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FACTORS INFLUENCING ELEPHANTS TO DESTROY FOREST TREES ESPECIALLY *Olea africana*: THE CASE OF NGARE NDARE FOREST RESERVE IN MERU COUNTY, KENYA

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Abstract

Elephants are terrestrial mammals which adapt to many habitats ranging from forests to deserts. At birth an elephant weighs up to 120 kg and an average of 4,000 to 6,500 kg at maturity. Elephants are herbivorous and their feeding pattern greatly impact on vegetation. This study examined factors which lead elephants to destroy trees such as Olea africana in the forest. The study was undertaken in Ngare Ndare forest reserve covering 5,554.3 hectares in Meru County. Objectives of the study were; to establish relationship between feeding habits of elephants and destruction of O. africana, to establish the relationship between behaviour of elephants and destruction of O. africana, to describe the significance and status of forests in relation to elephant destruction and finally to determine whether there are other tree species destroyed by elephant in forests. A qualitative research design was used in the study and data was collected using questionnaires, interviews and observation. Data was sorted out, edited and analyzed using Statistical Package for Social Scientists. Presentation of data was done using tables, frequencies and percentages. The study found that elephants destroy more trees during dry periods compared to wet seasons as supported by 64(93%) out of 69 sampled respondent in forest user category and 100% of respondents in forest and wildlife manager's category. Increase in elephant numbers observed by 67(97%) respondents out of 69 was a key reason for increased destruction by elephants. 38(55.1 %) out of 69 respondents held that elephants prefer O. Africana as food compared to other tree species while behavior of elephants especially rogue/lone elephants accounted for 54% (37/69 respondents) of forest destruction. The study concluded that increasing elephant numbers and elephant's behaviour were key factors in forest destruction.

Key Words: *Elephant, Destruction, Forest, Tree, Behaviour, Feeding*

Introduction

Nature is a delicate balance and needs to be maintained by all people as they strive to meet their needs in an ever scarce resource world. Ecosystems function best when all the components are allowed enough space and resources to play their natural functions. This stresses the fact that inter-dependence and synergy creation is at the center of maintaining a healthy ecosystem. Key component of the ecosystem is forests, which as defined by Hansen (2001) is a land area where trees are the dominant or most obvious type of

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vegetation. Some areas of the forest may have a heavy growth of trees. The and perennial plant at least 15 feet tall at maturity and at least 3 inches in diameter, with more or less recognizable crown of foliage (Michael 2008). The value of forests to man and the ecosystem is underscored by direct, indirect and intrinsic benefits it provides. These benefits include provision of timber, firewood, water, recreation, employment, wildlife habitat, tourism, plant and animal genetic materials, pharmaceuticals and industrial purposes, grazing and non-wood forest products (Ogweno *et al*., 2008). The indirect benefits include water catchment protection, carbon sequestration, nutrient cycling, and protection of soil and the reduction of air pollution. The intrinsic values are associated with the existence of a forest in an area. The values include cultural/religious, sacred trees and shrines, aesthetic and heritage values.

Forests have many threats ranging from diseases to insects. Gripne and Ward (2001) reported that forest benefits can be threatened by many factors including harmful insects such as spruce budworm, gypsy moth and southern pine beetle: tree diseases such as chestnut blight, and pine root rot, fire, pollutants, exotic species invasion, and damage by wildlife and storms. To obtain maximum benefit from forests, there should be a conscious effort to avoid all these threats. However, threats like fires, diseases and wildlife damage are more serious than others and require greater attention.

Wildlife, which includes all non-domesticated plants, animals and other living organisms, forms part of the ecosystem. Wildlife such as elephants (*Loxodonta africana*) has great impacts on the environments in which they live for instance forests. Elephants are herbivore definition of a tree adopted in the study is a woody, single stemmed, self supporting requiring a lot of food daily. Beverly (2011) noted that elephants need a lot of space with their food, which is composed, of grasses, trees and shrubs. According to WWF (2010) forest elephants are essential for germination of many forest tree species. The seeds of some tree species can only germinate after passing through the digestive tract of the elephants. The report also noted that the forest elephant's diet varies from season to season and between regions, but often a wide variety of trees and fruits.

Mount Kenya region is estimated to have about 7,000 elephants (Straziuso, 2010). The area on the northern side of Mt. Kenya forest is composed of conservancies which also have elephants. In Lewa Wildlife Conservancy (LWC) the number of elephants has increased from 10 elephants observed in April 1991 to 392 observed in March 2006 (Chege 2011). The variation of elephant numbers in LWC is attributable to migrations to the Ngare Ndare forest and adjoining conservancies such as Borana farm in search of pasture. Elephants are able to communicate with one another using sound both as high-pitched squeals and grunts (audible to humans) and as low-pitched infrasound (15-35 HZ inaudible to humans). Infrasound pass through the ground as well as through the atmosphere, and they can be felt through the feet of elephants over long distances of up to 10 kilometers (Blatchford, 2009).Based on this finding it can be deduced that elephants will be able to communicate when they find valuable edible material thus attracting others to the sites. When numbers grow then the impact on the environment is bound to be enormous often detrimental.

The negative effect of elephants feeding behavior is overexploitation of the particular plant material if it fails to get adequate time for regeneration. The end result is the appearance of large open areas devoid of vegetative cover leading to desertification.

Study Area

Ngare Ndare forest reserve lies between 0° 07′N to 0° 10′N and 37° 18′ E to 37° 27′E (Ruhiu, 1998). It is approximately 250 Km North of Nairobi off the Nairobi – Isiolo highway. The forest is south of illingwesi group ranch and west of Meru National Park as shown I figure 1.

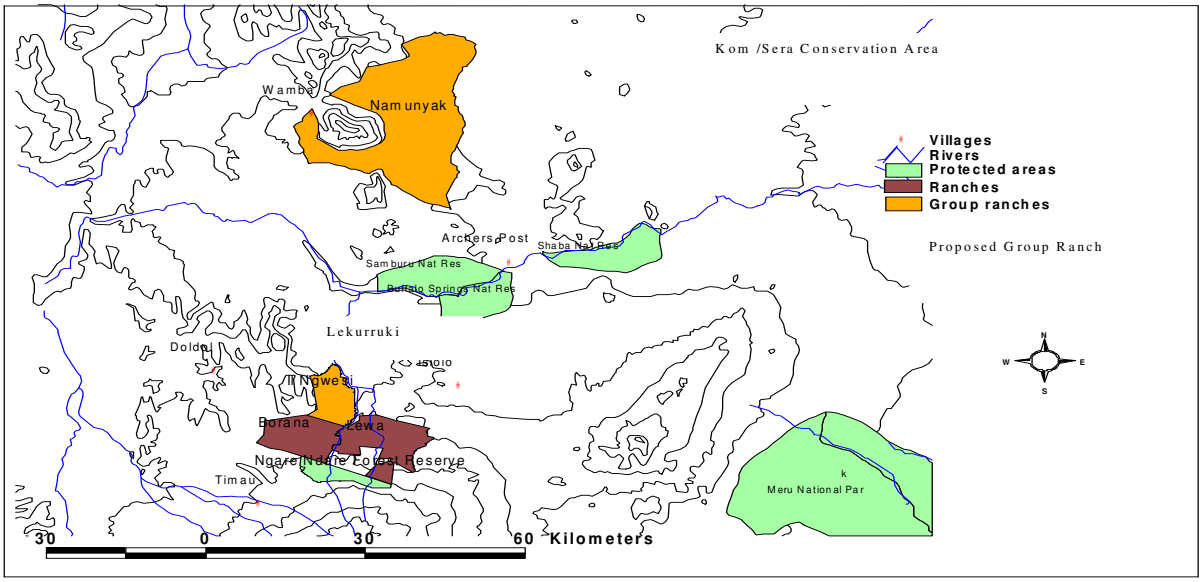

Figure 1: Location of Ngare Ndare Forest Reserve
Map adopted from NNFT (2009)

Methodology

Experimental Design

The study utilized qualitative as well as quantitative research designs. A qualitative research design includes techniques and measures, which do not produce discrete numerical data (Mugenda and Mugenda 2003). The research did not only focus on documenting the phenomenon or report on it but also developed a better way of understanding the phenomenon of elephants destroying *O. africana* trees species. The qualitative part of the research further strengthened the findings of the study.

Data Collection

Experts such as the KFS forester, KWS warden and Management Committee Members of Ngare Ndare Forest Trust were targeted to provide technical information related to this study. Other target groups were institutions bordering the forest reserve such as the Kisima farm and Bill Woodley Mount Kenya Trust (BWMKT) that have joined hands with NNFT to construct an elephant corridor linking Mt. Kenya forest to Ngare Ndare Forest reserve.

Purposive sampling and stratified random sampling techniques were used to ensure representativeness of the population. Purposive sampling enabled selection and concentration of efforts in particular areas to obtain information. This is because within the forest there are areas where elephant damage is more pronounced than in other sections. Stratified random sampling was carried out at random from

each stratum of the stratified sections of the forest. The forest is divided into 6 sections each under the stewardship of a Community Based Organization (CBO). Under each CBO there are 7 resource linked user groups such as water users, firewood collectors, herdsmen and beekeepers and herbalists.

Two sets of structured and unstructured questionnaires were used for data collection. The first set was for the community members who are key beneficiaries of the forest resource while the second set was for the managers of the forest resource such as the management committee members of NNFT, KFS forester and KWS warden in the area. The other method that was used is direct observation. The researcher counted number of trees destroyed by elephants within selected strata.

Eight open ended questionnaires for forest and wildlife managers were issued out and 6 questionnaires returned representing 80% return rate. Out of the 80 forest resource users sampled, 69 questionnaires were returned representing 86.3% return rate. The average return rate for questionnaires was therefore 83.2%.

Validity of Research Instruments

Validity which is the extent or scale to which a question or scale is measuring a concept, attribute or property was considered. According to Gatumu (2009) when a research has internal validity it means any relationship, may it be casual or otherwise, observed between two or more variables should be meaningful in its own right, rather than being as a result of something else or a third variable (extraneous variable). External validity on the other hand is the degree to which results of a research can be generalized to the entire population. To ensure internal validity, the research instruments were shared with expert(s), in this case my supervisor whose professional input ensured the instrument was well constructed to measure what it was intended to measure.

To test validity of research instruments, Kunder-Richardson formula 20 was used

Rosenberg (1993). $K\text{-}R_{20}=\frac{K(SD^2)-X(K-X)}{(SD^2)-(K-1)}$

Where;

R=Total test X = Mean of scores

K= No. of items in the test

SD= Standard deviation of scores

This was preferred because the items were scored dichotomously.

The research ensured internal and external reliability by using research instruments that were validated through expert knowledge. Secondly, a test-retest method was applied to further validate the instrument. A section of respondents with similar characteristics was selected and the questionnaires administered to them and the results evaluated to see if they posted back the expected results [pretest and revise method (Brian and Martha 2000)]. Through this method all weaknesses, ambiguities and omissions were removed. Mulwa (2008) concurs that this improves the quality of the research instrument.

Data Analysis

Both qualitative and quantitative analysis techniques were used in data analysis. Data from structured questionnaires was edited for completeness and consistency. The data was thereafter coded so that responses were grouped and analyzed using Statistical Package for the Social Sciences (SPSS) to yield results. Data from field notes was tabulated, analyzed and conclusion made.

Operationalization of Variables

Under the research objective that sought to establish the relationship between feeding habits of elephants and destruction of *O. Africana*, there were two variables

namely source of food and source of minerals that were measured or varied to determine their effect on the dependent variable (type of tree mostly destroyed). Ordinal and ratio scales of measurement were applicable in this case that utilized descriptive and quantitative data.

The independent variables derived from the research objective that sought to establish the relationship between the behaviour of elephants and destruction of brown olive trees were rubbing off parasites, weak *O. Africana* stems, and testing of physical strength by elephants. Ordinal and ratio data on the variables was collected through observation and Interviews.

The independent variables derived from the research objective that sought to establish the existence of other tree species destroyed by elephants in Ngare Ndare forest were; increasing elephant numbers and tree species mostly destroyed. Nominal and ratio data on these variables was collected through questionnaires, observation and interviews.

Results and Discussion

To achieve its intended purpose, this research concentrated on four objectives and four research questions whose answers essentially provided the research findings.

Respondents in the forest user category indicated they enter the forest at different frequencies depending on need. This is indicated in the Table 1.

Table 1: Frequency of entering the forest

Frequency	Number of respondents
Everyday	26
Two times every week	18
Monthly	23
More than a month	2
Total	69

From this data, forest users are likely to have a lot of information regarding the destruction caused by elephants.

Elephants Main Food in the Forest

Out of the 69 sampled respondents, 28 indicated that elephant mainly destroy *O. Africana* and *Juniperus procera* tree species while 38 indicated it mainly destroys *O. African* and acacia tree species. Only 2 respondents indicated they destroy other tree species within the forest reserve. These responses show that *O. Africana* is the preferred elephant food material within the forest reserve. This data is presented in Table 2.

Table 2: Tree species mostly destroyed by elephants

Tree species	Number of trees broken
Olea africana and *Juniperus procera*	28
Olea Africana and acacia	38
Other tree species	2
Total	69

Further, 37 respondents out of 69 sampled indicated that elephants main food materials is different trees species. A further 32 respondents indicated that elephants feed mostly on different tree species and grass. None of the respondents indicated that elephant's main food material is grass. This information is represented in the Table 3.

Table 3: Elephants main food material in the forest reserve

Tree species/food material	No of respondents	Percentage
Different tree species	37	54
Grass only	0	0
Trees and grass	32	46
Total	69	100

Analysis of data in Table 3 shows that elephant's food material included trees of different species and grass

Behaviour of Elephants

In understanding elephant behaviour, the study sought to unearth other reasons apart from feeding that makes elephants destroy *O. africana* tree species. In reaction, 25 out of 69 (36%) respondents indicated that elephants rub off parasites such as ticks, 11 out 69 (16%) said they go for minerals while 22 out of 69 (32%) indicated they test physical strength and 10 out of 69 (16%) did not have an idea as to why this happens. Testing of physical strength is mainly undertaken by rogue elephants that intend to fight-off dominant males in the herd and take control. This position is supported by 46 out of 69 respondents (67%) who indicated that rogue male elephants do re-join the herd at different times after fighting off the dominant male.

However, a question aimed at finding out whether *Olea africana* tree species had any special features that made it susceptible to elephants posted the following results. 46 respondents (67%) indicated that the *Olea africana* tree species is easily broken by elephant because of its weak/brittle stems and poor root system while 23 respondents (33%) indicated that the tree is just as strong as others. From this it can be deduced that the *Olea africana* tree species is a tree with weak stems that break easily.

A question geared towards determining which elephant is more destructive between lone/rogue and those in a herd showed the rogue elephants to be more destructive as shown in Table 4

Table 4: Level of destruction by rogue and herd elephants

Category of elephant	Respondents	Percentage
Rogue/lone	37	54
Herd	32	46
Totals	69	100

Analysis of data in Table 4 shows that rogue elephants are more destructive in the forest compared to elephants in a herd. This could be attributed to anger due to isolation from the herd or a means of testing their physical strength prior to fighting off dominant bull in the herd.

The results of a question aimed at finding out the elephant carrying capacity of the forest reserve are shown in Table 5.

Table 5: Elephant carrying capacity of the forest reserve

Number of elephants	Respondents	Percentage
50	40	58
100	16	23
Over 100	13	19
Total	49	100

In the literature review, the estimated number of elephants within the lower zone where the forest reserve is located is over 5,000 which mean the carrying capacity of the forest reserve has been exceeded.

The study also found out that the elephant population is increasing in the forest gauging from the fact that 64 (93%) respondents indicated so against 5 (7%) who felt that the numbers were decreasing.

Species of Trees Destroyed by Elephants in the Forest

The study asked respondents whether there are other tree species in the forest destroyed by elephants. In response 67 out of 69 (97%) said there were other tree species destroyed by elephants while 3 respondents (3%) said there were no other tree species destroyed by elephants.

Focused group interview with 13 herdsmen within the forest also revealed that there are a number of other tree species destroyed by elephants such as *Cussonia holstii, Mystroxylon aethiopicum,* and *Acacia candelebrum.* This information is presented in Table 6

Table 6: Other tree species destroyed by elephants

Tree species	Number of respondents
Other tree species are destroyed	12
No other tree species destroyed	1
Total	13

Analysis of this information shows that elephants do not particularly target the *Olea Africana* tree species in the forest reserve.

Impact of Elephant Destruction on Forests

This study found out that elephant destruction is huge as indicated by 55% of respondents who claimed it stands at over 50 acres. The study also found that *Olea africana* tree species has the capacity to regenerate after destruction. However, given the slow growth rate of the tree species the effect on the forest resource remains significant.

The study also discovered that elephant numbers are increasing in Ngare Ndare forest reserve despite the fact that the carrying capacity has been exceeded.

Other Tree Species Destroyed by Elephants

According to this study there are many other tree species that are destroyed by elephants within Ngare Ndare forest reserve. Many of the tree species are indigenous, possibly because the forest is almost 100% indigenous. Among the tree species are *Cussonia holistii, Mystroxylon aethiopicum, Acacia candelabrum* and *Acacia xanthomphloea.*

Elephant Feeding Habits and Destruction of Olea africana Tree Species

The first objective addressed the relationship between elephant feeding habits and destruction of brown olive trees (*Olea africana*). It is therefore notable that elephants in Ngare Ndare forest reserve destroy the *Olea africana* tree species in an effort to feed themselves. This is actually supported by research findings in which 54% of respondents indicated elephants feed on grass and trees in the forest and that *Olea africana* tree species alongside acacia are mostly destroyed as indicated by 57% of sampled respondents.

Destruction of Olea Africana Trees Species and Elephant Behaviour

Elephants react differently in different situations. John (2005) argued that elephants associate in herds and those that leave the herd end up living a solitary life. This stirs-up anger in those individual elephants leading to occasional destruction of anything including trees in the forest. Michael (2001) also noted that elephants especially bulls occasionally come into a state of heightened aggressiveness called

musth. A musth elephant is primed to mate, fights other bull elephants, attacks other animals and destroys inanimate objects on its way. Findings of this study appear in line with what other scholars have written especially on the fact that male elephants test physical strength by breaking trees prior to fighting off herd bull.

Rubbing off parasites on elephant's skin also leads to destruction of *O. africana* tree species. Despite the fact that elephants do not particularly target the tree species to rub-off ticks it breaks easily hence the pronounced damage observed in the forest.

Impact of Elephant Destruction Especially on O. africana Trees on Forest Cover

Forests provide a lot of benefits to man worldwide. Hansen (2001) concurs by arguing that forests provide a wide variety of benefits and values that include wood and non-wood products, wildlife habitat, recreation, water and natural protection. However, forests are decreasing in size as shown by this study. In Ngare Ndare forest reserve, 58% of sampled respondents indicated that over 50 acres of forest cover have been destroyed. This discovery is in tandem with UNEP (2002) which indicated that in Kenya an average of 5,000 hectares of forest land is lost yearly.

This study shows that currently elephant carrying capacity in Ngare Ndare forest reserve has been surpassed despite the fact that the elephant numbers are increasing. It therefore implies that the impact of forest destruction by elephants will increase. The more than 50 acres already destroyed representing a relatively large portion of the forest considering the fact that the forest is approximately 12,000 acres (5,554.3 hectares).

Other Tree Species Destroyed by Elephants

Nature Kenya (2002), noted that elephants eat a lot of vegetation both in the forest and adjacent farmlands. Arabuko Sokoke forest for instance, which has between 80 – 100 African elephants (*Loxodanta africana*) cause a lot of damage to forest tree species and crops in adjacent farmlands. This finding is similar to this research in the sense that it showed elephants destroy different tree species such as *Cussonia holistii, Mystroxylon aethiopicum* and *Acacia candelabrum.* Shinde (2000) argued that elephants are among animal species, which can adapt to almost any habitat. This implies they rely on different tree species and vegetation as different habitats vary in composition of tree species.

Elephants (*Loxodonta africana*) are terrestrial mammals that rely on vegetation for their daily food needs. Ngare Ndare forest reserve is utilized by these mammals as a feeding ground and home. In their quest for food, elephants destroy vegetation at varying degrees during dry period and wet seasons.

Conclusions

The following conclusions were made from the study.

- Elephants feed on trees and grass in the forest
- Trees destruction by elephants is more serious during dry periods.
- *Olea africana* tree species breaks as elephants rub off parasites such as ticks.
- Elephants test physical strength by breaking trees prior to attempting to fight off herd bull in order to take over the herd as dominant male
- Impact of elephant destruction of *Olea africana* tree species is significant in the forest
- Elephant population is increasing within Ngare Ndare forest despite the fact that the forests carrying capacity has been surpassed.

- Increasing elephant population is a factor contributing to destruction of forests by elephants.

Recommendations

- Elephant population within the Ngare Ndare forest reserve be reduced through different acceptable ways such as translocation to other areas/reserves or wildlife parks with low elephant population.
- Forest regeneration should be aided in Ngare Ndare forest reserve to curb continued forest degradation. This can be done through tree planting and fencing off replanted sections of the forest until planted trees establish adequate root system to withstand certain level disturbance by wildlife.

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