



Final Project report

Project Title:

**Are the endemic and endangered Tana River primates culprits of crop raiding?
Evaluating Human – Nonhuman primate conflict status around Tana River
Primate Reserve, in Kenya.**

Prepared by:

Kivai Stanislaus Mulu,

Institute of Primate Research, P.O Box 24481, Nairobi, Kenya.

October 2010

Funded by:

Rufford Foundation

Summary

Human-wildlife conflict is currently a major threat to most of globally endangered mammal species. The conflict occurs where human requirements overlap with those of wildlife resulting to resource competition hence costs to either. Nonhuman primates have been shown to be a major problem in agricultural production. Lack of effective deterrent methods targeting monkeys complicates the situation. Unfortunately, no studies have been conducted to assess the conflict status in the area. This impedes conservation efforts in this key primate ecosystem. Therefore, to enable informed decision making, a survey was conducted in Tana River primate national reserve and its environs to determine the extent of human-nonhuman primate conflict, nonhuman primate species involved in the conflict and factors that render the poor farmers vulnerable. The study used the following methods; questionnaires, informal interviews, participant observation, quadrant sampling and focal observations. All the five diurnal nonhuman primates found in Tana River were implicated in crop raiding. The results indicated baboons and lowland sykes monkeys raided crops most at a magnitude of 100% and 98%, respectively, while Tana red colobus at 28% and the Tana river mangabey at 63%. Statistically, the level of crop raiding by Tana primates was significant ($P < 0.05$), apart from Tana River red colobus. Crop raiding happened mostly during the early fruiting stage. The most targeted crops were; mangoes (34%), maize (28%) and bananas (16%). Baboons raided 16 different crops while lowland sykes, vervets, Tana River mangabey and Tana River red colobus raided, 11, 6, 5 and 1 crop respectively. Most primates were consumed as bush meat and this differed significantly ($t = 15.124$, $df = 92$, $p < 0.0001$). Use of sling and guarding were the two common deterrent methods used. The human-nonhuman primate conflict is mediated by rapidly shrinking primate habitat. The forest fragmentation restricts the primates in small area and subsequently decline of food resources. The conflict is associated with huge economic and food losses and requires urgent redress.

Table of Contents

Summary.....	2
List of Tables and Figures.....	4
1.0 INTRODUCTION	5
1.1 Background information, problem statement and justification.....	5
1.2 Project goal.....	7
1.3 Objectives.....	7
2.0 MATERIALS AND METHODS	8
2.1 Study area	8
2.2 Data collection.....	9
2.3 Methods	10
3.0 RESULTS	12
3.1 Spatial distribution of human-nonhuman primate conflict around Tana River primate ecosystem	12
3.2 Crop and raiding and livestock predation by nonhuman primates	13
3.3 Pattern of crop raiding by different primate species.....	13
3.4 Crop raiding by Nonhuman primates in Tana River.....	14
3.5 Preferred crops and magnitude of raiding by nonhuman-primates.....	15
3.6 Variations in crop raiding by different Nonhuman primates	16
3.7 Comparison of crop raiding between Nonhuman primate and other wildlife.....	17
3.8 Economic losses associated with primate crop damage.....	18
3.9 Factors that render primates vulnerable to the conflict.....	19
3.10 Threats to the Tana River Primate habitat	22
3.11 Deterrent methods used	23
3.12 Resource competition	24
4.0 DISCUSSION.....	27
5.0 CONCLUSION AND RECOMMENDATIONS.....	30
6.0 ACKNOWLEDGEMENT.....	31
7.0 REFERENCES:	32

List of Tables and Figures

TABLE 1: ESTIMATION OF ECONOMIC LOSSES OF THE TEN MOST AFFECTED CROPS BY NONHUMAN PRIMATES BY FARMERS IN TANA RIVER PRIMATE ECOSYSTEM	18
Figure 1. Map of the study area showing the areas sampled in red circles	8
FIGURE 2. DISTRIBUTION MAP OF HUMAN-NONHUMAN PRIMATE CONFLICT IN TANA RIVER PRIMATE ECOSYSTEM ..	12
FIGURE 3. CROP RAIDING AND LIVESTOCK PREDATION BY DIURNAL NONHUMAN PRIMATES IN TANA RIVER PRIMATE ECOSYSTEM.....	13
FIGURE 4. CROP RAIDING PATTERN BY NONHUMAN PRIMATE IN TANA RIVER AND DIFFERENT STAGES OF CROP DEVELOPMENT	14
FIGURE 5. CROP RAIDING INTENSITY BY DIFFERENT PRIMATES IN TANA RIVER PRIMATE ECOSYSTEM	15
FIGURE 6. TARGET CROPS BY RAIDING PRIMATES AND THEIR RELATIVE PREFERENCE	16
FIGURE 7. GRAPH SHOWING THE CROPS RAIDING AND INTENSITY OF RAIDING BY DIFFERENT PRIMATE SPECIES. ...	17
FIGURE 8. CROP RAIDING INTENSITY AND LIVESTOCK PREDATION BY NONHUMAN PRIMATE AND OTHER WILD ANIMALS AROUND TANA RIVER PRIMATE ECOSYSTEM.....	18
FIGURE 9. PERCEIVED CHANGE IN PRIMATE HABITAT IN TANA RIVER PRIMATE ECOSYSTEM IN THE LAST 1-2 YEARS AGO, A FACTOR AGGRAVATING THE PRIMATE CONFLICT.19	19
FIGURE 10. LEVEL OF DIFFERENT HABITAT DISTURBANCES TANA RIVER PRIMATE HABITAT	20
FIGURE 11. CONSUMPTION OF NONHUMAN PRIMATES IN TANA RIVER PRIMATE ECOSYSTEM AS BUSH MEAT BY HUMANS.....	21
FIGURE 12. THREATS FACING THE NONHUMAN PRIMATE HABITAT IN AND AROUND TRNPR AS PERCEIVED BY THE LOCAL PEOPLE.	23
FIGURE 13. DETERRENT METHODS AND LEVEL OF USE BY LOCAL FARMERS TO COUNTER CROP RAIDING AND LIVESTOCK PREDATION BY NONHUMAN PRIMATES	24

1.0 INTRODUCTION

1.1 Background information, problem statement and justification

Human-wildlife conflict is currently a major threat to most of globally endangered mammal species. The conflict occurs where human requirements overlap with those of wildlife resulting to resource competition hence costs to both (Lieberman and Reed, 2008). The major driving forces of human – wildlife conflict include human population growth, species habitat loss, degradation and fragmentation, land use and transformation, rapid growth of ecotourism, climatic change and stochastic events, conservation programs resulting to increased wildlife populations (Muruthi, 2005). Human-wildlife conflict has deep reaching consequences on the ecosystem. For instance, species exposed to conflict are more prone to extinction due to injuries and deaths (Oganda *et al.*, 2003). Human induced mortalities as a result of the conflict adversely affect the species population viability and shift the ecosystem equilibrium leading to its instability. Moreover, the conflict impact on human health, safety and have immense socio-economic costs.

Nonhuman primates have not been spared in human-wildlife crisis. A third to a half of all primate species are now endangered as a result of human conflict related causes such as overexploitation, hunting and habitat destruction. Previous studies have shown that hunting for bush meat is capable of decimating primate populations in different habitats (Mittermeier, 1987; Butynski, 1985; Fitzbiggon *et al.*, 1995; Moinde *et al.*, 2004). Moreover, the non-human primates have also been killed due to crop raids or livestock predation. This poses a great risk of extinction to primates if conservation interventions are not considered. Nevertheless, there is dire need to understand the human-nonhuman primate conflict, its mediating factors and the best approaches to redress the problem if we have to save the primates from the alarming rate of threat. This will enhance in-situ conservation of primates which should be prioritized since captive (ex-situ) conservation is stressful and expensive (Johnson *et al.*, 1973; Suleiman, 1998). Tana river primate ecosystem as a major primate hotspot presents the best study site for this. It hosts diverse primates including some of the world's most endangered primates; Tana River Red Colobus and Tana River Mangabey (Butynsi & Mwangi, 1994). Agricultural and pastoral activities in the area make more ideal to study human-nonhuman primate conflict which might be poorly understood.

Previous studies in Tana River National Primate Reserve and surrounding areas have paid little attention to human-wildlife conflict but instead focused on population demographics, habitat quality, behaviour and dietary needs (Homewood, 1976; Hughes, 1988; Kinnaird, 1990; Medley, 1993; Wahungu, 2000; Wiczowski, 2005, Wiczowski & Kinnaird 2008). However, it has been shown that habitat fragmentation and restriction of primate in small isolated forest patches threatens the two endangered primates

endemic to Tana river (Mborá & Wieczkowski, 2000). Restriction of primate communities into highly fragmented forest patches lead to both intra and interspecific competition including baboon predation on other primates (Begon & Motimer, 1992; Personal observation, 2010). Consequently, the risk of disease transmission increase, food resources decline and foraging strategies change which encourage human-wildlife conflict (Estrada and Coates-Estrada 1996; Chapman et al., 2007).

Human encroachment, unsustainable resource utilization, changing hydrological patterns and elephant disturbance in Tana River primate habitats have resulted to decline in plant diversity and key resources (Kahumbu, 1992; Kinnaird, 1992; Medley, 1993; Wieczkowski & Mborá, 2002; Wieczkowski & Kinnaird 2008). Ganzhorn (2002) found that if food availability drops below the normal of average years, the primate communities starve to death. Therefore, with pressure on the primate habitats, the same is likely to happen in Tana River primate ecosystem and perhaps it will be preceded by intense crop raiding and livestock predation should it be alternative source of food. According to Wieczkowski & Kinnaird (2008), already some of the primate communities in Tana River have shown shifts in their diet choice and foraging patterns implying the habitat changes are impacting negatively upon the primates. Given that 54% of the Red Colobus population and 47% of the Tana River Mangabey occur outside the protected areas, and over the last two decades forest loss in Tana river stood at 29% and 38% in and outside the protected areas, respectively (Moinde *et al.*, 2007), the vulnerability of these species in the phase of intense human-wildlife conflict still remains a challenge to their survival. This shows the significance of undertaking this study.

Although all wild animals are potentially capable of causing some conflict with humans, gregarious and large animals have severe impacts (Muruthi, 2005). The intelligence nature, gregarious behaviour and omnivorous character of most nonhuman primates make them more destructive than other large mammals (Macfie, 2003). This leads to development of negative attitude towards primate conservation as they are seen as nuisance and pests (Kangwana 1993; Kivai, 2008). However, primates significant ecologically and need protection which becomes possible through mitigation of the conflict. The approaches in resolving wildlife conflicts are; conflict prevention, mitigation and change of people attitude through education and making communities realize benefits of wildlife conservation (Muruthi, 2005). Preventive approaches include; eradication, population management, regulated harvesting, fertility control, exclusion by using barriers, crop or livestock guarding, use of repellants and taste aversion, land use management and landscape modifications, and fear provoking stimuli (Kangwana, 1993; Crook 2002). The mitigation measures are elimination, problem animal control and translocation (Conover 2002; Muruthi, 2005). However, efficacy of these

approaches in controlling human-nonhuman primate conflict has not been evaluated. Therefore understanding the human-nonhuman primate conflict status and exploring the possible effective mitigation measures in Tana river remains significant in conservation of endangered primates and promotion of harmonious coexistence with local livelihoods.

1.2 Project goal

In order to enhance the survival of the endangered and endemic nonhuman primates in Tana River and minimize the primate conflict impacts on the local livelihoods, the study sought to provide crucial information on human-nonhuman primate conflict status around Tana River National Primate Reserve and explore the local people coping strategies to the conflict by June 2010.

1.3 Objectives

The aims of this study were; by June, 2010;

- (i) Map the spatial distribution of nonhuman primates' crop raiding and livestock predation and factors that render the poor farmers vulnerable to these conflicts around the threatened Tana River Primate Reserve Ecosystem.
- (ii) Identify the type of nonhuman primate species involved and the target crops or livestock.
- (iii) Assess the food and economic losses by the local livelihoods through crop raiding and livestock depredation by nonhuman primates.
- (iv) Explore the range of deterrence methods in place, their effectiveness and suitability at different situations.



Plate 1. Doum palm tree topped by elephants in Mchelelo (right) and Stan Kivai interviewing a Pokomo woman on her farm while guarding crops from monkey raids

2.0 MATERIALS AND METHODS

2.1 Study area

The study was carried out in Tana River National Primate Reserve (TRNPR) and surrounding villages. The reserve is 171km² and it lies between 1°45'–21°0' S and 40°7' E, in southeastern Kenya (Fig. 1). There are about 80 forest patches distributed on both side of the Tana River and vary in sizes (Butynski and Mwangi 1994). Twenty seven of these forest patches occur within the TRNPR according to 2000 habitat survey (Moinde et al., 2007).

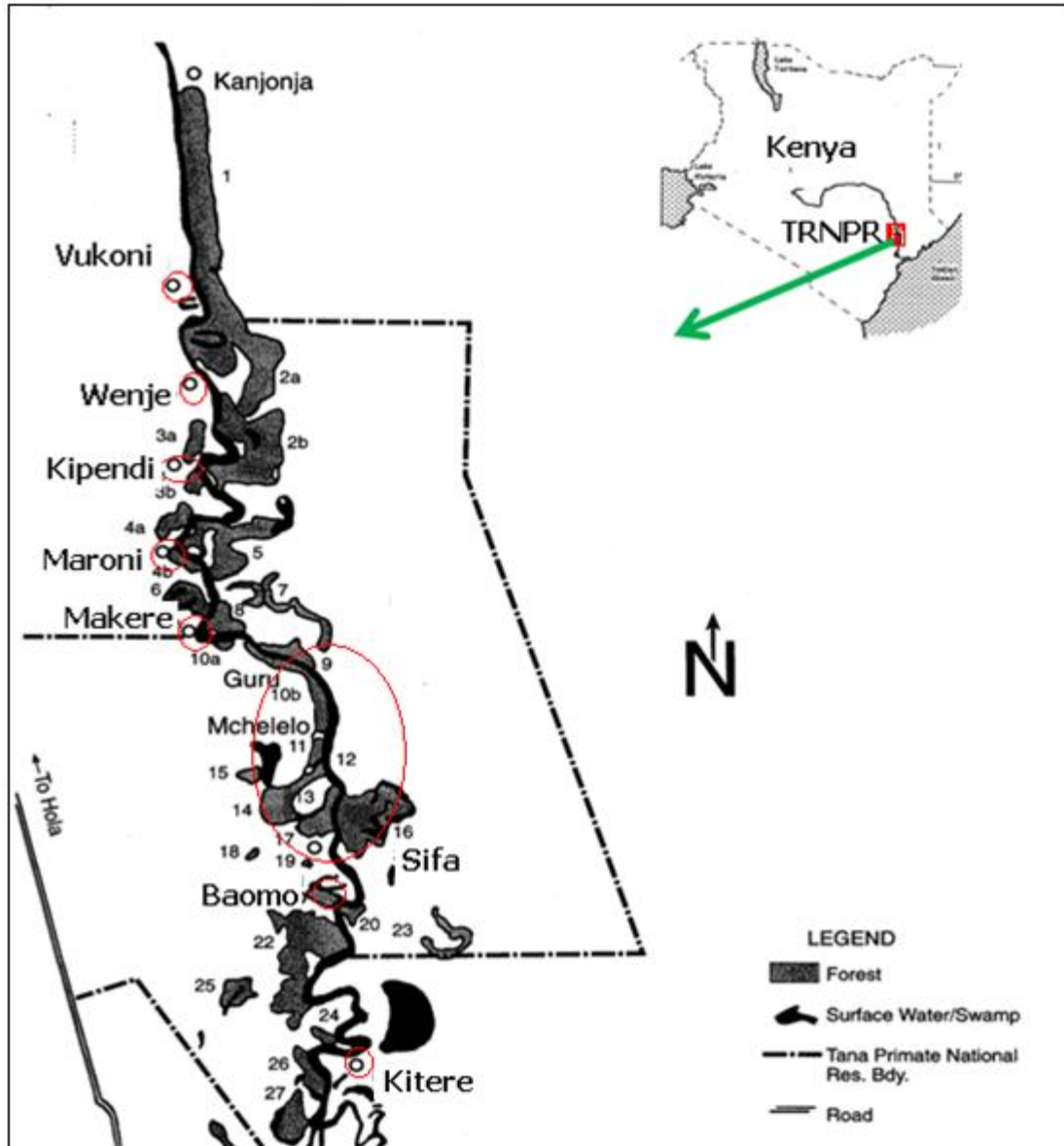


Figure 1. Map of the study area showing the areas sampled in red circles

However, due to fragmentation the numbers might have declined. The mean annual rainfall is about 400 mm and daily temperature ranges between 30-38°C (Butynski & Mwangi, 1994; Hughes 1990). The Tana River forest patches exhibit insignificant climate variability and harbor most of the diurnal primate species (Mbora & Meikle 2004). These include; *Papio anubis*, *Cercopithecus mitis albotorquatus*, *Procolobus rufostratus*, *Cercocebus galeries galeries* and *Cercopithecus aethiops*.

The lower Tana River primate ecosystem is mainly surrounded by major agricultural development activities with recent sugar irrigation scheme south of the Reserve toward the delta and Hola-Bura maize irrigation scheme to the north. The Pokomo people occupy area close to the river and being agriculturalist they cultivate along the river banks. Their farming practice is largely dependent on the floodwater to irrigate their crops and also the fertile soils deposited during the floods. Population growth of the Pokomo people put pressure on the riverine forests as demand for cultivation has been increasing. Besides the agriculturalists, the area is also inhabited by Orma, Somali and Wardei who are purely pastoralist. They utilize the dry woodland and grassland for grazing but rely on the river for watering their livestock. However, during period of prolonged drought and pasture paucity they make use of the river bank as dry season grazing zones.

2.2 Data collection

Data collection was designed to cover both wet and dry seasons. Sampling started over the dry season from end of July 2009. Sampling sites were selected based on presence of forest patches occupied by primates, possibility of experiencing human-nonhuman primate conflict and support by local people. Villages both in south and north of the Reserve were selected for the study. In order to capture the pattern of crop raiding and livestock predation in the area, crop fields were selected in different village and crop raiding by primate monitored through out the crop growing period as well as livestock predation incidences. To collect information on deterrent methods, crop fields with diverse crops were actively guarded and monitored during crop growing period and methods adopted by the local farmers to prevent crop raid by primates identified. Market surveys were conducted in the market centers in the area to determine crop prices and also help sought from the divisional agricultural office in Wenje. To assess factor which render the primates vulnerable to the conflict, vegetation plots were established in both inside and outside protected area and plant diversity and habitat threats assessed. To supplement the field data, a questionnaire was administered in all the villages in and around TRNPR. This targeted the local farmers, mainly those experience the conflict. Care was also taken to have a respondent balance in terms of age, sex, occupation and educational level.

2.3 Methods

Mapping the spatial distribution of nonhuman primates crop raiding and livestock predation and factors that render the poor farmers vulnerable to the conflict.

Geographical Information System (GIS) and field observation techniques (Anderson & Pariela, 2005; Naughton-Treves, 1998) were used to meet this objective. Using well trained personnel comprising the local scouts, coordinates of all conflict points related to nonhuman primates were recorded using GPS. The points were identified through reports on the conflict by local farmers and direct observations by the research team. Based on continuous monitoring of the conflict, spatial patterns of the conflict were determined. On the other hand, to determine the factors that render the primates vulnerable to the conflict, primate habitat was assessed using quadrant method. Data collected included abundance of key food resource plants, anthropogenic and natural habitat disturbances and food resource availability. This was also supplemented by a field observations and questionnaire administered to capture same information. These methods captured data on; animal husbandry practices, location and accessibility of crop fields by primates, where the crop raiders come from, land use and tenure practices, village settlement patterns, encroachment of cultivation and herding into core primates habitat, natural resources utilization from the reserve.

Identifying the type of nonhuman primate species involved and the targeted crops or livestock.

Participant observation, farm visits and questionnaire methods as used by Hill (1997), Naughton-Treves (1998) and Kagiri (2005) were used to achieve this objective. At least five farms were randomly selected at each of the four sampling area around the reserve, and actively guarded to record all the nonhuman primates which raided crops at different stages of crop development. Guarding was done in a way to cover the entire growing period of most crops grown by locals. During the observations and farm guarding data on the following was recorded where possible, crop pest species, time of the raid, type of crops destroyed, the age, crop condition and action taken by the farmer. In case of animal depredation by primates, where cases were reported by the farmers the researcher or local scouts made efforts to visit the scene of the incidence and ascertained the event was as a result of primates. In addition, questionnaires were administered targeting key informants especially the farmers who experienced the problem and were actively involved in farm guarding or herding. The questionnaire was also used to establish; when and where the predation occurred, the livestock type killed, age and condition, number and the predator responsible. Indirectly stage of crop damage, impact on final crop yield and timing of the raiding event and the target species were determined.

Assessing the food and economic losses by the local livelihoods through crop raiding and livestock depredation by nonhuman primates

This was achieved through use of both direct and indirect methods (Hill et al., 2002; Bell, 1984). Independent assessment of the crop damage by the research team formed the main direct method of data collection, but still the farmers were asked to provide their own crop loss estimates using questionnaires. This helped in comparing direct and indirect estimates and also captured additional valuable information from the farmers. Independent assessment of crop damage was done through examining the portion of damaged crop area relative to the total area of the standing crop (for lower cover crops) or number of crop plants destroyed or fruits relative to the standing total number of crop plants or fruits on the farm. Based on crop production records (per hectare/plat) available at Wenje agricultural office and existing market prices economic losses were estimated (Jones, et al. 2008; Kivai, 2008; Hill, et al., 2002; Hill, 2000; Naughton-Trevens, 1999). Incases where fruits such as mangoes, pawpaw were destroyed number of pieces were used to estimate the loss, then based on market prices losses in money value were estimated.

Exploring the range of deterrence methods in place, their effectiveness and suitability at different situations

Questionnaires and field observations were used to establish the deterrent methods in place (Anderson & Pariela, 2005; Hill et al., 2002). Using the two methods, different basic deterrent methods used by the farmers to protect their crop or livestock were identified and their use monitored over both wet and dry season. Moreover, observations were made on the nature of physical barriers (fences, walls, ditches, among others) on the farms monitored. This helped to establish the impact or effect of each method on preventing, reducing or completely eliminating either crop or livestock loss. It should be noted that, it was easier to observe a combination of different method deterrent methods already under application by farmers. However, other deterrent methods such as taste aversions, repellants, use of grease and chilly are not used by the farmers and were hard to be tried. Also poor season in months of November December presented an unsuitable opportunity for trying combination of a number of methods and testing their efficacy.

3.0 RESULTS

3.1 Spatial distribution of human-nonhuman primate conflict around Tana River primate ecosystem

Human-nonhuman primate conflict occurs all around the TRNPR (Fig 2.). The conflict distribution map indicates that crop raiding and livestock predation by different primates occurs in different magnitudes in the study area. However, the conflict seems to be intense in Kitere followed by Makere and Kipendi areas, Wenje and then Baomo. Baboons are the major sources of the conflict as they raid crops and predate on livestock in all the areas of our study. Human conflict with Tana River red colobus was only reported in Kitere

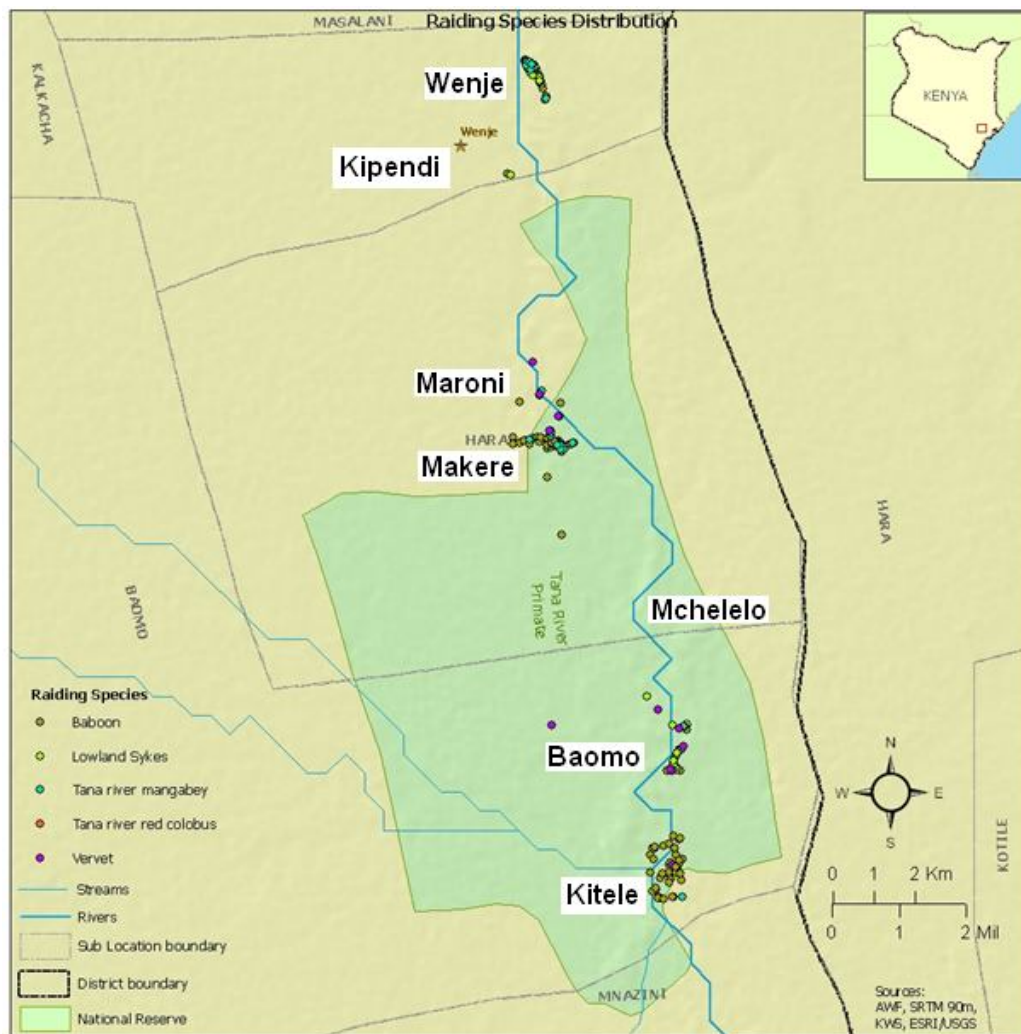


Figure 2. Distribution map of human-nonhuman primate conflict in Tana River primate ecosystem

3.2 Crop and raiding and livestock predation by nonhuman primates

The five diurnal primate species in Tana River primate ecosystem were all implicated in crop raiding (Fig. 3). Baboons and Lowland Sykes monkeys raided crops most at a magnitude of 100% and 98%, respectively. The Tana Red Colobus raided crops at a magnitude of 28% while the Tana River Mangabey at 63%. Statistically, one sample t test indicate that the level of crop raiding by Tana primates was significant ($P < 0.05$), apart from Tana River Red Colobus. Except Tana River Red Colobus the other four primates were implicated in livestock predation (Fig. 3). The Baboon predated livestock most and was implicated by 98%, and was the only primate that attacked livestock significantly ($t = 80.96$, $df = 115$, $p < 0.0001$).

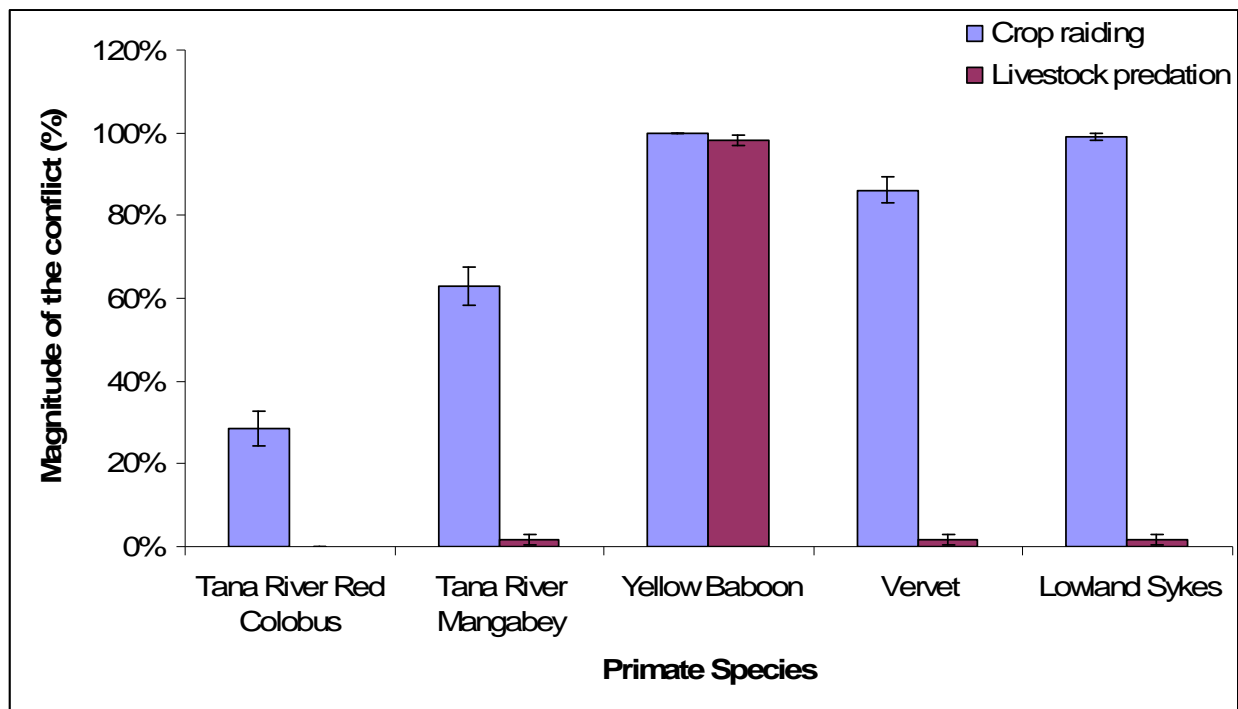


Figure 3. Crop raiding and livestock predation by diurnal nonhuman primates in Tana River primate ecosystem

3.3 Pattern of crop raiding by different primate species

Baboons raided crops intensively through out the development stages right from sowing (Fig 4). Crop raiding at any stage was above 80% by baboons. Tana River Red Colobus caused the least damage to crops and only raided crops (particularly mangoes) at flowering stage and early fruiting stages and the intensity of raiding was less than 40%. The Sykes, Tana River Mangabey and Vervet monkeys showed a similar trend of crop raiding, with raiding activity increasing gradually and peaking at early fruiting stage before declining drastically (Fig 4). Generally, severe crop damage occurred during the

flowering and early fruiting stage and this coincided with the peak of raiding for all species.

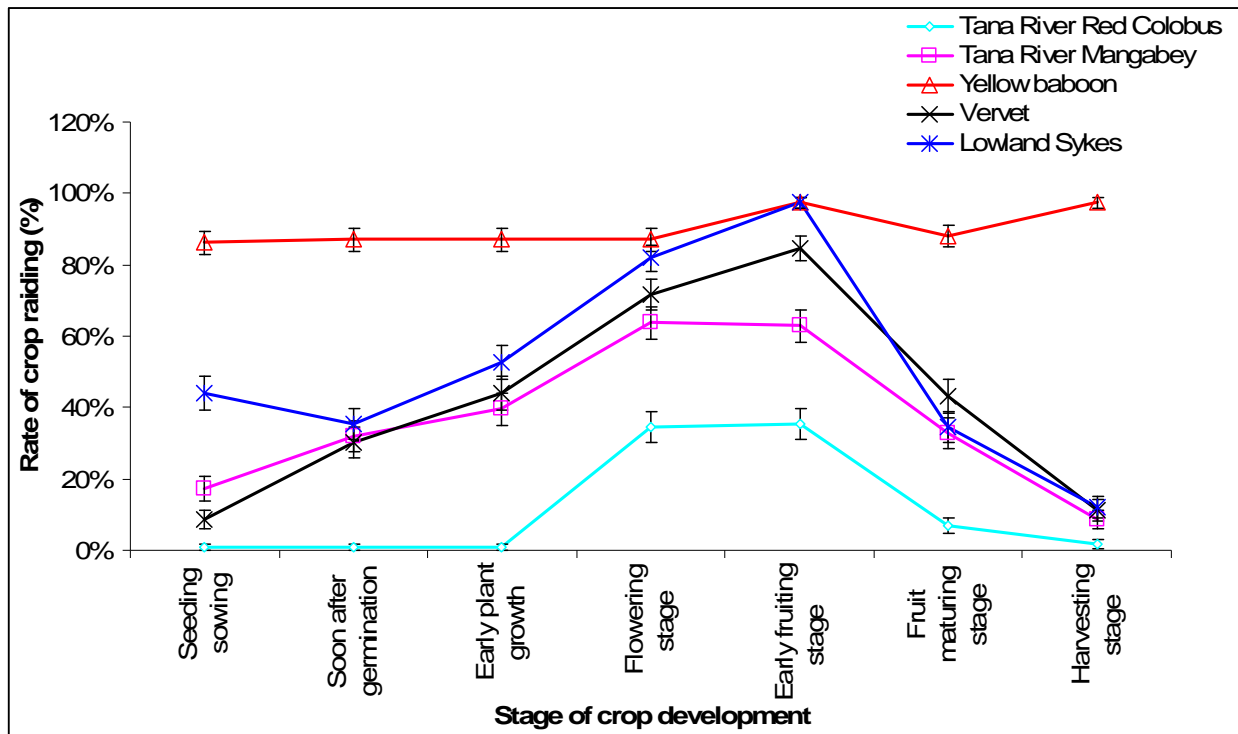


Figure 4. Crop raiding pattern by nonhuman primate in Tana river and different stages of crop development

3.4 Crop raiding by Nonhuman primates in Tana River

The Baboon was the most notorious in crop raiding accounting for 64% of the total cases of nonhuman crop raiding in the areas (Fig. 5). The Tana River Red Colobus was the least implicated in crop raiding contributing to 1% of the total raiding case observed. Cases of crop raiding by other primates were 23%, 9% and 3 % for Lowland Sykes, Tana River Mangabey and Vervet monkeys, respectively.

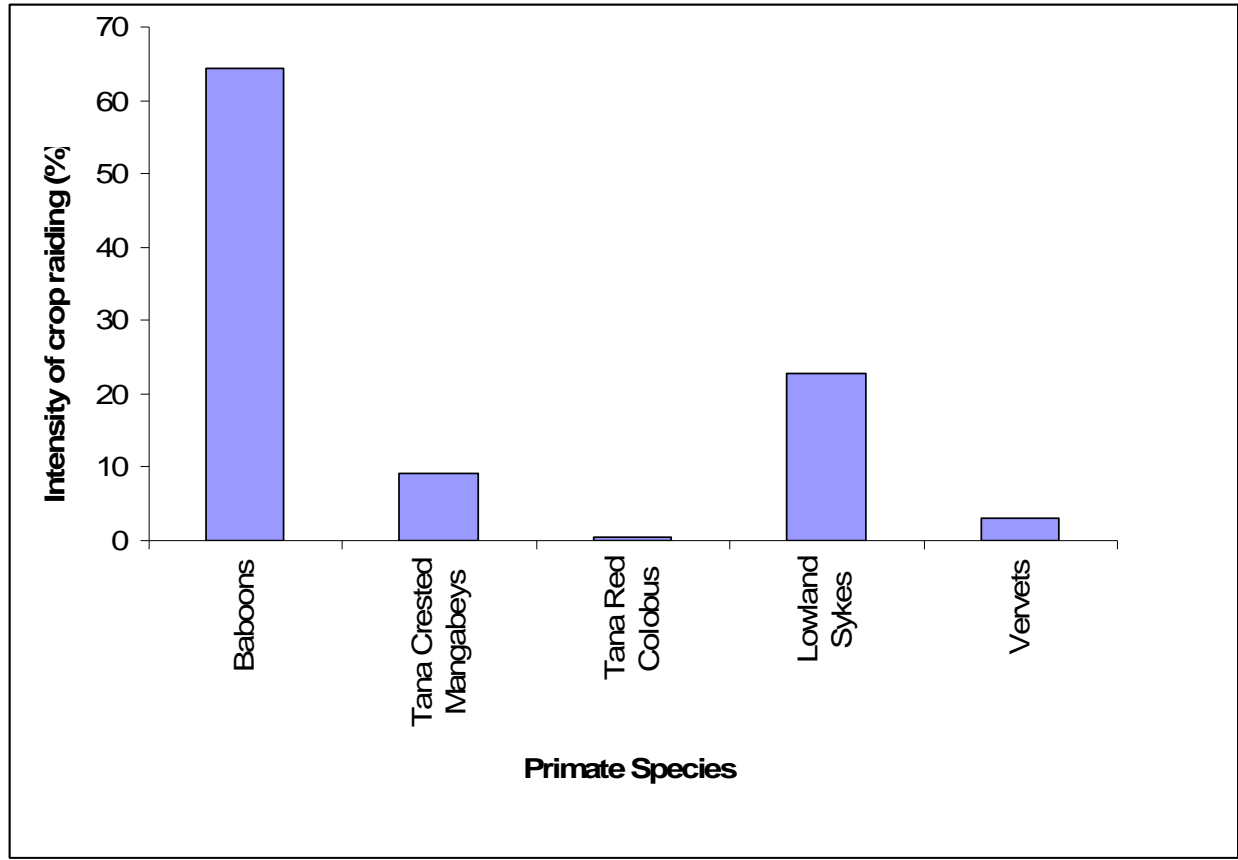


Figure 5. Crop raiding intensity by different primates in Tana River Primate ecosystem

3.5 Preferred crops and magnitude of raiding by nonhuman-primates

Eighteen different crops grown by farmers in lower Tana River were found to be raided by nonhuman primates. These were raided at different magnitudes with Mangoes (34%), Maize (28%) and Bananas (16%) as the most targeted crops by primates, respectively (Fig 6). Mangoes were grown mainly as a cash crop while Maize and Bananas for subsistence.

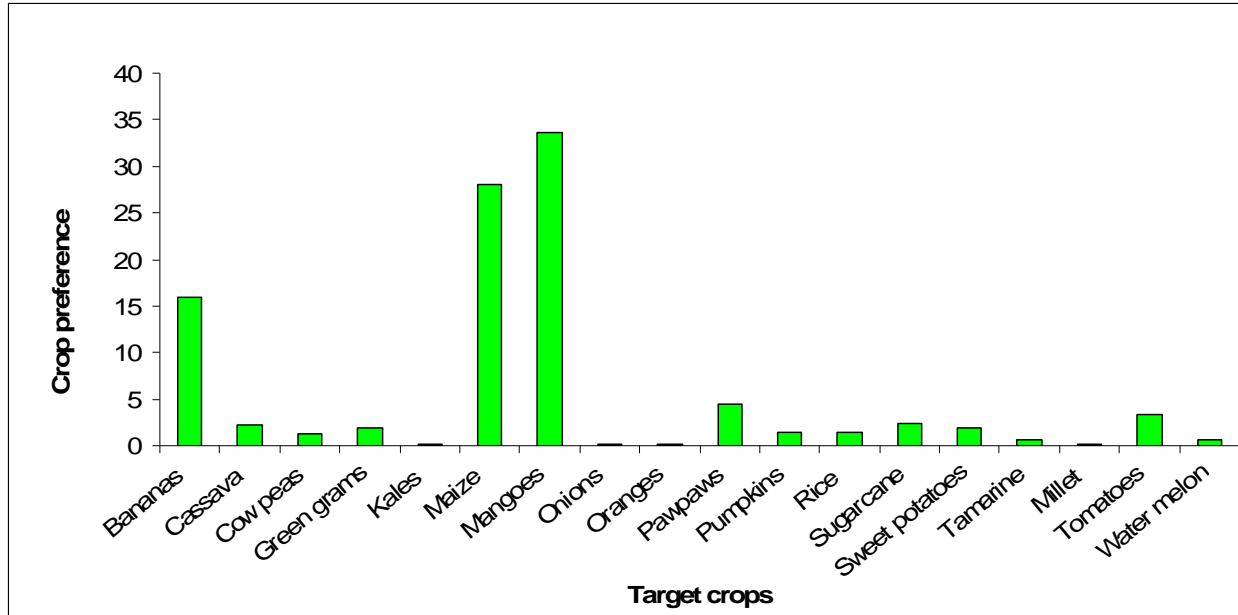


Figure 6. Some of the most targeted crops by raiding primates and their relative preference

3.6 Variations in crop raiding by different Nonhuman primates

The five nonhuman primates showed variation in target crops in the raiding activity (Fig 7). Baboons raided 16 different crops while Lowland Sykes, Vervets, Tana River Mangabey and Tana Red Colobus raided, 11, 6, 5 and 1 crop, respectively. The main target crop for the Yellow Baboons was maize while the Lowland Sykes and Tana River Mangabey targeted the mangoes. The Vervet monkeys raided the green grams most while the Tana Red Colobus only the Mangoes. Mangoes were raided by all the five species while maize and rice were raided by all the species except the Tana Red Colobus.



Plate 2. Research team training exercise at Mchelelo research camp in TRNPR

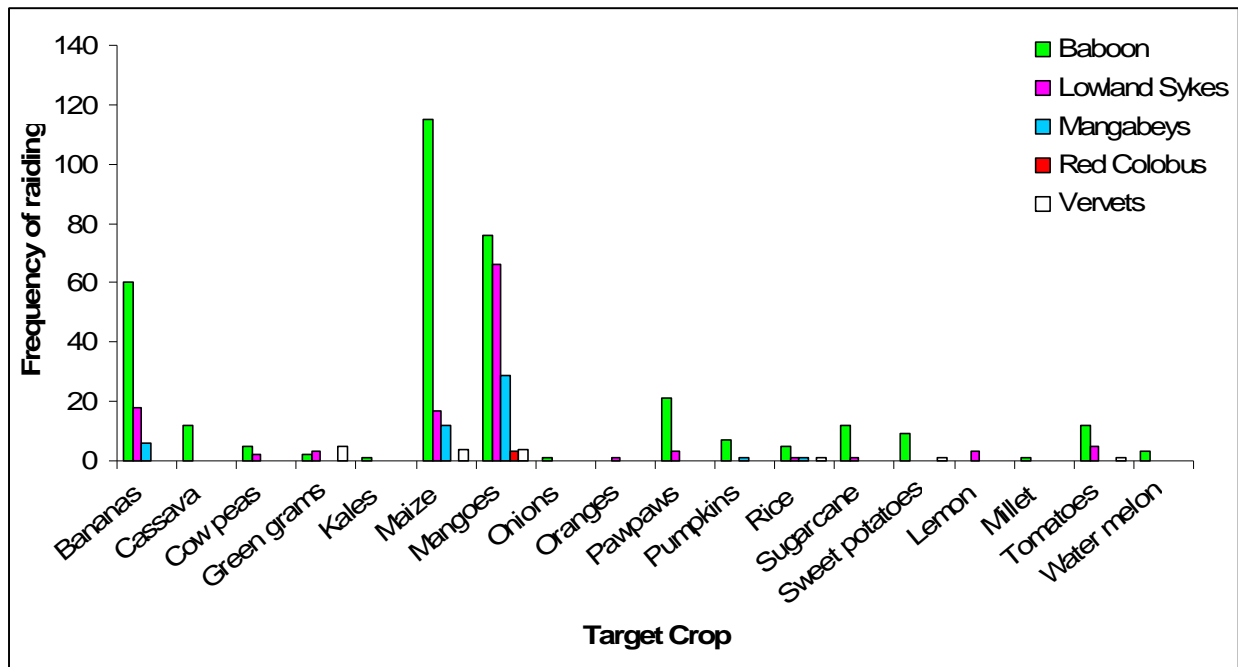


Figure 7. Graph showing the crops raiding and intensity of raiding by different primate species.

3.7 Comparison of crop raiding between Nonhuman primate and other wildlife

Nonhuman primates caused severe problem in crop raiding compared to other wild animals while other wild animals predated livestock more compared to nonhuman primates (Fig 8). Crop raiding by Nonhuman primate accounted for 61% of the cases reported while other animal accounted for 84% of the livestock predation cases reported.

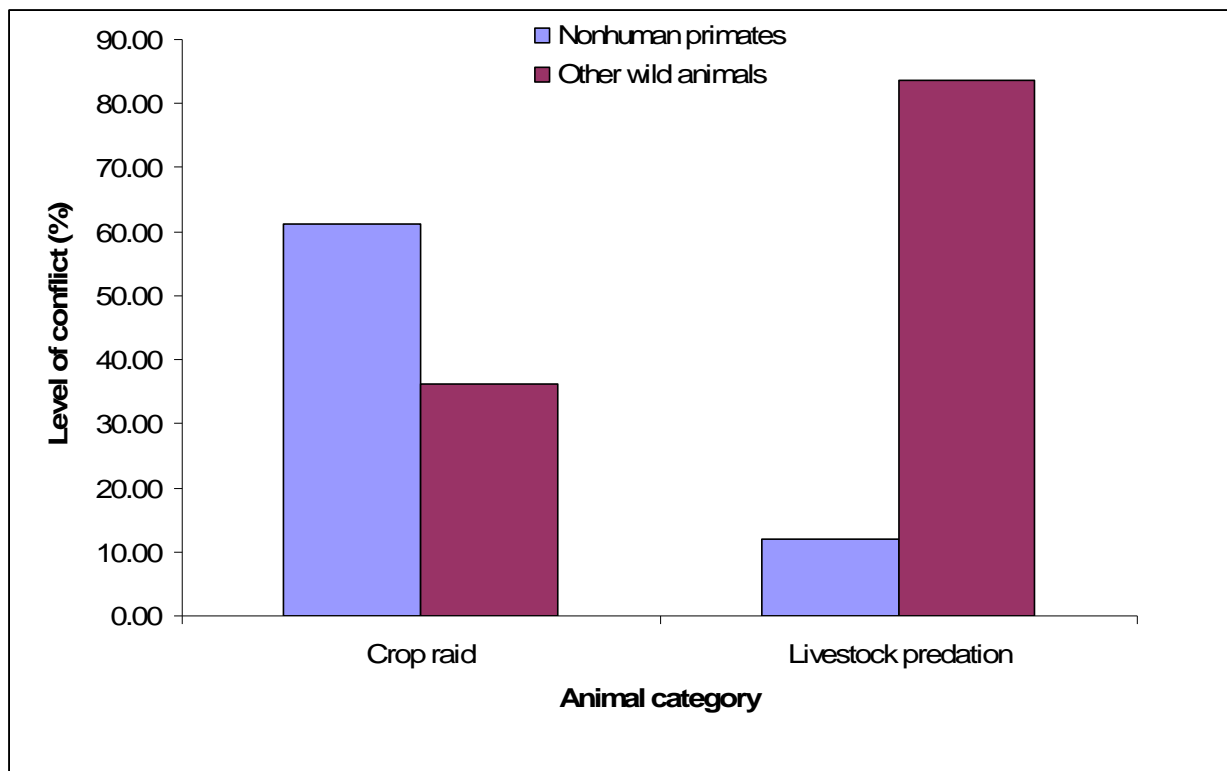


Figure 8. Crop raiding intensity and livestock predation by Nonhuman primate and other wild animals around Tana River Primate ecosystem

3.8 Economic losses associated with primate crop damage

Among the ten most raided crops by primates, maize and mangoes were the two crops which the farmers incurred huge financial losses due to crop raiding (47.19% and 18.99%, respectively), Table 1. Maize and mango are the main food and cash crops in the area, respectively. Six of the ten most raided crops were food crops which the local people rely on for food while 3 were multipurpose and one a cash crop.

Table 1: Estimation of economic losses of the ten most affected crops by Nonhuman primates by farmers in Tana River primate ecosystem

Crop raided	Crop use	Crop loss in monetary terms (%)
Maize	Food	47.19
Mangoes	Cash	18.99
Banana	Food & Cash	11.19
Pawpaw	Food	6.39
Cassava	food	4.38
Green grams	food & Cash	3.64
Tomatoes	food & Cash	1.87
Cowpeas	Food	1.58
Pumpkins	Food	1.46
Rice	Food	1.40

3.9 Factors that render primates vulnerable to the conflict

Primate Habitat changes

The primate habitat had changed with 40% of the locals indicating that it has decreased, while 29% and 24% thought it has increased or remained unchanged, respectively (Fig, 9). However, according information gathered the habitat has decreased significantly ($t=26.87$, $df=108$, $p<0.001$)

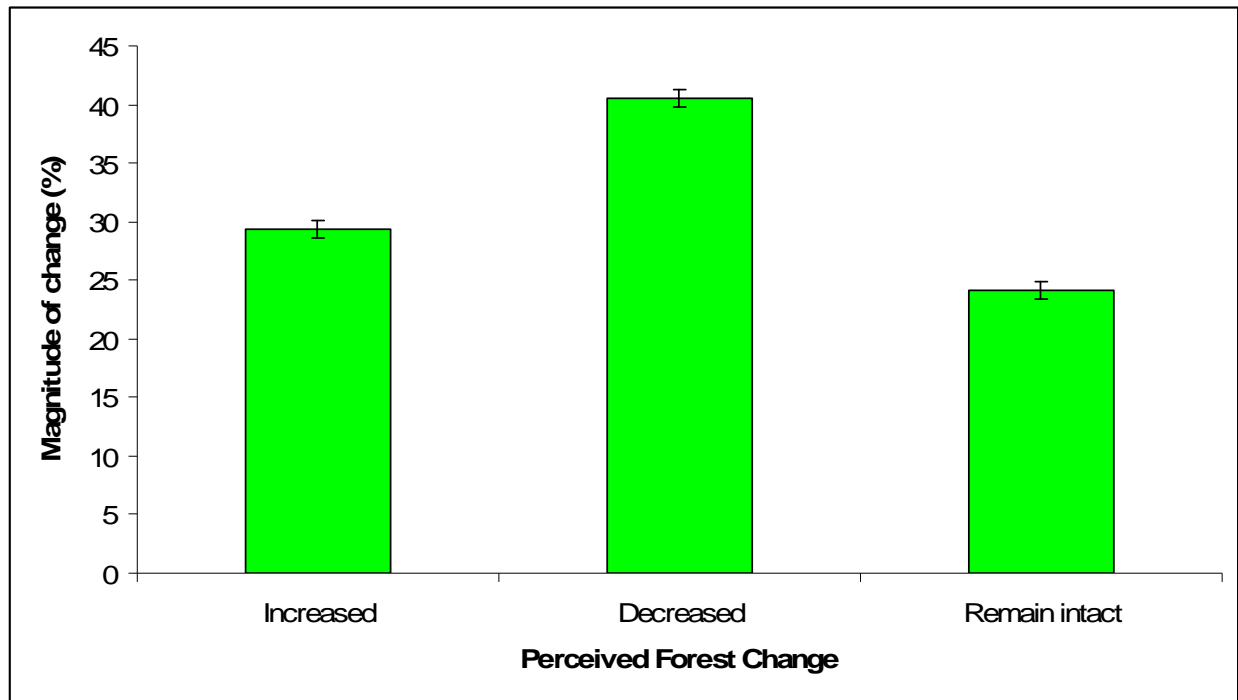


Figure 9. Perceived change in primate habitat in Tana River primate ecosystem in the last 1-2 years ago, a factor aggravating the primate conflict.

Habitat disturbances assessment

Human disturbances which included unsustainable exploitation of forest resources were the major threat to the primate habitat (Fig 10). The mean plant destruction in the three transects surveys was 5 ± 1.17 plants. Elephants and natural process also contributed to the habitat loss as indicated in fig 10. The three forms of perturbation differed significantly ($F=15.374$, $df=2$, $P<0.0001$). Human disturbances were significantly higher compared to elephant destruction and natural disturbance.

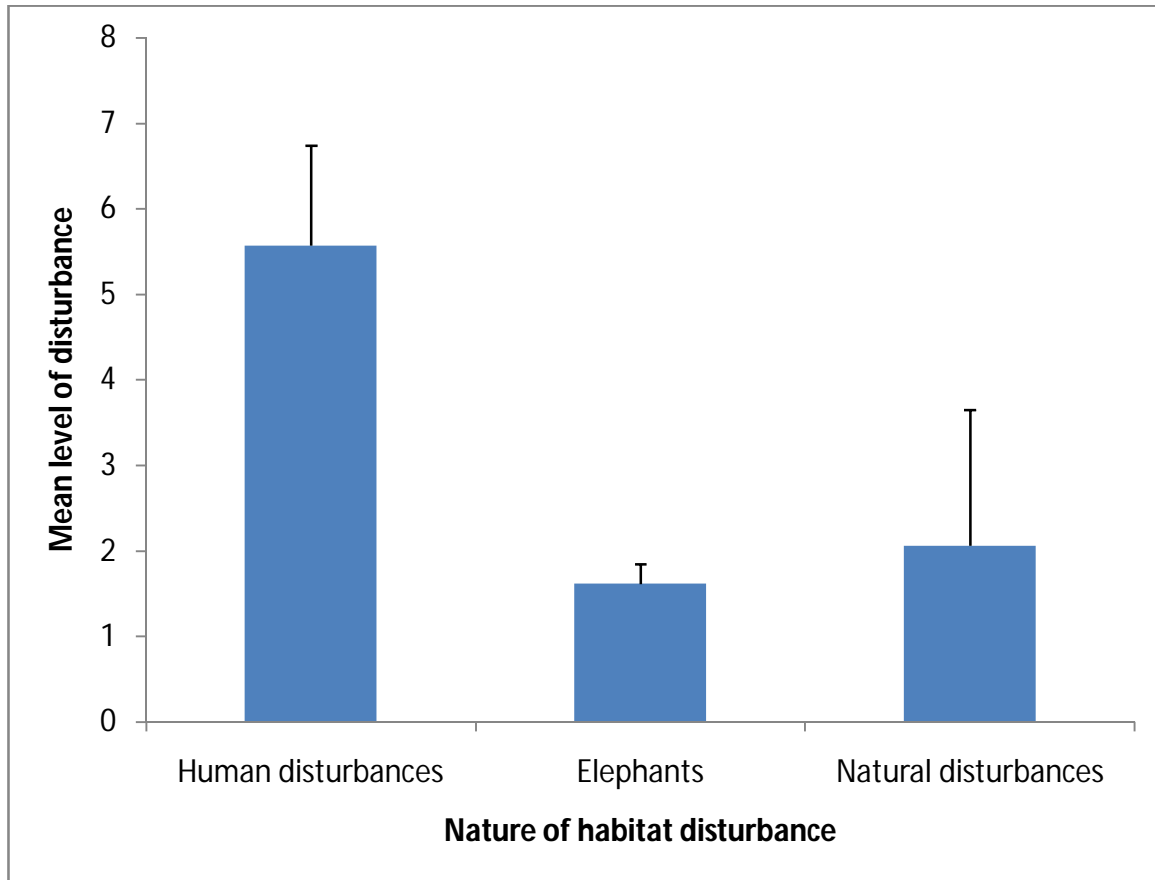


Figure 10. Level of different habitat disturbances Tana River Primate Habitat

Primate consumption as bush meat in Tana River

The results indicated that all the nonhuman primates in Tana River are consumed as bush meat (Fig. 11). The Baboons are the most affected and 54% of the population consumes the species. Sykes monkey are the second affected, then Tana River Mangabey, Vervet and Tana red Colobus. Consumption of primates as bush meat in Tana River was significant ($t=15.124$, $df=92$, $p<0.0001$).

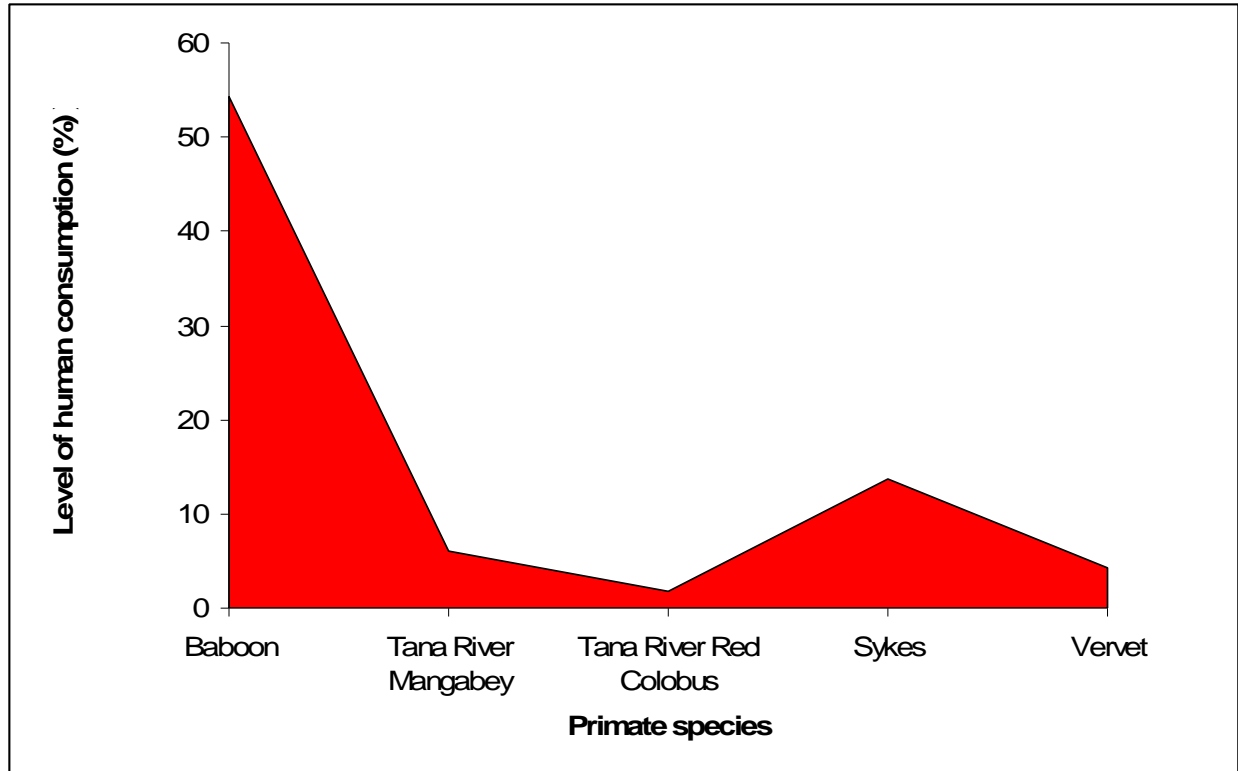


Figure 11. Consumption of nonhuman primates in Tana River Primate ecosystem as bush meat by humans

Farm husbandry practices

Animal predation by primate and other wildlife occur both during the day and at night. Other wildlife mainly large carnivores attack the animals at night while the primates during the day. Most of the attack during the day take place in the grazing field and happen when the livestock is left unattended. The livestock enclosures especially for the Warndei community are poorly made and this encourages predation while the Pokomos have raised enclosure which deters predators from night attacks especially for shoats (plate 3). Predation by baboons on young shoats is facilitated by livestock tethering which makes it easier for the baboons to attack. On the other hand, crop fields were located away from settlement area and close to the forests. In addition, the crop fields had no fences or barriers to prevent the access by primates or other wildlife. The farming practices also did not take into consideration measures to minimize crop loss. For instance cover crops with underground tubers could have been grown close to the forest edges but this was not the case (plate 3).



Raised livestock enclosure of pokomo people



Crop field located within the primates habitat



Unfenced farm with easily raided crops at the edge



Warndei homestead and livestock enclosure

Plate 3. Some farm husbandry practices which might encourage or minimize the human wildlife conflict in the study area.

3.10 Threats to the Tana River Primate habitat

Palm wine tapping, overgrazing and overexploitation of raw materials (construction and basketry industry) are the leading threats to the Tana River Primate habitats and rated as severe by 63%, 61% and 59% of the respondent, respectively (Fig 12). Elephant destruction and forested cutting for agriculture were rated as moderate threats contributing 36% and 31%, respectively. The threat of invasive species in the area was also perceived to be moderate (26%).

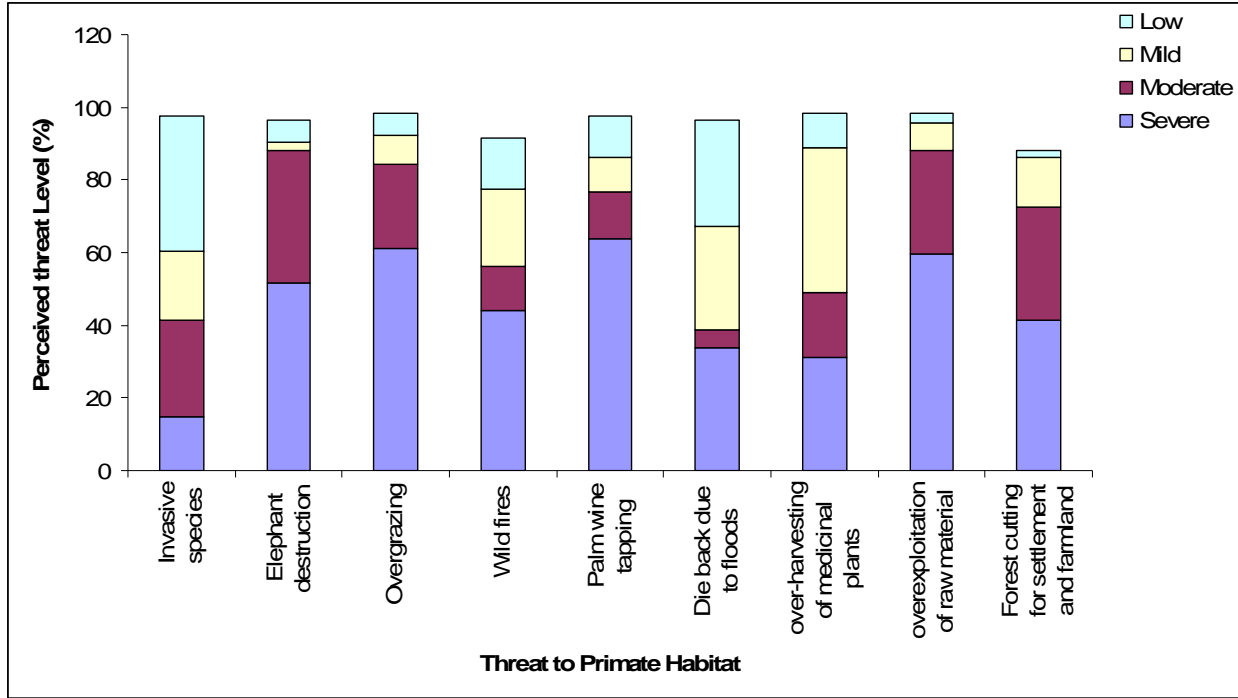


Figure 12. Threats facing the nonhuman primate habitat, in and around TRNPR as perceived by the local people

3.11 Deterrent methods used

There are about eight strategies adopted to protect or prevent crop raiding in the areas around Tana River (Fig 13). These include; use of sling, scarecrows, stoning, shouting, spearing, guarding, catapulting and use of dogs. The methods showed different level of use by the local farmers. Use of sling and guarding seemed to be the method of choice to many and was adopted by 34% and 32% of the farmers, respectively. Other methods were used by less than 10% of the farmers in the area. Spearing, catapulting and use of dogs were lethal methods and were associated with killing of different primates raiding crops in the area.



Plate 4. A Pokomo man guarding his farm demonstrates how they use the sling

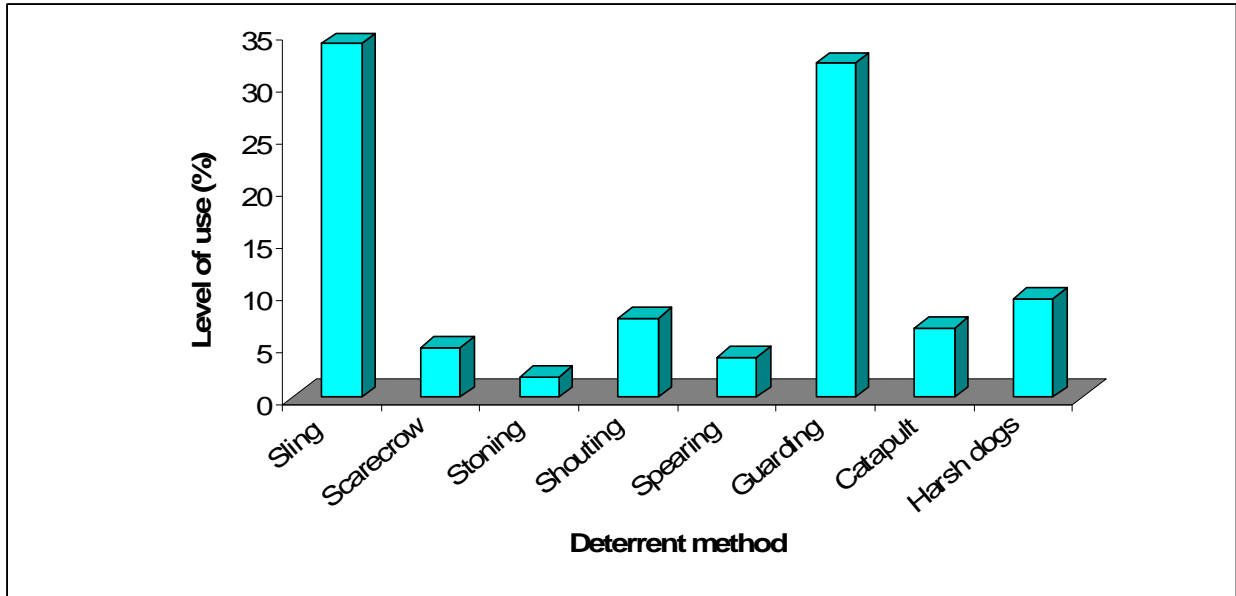


Figure 13. Deterrent methods and level of use by local farmers to counter crop raiding and livestock predation by nonhuman primates

3.12 Resource competition

Resource competition especially for food was observed between the human and nonhuman primates and within the nonhuman primate (Plate 7). The local people exploited key food plant species for nonhuman primates for different uses. Fruits from *Phoenix reclinata* were used by human yet it's the sole plants species forming which influence distribution of Tana River mangabey. In addition, elephants also threaten the primates' habitat in Mchelelo as many individual of *Hyphean compressus* were knocked down by elephants and many seeds were found in their dung (Plate 1). Competition among the nonhuman primate species was characterized by a unique but dangerous trait of Baboon preying on mangabeys (Plate 5).



Plate 5. Remains of Tana River Mangabey preyed on by a male yellow baboon in Tana River primate ecosystem, unique and rare incidence



Scare crow



Fruits covered with a cloth



Farm guarding using sling



a spear used for spearing

Plate 6. Some crop raiding deterrent methods in place among the locals around Tana River primate ecosystems.



a). Pokomo boy eats fruits of *P. reclinata*



b). Charcoal burning activity in Vukoni village



c). *P. Reclinata* leaves harvested for mat making



d). Warndei women harvest grass for livestock in TNPR

Plate 7. (a,b,c &d). Some Resources competition incidences observed in Tana River Primate ecosystem which may mediate the Human-nonhuman conflict in the area.

4.0 DISCUSSION

The cost of living with wildlife in rural Africa most of time outweighs the benefits (Parker, 2003). This mimics the situation in community areas around TRNPR. The five diurnal nonhuman primates in Tana were all involved in either crop raiding or livestock predation. Baboons raided crops and preyed on livestock most compared to other species. Tana Red Colobus was the least implicated in the conflict with no cases of livestock predation recorded and few cases of crop raiding. The conflict status could be explained by rising human population pressure in Tana River resulting to encroachment and fragmentation of the primate habitat (Moinde et al., 2007). These factors increase the level of human-nonhuman primate interaction and subsequently reducing the primate's range and resource base. This could be supported by the fact that the primate habitat was facing several anthropogenic threats including food competition with humans. Reasons to why Baboons, Sykes and Tana River mangabey raided crops most could be attributed to their numbers, distribution, foraging behavior and home range. Baboon was the species which caused significant losses in livestock. This could be explained by its omnivorous nature, body size and ability to kill shoats.

Pattern of crop raiding varied with primate species. Baboon showed that they were capable of raiding crops through out the growing stages. Crop raiding peak for Sykes, Mangabey, Vervets was during early fruiting stage. During the harvesting time crop raiding declined for these species. This could be due to hardening of the fruits or seeds making it difficult for the species to process and ingest. Nonetheless, the pattern of crop raiding in all the five nonhuman primates seemed to be influenced by the stage of crop growth and development. All the primates showed a peak of crop raiding during the early fruiting stage of the crops. Except for baboons, raiding by other primates was low during seed sowing period and increased in the flowering period and peaked in early fruiting stage. Subsequently it dropped during the harvesting stage of the crops. This might be influenced by plant phenophases and foraging behaviour of the primates (Wieczkowski and Kinnaird, 2008). While other primate raided crops in several stages of development, the red colobus raided only during the flowering and fruiting stage. This shows that food availability and resource base might have reduced forcing the species to expand the choice of its food, since this had never been reported in the previous studies.

Baboons and Sykes monkeys were the notorious crop raiders. More than 60% of the crop raiding was caused by the baboons while about 25% by sykes monkeys. This presents the two NHP as the most problematic in the area. This reflects similar findings in Nthongoni area in Kibwezi by Kivai, (2007) where baboons were the most problematic animal. Tana River mangabey accounted for 10% of the crop raiding and

was the third most destructive primate. This implies that the conflict remains a major threat to critically endangered and endemic primates of Tana River due to endangered primates being problem animals. With poisoning, spearing and catapulting as some of the conflict control methods in the area, this means the endangered primate are lost in the process of conflict mitigation in the area hence adversely affecting their population status (Muruthi, 2005).

Human-nonhuman conflict has been a major conservation and management issues in areas where monkeys co-exist with humans (Parker, 2003; Kivai, 2007; Nyindo, 2007). This is because the primates inflict both social and economic losses to the poor farmers. In Tana River, NHP raided about 18 different crop types grown by the local farmers in Tana River. The three most targeted crops were; maize, mangoes and banana. Maize is the main food crop in the area while mango is the common cash crop. Bananas are use as both cash and food crop. Most of the economic losses realized involve food crop, hence given that primates cause more crop raiding compared to other wildlife, they contribute immensely in food insecurity in the area. This indicates that associated risk of food insecurity and poverty induced by NHP conflict in the area is high. Similar observation was made by Nyindo (2007). Baboon and sykes raided 11 and 5 crops, respectively. This implied that if the conflict continues unchecked especially with mitigation measures targeting these species, food and economic losses will continue to hit the local people. This is likely to worsen with rapid shrinking primate habitat. The yellow baboons targeted mainly the maize while the sykes and Tana mangabeys targeted the mangoes. This indicated that baboons contribute more in food insecurity while the Tana River Mangabeys and Sykes monkey contribute much in economic losses in the area. Because of the need to guard the farms, the conflict also negatively impacts on the social well being of the local people. School children have to suspend school activity to help in guarding thus affecting the education levels in the area. This affects the future of livelihood developments and well being.

NHP contributed to 61% of the crop raiding activity compared to other wildlife in the area. On the other hand, livestock depredation was by 84% attributed to other wildlife other than the NHP. The implication was that crop raiding losses are mainly due to primates while livestock predation is mainly caused by other wildlife. Similar observation was made by Nyindo (2007) in a similar study in Tanzania. Therefore, in management and control of crop raiding should focus on primates while for livestock predation on other wildlife. The primate habitat has decline by 40% in the areas according to the local people. This is mainly attributed to increase in human population pressure, increasing the demand on land for cultivation. Habitat loss and fragmentation is likely to increase

human-NHP interactions and eventually increased human-NHP conflict. On the other hand, livestock predation either by other wildlife or primates is mediated by poor husbandry practices. Tethering, leaving livestock unattended while in the field and poorly made livestock enclosure render the livestock vulnerable to predation (personal observation).

Bush meat hunting and trade has been a major challenge in wildlife conservation at local, national and international levels (Kangwana 1993, Conover 2002, Treves and Karanth 2003). Our study fully supports this claim since bush meat consumption might be another silent threat to the NHP in Tana River primate ecosystem. Majority of the local people kill the primates as well as other wildlife for bush meat. Baboons seem to suffer most from this practice. Sykes and Tana River mangabeys are the second most targeted primates. Red Colobus is the least targeted species in bush meat consumption. This supports the findings that monkeys have been good sources of protein among some local communities at the coastal area (Fitzbiggon et al 1995; Moinde *et al.*, 2004). However, as climate change continues, this might have a devastating effect to all Tana River primates in future. Unsustainable exploitation of plant resources mainly for raw material and food remain a major threat facing the Tana primate habitat. Invasive species are viewed as a moderate threat, but this might be more than it might be predicted. The *Prosopis juliflora* is fast spreading along the roads and the river bank and slowly penetrating into the core primate habitat in Tana (Plate 8).

Human-wildlife conflict is one of the critical management issues in conservation today. Current techniques designed to reduce the impact of nonhuman primate as well as other wildlife crop damage are inadequate, either being too expensive for rural farmers to afford, or being logistically unworkable in remote locations (Parker, 2003). Consequently, local farmers opt to adopt cheap deterrent methods whether harmful to conservation or not. This as well supports our findings in that deterrent methods in place are mainly preventive and include lethal strategies. Although many people prefer the use of slings and guarding approaches to protect their crops in Tana, poisoning, spearing and killing using dogs are also practiced. This is likely to impact negatively on the primate populations. Studies in Amboseli ecosystem on Human-wildlife conflict showed that similar deterrent methods have been used and they are anti wildlife survival (Kangwana, 1993). Therefore there is need to sensitize the community on the importance of conserving the species in the area and the danger involved by poisoning the primates. This calls for a real need to develop new conflict mitigation strategies in communal farming areas.



Plate 8. Invasion of primate habitat by *Prosopis juliflora* (Mathenge) in TNPR

5.0 CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study the following conclusions and recommendations can be drawn;

- i. Human – nonhuman primate conflict around TRNPR is a major conservation challenge threatening not only food security but also the endemic and endangered primates of Tana River. Therefore, this needs continuous monitoring in order to develop appropriate management and conservation interventions. Conservation efforts need to think of alternative livelihoods as incentives for the locals to enhance conservation of the nonhuman primates in the area.
- ii. Crop raiding is a major sources of the conflict as opposed to livestock predation which seems to be minimal and occurs in extreme dry season. All primates engage in crop raiding causing considerable losses but only baboon is the main primate livestock predator.
- iii. The conflict is complicated and requires immediate attention since the two endemic and endangered primates are problem animals and are implicated in crop raiding.
- iv. Poor farming husbandry practices, habitat loss and fragmentation and human encroachment into primates habitat are some of the factors which render the nonhuman primate vulnerable to the conflict. The farmers need to be educated on good farm husbandry practices to minimize crop and livestock losses due to the conflict. Moreover, there is dire need to create habitat connectivity to avoid restriction of the primates in small isolated patches. This could be done even sustainably using fruit trees like mangoes especially across farmer's farms.
- v. Elephant destruction, bush meat consumption, human competition and encroachment and spread of invasive species are some major silent threats

which might mediate the conflict. There is need to undertake a study on the impacts of all these threats on primate populations. More important due to health implication community education awareness is required on risks involved in consumption of primates as bush meat.

- vi. The deterrent methods in place are just preventive and ineffective hence there is need for urgent trial of the methods and development of simple affordable methods to mitigate the conflict. Invasive methods of conflict mitigation need to be discouraged and instead replaced by non invasive but effective deterrent methods
- vii. The human-nonhuman conflict contributes to the food insecurity and low economic gains of the local people around TRNPR and there is need for incentives to the locals to enhance conservation of the primates. In order to overcome such effects the locals need to be educated and encouraged to engage in other alternative livelihoods such as bee keeping, butterfly keeping among others.
- viii. Farming practices in the study area seem not to consider the conflict and farmers need to be educated on the best cropping practices which can help to reduce the crop loss. Farmers should also consider growing quick maturing crops which might reduce the time crops stay in the farms and subsequently losses due to wildlife raiding.

6.0 ACKNOWLEDGEMENT

I would like to express my sincere appreciation to Rufford Small Foundation for funding this study. All was not possible if it were not for their support. I am also beholden to Institute of Primate research for the technical support and help in getting the necessary research approval for the study. Kenya Wildlife Service offered camping ground and accorded us security while in the field with my assistances and am grateful for this. The local communities the Pokomo and Warndei co-operated with and facilitated our study and I am very grateful too. Finally my research assistants; Micheal, Bahatisha, Musa, Komora and Ronald were of great help and their effort made this study successful I thank them for their contribution too.

7.0 REFERENCES:

Anderson J.L and Pariela, F (2005). Strategies of mitigating human wildlife conflict in Mozambique. *Wildlife management working paper no. 8, FAO*.

Bell, R.H.V. (1984): The man-animal interface: an assessment of crop damage and Wildlife control. In: *Conservation and wildlife management in Africa*. Bell, R.H.V. & Mcshane-Caluzi (eds.), US Peace Corps seminar, Malawi.

Hill, C. M. (2000). "A conflict of interest between people and baboons: crop raiding in Uganda." *International Journal of Primatology* **21**(2): 299-315.

Hill, C., Osborn, F. and Plumptre, A.J. (2002). Human –wildlife conflict: Identifying the problem and possible solutions. *Albertine Rift Technical Report Series* Vol. 1. Wildlife Conservation Society.

Jones, I.B, Barnes J.I, Shrestha, R, Muhammad, A.A and Yahya, A (2008). Common grounds: Solutions for reducing human, economic and conservation costs of human wildlife conflict. *WWF report*.

Kagiri, J (2005). Human – Wildlife Conflicts in Kenya: A Conflict Resolution Concept.

Kivai S.M (2008). Survey of Human-Nonhuman primates in Nthongoni area in Kibwezi District, Kenya. *Unpublished work (Technical report)*, Institute of Primate Research, Kenya.

Naughton-Treves, L. (1998): Predicting the patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conservation Biology* 12 (1): 156-158.

Naughton-Treves, L. (1999). "Whose animals? A history of property rights to wildlife in Toro, Western Uganda." *Land Degradation & Development*, **10**: 311-328.

- Naughton-Treves L. (1997). Farming the forest edge: Vulnerable places and people around Kibale National Park, Uganda. *Geographical Review*, 87(1):27-46.
- Wieczkowski J. 2005. Examination of increased annual range of a Tana mangabey (*Cercocebus galerritus*) group. *Am J Phys Anthropol* 128:381–388.
- Wieczkowski J, Mbora DNM. 2000. Increasing threats to the conservation of endemic endangered primates and forests of the lower Tana River, Kenya. *Afr Primates* 4: 32–40.
- Medley KE. 1993. Extractive forest resources of the Tana River National Primate Reserve, Kenya. *Econ Bot* 47:171–183.
- Kahumbu P. 1992. The sustainability of fig tree (*Ficus sycomorus*) harvesting for canoes in a Kenyan reserve. MSc thesis. Gainesville: University of Florida.
- Kinnaird MF. 1992a. Competition for a forest palm: use of *Phoenix reclinata* by human and nonhuman primates. *Conserv Biol* 6:101–107.
- Hughes FMR. 1988. The ecology of African floodplain forests in semi-arid and arid zones: a review. *J Biogeogr* 15: 127–140.
- Homewood KM. 1976. Ecology and behaviour of the Tana mangabey (*Cercocebus galerritus galerritus*). PhD dissertation. London: University College, London. 416p.
- Estrada, A., & Coates-Estrada, R. (1996). Tropical rainforest fragmentation and wild populations of primates at Los Tuxtlas, Mexico. *International Journal of Primatology*, 17, 759–783.
- Colin A. Chapman, C. A., Naughton-Treves, L., Lawes, M. J., Wasserman, M. D. & Gillespie, T. R. (2007). Population Declines of *Colobus* in Western Uganda and Conservation Value of Forest Fragments. *Int J Primatol* (2007) 28:513–528
- Woodford, M. H., T. M. Butynski, and W. B. Karesh. (2002). Habituating the Great Apes: the Disease Risks. *Oryx* 36(2): 153-160.
- Kiyiapi, J. L. 2003. Koiya, Tiemamut and Kijabe Group Ranches: AWF Supported Community Based NRM Planning Process. Unpublished Report to AWF Nairobi.
- Kangwana, K. 1993. Elephants and Maasai: Conflict and Conservation in Amboseli, Kenya. Ph.D. Thesis, University of Cambridge, UK.
- Forthman Quick DL, Gustavson CR & Rusiniak KW (1985): Coyote control and taste aversion. *Appetite* 6:253-264.

Conover, M. 2002. Resolving human-wildlife conflicts: the science of wildlife damage management. Lewis Publishers, New York.

Crooks, K. R. 2002. Relative sensitivities of mammalian carnivores to habitat fragmentation. *Conservation Biology* 16: 488-502.

Butler, V. 1998. Elephants: trimming the herd. *Bioscience* 48: 76-81.

MacFie, E. 2003. Human-Gorilla conflict resolution: recommendations for component within IGCP Uganda Programming. International Gorilla Conservation Program, Nairobi.

Muruthi, P. (2005). Human Wildlife Conflict: Lessons Learned From AWF's African Heartlands. AWF working paper, AWF Nairobi.

Forthman-Quick, D. (1999). Unpublished report to AWF. AWF Nairobi office.