Community-based methods to reduce crop loss to elephants: experiments in the communal lands of Zimbabwe

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Abstract

Crop damage by elephants is a widespread conservation concern across Africa and Asia where humans and elephants coexist. Elephant damage to crops and property creates intensely negative attitudes towards conservation by those affected. Methods for deterring crop-raiding elephants are problematic, as traditional deterrent methods that rural farmers use become ineffective over time, and interventions by NGOs or wildlife authorities tend to be both expensive and unsuitable in remote locations. In this study an experimental community-based strategy for protecting crops was developed and compared with current deterrent methods. The experimental deterrents included warning systems, barriers and active deterrents and were designed to increase the capacity of farmers to detect and repel elephants. Individual experimental methods were more effective at deterring elephants than current traditional methods and the 'integrated strategy' significantly reduced the total crop damage in study villages. The results of this study suggest that elephants can be deterred from crop raiding using inexpensive materials that are locally available and that local communities can administer.

Additional key words: African elephants, human–elephant conflict, *Loxodonta africana*, rural communities, problem animal control, wildlife management, semi-subsistence agriculture

Résumé

Les dommages causés aux récoltes par les éléphants sont un problème fréquent dans toute l'Afrique et en Asie, partout où hommes et éléphants coexistent. Les dommages causés par les éléphants aux récoltes et aux biens engendrent chez ceux qui en sont victimes des sentiments extrêmement négatifs envers la conservation. Les méthodes destinées à dissuader les éléphants qui font des dégâts posent problème dans la mesure où les méthodes traditionnelles utilisées par les fermiers deviennent inefficaces avec le temps et que les interventions des ONG ou des autorités en charge de la faune ont tendance à être coûteuses et mal adaptées aux régions reculées. Dans cette étude, on a développé une stratégie expérimentale communautaire pour protéger les récoltes et on l'a comparée aux méthodes de dissuasion actuelles. Les moyens expérimentaux comprenaient des systèmes d'alarme, des barrières et des instruments actifs et ils étaient conçus pour augmenter la capacité qu'ont les fermiers de repérer et de repousser les éléphants. Les méthodes expérimentales individuelles étaient plus efficaces pour dissuader les éléphants que les méthodes actuelles, et la « stratégie intégrée » a significativement réduit le total des dommages causés aux récoltes dans les villages couverts par l'étude. Les résultats de l'étude suggèrent qu'on peut dissuader des éléphants de dévaster des récoltes en utilisant des moyens peu coûteux qui sont disponibles sur place et que les communautés locales peuvent employer elles-mêmes.

Introduction

Conflict between rural farmers and elephants is a major conservation concern across Africa and Asia (Sukumar 1989; Dublin et al. 1997). Subsistence farmers' livelihoods can be seriously affected by crop damage. In some semi-arid rural farming areas of Zimbabwe and Kenya elephant damage to food crops accounts for 75 to 90% of all incidents by large mam-

mal pest species (Waithaka 1997). In Africa, 80% of elephant range lies outside protected areas (Taylor 1999) and responsibility for elephant management increasingly falls to local authorities. The widespread adoption of community-based natural resource management (CBNRM) schemes has simultaneously made elephants the most valuable and the most problematic resource in many wildlife-rich areas. The attitudes of rural communities and their relationship with wildlife are critical to the success of community-based schemes (O'Connell-Rodwell et al. 2000). In Africa, rural populations incur the primary costs of living with wildlife but receive few of the benefits (Barnes 1996; Naughton-Treves 1998), and their attitudes towards wildlife are frequently negative as a result.

A common approach to reducing the costs of living with wildlife has been the development by wildlife managers of problem animal control (PAC) strategies. Although many wildlife management authorities and conservation agencies have been involved in implementing conflict-reducing programmes, current measures only partially address the problem (Lahm 1996; AfESG 2001). Disturbance shooting continues to be the method that wildlife managers throughout southern Africa use, despite evidence to suggest that it has little deterrent effect upon crop-raiding elephants (Bell 1984; Osborn 1998). In addition, centralized units are unable to respond to the demand for their services at the peak conflict time during crop harvest (MZEP and Zambezi Society 2000).

Electric fencing can be a highly effective intervention (Thouless and Sakwa 1995), but the high costs of establishing and maintaining the fence make it unaffordable for most rural communities unless an international donor assists.

Communal farmers commonly resort to their own methods of deterring crop-raiding elephants. These include burning fires around the fields, beating drums and throwing missiles at approaching elephants. Farmers and wildlife managers in general, however, perceive these traditional methods as deterring crop-raiding elephants only minimally (Thouless 1994; Osborn 1998). At present, no single management option successfully deals with all problem elephant and conflict situations (Hoare 1999; Taylor 1999).

Over the past two years, the Mid Zambezi Elephant Project (MZEP) has been working with rural district councils and communities of the mid Zambezi Valley to develop appropriate, community-based methods for crop protection that are effective, use local materials, and enable rural farmers to tackle their own problems of conflict with wildlife.

In this paper we present the results of an experiment comparing the effectiveness of current and experimental PAC methods. We discuss the involvement of communities in selecting and evaluating deterrents. We explore the problems of assessing PAC in situ and make recommendations for developing PAC interventions in communal farming areas.

Study area

Lower Guruve District encompasses an area of 2700 km^2 in the mid Zambezi Valley in northern Zimbabwe (fig. 1). The Zambezi Valley (altitude 350–500 m) receives low rainfall (650–850 mm per year), which falls mainly between December and mid-March. There is a long dry season from April to November. The dominant vegetation is mopane–*Terminalia* and mopane–*Combretum* woodlands, with dense riverine thickets of mixed species along the major rivers. Agriculture is practised mainly in bands of colluvial soil along the Zambezi escarpment and in alluvial soils bordering the major rivers. Most farming is small-scale dryland cultivation, and the main wet-season crops include maize, groundnut and cotton. These rainfed crops are planted extensively in November and harvested between April and June.

The human population is expanding rapidly in response to a government resettlement scheme; the population increase is estimated to be 9% per annum. The elephant population is circa 3000 (Davies 1999) and is contiguous across the entire area. Human–elephant conflict occurs in distinct seasonal patterns; it is both chronic and predictable (Parker and Osborn 2001).

Materials and methods

We selected seven villages within the mid Zambezi Valley that experienced high levels of crop damage during the 2001 cropping season. Each village displayed similarities in the number of crop damage incidents, the number of homesteads and the area of cultivation. A series of participatory rapid appraisals were conducted by MZEP within these communities to identify key problems with elephant crop raiding.

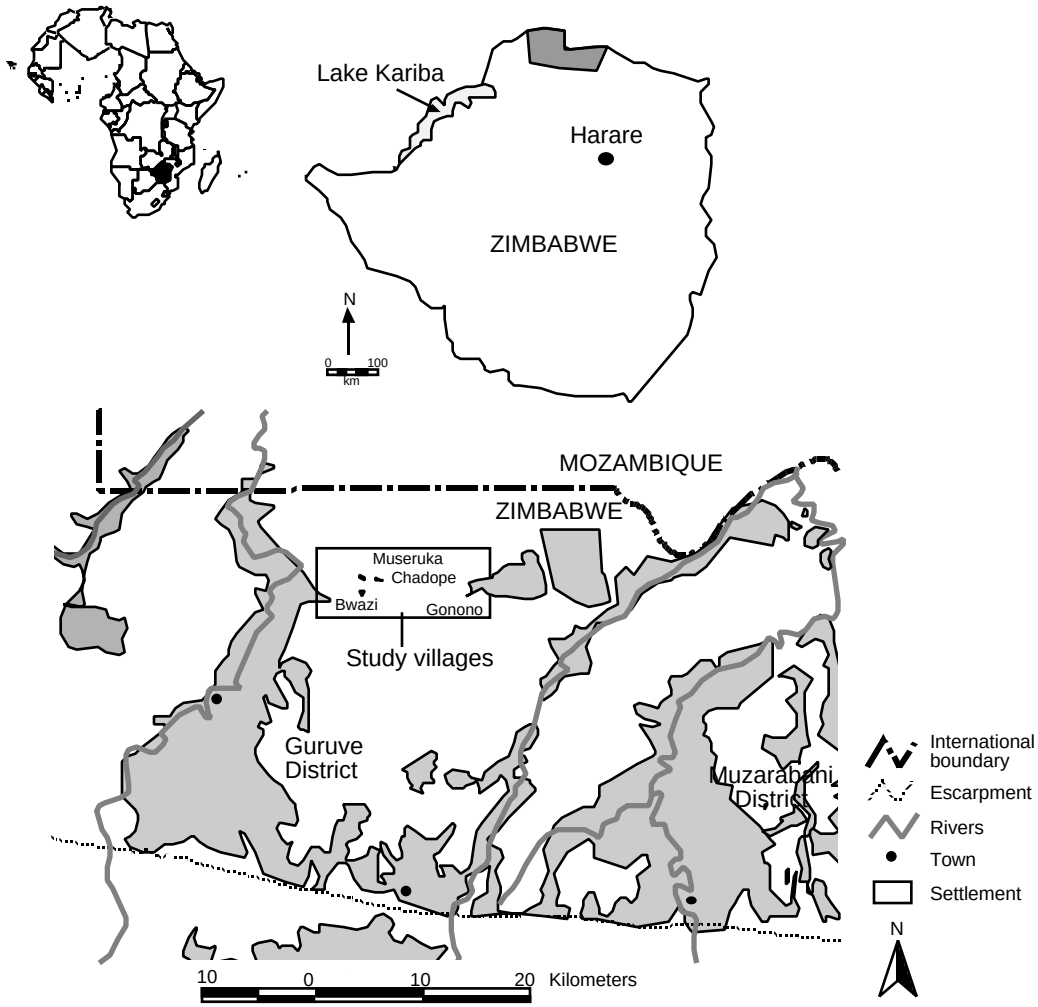

Figure 1. Map of the study area.

From these surveys it was ascertained first that farmers often could not detect when elephants entered their fields. Second, the traditional methods used to deter the elephants were ineffective.

The experimental methods that MZEP developed were therefore designed to increase the farmers' capability to detect crop-raiding elephants and to effectively chase the elephants away once detected. To improve vigilance, a 5-m buffer zone was cut between the edge of the fields and the surrounding woodlands. Within the buffer zone a fence was constructed comprising poles bound with thatching twine. Cowbells were attached to the fence to act as a warning system. If any large animal moved against the fence, the bells would ring. Active deterrents to chase the elephants away included locally made firecrackers and dry chillies, which were burnt in fires to produce an irritating smoke.

In three of the villages, experimental PAC methods were introduced (table 1). In the remaining four villages, traditional methods that farmers commonly used were employed, and these were considered the control plots. The traditional active methods currently being used by farmers included beating drums and throwing stones at crop-raiding elephants.

To establish the relative pressure of elephant activity in each village, the number of elephant incidents was recorded at every site. An elephant incident was described as a situation where elephants came to within 25 m of the edge of the fields.

Table 1. Passive and active, traditional and experimental problem animal control methods used

Method	Category	Description
Watchtowers	Passive traditional	Farmers with fields on the forest boundary built watchtowers at approximately half-kilometre intervals to increase their vigilance capacity.
Fires	Passive traditional	Fires were kept burning all night in areas where elephants came regularly. These fires were also used to burn pepper dung (see below).
Buffer zones	Passive experimental	Farmers were asked to clear a 5-m buffer zone around their fields (or in some cases along the edge of the whole village) to increase sightings of advancing elephants.
Cowbells	Passive experimental	Cowbells were placed at 30-m intervals along a string fence (see below) to alert farmers when elephants came to the fields.
String fences	Passive experimental	Farmers cut 3-m poles and placed them at 30-m intervals along the buffer zone. Bailing twine was strung between them and squares of burlap were tied at 5-m intervals along the string.
Beating of drums	Active traditional	Farmers beat on drums or metal objects when elephants approached the fields.
Throwing rocks with catapults	Active traditional	Catapults made of wood and rubber were used to shoot small rocks at approaching elephants.
Firecrackers	Active experimental	Farmers used firecrackers to chase elephants from the fields by throwing them towards the animals.
Dung and chillies	Active experimental	Farmers mixed elephant dung with ground chillies then sun-dried the bricks they made of the mixture. When farmers heard elephants in the bush, they burned these bricks along the field boundaries to create a noxious smoke.

Farmers set up passive systems before elephants approached fields and used active systems when elephants were either near or in the fields.

Three indicators were used to assess the effectiveness of the PAC systems. In each case, for each PAC method, enumerators recorded the time it took to repel elephants. Enumerators recorded elephant reactions to each type of method during crop raiding by noting the time an elephant entered a field, the time at which PAC began, and the time it took to drive the elephant from a field.

To measure the effect of alarm systems, enumerators recorded the number of occasions elephants entered the fields and the proportion of times they were detected by farmers. Figures were compared for villages with alarm systems and those without.

The overall effectiveness of the systems was assessed by quantifying crop damage in each of the study villages: how many incidents of crop damage occurred, and what was the total area of crop damage in each case. Crop damage incidents were monitored in all seven villages, six days a week, by eight local staff over the study period (1 January–30 June 2001). For each incident the total field and the area of damage were measured by pacing. The method followed is according to that described in detail in Parker and Osborn (2001). Inter-observer reliability of data collection by field staff was assessed throughout the season.

All data collection occurred in the fields at night during crop-raiding incidents. It was therefore impossible to attain clinical experimental conditions, and many confounding variables existed, including noise, smell and human presence.

Results

The number of elephant incidents within each of the

seven villages was found to be similar, ranging from 27 to 43, indicating that elephant pressure was similar in each village during the 2002 season.

Figure 2 shows that in the experimental (E) villages, crop damage was consistently lower than in traditional (T) villages. The smallest traditional value (T2) was compared with the largest experimental value (E2) using the Mann-Whitney U test, but there was not a statistically significant difference between the medians of the two data sets.

The effectiveness of four different problem animal control methods was tested, and the mean elephant reaction time to each method was compared (fig. 3). The mean reaction time of elephants to traditional (T) methods was slower than to the experimental (E) methods, and the difference was highly significant (Kruskall-Wallis K = 133, $p = 0.01$). There was no significant difference between the reaction times to the three experimental methods (U = 188, $p = 0.01$).

In the experimental villages with alarm systems, farmers detected elephants as they entered the fields 67% of the time, as compared with only 42% of the time when no alarm systems were implemented.

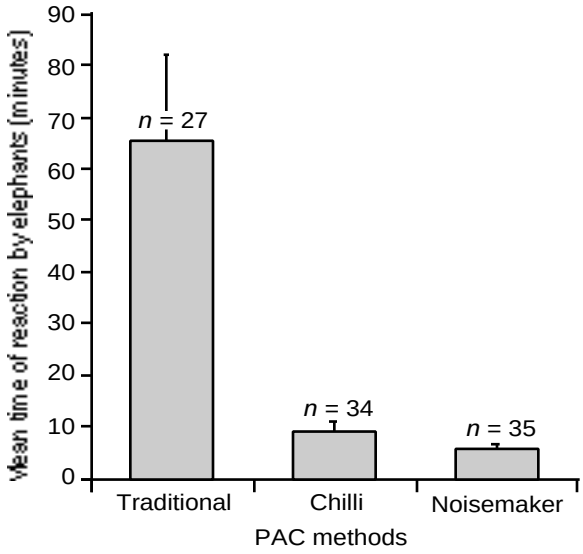

Figure 3. Mean reaction times of elephants to PAC methods. 'Traditional' refers to the methods outlined in table 1, 'chilli' refers to burning a mix of elephant dung and chillies.

Discussion

Elephants were deterred more rapidly by experimental methods of PAC than by methods traditionally used by villagers. This may, in part, be because elephants become accustomed to control methods to which they have been exposed for a long time, as noted in Kenya (Thouless 1994) and in Sumatra (Nyhus et al. 2000). To ensure long-term effectiveness, it is likely that farmers will need to continuously develop new deterrent methods to avoid eventual habituation. It seems more likely that elephants would ignore 'empty threats' such as fire and noise than the chilli-based methods, which inflict considerable short-term pain. This conclusion, however, is beyond the scope of this study.

The alarm systems clearly improved a farmer's ability to detect elephants, presenting the opportunity to deter them before they caused crop damage. This in part would explain the reduction in the number of incidents of crop damage and the overall area

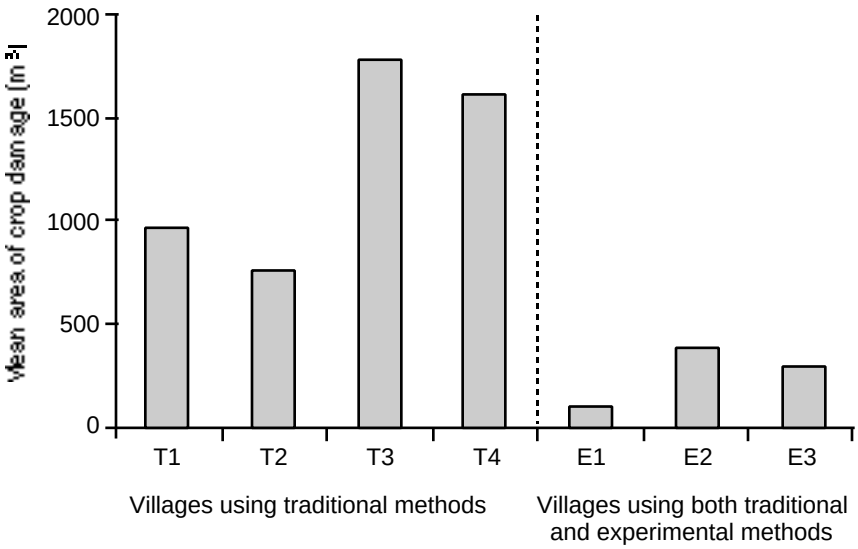

Figure 2. Mean area of crop damage. Crop damage is expressed as mean area of damage per crop-damage incident, in square metres.

of crop damage in the study villages where experimental PAC and alarm systems were employed.

In discussions with farmers MZEP found that warning systems also offered farmers a measure of security. They were more willing to spend the night in their fields if they knew they had sufficient forewarning of elephants approaching.

As an overall strategy the experimental PAC system was effective in limiting the area of crop damage. A combination of increased farmer vigilance and a new range of deterrents appeared to reduce the damage that crop-raiding elephants caused. Because of the limited replication of each treatment of PAC and the high level of variation in the data collected, the results from this study cannot be taken as conclusive evidence that experimental systems are more effective than traditional ones. Rather, the results indicate that this is likely to be the case. A complication of the experimental design was identifying villages with similar characteristics in which to work. In addition, when testing PAC methods, it was difficult to isolate the trials from external influences of noise and smell, and this in part may explain the high variation in results.

Identifying the methods that farmers found most effective was key to developing community PAC strategy. In evaluating potential methods farmers considered the effectiveness and practicality of each. Any methods developed need to be available and acceptable to the people using them. Crop defence is complicated and dangerous. Farmers may not sleep in their fields for a range of reasons, including fear for their lives, concern that their homesteads could be robbed while they were absent and risk of increased exposure to malaria (Hoare 2000; O'Connell-Rodwell et al. 2000).

Convincing farmers that they could take responsibility for their own crop protection was central to the success of this new approach for dealing with crop loss from elephants. Developing the tools that were inexpensive and easily maintained proved that it was not necessary to rely entirely on the central PAC units of the wildlife authority.

Methods need to be financially and technologically within the capacities of the people implementing them if they are to provide long-term solutions (Kangwana 1995). A village-based scheme not wholly dependent on outside intervention is seen as the option most likely to be sustainable in the long term, being both cheaper than donor interventions and more reliable than centralized interventions.

Several conservation implications emerge from these results. If farmers are able to address their elephant conflict problems, the adverse effect of the elephants upon farmers' lives will be reduced. This may be the first step towards redressing the cost–benefit imbalance that currently exists. In many CBNRM initiatives it is recognized that the responsibility of wildlife management has not been devolved to the community. Community-based PAC potentially can enable farmers to deal with their own issues, and shift the responsibility and blame for crop damage away from the local wildlife authority. Generally, wildlife authorities expend a great deal of resources on PAC with little net result. Effective community-based PAC will make additional resources available to tackle other pressing wildlife management issues.

The methods described here are not presented as a panacea for resolving human–elephant conflict. Rather they form a component of the growing range of methods and approaches that are required to mitigate this complex management problem.

Conclusions

The most effective PAC strategy combines a number of methods that make it difficult for elephants to enter fields, alerts farmers to their approach and gives them the ability to chase the elephants from their fields. The methods presented are effective, cheap and can be implemented by rural communities. For the methods to continue to be effective they will need to undergo constant adaptation while adhering to the technological and financial capabilities of a community. Evaluating the effectiveness of PAC methods is complex, as many confounding variables exist. Indicators may be used to measure comparative success, but treatment replications should be extensive. Implementing an efficient and affordable community-based system of PAC not only allows farmers to protect their own crops, but it also reduces the management pressures upon the wildlife authorities.

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References

[AfESG] IUCN African Elephant Specialist Group. 2001. *A decision support system (DSS) for managing human–elephant conflict situations in Africa,* by R. E. Hoare. IUCN AfESG, PO Box 68200, 00100 GPO, Nairobi Kenya. 104 p. Also www. iucn.org/afesg.

Barnes, R.F.W. 1996. The conflict between humans and elephants in the central African forests. *Mammal Review* 26(2/3):67–80.

Bell, R.H.V. 1984. The man–animal interface: an assessment of crop damage and wildlife control. In Bell, R.H.V. and McShane, T., eds., *Conservation and wildlife management in Africa.* US Peace Corps Seminar, Malawi.

Davies, C. 1999. *Aerial census of the Zambezi Valley.* WWF, Harare, Zimbabwe.

Dublin, T., McShane, T., and Newby, J. 1997. Conserving Africa's elephants: current issues and priorities for action. WWF, Gland, Switzerland. 28 p.

Hoare, R. 1999. Determinants of human–elephant conflict in a land-use mosaic. *Journal of Applied Ecology* 36(5):689–700.

Hoare, R. 2000. African elephants and humans in conflict: the outlook for co-existence. *Oryx* 34(1):34–38.

Kangwana, K. 1995. Human–elephant conflict: the challenge ahead. *Pachyderm* 19:10–14.

Lahm, S. 1996. A nation-wide survey of crop raiding by elephants and other species in Gabon. *Pachyderm* 21:69–77.

MZEP and Zambezi Society. 2000. *Elephant research and management in Muzarabani District and the mid Zambezi Valley of Zimbabwe.* Zambezi Society, Highlands, Harare, Zimbabwe. 22 p.

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

Nyhus, P.J., Tilson, R., and Sumianto. 2000. Crop-raiding elephants and conservation implications at Way Kambas National Park, Sumatra, Indonesia. *Oryx* 34(4):262–274.

O'Connell-Rodwell, C.E., Rodwell, T., Rice, M, and Hart, L.A. 2000. Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? A five-year case study in east Caprivi, Namibia. *Biological Conservation* 93(3):381–391.

Osborn, F.V. 1998. The ecology of crop-raiding elephants in Zimbabwe. Dissertation, University of Cambridge.

Parker, G.E., and Osborn, F.V. 2001. Dual-season crop damage by elephants in eastern Zambezi Valley, Zimbabwe. *Pachyderm* 30:49–56.

Sukumar, R. 1989. *The Asian elephant: ecology and management*. Cambridge University Press, Cambridge.

Taylor, R., 1999. A review of problem elephant policies and management options in southern Africa. HEC Task Force, IUCN AfESG, Nairobi.

Thouless, C. 1994. Conflict between humans and elephants on private land in northern Kenya. *Oryx* 28(2):119–127.

Thouless, C., and Sakwa, J. 1995. Shocking elephants: fences and crop raiders in Laikipia District, Kenya. *Biological Conservation* 72:99–107.

Waithaka, J. 1997. Management of elephant populations in Kenya—what have we learnt so far? *Pachyderm* 24:33–36.