Crop raiding around Lake Mburo National Park, Uganda

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Abstract

In areas around Lake Mburo National Park, large wild animals wander in close proximity to human settlements. This poses serious conflict in terms of crop damage. The integration of conservation with other land uses is difficult where densely settled agricultural land surrounds a protected area potentially containing problem animals, as is the case for several parks in Africa and Asia. The intensity of crop raiding was quantified through the use of random crop quadrants/plots and area estimation techniques in a portion of raided fields. The animal species concerned were documented from observations, footprints and any other marks left behind. Three variables were tested as predictors of damage: human population density, distance from the park boundary and season. In this study, data is presented regarding crop loss in the different seasons of the year, analysis of crop damage variation and animal species involved in crop loss. A diverse assemblage of animals foraged on subsistence crops and analysis of crop damage revealed significant crop depreciation by wildlife.

Key words: community, conservation, crop raiding, wildlife

Résumé

Dans les environs du Parc National du Lac Mburo, de grands animaux sauvages se promènent tout près des installations humaines. Ceci entraîne de graves conflits en raison des dommages causés aux récoltes. L'intégration de la conservation à d'autres utilisations du sol est difficile lorsque des terres agricoles densément peuplées entourent une aire protégée abritant des animaux qui peuvent causer des problèmes, comme c'est le cas de plusieurs parcs en Afrique et en Asie. On a quantifié l'intensité des dégâts au moyen de quadrats/parcelles de cultures choisis au hasard et de techniques d'estimation de la surface, dans une partie des champs dévastés. Les espèces animales concernées ont été documentées grâce à des observations, des empreintes et toutes autres marques laissées derrière elles. On a testé trois variables pour prédire les dégâts : la densité de population humaine, la distance par rapport à la limite du parc et la saison. Dans cette étude, les données sont présentées en termes de pertes de récoltes pendant les différentes saisons, l'analyse de la variation des dégâts et celle des espèces animales impliquées dans ces dégâts. Divers animaux ont causé des dommages aux cultures vivrières, et l'analyse des dégâts a révélé une dépréciation significative des récoltes par la faune sauvage.

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Introduction

Lake Mburo National Park is located in south-western Uganda 0°19′ to 0°37′ and 30°46′ to 31°04′. Six sites (parishes) were selected according to the proximity to the parks boundary (Infield *et al.*, 1998) number of reports received by the park authorities regarding vermin animals, and the distance from the park boundary. The parishes included Rwabarata and Nombe to the north, Rurambira to the east, Akayanja to the northeast, Rwenjeru to the west and Rwentango to the south (Fig. 1). Lake Mburo National Park experiences a bimodal pattern of rainfall with an annual mean of 750 mm. Short rains occur in March to May while the long season is from August to December (Hoag *et al.*, 1991). The western part of the park receives more rainfall than the north and northeastern parts.

As a result of the increased human population, loss of natural habitat, change of land use patterns and increased conservation efforts, there have been increased wildlife–human conflicts (Sukumar, 1990). Lake Mburo National Park was gazetted in 1982. Since 1986, the park has been reduced in size from 650 to 260 km^2.

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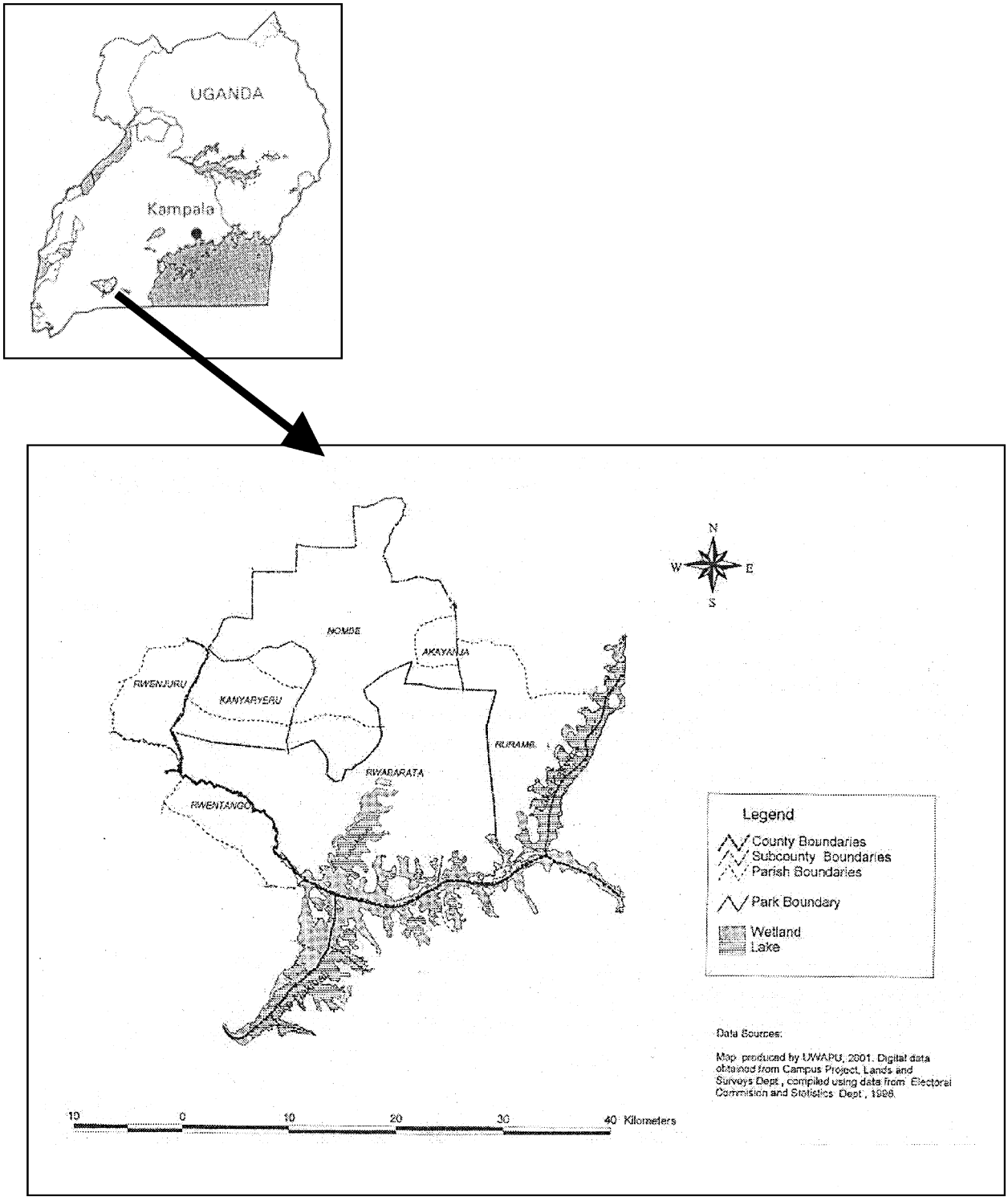

Fig 1 Showing location of Lake Mburo National Park and the study sites (parishes).

These reductions did not take into account the natural ecological and dispersal ranges of wildlife. The animals therefore wander in close proximity to the community's agricultural land.

Lake Mburo National Park conserves part of a unique interlacustrine grassland ecosystem that has biological peculiarities and species of restricted distribution. The presence of permanent sources of water in a rather dry enclave has provided a refuge of such a rich concentration of wildlife species. Thus, the area is the most biologically diverse savanna ecosystem in Uganda (Kamugisha, Ogutu, & Stahl, 1997).

Lake Mburo National Park is the only park in Uganda with the impala (*Aepyceros melampus*); two IUCN red data book bird species Shoebill stork (*Balaeniceps rex*) (Collar & Stuart, 1998) and Papyrus yellow warbler (*Chorepeta gracilirostris*) and rich concentrations of Zebra, *Equus burchelli*. This in conjunction with its being a corridor for wildlife from Northern Tanzania to Karamoja makes it very crucial for conservation. However, this whole corridor has been turned into agricultural land and pastoralism has been reduced.

Farmers around protected areas lose lots of dollars worth of crops and, sometimes, human lives in the process of guarding these crops each year because of the crop raiding animals. There is little doubt that vermin is a constant source of misunderstanding between local people and the park authorities (Kamugisha *et al.*, 1997). A diversity of wild animals has been recorded to cause considerable damage to crops around other African Protected areas (Bell *et al.*, 1984; CARE, 1994; Hawkes, 1991; Balakrishnan *et al.*, 1992; Lahm, 1995).

On average, the Lake Mburo rangeland is generally sparsely populated with average population densities of 19 person km^{-2}. The most densely populated area in the north of the park has 31 persons km^{-2}. The least populated parish, Rurambira has 8 persons km^{-2}. Parishes to the north-west have population densities ranging from 140 to over 200 persons km^{-2} while those to the south-western and south range between 20 and 139 persons km^{-2}.

Materials and methods

Crop damage determination

Animals were not viewed foraging in gardens. Therefore, dung, feeding habits, digging, foot prints and other physical remains like hair were used to identify the animal causing damage (Stuart & Stuart, 1994). Amount of damage was recorded by counting damaged stems of individually planted crops (e.g. bananas, maize, and cassava).

Damage to sown crops (e.g. sorghum, millet, beans, and groundnuts) was measured directly in square meters (Sukumar, 1990). A $1 \times 1\,m^2$ quadrat was used to determine crop loss for the sown crops. It was thrown evenly and randomly onto destroyed gardens. Stems eaten were counted. Uneaten stems were also counted. Total loss was determined by averaging eaten stems in all the quadrats per garden and converting this to square meters using average planting densities of these crops.

In the case of banana stems with bunches destroyed by bush pigs, the height at which the pig first bit and the height at which the stem broke were recorded. The diameter of the stem at ground level and the corresponding bunch weight were also recorded to explain why the stems break at those points. Diameter at ground level at all stages of growth of banana stems was recorded. Height from ground level to where the youngest leaf emerges from the stem was also recorded. Using the diameter of pseudostems at ground level, a graph was plotted to determine the height of banana plants without bunches but destroyed by bush pigs (*Potamochoerus porcus*).

In all cases apart from banana plantations, the area of the garden was measured, the animal species responsible for the damage and parts of the crop eaten were noted.

In each case, attempts were made to quantify the loss in monetary terms. It was assumed that the yield for each crop was constant despite varying soil fertility and climatic differences and that price changes would be negligible.

The average harvest and monetary value of each quadrat of undamaged crop was determined. Using the percent damage in destroyed gardens, the amount of harvest and monetary loss was determined. The monetary value was determined according to the present market values. For individually planted crops, monetary value for each unit or cluster was determined.

Crop preferences

Crops preferred by the three top crop-raiding animal species were determined by calculating the preference index (P1):

$$P1 = \frac{\%\ Frequency\ of\ being\ eaten}{\%\ Availability}$$

where:

$P1 = 1.0$ means no choice,
$P1 < 1.0$ means avoidance,
$P1 > 1.0$ means preference.

Variation in crop damage between study sites

Ranking of the parishes was done in terms of availability of preferred crops. This was calculated for each parish by the following equation (Naughton-Treves, 1998).

$$X(Parish) = \frac{\sum(A1 \ldots An)}{\sum(D1 \ldots Dn/n)}$$

where:

A is the area (m^2) of n fields of the top five animals' most preferred crops.

D is the shortest perpendicular distance (m) between each of the (n) preferred crop fields to the park boundary.

X, thus weighs preferred crops more heavily if they lay close to the park boundary.

Once X was calculated for each parish, the relative rank of each parish was its X divided by the summed X for the six parishes. The relative ranking reflects the expected frequency of wildlife raiding for a certain village. The student t-test was used to determine whether there was significant crop loss during the dry season. It was also used to test whether crop loss depended on human population density.

Results

Crop damage frequency

Various animals featured in varying degrees of crop raiding. Not all these animals migrate from the park; some are resident outside the park boundary. They live in suitable habitats between the gardens within the community. The bush pig caused great crop loss, in addition to the fact that it is not easy to guard against, being a nocturnal animal. Ninety percent (90%) of crop damage was caused mostly by bush pigs, both by the extent of feeding and the variety of the crops fed on. They were found to feed on about 45% of all the crops grown. Bush pigs were capable of causing 100% destruction of the visited gardens except for large banana plantations. It was observed that bush pigs destroy both fruits and young pseudostems of bananas. Banana fruits are usually at different stages of growth and therefore not all would be very palatable.

Crop loss during dry and wet seasons

There were a variety of crops being grown (at subsistence level) by the communities around the park. These were destroyed to different extents in different seasons (Fig. 2).

Cultivation was the basic source of food and income for most homesteads. Banana and beans were the staple food crops.

Animals, in varying degrees destroyed 85% of the crops grown. Root crop gardens planted with cassava and sweet potatoes were heavily guarded and that is why the percentage of the destroyed crops to the number of gardens is not 100%. For the gardens that were not guarded, destruction was usually 100%. The extent of destruction was highest for tobacco and paw paw. These gardens were few in number and small. The animals involved in crop raiding mostly destroyed bananas, beans and maize, which were grown abundantly. Guarding reduced the percentage of destroyed gardens to planted ones to a range of 25–35%.

The top three of all crop raiding animals that caused great crop loss included the bush buck (*Tragelaphus scriptus*), the baboon (*Papio cynocephalus*) and the bush pig (*Potamochoerus porcus*). Their crop preferences are as shown in Fig. 3. The bush buck (*T. scriptus*) mainly fed on leaves and pods of beans with the percentage destroyed being 18.6% of the beans grown. For the rest of the crops, the bush buck (*T. scriptus*) mainly fed on leaves. One of the important human foods fed on by the baboon (*P. cynocephalus*) was maize cobs and they destroyed 23.3% of the maize grown. The baboon (*P. cynocephalus*) also broke oranges but was not seen eating them.

The bush pig (*P. porcus*) did not feed on the tobacco but destroyed it by trampling. Comparing these three crop raiders, the bush pig (*P. porcus*) destroyed greater variety of crops and in greater percentages. This is attributed to the nocturnal fierce feeding behaviour of the bush pig (*P. porcus*), which is very difficult to guard against. This shows that it is the most notorious at crop raiding in this area. The bush pig (*P. porcus*) mainly destroyed crops like tobacco, cassava, maize, sweet potatoes and banana. The porcupine (*Hytrix cristata*) destroyed root crops also. It was however, observed that it was not as destructive

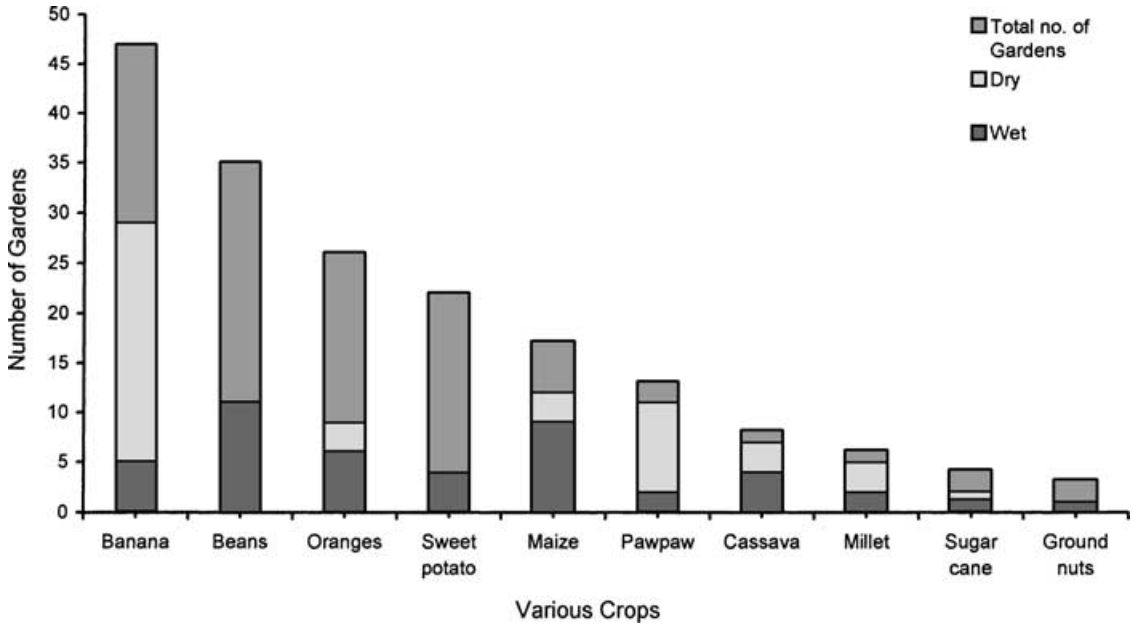

Fig 2 Crop damage during wet and dry season.

as the bush pig (*P. porcus*), which uprooted the plant; the porcupine (*H. cristata*) dug up to the roots leaving the plant upright.

Bush bucks (*T. scriptus*) mainly fed on beans, millet and sweet potato leaves. Duikers (*Cephalophus natalensis*) fed on beans, but preferred pods and stem stalks while the former preferred leaves. Not all crops grown in the wet season were present in the dry season. Crops like beans, Irish potatoes, onions and sorghum were rare during the dry period.

The bush pigs, baboons, vervet monkeys, guinea fowl and buffaloes damaged a lot of banana during the dry season. The baboons, vervet monkeys and guinea fowls mainly fed on fruits. The bush pigs, however, fed on fruits and the pith of the young pseudostems. The buffaloes only trampled the banana. During the late dry season, the number of young pseudostems destroyed was higher than that in the wet season. However, this also depended on the location of the study site. Rwabarata, which was not near a permanent water source, had more damage of young banana pseudostems than Akayanja, which was near the Kizimbi swamp with a more permanent water source.

The bush pig destroyed banana pseudostem more than the fruit in dry season. Results showed that pseudostem destruction was higher by 25%. However, the overall comparison of banana destruction in the wet and dry season shows that destruction was higher in the dry season by 55%. Bananas are annual crops. Destruction of other crops was dictated by the growing/fruiting season. Some crops like beans were only present in the wet season while sweet potatoes and groundnuts although present in both seasons, were ready with tubers only in the dry season. Bush bucks fed on groundnuts in the wet season while pigs did so in the dry season. Potatoes were devastated at the beginning of the wet season because the rains soften the soil, thus making it easy to dig out the tubers. Statistical analysis showed a significant crop loss during the dry season.

There was selection of different types of banana among the animals that destroyed bunches. It was only the vervet monkey that was found to be very selective. The bush pig was not very selective although it destroyed mostly the cooking banana. The bush pig fed on the brewing banana while the guinea fowl did not discriminate between the cooking and brewing banana. Guinea fowls feed on raw banana by pecking at it.

The bush pigs caused massive destruction of banana during the dry season. They destroyed young banana pseudostems and chewed the pith and also ate the bunch. The height and diameter of randomly selected banana pseudostem at different stages of growth were

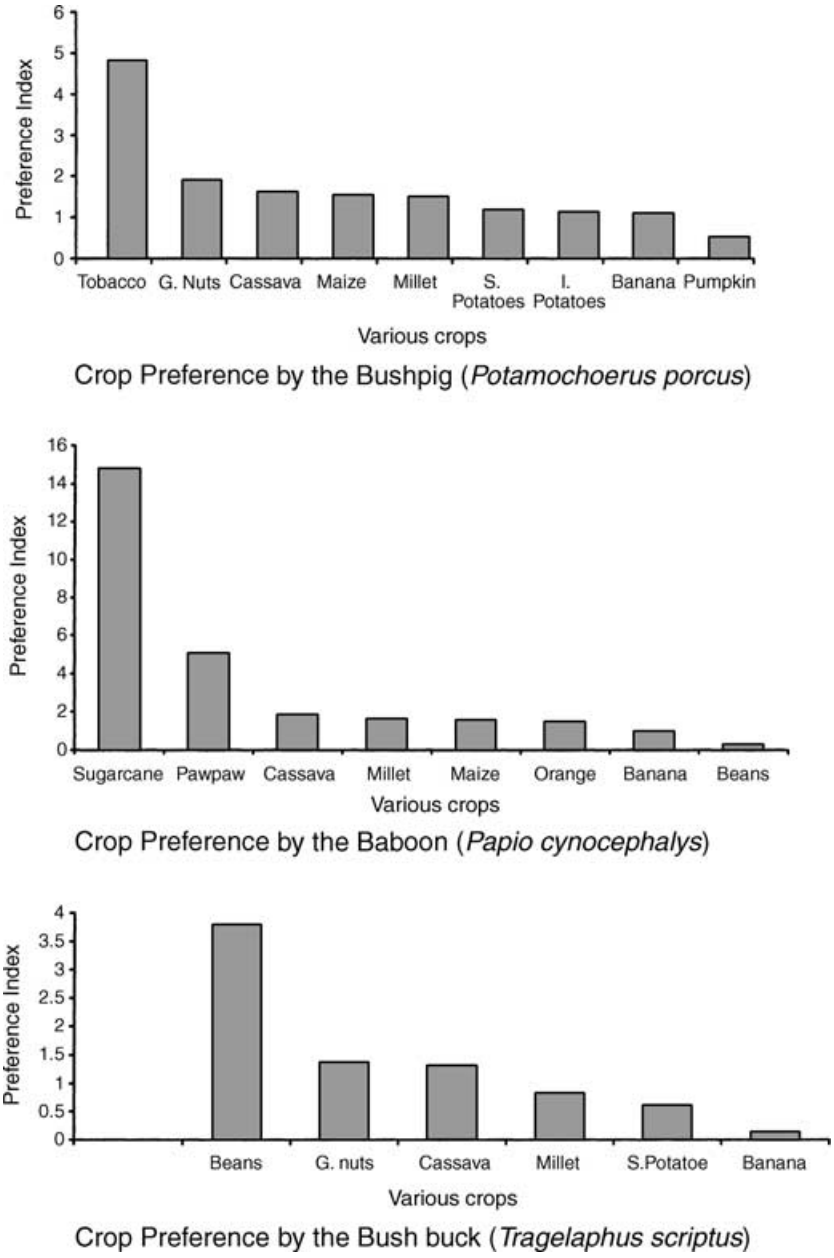

Fig 3 Crop preference by the top three crop raiders.

measured and plotted. These measurements were used to determine the height of the young pseudostems destroyed because the height of the latter could not be measured after destruction. The points segregated into the two different stages of banana preferred by bush pigs (Fig. 4). The pseudostems that were carrying bunch had a pig's first bite ranging from 100 to 200 cm from ground level.

Analysis of variation in crop damage/monetary loss

Crop loss in monetary terms was documented according to study areas (parishes) and crop raiding animals. The rank showed that among the six study sites, Rwabarata showed the highest rank and Nombe the least (Fig. 5).

Crop loss was tested against population density and it was found that crop loss was significantly higher in

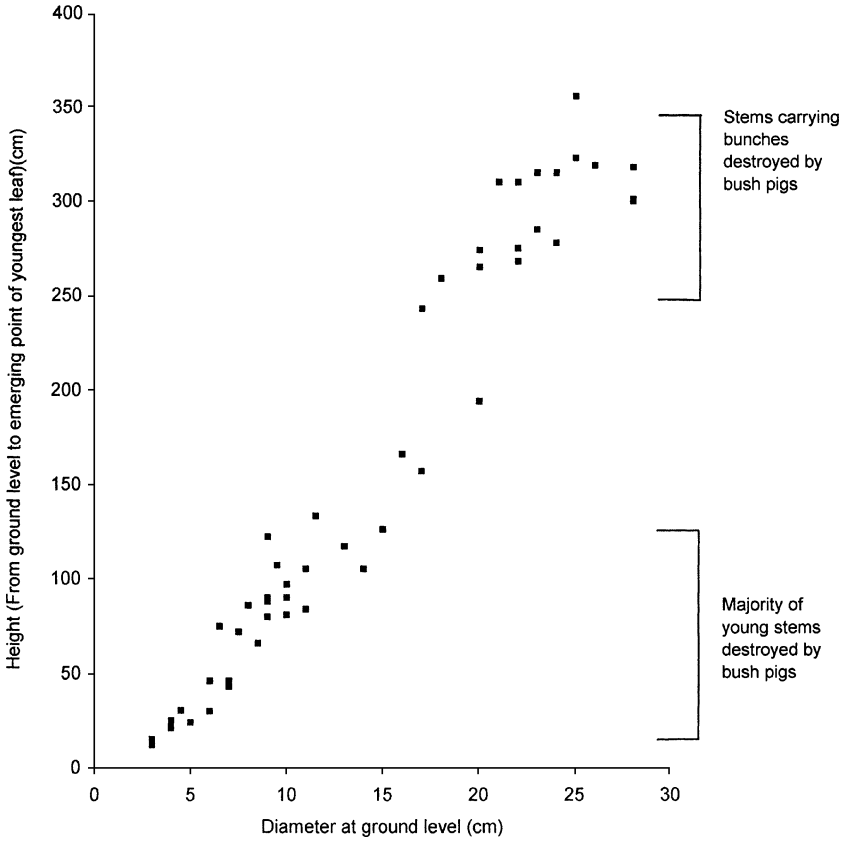

Fig 4 Stages at which banana plants are destroyed by wild pigs.

low-populated areas than in highly populated ones ($t = 3.169$; $P > 0.01$). The bush buck was found to cause the greatest monetary loss of about $1570 per month per growing season per study site followed by the bush pig and the buffalo caused the least monetary loss.

Crop loss decreased with distance from the park boundary in all study sites (parishes)(Fig. 6). There was an increase at 18 km. This study site (Nombe) is only occupied by pastoralists. It is, therefore, occupied by a considerable number of resident wildlife because of the presence of large thickets and low human population.

Discussion

Crop damage

The diverse assemblage of animals at Lake Mburo National Park is reflected in the diversity of animals damaging the crops. Bush pigs dominated the assemblage of crop raiders. It accounted for 90% of recorded events and 45% of the total damage to crops. Others included baboons, porcupines, brown parrots, bush bucks, vervet monkeys, duikers, buffaloes, guinea fowls and *Quelea* species. Their long-term survival is at risk because of the low community tolerance to crop raiding animals. The bush pigs, baboons and bush bucks were the worst raiders, and the medium to large size mammals (3 kg) received greater ranking than rodents and birds. Complaints about damage by rodents related more to harvested and stored food field crops.

Changing lifestyles from pastoralism to agriculture and increasing wildlife populations have increased crop raiding (Wild & Mutebi, 1997). Education or extension programmes that seek to reverse the trend of crop raiding cannot influence the attitude towards the park resource as it is directly related to income losses experienced (Kazoora & Vicuturine, 1997). Programmes that seek to deal directly with the raiders control and loss compensation can influence it (Lewis, Kaweche & Mweya, 1989).

The biggest number of animals that caused crop damage did not necessarily move from the park. After

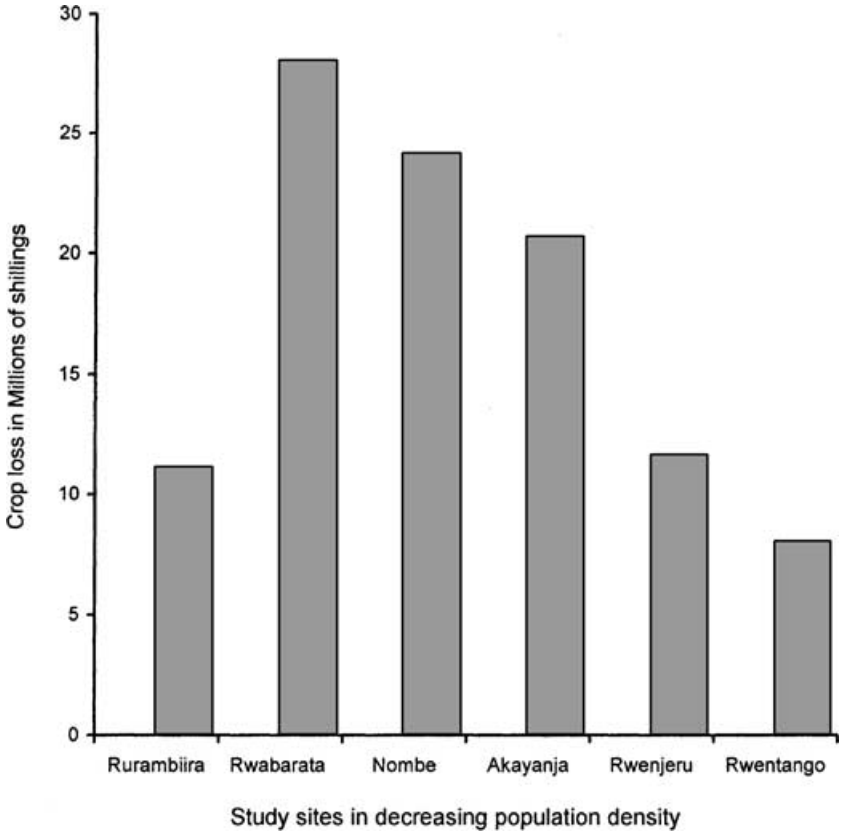

Fig 5 Crop loss in millions of shillings.

the reduction of the park by 60%, the animals remained in their previous home ranges. Therefore, these animals are resident outside the present park boundary. Gardens are cultivated within their home ranges and it is therefore easy for them to raid. Animals that fall in this category include bush pigs (*P. porcus*), bush bucks (*T. scriptus*), baboons (*P. cynocephalus*), duikers (*C. natalensis*), porcupines *(H. cristata)* and buffaloes (*Syncerus caffer*).

Various game species are widely dispersed in the rangelands during the wet season. This is the season for cultivation when most of the crops are at their best. The effect of destruction of such crops is also increased by the uneconomic state in which ranches exist. If they are well managed for proper cattle ranching, this would decrease habituation by animal raiding species, especially the bush pigs and bush bucks.

The pattern of damage by different wildlife species has implications for farmers' capacity to absorb damage. An individual farmer suffering from damage caused by the bush pig is likely to view it as a catastrophic loss that overshadows the damage caused by other animals. However, bush bucks have been found to cause the highest monetary loss.

The extent of monetary loss depends on the feeding habits of the animal species and the type of crop. The bush buck feeds extensively and also feeds on an expensive crop (beans). Bush pigs' preference for tobacco may be because bush pigs use tobacco to kill off body lice. The baboon also destroyed a lot of maize but sugarcane featured the highest because of its long growing season. Also, sugarcane could have been a source of water during the prolonged dry season. During the month of December, baboon raids were not common. This was probably because of the presence of ripe wild fruit. The bush buck mainly fed on the leaves before pod formation when they were still soft.

Similarly, bush pigs damaged banana rampantly during the dry season because of their great availability. The pigs derive moisture from the young banana pseudostem piths that they chew. For the pseudostems carrying bunches, the first bites on the banana

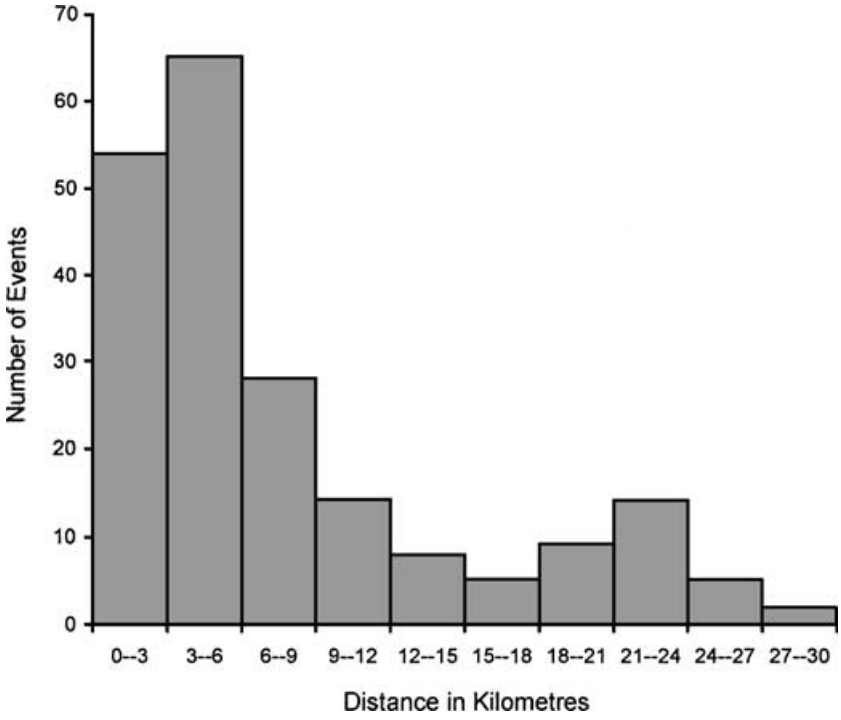

Fig 6 Crop damage as a function of distance from the park.

pseudostems indicated the height of the pigs and could be a sign of tasting to find out whether the pseudostem was carrying a bunch or not.

Estimated distance was included as a predictor variable of crop damage. During data collection, it was evident that gardens near thick bushy conditions suffered a lot of damage by both bush pigs and bush bucks.

Farmers in valleys near kopjes also suffered a great deal from baboon raids. Meanwhile, overall damage decreased with distance from the park boundary, increased slightly and then decreased to zero. The slight increase was brought about by one of the study areas in which human population density was very low. This area consisted mainly of ranches, which were not cleared and thus offered proper vegetation cover for the raiders.

The pastoralists have been given permanent land and have settled. They have thus started growing some crops. These crops are vulnerable to these wildlife species. Secondly, these pastoralists do not regard guarding these gardens important yet. They still value their cattle more than anything else. Otherwise, in uniformly settled areas, crop damage decreased with increasing distance.

Human population density varied. When two study areas with almost similar land use patterns but different human population densities were compared (e.g. Rwabarata with 11.6 persons km^{-2} and Rwentango with 64.8 persons km^{-2}) it was found that Rwabarata suffered higher monetary loss than Rwentango. This is evidence that crop damage increases with decreasing human population density. Elsewhere, human population density has been linked to variation in patterns of wildlife crop damage for example densely populated areas suffer damage from small rather than large animals (Newmark *et al.*, 1994).

Low population density gives room for unoccupied habitats that are suitable for habituation by the large animals. Scaring away raiders by human beings is also low at low human population densities. However, farmers owning relatively large gardens, ($>2000\ m^2$) have the greatest flexibility in coping with crop raiding. The most vulnerable are the farmers growing food crops on small gardens ($<1000\ m^2$). This confirms other studies that a densely settled band of gardens forms the best barrier to wildlife incursions deep into the agricultural land (Bell & McShane-Caluzi, 1984; Sukumar, 1990, 1995).

Lake Mburo National Park Management Plan (1994–98) highlighted the degree of seriousness of the problem of wildlife existing outside the boundaries of the park on private land. Many farmers attempt to defend their crops by guarding. This is very tiresome and risky for

nocturnal animals like the bush pig and has also led to disruption of the social life of homesteads. Men no longer sleep in their houses, they have to stay in the gardens in which they construct small guarding huts. Children have got shorter school days because they have to keep chasing baboons, vervet monkeys and guinea fowls. Women may sometimes fail to fetch water and firewood for domestic use because of the presence of aggressive buffalo.

Acknowledgements

This work was funded under the Integrated Pastoral Development-German Technical Cooperation project. I'm also grateful to the management and staff of the IPDP-GTZ Project and technical help of Professor Jonathan Baranga.

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(Manuscript accepted 6 January 2003)