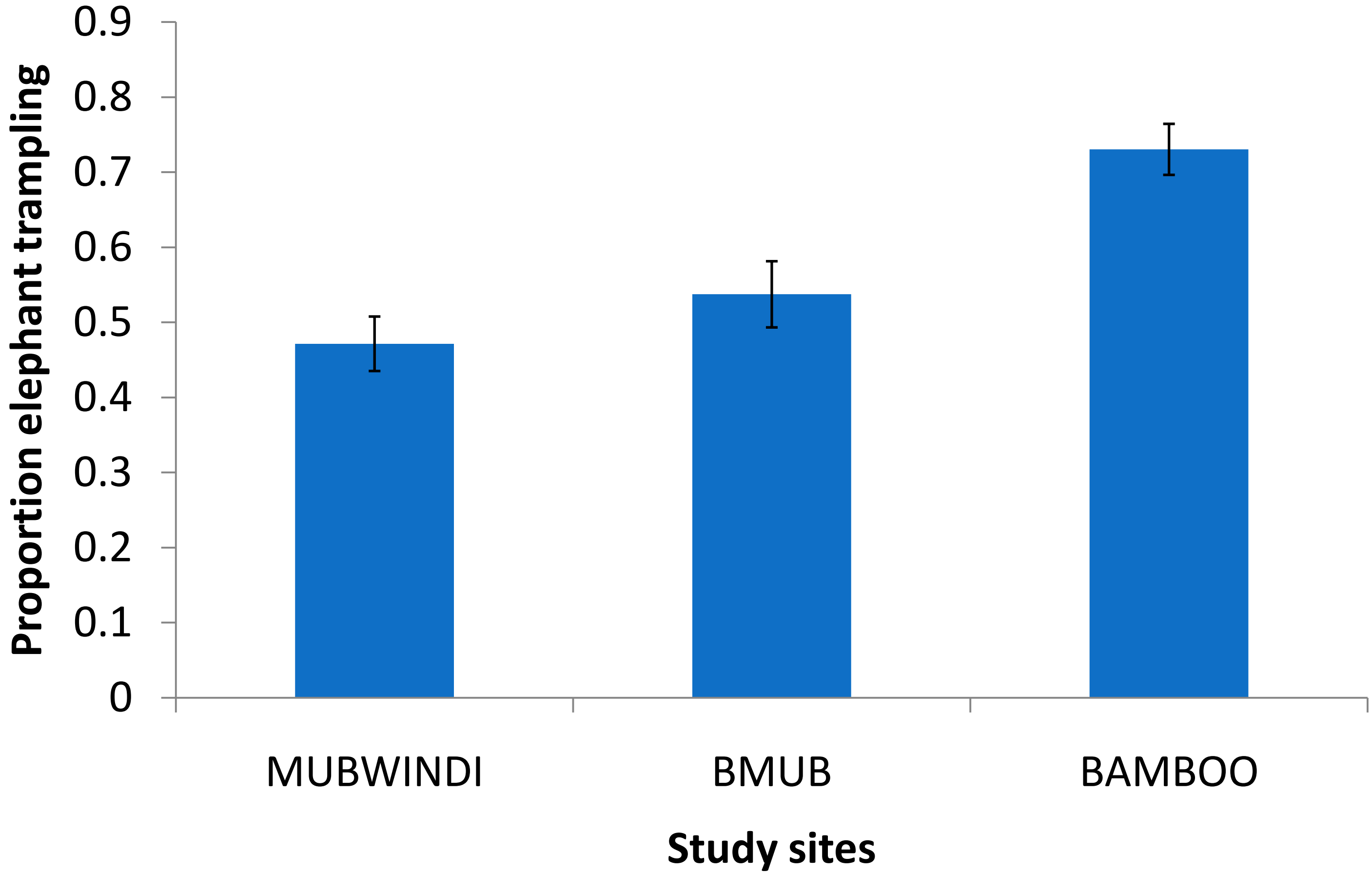
- Modelled per stem probability of a given tree being damaged using generalised linear models (McCullagh & Nelder, 1989) with a logit link function (logistic regression)

Seeds recovered from elephant dung across sites

Species	Number of dung piles	Number of seeds	Seeds per dung pile
Allophyllus griseotomentosus	2	19	9.5
Lagnaria sphaerica	28	110	3.9
Solanum anguivii	7	17	2.4
Ampelocissus africana	7	12	1.7
Myrianthus holstii	5	6	1.2
Galiniera saxifraga	3	3	1.0
Unidentified (damaged)	4	5	1.25

Tree species

Proportion of trampled ground in three study sites



Preference ratios for any elephant impact across tree size classes

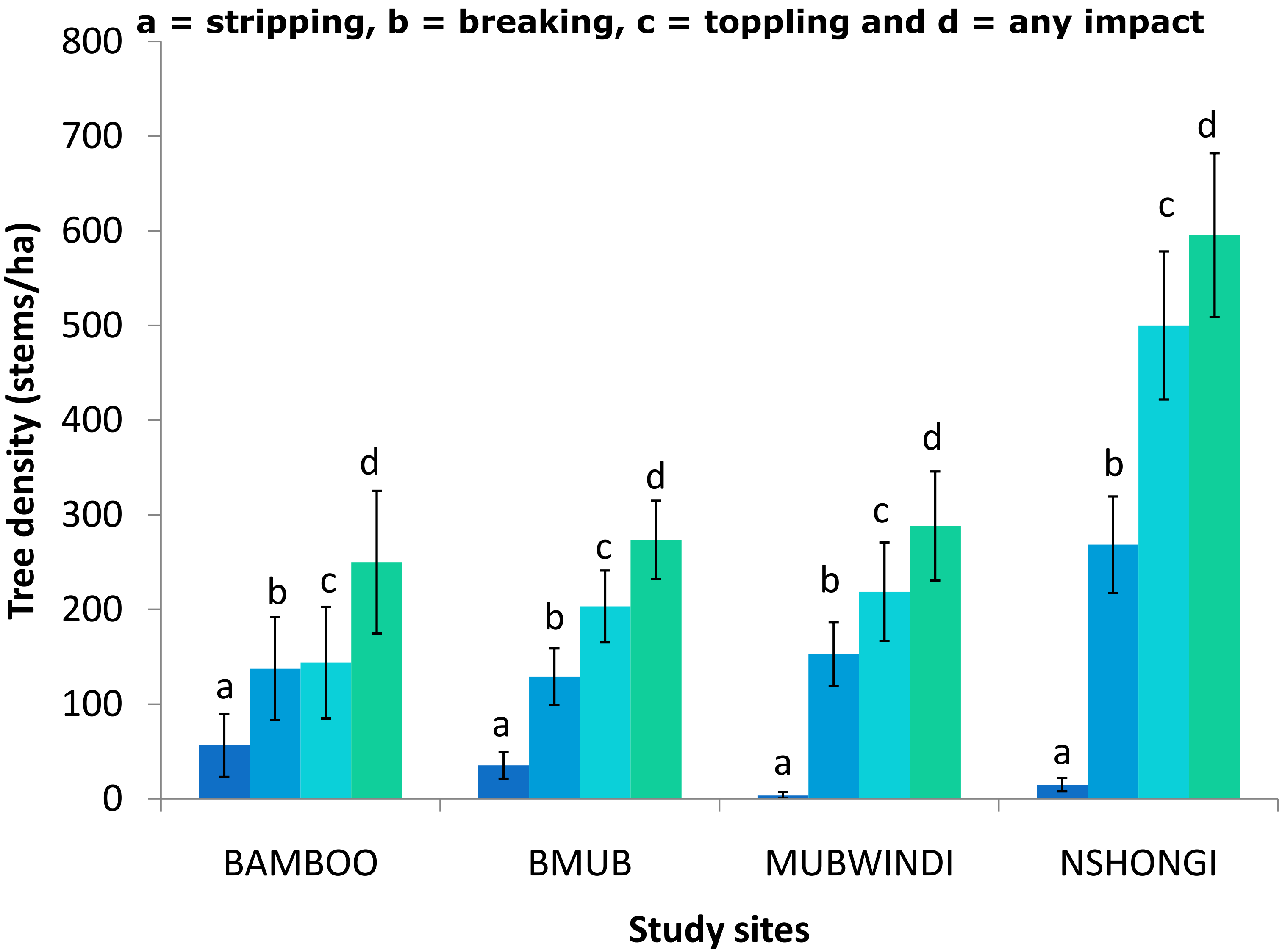
Size class	Available absolute	Utilized absolute	Available proportion	Utilized proportion	Preference ratio
2 – 9.9 cm*	623	304	0.705	0.856	1.22
10 – 19.9 cm	120	33	0.136	0.093	0.68
20 – 29.9 cm	50	9	0.057	0.025	0.45
≥ 30cm	91	9	0.103	0.025	0.25

Selected

Trees preferred for bark stripping, stem toppling or branch breaking

Species	Preference ratio for stripping	Preference ratio for toppling	Preference ratio for breaking
Xymalos monospora[2,3]	0.00 (0/17)	6.04 (5/17)	5.03 (6/17)
Syzygium guineense[1,3]	3.80 (4/12)	0.00 (0/12)	1.43 (1/12)
Psychotria mahonii[1]	3.47 (7/23)	0.00 (0/23)	0.74 (1/23)
Macaranga kilimandscharica[1,3]	2.07 (2/11)	0.00 (0/11)	1.55 (1/11)
Neoboutonia macrocalyx[2,3]	0.00 (0/33)	2.07 (2/33)	1.04 (2/33)
Faurea saligna[1]	1.04 (1/11)	0.00 (0/11)	0.00 (0/11)
Podocarpus milanjianus[1]	1.04 (1/11)	0.00 (0/11)	0.00 (0/11)
Olinia rochetiana	0.00 (0/16)	0.00 (0/16)	0.00 (0/16)
Cassipourea gummiflua	0.00 (0/13)	0.00 (0/13)	0.00 (0/13)
Rapanea melanophloeos	0.00 (0/13)	0.00 (0/13)	0.00 (0/13)
Strombosia scheffleri	0.00 (0/11)	0.00 (0/11)	0.00 (0/11)

VARIABILITY OF ELEPHANT IMPACTS AMONG SITES



Best GLMs explaining elephant stripping

	Estimate	Error	Probability
Model 1. $P(\text{stripping}_i) = \text{constant} + \beta_1 DBH_i + \beta_2(\text{Dperm}) + \text{as.factor}(\text{site}_i) + e_i$, AIC = 167.41			
Intercept	-1.71E+00	7.06E-01	0.0154
DBH	3.46E-02	8.98E-03	0.0001
Permanent water	-1.44E-03	8.29E-04	0.0819
BMUB (i.e. site)	-1.21E+00	5.18E-01	0.0198
Nshongi (i.e. site)	-2.58E+00	7.06E-01	0.0003
Model 2. $P(\text{stripping}_i) = \text{constant} + \beta_1 DBH_i + \beta_2(\text{slope}) + \text{as.factor}(\text{site}_i) + e_i$, AIC = 167.68			
Intercept	-2.09448	0.57207	0.0003
DBH	0.033893	0.009141	0.0002
Slope	-0.02623	0.016455	0.1109
Model 3. $P(\text{stripping}_i) = \text{constant} + \beta_1 DBH_i + \beta_2(\text{Dwater}) + \text{as.factor}(\text{site}_i) + e_i$, AIC = 168.32			
Intercept	-3.38346	0.623242	5.67E-08
DBH	0.037224	0.009065	4.02E-05
Any water source	0.003385	0.002243	0.1313

Model explaining toppling by elephants

	Estimate	Error	Probability
Model: $p(toppling_i) = constant + \beta_1 DBH_i + as.factor(site_i) + as.factor(species_i) + e_i$, AIC = 810.7			
Intercept	2.10317	1.02819	0.0408
DBH	-0.19131	0.02543	5.36E-14
Drypetes gerrardii	-2.80611	0.97042	0.0038
Neoboutonia macrocalyx	-2.75412	1.14224	0.0159
Teclea nobilis	-3.39404	1.42084	0.0169
Syzygium guineense	-3.07581	1.42857	0.0313
Psychotria mahonii	-2.04203	1.02585	0.0465
Cassipourea gummiflua	-1.82392	1.03434	0.0778

Model explaining branch breakage by elephants

	Estimate	Error	Probability
Model: $P(\text{breaking}_i) = \text{constant} + \beta_1 \text{DBH}_i + \text{as.factor}(\text{site}_i) + \text{as.factor}(\text{species}_i) + e_i$, AIC = 723.59			
Intercept	-0.447	1.19	0.7073
DBH	-0.0836	0.0162	2.34E-07
BMUB (site)	-1.08	0.430	0.012
Myrianthus holstii	2.51	1.24	0.043
Alangium chinense	2.63	1.41	0.0618
Allophylus macrobotrys	3.37	1.80	0.0618
Xymalos monospora	1.96	1.15	0.089

CONCLUSIONS

- Elephants are selective in where and how they feed
- Elephants were targeting the large and usually less abundant trees for stripping. Trees toppled or with broken branches were usually small and abundant.
- Elephant damage was not evenly distributed by location, with more stripping occurring in Bamboo whilst more toppling and breaking occurred in Mubwindi, Nshongi and BMUB.
- Habitat change mediated by elephants may not homogenize the park’s vegetation but rather lead to increased habitat patchiness.

RECOMMENDATIONS

- A plant centred study is needed to ascertain the extent of tree mortality, survivorship of recruits and the progress of individual trees after they have been damaged.
- A study on physiological changes and phenology of the trees preferred by elephants is recommended to understand factors that drive elephants to damage trees
- Investigate elephant crop raiding patterns and the relationship with quality of the preferred food items in their natural habitat.
- Actively remove ferns (*P. aquilinum*) that tend to persist as a result of elephant trampling
- Investigate the status of the soil seed bank and nutrient availability or absence in the soils of trampled sites
- Periodically monitor the trend of natural tree regeneration to establish the potential of BINP to provide elephants' foraging needs in the long term.
- Investigate the interaction of anthropogenic activities, such as wild fires and illegal harvesting, and elephant impacts in BINP
- Further clarification of how elephants contribute to or subtract from other conservation values in BINP.

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