ELEPHANT PROBLEM IN THE MUNGO DIVISION, LITTORAL PROVINCE CAMEROON

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RESUME

Cette étude préliminaire a montré qu'il existe encore une importante population d'é1éphants dans le département du Nkam et du Mungo, avec une densité estimée à 1.3 ± 0.3 é1éphants par km^2. Une pressio constante exercée par le braconnage sur les é1éphants à l'intérieur de la forêt apparaît être la principal cause qui les repoussent vers les villages. En restant constamment aux abords des villages, les éléphants auraient graduellement exploré des nouvelles aires (telles que des vielles et des nouvelles plantation regorgeant de cultures vivrières plus succulentes et nourrissantes que la végétation naturelle. Cette découverte les aurait amenés à mettre au point un nouveau cycle de migration pouvant leur perrnett d'avoir une alimentation riche pendant tout le cycle saisonnier. A cela, il faudrait ajouter le développeme agricole de la zone dû elle-même à la population humaine galopante qui a pour conséquence la dégradation continue de l'habitat de 1'éléphant.

Contrairement au probléme des é1éphants de Kaélé dans I'extrême nord Cameroun, celui du Mungo semble être la conséquence des activités humaines telles que l'agriculture et le braconnage. Avec I'expansion de l'agriculture dans la zone, le conflit deviendra plus important et les é1éphants seront sûrement les grands perdants. Les pertes que pachydermes imposent aux populations rurales dans la zone doivent à tout prix être réduits sinon, ils ne scront plus tolérés par les populations humaines a qui ils partagent l'écosystème et leur survie sera compromise. Le probléme des é1éphants destructeurs de cultures dans le Mungo mérite une attention particulière et urgente.

Il est suggéré un projet de recherche dans la zone qui devra comprendre deux principaux volets:

- Une étude systématique de la distribution l'espace et dans le temps des destructions des cultures par les é1éphants. Ceci fournira des éléments de base nécessaires pour la compréhension de la nature et l'importance du problème. Ces travaux devront être suivis par un phase d'expérimentation des méthodes pouvant être efficace à repousser les é1éphants maraudeurs.
- Une étude systématique des densités, mouvements et de la distribution au cours de tout un cycle saisonnier par des transects à largeurs variables distribués au hasard dans la forêt. Ces travaux permettront de connaître la zone d'action de ces é1éphants et d'être capable de prévoir leurs mouvements. Ces données pourront aussi être utiles pour la planification de l'utilisation des terres ainsi que pour la localisation et la délimitation du site d'une réserve qui devra être crée pour la conservation de ces é1éphants.

Deux solutions à court terme sont proposées en attendant la mise en ceuvre d'un tel projet:

- Les dérangements (battues, coups de feux au-dessus des têtes des é1éphants, les feux d'artifices, les gaz lacrymogènes, le feu, et des bruits des tam-tams)
- Les battues contrô1ées.

Le succès de toutes ces méthodes est conditionné par la réduction du braconnage à l'intérieur de ce grand massif forestier.

SUMMARY

This preliminary survey has shown that there is an important elephant population in the Mungo and Nkam divisions (Littoral Province, Cameroon), a density of 1.3 ± 0.30 elephants per km^2. A con poaching pressure on elephants in the inner part forest appeared to he the main cause that keeps close to villages. It is possible that with a constant stay in the forest edge, elephants have been gradually exploring new areas (such as fallow lands and farms and have found locations where there are crops

that are richer food source than natural vegetation. This discovery might have brought them to redesign a new cyclic migration pattern that enables them to have rich food during the whole seasonal cycle. To poaching should be added the spread of agriculture in the area due to an increased human population density that has as side effect a constant encroachment on elephant natural habitat.

Unlike in Kaele, problems in the Mungo division may have resulted from human activities such as poaching and farming that triggered changes in elephant movements. As agriculture will expand in the forest zone, conflicts will escalate and it is sure that elephants will lose. The costs elephants impose on the rural population in the Mungo division should be reduced. Otherwise, they will not be tolerated by people who share the forest with them and their survival will be in doubt. The issue of crop-raiding in the Mungo and Nkam division needs to be urgently tackled.

It is suggested that research be carried out in the area and this should include:

- A systematic survey of the spatial and temporal distribution of crop-raiding that will furnish a basic understanding of the nature and scale of the problem. This work should be followed by an experimental phase to test methods of deterring marauding elephants.
- A systematic study of densities, distribution and movements over a whole seasonal cycle using randomly distributed line transects in cells. This will make it possible to determine the elephant range, the population size and migration patterns over a seasonal cycle. These data could also be useful in land use planning and in the choice of the exact location, size and shape of a reserve for the conservation of the elephant population in the area.

Two short-term solutions of controlling marauding elephants are suggested:

- Disturbance (shooting, firecrackers, drums, lights, **fires,** pepper gas, thunderflashes and shooting over elephants' heads).
- Control shooting.

The success of these management options will only be possible with a dramatic reduction of poaching in the area.

INTRODUCTION

A joint WWF/MINEF team spent 25 days in the Mungo Division, from 28 November to 22 December 1995, to undertake preliminary studies on elephant herds that have been raiding crops in the area

The villages of Ebone, Ekomtolo, Djanga, Badjong, Nlonako and Balondo (south-east of Nkonsamba, Mungo division), are located in an important primary forest adjacent to the Nkam division where significant herds of elephants are still found. Minor crop-raiding by elephants in these villages started in 1991. Since February 1994, important crop destruction has been reported on a regular basis and one hunter was recently killed by these elephants. The "Cellule Centrale du Système National d'Alerte Rapide et d'lnformation sur les marchés" estimated a total of 94 plantations (palm, raffia, cassava, plantains, cocoyams, Colocassia, yams, pineapples, coffee, various fruit trees, and sugar cane) destroyed in the above cited villages.

Development Committees of the concerned communities, in collaboration with MINEF services in the Mungo division, have been shooting elephants to deter them from destroying crops. This technique has kept the bulk of the herds away, although some isolated crop-raiders are still reported to be present in the area. The populations of these villages are facing starvation, according to the "Cellule Centrale du Systeme National d'Alerte Rapide et d'lnformation sur les marchés". Therefore, it was of the utmost importance to undertake a preliminary study of these elephant populations.

OBJECTIVES

This study aimed to assess the importance of the elephant problem in the Mungo and to provide MINEF with preliminary recommendations for the conservation of elephants in the area. It also addressed issues of basic importance in mitigating human-elephant conflicts which are a major concern here and around Africa.

The primary objectives were as follows:

- Collect preliminary data on density, range and seasonal movements of elephants in the area.
- Collect preliminary information on crop depredation by elephants in villages.

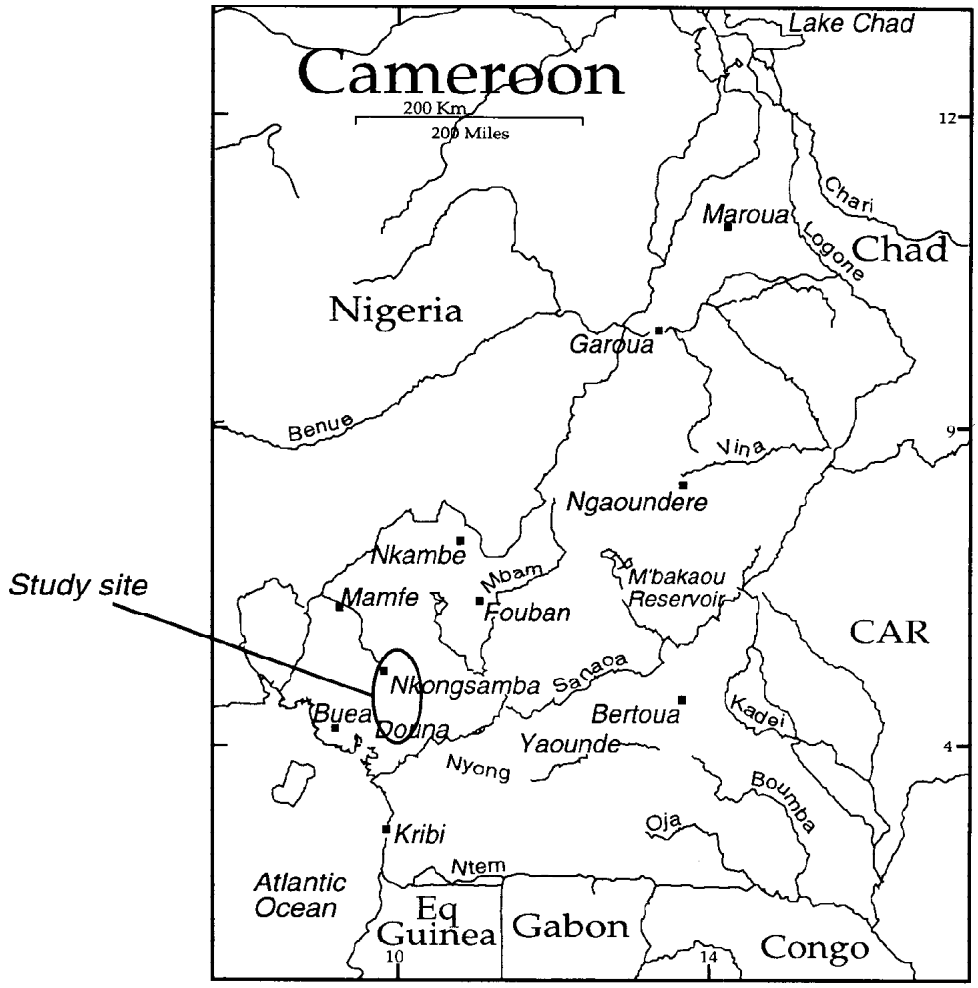

Figure 1. Map of Cameroon showing the study site.

STUDY AREA

The study area covers part of the Mungo division and the Nkam division in the Littoral province (Figure 1). The town of Nkongsamba borders on this study site to the west, the town of Nkondjok to the east, the town of Yabassi to the south and the Nkam river to the north-east (Figure 2). The lack of a good map made it impossible for us to estimate its area. However, the Mungo division is estimated to cover an area of 3,720km^2, with a population of 430,000 inhabitants, or an approximate density of about I 1 6 people per km^2.

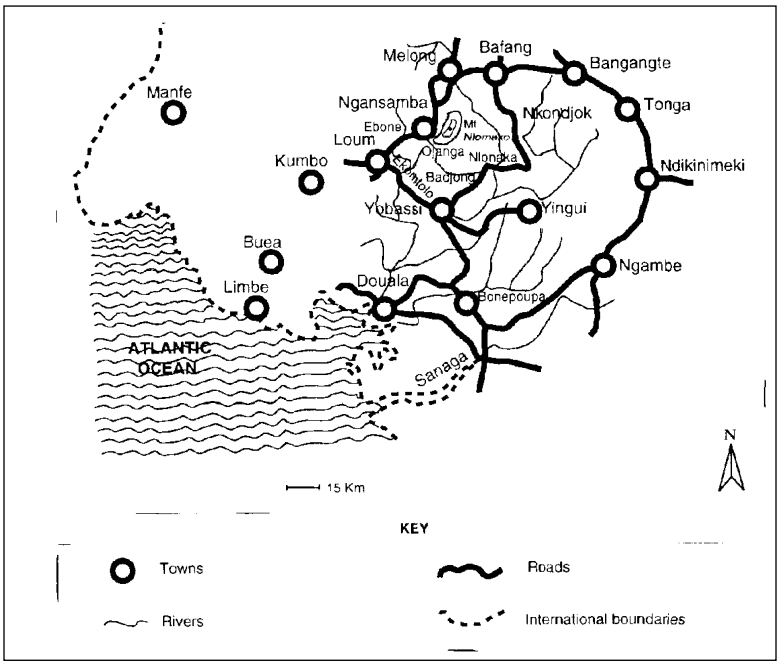

Figure 2. Map of the study area.

The flora could be described as an evergreen rainforest with an open understory, dominated by species such as *Afzelia sp, Lophira alata, Chlorophora excelsa, Pterocarpus soyauxii, Nauclea diderrichii, Lovoa trichiloides, Erythrophleum ivorense, Piptadeniastrum africanum, Entandrophragma cylindricum, Guibourtia sp, Terminaliasuperba, Distenionenthus banthamianus, Khaya sp, Garcinia kola, Garcinia lucida and lrvingia gabonensis.* An area of 41,375ha has been given as logging concessions to two companies: SICAB (Licence no 1654 of 9,375ha and Licence no 1738 of 11,120ha) and SFS (Licence no 1773 of 20,880ha). However, the uneven terrain makes it difficult for logging companies to operate in the area.

Despite heavy poaching pressure, the fauna is rich in important species such as the elephant *(Loxodonta africana), chimpanzee (Pan troglodytes),* drill *(Mandrillus leucophaeus),* African buffalo *(Syncerus coffer nanus)* and sitatunga *(Tragelaphus spekei).*

The climate is characterised by rain for most of the year, with a relatively dry period from December to February. The annual rainfall is about 3,000mm. The mean annual temperature varies between 21^{0}C and 23^{0}C.

METHODS

Elephant density

The line transect method based on dung counts was used to estimate elephant density in the area. For this preliminary survey, transects were not randomly distributed. Seventeen transects were surveyed in total. The first transect (2km in length) was cut due cast from the Ekomtolo village. The geographical coordinates of its starting point are: N 4^0 49, E 9^0, 54'; altitude 515m. A base-line of 20km in length was cut due east, with the starting point located in the Badjoki village at N 4^0 50', E 9^0 56', and at an altitude of 447m. This base-line was subdivided into eight transects of 2.5km each. Another set of eight transects, 2.5km each, were surveyed (four due north and four due south) along the same base-line. The starting points were located at 2.5km, 7.5km, 12.5km and 17.5km from the village. A total distance of 42km of transects was therefore surveyed for this study.

The following data were recorded for each dung-pile detected: The distance (y) along the transect (in kilometres); the perpendicular distance (x) from the line to the centre of the dung-pile (in metres); the dungpile

grade (following the grades used by Barnes and Jensen [1987], as follows: Stage A - boli intact, very fresh, moist with odour, Stage B - boli intact, fresh but dry, no odour; Stage C I - some of the boli are disintegrated, but more than half are distinguishable as boli; Stage C2 - less than half of the boli are distinguishable, the rest are disintegrated; Stage D ≠all boli form an amorphous flat mass; Stage E - it is impossible to detect the dung-pile at 2m range in the undergrowth). Distances of dung-piles of grade E were not recorded as they were assumed to have "disappeared" (Barnes and Jensen, 1987). In addition, information on other elephant signs (feeding, footprints, digging), vegetation change (primary forest, logged forest, swampy forest, clearing), human activities (logging, hunting, fishing, farming) and streams were also recorded

DATA ANALYSIS

The x values (perpendicular distances from the**)** in transect to the centre of dung-piles) for all the droppings were used by the programme DISTANCE (Laake *et al.*, 1994) to estimate the detection function g(x). This is the probability of detecting a dung-pi] given that it is at distance x from the transect (Buckland *et al.*, 1993). The DISTANCE programme uses g(x) to estimate the probability density function (pdf) f(x) of the perpendicular distance data, conditional on the dung-pile being detected (Buckland *et al.*, 1993). Fro the probability density function. the DISTANCE programme calculates an estimate for f(O), which an estimate of the frequency with which dung-pi] occur on the centre-line (Barnes and Jensen, 1987) as well as its 95% confidence interval.

The detection function g(x) is not known in advance and it varies with factors like the environment observer effectiveness to detect dung-piles. Several models of *g(x)* are implemented in the program DISTANCE. Three different statistical tests can used in selecting the best model that **fits** the data. These tests are the likelihood ratio test, the goodness of test and the Akaike's Information Criterion (AIC) test. However, Buckland *et al.*, (1993) advise the use the AIC test because, unlike the likelihood ratio test which works only for nested models and the goodness of **fit** test which provides only the warning that model might be poor, the AIC test allows all the mod implemented in the programme DISTANCE to tested at the same time and the best model is the with the lowest AIC. The AIC test was therefore chosen for data analysis.

For this survey, the hazard rate model was selected (AIC = 376.29) The formula is:

$$g(x-) = 1 - exp(-x/A,)^{-A_2}, \qquad (1)$$

A, and A, were calculated by the DISTANCE programme.

For each transect, the programme DISTANCE estimated the dropping density per km^2 (Y) using Equation 2 (Buckland *et al.* 1993).

$$Y = \frac{n.\ f(0)}{2L} \qquad (2)$$

where n in the number of dung-piles in the transect and L is the total length of the transect.

After estimating dung-pile densities for each transect the programme pooled the data over the 17 replicate transects for the estimation of the dung-pile density of the study site. The coefficient of variation an confidence limits were also calculated by the programme DISTANCE.

It was assumed that dung-piles in the study area we in a steady state (number of dung-piles disappears each day were equal to the number of dung-piles being deposited). The density of elephants (E) per square kilometre was therefore estimated using the three variables (McCIanahan, 1986; Barnes and Jensen 1987): dung-piles density (Y), elephant defecation rate (D) and dung decay rate (r).

$$E = \frac{Y.\ r}{D} \qquad (3)$$

The defecation rate estimated by Tchamba in 199 the Santchou reserve (D = 20 defecations per day). and the decay rate estimated by Ekobo in the Lobeke forest in 1995 (r = 0.008333) were used for data analysis because those two parameters have not have not been estimated for the study area.

Each of the variables *(Y, r, D)* is an estimate with its own variance. The variance of each of the three variables will contribute to the variance of E, which is estimated by:

$$Var(E) = Var(D) \times \frac{(Yxr)^2}{D^2} + Var\left(\frac{Y \times r}{D^2}\right) \qquad (4)$$

(Barnes)

where

$$Var (Y \times r) = Var (Y) \times Var (r) + y^2 \times Var (r) + r^2 \times Var (y) \quad (5)$$

The 95% confidence interval was estimated as

E ± 2. 12 x SE

because, with a sample size n = 17, $t_{0.05}$ is about 2.12 (Zar, 1984). Pearson correlation was used to test the relationship between the number of observations per transect and the distance to the nearest village.

QUESTIONNAIRE SURVEY

Individual interviews were conducted in Nkongsamba, Nkondjok, Yabassi as well as in 16 other villages which are experiencing crop-raiding. All interviews were started opportunistically and questions asked in the course of conversation. This approach gave informants the opportunity to develop their answers outside a structured format and therefore were more likely to provide other useful information. The set of topics investigated were: the presence or absence of elephants; the period of the year when crop-raiding occurs; the probable range and migration patterns; the location of farms; the methods used to deter elephants from raiding crops; the human-elephant relationship in the area; as well as poaching pressure.

We could not undertake an assessment of crop-raiding damage as no incidents of crop-raiding reported during the study period. It would have been too subjective to study old signs which were not clearly elephant related.

RESULTS

Elephant density

The sampling effort was 42km for a sample size of 17. The largest x value was 10.94m for a total of 138 observations. Table I gives parameters used by the DISTANCE programme for line transects' data analysis.

Table 1. Summary of statistics for the survey using the Hazard rate detection function.

Parameter	Point estimate	Standard error	Coefficient of variation(%)	95% confidence limits
A(I)	0.1094	0.03718	33.99	–
A(2)	1.031	0.1104	10.71	–
f(O)	1.9240	0.30695	15.95	1.4101 -2.6251
p	0.04751	0.00757	15.95	0.03482-0.064823
ESW	0.51976	0.08290	15.95	0.38093-0.70917

A(1) = first parameter in the estimated probability density function (pdf)
A(2) = second parameter in the estimated pdf
f(O) = the pdf of the perpendicular distances from the line, evaluated at zero distance
p = probability of detecting a dung-pile
ESW = effective strip width *(w x P)* in metres

The programme DISTANCE calculates the estimated dung-pile density for each transect using the genera) estimator **(Equation** 2). The mean estimate, its standard error and 95% confidence interval are presented in Table 2

Table 2

Mean dung density	Standard error	95% confidence interval
3160	331	± 702

The mean elephant density and its 95% confidence limits were calculated from **Equation 3, Equation 4 and Equation 5**. The result is presented in Table 3.

Table 3.

Mean elephant density estimate (per km2).

Point estimate (per km2)	Standard error	95% Confidence limits
1.3	0.14	± 0.30

Elephant populations could not be estimated as the area of their range is not known.

The scatterplot of the number of observations per transect against the distance to the nearest village is shown in Figure 3.

Pearson correlation analysis suggests a strong negative relationship between the number of dung-piles detected per

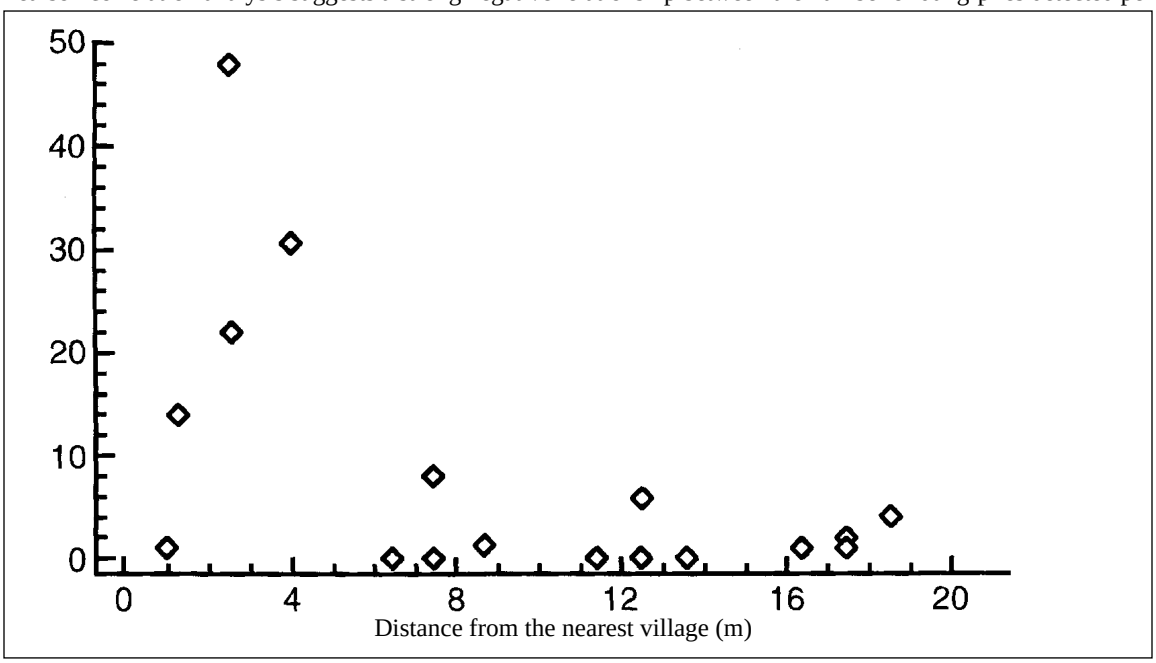

Figure 3. Plot of the number of observations per transect versus the distance from the nearest village

transect and the distance from the nearest village (r = -0.549, df = *15*. $P < 0.05$). In other words, there is a significant decrease of the number of dung-piles observed per transect with an increase in distance from the nearest village.

QUESTIONNAIRE SURVEY

For the entire survey, 100 people were interviewed. The youngest informant was 16 years old and the oldest I] 4 years old

The questionnaire survey suggests that most of the local community farms (85%, n = 100) are located less than 4km from villages. This was confirmed by the line transect survey in the forest. According to 82% of the informants, elephants come within 500m of their houses and 98% of them locate elephant crop-raiding activities within five kilometres of their villages.

Most of the local people think that elephants are simple wild animals (57%, $n = 99$). According to 25% of people interviewed, elephants are totems and 19% consider elephants as enemies. Most people talked to valued elephants for their meat (92%, n = 100).

Evidence indicates that elephants are poached in the area. Poaching is more frequent in the Nkam division than in the Mungo division ($X' = 34.346$, df = *1*, $P < 0.001$).

Methods used by the local communities to deter elephants from raiding their crops include noise (51 %, $n = 78$), smoke (42%), killing (5%), lights (1%) and burning elephant dung (1%). According to most of the informants (72%, n = 100), elephants come to their villages just to raid their farms. However, some (24%) do think that crop-raiding is a side effect of high elephant poaching in the area. Few of them (3%) attribute crop raiding to a migration phenomenon, and only 1 % of the informants linked crop-raiding to witchcraft.

This survey suggests an elephant range covering the area located between the towns of Nkongsamba (Mungo division), Yabassi and Nkondjok (Nkam division) and Ngambe and Bonepoupa (Sanaga Maritime division). Figure 4 shows the probable elephant range.

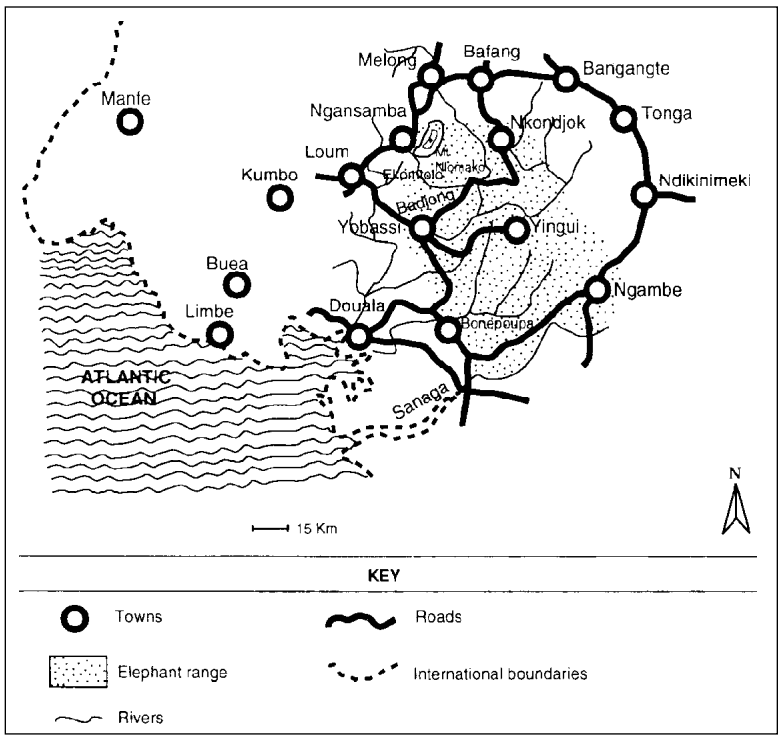

Figure 4. Probable elephant range in the study area

Crop-raiding by elephants appeared to present a cyclic pattern. Elephants are reported to destroy farms in the subdivisions of Nlonako and Nkongsamba between February and June. This activity is reported to occur in Nkondjok subdivision between July an October and in Yabassi subdivision between December and January. Figure 5 shows the probable direction of migration patterns.

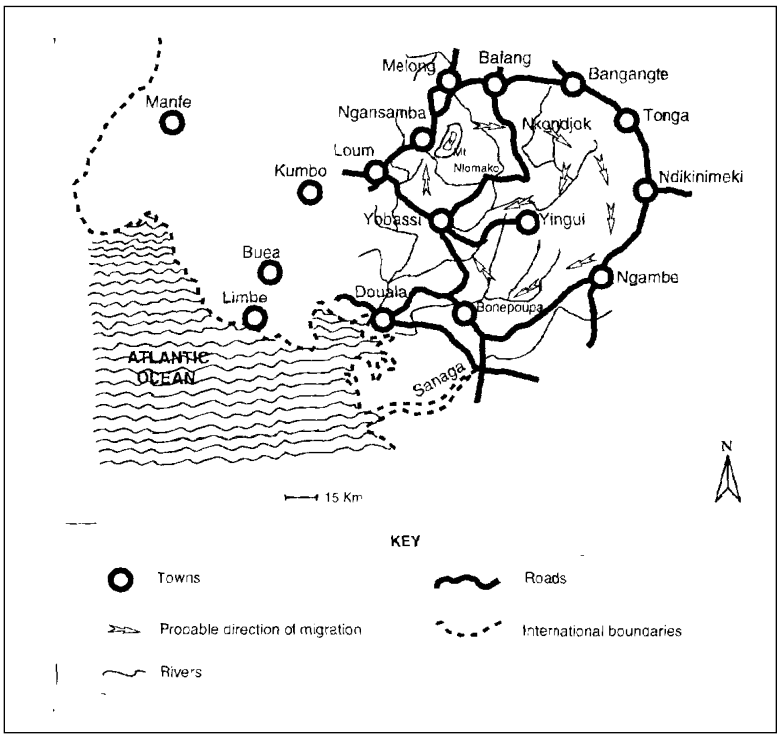

Figure 5. Probable elephant migration patterns

POSSIBLE CAUSES OF CROP-RAIDING

Poaching pressure on elephants

This preliminary survey has shown that there is an important elephant population in the Mungo Nkam divisions, with a density of 1.3 ± 0.30 elephants per km^2. Pearson correlation analysis suggests concentration of elephants in the vicinities of villa contrary to what is observed in the south-cas Cameroon (pers. obs.), in Gabon (Barnes, pers. comm. or Congo (Agnagna, pers. comm.). This unusual phenomenon could be explained by a high concentration of poachers in the forest. In fact, about 15km along the base-line an increased number of poachers encampments were recorded. Some poachers are equipped with modem weapons, sue the 458 and 375 rifles, Constant poaching pressure on elephants in the inner part of the forest appears to be the main cause forcing elephants close to villages.

Acquisition of a taste for crops

It is possible that with a constant stay in the forest edge, elephants have been gradually exploring new areas (such as fallow lands and farms) and have found locations where there are crops that are a richer food source than natural vegetation. This discovery may have brought about a new cyclical migration pattern (Figure 5) which enables the elephants access to rich food sources throughout the year.

Increased agricultural development in the Mungo Division

The estimated population density in Mungo division is 116 inhabitants per km^2. Increased levels of conflicts in the area may be partly explained by a high human population density with resultant encroachment on elephant habitat, The spread of agriculture increases

competition between humans and elephants for land, and exacerbates conflicts between the two.

RECOMMENDATIONS

Unlike in Kaele, problems in Mungo and Nkam divisions may have resulted from human activities, such as poaching and fanning, which triggered changes in elephant movements. As agriculture expands into the forest zone the number of conflicts will escalate. The costs these conflicts impose on the rural population in the Mungo division need to be reduced, otherwise elephants will no longer be tolerated by the people who share the forest with them, and the elephants' long term survival will be in doubt. To the local people, conflict with elephants seems insoluble (unless all the elephants are killed!), as their methods of controlling crop-raiders (including burning elephant dung!) have been, to date, ineffective. However, these problems are not intractable, and solution do exist to improve the situation.

It is suggested that a research project be initiated in the area to look at some of the basic aspects of human and elephant dynamics to determine solutions to the problems outlined in this paper. Any project initiated should include:

- A systematic survey of the spatial and temporal distribution of crop-raiding. This work will furnish a basic understanding of the nature and scale of the problem. This phase should be followed by an experimental phase to test methods of deterring problem elephants.
- A systematic study of elephant population densities, distribution and movements over an entire seasonal cycle using randomly distributed line transects in cells (Ekobo, 1995) to determine the elephant range, the population size and migration patterns over a seasonal cycle. It would therefore be possible to anticipate elephant movements in relation to existing human settlements. These data would also be useful in land-use planning and in the choice of the exact location, size and shape of a conservation reserve for the elephant population in the area.

There are also a wide range of possible short-term solutions or methods of controlling marauding elephants. Two of these management options are more realistic and suitable to an evergreen rainforest ecosystem:

1. Disturbance
   This solution involves attempting to drive elephants away from farms by methods such as shooting, firecrackers, drums, lights, **fires,** capsicum (pepper gas), thunderflashes and shooting over elephants' heads. Many of these methods have been tried by local communities in the area and have proven to be ineffective because they were used in isolation and elephants became accustomed to them. Appropriate forms of disturbance such as those cited above, when used in combination with control shooting could increase the effect of disturbance.

2. Control shooting
   This solution involves shooting individual elephants as a deterrent, in an attempt to drive other elephants away. This method has also proven to be ineffective in the area because:

- poachers and hunters who are hired to kill problem elephants generally select bulls because they carry large tusks and because they are usually the ones found to raid crops most frequently. Experience from other parts of Africa where crop-raiding occurs has shown that the deterrent effect of shooting bulls is very small.
- shooting often takes place well after elephants have become established in the area and when the elephants are not actually raiding crops. This does not give a clear message to elephants.

It is important to understand that if the shooting is badly done, the situation may be exacerbated with aggressive wounded elephants.

Control shooting should take place in the crop-raiding area to deliver a clear signal to elephants. Ideally, young females below breeding age should be shot. Shooting should take place as soon as animals arrive in the area and all animals shot should be killed. Single-shot heavy calibre guns should be used rather than light automatic machine guns.

It should be noted that all of the above suggested solutions will only be effective if there is a dramatic reduction of poaching in the area.

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