# Human–wildlife conflict in Mochongoi Forest, Baringo, Kenya: a case study of elephants

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## Abstract

This study was carried out to assess the influence of human settlement on habitat structure and distribution of elephants in the heavily exploited Mochongoi Forest in Baringo District, Kenya. The distribution of elephants was estimated by dung counts on line transects. Elephant dung density was highest in the intact forest patch, Kimoriot, followed by Kamailel and Mochongoi. The spatial distribution of elephants in the study area was attributed to human influence on the structure of elephant habitat.

## Résumé

Cette étude a été réalisée pour évaluer l'influence des installations humaines sur la structure de l'habitat et la distribution des éléphants dans la Forêt de Mochongoi, dans le district de Baringo, au Kenya, qui est très exploitée. La distribution des éléphants a été évaluée par le comptage des crottes sur des transects linéaires. La densité de crottes d'éléphants était maximale dans l'îlot de forêt intacte, Kimoriot, suivie de Kamailel et de Mochongoi. La distribution spatiale des éléphants dans la zone étudiée a été liée à l'influence humaine sur la structure de l'habitat des éléphants.

## Introduction

As human populations rapidly increase in Kenya, many elephant ranges are being converted to farmland to meet food requirements for the growing population. In Kenya, the spread of farming to more marginal rangelands has pushed elephants out of their habitat, intensifying human–elephant conflict (HEC). Although some observers blame colonialism for ruining traditional harmonious relations between wildlife and local people (Martyn 1991; Adams and McShane 1992), others believe that HEC is as old as agriculture in Africa (Bell 1987; Naughton-Treves 1999). Conflict between people and elephants today undoubtedly ranks among the main threats to conservation in Kenya, alongside habitat destruction. The scenario has now turned from the number of people killing elephants to the number of people being killed by elephants and damage to property (Mwathe and Waithaka 1995). Despite these problems, many communities seem tolerant to the elephant menace, hoping for a solution to come one day.

Much of the original Mochongoi Forest has been excised for human settlement, leaving only areas of rugged terrain that are unsuitable for farming. This continuous encroachment has increased the contacts between people and elephants, further intensifying HEC. The forms of HEC in Mochongoi include crop destruction, competition for grazing and water, livestock diseases, and human deaths and injuries. This raises a fundamental question of whether it is reasonable to expect these resource-poor local people to coexist with elephants. Many conservationists argue that coexistence is possible, even desirable, and indeed that if properly managed the presence of elephants presents both an opportunity and an escape route out of poverty. There is the need to put in place measures and policies that will reduce HEC. Without these measures and polices, local people will undoubtedly take action to defend their interests by killing the elephants. Thus, this study was aimed at establishing elephant population, density, movement patterns, distribution, and possible conflict-mitigation measures.

## Study area

Mochongoi Forest is situated in Mochongoi Division of Baringo District, Kenya. It covers an area of 390 km$^2$ and lies between latitudes 0°36'N and 36°0'E with an altitude of 1800 m. Figure 1 shows the location of the study area in Kenya. The division is influenced by the intertropical convergence zone, giving it a bimodal rainfall pattern, with the 'long' rains from March to July, and the 'short' rains from mid-September to November. Mean annual rainfall is about 600 mm with mean annual temperature ranging between 25°C and 30°C. The topographical features are rivers, valleys and plains. The soils are tertiary volcanic in origin with porous volcanic sandy and clay dominating. These soils rapidly dry and crack during the dry season and become soggy and waterlogged in the wet season. The main vegetation types in the forested area are *Olea africana*, *Croton megalocarpus*, *Juniperus procera*, *Podocarpus gracilior* and *Acacia* species (Kahata 2002). The forest was previously gazetted but following degazettement of some portions cultivation and settlements have encroached upon it. The areas that are still under forest cover are rugged and steep, making them unsuitable for settlement and cultivation.

## Materials and methods

The elephant population was established through dung counts using line transects. Line transects totalling 16.64 km were laid in seven sites in the three major forest patches (Kimoriot, Mochongoi and Kamailel). The perpendicular distance ($x$) of each dung pile from the centre line was measured using a tape measure. The perpendicular distance for all dung piles visible from the centre line was measured and recorded. To calculate the number of

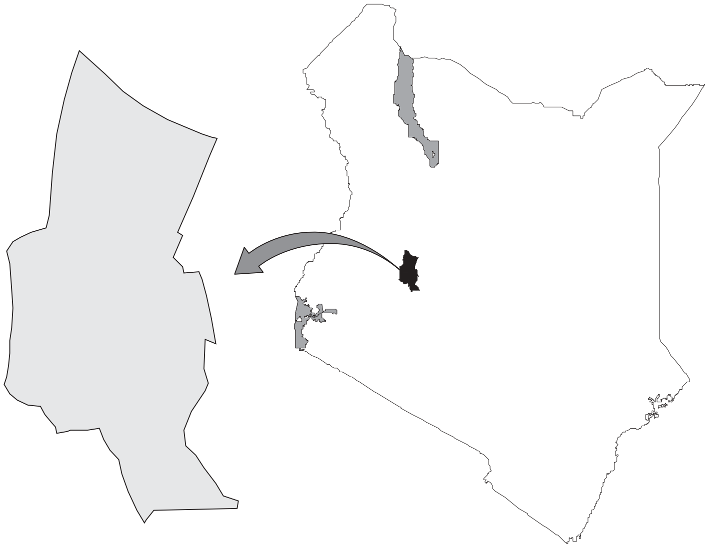

Figure 1. Location of Mochongoi Division in Kenya (from International Livestock Research Institute).

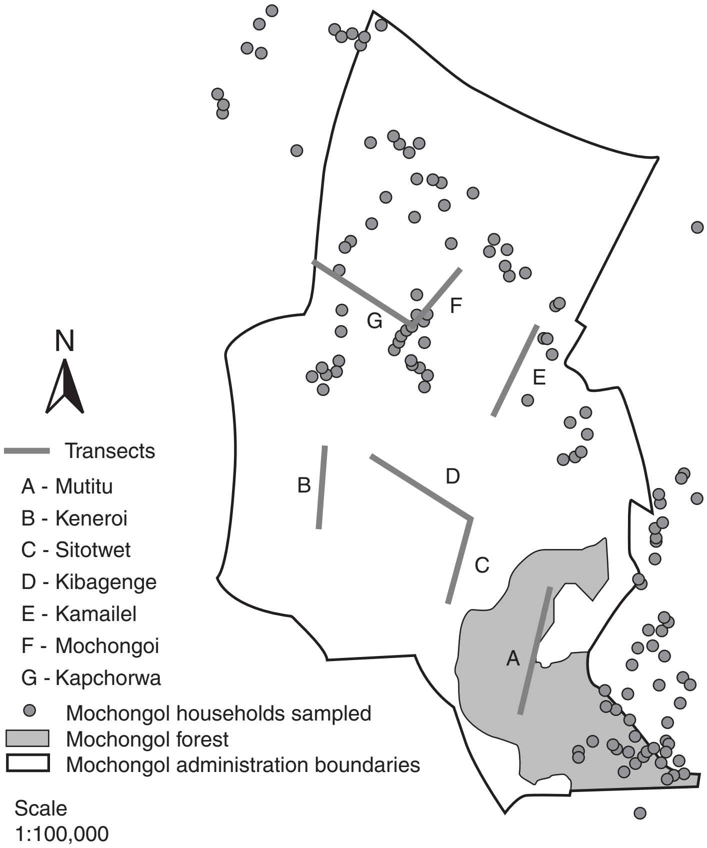


Figure 2. Location of transects, Mochongoi forest and households sampled in Mochongoi Division.

elephants in Mochongoi Forest, a standard method of dung count was adopted (Barnes 1996; Barnes et al. 1997).

Data were collected on vegetation attributes such as density, cover and diversity on the remnant forest patches. A completely randomized design (Steel and Torrie 1980; Gomez and Gomez 1984) was used. Two main transects of one kilometre each were located. From each main transect three perpendicular line transects measuring 500 m each were established at an interval of one kilometre. On each subtransect three plots were used to collect data: 10 x 10 m for trees, 4 x 4 m for shrubs, and 1 x 1 m for herbs. Multistemmed vegetation less than 4 m in height was considered a shrub. Then analysis of variance (ANOVA) was conducted for species cover, relative density and diversity within the forest. The line intercept technique was used for herbaceous vegetation; the percentage of tree and shrub cover was derived as described by Ekaya et al. (2001). In addition to the vegetation analysis, socio-economic data were collected through questionnaires. A questionnaire was administered to 149 randomly chosen respondents to obtain information on socio-economic activities such as household size, age composition, sources of livelihood, incidents of conflict with wild animals, extent of wildlife damage, and possible HEC mitigation measures. These data were analysed using the Statistical Package for Social Science (SPSS) (Norusis 1991).

## Results

To estimate the elephant population, methodology by Barnes and Jensen (1987) was adopted. It was assumed that for the three parameters to function, there must be a 'steady state' in the forest—that is, there must be a steady state in elephant numbers in that forest. Thus, estimated values of dung density is calculated:

$$E = Y \times r/D$$

where $E$ = elephant density, $Y$ = dung density, $r$ = dung decay rate, and $D$ = defecation rate.

The estimates of dung density for the six transects at 95% confident limit and the coefficient of variations are illustrated in table 1. In only one transect, Mutitu, were no dung piles recorded. To estimate the elephant numbers, an estimated dung decay rate of 0.002 and defecation rate of 17 dung piles per elephant per day from Rumuruti Forest (Laikipia) were used, since Mochongoi has similar rainfall and habitat conditions. The mean dung density for Mochongoi Forest was 5017.23 ± 2422 dung piles per km$^2$ (table 1). Using the above formula, it converts to 0.59 ± 0.31 (or 0.28 to 0.9) elephants per km$^2$. The remnant forest is 17.735 km$^2$; this gives the number of elephants in the area as 5 ± 16. The highest densities were encountered in Kapchorwa and Sitotwet, all in Kimoriot block. Kamailel block transects (Kibagenge, Kamailel) had average densities, and Mochongoi block (Keneroi and Mochongoi) had the lowest.

### *Land use*

Crop production is the main land use in Mochongoi: 59.7% of the respondents practise crop production, 33.56% are involved in small-scale mixed agriculture, and 6.71% burn charcoal for subsistence. Crops grown are maize, beans, sorghum, pyrethrum, vegetables, potato, sugarcane, avocado, citrus fruits, wheat and bananas. There is only one cropping season, April to December, due to the cold weather conditions associated with high altitudes; rain falls between April and June. The calendar of events in the division is shown in table 2.

Table 1. Summary of Mochongoi Forest transect analysis

| Transect | Length (km) | Sightings | Density | 95% | CV | Var F (0) | F (0) |
|---|---|---|---|---|---|---|---|
| Kamailel | 2.52 | 16 | 4548.30 | 1979.00 | 32.71 | 0.064 | 1.299 |
| Kapchorwa | 2.89 | 20 | 6286.78 | 2731.22 | 19.73 | 0.003 | 0.190 |
| Keneroi | 1.98 | 35 | 2012.35 | 874.04 | 21.39 | 0.005 | 0.463 |
| Kibagenge | 2.68 | 34 | 5321.01 | 2397.31 | 28.02 | 0.003 | 0.245 |
| Mochongoi | 1.34 | 9 | 1947.44 | 1019.13 | 24.61 | 0.004 | 0.239 |
| Mutitu | 3.10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sitotewet | 2.13 | 68 | 9987.52 | 5534.11 | 38.87 | 0.075 | 1.725 |
| Total | 16.64 | 182 | 30103.40 | 14534.80 | 165.30 | 0.154 | 4.160 |
| Mean | 2.38 | 26 | 5017.23 | 2422.47 | 27.55 | 0.025 | 0.693 |

Table 2. Calendar of events for Mochongoi Division

| Month | Activity | Elephant interference | Types of conflict |
|---|---|---|---|
| January–March | land preparation | low | store, waterpoint, threats to human life |
| April–May | planting maize, beans, peas, potatoes | low | crops, threats to human life |
| May | planting wheat and pyrethrum | low | crops, threats to human life |
| June –July | first weeding | low | crops, threats to human life |
| July–August | second weeding of maize, beans, potatoes | medium | crops, threats to human life |
| August–September | harvesting of beans, peas, potatoes | high | crops, threats to human life |
| September–October | harvesting of wheat, pyrethrum | high | crops, threats to human life |
| October–December | harvesting of maize | high | store, crops, threats to human life |

Livestock species kept include cattle, sheep, goats, donkeys, chickens, ducks and geese. Only a few households manage the exotic breeds of cows such as Friesian, Ayrshire, and Jersey for commercial and subsistence milk production. The forest has a limited variety of wild mammal species— black-and-white colobus monkey, porcupine, aardvark, bushbuck, dikdik, buffalo, warthog, elephant and hyena.

Mochongoi Forest yields a variety of benefits for the local people. All respondents interviewed appreciate the forest as a source of fuelwood; 94 (63%) noted it as important as a water catchment and for medicine and food; 42 (28%) said it provides timber and poles for construction; 13 (9%) value it for forage for livestock. Opinions about forest ownership varied: 47% said the forest belongs to the government; 24% said it belongs to both community and government; 14% said it was owned by the community; and 15% had no opinion. These responses indicate that it is necessary to make people aware of who owns the forest and its resources.

Deforestation of Mochongoi Forest dates back to 1996 (Kahata 2002), although the government did not degazette it (Divisional Officer, pers. comm. 2003). This contradicts reports by Bitok and Omondi (1999) that portions of the forest were degazetted. Thus settlement in those areas is illegal. The demand for settlement and more agricultural land has resulted in reduced forest cover. This in turn has reduced the elephant range and increased human–elephant conflict in the division. Bitok and Omondi (1999) further approximated the area under forest cover as 20 km$^2$. At the time of the study, the area under forest cover was calculated at 17.725 km$^2$. If the forest continues to shrink at the same rate of 0.76 km annually, the forest has a lifespan of only 23.3 years.

### *Extent of elephant–human conflict*

Reported human–wildlife conflict incidents from 1997 to 2003 are analysed in table 3. The decline in the number of incidents reported in 2002 was attributed not to fewer incidents occurring but to the community complaint that neither Kenya Wildlife Service (KWS) nor the government had taken action on previously reported conflicts (fig. 3). Also in discussions with chiefs in 2001, the divisional officer said, 'You are illegally settled in this forest. You must adjust and live with the elephants.' As a result, the local people feel sidelined by the government.

Elephant crop raiding in Mochongoi Division has become so intense that farmers spend sleepless nights guarding their farms to reduce crop raiding. They have adopted various mechanisms such as forming groups with farmers guarding farms in shifts. While guarding, they have adopted both passive and active methods. The passive methods include constructing live

Table 3. Analysis of the reported human–elephant conflict incidents, 1997–2003

| Year | Kamailel | Kimoriot | Mochongoi |
|---|---|---|---|
| 1997 | 75 | 25 | – |
| 1998 | 50 | 50 | – |
| 1999 | 76.32 | 13.16 | 10.52 |
| 2000 | 37.14 | 41.43 | 21.43 |
| 2001 | 18.03 | 40.98 | 40.98 |
| 2002 | 24.13 | 51.72 | 13.79 |
| October 2003 | 49.01 | 29.41 | 21.56 |

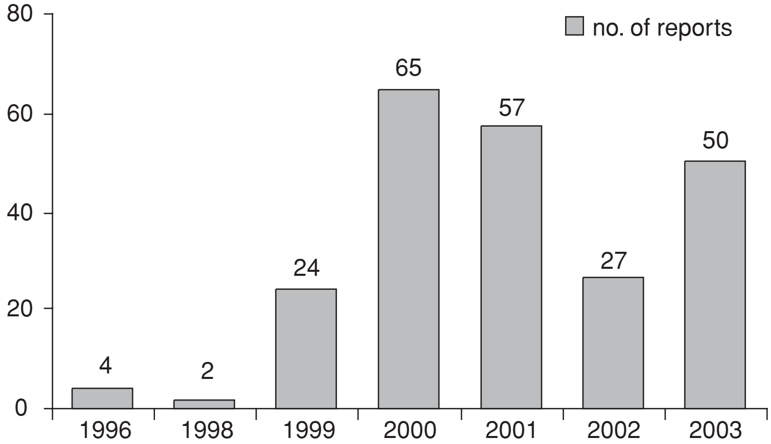


Figure 3. Reported cases of human–wildlife conflict, 1996–2003 (*KWS Occurrence Book,* 1996–2003)

fences around the crop fields and watchtowers, and burning diesel-wrapped cloths; active methods consist of burning fires, making noise, and planting wildlife-resistant crops such as beans, wheat, pepper and pyrethrum.

An increase in settlement in the area has created a demand for more land to increase food production; thus, deforestation has increased. About 88% of the cases reported are elephant related with maize being the most affected. Maize, the staple food in the area, is grown by 92% of the respondents. The major crops reported to be highly susceptible to elephant raids include maize, banana, fruit, millet, cassava, potato, vegetables and sugarcane. Crops such as wheat, pyrethrum, beans, and onion are less susceptible to elephant raids and are only trampled on as the elephants move. The survey shows that 92% of the respondents had had crops destroyed by elephants; only 8% were not affected, and that only because they had been in the area for less than a year.

### *Vegetation parameters in relation to elephant density*

Vegetation analysis was carried out in the three forest patches: Kimoriot, Kamailel and Mochongoi blocks. The grand mean for absolute density within the three blocks is 5.83 with a standard error of means of 1.10. The mean absolute densities of these different blocks are 10.28 for Kimoriot, 0.90 for Kamailel, and 6.31 for Mochongoi. The results from analysis of variance show significance at 1% level ($P < 0.001$). Further statistical test shows that the differences between the three means (7.16, 5.41 and 3.21) are greater than the LSD value (3.104), showing significance. This implies difference in absolute species densities within the three blocks. Kimoriot has the highest absolute density (10.28) because it was intact while Kamailel block had the lowest due to encroachment. The analysis of variance for species relative density showed that the results are not significantly different at 10% level and below. The grand mean for the three blocks was 2.90 with a standard error of difference of 0.96. The mean relative densities of these different blocks were 3.33 for Kimoriot, 2.08 for Kamailel and 3.29 for Mochongoi. The results from analysis of variance show insignificance at 10% and below ($P < 0.342$). This shows that the frequencies of different species within the three blocks are not different. It further shows that the difference between the relative density means of the three blocks is smaller than the LSD value (1.908), showing further insignificance. The results show the relative density highest in Kimoriot, next in Mochongoi and lowest in Kamailel.

The grand mean for percentage of species cover was 0.80. The individual block species cover was 1.09 for Kimoriot, 0.60 for Kamailel and 0.71 for Mochongoi. Kimoriot block had the highest species cover, next Mochongoi, and lastly Kamailel. Analysis of variance for percentage species cover was insignificant at 10% and below ($p < 0.202$). This implies that even with the difference in means for percentage species cover the difference is statistically insignificant.

## Discussion

Elephant movement patterns within the three patches were undefined due to limited space and resource availability. Frequent elephant movement was noted in Kimoriot block due to plant regeneration providing food for the elephants. Moreover, this block is intact forming a suitable habitat. For Mochongoi and Kamailel blocks, settlement and encroachment have constricted elephant range, reducing the frequency of elephant sightings, thus few dung piles.

Table 4. Conflict resolutions as suggested by the respondents

| Conflict resolution | Number of respondents | Cumulative (%) |
|---|---|---|
| Translocation | 103 (69.1) | 69.1 |
| Electric fence and elephant sanctuary | 32 (21.5) | 100.0 |
| Moats and more outposts | 14 (9.4) | 78.5 |
| Total | 149 (100.0) | |

Local people interviewed expressed fear for their lives because of the presence of elephants in the area. Kahata (2002) reported about 100 farms abandoned; this current study recorded an additional 21 parcels of land abandoned. The owners argued that an alternative livelihood was preferable to farming for the elephants. Also, local people reported their lives were at risk because elephants come out of the forest as early as 3 p.m., restricting mobility. A male elephant nicknamed 'John Killer' continually marauds in the three blocks throughout the year.

The current situation contradicts the findings of Kahata (2002) that the frequency of elephant attack was higher during the wet season. This survey reveals that conflict is no longer seasonal. During the wet season elephants trample seedlings; raiding occurs at intermediary and maturity stages of the crops; and after harvesting, elephants raid food stores and houses. However, HEC is more intense in August when elephants from Laikipia Ranch enter Kimoriot block through Marmanet Forest to the north.

The ways forward suggested by the local communities to resolve HEC in Mochongoi Division were as illustrated in table 4.

The questionnaire survey showed that economic loss due to elephants was quite significant. Crop production was the main source of livelihood. These losses in monetary terms ranged from between KES 5000 to 150,000 (USD 75 to 2000), with a mean of KES 30,000 (USD 450) per farmer annually. A survey by Kahata (2002) recommended translocation to minimize conflict in the area. This may not be feasible because elephants act as security for the remnant forest patches, which are important water catchments, in addition to other benefits that accrue from forests. Translocating the elephants will provide argument for excising the remnant forest patches to create more land for agriculture. To avert the trend, farmers within a kilometre from the forest need to be allocated other land and a reforestation programme needs to be initiated immediately.

## Conclusion

The study classifies elephants as the problematic wild animal that causes considerable economic loss and reduces efficiency of the local people, thus jeopardizing their livelihoods. Collaboration of stakeholders in conservation is essential to reduce the stress of elephants on the local residents through educating them about conservation, natural resources management and compatible alternative livelihood sources.

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## References

Adams JS, McShane TO. 1992. *The myth of wild Africa.* WW Norton and Co., New York.

Barnes RFW. 1996. The conflict between humans and elephants in the Central Africa forests. *Mammal Review* 26:67–80.

Barnes RFW, Beardsley K, Michelmore F, Barnes KL, Alers MPT, Blon A. 1997. Estimating forest elephant numbers with dung counts and geographic information system. *Journal of Wildlife Management* 61:1384–1393.

Barnes RFW, Jansen KL. 1987. *How to count elephants in forests.* Technical Bulletin No 1. African Elephant and Rhino Specialist Group, Nairobi

Bell RFV. 1987. Conservation with a human face. In: Anderson R, Groove R, eds., *Conservation in Africa.* Cambridge University Press, Cambridge.

Bitok EK, Omondi PO. 1999. A survey of Mochongoi Forest elephant population and status of human–elephant conflicts. December progress report. Elephant Programme, Kenya Wildlife Service, Nairobi.Unpublished.

Ekaya WN, Kinyamario JI, Karue CN. 2001. Abiotic and herbaceous vegetational characteristics of an arid rangeland in Kenya. *African Journal of Range and Forage Science* 18:117–124.

Gomez KA, Gomez AA. 1984. *Statistical procedures for agricultural research*, 2nd ed. Wiley and Sons, New York.

Kahata MJ. 2002. Elephant pre-translocation survey report: elephant translocation from Mochongoi to Meru National Park. Elephant Programme, Kenya Wildlife Service, Nairobi. Unpublished.

Martyn R. 1991. People–wildlife conflicts in Africa are there symbiotic alternatives? Wye College, University of London.

Mwathe MK, Waihtaka JK. 1995. An assessment of the elephant–human conflict situation in Arabuko-Sokoke Forest, Kenya. Elephant Programme, Kenya Wildlife Service, Nairobi.

Naughton-Treves L. 1999. Whose animals? A history of property rights to wildlife in Toro, western Uganda. In: *Land degradation and development, Uganda*.

Norusis JM. 1991. *The SPSS guide to data analysis for SPSS/ PC+*, 2nd ed. SPSS Inc., Chicago.

Steel RG, Torrie JH. 1980. *Principles and procedures of statistics.* McGraw-Hill Book Co., New York.