The influence of human activities on the population structure and abundance of P. *africana* (Hook. F) Kalkm across Western Mau Forest

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ABSTRACT - *Prunus africana* (Hook. f) Kalkman, 1965 (previously Pygeum africanum Hook.f) is a topographically far and wide tree confined to high country woods of fundamental land Africa and remote islands. The appeal for the bark has prompted remarkable obliteration of the species in regular woods, prompting worries on the drawn out manageability of gathering and the preservation of the species. In spite of the way that Mau woods is a secured region, the district encounters illicit abuse with *P. africana* being one of the primary targets. The tree is of incredible interest for its solid wood and profoundly restorative bark making its population to be under danger. Thus *P. africana* is recorded as weak species under Appendix II of CITES. In this review, data on *P. africana* was gotten basically from writing study while population information was acquired by examining strategies. The review was led in Western Mau woodland (longitude E35027.05' to E35039.42' and scope 0010'46"S to 0017'42"S) which is found in the South Rift area, Kericho region. Cuts across were laid across four squares in Western Mau timberland and breadth at bosom stature (dbh) and tallness of mature trees estimated. The level and reasons for unsettling influences were gathered utilizing surveys and through perception and recorded for every one of the plots. Saplings were included and recorded in subplots and seedlings included in miniature plots. Densities of seedlings, saplings and mature *P. africana* trees were inspected across the Western squares of Mau woodland. A financial overview was additionally directed to decide local area insights on the situation with the tree under study. The information produced were dissected utilizing both distinct and inferential insights. Information on tallness and dbh were summed up as mean ± SE and varieties tried utilizing one way ANOVA. Information was introduced in histograms, tables and charts. Inferential measurements uncovered critical variety in the thickness of saplings ($p<0.05$).The seedling numbers surpassed saplings and trees, recommending potential for recovery and population increment despite the fact that the population isn't expanding. Perceptions showed that human activities, herbivory and illnesses present genuine dangers to *P. africana* tree.

***Index Terms* –** Human Activities, Population structure, and abundance

I. INTRODUCTION

Prunus africana is geographically widespread forest tree, restricted to African highland forests, generally above 1000m in altitude (Hall, 2000). It extends along an escarpment, Rift Mountains and volcanoes, from latitude 33^0 40’S in South Africa to latitude 11^o 55’N, near the Gulf of Aden. There are extensions west into central Africa and disjunction populations in Western Africa and islands of Comoros and Madagascar (Hall, 2000). The distribution appears to be associated with climatic conditions (especially temperature and forest regimes) rather than elevations. *P. africana* has been reported in many African countries such as Angola, Democratic Republic of Congo (DRC), Ethiopia, Kenya, Malawi, Mozambique, South Africa, Swaziland, Sudan, Tanzania, Uganda, Zambia and Zimbabwe. Islands where the species occur are Bioko, Grand Comore, Madagascar and Sao Tome (Hall, 2000). This species occurs mainly at altitudes above 1500m in Kenya (Navarro-Cerrillo *et al*., 2008). It occurs in moist evergreen forests, riverine, often in remnants or on forest margins between 1350-2750 m above sea level (Navarro-Cerrillo *et al*., 2008). It is common in Mt. Kenya, Aberdares, Kakamega, and Cherangani forests. It also occurs in Timboroa, Nandi, Tugen hills and western part of Mau forest (Nguta, 2012).

Trees are a part of our heritage and should be saved from extinction. Most trees occur in areas where human influence is diminishing their habitat (Musila *et al*., 2009). In the course of recent many years, African cherry populations have been declining in many backwoods because of impractical bark double-dealing for worldwide restorative plants exchange (Hall, 2000; Betti, 2008). Following the revelation in1966 that a concentrate from P. africana bark adequately treats prostate organ hypertrophy and harmless prostatic hyperplasia, drug organizations started recruiting Africans to gather *P. africana* bark for product to Europe (Fashing, 2004; Orwa et al., 2009). Since that time, how much *P. africana* bark took from African timberlands has expanded dramatically, with a more prominent than 17-overlay increment during the period 1980–1999 alone (Orwa et al., 2009). Sadly, a lot of this double-dealing has been flighty with whole trees being supported of their bark and left to pass on or, in different cases, felled to work with simpler admittance to their bark (Orwa et al., 2009). This gigantic expansion in the force of *P. africana* bark collecting over a generally brief period incited CITES to classify the species as Appendix II and IUCN to show it as Vulnerable (IUCN, 2002). Notwithstanding the insurance managed by these assignments, *P. africana* remains Africa's most seriously sent out restorative plant species by volume (Cunningham et al., 2002).Several investigations and studies have given proof of the antagonistic impacts enormous scope bark gathering has on *P. africana* populations (Cunningham et al., 2002; Orwa et al., 2009). This review zeroed in because of human activities on the population design and bounty of *P. africana* in Western Mau Forest.

II. LITERATURE REVIEW

Prunus africana is an African tree and exhibits different population structure and distribution pattern between different African countries. Until the last part of the 1960s, the tree was known distinctly for its lumber, as fuel and as a conventional medication (Stewart, 2001). Cameroon has the longest history of bark collect, and most investigations of the reap are from here, especially from Mount Cameroon. The desperate condition of the excess populations of P. africana in Cameroon seems, by all accounts, to be because of intricate and between related social and monetary elements. For instance, until the last part of the 1980s, many square kilometers encompassing Mount Oku in the North West territory were totally forested. Today only10,000 ha of Montane timberland remain. A similar case applies in Madagascar (Stewart, 2001).

In South Africa, P. africana has a restricted dispersion and little collect happens in the Eastern and Transkei Mist-belt woods situated in the eastern Montane areas for the most part between the urban communities of Umtata and Peitermaritzburg. The tree can be portrayed as scant in Rwanda which is certified by absence of reap from the country (Ingram et al., 2009). In Kenya, development preliminaries have been directed, however huge scope manors are not yet underway (Kuijper, 2011). Mature trees are likewise taken advantage of for their wood. Following harvest of mature trees for nearby and trade lumber items, Farwig et al. (2007) inspected the Kakamega backwoods in Western Kenya and observed not many saplings and youthful trees, proposing helpless enrollments coming about because of the evacuation of mature trees, helpless germination or herbivory on seedlings.

Deforestation

Due to increased human demand for food and other forest products such as timber and agricultural land as a result of the growing population, deforestation has become a global concern (Achard *et al.*, 2007; Vander Werf *et al.*, 2009; Hansen *et al.*, 2013). The increased demand has resulted in forest destruction and fragmentation. The most detrimental pressures often exist in areas of high biodiversity coupled with lack of infrastructure and anti-deforestation policies (FAO, 2015).

The Western Mau forest is an afromontane forest in the Rift Valley, Kenya. The area is characterized by complex land use history, and is influenced by growth and development within the around it. The main communities living around the forest are Kipsigis and Ogiek. These communities survive mostly by practicing subsistence farming where they keep domestic animals and planting food crops (Ingram *et al*., 2015).

As a result of the increasing scarcity, *P. africana* was listed under Appendix II of CITES 2004 (The Convention on Trade in Endangered Species) and further listed as vulnerable by the IUCN, 2002) making it mandatory to declare all imports and exports of *P. africana* in all countries. The exporting countries are also obliged to demonstrate that the *P. africana* was harvested in a" sustainable" manner. The main challenge in enforcing such regulations is the complexity in monitoring the trade since *P. africana* is exported in different forms, such as bark, bark extract, capsules and tonic (Hall, 2000). The situation is worsened by lack of regulatory infrastructure within forests where *P. africana* thrives.

III. RESEARCH METHODOLOGY

Study Area

This research was completed in Western Mau Forest square which is the fifth biggest square of Mau Complex in the South Rift locale of the Rift Valley Region of Kenya (Figure 3.1). It is situated in Kericho County at a height of somewhere in the range of 2000 and 2600 m above ocean level; and between scope 00 10' 46"S to 00 17' 42" S and longitude of 350 27' 05" E to 350 39' 42" E. It is overseen by Kenya Forest Service and covers around 22,712 hectares of native backwoods. In the Mau forest, tea zones were created by a Presidential decree in 1986 and were also to provide alternative fuel wood plantations. The Mau forest is the catchment area for 12 major rivers and also has streams that drain into Lake Victoria, Sondu, Nyando and Mara and others draining into the Rift Valley lakes notably Njoro and Molo which drain into Lake Nakuru and Lake Baringo respectively. The ecosystem supports key economic sectors in the country that include hydropower generation, tourism, agriculture, livestock and supply of water for domestic and industrial uses.

Sampling and Sampling Procedure

Stratified sampling was utilized to lay an aggregate of six cuts across and six quadrats in every one of the woods blocks. The six plots examined in each sampling block were corresponding to the backwoods region covered by each class. Distances somewhere in the range of 0 and 500m were drawn between the successive cuts across and quadrats stamped. In every one of the 50x50m square quadrats, corners were checked utilizing GPS arranges for geo-referring to. Two quadrats were put toward the start, two at the center and the excess two toward the finish of the checked cut across per sampling block.

Data Collection and analysis

Both primary and secondary data were collected. Physical counting of the trees was done and the plant height and diameter measured using Suunto clinometers and girth tapes, respectively. Disturbance types such as number of debarked trees and cut down *P. africana* trees in each forest block were noted and recorded.

Respondents for this study was drawn from those who stay within 50 metres from the study block was done for the purpose of data collection. From each square, 30 respondents were talked with utilizing organized polls to decide how they utilize the objective tree and their discernments on the elements influencing the tree. The respondents were chosen utilizing defined testing technique to address the different gatherings as far as age and financial status. Key sources, for example, botanists and common directors were additionally met with isolated arrangement of inquiries.

Qualitative data were changed over into quantitative construction and tended to in sort of degrees. The impacts of human activities and herbivory was tried utilizing chi-square insights at 95% certainty levels. Connection investigation was additionally done to decide the connection between human activities and herbivory on one hand and population structure.

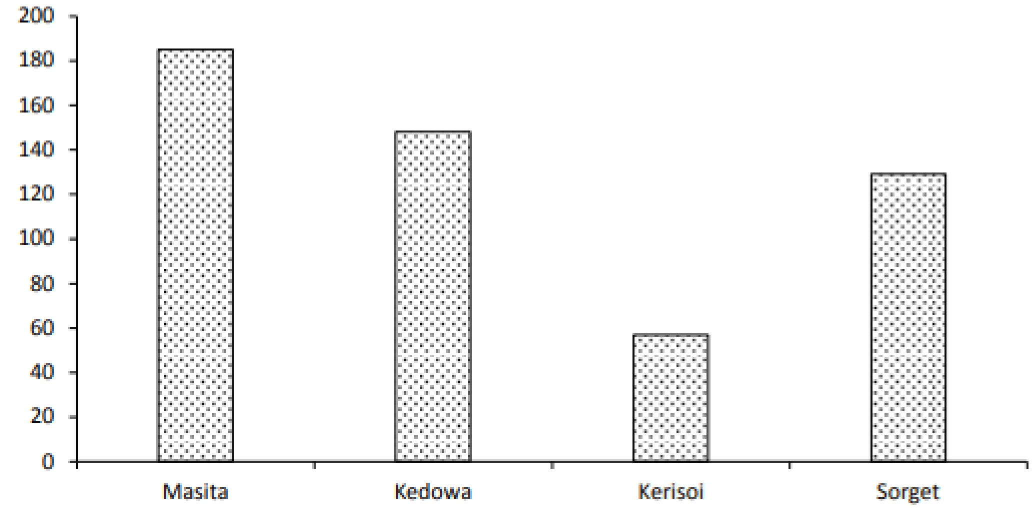
Ethical Considerations

The researcher proclaimed that the character of the respondents was exceptionally secret. The research likewise embraced to acknowledge any mistakes because of exclusion or commission while gathering the report of the review.

IV. RESULTS

Abundance of *P. africana.*

The study identified 305 *P. africana* trees and recorded from all the 24 quadrats from the four blocks of Western Mau forest that were studied. This translates to an average of approximately 13 plants in a 50m × 50m quadrat translating to approximately 130 trees per ha. On a spatial scale, Masaita block had the highest density of *P. africana* plant (185 individuals per ha) representing 36.4% while Kerisoi had 57 individuals per ha which was the least (11.8%) where as Kedowa and Sorget were second and third in total abundance



respectively (Fig. 4.1).

Figure 4.1: Population density of *Prunus africana* per block within western Mau forest during the study period.

Kruskal-wallis test revealed significant variation in total abundance between the blocks ($p = 0.041$) though Mann Whitney u test grouped together Masaita and Kedowa but separated kerisoi and Sorget from the two blocks.

Population structure of *P. africana.*

Three age categories of *P. africana* namely seedlings, saplings, and trees were observed and recorded in varying proportions. The forest was generally dominated by seedlings accounting for 39.0% of the total population recorded followed by saplings (36%) while the mature trees (25%) were the lowest in proportion (Fig. 4.2).

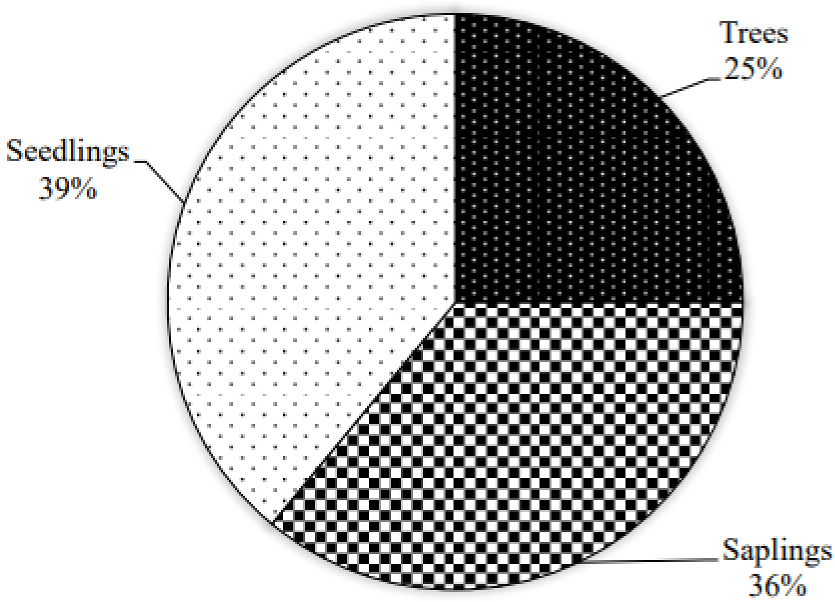


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Figure 4.2: Proportions of trees, saplings, and seedlings of *Prunus africana* within western Mau forest during the study period.

On examining the various age categories per site, the populations of *P. africana* in Kedowa and Kerisoi were dominated by saplings followed by seedlings and finally trees (Fig. 4.3). Masaita had an almost equal proportion of saplings and seedlings while trees were the least in proportion. Sorget had seedlings being the most dominant whereas saplings were the least in proportion.

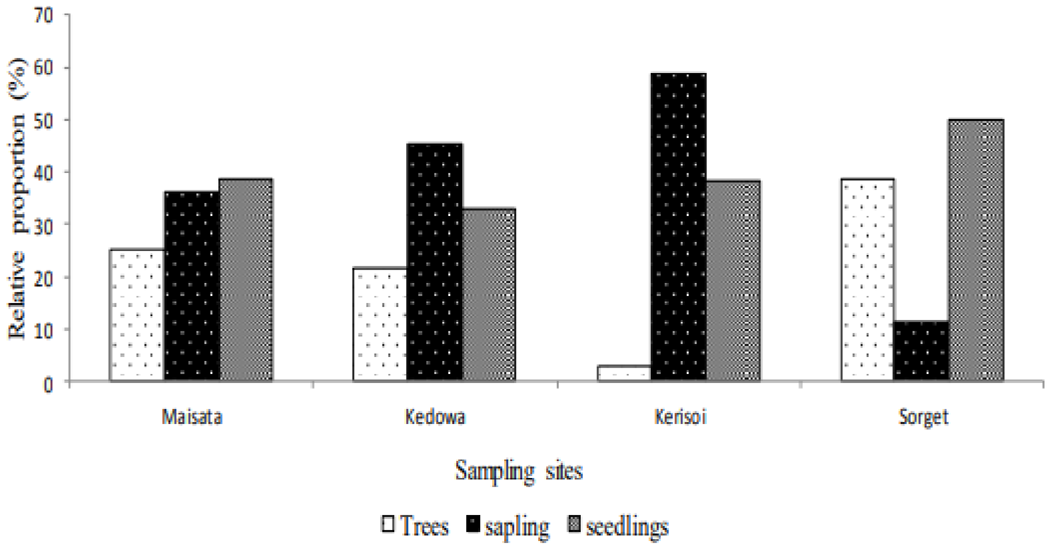

Figure 4. 3: Proportions of trees, saplings, and seedlings of *Prunus africana* at thevarious sites within western Mau forest

The highest density of seedlings was found in Masaita with an average density of 72 seedlings per hectare followed by Sorget with 58 seedlings per hectare while Kerisoi block had the lowest density (Table 4.1). A log transformed one way ANOVA revealed that there was no significant difference in the number of seedlings between the blocks ($p>0.05$). Turkey test further grouped Masaita, Kedowa, and Sorget blocks in one sub set as c and separated Kerisoi from them as b an indication that Kerisoi block differed significantly from the other three blocks in terms of seedling abundance. Just like for seedlings, a higher density of saplings were recorded in Masaita though this was followed by Kedowa block and not Sorget which was the least dense. One way ANOVA revealed significant difference in number of saplings recorded between the blocks ($p <0.05$). Turkey test grouped the blocks in three sub sets, putting Masaita and Kedowa together in one sub set as c where as Kerisoi and Sorget were in different sub sets as b and a respectively as shown in Table 4.1 below. The trees exhibited an almost similar trend as that of seedlings with highest densities at Masaita and Sorget and the lowest at Kerisoi block. One way ANOVA revealed that there was no significant variation in the number of trees between the blocks ($p > 0.05$) but Turkey test separated Kerisoi as a from the rest which were grouped as c.

Table 4.1: Mean density of *Prunus africana* per ha in different blocks within the Western Mau Forest (different superscript letters in a row show significant variation).

Plant type	Study sites				Statistics	
	Masaita	Kedowa	Kerisoi	Sorget	F value	p value
Seedlings	72[c]	48[bc]	22[b]	58[c]	1.51	0.284
Saplings	67[c]	65[c]	33[b]	13[a]	5.09	0.029*
Trees	47[c]	32[c]	2[a]	45[c]	3.93	0.054

Observed human activities

During the study and site visits, a sum of six human exercises that effect on populace, appropriation and wellbeing of *Prunus africana* were noticed. These incorporate creature touching, debarking, tree felling, *P. africana* seed assortment, kindling assortment, and charcoal consuming. Different uses however not definitively connected with the tree were picnics by individuals of young age, instructive visits, and examination.

Debarking, apparently for restorative purposes, had the largest number of event with a normal of 7 debarked trees for each visit. It was additionally seen that 70% of the debarked trees vanished, a sign that the interaction was not done in an economical and suggested way. No less than four new tree stumps were additionally seen inside the woodland each inspecting undertaking. Tree stumps are normally the best signs of tree felling or logging however the reason can scarcely be derived. Steers, sheep and jackasses were noticed touching inside the woods. This could suggest that the tree not just give food to creatures by means of its leaves yet in addition gives great climate to creature field. Seed and kindling gatherers were likewise noticed however not as incessant as touching creatures and newly debarked trees. A normal of one charcoal consuming episode for every visit was noticed however the specific wellspring of wood and tree type couldn't be determined since those doing the consuming couldn't be found for meet.

On looking at the force of logging dependent on number of stumps and charcoal consuming rates between the squares, it was seen that Kerisoi had the most noteworthy rates while Kedowa recorded the least (Figure 4.10). Out of the relative multitude of charcoal consuming occurrences recorded inside the review region, 47.3% were seen in Kerisoi block however just 12.3% and 9.2% were seen in Masaita and Kedowa separately. A similar pattern, however with shifting extents, was seen for number of stumps which was straightforwardly connected to logging.

V. DISCUSSION

Abundance and Population Structure of *P. africana.*

The high number of *P. africana* plants in Masaita block and low numbers in Kerisoi were probably due to variation in the intensity of human activities such as charcoal burning and logging within the blocks. Previous studies have shown strong negative correlation between logging incidences and sizes of trees (Bolognesi *et al*., 2015). The absence of bigger trees in Kerisoi as opposed to Kedowa and Masaita blocks can therefore be attributed to charcoal burning and logging.

The presence of more seedlings and saplings in the forest indicates that Prunus is regenerating while the bigger trees are constantly being felled. Research has shown high preference of bigger trees for logging and charcoal burning purposes (Hansen *et al*., 2013). It can therefore be deduced that the low population of *Prunus* tree in Kerisoi was as a result of human logging. Sedano *et al* (2016) reported that charcoal burning is one of the major causes of forest degradation and reduced tree population density. Previous studies have shown that charcoal burning not only leads to deforestation from logging but also causes death of other trees around the kiln (Hansen *et al*., 2013; Rembold *et al*., 2013; Bolognesi *et al*., 2015). A strong negative correlation has been shown to exist between the intensity of charcoal burning kilns and tree population in the surrounding area (Sedano *et al*., 2016). The result of this study therefore corroborates these earlier conclusions.

In a normal functioning forest system, it is expected that the seedlings will be highest in proportion followed by saplings then finally mature trees (Nowak and Crane, 2002), a situation that was only observed in Masaita block. Deviation from this trend is a clear sign of disturbance. Population of mature trees are usually influenced by logging where as that of saplings are influenced by herbivory and to a small extent disease infestation (Nowak *et al*., 2004).

Sorget block which had the highest frequency of animal grazing recorded the lowest proportion of saplings relative to other two groups i.e. mature trees and seedlings. Low number of saplings and seedlings in an area can be attributed to poor germination and low post germination survival as a result of several factors both natural and anthropogenic (Kuijper, 2011; Clasen *et al*., 2015; Apollonio *et al*., 2017). These include damage due to foot path creation, herbivory both insect and animal, diseases, and smothering during charcoal burning (Apollonio *et al*., 2017). Since there were more seedlings, the small number of saplings can thus not be as a result of poor germination but poor post germination survival probably due to herbivory and presence of several foot paths in Sorget block.

VI. CONCLUSION

Abundance and population construction of *P. africana* in Western Mau forest changed on a spatial scale for the most part because of human variables. From this review it very well may be derived that activities, for example, de-yapping, logging, and creature brushing enormously affected the circulation, abundance and population construction of the tree inside the forest. The three activities (de-yelping, logging, and creature touching) were the most well-known activities across the review region. The nearby local area was further in understanding from the meetings that these are the fundamental variables impacting the situation with the forest.

Population density of *P. africana* is greatly decreasing within Western Mau forest based on community perception and in comparison to other previous studies within Kenya and outside. This is an indication that the conservation status is deteriorating or the tree is threatened and the situation could be made worse if no action is taken to regulate the ever increasing human pressureon the tree. The local community expressed preference for the tree stem for charcoal making and above all its bark for medicinal use. These human activities negatively affect the forest as a whole.

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