ELEPHANT MOVEMENT AND LOCAL COMMUNITY ATTITUDES TOWARDS THE PROPOSED CORRIDOR BETWEEN THEGU FOREST AND SANGARE RANCH

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Abstract
Rapid human population growth has drastically reduced elephant range by reducing habitats and blocking traditional migration routes over the last several decades. Attempts to reopen migration routes have been met with mixed, albeit strong, reactions. A wider study to analyse human-elephant interactions in the area also sought the attitudes of local people towards re-opening migration between Mt Kenya forests and the nearby Sangare ranch. The route commonly traversed by elephants was mapped using Global Positioning Systems (GPS) and Geographical Information Systems (GIS) techniques. Two elephant sightings, footprints, dung and residents' accounts confirmed this as the only route currently used by elephants out of Mt Kenya forests. The footprints and dung were observed within a 4 -10 m wide strip along the entire 7 km stretch between Mt Kenya and Sangare. A questionnaire was administered to collect data on demography and impacts of elephants on adjacent farms, while the dung pile count technique was used to estimate elephant distribution and densities. Results showed that 33% of the community resented elephants, which was strongly associated with alleged levels of damage to lives and property (X^2= 0.797, df =4, P < 0.01). This caused unwillingness to provide passage through their land, with only 2.6% of the respondents indicating they would let elephants on their property. About 42% of those against the corridor attributed this to damages and losses caused by elephants whereas 10.5 % did not give reasons. A majority of the respondents were aware of importance of elephants in tourism, as agents of seed dispersal, sources of bush meat and ivory, and in revenue generation, but only a 3% admitted having gained in any way. The corridor seemed unviable under the prevailing land uses and negative public attitudes towards elephants.

Key words: Human-wildlife conflict, habitat fragmentation, migration

1.0 Introduction

Before 1650, most of central Kenya was densely forested probably because the sparse human population had little impact on the forest cover (Wass, 1995). The hunter-gatherer Gumba and Okiek peoples (Castro, 1995; Dundas, 1908; Muriuki, 1974) inhabited the land around Mt Kenya. Agricultural communities later settled to the south and east of the mountain, joining the pastoral communities who had already settled in the area to the west and north. The newly arrived communities destroyed the forests through burning and clearing for crop cultivation, driving the hunter-gatherers deeper into the forest (Muriuki, 1974). The arrival of the European colonialists and settlers led to further loss of the natural forests. By the turn of the 19th century, much of the forest on Mt Kenya had been cleared up to about 2,300 m above sea level (Pestalozzi, 1986). Human population has increased dramatically with time increasing pressure on forests (Ayiemba, 1991), occasioning a series of excisions of gazetted forestland over the last 50 years. One of the impacts of this was the blocking of elephant movement routes. Accordingly, there has been contraction, fragmentation and isolation of elephant habitat forcing them to constantly transgress into nearby farms. This created serious conflict similar to that observed in many other elephant range states (Parker and Osborn 2001; Waithaka, 1994).

Human-wildlife conflicts generate and escalate hostilities among the affected local people, affecting negatively the management and conservation of elephants (Spinage 1994, Waithaka, 1994). Wildlife managers have resorted to various ways to mitigate these negative effects. In Kenya and elsewhere, culling, translocation, contraception, restriction of elephants behind dugout moats and high voltage electric fences have been tried with varying degrees of success (Holloway, 1962; Thouless, 1994; Waithaka, 1994; Njumbi *et al*. 1995; Thouless and Sakwa, 1995). These strategies are constrained by several factors ranging from the trauma they cause to elephant family units (Kemf, 1996), heightened aggression towards other species and to human beings and cost (Njumbi *et al.* 1995; WWF Website, 1997). Although considered largely successful in southern Africa, translocation and fencing are expensive, costing 2 - 5 times more than culling.

Newmark, *et al.* (1991) suggested that opening migration corridors might be crucial for resolving human-elephant conflicts. Several stakeholders have proposed the re-opening a corridor connecting Sangare Ranch and Thegu forest on the western fringes of Mt Kenya forest. Some ranchers and members of the local community interested in nature-based income generating initiatives supported the idea (Prettijohn pers. comm.).

Anecdotal evidence suggested that transient elephants used Sangare Ranch and Thegu forest for only up to a fortnight at a time. They have recently established themselves on a semi-permanent basis and Thegu forest offered them a

sanctuary in the dry season. Little has, however, been documented on the nature and intensity of its utilisation this with a view to evaluating acceptability to the stakeholders of the creation of a corridor, the opinions of the local community were sought in this study that analysed the feasibility of a corridor through private land.

The objectives of this study were to map out the elephant movement route between Thegu forest and Sangare Ranch, assess land use and, assess the attitudes of the local community towards the elephants. In particular, community views were sought on a proposal to re-open the elephant corridor on their land and impacts of human activities on elephants were evaluated.

2.0 Materials and Methods

2.1 The Study Area

This study was conducted on the swathe of land between Sangare Ranch and Thegu forest to the southwest of Mt Kenya, about 200 km north of Nairobi (Figure 1). Sangare is a privately owned ranch covering about 2,083 Ha, whereas Thegu forest covers about 7,500 Ha. Thegu is part of Mt Kenya Forest Reserve on the western slopes bordering human settlement with intensive agricultural activities that lessen with distance towards Sangare Ranch located further west. Progressive human encroachment has reduced the Mt Kenya forest into smaller fragments, resulting in Thegu forest being surrounded by an agrarian community and by ranches further out. The area has a fast growing human population density (Jaetzold and Schmidt, 1983; Ayiemba, 1991; Central Bureau of Statistics, 2001) which not only limits elephant movement but also intensifies resource harvesting.

Altitude ranges between 1,500 m and 5,199 m above sea level. Rainfall is bimodal averaging 2500 mm per annum and the mean annual temperatures range from 18^{o} to 20^{o} C. A dry season occurs from December to March, with the wet season being between June and October.

The soils are volcanic (Speck, 1986) and support intensive agriculture (Ayiemba, 1991). Over 90% of the local community are farmers who produce cereals, Irish potatoes, legumes, vegetables, fruits and agro-forestry products. Livestock production and large-scale cattle rearing are also important land uses in the study area (Kamweya, 2002).

Mt Kenya forests harbour many wild plants and animals, including elephants and some primates, which are regarded as serious agricultural pests in nearby farms. Agriculture and agro-forestry extend on average up to the 2,375 m above sea level.

2.2 Establishment of Thegu-Sangare Ranch Migration Route

A reconnaissance survey was conducted to identify and map the route used by elephants to move between Thegu forest and Sangare ranch. A team comprising of an elephant surveillance group (Laikipia Elephant Watch Group), the local

community and Kenya Wildlife Service (KWS) rangers assisted in locating the elephants and following their spoor. The course of movement was recorded using Global Positioning System (GPS) and the resulting coordinates plotted on a map using Geographical Information System Arc Info software.

2.3 Estimation of Elephant Population Density

Dung-piles were counted along 13 randomly placed 2,000-m long transects as described by Barnes and Jensen (1987) and Barnes (1993, 1996). These were used to establish the distribution of elephants as a measure of area use. Densities were estimated by using the formula below described by Barnes (1996);

$$Y = n. f(0)/ 2l$$

Where, n = number of dung piles, l = length of transect (in metres) and f (0) = estimate of reciprocal of the effective strip width, and Y =dung density.
The "ELEPHANT" computer program (Dekker and Dawson, 1992) was used to analyse the perpendicular distances between each dung pile and the centre-line of the transect as observed by walking along the transect to calculate f(0) and r, the decay rate. The program is based on the line transect sampling method described by Burharm *et al*. (1980).

Elephant density, E, was calculated from the dung density, Y, defecation rate, D, and r by the equation (Barnes and Jensen, 1987);

$$E = Y.r/D$$

The variables of Y, r and D contribute to the variance of E. Defecation rate is the mean number of dung piles produced by an elephant per day (Barnes 1996). A defecation rate of 17 dung piles per day per elephant was used to calculate elephant population based on estimates for similar habitats (Barnes and Jensen, 1987; Plumptre and Harris, 1995; Tchamba, 1992; Wing and Buss 1970).

Dung decay rate, r, was estimated by monitoring 60 fresh dung piles for 210 days within Thegu forest. These were observed fortnightly during the first three months and weekly thereafter. Barnes (1996) suggested 50, as the optimum number of dung piles required to establish an estimate of rate of dung decay.

2.4 Assessment of Elephant Damage on Farms

Intensity of elephant use of the farms was estimated from data on frequency of raids, herd size, damage and losses. Since a pilot study to test the questionnaire method indicated that some respondents were liable to give misleading information in expectation of higher compensation, this study disregarded those damage estimates that were greater than the expected production (yield) for the household concerned. In all reported cases, an independent assessment of the alleged types and levels of damage was done to validate the data and appropriate adjustments following Kangwana (1996). Additional information on losses from

losses due to elephant damage included estimates of realised and expected crop yields and local market prices (in Kenya Shillings) for 1999 and 2000, obtained from the Ministry of Agriculture (Table 2). Standard units of measurement were used for yields, losses and monetary value.

2.5 Assessment of Local Community's Attitudes to Re-opening of Elephant Corridor

The proposed corridor runs along the whole length of the interface between Thegu forest and Sangare Ranch. Its breadth has never been clearly defined. However, this study focused on a 10x7 km strip along the established route of elephant movement within which a questionnaire was used to gather data on local community's attitudes to the elephants living amongst them (Figure 1).

The optimum number of households required to determine attitudes towards elephants was calculated as n = 384 for the broader study, from the formula below following Fisher *et al*. (1998).

$n = Z^2 pqD/d^2$

Where, Z = 1.96 representing the 95% level of confidence desired for Z-scores.

p = proportion of households affected by elephants, assumed to be 0.5 where the p is unknown.

q = proportion of households unaffected by elephants, assumed as 0.5 where q is unknown.

d = the level of confidence required (0.05 for this case).

D = 1 (where there is no replication or comparison)

The sample size was adjusted from 384 to 467 in order to increase response rate and correct for inadequate responses (Kothari, 2004). Prettijohn (pers. comm.) provided information on the proposed physical location of the corridor and its operational cost.

Respondents were asked to state whether elephants raided their farms and how much damage and loss was incurred. Additional information sought was the size of elephant herds and the seasons/months of their raids, opinions on whether elephants were useful or harmful and how. Further questions included what they would feel if elephants were eradicated from the Mt Kenya forests; whether they were willing to tolerate elephants on their land; what mitigating actions (and their effectiveness), if any, were used. The views of the landowners was sought on letting elephant passage through their land at a rental fee of KES 3,705/= per Ha as per the corridor proponents (Prettijohn, pers. comm.). Additional data included type and amount of damage, frequency and timing of elephant raids, how long respondents had lived on their land and, the acreage of their landholding.

2.6 Assessment of Local Community Land Use Practices

Data on land use practices within the proposed corridor were derived from responses on types of preferred crops and livestock. Estimates of actual annual production were compared with the potential gains of the proposed elephant corridor. Human population trends were examined from government records on national censuses for 1969, 1979 and 1989 (Ayiemba, 1991) and 1999 (Ministry of Finance and Development, 2001).

3.0 Results

3.1 Elephant Migration Route

Two sightings were made of elephants on the route, one consisting of two bulls and another of a mixed herd of five elephants. Residents corroborated that this was the only route that was currently used by elephants. Footprints and dung were observed at various stages of rotting. The footprints and dung were found within a single file approximately 7000 m long and 4-10 m wide. GPS coordinates of the route were plotted on a map (Figure 1).

3.2 Elephant Population Density in Thegu Forest

Results showed a mean dung decay rate of 0.0073 ± 0.0031SD for the 189 boli from the sixty dung piles, which gave r-value of 0.73% of dung per day. This value was used to calculate elephant population densities in Thegu forest which ranged between 0.1 and 8.9 individuals at an average of 3.5± 3.11SD elephants per Km^{2}. The variation in these densities between the various transects was not significant (Kolmogorov-Smirnov test: Z = 1.00, P = 0.178, n = 13 (Table 1).

3.3 Elephant Damage to Farms

About 94.8% of household owners cited raids by elephants on their farms, out of which 87% resulted in damage while 3.9% were on transit to other parts of their range without causing damage. About 88.3% of the transgressions involved crop raiding making it the main type of damage. The rest (2.6%) of the respondents did not give the status of damage to their farms.

Results showed that 49% of the respondents did not estimate amounts of crop yields, 24% did not estimate elephant damage and 13% exaggerated the amounts of damage to crops. All these data were excluded from calculations of amounts of elephant damage to farms. Out of the 14% of respondents who provided both the estimates of crop yields and elephant damage, 10.4 % of the farms had serious crop losses while 3.9% had moderate amounts of damage. Table 2 summarises the various types of damage and estimates of monetary value. In addition, some people sustained injuries sometimes resulting in death while others suffered trauma that interfered with their livelihoods, measurements of which were beyond the scope of this study.

The estimated total loss on farms caused by elephants was KES 392,122 per household per year and KES 38,239.1 per Ha per year under crops, respectively. Crop damage alone accounted for 35% of the total losses at KES 137,205.7± 89,497SE followed by loss of KES 110,000±10,000 to livestock.
The mean area under crop cultivation was 0.9±0.24SE Ha. Thus, on average, each household within the corridor area lost about KES 7,225 per month. Assuming that all the approximately seven sq km of the proposed corridor was under crop production, the total losses under uniform production and damage would be KES 26,767,370 per year.

Incidences of elephant attacks on farms adjacent to Thegu forest occurred during all months throughout the year (Figure 3*)*. This frequencies were not insignificant (X^2= 1.50, df = 8, P =0.993) between months. Respondents indicated that groups of > 50 individuals rarely stopped to feed, although these comprised only 3.9% of elephant visits, while 87% of visits resulted in damage. Groups of <10 were the most frequent raiders.

3.4 Impact of Local Community on Elephants

Land holding ranged from 0.4 Ha among the small-scale farmers and approximately 2,000 Ha in the ranches, averaging 44 Ha per household. About 65% of this land was under livestock grazing and the rest was under crops such as maize and potatoes (Table 3), amounting to restriction to elephant use.

There was widespread harassment of elephants on farms during migration or otherwise. This pestering revolved around employing various means of elephant control against crop raiding.

Table 4 shows the frequency of occurrence and alleged effectiveness of the control methods used against elephants. Whereas a majority (63.1%) of farmers largely failed to deter elephants, about 11.8% of them effectively kept elephant away from their farms. About 25% of the respondents had not applied any measure against elephants. The most effective barriers were electric fences and the least effective were fire, lights and noises used to scare away the animals. Effectiveness was significantly different between various control methods (Kendall's tau c = 0.252, P = 0.005).

3.5 Attitudes of the Local Community to the Re-opening of an Elephant Corridor

Seventy-seven households gave their opinion on the proposed corridor. Their views were divergent with a majority (52.6%) supporting the proposal to open the migration pathways whereas 32.9% were opposed to it (Figure 2). Approximately 14.5% were undecided. Those who supported gave the reasons that they would experience better economic gains, and that it would be good for conservation and posterity. Many (42.1%) of those against the corridor were apprehensive because

of the damages and losses incurred due to elephants, whereas 10.5 % did not give reasons for opposing the idea.

Table 3 shows that a majority (89.3%) of respondents had not benefited from the presence of elephants but the rest mentioned benefits such as tourism, aesthetic and securing tree seedlings from elephant dung.

There was a strong association between the negative attitudes towards elephants and their alleged levels of damage (X^2= 0.797, df =4, P < 0.01), as well as the hostility directed to them by the community (X^2= 0.673, df = 4, P < 0.01). Indeed, 48.1% of landowners disliked elephants because of the damage they caused and the lack of meaningful compensation for the losses incurred. A majority of the local community were aware of importance of elephants especially in tourism, their ecological role as agents of seed dispersal, sources of bush meat and ivory, and revenue generation to the local government, rancher owners and to the public. However, only a small percentage (3%) of the respondents admitted having gained directly or indirectly in any way.

Most (58.4%) of the landowners who put up with elephants on their land did so because of their inability to keep them away. The intolerance was strongly related to the much damage caused on property (X^2= 0.745, df = 4, P< 0.01). Only 2.6% of the respondents indicated a willingness to let elephants on their property because of their conservation needs and the levels of damage caused were tolerable.

3.6 Local Community Land Use Practices

Results from the questionnaire show that the main land uses were agriculture, where a majority (91%) of the landowners practiced crop cultivation and a few livestock per household while the rest were mainly ranchers. Most of the local community settled within the study area during the last 40 years. The human population density has increased by over 200% from a low of 168 persons per sq km in 1968 to a high of 385 persons per sq km in 1998 (Table 2).

4.0 Discussion

The proposed corridor would link some of the remaining elephant habitats in Mt Kenya and the expansive ranches in the region separated by only 7 km. in the region. Graham (2000) had noted that elephants left Sangare Ranch for Thegu Forest during periods of low rainfall (May - October 1999), and then dispersed back to the low-lying ranches during the wet months. Balfour *et al.* (2007) recognised this as an important corridor for expansion elephant range. KWS Strategic Plans for 2002-2008 also cited this corridor as an opportunity for future consideration in mitigation of human-wildlife conflict. However, a growing number of small-scale agricultural communities have settled on this land and elephant presence is becoming increasingly resented. Increasing human density in the

settled parts of the study area therefore likely prohibit the option of creating a corridor

Thegu Forest provides an important sanctuary to a high density of elephant population (3.5 per sq km) compared with that occurring at higher elevations on Mt Kenya National Park (2.6 elephants per sq Km). An earlier survey conducted in 1991 estimated a density of 3.1 elephants per sq km (Reuling *et al.* 1992: cited by Said *et al.* 1995) for Mt Kenya. The estimates observed for Thegu forest demonstrated its crucial role for elephant conservation and compares favourably with other protected areas in Kenya (Said, *et al.* 1995). Along the proposed corridor, the elephant density was 0.26 per sq km.

The elephant population density at 3.5 per sq. km within the study area where human densities was 385 per sq. Km might be considered too high for people and elephants to co-exist, which is only possible up to about 15 people per sq km (Hoare and du Toit, 1999). The more marginal habitats especially in the southern Africa, wildlife use offers better alternatives to growing crops. This is in sharp contrast to the western slopes of Mt Kenya where crop cultivation and livestock keeping competes with elephants.

To avert negative impacts, the local community employed various methods in efforts to protect their farms from elephant menace, a majority of which were largely ineffective. Being powerful and formidable animals it was not surprising that most of the methods achieved little, if any, in forestalling elephant raids, except for electric fences (Hoare, 2001). A majority of the farms were susceptible to elephant damage as only 11.8% of farmers protected their farms effectively against elephants.

The views of the local people indicated that any attempt to unblock the corridor would be difficult. A majority of the local community considered elephants a dangerous economic burden for which compensation was inadequate. The costs of living with elephants therefore outweighed the benefits.

Whereas a majority of people were aware of importance of elephants, e.g. as a stimulus for tourism, a significant proportion (89.3%) did not find elephants useful to them and only 3% admitted having gained directly or indirectly in any way. Accordingly, they were unwilling to accommodate and continued presence of elephants on farms was only because the landowners lacked capacity to keep them away.

At the proposed rental fee of KES 3,705 per Ha per year, the financial implication to the local community would be is considerable. Rearing cattle at Sangare Ranch was about KES 2,445.3 per Ha per year (Prettijohn, pers. Comm.). This explains the

marginal support by the local ranchers who were willing to lease 810 Ha for the proposed corridor

5.0 Conclusion

This study found substantial potential for reopening of a migration corridor linking Mt Kenya, Sangare Ranch and other elephant dispersal areas to the north and west. It also found strong resentment to the idea that may only be reversed through policy change and adoption of proactive approaches to resolving elephant-human conflicts. The corridor seemed unviable under prevailing agricultural practices and public attitudes.

Despite the formidable hurdles, a window of opportunity existed provided by the local community who were not too strongly opposed to the presence of elephants with adequate control measures. This study recommends the provision of tangible benefits that significantly outweigh both material and psychological costs if the idea is to be pursued any further.

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Table 1: Distribution of elephant population densities (km^2) in thirteen sampling locations within TheguForest Reserve.

Transect	Length (km)	Pile count	Dung density (km^2)	Elephant density (number per sq km)
1	2	10	339	0.1
2	2	8	217	0.1
3	2	51	1294	0.6
4	2.3	13	1942	0.8
5	2	131	10198	4.4
6	2.2	120	11272	4.8
7	2	89	5275	2.3
8	2	293	20700	8.9
9	2	200	15540	6.7
10	2	14	617	0.3
11	2	209	19259	8.3
12	2	158	9413	4.0
13	2.3	131	8955	3.8
Mean	2.1	109.8	8078.5	3.5± 3.11SD

Each location was a 2-km long transect along which elephant dung piles were counted to estimate elephant population densities. The variation in elephant population densities between various sampling locations was not significant (Kolmogorov-Smirnov test: Z = 1.00, P = 0.178, n = 13).

Table 2: Types and amounts of elephant damage (in Kenya shillings) to farms and local community in Thegu forest-Sangare Ranch elephant corridor (n = 77 respondents)

Type of damage	Number of reported raid incidences	Percent frequency of raids	Mean (± SE) damage per household per year	Mean (± SE) damage to each household per Ha of cultivated land per year
Crop damage	35	45.5	137,205.7±89,497.0SE	38,239.1± 8,246.1SE
Fence breakage	26	33.8	39,750.0±16,584.1SE	-
Livestock deaths and injury	2	2.6	110,000.0±10,000.0SE	
Human fear	8	3.9	52,666.7± 26,591.6SE	

Water pipes	2	2.6	35,000.0± 25,000.0SE	
Tree damage	4	5.2	17,5000.0±10,897.2SE	
Human death/injury	1	1	No estimate	
Mean Total			392,122.4	

Table 3: Human population density (number /km^2) in the land adjacent to Thegu forest in 1999/2000

Year	density	Source of data
1968	167.9	*Kenya population census, 1969
1978	258.4	*Kenya Population Census, 1979
1988	305.4	*Kenya Population Census, 1989
1998	384.7	Ministry of Finance and Development , 2001

* Reference citation in Ayiemba (1991)

Table 4: Economic value (in Kenya shillings per Ha per year) of the various types of cultivated crops in farms astride Thegu forest- Sangare Ranch corridor in 1999/2000

Type of crop	Yield	Market price	Economic value
Vegetables	90,000	7.5	138,727.4 ± 91,055.4
Maize	360	21.25	23,633.1 ±6,547.6
Legumes	270	40	6,413.0 ± 4,130.3
Potatoes	14,000	7.2	4,597.4 ± 1,867.6
Wheat	2,700	23.75	1,142.9 ± 935.7
Bananas	11.0	5.6l	129.1 ± 93.1
Total			174,643

Yields of crops in Kg/Ha/year and their local market price in Kenya Shillings during 1999/2000 in the study area. Yields and prices are means for the two years. Mean annual economic value (mean ± SE) in KES

Table 5: Frequency of occurrence and alleged effectiveness of the methods used to protect farms against elephant raids

Alleged effectiveness of control measures	Method of control				
	No control method	Fires, lights and noise	Electric fence	Thunder flashes	Total
Not applicable	19	0	0	0	19 (25.0)
Not effective	0	20	0	1	22 (28.9)
Slightly effective	0	24	0	1	26 (34.2
Effective	0	8	0	0	8 (10.5)
Very effective	0	0	1	0	1 (1.3)
Total	19 (24.7)	52 (67.5)	1 (1.3)	4 (5.2)	76 (100)

In brackets is percent number of respondents. The efficiencies between different methods were significantly different (Kendall's tau c = 0.252, P = 0.005).

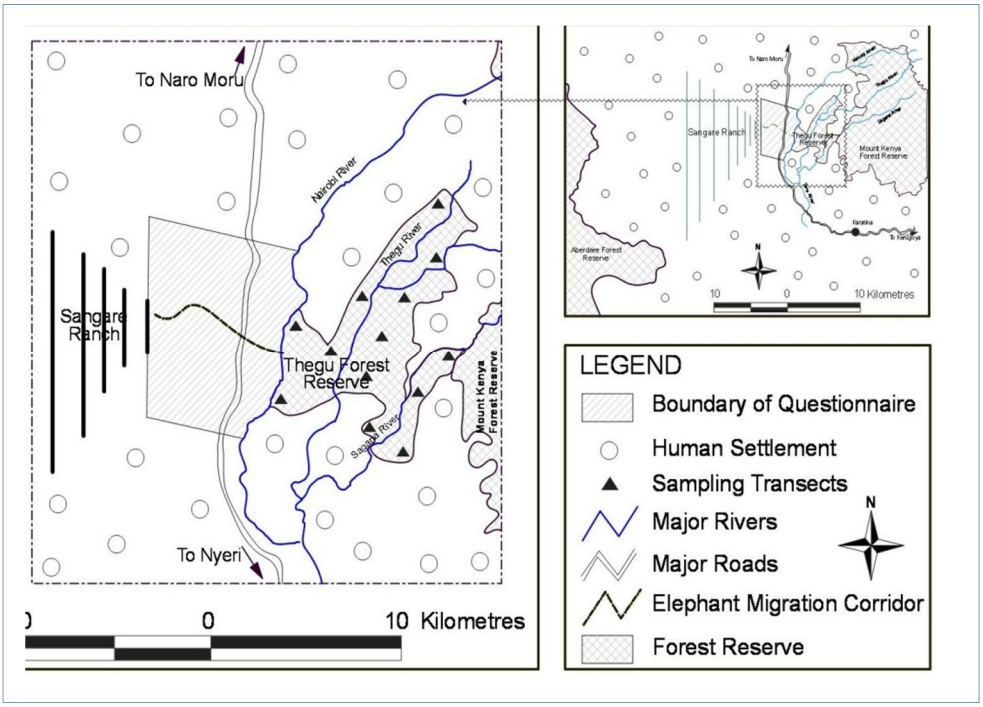


Figure 1: Map showing location of the study area in 1999 and 2000.

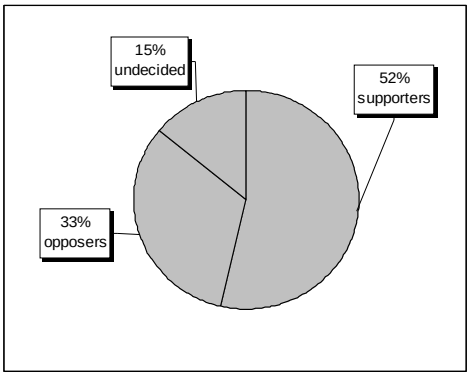
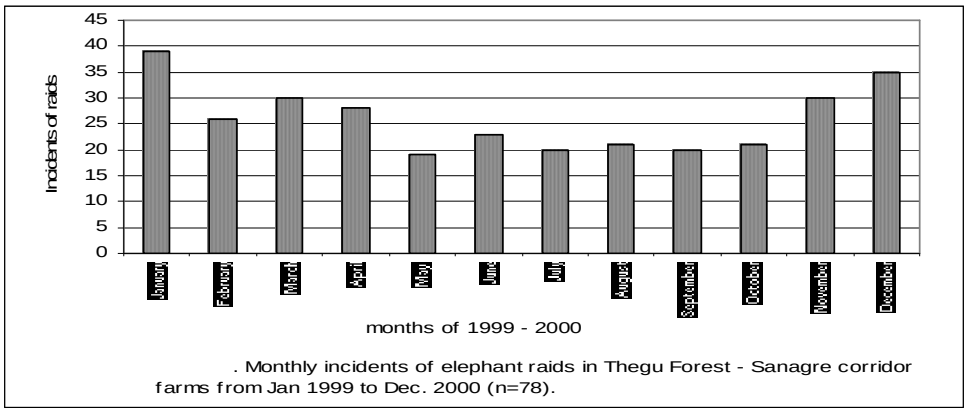


Figure 2: Percent of local peoples' views on whether proposed elephant corridor should be re-opened between Thegu forest and Sangare Ranch in 1999/2000 (n=77 respondents)



. Monthly incidents of elephant raids in Thegu Forest - Sanagre corridor farms from Jan 1999 to Dec. 2000 (n=78).

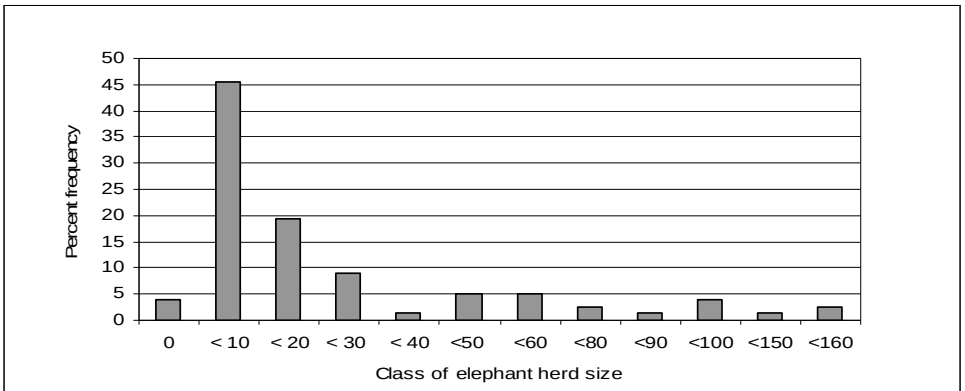


Figure 3. Frequency distribution of herd size of elephants attacking farms along Thegu -Sangare corridor.