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Assessment of Tree Species (*Cupressus lusitanica* and *Pinus patula)* Debarking by Monkeys in Cerengoni Forest-Block Ecosystem in Nandi County, Kenya

Ms. Barbara Mong'ina[a*], Prof. Benard Muok[b]

[a]*PG Student, Conservation Biology, University of Eastern Africa Baraton, P.O.BOX. 2500-30100 Eldoret, Kenya*

[b]*Director, Centre for Research, Innovation and Partnerships at Jaramogi Oginga Odinga University of Science and Technology. P.O. Box 210 - 40601 Bondo, Kenya.*

[a]*Email: barbaraogori@gmail.com ,* [b]*Email: bmuok@jooust.ac.ke*

Abstract

Monkeys strip the bark off the trees to feed on underlying vascular tissues, leading to the death of trees, which causes the destruction of the habitat. The main objective of this study was to elucidate information and knowledge of debarking by monkeys and their effect on the forest ecosystem in Cerengoni forest in Nandi County, Kenya. The study area is covered by 45.9 Ha of Cupressus lusitanica and 47.8 Ha Pinus patula plantations. The study employed a systematic survey, descriptive designs, and experimental designs. A random sampling technique was used where a troop population of monkeys was established, as they were crossing the observation paths. Fieldwork commenced in February 2021, and continued till May 2021. Data (type, height and age of debarking) from the two compartments involved was collected. Descriptive statistics were used to analyze the extent of Cupressus lusitanica and Pinus patula damage as a result of debarking. Frequencies and percentages were tabulated to describe the debarking of the trees based on type, height and age. A total of 73% of the sampled trees were debarked by monkeys. The monkey species that debark Pinus patula and Cupressus lusitanica in Cerengoni Forest are the vervet (Chlorocebus pygerythrus), and sykes (Cercopithecus albogularis) monkeys. The study recommended that a routine survey be conducted and data kept on the monkey debarking.

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* Corresponding author.

This will help to obtain financial losses experienced due to monkey debarking and design appropriate control strategies.

Keywords: Debarking; Monkey; *Cupressus lusitanica*; *Pinus patula*.

1. Introduction

Anthropogenic activities have increasingly influenced the ecosystem worldwide and people have gradually shaped the planet and changed the living condition and environment of other organisms [1]. Food and water also adapt to human environments and invades farm monocultures and planted forests. Omnivorous primate species are also adaptable. Such behavioral and ecological changes can often survive the adverse effects of habitat loss or fragmentation on ecologically marginalized primate populations [2]. For exotic, or natural forests (which are wholly indigenous forests and plants) (those which come from other countries), the monkey strips the bark off the trees to feed on underlying vascular tissues, destroying the habitat. This can increase the risk of viruses or insects attacking leading to tree mortality. Bark stripping behaviors, since they can cause significant economic harm to farmers, are also viewed as pests.

The xylem and phloem tissues are the cells that carry the whole plant with water and nutrients. Bark stripping therefore interrupts the carriage of water and nutrients throughout the whole plant. Bark removal is a common phenomenon in vertebrates worldwide to obtain these tissue [3]. Research showed that the *Acacia koa* bark had been stripped by *Rattus Spp* in Hawaii and Mauai Islands frequently causing death [4]. Councils tend to only strip young trees and have not been seen to ring-bark the trees, as all other destructive vertebrates have been recorded [4]. It has been reported the removal of bark from trees in North America of the snowshow hares (*Lepus americanus*) and red squirrels (*Tamiascitirus hudsonicus*) consequently they die based on the extent of girdling. The increased food shortage and forest cover associated with plantations is also responsible for this destruction [5]. It was also discovered that bark nutrients could not be accessed substantially by squirrels [6]. Studies also recorded removal and disruption to North America by voles (*Microtus agrestis*) where damages are most commonly recorded in trees six years and younger [7].

Rabbits, wallabies, rodents and possums are causing harm in Australia [8]. It was suggested that fencing will exclude rabbits which will still lead to destruction. However, possum is more troublesome [8]. McNally from his study found that two species of possum (*Trichosurus caninus* and *T. vulpecula*), a wallaby (*Wallabia bicolor*) and the allied rat (*Rattus assimilis*) were responsible for the damage [9]. He related this to the fact that the land is accessible in the plantations, which provides an adequate environment. Availability of water and the close proximity of native vegetation is an additional attraction. Exotic trees are used as a food source during times of shortage. Removal of cover should help minimize damage levels inside the plantation [9].

In Malawi, South Africa and Tanzania the bark removal of monkeys from commercial plantations was registered [10]. Estimates of damaged areas in South Africa suffered financial losses due to bad wood and other problems, including decreased damage growth. The economic losses sustained by capping and replanting of compartments should also be considered [10]. Certain regions have been affected so seriously that they are replanted twice at Storms River State Forest and in Southern Cape. RI100/ha was used for replanting in this case [10]. The samango monkey (*Cercopithecus albogularis*), the sykes monkey (*Cercopithecus mitis kolbi*) and the blue monkey (*Cercopithecus mitis*) from Malawi were other primes responsible for extracting bark from trees in commercial plantations in Africa [11]. The reduction of bark may have begun due to a sudden lack of food. Due to the poor nutritional value of the "cambium" tissues as a food component, it did not continue as a feeding trend. Bark stripping is most likely due to the taste for sapphire [12]. The beginning of the bark erosion process coincided with large natural vegetation clearances for plantations [12]. The study supported findings that bark stripping only is done by certain individuals nearest to the plantations. It also indicates that it is necessary not to eradicate natural supplies of food within the plantations, but to leave the areas of indigenous blossoms adjacent to plantation areas [13]. The occurrence of the eland (*Taurotragus oryx*) in Zimbabwe scraping the bark from pine trees [14]. He noticed that while bark removal by other vertebrates seems similar to primates, the behavior might not be similar. There is no research in Kenya on forest debarking that has been reported in particular Nandi County Cerengoni, in particular, monkeys. Based on the assumption that this type of forest is a natural mountain forest, the Old-World monkey’s primate in particular, and therefore the effects of debarking in such habitats are detrimental. This research was also to fill this divide by providing knowledge about monkeys' forest debarking.

2. Materials and Methods

a) Study Area

This study was conducted in Cerengoni forest, Northern Tinderet part which is 12, 578 Ha located between Latitude 0^0 3” and Longitude 35^0 25” of Nandi County, Rift Valley Kenya. The study area is covered by 45.9 Ha of *Cupressus lusitanica* and 47.8 Ha *Pinus patula* plantations. Cerengoni forest, has a complex topography with altitude of 2100 meters above sea level. The climate is warm, and have average temperatures of 17.4 °C | 63.3 °F. In a year, the rainfall is 1551 mm and is evenly distributed annually.

b) Study Design

This study employed a systematic survey, descriptive designs, and experimental designs. The survey areas were selected on the basis of the first-hand reports from the forest department officials (mainly the Kenya Forest Service in Nandi County) on the extent of *Cupressus lusitanica* and *Pinus patula* debarking by monkeys in the forest.

c) Study Population

A random sampling technique was used where a troop population of monkeys was established, as they were crossing the observation paths [15]. The sub compartment was selected in December 2020, as Cerengoni 1A and Cerengoni 2G with extensive debarking and successful distribution.

d) Sampling Technique

The researcher sampled ¼ of each compartment. Cerengoni A1 had a total area of 47.8 Ha. While Cerengoni 2G had a total area of 45.9Ha where ¼ of the two areas was approximately 11Ha which is equivalent to 44,515M^2. This is a representation of approximation of 210$M^{2.}$ From the 210M^2, the researcher used a belt transect at 50M^2 on the diagonal of the 210M^2 to divide the sampled are into 6 plots of 50M^2. These plots were used as the sample plots where trees in these plots were counted and used as a representative of the entire compartment.

e) Ranging Behaviour and Species Identification

Fieldwork commenced in February 2021, and continued till May 2021. Three days a week, three weeks a month was the average period spent on the forest compartments during these entire 4 months. Fieldwork relied on the location and observation of monkey troops in the ground of research. The Kenya Foresters assistants located monkeys by use of GPS and visual and auditory cues, a form of method used by the endemic people who habituate in this forest (majorly the "*Ndorobo people"*) to locate primates in this forest. All this information helped in collecting data on species identification. As a result of control operations in the study compartments, the behavior of monkey in the forests did not range. Therefore, observational information was systematically obtained, giving a first-hand information. The Kernel Worton Method (1989) was implemented to help in studying the different range of behaviors of monkeys in their groups as animals or as individuals. This helped in gathering of data to assess the distribution.

f) Feeding Behaviour

The researcher gathered information on the monkeys eating through first-hand data. The endemic people at the forest were able to give reasons for the monkeys' debarking of trees.

g) Monkey's Debarking at Cerengoni

Data (type, height and age of debarking) from the two compartments involved was investigated. Furthermore, in the two sampled compartments, all trees were examined. Presence or absence of debarking was recorded on regular data sheets and the following characteristics; Type, height and age.

h) Data Analysis

Descriptive statistics was used to analyze the extent of *Cupressus lusitanica* and *Pinus patula* as a result of debarking. Frequencies and percentages were tabulated to describe the debarking of the trees based on type, height and age. Findings obtained from debarked trees was presented through tables [16]. The data was analyzed using Microsoft excel version 2016 for windows 10, and SPSS statistical software tool version 20 to test on the significance by use of a Chi-square test method.

3. Results

a) Extent of *Cupressus lusitanica* and *Pinus patula* Debarking by Monkeys in the Cerengoni forest, Nandi County

Debarking at the Cerengoni was distributed all over the forest, of both indigenous and planted trees. Troops of monkeys were observed moving throughout the forest in all the compartments. Monkeys thus debark trees in all the compartments at Cerengoni. *Cupressus lusitanica* and *Pinus patula* form a major source of food for monkeys thus they are attracted into the forest to utilize this food resource. It is also evident that they get shelter from the forest vegetation from the fluctuating climatic condition and exposed habitat.

Table 1: Trees Debarked at the Cerengoni Forest.

Compartments	**Species**	**Age**	**Total Area (Ha)**	**Area Sampled (Ha)**	**Sampled Plots**	**Trees**	**Debarked**	**Percentage**
Cerengoni 1A	*Pinus patula*	27 years	47.8	11	**Plot 1**	43	11	25.60%
					Plot 2	32	12	37.50%
					Plot 3	34	12	35.30%
					Plot 4	12	3	25%
					Plot 5	10	4	40%
					Plot 6	32	10	31.30%
Total						**163**	**52**	**31.9%**
Cerengoni 2G	*Cupressus lusitanica*	16 years	45.9	11	**Plot 1**	24	16	66.70%
					Plot 2	11	9	81.80%
					Plot 3	20	15	75%
					Plot 4	25	16	64%
					Plot 5	18	18	100%
					Plot 6	31	20	64.50%
Total						**129**	**94**	**72.8%**

From table 1 above, the total percentage of the sampled *Pinus patula* trees debarked from Cerengoni1A compartment was 31.9%. The table also shows that the total percentage of sampled *Cupressus lusitanica* trees debarked from Cerengoni 2G compartment was 72.8%. These results, however, are not showing the extent of the debarking on individual trees.

b)Significant Difference between Total Number of Trees and Total Debarked Trees

To find out the difference between total number of trees and total debarked trees, the researcher used Pearson's chi-square test of association. This was used to discover if there is a relationship.

From the table 2 above, the study was interested in the results of the Pearson Chi-Square row. From the table above, p = .285. This tells that there is no statistically significant difference between type of trees and debarked trees that is, both total trees and debarked trees do not differ significantly.

Table 2: Chi-Square Tests.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.000[a]	10	.285
Likelihood Ratio	16.636	10	.083
Linear-by-Linear Association	.884	1	.347
N of Valid Cases	12		

c) Debarking Based on Type, Height and Age

Table 3: Debarking Based on Type, Height and Age.

Compartment	**Cerengoni 1A (*Pinus patula)***	**Cerengoni 2G (*Cupressus lusitanica)***
Trees Debarked	32%	73%
Debarked more than once	21%	60%
Type of Debarking		
Class 1.	0%	24%
Class 2.	0%	8%
Class 3.	0%	2%
Class 4.	4%	0%
Class 5.	2%	13%
Class 6.	25%	26%
Height of Debarking		
0-0.5m	2%	3%
0.5m-1.0m	3%	2%
1.0m-1.5m	2%	5%
1.5m-2.0m	4%	2%
2.0m-3.0m	4%	9%
>3.0m	17%	51%
Age of Debarking		
New Debarking	0%	30%
Old Debarking	32%	45%

d) Type of Debarking

Table 3 above gives the representation on the type of debarking. As indicated, 21% of the debarked *Pinus patula* in Cerengoni 1A were debarked more than once while in Cerengoni 2G, 60% of the debarked *Cupressus lusitanica* were debarked more than once. The table indicates that class 1, 2 and 3 debarking were recorded in Cerengoni 2G among the *Cupressus lusitanica* only. 24% *Cupressus lusitanica* were recorded to have class 1 debarking, 8% had class 2 debarking and 2% had class 3 debarking. Class 4 debarking was only recorded in Cerengoni 1A among the *Pinus patula* where 4% of them were recorded. *Cupressus lusitanica* of Cerengoni 2G recorded the highest number of class 5 debarking (13%) with *Pinus patula* of Cerengoni 1A recording only 4 class 5 debarking. Lastly, *Cupressus lusitanica* of Cerengoni 2G recorded the highest number of class 6 debarking (26%) as compared to the *Pinus patula* of Cerengoni 1A (25).

e) Class of Debarking

Class 1 Debarking Class 2 Debarking

Figure 1

Class 3 Debarking Class 4 Debarking

Figure 2

Class 5 Debarking

Class 6 Debarking

Figure 3

Generally, class 6, class 1, class 5 and class 2 debarking were the majority of debarking in Cerengoni forest station. This means that the debarking of trees in this forest station starts from removal of less than 50% of the circumference of the bark, removal of greater than 50% of the circumference of the bark, breaking of branches to healing of the trees.

f) Height of Debarking

g) <3.0m

Figure 4

>3.0m

Figure 5

From table 1 above, *Cupressus lusitanica* of Cerengoni 2G recorded the highest number of 0-0.5m height of debarking (3%) as compared to the *Pinus patula* of Cerengoni 1A (2%). *Pinus patula* of Cerengoni 1A recorded the highest number of 0.5m-1.0m debarking (3%) as compared to *Cupressus lusitanica* of Cerengoni 2G (2%). *Cupressus lusitanica* of Cerengoni 2G recorded the highest number of 1.0m-1.5m debarking (5%) as compared to *Pinus patula* of Cerengoni 1A (2%). *Pinus patula* of Cerengoni 1A recorded the highest number of 1.5m-2.0m debarking (4%) as compared to *Cupressus lusitanica* of Cerengoni 2G (2%). *Cupressus lusitanica* of Cerengoni 2G recorded the highest number of 2.0m-3.0m debarking (9%) as compared to *Pinus patula* of Cerengoni 1A (4%). *Cupressus lusitanica* of Cerengoni 2G recorded the highest number of >3.0m debarking (51%) as compared to *Pinus patula* of Cerengoni 1A (17%). Generally, majority of the debarking in Cerengoni forest station were higher than 3 meters. However, other debarking in this forest station were ranging from 0m-3m high.

h)Age of Debarking

As indicated in the table 1 above, *Pinus patula* of Cerengoni 1A did not record any new debarking as compared to *Cupressus lusitanica* of Cerengoni 2G which recorded 30% new debarking. 32% of the debarked *Pinus patula* of Cerengoni 1A were old debarking. Of the debarked *Cupressus lusitanica* of Cerengoni 2G, 45% were old debarking. Generally, the majority of debarking in the Cerengoni forest station were old debarking as compared to the new debarking.

New Debarking Old Debarking

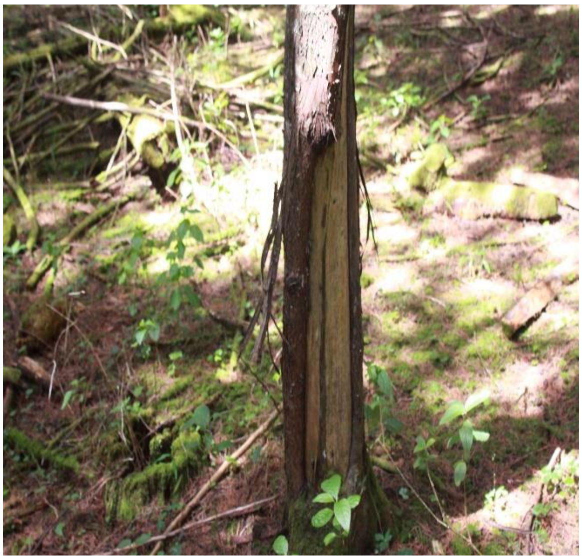

Figure 6

i) Monkey Species Debarking *Cupressus lusitanica* and *Pinus patula* in Cerengoni

The Kenya Foresters assistants located monkeys by use of GPS and radio trackers and visual and auditory cues. The visual and auditory cues is a method of identification which have been in use by the endemic people who live in this area. The researcher with the help of research assistants, interviewed people in village close to the forest and also staff from the Kenya forestry Servive, asking them to describe the primates they see in the forest and to mimic their calls. The researcher showed them photographs of different species afterwards to confirm their identifications. The researcher gathered the information about the presence of monkeys, particularly Vervet (*Chlorocebus pygerythrus*) and the Sykes (*Cycopithecus albogularis*) monkeys in Cerengoni. The researcher and research assistants walked slowly and quietly along the paths at 1km/hour, for an average of 5 hours per day. The walking was back and forth to note any visible or acoustic sign of the presence of monkeys. This was done early in the morning at 07:00H to 12:00H. When a group was detected, the researcher and research assistants stayed with the group for observation as long as possible from a distance. The researcher used

Kingdon and Largen, (1997) for the identification of species of the monkeys. Based on this observation, the monkey species that debark *Pinus patula* is Vervet monkeys and *Cupressus lusitanica* is debarked by Sykes monkeys in Cerengoni.

Ververt Monkey Sykes Monkey

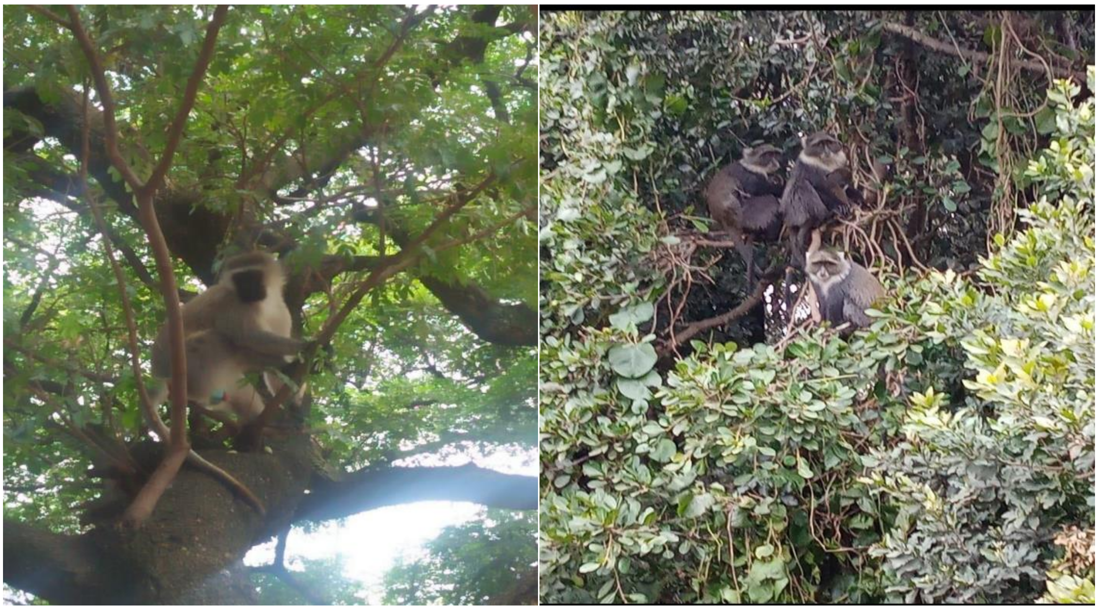

Figure 7

j) Estimated Losses Due to Debarking of *Cupressus lusitanica* and *Pinus patula*

Based on the results of the study, if not controlled, Cerengoni forest is at risk of the monkey debarking. With at a rate of 50% of the sampled trees being debarked, Cerengoni is at a risk of losing its two major species, *C. lusitanica* and *P. patula*. Economically, there is no recorded data on tree debarking in Cerengoni forest station. Therefore, these results lack secondary data for quantification of loss and comparison on the extent and significance of damage.

4. Discussion

Cerengoni forest station had 73% of the sampled trees debarked which is a high incident of debarking by the monkeys. This high incidence of debarking is evidence that the monkeys are under pressure on their diet base where the lack of nutrients in the surrounding environment contribute to the shift in their feeding habit. Evidence is clearer that debarking by these monkey species has greatly affected Cerengoni forest in Nandi County and it is in for a greater risk of losing its only species left in this forest. From the collected samples of trees, the biggest percentage is the one which has been affected more than once. Even though the healing rate is much higher especially in the *Pinus patula* species, an action has to be taken in order to save the remaining few species of trees from debarking in this forest.

The findings of this study are in agreement to the findings of Fashing who also found out from his study that *Colobus guereza* preferred and shifted to *P. africana* as an alternative resource when preferred Moraceae family was scarce in the Kakamega forest [17]. The debarked parts of the tree not only provide entry points to the destructive particles but also adversely affect the tree growth. In this study, it is likely that *C. lusitanica* and *P. patula* are the fallback resources in Cerengoni forest. Monkeys were found to prefer the barks of these two species. Debarking predisposes stems that have been affected to a wide range of destruction, secondary infections and damage. The USDA guide for forest service and UNO points out that debarking contributes to bole damage and decay. While the disturbance of the habitat and availability of food are major factors thought which helps in determining the abundance of monkeys, evidence for their importance is uneven.

The two forest compartments of Cerengoni 1A of *Pinus patula* and Cerengoni 2G of *Cupressus lusitanica* were situated inside Cerengoni forest habitats where there were no human settlements in this specific locality. This hence made the animal species outside these compartments enjoy habituating more in these two types of tree species in the forest. The nature of the tree species of both Cupressus and Pinus in this forest appeared in thickets, were strategically grown, ever green trees, and evenly distributed. The environment being cool and calm, away from anthropogenic activities, made it even more susceptible for the animal species outside the forests plantations to delve in these two forests compartments hence debarking causes to these trees.

a) Diameter of Trees in Each Compartment

From the study carried out, it was found out that the diameter of trees greatly played a major significance in the debarking activities of these trees. For example, from the findings in the diameter of trees in each of the two compartments, the 43 sampled trees in the entire *Pinus patula* tree species compartments, the largest diameter of tree recorded was 43.9cm and the lowest diameter was 4.1cm. From the compartments of *Cupressus lusitanica* plantations, 31 trees were sampled and the largest tree diameter was 42cm and the lowest diameter was 6cm. This hence stated that, the larger the tree diameter, the higher the debarking rates. In the case of *Cupressus lusitanica* plantations, most debarking was thicky girdled and this happened at the crown. The vervet monkeys and the sykes monkey species preferred thick, and huge trees from both of the tree species. This finding is further supported by a study done by Yiming and colleagues who found out that monkeys showed preference for older forest trees [18]. The mature stem barks provide the thickest moist and nutrient-rich living tissue compared to young ones [19]. A study carried in South Africa on the relationship between bark thickness and diameter at breast height for six species used medicinally, it was found out that Bark thickness generally increases with stem age and diameter [20]. This is true also in this study on the highest diameter recorded of *Pinus patula* tree. The tree was found out to be thick, old in age, and the debarking was so intense at the highest region of the tree.

b) Diameter Breast Height of Trees in Each Compartment

The study sampled 55 trees of *Pinus patula* plantation. The highest recorded height in the 6 sampled plots in the forest was 20m while the lowest height was 4m. The diameter of *Cupressus lusitanica* was 17m and the lowest height was 3m. In this case, The higher the tree height, the higher the debarking occurrence at the middle and upper crown. The fact that this portion occupied the upper canopy; where monkeys prefer to stay, might have been the major cause of intense debarking on this part of the tree trunks. In rain forest of Peru, the white fronted capuchin and brown capuchin monkeys preferred to live on the upper canopy spending about 80% of the daylight moving through the forest debarking trees. In the case of *Cupressus lusitanica* species, when debarking occurred at the middle trunk, the tree died [21]. In a study done in Kibale National Park, Uganda, there was a significant difference between the age categories of the bark, between the number of the barks eaten and those not eaten by the Colobus [22]. They also found significant differences between the lower, middle and upper branches in percentage and the mean number of bark samples was positively correlated to the percentage damage. Unlike the *Pinus patula* species where when debarking occurred, the tree healed. Therefore, the larger trees in *Pinus patula* can withstand higher rates of survival as compared to *Cupressus lusitanica* tree species.

c) Extent of *Cupressus lusitanica* and *Pinus patula* Debarking by Monkeys

Cerengoni 1A of *Pinus patula* forest compartments recorded a percentage of 31.9 debarking rate whereas, Cerengoni 2G of *Cupressus lusitanica* recorded 72.8%. This stated therefore that Cupressus tree species tend to experience almost daily debarking activities which caused severe deterioration to the entire tree species plantation and the chance of these tree species to recover was void. From this study, it was found out that the sykes monkeys (*Cercopithecus albogularis*), preferred to debark the Cupressus lusitanica species because of the resin content found inside the bark of these trees. This agrees well with a study done by Giesen, (2015) where he stated that resin can serve as a scent trigger that draws singes to trees. Debarking in these two forest compartments at Cerengoni occurred throughout the whole forest plantations, and since there was no human anthropogenic activities, regeneration took place especially in *Cupressus lusitanica* plantations.

d) Monkey Species Debarking *Cupressus lusitanica* and *Pinus patula*

Three species of monkeys are considered pests: baboons, sykes, and vervets. Many of these primate species today, face a variety of anthropogenic threats including habitat loss and fragmentation, disease, hunting as a result of crop raiding, and climate change [23]. Consequently, more than half of the world's primate species are currently threatened with extinction [24]. The biggest threat for primate species is extensive conversion of their habitat into cultivated land for agriculture, human settlement and plantations [25].

Conversion of primate habitats into agricultural land, in particular, creates a potential conflict between hungry primates and local people [26]. Many primate species living in small fragmented forests adjacent to agricultural land are known to engage in crop raiding [26]. Local communities are, therefore, likely to develop negative attitudes towards crop raiding primates resulting in conflict further endangering primates already at risk of extinction due to habitat destruction [27]. As a result, many primates are threatened because of hunting by humans due to their crop raiding behaviour [28, 27 and 29]. Due to increasing habitat loss and degradation, primate populations are living in small fragments isolated by human dominated landscapes [27]. Even today, many primates tend to occur in relatively small forest blocks [28]. In small fragments, the quantity and quality of available forest habitat would be reduced, minimizing the carrying capacity of the fragment and eliminating suitable monkey habitats with subsequent reduction in quantity and quality of monkey food resources and sleeping trees [30]. Thus, the distribution and abundance of monkeys would be severely affected, with the 6 consequent reduction in population size [32]. For forest dwelling arboreal folivore primates, however, habitat fragmentation could have a negative influence on habitat quality within fragments [33] by affecting feeding ecology, habitat use, activity patterns [34] and ranging ecology. As a consequence, the persistence of such primates in small fragmented forests depends on their ability to cope with changes [35]. Studies suggest that some primates can persist in fragmented forests based on their ability to feed on available food species and items [35], adjust their activity pattern to the new modified habitats [35] and to use smaller home ranges [35]. However, several other factors may also influence the activity patterns and ranging ecology of monkeys including food availability, season, group size, age and social rank, human disturbance and scramble competition [29]. Common species perform ecosystem services upon which nature and we rely. Bees are pollinators. Edge species like vervet monkeys *Chlorocebus pygerythrus* are seed dispersers that can aid in forest regeneration [36]. From the study conducted, the two forest plantations were debarked by different animal species. For example, the vervet monkeys (*Chlorocebus pygerythrus*) debarked the *Pinus patula* planations, while the Sykes monkeys (*Cercopithecus mitis albogularis*) debarked *Cupressus lusitanica* plantations. The major reason why these species debark is just for fun. They are enticed by the contents of these tissue components. The damage caused by the sykes species could not be compared to the vervet monkey damage.

d)Estimated Losses due to Debarking of *Cupressus lusitanica* and *Pinus patula*

From the study conducted, it was found out that due to a higher percentage of debarking especially in *Cupresssus lusitanica* tree species, it was concluded that losses of these trees had a tremendous long effect in this forest. There were no previous studies carried out in the forest region of specific these two compartments. When Cupressus tree species are debarked, the die completely. So, this is an indication that the whole forest goes into a loss because useful trees of importance exotic trees are lost. As in the case of *Pinus patula*, where at least when debarking occurs, the tree heals and regenerates. There was a huge loss in the Cupressus species as compared to the Pinus species.

5. Conclusion and Recommendations

From the findings of this study, the following conclusions were drawn: Monkeys debark both *C. lusitanica* and *P. patula* trees in Cerengoni forest at a rate of 73% and 32%, respectively, leading to damage to trees such as breaking of brunches, removal of ring and killing of crown. The most prevalent type of debarking in Cerengoni is class 6 which implies that the debarked trees are healing. This is followed closely by class 1 which implies that less than 50% of the circumference of the bark is removed. Class 5 also was prevalent implying that branches of the debarked trees were broken. Based on the results of the study concerning the height of debarking, it can be concluded that the prevalent debarking in Cerengoni forest station was higher than 3 meters. Based on the age of debarking, the study can conclude that *P. patula* had no new debarking while *C. lusitanica* had both new and old debarking. This implies that the *P. patula* of Cerengoni are debarked while still young and hence grows as the debarking heals while *C. lusitanica* in Cerengoni is debarked at any age.

With the help of research assistants, villagers and observation made, the study can conclude that Vervet and Sykes are the monkey species that debark *P. patula* and *C. lusitanica* in Cerengoni forest, respectively, and cause damage to these trees. There are no data on the programs for controlling the monkey's activities in the forest. The present condition which does not provide any form of control pose a danger to the existing trees in the forest. The scarcity of detailed information on the monkeys also is evidence of imperative understanding of the monkey's population in order to exercise effective control measures.

If one of our central aims as conservation biologists is the prevention of species decline and loss [37], surely there is much support for the need to be proactive. Perhaps it is that the environmental impacts of common species are so obvious they are too easily overlooked. Declines in widespread and abundant species can be incremental rather than one acute incident. And perhaps as humans we are more adept at perceiving complete loss rather than gradual declines in populations. This lack of perception of gradual change in an environmental feature is problematic as, due to the severity of nonlinearity of the relationship between population size and range size, later declines can be extremely rapid. Therefore, we need to improve our ability to detect threats to common species as well as changes in trajectories of abundance and contractions in distributions [38]. We must rectify the disparity in conservation focus to a more balanced approach: rather than the focus we now have on rarity and extinction, we need to broaden conservation to include valuing common species and maintaining abundance [39].

Forest law is principally concerned with ensuring the sustainable utilization of forest resources. In an ideal setting, the utilization of forests resources should adhere to the principles of environmental law which include sustainability, and the principle of prevention. It will be of great importance for the forest management to carry routine survey to obtain and keep data on the monkey debarking. This will help to obtain financial losses experienced due to monkey debarking. What has been established in this study is that there is no information of this kind and it would appear that the extent of monkey debarking is exaggerated and losses are not quite server.

A similar study to be done on other forest within Nandi County and Kenya as a whole, on other tree species to help confirm the results of this study. In the forest Management Act of Kenya 2016, the constitution of Kenya is examined for the purposes of assessing how the right to a sound and healthy environment as well as forestry conservation issues are incorporated into the Constitution. The framework statute, the Environmental Management and Coordination Act, is examined as regards the pertinent provisions for environmental governance and the promotion of sustainable development in Kenya. Its strengths and weaknesses as related to the implementation of the Act as well as coordination of the diverse sectoral initiatives in relation to forestry are examined. The Forests Acts is relied on to provide the main legal strategies employed by Kenyan law to ensure sustainable management and conservation of Kenya's forests. The Act offers guidance and identifies the various stakeholders who are involved in the conservation of forests in Kenya. It creates the Kenya Forest Service and empowers it to manage and conserve forests in Kenya. It provided for the various techniques of conservation and establishes standards on the accepted conduct in relation to forests and sets out the penalties in the event of any breach of the Act. The principle of prevention states that the protection of forests is best achieved by preventing harm in the first place, rather than relying on remedies or compensation for such harm after it has occurred. The reasoning behind this principle is that, prevention is less costly than allowing environmental damage to occur and then taking mitigation measures thereafter. The thrust of this principle is that environmental damage should be prevented at source and before it occurs. This principle is important to sustainable forestry management, especially given the speed of forest destruction and the length of time for regeneration. A good example of this is Cerengoni forest. If a survey had been previously conducted on these two tree species concerning the debarking occurrence by these monkeys, an alternative solution would have been taken and prevented the loss of these tree species type.

The food and Agriculture Organization of the United Nations defines participatory forestry as the processes and mechanisms that enable those people who have a direct stake in forest resources to be part of decision making in all aspects of forest management, from managing resources to all aspects of formulating and implementing legal frameworks. Several interlinked legal concepts therefore come into play when discussing participatory forestry management. These are devolution, good governance, transparency, access to resources, and the protection of the interests of local and indigenous communities. Mechanisms for community-based forest management have therefore, become common in forestry laws. Public participation may be proved through at least three legal mechanisms. As a right through the National Constitution of Kenya, review of environmental impact assessment, and lastly, through direct *locus standi* for the public to participate in environmental protection through judicial and administrative procedures.

6. Study Limitations

This study was limited to Nandi County at Cerengoni forest-block ecosystem. Therefore, it identified all the *Cupressus lusitanica* stands (45.9 Ha) and *Pinus patula* stands (47.8 Ha) in the forest.

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