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Source: Wildlife Biology, 11(3) : 237-247

Published By: Nordic Board for Wildlife Research

URL: https://doi.org/10.2981/0909-6396(2005)11[237:POCRBP]2.0.CO;2

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Tweheyo, M., Hill, C.M. & Obua, J. 2005: Patterns of crop raiding by primates around the Budongo Forest Reserve, Uganda. - Wildl. Biol. 11: 237-247.

Crop raiding by primates in particular and wild animals in general is a significant source of people-forest conflict around the Budongo Forest Reserve, Uganda. Crop loss to wild animals undermines local support for conservation efforts in this area. Patterns of primate crop raiding were studied over a period of 14 months in six villages (five adjacent to the Budongo Forest Reserve and one that is approximately 3,500 m from the forest edge). Data were collected via a questionnaire survey. Additional information was obtained from the relevant local government offices. Chimpanzees *Pan troglodytes*, baboons *Papio anubis*, other monkeys, bush pigs *Potamochoeus procus* and porcupines *Hystrix cristata* were reported by farmers to be the major causes of crop losses by wildlife. Of farmers, 73% reported suffering crop damage caused by primates, and 79% considered baboons to be the most destructive of all crop raiding species. Drought, insect pests, poor sowing, plant diseases and accidental fires were other sources of crop losses to farmers, though the risk of crop damage particularly by primates is perceived as the most serious potential cause of losses. Using chimpanzees as a case study, patterns of crop damage across the year are compared with seasonal fluctuations in availability of wild foods.

Key words: Budongo Forest Reserve, conservation, crop raiding, farmers, primates, Uganda, wild animals

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Received 15 May 2003, accepted 3 May 2004

Associate Editor: Göran Ericsson

Conservation is often difficult where densely settled agricultural lands are adjacent to protected areas inhabited by animals that pose a potential threat to farmers' crops, as is the case for many forest reserves and national parks in Africa and Asia (e.g. Dudley et al. 1992, De Boer & Baquete 1998, Naughton-Treves et al. 1998). In partic-

ular, primate crop raiding and human conflict is wide spread in many parts of Africa. For example, around Bwindi Impenetrable Forest National Park, Uganda (CARE 1994), around protected areas in Tanzania (Newmark et al. 1994), around Ituri Forest, the Democratic Republic of Congo (Mubalama 1996), and around Maputo Elephant Reserve, Mozambique (De Boer & Baquete 1998).

Especially, baboons *Papio anubis* are notorious for their crop raiding activities throughout Africa (Else 1991). At present it is generally accepted in Africa that farmer-wild animal conflict has increased over the last 30 years mostly because of increased amounts of land being converted to agriculture (Hill 1997). Around the Budongo Forest Reserve, Uganda, where the risk of crop damage by primates is perceived to be significant, local communities are hostile to conservation programmes (Reynolds 1992, Johnson 1996). In this case crop loss to primates undermines local support for conservation efforts.

Studies on human settlements have provided evidence of increased complaints of damage to crops by wild animals in western Uganda (Aluma et al. 1989, Obua et al. 1998). Despite the frequency of primate-human conflict, until recently few studies have analysed factors concerning primate crop raiding (Naughton-Treves 1997, Knight 1999, Hill 2000, Saj et al. 2001, Sprague 2002). The objective of our study was to gather information on the farmers' knowledge of patterns of crop raiding to help conservation authorities, government and local people to devise more effective mitigation measures. In particular, we identified the primates regarded by farmers as causing most damage, the crops they raid, and seasons of raiding. We also compare availability of forest and crop foods with farmers' reports of chimpanzee *Pan troglodytes* raiding patterns. Availability of forest fruits has been used to indicate availability of chimpanzee food in the forest because chimpanzees are primarily frugivores with more than 70% of their diet consisting of fruits (e.g. Reynolds & Reynolds 1965, Wrangham et al. 1994, Tweheyo & Obua 2001), and are reported to feed on other foods only when fruits are scarce (Wrangham 1977, Naughton-Treves et al. 1998, Newton-Fisher 1999). We could not compare farmland food with forest foods for other primates because of insufficient information on the seasonal availability of natural food resources important to other primate species in the Budongo Forest Reserve. In this paper, we compare patterns of chimpanzee food in the forest with patterns of crops in the farms to assess whether chimpanzee raiding behaviour occurs as a consequence of shortfall in the availability of forest foods. For baboons, other monkeys, bush pigs *Potamochoerus procus* and porcupines *Hystrix cristata*, we record their patterns of crop raiding based on interviews with farmers only. Since permanent methods to prevent crop raiding are not easily affordable by local farmers (Poole et al. 2002), our findings highlight specific seasons when crop protection methods should be a primary focus for farmers rather than trying to implement strategies year round that may be expensive and require much labour.

Methods

Study area

The Budongo Forest Reserve (BFR), Masindi District, western Uganda, lies between 1°35' and 1°55'N and 31°8' and 31°42'E, and has an average altitude of 1,100 m a.s.l. The reserve was gazetted as a central forest reserve in 1932. It comprises a mixture of tropical high forest with a large population of mahoganies, woodlands and savanna grasslands believed to be capable of supporting forest. It is the largest forest reserve in Uganda, covering about 825 km^2, 53% of which is a continuous tropical forest; the remainder comprises grassland communities (Hamilton 1984, Howard 1991).

Regional records from the nineteenth century describe a vast forest surrounded by scattered agricultural settlements (Paterson 1991). Traditionally, farmers protected their field crops against damage from wild animals by hunting and trapping the animals in and around their fields (Paterson 1991). This was regarded as an effective way of protecting crops because it had an additional benefit of providing households with meat, which was partly perceived to compensate for crop losses (Vansina 1990). Up to the middle of the 1900s, crop damage by wild animals, particularly by elephants *Loxodanta africana* made some arable land uninhabitable (Paterson 1991, Hill 1998). As a consequence of increasing elephant-people conflict in the middle of the 1900s, elephants were killed locally in large numbers (Brooks & Buss 1962). The elephants that survived migrated to the neighbouring Murchison Falls National Park. Thus there are no elephants at present within in the BFR.

Daily temperature and rainfall data recorded by the Budongo Forest project field station from 1993 to 2001 demonstrate that rainfall at this site exhibits a bimodal pattern, but the forest is generally wet year round (Fig. 1). The mean monthly rainfall is 139 ± 67 mm (± SD), and there is a relatively constant minimum temperature with a monthly mean of 20.9 ± 1°C (± SD). The precipitation bars depict a dry season between December and February, and in this period temperatures rise up to 31°C.

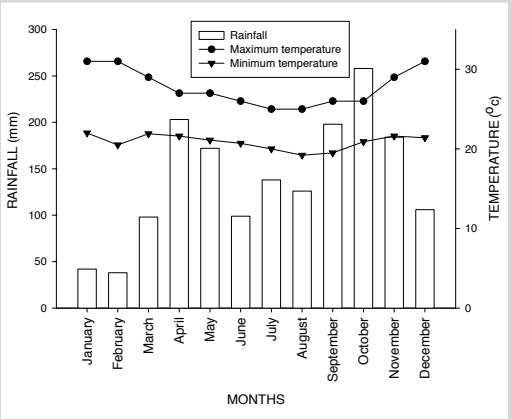

Figure 1. Mean monthly temperature (in ˚C) and rainfall (in mm) in the Budongo Forest Reserve, based on a yearly average for the period 1993-2000. Data obtained from the Budongo Forest project.

The conversion of forested areas for agricultural use in western Uganda is closely correlated with human population growth. Human population density around Budongo more than tripled during 1960-2000 (NEMA 1999, Masindi District Profile 1989-2000). Most farmers cultivate two major crops, and sometimes three during years with high precipitation. Farmers cultivate a mixture of subsistence crops; sugarcane and tobacco are sometimes grown for cash income.

The rapid population growth in western Uganda has resulted in land scarcity and has left Budongo Forest Reserve and a few other forests as the last refuges for wildlife. Budongo Forest Reserve is important globally for its high biodiversity, ranking third in overall importance for Uganda's forests (Howard et al. 1997). There are approximately 465 species of trees and shrubs, though the forest is dominated by the stinkwoods *Celtis africana*, *C. gomphophylla*, *C. mildbraedii*, and *C. zenkeri,* mahogany *Khaya anthotheca*, and ironwood *Cynometra alexandri* (Plumptre 1996). In addition, there are five species of diurnal primates, chimpanzee, black and white colobus monkey *Colobus guereza occidentalis*, baboon, blue monkey *Cercopithecus mitis stuhlmanii* and red-tailed monkey *C. ascanius schmidti*.

Data collection

Three parishes, i.e. Kabango, Nyabyeya and Nyantonzi, on the southern border of the Budongo Forest Reserve (Fig. 2) were selected for household questionnaire surveys. Six villages: Kapeka III, Binamira II and Wafala in Kabango, Nyakafunjo and Nyabyeya II in Nyabyeya, and Kanyege in Nyantonzi were selected. Apart from Binamira II (approximately 3,500 m from the forest boundary), all other villages share a common boundary with the Budongo Forest Reserve. There are many parishes and villages that surround the Budongo Forest Reserve, but due to inadequate time and logistical constraints, we only interviewed farmers from six villages, which were located in three parishes. The five villages that share a common border with Budongo Forest Reserve were chosen randomly from the list of the villages that border the forest. We assigned each village that borders the forest a number, we inserted the village numbers in the box and then we chose the surveyed villages randomly by picking their corresponding numbers from the box. Except Binamira II, which was selected specifically because, though far from the Budongo Forest Reserve, it is surrounded by forest patches.

Data were collected between June 2000 and August 2001 using open-ended questionnaire interviews with households distributed among the six villages. Secondary data were obtained from wildlife conflict data books maintained by subcounty chiefs, Budongo Forest Project, Budongo Ecotourism Project, Nyabyeya Forestry College, Uganda Forest Department and Masindi District Vermin Control Department. Data on availability of chimpanzee forest foods were gathered via an ecological survey of forest food.

A total of 144 interviews were accomplished; 78 men and 66 women. Of the people interviewed 72% were exclusively farmers, 11% were employed by Kinyara Sugar works, 8% were employed by the Uganda Forest Department, 4% were pit sawyers, 3% were carpenters

Figure 2. The Budongo Forest Reserve and location of the study parishes of Kabango, Nyabyeya and Nyantonzi along the southern border of the forest reserve.

and 2% were business people. In each interview, an adult member of the household was interviewed. In the six villages, there was an average of 56 households, and we interviewed 24 households (about 43%) per village. Households were chosen through random sampling. The subcounty chief of Budongo County had a list of all households in each parish and village, and from this list we chose our study households randomly. We looked at the list of households in each village and assigned each household a number. Then we inserted the household numbers in the box and later picked their corresponding numbers from the box randomly. The sampled households in each village were representative of the randomly chosen numbers from the box. The household member to be interviewed (man or woman) depended on the member who was available at the time of the interview. The age of the farmers interviewed ranged from 15 to 70, but the greatest percentage (33%) were between 40 and 49 years of age. Most interviews were carried out in Kiswahili, but we sometimes used English, Runyoro or Luo. To minimise biases from farmers' perceptions, which is always embedded in people's personal history and sometimes even in researchers' thinking, the following measures were taken:

1. with the help of a resident research assistant and the subcounty chief, we disclosed to the community what the research was about and its intentions through the village chairpersons. We talked with the chairperson of each village, and then the village chairperson talked to the village members. We clarified that the research was meant for scientific and academic purposes, and that it had no legal or political implications;
2. we formed a committee, which consisted of the subcounty chief, the parish chairpersons and the village chairpersons, whom we worked with to recast the questionnaire. In this committee we avoided questions that were considered taboos in this community and factors considered private;
3. to avoid any content bias we crosschecked information given by direct observation, asking different people and reviewing literature.

Farmers in the area reported to know the type of damage caused by particular animals. They believed that they were able to differentiate between damage caused by primates and damage caused by bush pigs or porcupines. Demographic, household and cropping data were collected from participants as well as information about animals raiding crops, the time(s) of the year when crop raiding occurs, extent of crop damage experienced by individual farmers, frequency of animals visiting farms, protection methods adopted against crop raiding animals, and other causes of crop losses. Initially farmers were asked to rate the crop losses they incur from different species and also across the seasons using a scale of 1-6, where 1 was equivalent to 'little or no damage' and 6 represented 'most severe damage'. For the purposes of analysis we compressed the 1-6 ranking scores used by farmers into three categories: 'severe damage' (3), 'modest damage' (2) or 'minimal damage' (1) by combining pairs of consecutive ranks, e.g. ranks 1 and 2 were combined to give a final rank of (1) equivalent to 'minimal damage' to generate an index of perceived severity of crop raiding. We then related the farmers' severity index response to crop raiding with time and total number of crops in the field.

We also asked farmers to rank all causes of crop loss that they experience on a scale of 1-6 as above to determine the degree to which farmers consider crop damage by wildlife as a significant cause of loss. Categories included were: drought, fire, insect pests, plant diseases, poor sowing and wildlife. Again these factors were grouped according to farmers' perception as: a) cause greatest loss, b) cause modest loss, c) cause least loss, as outlined above. Each category of perception was analysed by scoring it against the cause of crop damage. After scoring each cause of crop damage in the three groups (greatest loss, modest loss and least loss), we weighed them by addition in each category (drought, fire, insect pests, plant diseases, poor sowing and wildlife) for analytical purposes to get total scores. With total scores, we assessed the single greatest cause of crop loss in accordance with farmers' perception.

Phenological sampling for fruit availability was carried out between June 1999 and June 2001 in circular plots (radius: 20 m) which were established systematically along eight line transects. Each transect was 2 km long. The sample plots were laid along each transect at intervals of 100 metres, giving a total of 160 sample plots along transects. In addition, one sample plot was laid out at a random position at 500 m distance on each side of the line transect, giving a further 16 random sample plots. Only tree species that were known to be edible to chimpanzees were monitored in both systematic and random sample plots. The Budongo Forest Project has records of trees known to be edible to chimpanzees. A total of 176 sample plots were surveyed, and 521 individual trees representing 29 species belonging to 15 families were monitored. Fruit trees were identified as those individuals with at least a 10-cm diameter at breast height (DBH) following the method of Chapman et al. (1992). Fruit availability was recorded twice a month.

Scan sampling (Altmann 1974) was used to record

Table 1. Farmers' rating of wild animals according to their value judgement as the degree of damage to their crops. The numbers in parentheses indicate the proportion (in %) of farmers who responded to the particular question (N =144).

Rating	Baboons		Bush pigs		Chimpanzees		Other monkeys		Porcupines	
Very destructive	84	(79%)	20	(19%)	0		2	(2%)	0	
Destructive	14	(14%)	70	(72%)	0		14	(14%)	0	
Moderately destructive	0		2	(2%)	38	(53%)	28	(39%)	4	(6%)
Mildly destructive	0		0		22	(48%)	18	(39%)	6	(13%)
Least destructive	0		0		0		2	(14%)	12	(86%)

chimpanzee diet in the forest. Chimpanzee groups were followed from dawn to dusk between June 2000 and August 2001. During this period M. Tweheyo followed the chimpanzees for 176 days. Scans were made at 30-minute intervals to record the activities of each visible individual in the food trees. During this process all types of food eaten by chimpanzees were recorded: flowers (FW), insects (IS), buds (B), fruits (F), leaves (L), pith (PI), bark (BK), seeds (SE), prey (PE), nuts (NT), soil (SO) and wood (W). Scan sampling data were used to determine the different foods eaten by chimpanzees in different months.

Our study compares only direct observations of forest and cultivated food for chimpanzees. Information about other animals is based on interviews with farmers only. Chimpanzees, baboons, red-tailed monkeys and blue monkeys have all been observed feeding on cultivated foods during this and a previous study (C.M. Hill, unpubl. data). Data were analysed using SPSS version 8.0 (1997).

Results

Raiding animals, season of raiding and food in the main forest

Locally farmers consider crop raiding by primates, bush pigs and porcupines to be a major cause of crop loss. Of the farmers, 93% reported crop loss from primates, bush pigs and porcupines while 73% of farmers reported crop losses due to primate raiding. Five wild animals are listed as significant threats to crops (Table 1). Farmers' reports of the months in which wild animals raided their farms varied significantly ($\chi^2 = 32.24$, df = 11, $P < 0.05$). Baboons and bush pigs were considered by farmers to be the most destructive wild animals (see Tables 1 and 3).

Based on farmers' responses, the most severely raided crops in the field varied significantly with months; ($\chi^2 = 55.71$, df = 40, $P < 0.05$). The months of severe crop raiding by all problem animals (Table 2) were positively related ($R^2 = 0.77$, $P = 0.001$) to months with many crops in the field (Fig. 3). The only contradictory response about severity of crop raiding was with farmers who planted sugarcane *Saccharum officirum*; they expressed severe raiding problems during December, January and February, which coincides with the period of fruit scarcity in the forest. When forest fruits are scarce, chimpanzees feed on a range of other foods (Fig. 4), including leaves, flowers, pith, bark and seeds. There were no data available on forest foods eaten by other crop raiding species, therefore we cannot say with utmost certainty whether this reflects a period of low availability of forest foods for all these animals. However, since

Table 2. Season of crop raiding by wild animals, farmers' claims to times of crop damage, and cropping patterns around the Budongo Forest Reserve.

	Number of farmers reporting how they experience crop damage in any month (N = 144)							
Season	Most severe	Severe	Moderately severe	Mildly severe	Least severe	Little/no crop damage	Main activity in the fields	Crops in the field
Early dry season (June, July & November)	24	37	24	15	-	-	Harvesting and ploughing	All crops (see Table 3)
Early wet season (March & August)	3	7	30	60	-	-	Sowing and weeding	All crops (see Table 3) except ripe mangoes
Late dry season (February)	3	3	3	7	63	21	Ploughing, sawing and resting	Sugarcane and sometimes cassava
Late wet season (May & October)	71	19	8	2	-	-	Weeding and harvesting	All crops (see Table 3)
Peak wet season (April & September)	14	53	33	-	-	-	Sowing and weeding	All crops (see Table 3)
Peak dry season (December & January)			8		28	64	Ploughing and resting	Sugarcane and sometimes cassava

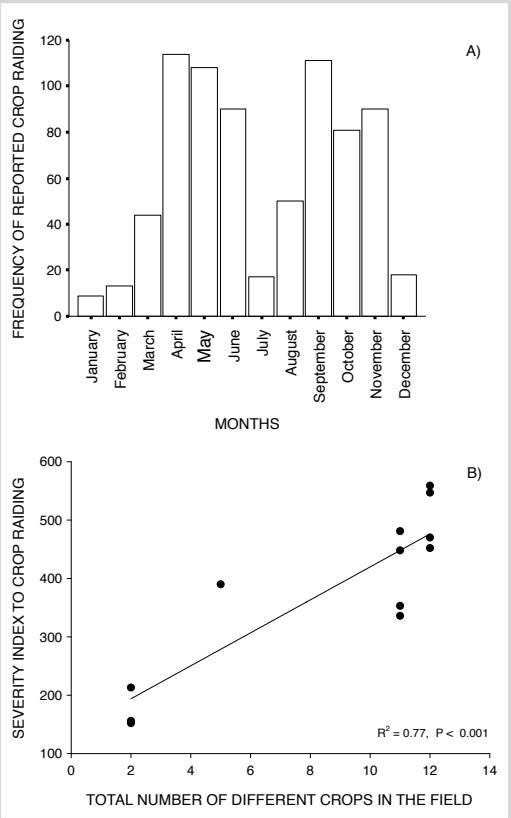

Figure 3. Number of the 144 farmers interviewed responding to severe times of crop raiding (A), and relationship between index of crop raiding severity as calculated from most severe to little damage as shown in Table 2 and total number of crops in the field (B). Most severe months of crop raiding ranked as 6, severe as 5, moderately severe as 4, mildly severe as 3, least severe as 2 and little or no crop damage as 1. See Table 3 for crop names.

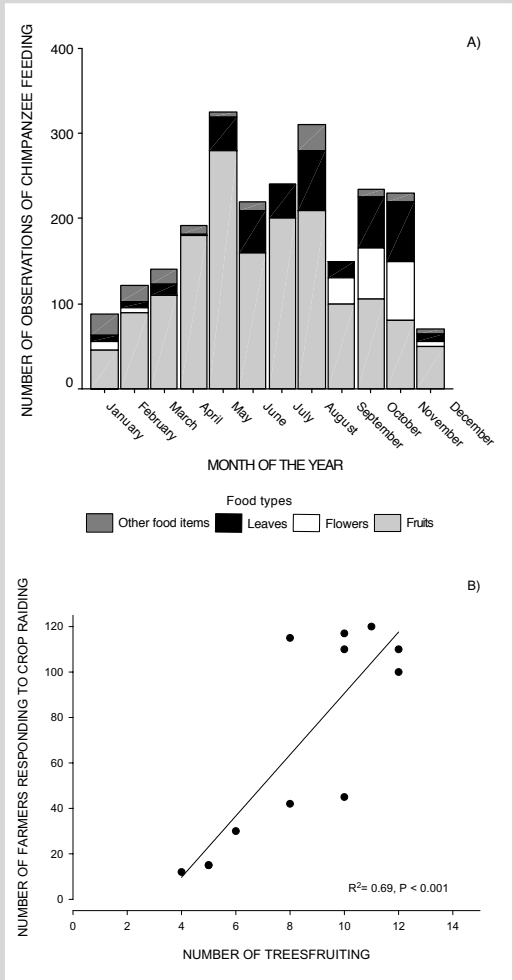

Figure 4. Food types eaten by chimpanzees during different months in the Budongo Forest Reserve recorded between June 2000 and August 2001 (A), and relationship between number of farmers responding to crop raiding and total number of chimpanzee food trees fruiting in the Budongo forest (B). Number of trees fruiting was recorded between June 1999 and June 2001 based on monthly averages for two years. Number of farmers responding to crop raiding is based on their response to different months. *: Other food items include seeds, wood, soil, pith, prey, nuts, buds, insects and bark. Data are based upon equivalent sampling efforts for all food items throughout the year.

diets for wild animals can overlap, scarcity of chimpanzee foods in the forest may indicate scarcity for other sympatric primates. In Budongo forest there are more fruiting trees in the wet season. When we compared the number of farmers' reporting crop damage and the number of chimpanzee fruiting trees in any month (see Fig. 4), there was a positive relationship between the number of fruiting trees and crop raiding across the year ($R^2 = 0.69$, $P < 0.001$). This confirmed our personal observations that the months of severe crop raiding are not necessarily months of limited chimpanzee food in the forest, with the exception of periods when chimpanzees are reported to raid sugarcane. Thus crop-raiding behaviour would appear to be linked more to availability of preferred crops rather than to scarcity of wild food resources. While raiding crops, chimpanzees adopt more stealthy behaviours than when they are feeding in the forest, and they rarely move up to 500 m into the hinterland. It is mainly the adult chimpanzees that raid crops; females with infants rarely risk moving into cropland.

Type of crops grown and frequency of crop damage

Bush pigs and porcupines raided farms only at night thus people guarded their fields at night. Guarding was the most common method used to chase away primates,

bush pigs and porcupines from their crops as is the case for other studies (Hill 1997, Naughton-Treves 1998). Young and old people spent long hours scaring away animals, and there is no government intervention to help them. However, it is important to bear in mind that this is based on information largely obtained from farmers rather than independent observation. Therefore, we cannot rule out possible biases associated with farmers focussing on what happens in their fields when they think they have most loss.

A total of 12 different crops were reported to be raided by wild animals (Table 3). Sugarcane was the only cash crop that primates raided year round. Crop damage frequency as reported by farmers varied significantly among the most destructive animal species ($\chi^2 = 94.7$, df = 2, $P < 0.001$). Baboons raided a wide range of crops (see Table 3), and farmers indicated that baboons raided some crops at all stages of growth from sowing/planting up to harvesting. Chimpanzees raided ripe fruits of mango *Mangifera indica*, pawpaw *Carica papaya* and sugarcane. Damage to sugarcane tended to increase during the dry season when all other crops had been harvested and there were relatively few chimpanzee fruits in the forest. Most of the crops were harvested during the early dry season, although some crops such as cassava *Manihot esculenta* persisted during the dry period (see Table 2). In general, farmers considered crop damage to be greatest during the harvesting time or just before harvesting when crops are mature (see Fig. 3 and Table 2).

Age of farmers, time spent in the area and other causes of crop losses

Most of the farmers are recent immigrants and 35% have lived in the Budongo subcounty for less than 10 years

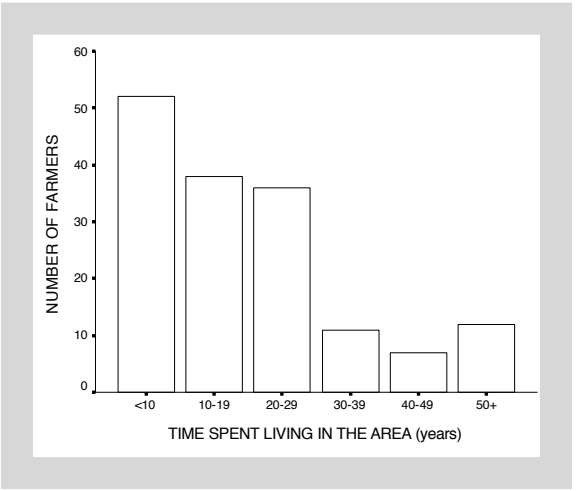

Figure 5. Time spent living in the area by the 144 farmers interviewed.

(Fig. 5). There was a significant difference between age of respondent and time spent living in the area ($\chi^2 = 95.86$, df = 30, $P < 0.001$) but no linear association (Spearman's correlation coefficient: $r^2 = 0.14$, $P < 0.1$) between the two variables. The lack of linear association between farmers' age and time spent living in the area may show that there has been increased immigration locally in recent times. Farmers report that competition for land has reduced forest cover and increased raiding by wild animals. Indeed, 93% of the farmers interviewed consider that crop raiding by wild animals has increased in the last 10 years. It is not possible to verify whether this is actually the case or not. However, farms from which crop raiding is reported to be a problem are often within 100 m from the forest boundary. Previous studies have already demonstrated the link

Table 3. Type of crops grown, raiding animals and number of farmers reporting the vulnerability of various growth stages of crops.

		Animal species									
		Chimpanzees		Baboons		Bush pigs		Monkeys		Porcupines	
Crop	Scientific name	Frequency	Stage of damage	Frequency	Stage of damage	Frequency	Stage of damage	Frequency	Stage of damage	Frequency	Stage of damage
Sugarcane	*Saccharum officirum*	34	Mature	40	All	10	All	4	Young	-	-
Mango	*Mangifera indica*	16	Ripe fruits	6	Fruits	-	-	-	-	-	-
Pawpaw	*Carica papaya*	10	Ripe fruits	4	Fruits	-	-	-	-	-	-
Beans	*Phaseolus vulgaris*	-	-	4	All	-	-	10	All	-	-
Cassava	*Manihot esculenta*	-	-	8	Tubers	36	Tubers	2	Tubers	-	-
Maize	*Zea mays*	-	-	20	All	34	Cobs	40	Cobs	-	-
Finger millet	*Eleusine coracana*	-	-	6	Seeds	2	Seeds	-	-	-	-
Sweet potato	*Ipomoea batatas*	-	-	6	Tubers	8	Tubers	2	Tubers	12	Tubers
Tomato	*Solanum lycopersicum*	-	-	2	Fruits	-	-	-	-	-	-
Yam	*Calocasia esculenta*	-	-	2	Tubers	-	-	-	-	-	-
Ground nuts	*Arachis hypogaea*	-	-	-	-	2	Nuts	-	-	18	Nuts
Cabbage	*Brassica oleracea*	-	-	-	-	-	-	4	Leaves	-	-

between proximity to forest boundary and increased risk of crop damage by wildlife (Hill 1997, Naughton-Treves et al. 1998). We observed that most forest patches surrounding the Budongo Forest Reserve are being cleared and turned into agricultural land primarily for sugarcane, thus there are many more farms located at the forest edge now than was the case previously.

Though primates, bush pigs and porcupines do, according to farmers, cause significant crop losses locally, farmers considered the extent of the crop damage caused by wildlife to be less than that caused by drought and insect pests (Fig. 6A). The weighted rank index (Fig. 6B) from the farmers' perspective shows that wildlife is not considered to cause the greatest crop loss in this area. Many other factors contribute to crop loss (e.g. drought, fire, insect pests, plant diseases and poor sowing methods) around the Budongo Forest Reserve.

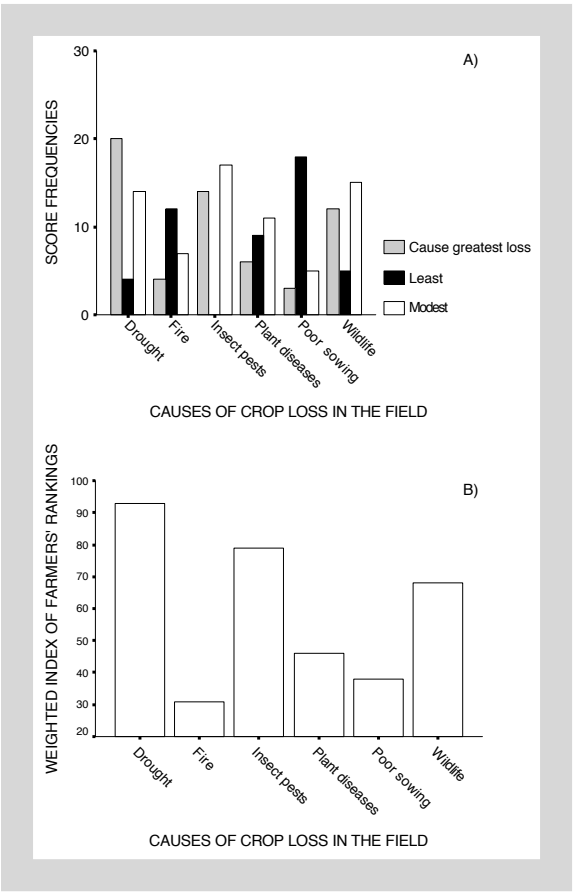

Figure 6. Farmers score frequencies of the causes of field crop losses, ranking cause of most crop damage as 3, cause of modest crop damage as 2 and cause of least crop damage as 1 (A), and weighted index showing absolute scores of overall farmer rankings of causes of crop losses (B).

Discussion

People's perceptions of patterns of crop raiding around the Budongo Forest Reserve resembled the results obtained elsewhere (e.g. Newmark et al. 1994, Mubalama 1996, Naughton-Treves et al. 1998, Poole et al. 2002). That 73% of farmers around the Budongo Forest Reserve complain about crop raiding by primates is not surprising since many farms are close to the forest boundary. Forest patches have reduced in size, leading to loss of habitat and resources to primates. However, some species seem to prefer forest-agricultural land boundary areas as demonstrated by Butynski in Bwindi where he recorded higher populations densities of red-tailed monkeys and baboons on the edge of the forest as compared with the interior (Butynski 1984). In addition, farmers living in the neighbourhood of other forests in western Uganda and the Democratic Republic of Congo have reported that primates dominate the assemblage of crop raiders (CARE 1994, Mubalama 1996, Naughton-Treves et al. 1998). It is interesting to note that 93% of the farmers sampled thought that crop raiding has increased over the last 10 years. This shows that primates in particular and other wild animals in general are a growing concern in village farms adjacent to the Budongo Forest Reserve, though this does not necessarily confirm that crop raiding is increasing. As argued in Hill (in press), Naughton-Treves (1997) and Nyerges (1992), various factors such as increasing dependence on agriculture for livelihood, declining alternative employment opportunities, time spent in any location, and influence of past and present conservation and wildlife management strategies can all contribute to people's declining tolerance of local wildlife.

The reported increase in crop raiding incidences from the late 1980s has coincided with the clearing of many forest patches (Marriott 1999, Lauridsen 1999). According to farmers the frequency of crop raiding by primates appears to increase during the months when crops are ready for harvest. Crop raiding was related to seasonal patterns of wet and dry periods. Though severe crop raiding took place in the months when there were plenty of chimpanzee fruits in the forest, the availability of sugarcane in farms throughout the year makes crop raiding a problem to sugarcane growers in the dry season. Similar to other findings (e.g. Reynolds & Reynolds 1965), our results show that during the months of low fruit availability in the forest, chimpanzees feed on many other food items. This is also consistent with other studies which have shown that during periods of food scarcity, animals extend their ranging patterns (Leighton & Leighton 1983) or maintain their usual range areas but

exhibit a dietary shift utilising other foods (Terborgh 1983), and this is true for the chimpanzees of Budongo. Accordingly, chimpanzee movement in and out of the Budongo Forest Reserve may be considered adaptive, and this also may apply to sympatric monkeys. Fluctuation in availability of primate forest foods has also been reported in the nearby forest of Kibale National Park about 300 km south of the Budongo Forest Reserve (Naughton-Treves et al. 1998).

Sugarcane must grow for at least 18 months before harvesting, making it a perennial crop and always available, even when all other crops have been harvested. Additionally, sugarcane is a preferred food for chimpanzees (Naughton-Treves et al. 1998), thus the combination of year round availability and being a highly attractive food source for chimpanzees makes sugarcane extremely vulnerable to extensive damage from these animals, resulting in increased conflict between sugarcane growers, forest managers and primate conservationists locally. The conflict arises because farmers have to spend long hours guarding their crops or risk losing them to wildlife. This reduces household time that could be spent on other activities (Hill 1997, 2000).

One outcome of crop raiding is when primates, especially baboons, damage very young crops or germinating shoots, and farmers are forced to replant the damaged areas. Farmers indicated that during the planting season, seeds are scarce and some farmers finish all their seed stock at the first sowing. Replanting of damaged fields is thus very costly, as farmers have to buy the seeds from markets or go through the whole period with little hope of harvesting. It is important to note that, though wild animals were not considered the major cause of crop loss to farmers' harvest, some farmers living close to the forest boundary claim up to 100% losses due to problem animals raiding their crops. This perhaps is, at least in part, a reflection of their heightened perceived risk of crop losses to wildlife.

Farmers also lose crops through other causes such as insect pests, drought and plant diseases, which are hard to control given the poor financial positions of many farmers. The only major cause of crop loss for which it is apparently easy to apportion blame is wildlife from the Budongo Forest Reserve. Thus tension between farmers and conservationists is not necessarily because crop raiding animals are the major cause of crop loss, but rather that crops that survive drought, insect pests, poor sowing, plant diseases and fire are also at risk of being damaged at a stage when farmers have high expectations of the coming harvest. As such, crop raiding though not necessarily the single most drastic source of crop loss, confounds other problems.

Understanding the patterns of primate crop damage requires careful attention to scale, both spatial and temporal. Given that forests are being fragmented and converted to agriculture throughout East Africa, adaptable primates such as baboons and other Cercopithecine monkeys may become highly destructive to forest edge crops (Kavanagh 1980). Thus the long-term survival of primates is at risk from the low human tolerance for 'pests' and the potential impact of eradication of their habitats (Altmann & Muruthi 1988). Given that chimpanzees are an endangered species, understanding patterns of their crop raiding is essential for making informed decisions about their management. Conservation of primates around protected areas like Budongo needs an integrated approach involving the local people because they are directly affected by living alongside wildlife. The significant implication of our findings to the management of Uganda's forests in particular, and protected areas in general, is that measures targeted at reducing crop raiding due to problem animals are likely to improve a sometimes fragile relationship between farmers, forest managers and conservationists.

Acknowledgements - NORAD and NUFU project 63/2003 funded this research through the Faculty of Forestry and Nature Conservation, Makerere University and the Department of Biology and Nature Conservation, Norwegian University of Life Sciences. We are grateful to F. Babweteera of Budongo Forest Project and Prof. V. Reynolds of Oxford University for their help with the study. We thank the two anonymous reviewers for their comments on the manuscript. Prof. J. Swenson, Prof. K.A. Lye, Prof. S.S. Dhillion and Ms Ymke Warren kindly reviewed an earlier draft of the manuscript. We thank Prof. K.A. Lye for the field data collection support as well. We also thank the Budongo Forest Project staff, especially M.G. Mbotella for assisting with data collection.

References

Altmann, J. 1974: Observational study of behaviour sampling methods. - Behaviour 49: 227-265.

Altmann, J. & Muruthi, P. 1988: Differences in daily life between semi-provisioned and wild-feeding baboons. - American Journal of Primatology 15: 213-221.

Aluma, J., Drennon, J., Lawry, S.W., Muwanga-Zake, E.S.K. & Were, J. 1989: Settlement in Forest Reserves, Game Reserves, and National Parks in Uganda. - Makerere Institute of Social Research, Kampala, Uganda, 78 pp.

Brooks, A.C. & Buss, I.O. 1962: Past and present status of the elephants in Uganda. - Journal of Wildlife Management 26: 38-50.

Butynski, T.M. 1984: Primates and their conservation in Uganda. - Primate Conservation 6: 68-72.

CARE (Cooperative for Assistance and Relief Everywhere)

1994: The people of Bwindi Impenetrable National Park. - DTC (Development through Conservation project), Kabale, Uganda, 63 pp.

Chapman, C.A., Chapman, L.J., Wrangham, R.W, Hunt, K., Gebo, D. & Gardner, L. 1992: Estimators of fruit abundance of tropical trees. - Biotropica 24: 527-531.

De Boer, W.F. & Baquete, D.S. 1998: Natural resource use, crop damage and attitudes of rural people in vicinity of the Maputo Elephant Reserve, Mozambique. - Environmental Conservation 25: 208-218.

Dudley, J.P., Mensah-Ntiamoah, A.Y. & Kpelle, D.G. 1992: Forest elephants in a rainforest fragment: preliminary findings from wildlife conservation project in Southern Ghana. - African Journal of Ecology 30: 116-126.

Else, J. 1991: Nonhuman primates as pests. - In: Box, H. (Ed.); Primate Response to Environmental Change. Chapman & Hall, London, pp. 115-165.

Hamilton, A. 1984: Deforestation in Uganda. - Oxford University Press, Nairobi, 92 pp.

Hill, C.M. 1997: Crop-raiding by wild vertebrates: the farmer's perspective in an agricultural community in Western Uganda. - International Journal of Pest Management 43: 77-84.

Hill, C.M. 1998: Conflicting attitudes towards elephants around Budongo Forest Reserve, Uganda. - Environmental Conservation 25: 244-315.

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

Hill, C.M. in press: People, crops and primates: a conflict of interest. - In: Paterson, J.D. (Ed.); Primate commensalism and conflict. Special Topics in Primatology, ASP Series Editor.

Howard, P.C. 1991: Nature conservation in Uganda's tropical forest reserves. - IUCN, Gland Switzerland, 313 pp.

Howard, P.C., Davenport, T. & Kigenyi, F. 1997: Planning conservation areas in Uganda's natural forests. - Oryx 31: 253-264.

Johnson, K. 1996: Local attitudes towards the Budongo Forest, Western Uganda. - Indigenous Knowledge and Development Monitor 4(3): 31.

Kavanagh, M. 1980: Invasion of the forest by an African savannah monkey: behavioural adaptations. - Behaviour 73: 238-260.

Knight, J. 1999: Monkeys on the move: the natural symbolism of the people-macaque conflict in Japan. - Journal of Asian Studies 58: 622-647.

Lauridsen, M. 1999: Workers in a forest: Understanding the complexity of incorporating local people in modern management. - M.Sc. thesis, University of Copenhagen, 125 pp.

Leighton, M. & Leighton, D.R. 1983: Vertebrate response to fruiting and seasonality with a Bornean rain forest. - In: Sutton, S.L., Whitmore, T.C. & Chadwick, A.C. (Eds.); Tropical rain forest: ecology and management. Blackwell Science, Oxford, pp. 181-196.

Marriott, H. 1999: Micro-demography of a farming population of Western Uganda: a preliminary analysis investigating population pressure on the Budongo Forest Reserve. - Social Biology and Human Affairs 64: 1-11.

Masindi District Profile 1989-2000: Agriculture development work plan. - Unpublished.

Mubalama, L. 1996: An assessment of crop damage by large mammals in the reserve de Faune a Okapis in the Ituri Forest, Zaire - with special emphasis on elephants. - Report, Wildlife Conservation Society, Bronx, New York, 156 pp.

Naughton-Treves, L. 1997: Farming the Forest Edge: Vulnerable Places and People around Kibale National Park, Uganda. - The Geographical Review 87: 27-46.

Naughton-Treves, L. 1998: Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. - Conservation Biology 12: 156-168.

Naughton-Treves, L., Treves, A., Chapman, C. & Wrangham, R. 1998: Temporal patterns of crop-raiding by primates: linking food availability in croplands and adjacent forest. - Journal of Applied Ecology 35: 596-606.

NEMA (National Environment Management Authority) 1999: State of environment report for Uganda 1998. - Advance printing company Pty Ltd., South Africa, 217 pp.

Newmark, W.D., Manyanza, D.N., Gamassa, D-G.M. & Sariko, H.I. 1994: The conflict between wildlife and local people living adjacent to protected areas in Tanzania: human density as a predictor. - Conservation Biology 8: 249-255.

Newton-Fisher, N.E. 1999: The diet of chimpanzees in the Budongo forest reserve, Uganda. -African Journal of Ecology 37: 344-354.

Nyerges, A.E. 1992: The ecology of wealth-in-people: Agriculture, settlement, and society on the perpetual frontier. - American Anthropologist 94: 860-881.

Obua, J., Banana, A.Y. & Turyahabwe, N. 1998: Attitude of local communities towards forest management practice in Uganda: the case of Budongo Forest Reserve. - Commonwealth Forestry Review 77: 113-117.

Paterson, J.D. 1991: The ecology and history of Uganda's Budongo forest. - Forest and Conservation history 34: 179-187.

Plumptre, A.J. 1996: Changes following sixty years of selective timber harvesting in the Budongo forest reserve, Uganda. - Forest Ecology and Management 89: 101-113.

Poole, D.W., McKillop, I.G., Western, G., Hancooks, P.J. & Packer, J.J. 2002: Effectiveness of an electric fence to reduce badger (Meles meles) damage to field crops. - Crop Protection 21: 409-417.

Reynolds, V. 1992: Conservation of chimpanzees in the Budongo Forest Reserve, Western Uganda. - Primate Conservation 11: 41-43.

Reynolds, V. & Reynolds, F. 1965: Chimpanzees of the Budongo forest. - In: Devore, I. (Ed.); Field studies of monkeys and apes. Holt, Reinhart and Winston, New York, pp. 368-419.

Saj, T.L., Sicotte, P. & Paterson, J.D. 2001: The conflict between vervet monkeys and farmers at the forest edge in Entebbe, Uganda. - African Journal of Ecology 39: 195-199.

Sprague, D. 2002: Monkeys in the backyard: encroaching wildlife and rural communities in Japan. - In: Fuentes, A. &

Wolfe, L.D. (Eds.); Primates Face to Face. Cambridge University Press, Cambridge, pp. 254-272.
SPSS INC. 1997: SPSS for Windows releases 8.0. - SPSS Inc.
Terborgh, J. 1983: Five new world primates. A study in comparative ecology. - Princeton University Press, Princeton, 260 pp.
Tweheyo, M. & Obua, J. 2001: Feeding habits of chimpanzees (Pan troglodytes), red-tailed monkeys (Cercopithecus ascanius schmiditi), and blue monkeys (Cercopithecus mitis stuhlmanii) on figs in Budongo forest reserve, Uganda. - African Journal of Ecology 39: 133-139.
Vansina, J. 1990: Paths in the rainforests: toward a history of political tradition in equatorial Africa. - University of Wisconsin Press, Madison, 428 pp.
Wrangham, R. 1977: Feeding behaviour of chimpanzees in Gombe National park, Tanzania. - In: Clutton-Brock, T.H. (Ed.); Primate ecology. London Academic Press, pp. 503-538.
Wrangham, R.W., Chapman, C.A. & Chapman, L.J. 1994: Seed dispersal by forest chimpanzees. - Journal of Tropical Ecology 10: 355-368.