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# ELEPHANT STATUS AND CONFLICT WITH HUMANS ON THE WESTERN BANK OF LIWONDE NATIONAL PARK, MALAWI

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## ABSTRACT

The study was conducted to assess the status of elephants in a new range of the Liwonde National Park in Malawi and relate it to elephant-human conflict. Elephant numbers estimated from aerial counts and ground surveys were used to estimate herd sizes and sex ratios and assess movements. Elephant herds were identified as either male or female herds and their locations were noted. Outside the Park, sampling of crop damage by elephants was done in agricultural land and the elephants responsible were identified as far as possible. Overall, crop damage levels were 10-25% of the potential harvest despite the high potential for such conflict. This is attributed to the small number of adult bulls and the availability of sufficient natural forage elsewhere. The bulls frequented the crops 5.8 times more than the females.

## RESUME

Cette étude a été menée pour évaluer le statut des éléphants qui ont traversé la rivière du Shire pour la première fois dans le Parc national de Liwonde et leur implication dans le conflit homme/éléphant. Les effectifs des éléphants ont été établis à partir des comptages aériens et des inventaires terrestres. Les troupeaux d'éléphants ont été identifiés et leurs emplacements repérés. A l'extérieur du Parc, un échantillonnage régulier des dégâts des cultures a été effectué en 1996, et les éléphants responsables de ces dégâts ont été identifiés. En général, il y avait entre 1992 et 1995, un seul troupeau à structure familiale et un troupeau composé de célibataires. Le niveau des dégâts se situait entre 10 - 25% malgré l'importance de tel conflit. Cela est lié au nombre réduit des éléphants mâles et à la disponibilité suffisante de forage dans la nouvelle zone de distribution. Les troupeaux de célibataires fréquentaient les cultures 5 à 8 fois plus que les troupeaux familiaux.

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## INTRODUCTION

The western boundary of Liwonde National Park, Malawi runs parallel to, but approximately 1km away from, the Shire River for some 35km (Figure 1) and is commonly referred to as the Western Bank. In July 1992, elephants (*Loxodonta africana africana* Blumenbach) crossed the river to this area for the first time since the creation of the Park in 1972, and have not since left the area. In this area, 151 elephants were counted in one group in December 1995 (i.e. density 4.3 elephants/km<sup>2</sup>).

Neighbouring the Western Bank, are high human densities with a mean of 302 persons/km<sup>2</sup> (Machinga Agricultural Development Division, 1996). The people are mostly subsistence farmers and their crop fields extend to the Park boundary. When elephants occur close to people, conflicts such as destruction of crops, damage to property and even loss of human life are bound to occur

(e.g. Bell, 1984; Kiiru, 1995; Tchamba, 1995).

The elephants first crossed the Shire River during the worst drought in living memory in southern Africa (Magadza, 1994; Braack, 1995; Zambatis and Biggs, 1995). They were probably seeking better forage after the floodplain on the Eastern Bank was over utilised (Bhima and Dudley, 1997). This, together with the above factors, i.e. small area and high density of subsistence farmers, contribute to a high potential for elephant/human conflict (e.g. Sukumar, 1990; Kangwana, 1995; Kiiru, 1995). The objectives of this study were to assess the status of these elephants and relate this to human-elephant conflicts on the Western Bank. Many studies on human-elephant interactions pay little attention to ecological perspectives of the animals involved (Sukumar, 1990). In this study ecological aspects which were assessed, such as the numbers, group size and density of the elephants, were related to the observed conflict pattern.

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## STUDY AREA

The Liwonde National Park (538km<sup>2</sup>) is located in southern Malawi, between 14° 36' -15° 03' S and 35° 26' E. The Park topography is flat with a mean elevation of 500m above sea level. The Shire River, the only outlet of Lake Malawi, is the most dominant physical feature in the Park and it flows southwards. The area has two marked climatic seasons: the dry season lasts from May to October, and the wet season from November to April. The mean annual rainfall for the period 1987/88 -1995/96 is 803.3 m. The temperature ranges from mean lows and highs of 12 and 28°C in the early dry season and 20 and 41°C in the late dry season.

The major vegetation type is dry, deciduous mopane woodland, which occupies 74% of the Park area. Other vegetation types are floodplains, grasslands, forest thickets and mixed woodlands, all occupying small areas. The Western Bank has four vegetation types (Figure 1). The floodplain covering about 12km<sup>2</sup> occurs along most of the riverbank. The major species are *Phragmites mauritianus*, *Cyperus papyrus* and *Typha domingensis*. The dry deciduous mopane woodland covering about 14km<sup>2</sup> occurs in the south and central areas. *The Acacia xanthophloea* woodland covering about 7km<sup>2</sup> is the major woodland of its type in the Park. Finally, there is a dense mixed woodland/thicket of under 2km<sup>2</sup> and with trees of about 25m tall which includes species such as *Borassus* palms, *Terminalia sericea*, *Acacia* spp and *Diospyros* spp.

The area outside the Park, where human-elephant conflict was studied, lies in the Machinga Agricultural Development Division (MADD) and in the Ulongwe

Planning Area of the Balaka Rural Development Project. The people have a small land holding of some 0.7ha per family (Table 1). The major agricultural crop is maize with some sorghum and cotton. The production of maize in this area was the lowest of all three Rural Development Projects in the MADD.

## METHODS

### Elephant movements and density on the Western Bank

Since the elephants crossed to the Western Bank, aerial total counts were conducted in the Park in the late dry season of 1992, 1993, 1994 and 1995. The locations of elephant herds were plotted on a map. In 1994, a GPS was attached to the aircraft to obtain more exact locations. Surveys were also done on the ground, recording the date, number of elephants seen, their location and the vegetation type occupied. A hand-held GPS was used to determine their exact ground locations. For groups seen at close range, sex was also recorded. Additional information on elephant locations was obtained from game scouts' reports and from safari boat operators who were requested to identify locations by using identifiable physical features such as the confluence of smaller rivers with the Shire River and the names of known places. The Wilcoxon-Mann-Whitney Test (Siegal and Castellan, 1988) was used to compare seasonal differences of male, female and overall herd sizes.

Dry and wet season elephant density distribution was determined for male groups and female herds. A map of

Table 1. Details of the Ulongwe Extension Planning Area in Malawi.

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<b>General statistics:</b>	
Surface area (km <sup>2</sup> )	397.40
Human density (no. per km <sup>2</sup> )	302
Number of farming families	22,431
• No. male-headed	11,375
• No. female-headed	11,056
Total arable land (ha)	18,699
Cultivated area (ha)	30,000
Mean crop field size per family (ha)	0.70
<b>Crop production estimates (kg/ha):</b>	
Local maize	650
Hybrid maize	1,057
Sorghum	843
Cotton	1,000

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Source: Machinga Agricultural Development Division (1996).

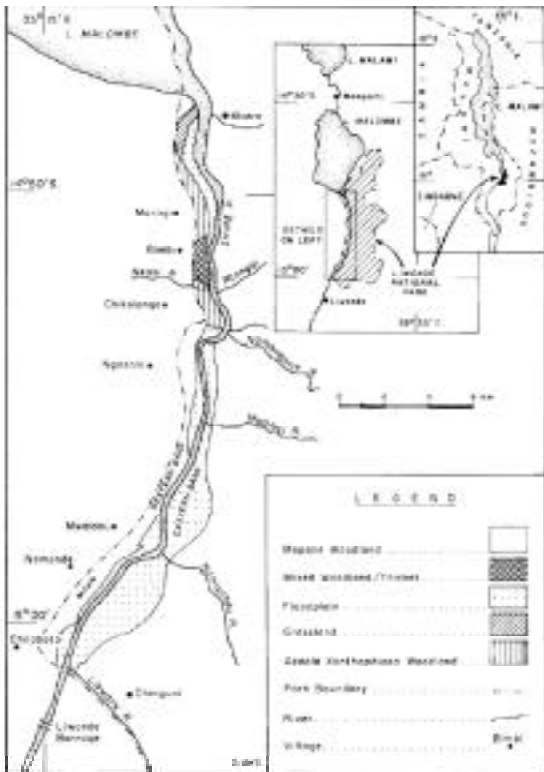


Figure 1. The Western bank of the Shire River showing the Liwonde National Park's Western Bank area, its vegetation and the villages adjacent to it.

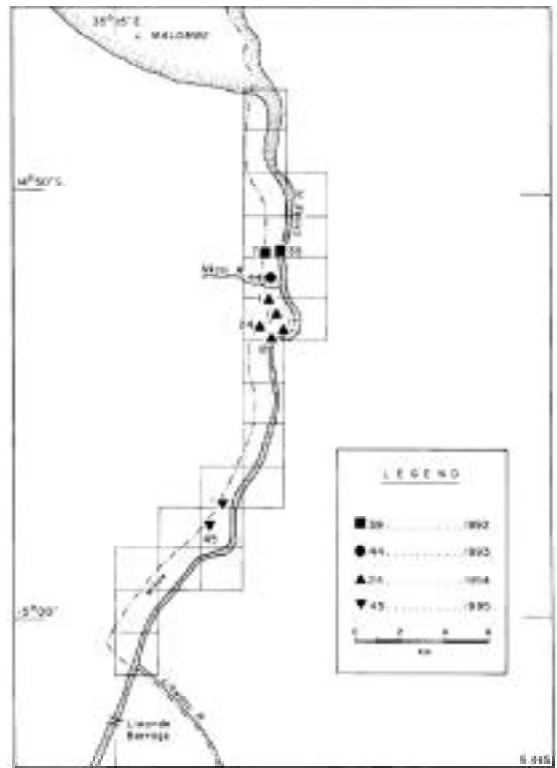


Figure 2. Group numbers and location of elephants seen on the Western Bank

the study area was divided into 1 x 1km grids based upon the Universal Transverse Mercator (UTM) Projection. For each grid square, a density value of elephants was estimated by dividing the total number of elephants observed in each cell by the total number of times they were observed in the dry season and in the wet season.

### Assessment of conflict

Human-elephant conflict was assessed during the crop season of November 1995 to April 1996. In all villages along the western Park boundary, reports of elephants raiding the villages were investigated. For each crop field assessed, the following information was recorded: the surface area of the field, type of crop(s) grown, the location of the field using the GPS, and an estimate of the shortest distance of the field to the Park boundary. Information on crop damage included the date of the damage, the surface area of the field damaged, the surface area damaged, the number of elephants involved, the date of previous damage in the field and where possible, the number of elephants involved in the previous two incidents. Other conflict, such as damage to property and loss of human life were recorded as they occurred.

For each village, the mean crop field size and area damaged were calculated. For raiding sorties by female and male herds, the frequency, mean size of the elephant group, area damaged per crop field, and the mean distance traveled by the elephants from the Park boundary were estimated and were compared statistically.

### RESULTS

#### Elephant numbers and density distribution

Forty-four elephants were counted during the aerial count on the Western Bank in 1992. In 1993 it was 46, in 1994 it was 67 and in 1995 it was 51 (Figure 2). From 1992 to 1994, all the herds were found in the mixed woodland/ thicket. In 1995 the herds moved south. These herds were suspected to be the same ones that had first crossed to the Western Bank in July 1992.

There were no differences between the dry and wet seasons for the mean female herd size ( $z = 1.225; P > 0.05$ ) and for the male herds ( $z = -0.77; P > 0.05$ ) (Table 2). The overall mean herd size for the wet season was

significantly higher than that for the dry season ( $z = -12.015$ ;  $P < 0.001$ ). A sex ratio of 0.68 males per female was observed.

Elephant density distributions for the female herds was more widespread in the dry season than in the wet season with a density in the dry season of three to seven elephants per km<sup>2</sup> in an area of about 7km<sup>2</sup> near the northern end of the study area and one of just over 1km<sup>2</sup> in the southern part (Figure 3). The same distribution pattern was observed for male herds, but at a lower density of 0.7 elephants per km<sup>2</sup> (Figure 4). The high-density area included the mixed woodland/thicket, the floodplain and the scrub mopane. The wet season distribution was reduced. This resulted in higher elephant densities of less than seven elephants/ km<sup>2</sup> for family herds in the core area which was almost entirely in the mixed woodland/thicket.

### Conflict with humans

Villages affected by elephant crop raiding on the Western Bank were within 0.5 km of the Park boundary and were near the high elephant density areas (Figure 1). The mean crop field size was 1.14 ha and mean area damaged per four consecutive nights in one area. Crop raiding began

in February after the maize crop had attained maximum height of some 2m. Most raids (30%) occurred in April and May when the crops were mature.

Female herds which raided crops were reported on three occasions in 1995 and five in 1996. Thirty-nine elephants walked out from the southern main elephant area in April 1996. This herd went 8km away from the Park boundary and killed five people, injured two people and killed two goats. Smaller herds followed the same route in May and August 1996. In the latter excursion, a male and a female elephant broke away and walked to the lower Shire Valley, some 200km away. All eight incidents were reported to the Parks and Wildlife Officer. It is unlikely that any other raids by these large family herds went unnoticed. We surveyed 11 crop fields raided by the herd of 39 in one night and nine fields raided by another herd, also in one night. The Wilcoxon-Mann-Whitney test shows that the family herds traveled significantly further away from the Park boundary than the bachelor herds ( $W_x = 32$ ;  $P < 0.05$ ). The mean area per field damaged by female herds, however, was not different from that damaged by male field was 0.10ha (0.09% of each field was damaged) (Table 3). In other areas, however, the degree of damage varied from 2.3 to 22.3%. The villages of Maninji, Bimbi and Chikolongu were adjacent to the

Table 2. The mean herd size of female and male herds separately and of the total elephant population ( $\pm$  sd) on the Western Bank in Liwonde National Park in the 1995/96 wet and dry seasons. Statistical data for the Wilcoxon-Mann-Whitney test are also given to show a significant difference for the total population between the seasons but no difference for the family and bachelor herds.

Herd size	Wet season	Dry season	z-value	Significance level
Female herds	56.94 ( $\pm$ 30.67) n = 16	48.79 ( $\pm$ 25.18) n = 22	1.225	>0.05
Male herds	3.69 ( $\pm$ 2.16) n = 12	4.21 ( $\pm$ 2.55) n = 19	-0.77	>0.05
Total population	33.07 ( $\pm$ 34.96) n = 28	22.87 ( $\pm$ 27.15) n = 41	-12.015	<0.001

high elephant density area near the northern end. Damage in this region ranged from 0.04 to 0.08 ha per field and was mostly caused by male herds. Chiloboto village is adjacent to the high elephant density area in the south and was most affected by female herd raids. In these villages, the major crop was maize.

Male elephants (Table 4) did most crop raiding. These elephants were either individuals, or small herds of up to six. These male herds accounted for 85% of crop raiding nights recorded. One herd raided up to three crop fields at most in a single night doing so for as many as three to herds ( $W_x = 22$ ;  $P = 0.05$ ).

### DISCUSSION

In all the aerial counts the elephants were in areas of about 1km<sup>2</sup>, and apart from the 1992 count, the elephants were found virtually in the same area. These similarities suggest that all the elephants on the Western Bank were from one family herd. This family herd is probably the one that initially crossed in 1992. Herds crossing later soon returned to the Eastern Bank.

The mapping of elephant distribution in this small area of the Park can be considered to be reliable because reasonable proportions of the area were covered, even during casual

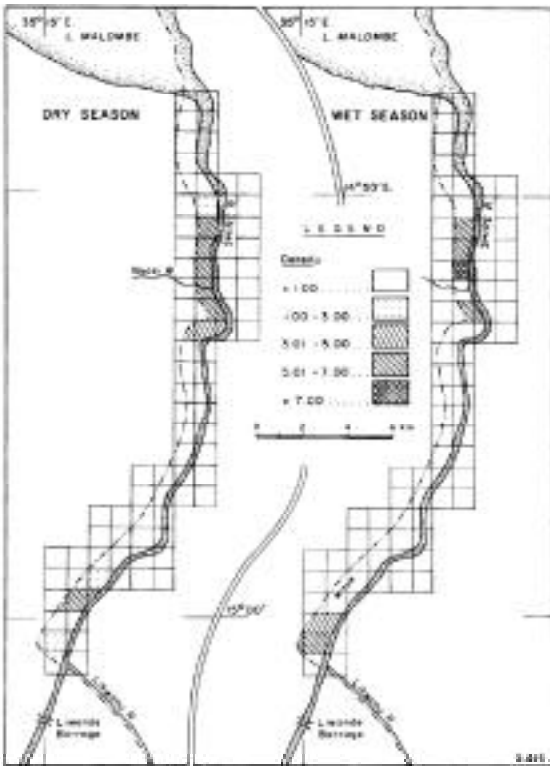


Figure 3. Density (per km<sup>2</sup>) distribution of family herds of elephants on the Western Bank of the Liwonde National Park, Malawi for the dry season.

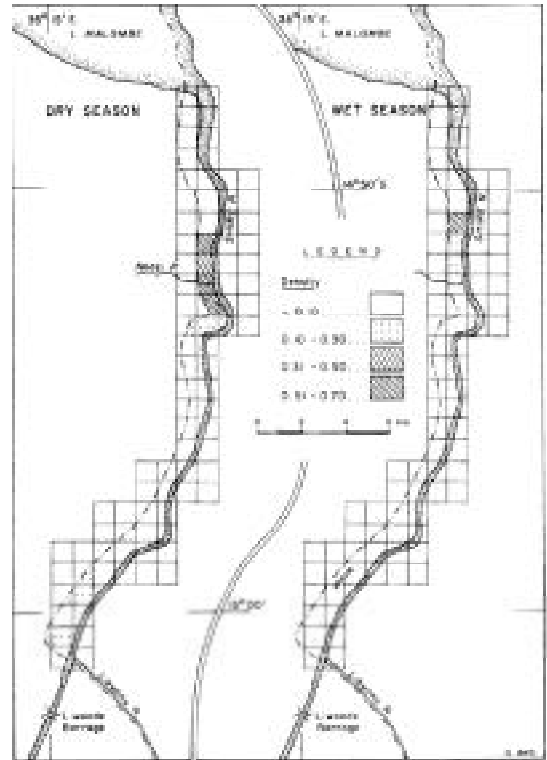


Figure 4. Density (per km<sup>2</sup>) distribution of bachelor herds of elephants on the Western Bank of the Liwonde National Park, Malawi for the dry and wet season.

forays of a few hours. The dense woodland/ thicket where the elephants concentrated is similar to the “drought deciduous forest” on the eastern side of the Park. The latter is the richest vegetation of the Park in terms of species numbers (Dudley, 1994). On the Western Bank, this vegetation was not utilised by elephants for many years prior to 1992 and consequently it had both good quality and large quantities of forage. Reduced use of the floodplain by the elephants in the wet season is similar to that observed on the east of the Shire River (*Bhima, pers. obs.*).

From the human population statistics of the Ulongwe Extension Planning Area (Table I), it is estimated that there are 70 farming families per km<sup>2</sup> in that area. If a high conflict zone were defined as the 1km wide strip along the 35km western boundary of the Park, then there were potentially 2,500 families at risk. With a mean field size of 1.14ha per family, and maize production of 2,057kg per ha, the potential crop loss is 515 tonnes (10%) for the whole area. Using Bell’s (1984) rating of crop damage by elephants, this level of crop damage is in category two, which is a moderate loss, despite the potential for a high level of elephant-human conflict. This was because the small number of male herds present caused most of

the crop damage. Of the 51 elephants counted in the aerial count in 1995, only one herd of six bulls was seen. In addition, although crop damage is done by male herds as elsewhere (e.g. Bell, 1984; Sukumar and Gadgil, 1988), some of them may not have participated in regular crop raids. Sukumar (1995), for example, found that only two bulls in one herd were responsible for 40% of all crop damage done by bulls in a much larger herd of Asian elephants.

Another reason for the moderate damage could be because the male herd often stayed near the female herd. This may mean that the males on the Western Bank are pubertal to young adult bulls *circa* 12 to 25 years old which return to the family herd from time to time (Croze, 1976). Consequently they usually raid the closest crop fields, returning quickly to the family herd in the Park.

The mean herd size of 33.07 elephants in the Park for the wet season is within the observed range of 28 to 42 elephants that crop raided. This implies that the whole female herd of the Western Bank went out of the Park to raid the crops when this happened, and not just some individuals. As for male herds, crop raiding seems to be

Table 3. Mean ( $\pm$  sd) of crop field sizes and areas damaged by elephants on the periphery of the western boundary of Liwonde National Park, Malawi during the 1995/96 crop season.

Village	Number of fields sampled	Mean field size (ha)	Mean area damaged per field (ha)	Mean area damaged per field (%)
Namonde	10	0.60 ( $\pm$ 0.43)	0.14 ( $\pm$ 0.20)	22.3
Ngasale	9	1.01 ( $\pm$ 0.64)	0.06 ( $\pm$ 0.11)	5.9
Bimbi	9	0.90 ( $\pm$ 0.56)	0.04 ( $\pm$ 0.05)	4.4
Maninji	8	3.45 ( $\pm$ 3.18)	0.08 ( $\pm$ 0.05)	2.3
Chiloboto	13	0.82 ( $\pm$ 0.51)	0.18 ( $\pm$ 0.10)	22.0
Mwalabu	9	0.47 ( $\pm$ 0.40)	0.04 ( $\pm$ 0.02)	8.5
Chikolongo	9	0.81 ( $\pm$ 0.73)	0.07 ( $\pm$ 0.20)	8.6
Total	67	1.14 ( $\pm$ 1.55)	0.1 ( $\pm$ 0.13)	8.8

Table 4. Comparison of crop raiding patterns on the Western Bank of Liwonde National Park, Malawi by elephant male and female herds of different sizes, including frequency of raiding, area damaged and maximum distance traveled from the Park.

Number of elephants	Number of nights raided	Number of fields raided	Total area damaged (ha)	Mean area damaged per field (ha)	Maximum distance traveled (km) from Park
<b>Male herds</b>					
1	6	8	0.22	0.027	0.1
2	9	15	0.66	0.044	0.6
3	2	5	0.26	0.051	0.3
4	2	3	0.03	0.009	0.4
5	6	9	2.08	0.231	0.7
6	4	3	0.08	0.024	0.4
<b>Female herds</b>					
28	2	10	0.79	0.079	8.0
29	1	1	0.04	0.042	4.0
39	1	11	2.16	0.196	3.0
42	1	1	0.15	0.148	0.5

part of their daily individual activities. They therefore could go on crop raids in any numbers, from one to six.

Because the main elephant areas on the Western Bank are adjacent to maize fields, it could be expected that this would lead to the total destruction of the crops. The female herds were, however, involved in crop raiding on only eight nights during two crop seasons. The presence of adequate forage on the Western Bank, particularly in the dense woodland/thicket may have kept them inside the Park as was observed by Dudley *et al.* (1992) in southern Ghana and by Smith *et al.* (1995) in Garamba National Park, Zaire. When these habitats become over utilised

crop raiding could become a big problem.

## CONCLUSION AND MANAGEMENT RECOMMENDATIONS

The proximity of human settlements and their crop fields to the Park on the Western Bank makes this area prone to conflict with elephants. Despite this, elephant damage to crops in the 1995/96 crop season was moderate. This can possibly be attributed to the small number of adult males present on the Western Bank, and the availability of suitable forage in the Park may have kept the elephants away from the crops. The incidence of crop raiding may,

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however, increase in future as the elephant population grows and the suitable habitats in the Park become overutilised. Currently the same bulls are causing most of the conflict. Killing some of these would cause a temporary reprieve to the problem. Another possibility would be trophy hunting, with some of the income earned accruing to the local people. However, this can only be possible if trophy hunting is legalised in the country. Construction of an elephant-proof boundary fence would also reduce elephant-human contact, if constructed and maintained properly by sensitising the local people to its advantages, and involving them in its maintenance. In this way, the fence ultimately will become the responsibility of the people most at risk to crop raids by these elephants.

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