

Albertine Rift  
Technical Reports  
Volume 1

# HUMAN-WILDLIFE CONFLICT



Identifying the problem and possible solutions

**WILDLIFE  
CONSERVATION  
SOCIETY**

**C.M. HILL, F.X. OSBORN & A.J. PLUMPTRE**

The WCS Albertine Rift Programme is working to conserve some of Africa's most biodiverse sites for the future generations of Africans and the global community. The Albertine rift stretches from the northern end of lake Albert down to the southern end of lake Tanganyika and encompasses the forests, savannahs, wetlands and mountains to be found in the rift and on the adjacent escarpment in Uganda, Rwanda, Burundi, Tanzania and Democratic Republic of Congo. This area of Africa contains 40% of all bird species and 25% of all mammal species on the African continent. Many species are endemic to this part of the world and it has been identified as being of global conservation importance by several global priority setting exercises (it is an endemic bird area, ecoregion and a hotspot). The Albertine Rift Programme focuses on three main goals:

- The provision of ecological information to enable protected area managers to better manage conservation sites within the region. We have focussed on undertaking surveys of most of the forests in the Albertine Rift to provide a baseline for future monitoring of populations, and to develop zoning plans that identify the core conservation areas within the forests based on biological criteria.
- Building capacity of African nationals to be able to use a scientific method in their approach to protected area management. Management can be thought of as a large experiment which requires monitoring and actions need adjusting in the light of the results of the monitoring. Management should focus on addressing threats to the protected areas and adapting management actions as threats change in importance. Training programmes have been developed with the Uganda Wildlife Authority, Office Rwandais de Tourisme et Parcs Nationaux, Tanzania National Parks and the Institut Congolais pour la Conservation de la Nature.
- Supporting management authorities to manage certain sites within the Albertine Rift through financial support for the basic operating costs, planning, training, monitoring and research programmes. WCS is committed to site conservation over long periods of time because it recognises the importance of long term support. WCS has supported Nyungwe Park throughout the civil war and genocide in Rwanda up to the present. WCS has also supported ICCN to manage Kahuzi Biega National Park and also supported Virunga National Park. WCS is also working with UWA, ORTPN, and TANAPA by providing training to support management.



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Section 1:  
INTRODUCTION



*The boundary between parks and people in Rwanda, A. Plumptre, WCS*

Crop raiding is a cause of much conflict between farmers and wildlife throughout the world. In Africa the great dependence of a large proportion of the human population for their survival on the land, coupled with the presence of many species of large mammal leads to many sources of conflict between people and wildlife. This in turn creates increasing friction between protected area managers, and local communities living in the regions that border these protected areas. In certain cases human-wildlife conflict is undermining what have been, to date, quite successful conservation programmes, such as the CAMPFIRE Programme in Zimbabwe (see Osborn & Parker, Appendix I). At a meeting of the Wildlife Conservation Society's Africa Program in 1997, human-wildlife conflict was identified by many present as one of the major threats to conservation, and one of the most difficult problems that conservation managers face in Africa.. At this meeting it was proposed that it would be useful to bring together experts in the field to share experiences and synthesise many of the lessons learned from crop-raiding research across Africa.

To date there has been comparatively little systematic research carried out to investigate patterns of crop raiding activity by wildlife and its potential impact on farmers' food and household economic security. The majority of the research that does exist has focussed on the issues related to crop damage by elephants and rodents, yet other animals such as primates, and ungulates, are often cited as troublesome 'pests' in agricultural areas. Unfortunately, much of the information that is available is 'hidden' within reports and papers, and not available in refereed journals. While there are numerous useful and informative reports to be

found in local Game Department or Ministry archives it can be very difficult to get hold of such resources unless one can visit in person. Thus, as more people begin to investigate human wildlife conflict at different sites, it is to everyone's advantage if there is greater sharing of information and expertise. Consequently, a workshop, funded by the Wildlife Conservation Society and hosted by their Cameroon Biodiversity Project, Nguti, was organized in January 2000 to:

- 1) facilitate the dissemination of results from research projects at different African sites,
- 2) highlight research priorities,
- 3) develop a guide to help protected area managers and researchers identify the problem and develop appropriate research strategies and methods for investigating human-wildlife conflict issues, and
- 4) Promote the development of linkages between researchers and managers, and encourage a future pan-Africa analysis of crop raiding, analysing the effects of farming practices, guarding strategies and hunting pressures on economic losses to farmers in different regions.

The range of expertise and experience amongst the participants was especially valuable in helping present a more comprehensive view of human-wildlife conflict issues, with particular reference to crop raiding by wildlife. The range of summary papers included in this publication (Appendix I) illustrates this. Authors provide examples of the range of different aims and objectives of human-wildlife conflict studies, from detailed social (e.g. Hill, Plumptre) and ecological studies (e.g. Ilukol, Rose) to outlining and evaluating monitoring strategies to assist in the management of human-wildlife conflict situations (e.g. Hoare, Kagiri, Nchanji, Osborn & Parker). It is apparent that while wildlife biologists, managers, and social scientists may have different research priorities and approaches, each approach has a valuable contribution to make in extending our understanding of different perspectives on human-wildlife conflict issues.

The workshop took place over four days, and individuals engaged in research and/or management of human-wildlife conflict issues throughout Africa were invited to attend. Participants, focussing on devoted the first day to presentations

1. the impact of crop raiders on farmers – crop losses and economics, and
2. the farmer's perspective.

These papers have been written up and included in the Appendix under three general themes:

1. The manager's perspective; 2. The farmer's perspective; and 3. Elephants – a special case.

After the presentations there was an opportunity for all the people involved to take part in a “brain-storming” session, to identify important issues for consideration when investigating crop raiding by wildlife. As a consequence of this initial exercise the following areas were highlighted for discussion during the remainder of the workshop:

- (a) Community factors associated with crop raiding by wildlife
- (b) The economic aspects of crop raiding and crop damage
- (c) Spatial and temporal distribution of wildlife crop raiding activities, and
- (d) Assessment of crop damage and identification of the animals involved.

Presentations given on the second day focused on issues related to ways of deterring wildlife from raiding crops, and facilitating conflict resolution. Participants then broke up into 3 groups to begin developing ideas of what a manager needs to know when trying to develop programmes to reduce human-wildlife conflict in the context of crop raiding. The three key areas for consideration were:

- 1) Local communities and the impact of crop raiding on food/economic security
- 2) Crop raiding activities of wildlife and the factors that render farmers vulnerable to crop damage by wildlife
- 3) The range of possible deterrence methods, and their effectiveness and suitability in different situations.

An important observation raised during informal discussions between participants concerned the frequent lack of compatibility between the information managers consider critical, when dealing with crop raiding issues, and the material that researchers are actually collecting. This can be a significant problem at a number of different levels within an administrative hierarchy, where research programs have been given permission to proceed by senior officials, but local managers, (i.e. the people who are required to deal with conflict issues in the field), consider themselves excluded from discussion of the suitability and value of the proposed research. Partly in response to this observation the penultimate day was given over to the issue of research methods, with a particular emphasis on (i) the type of information needed by managers to assess a conflict situation prior to the development of intervention strategies and (ii) appropriate data collection strategies for use in the field.

This document comprises summaries of all the case study presentations given at the workshop (Appendix I), a section on what managers and researchers should think about when planning to tackle this issue (Section 2) along with summaries of the outcomes of the different discussion groups (Sections 3, 4, and 5). Included within these sections are additional

discussions of various methodological issues such as possible biases in different types of information, pros and cons of applying absolute quantities to measures of crop damage, etc. The aim of this document is to provide researchers and protected area managers with (i) a better understanding of the issues that should be considered when investigating human-wildlife conflicts, (ii) an outline of useful research strategies and tools, (iii) an indication of the limitations of different research strategies and hence the resulting data, and (iv) to encourage better communication and consultation at all levels in negotiation between management needs and research aims and objectives.





## Section 2: ISSUES TO BE ADDRESSED



*A farmer's hut destroyed by elephants, F. Osborn, WCS*

### **What a manager needs to know**

It is important that anyone responsible for assessing or managing a human-wildlife conflict situation knows exactly what the important issues are locally, how far they extend geographically and temporally, and what portion or group within the local population are affected, or consider themselves to be at risk. In order to target an intervention it is vital that there is a good understanding of the problem at hand. Often attempts are made in the case of crop raiding to reduce the damage levels when actually this is not the real problem that needs to be addressed. More specifically, it is vital that the following types of information be readily available prior to implementing any conflict reduction/resolution strategy.

- I. The type of problem that exists, i.e. are people suffering (or claiming to suffer) crop losses, damage to property, or potential damage to and loss of human life?
- II. A good understanding of the actual problem. For example people may complain about losing crops to wildlife yet it is not so much crop damage that is the issue as their fear of the particular species they claim is causing the damage. Elephants are complained about more frequently and more vociferously than other species, yet they are sometimes not the species that causes most damage to a crop (Naughton-Treves 1996). People complain about them so vehemently because they fear them more than other animals. A not dissimilar situation is observed in the case of some nocturnal raiders such as wild pigs. Here the problem may be that people fear them; alternatively, the inconvenience of guarding at night, or fear of the bush at night, may be important factors that render people especially likely to complain about these

animals, even when they cause comparatively small amounts of damage (Hill; Nchanji, Appendix I).

- III. Detailed and accurate information as to the extent of the problem. For example are all people equally affected or are some, perhaps by virtue of their farm location in relation to natural habitat, more vulnerable to damage by wildlife (Hill 1997); (Hill 2000); (Naughton-Treves 1998); (Plumptre and Bizumwuremyi 1996)? Is the problem seasonal or year round, and which particular wildlife species are involved?
- IV. Knowledge of the degree to which people's perception of risk of crop loss reflects their actual risk of crop damage. Information of this sort may well prove vital when trying to understand when and why people's complaints may appear to exaggerate the situation.
- V. What are the possible options with respect to intervention and trying to reduce human-wildlife conflict? The spatial distribution of farms, the species of wildlife in conflict with people, the scale and distribution of the problem, the degree of financial and technical support available, and the willingness of local people to input resources into reducing conflict, are all important considerations for any manager trying to alleviate the problem.

### **The level of detail**

Other factors that are important when considering studies/investigations of crop raiding issues are (i) the purpose behind the particular piece of research, and (ii) the scale at which data are collected, i.e. at the national or district level, or at the level of the individual farm for instance. These factors will determine the level of detail required from an investigative program. Those responsible for planning intervention strategies are generally more likely to be concerned with information pertaining to the community level. However, on occasions it may be beneficial or even vital for them to have access to very detailed localized information collected at the level of the individual farmer/household. For example, information about the relationship between the spatial distribution of crop damage events and Protected Area (PA) boundaries may be essential when devising cost effective management strategies, yet to obtain accurate information of this nature may require very detailed monitoring at the level of individual farms and farming households. It is also important for researchers and managers to remember that information from key informants may not necessarily be representative of the whole community or even the section most severely affected by wildlife. Consequently, it is critical that researchers and managers recognise the limitations of the methods they use to

obtain information, and thus any shortcomings of the data they collect and employ to determine intervention policy and practice.

### **The types of questions to be asked**

The reason behind the research will determine

1. the particular avenues of investigation that are of significance in any instance
2. the types of data needed, and
3. the most appropriate methods for obtaining those data.

Inevitably factors such as time, logistics and financial constraints will also need to be factored in when making the final decisions about the exact details for any study.

Once the focus of the study has been identified then the types of information required will become clear. Areas for consideration include:

1. Community related factors such as socio-economic information, village residential patterns, local farming and land tenure practices, and the role of agriculture in local subsistence strategies, the particular human-wildlife conflict issue(s) as perceived by the farmers, whether people take any action to reduce the impact of wildlife on their livelihoods, and do they utilize species that crop raid?
2. Crop losses, including which crops are most vulnerable, their role in local food security, and the extent of the damage they sustain. Additional information about the species responsible, and their conservation status is also important.
3. Wildlife, including the species perceived as being problematic, and their conservation status.
4. Deterrence, including methods of reducing crop losses already in use and alternatives that might be introduced/adopted, and the presence/absence of local community management structures that might be used to implement monitoring and deterrence strategies if appropriate.

### **Why a combination of approaches is necessary**

Social scientists and wildlife biologists ask different research questions. While social science is likely to look at crop raiding from the farmer's perspective, wildlife biologists are often more concerned with crop raiding and its consequences vis à vis conservation from the perspective of the animals concerned. Both perspectives are valid and both are important.

Human-wildlife conflict involves both humans and wildlife; therefore we need to have a comprehensive understanding of the issues at stake. In order to obtain the necessary information to fully assess a situation it is appropriate to consider the conflict circumstances from a number of different perspectives. It may not necessarily be adequate, or appropriate, to concentrate just on devising techniques for deterring animals from raiding crops. Any such intervention must be acceptable to the farmers themselves as well as effective and affordable, thus it may be advantageous for researchers investigating crop protection methods to have some understanding of local social systems, labour divisions and constraints, gender roles, and land and crop tenure systems, when designing deterrence strategies. For example, farmers in Zimbabwe have been reluctant to adopt electric fencing patterns whereby individual household crops are fenced, yet this was shown to be the most effective pattern to adopt against crop raiding elephants. Instead it was more acceptable to local farmers that farms be communally fenced, rather than individuals be fenced separately (WWF, 1998; 2000). An understanding of how people locally view an individual who sets themselves apart from the rest of their community might help explain why in this case the most effective strategy was not acceptable to these farmers. A further example relates to a suggestion in the literature that farmers need to increase the time they spend guarding to help protect crops against wildlife, and particularly primates (Strum 1994). This is not necessarily practical for many households who may already be facing labour bottlenecks. Both these examples illustrate the point that what might seem like an appropriate intervention strategy to researchers may not necessarily be acceptable or practical to the particular community or individuals in question, thus there is a very real need to consider human-wildlife conflict issues within the context of local community and individual needs as well as conservation objectives.



### Section 3: MEASURING CROP LOSSES



*Crop loss in a field visited by elephants, F. Osborn, WCS*

#### **Introduction**

Once a conflict situation has been identified, a manager needs to assess the farmers' perception of the problem, and the actual crop loss, in order to develop an intervention strategy. It is important to identify which species are damaging which crops, and when and where crops are damaged. A researcher can easily create a very detailed study of crop loss that does little to provide a manager with the information needed if care is not taken to select the correct details. Initial consideration should include an assessment of the following:

- I. The amount of detail needed for a crop damage assessment study must be decided within the restrictions of budget and logistics. The minimum amount of data needed to understand the situation should be the baseline. For example, the micro-scale study of a village may require assessments of a few fields in some detail. If one is looking at a macro-scale level, such as the damage in a large administrative area, a broad overview with little detail may be more appropriate. (compare Nchanji with Hoare in Appendix I)
  
- II. What useful information should the researchers collect? The date, location, pest species and a simple measure of damage may be enough. However, in some cases more data need to be collected. Information about spatial and temporal patterns of crop damage, the type of crop(s) involved, area of standing crop damaged or the number of plants damaged relative to the size of the field, and/or an estimate of the monetary losses as a consequence of crop damage may well provide valuable information for researchers and managers alike,

depending on the purpose of the investigation. It is important to have a good idea of how the information will be used by managers before it is collected.

- III. What are the practical constraints on the study? Questions such as how often are researchers able to get to the conflict areas and when should they make their visits, need to be addressed. Other factors for consideration include: budgetary constraints and their implications for methods to be used, the need for provision of training and supervision for enumerators, need for and availability of transport to study sites, etc.
- IV. Will the crop damage survey include a socio-economic component (see Section 4: The Farmers Perspective, pg. 24), and will the assessment be linked to a future intervention?

### **The types of question to address**

The type of information and degree of detail needed in any investigation is dependent on a number of factors as outlined above.

#### *Patchiness of crop-raiding*

Whilst basic information must be collected, there is scope for gathering much more detail, to determine frequency of raiding events by particular species at any given location, and whether raiding is frequent, intermittent or limited to a particular season. Such information can be very useful when trying to determine (i) the severity of crop raiding locally, and (ii) whether more intensive use of particular protective measures at specific times of year might significantly reduce crop losses. Additional information about where potential raiders are coming from (e.g. PAs, forest patches or resident in farmland) is also useful when planning/investigating the construction of physical barriers such as fences, walls, hedges or ditches. If animals are coming from an identifiable location it may suffice to create a barrier between the habitat refuge and cultivated areas (See Biryahwaho, Appendix I).

#### *Importance of crop raiders to farmers*

Farmer's ranking of crop raiding species may also provide some preliminary information to help explain why particular constituents of a conflict situation are considered worse than others. This information can contribute to (i) identifying key species for intervention programmes to focus on, and (ii) explaining why crop raiding is often perceived by many to be a significant problem, even where the reality is that only a relatively small portion of the local population are at risk.

*Importance of crop species to farmers*

Just knowing that farmers are experiencing crop losses due to wildlife raiding may not necessarily give adequate information to determine the impact on local communities or individuals. Data on which crops farmers consider most important to their household, either as sources of food or because they are cash crops, help explain why even relatively small amounts of damage, to certain crops, aggravates farmers considerably, yet they will apparently tolerate quite extensive damage to other food crops (Hill, personal observation)<sup>1</sup>.

It is important to record the type of crops damaged and to measure which crops are considered most valuable and why. Likewise, a farmer's ranking of their crops with respect to their vulnerability to crop damage can provide very insightful information. Aside from giving the researcher more information about the potential vulnerability of different crop species to different kinds of damage such ranking can also help to indicate the value of different crops to different households. There may be occasions where farmers' ranking of crops does not coincide with the ranking according to actual amounts of damage experienced during a monitoring season. This may result because (i) farmers do not 'see' certain kinds of damage, i.e. that caused by small animals or domestic animals for instance, or (ii) that particular crop is not considered an important one in the context of household economic security or (iii) the crop in question is a "women's crop" - if the interviewee is male then they may be inaccurate in their information through lack of knowledge, or interest perhaps, and if one was to speak to a female respondent one might get a very different picture. Such information can help clarify why farmers (i) make the decisions they do, and (ii) may sometimes appear to complain about situations that are not necessarily especially problematic from an outsider's perspective.

*Stage of crop damage*

A consideration of the particular stage of plant growth vulnerable to damage by wildlife may also be useful. For example, bushbucks are known to feed on young bean shoots and may virtually clear a newly sprouted bean stand in a night. However, because the damage occurs early on in the growing season, the farmer is able to replant the field, having first fenced it, and still get a bean crop with relatively little extra work, thus bushbuck damage to beans is not rated as particularly problematic even though the damage can be extensive (Hill 1997). Extensive damage at a later stage in the plant's developmental cycle may well prevent a farmer from gaining any harvest, whereupon the situation becomes much more

<sup>1</sup> On several occasions quite extensive damage to pumpkins, tomatoes and other fruits in gardens in Nyabyeya Parish, Uganda, was observed, yet this was often not reported to the researchers during farm visits and was only mentioned after extensive questioning by the interviewer.

costly/problematic for the farmer. The stage at which damage occurs, and the potential impact it has on final crop yields, has significant implications when trying to quantify crop losses.

*Where crops are planted*

Information about the spatial distribution of crops within a field may also be valuable when considering possible intervention strategies such as the use of buffer crops or placing particularly vulnerable ones furthest away from the raiders' point of entry to the field, or closest to the guard hut, family house (see Osborn & Parker, Appendix I).

*Farming calendars and timing of raiding events*

In some situations it may be beneficial to draw up a calendar of the farming year, taking into account the timing of various labour-intensive activities such as clearing land, planting, weeding, guarding and harvesting, and preparing crops for storage, along with information about which household members are employed in each task. This information can be used to avoid creating potential labour bottlenecks in possible intervention developments. For example, it has been proposed in the primate literature that farmers might intensify their guarding activities during periods of peak conflict, such as just prior to the maize harvest. Whilst this may be a very suitable recommendation for specific sites, in other areas it is not a viable option because people are already working extremely hard at this particular time, and may be guarding fields at night as well as during the day. It is important to separate the information by sex and age of respondent also. Women and children are often responsible for most of the guarding against diurnal species such as squirrels and various primate species. Baboons, which are often cited as problem species, usually show very little fear of women or children and may threaten them to the point where the people guarding flee from the raiders (Hill, personal observation). Thus women and children appear to be less effective guards for these animals as compared with men. Such data can therefore provide valuable additional material, which is pertinent when developing or advising people on more effective ways to protect their crops.

*Estimate quantity of crop loss*

In certain situations it may be appropriate to make estimates of crop losses in order to assess the extent of crop damage occurring. There are a number of different quantities that can be estimated/measured (See Table 3.1 for details). However, all researchers should be aware of the methodological problems in getting accurate data of this kind, and should take time to



consider the likely sources of error in such data and how to minimise them prior to beginning data collection (Further discussion of this and associated issues can be found on page in the next section.

### **How to collect the data**

There are a number of different data collection strategies that can be used when investigating crop damage. Data can be obtained directly from farmers, where farmers are asked to give information such as the species of animals that damage their crops, estimates of the amount of damage caused, and frequency of damage events. These data can be collected retrospectively from farmers, i.e. by interview or questionnaire, or farmers can be asked to keep records of damage events as they occur. One advantage of making farmers the primary source of information is that it can reduce the costs associated with data collection, removing the need to employ full-time enumerators at the study site. However, there are also problems associated with such a strategy, namely the potential lack of objective reporting/recording of information (see below for a more detailed discussion).

Alternatively, trained enumerators can be employed to collect information from farmers, and make independent measurements of crop losses, identification of the species causing the damage, etc. This has the advantage of producing information that is likely to be more objective but, as mentioned above, will add to the monetary cost of the exercise because enumerators have to travel to and from the study site, or be provided with accommodation on site.

**Table 3.1: A summary of the types of information that might be useful in any investigation of crop damage by wildlife.**

	<b>Information to be collected</b>
<b>General information</b>	<ul style="list-style-type: none"> <li>• Date</li> <li>• Location</li> </ul>
<b>Animals</b>	<ul style="list-style-type: none"> <li>• Species causing damage (including domestic animals)</li> <li>• Timing of raiding behaviour, i.e. diurnal/ nocturnal?</li> <li>• Frequency of raiding (i.e. do animals come daily, weekly, only occasionally etc?)</li> <li>• Where do wildlife species come from, i.e. are they moving out specific areas such as Protected Areas (Pas) to enter fields or are they living in and around fields?</li> <li>• Farmer's ranking of raiding species, i.e. species ranked from 'most' to 'least' troublesome sp. (sometimes useful to know something about the reasons why individuals rank a particular species as 'most troublesome')</li> </ul>
<b>Crops and farming strategies</b>	<ul style="list-style-type: none"> <li>• Location of farm,</li> <li>• Description of surrounding vegetation and habitat type(s)</li> <li>• Distance from village/house to farm</li> <li>• List of main crops grown by farmer(s)</li> <li>• Types of crops damaged by wildlife/domestic animals</li> <li>• Quality of crops damaged (i.e. quality prior to damage event)</li> <li>• Other crops present but not damaged</li> <li>• Plant part(s) damaged, e.g. root/tuber, stem, leaves, flowers, fruits etc.</li> <li>• Spatial distribution of crops within fields/farm, with particular reference to their location with respect to Protected Area (PA) boundaries, boundaries with un-cleared/fallow land, riverine forest, etc., i.e. potential wildlife refuge areas</li> <li>• Whether neighbouring fields/gardens were raided</li> <li>• Brief outline of the agricultural calendar e.g. timing of planting, crop protection, harvesting etc.</li> <li>• Farmer's ranking of crops i.e. crops ranked from 'most important' to 'least important' (may also be useful to know why particular crops are ranked as important e.g. household food crops/cash crops etc.)</li> <li>• Farmer's ranking of crops with respect to their vulnerability to crop damage by animals</li> </ul>
<b>Impact on farming households</b>	<ul style="list-style-type: none"> <li>• Measure of crop losses <ul style="list-style-type: none"> <li>- farmer's estimate of crop losses (either as area lost or kgs lost)</li> <li>- independent measure of area of standing crop damaged</li> <li>- independent measure of no. of plants damaged/total no. plants (giving the percentage damage incurred)</li> <li>- conversion of area of crops damaged to kg/ha crops damaged</li> <li>- Economic losses</li> </ul> </li> </ul>

### **Farmer estimates versus independent measurements of crop losses**

A number of studies have recorded farmers' or protected area personnel's estimates of the frequency of raiding events by different animals. Similarly, some studies have asked farmers to rank animal species from 'worst' to 'least' troublesome. There are a number of problems with these methods of collecting data (without using additional sources of information to cross check the information) if one is looking for a way of determining accurately how frequently particular animals visit fields, or which animals cause most damage. It is important to bear in mind that informants are not necessarily intentionally giving what amounts to false information. People's perception and memory can be influenced by a number of different factors, and particular events may take on a greater significance in retrospect. To further illustrate this point some studies have used farmer estimates of crop losses, looking at either the amount of crops lost, and/or the monetary value of those crop losses. Where these studies have combined this with an independent assessment of crop losses by the researcher(s) it has become apparent that farmers tend to overestimate their losses by as much as 30-35%. Again, this is not to say that farmers are necessarily inflating their estimates intentionally – aside from the issue of potential compensation – but rather that (i) it can be difficult to estimate accurately in retrospect (simple 24 hour nutritional recall studies give ample evidence of that) and (ii) something as emotive and important to a farmer as crop loss is likely to be a conspicuous and therefore highly significant event, which may well influence their perceptions and thus their accuracy when estimating amounts/values of losses.

It is important to stress here that information from farmers and other stakeholders is not necessarily unreliable and inaccurate. However, such information, as with all data, has to be handled and interpreted appropriately. Having accurate, longer term, knowledge of the situation will enable crosschecking of information and add considerably to the value and usefulness of such results.

### **Putting a quantitative value to crop losses – some possible problems**

Measurement of actual crop losses is potentially both difficult and controversial. Aside from the problems of how to collect data on crop losses there is also the problem of determining what to measure, and therefore whether measures of losses are comparable from study to study or site to site. To put crop loss in perspective, it is useful to compare measures of crop damage, but there are some potential problems. Firstly, how accurate do the measurements of crop loss need to be? Any one who has tried to collect this information is well aware of how

difficult it can be to collect accurate information, and how data collection can be rife with sources of error! Yet, once there is an actual quantitative figure used to describe crop losses, or a monetary value placed on the loss, then this is often used by managers or local communities with an unrealistic sense of accuracy.

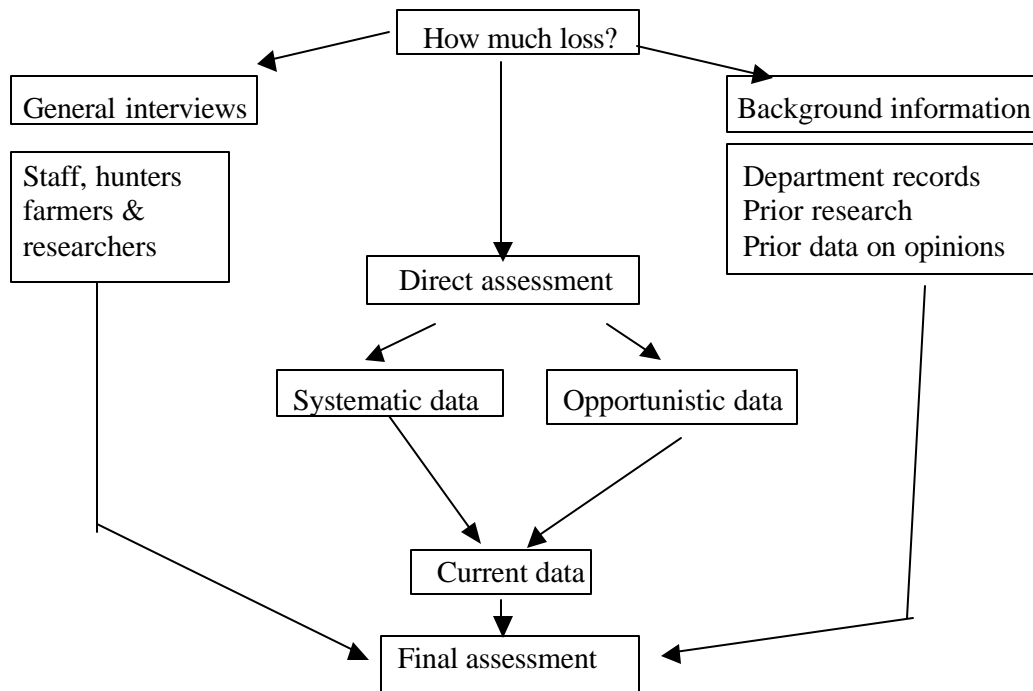
Secondly, different studies make different measurements – some convert an area of loss to an estimate of kg/ha lost – others may present the average percentage loss per field, or the average percentage loss per damage event, or even the overall mean annual percentage loss. It can be difficult to determine whether these figures are comparable or not. Certainly a greater degree of clarification of the exact measures used, and how they have been manipulated by the researcher, would be beneficial when trying to decide whether results across studies are comparable or not. In addition, perhaps some standardisation of methods of data collection and data handling are needed.

Within some of the studies that make use of quadrat techniques for sampling crop losses there appears to be the assumption that all areas within a field/crop stand are likely to be equally affected, therefore any mean percentage loss can be extrapolated to the entire area under that crop. However, case studies have demonstrated clearly that crop raiding wildlife generally only travel a certain distance from a protected area in their search for crop forage, thus it is important to take this into account when extrapolating rates of damage from one area of a field to another, otherwise estimates of crop losses/ha are likely to be unintentionally inflated. In addition, different farmers have different planting strategies. For instance the farmers around Budongo Forest Reserve, Uganda who, on average have small land holdings, tend to plant more than one stand of important staple crops in any one growing season (reasons given for this are that it reduces the risk of suffering high losses through wildlife, insects, disease and variable soil fertility) (Hill 2000). This is not an unusual planting strategy for small-scale farmers in tropical regions but it is not always apparent that this is taken into account when people are calculating the percentage crops lost – so again, losses may unintentionally be inflated. Where such values are extrapolated to the village, community, or district level, there needs to be some factoring in of differential risk across different farms.

Measurement of crop loss can also be a problem from the point of view of distribution of compensatory revenue from sources such as PA gate returns. Ugandan farmers are well aware of this, and express concern about the fact that any benefits that might accrue from living alongside wildlife (e.g. profits from local community run tourist wildlife viewing

facilities) will go to local institutions for the benefit of all people, yet it is only certain individuals that bear the actual costs of living alongside these animals, i.e. those farmers at the forest edge in effect buffer their colleagues farming more central regions (Hill 2000). This is an important issue (Western 1994), particularly when thinking about possible alternatives to traditional forms of compensation scheme.

**Figure 3.1: Flow chart of the different types of options for a researcher to develop a crop damage assessment and monitoring scheme**



### Setting up a crop damage monitoring scheme

The flow chart (Fig. 3.1) outlines some of the questions to be asked when setting up a monitoring programme. Firstly, how much loss is there? There are three main areas for collecting data; (i) through general interviews, (ii) direct assessment and (iii) background information. A combination of all three can give the best basis for developing an intervention. General interviews with PA staff, hunters, farmers and researchers give a sense of the current opinion among people interested in the conflict situation. Conducting a direct assessment either through collecting systematic data (e.g. standardised data sheets and pre-selected farms) or opportunistic data (e.g. reports by farmers/researchers) are the most reliable sources of information. Background information adds an historical context to the study. These sources of information will then guide a manager towards a final assessment of the questions to be asked regarding crop loss.

### **Summary**

Methods need to be tailored to the objectives of the crop loss assessment scheme. Outputs should translate easily into management goals. Data should be handled and interpreted appropriately, and having longer-term knowledge of the situation enables cross-checking of information and will therefore add considerably to the value and usefulness of such results.

Generally, the available literature presents information from case studies. These are potentially very useful, but they would be even more useful if one could compare information directly from site to site. This would enable one to determine what kinds of features are likely to be site-specific (e.g. particular cultural practices, perspectives or beliefs), which features, if any, might be habitat or species specific, and whether there are any general factors that are pertinent at most or all sites of farmer-wildlife conflict. It is important to carefully document the methods used when writing reports on crop-raiding research so that it is clear which measures have been made.



## Section 4: FARMERS PERSPECTIVE



*Woman removing beans from pods, Uganda C. Hill, Oxford Brookes University*

### **Introduction**

To understand exactly how particular types of human-wildlife conflict impact on people's lives we need to understand something of what that situation means to those individuals. Documented studies of wildlife crop raiding activities give some idea of the degree of loss farmers are likely to experience, but few studies have explored in detail exactly what this loss really means to farmers. Even where crop losses appear to be low, particularly for the community as a whole rather than the individual (Hill 2000; Moses, Appendix I; Naughton-Treves 1996; Nchanji, Appendix I), farmers can still express great concern about such losses, and may register many complaints to local wildlife authority personnel. Some of the studies in Appendix I quote damage levels that would be considered acceptable losses within highly mechanised farming systems, i.e. approximately 10-15%. However, when trying to understand why crop raiding by wildlife is considered to be such a vital issue by farmers it may, in some situations, be necessary to consider the losses experienced by individuals as well as the average losses experienced within different communities (See Hill, Appendix I, for further discussion).

Recording absolute levels of crop losses by individual farmers or communities will not necessarily adequately explain what those losses really mean to individual farmers. Where individual researchers have probed more deeply it has become apparent that the issue of crop raiding is sometimes conceived as part of a wider issue that people are concerned about, such as their loss of 'ownership' of wildlife to the State (Naughton-Treves 1999) and/or lack of control over resources or particular aspects of their lives (Hill, Appendix I). A further related issue is the fact that many communities appear to tolerate significant levels of crop damage by

domestic animals yet are very intolerant of smaller losses to wildlife (Hill 1998; Naughton-Treves 1996). Why should this be so? Naughton-Treves demonstrated that in some cases farmers around the Kibale Forest National Park, Uganda, actually experienced greater crop damage by domestic animals than they did from wildlife, yet the farmers' complaints focussed on wildlife activity (Naughton-Treves 1996). There are many reasons why this might be so, not least the fact that domestic animals are an important asset to local households. Domestic animals can be used for food but, more importantly, they act as a 'savings account'; people gain interest through the birth of young, and the accumulation of animals not only helps people pay for weddings, funerals and school fees, but it also provides a degree of security against seasonal shortfalls in agricultural productivity and other, unforeseen, eventualities. This example illustrates the point that to understand such issues, the whole question of crop raiding and crop losses needs to be considered within the appropriate social and cultural framework, as well as within an ecological and economic context.

There are often local mechanisms for obtaining compensation for crop loss by domestic animals. For example, in Uganda the Village Council impounds the offending animal and the owner required to pay compensation to the person who has suffered crop damage (the level of compensation being determined by the Council). If the animal's owner cannot, or will not, pay, then the animal is sold, compensation is paid to the claimant, and any remaining monies returned to the animal's owner. Interviewees from Nyabyeya Parish, Masindi District, Uganda, claim that the Government is not a good 'neighbour'. It 'owns' all wildlife (the Government is seen to own wildlife because it legislates as to what people can and cannot do in relation to wildlife) yet does not behave like a responsible owner, either by 'controlling' the actions of its wildlife (i.e. preventing wildlife from entering farming areas) or paying compensation for crop damage caused by that wildlife. Evidence here suggests that when farmers complain about wildlife causing damage to crops the issue is not just about the degree of damage they experience – they are also making a statement about the fact that they consider that by no longer having the legal right to hunt they have (i) lost access to a valuable resource (wild meat) and (ii) have lost the right to adopt a method of controlling crop raiding species that they consider effective (Hill, Appendix I).

There are various factors that may help identify areas where interventions should focus or which could help explain why crop raiding is such an emotive issue. For instance, whole communities may express great concern about the impact of wildlife on agriculture, yet only a few individuals within that community actually suffer regular or extensive damage to their



crops, i.e. people's perception of risk may not necessarily match the actual risk of crop losses to wildlife (Hill 2000). Additionally, there may be many serious complaints about particular species yet when the situation is investigated systematically it becomes apparent that those species do not necessarily cause the most damage (Naughton-Treves 1996). Understanding the context in which crop raiding is occurring may help to explain why people complain about particular species, even when those species may not be a major source of crop loss. For example, complaints often focus on elephants and other large bodied animals yet smaller, less dangerous species such as baboons and cane rats may well cause more damage (Hill 1997; Naughton-Treves 1996; Njchanji, Appendix I; Plumtre, Appendix I). While it is certainly important to understand the context in which rural people consider crop raiding to be a problem it is also crucial to remember that central to any intervention is the aim to improve livelihood security rather than just stopping crop raiding by wildlife (Osborn & Parker, Appendix I).

It is vital to understand the social context in which crop raiding is occurring, because crop raiding *per se* may not be the 'real' issue. Instead it may be used by people as a means of expressing their distress or dissatisfaction with a separate or related issue, e.g. the removal of access to particular resources, having to live alongside animals that are perceived as dangerous to people, such as elephants and buffaloes, or losing their autonomy in certain spheres of life (Hoare 1995 Hill, Appendix I; Plumtre, Appendix I).

By understanding the social context within which these complaints are made we gain a more comprehensive perspective on the issues at stake, facilitating the development of appropriate intervention strategies. Thus by understanding how people view a particular human-wildlife conflict issue one may be able to explain more fully why people act the way they do, thereby providing valuable insights into locally acceptable and effective control strategies.

### **The types of questions to address**

#### *Social context*

To understand the human dimension to crop raiding by wildlife it is essential to have a good working knowledge of the particular type of conflict within the local cultural, socio-demographic, political and economic context. Data on local land use strategies and tenure systems, gender roles, farming systems, and people's dependence on agriculture for subsistence will supply a social and economic context for understanding the impact of crop damage by wildlife.

Information about farmer's responses to wildlife that crop raid, their understanding of and compliance with wildlife laws, and their expectations of any intervention programme are useful when trying to contextualize the importance of human-wildlife conflict issues for rural communities. Knowledge of how people view a particular issue can help explain why those issues can suddenly become conflict issues to be dealt with by outsiders, when previously they were regarded as part of the normal agricultural cycle, eliciting specific and appropriate responses from within the local community. Identifying whether local people are using their apparent concern about crop raiding to express dissatisfaction with changing access to natural resources, government, or local political institutions, for instance, would be crucial for management intervention design (Hill, Appendix I; Naughton-Treves 1999).

The types of question that should be addressed in any study of the social context to crop raiding are summarised in Table 4.1. While this is not a definitive list of areas to be investigated it represents a set of key issues that participants at the workshop considered central to understanding the social context of crop raiding within rural African communities.

It is a mistake to assume that communities are homogenous entities. Not all members of a community have the same needs and concerns, thus information connected with gender issues such as division of labour, and responsibility for and ownership of crops, is vital for identifying which sections of a community should be consulted when developing appropriate intervention strategies. For example, knowledge of the local farming calendar yields useful information about potential labour bottlenecks, again an important issue when designing realistic intervention strategies.

**Table 4.1: A summary of the types of information needed to investigate the social dimension to crop raiding and crop damage.**

	Examples of possible areas for exploration
<b>Social Context</b> – background information about the affected communities	<ul style="list-style-type: none"> <li>• Local land use strategies and population densities</li> <li>• Land tenure systems</li> <li>• People’s degree of dependence on agriculture for subsistence</li> <li>• Men and women’s responsibility for, access to, and control of various resources such as land, cash, and crops</li> <li>• Local beliefs and taboo systems as regards wildlife</li> <li>• Traditional institutions for controlling crop raiding</li> <li>• National law and government policy with respect to wildlife, land and conservation issues</li> <li>• Local knowledge of wildlife laws and conservation issues.</li> </ul>
<b>Farming practices</b> – details of farming systems adopted locally (See Section 3. Measuring Crop Losses, pg. 18-20)	<ul style="list-style-type: none"> <li>• Farming cycle i.e. planting and harvesting times</li> <li>• Types of crops grown</li> <li>• Uses of, and value of, different crops to households, i.e. which are for household consumption, ‘famine’ foods, cash crops etc.</li> <li>• Location of farms in relation to human habitation, Protected Area (PA) boundaries, etc.</li> </ul>
<b>Human-wildlife conflict – the facts</b> (See Section 3. Measuring Crop Losses, and Section 5. Conflict Resolution)	<ul style="list-style-type: none"> <li>• The natures of the conflict, i.e. crop losses, damage to property, threat to human life, etc.</li> <li>• Presence/absence of crop damage by wildlife and the species thought to be responsible for crop losses (domestic animals should also be included here)</li> <li>• The number of households affected locally</li> <li>• Local perceptions of the severity of damage</li> <li>• Details of any measures taken to protect crops against damage by wildlife and/or domestic animals</li> <li>• Who are the people who complain most about problems with wildlife locally (i.e. sex, age, ethnicity, class, location of farms in relation to PAs, forests, etc.)</li> </ul>
<b>Local people’s perceptions</b>	<ul style="list-style-type: none"> <li>• Do local people value wildlife resources and if so which ones and why?</li> <li>• Do local communities think they get any benefits from local wildlife?</li> <li>• What are the local views on how crop raiding by wildlife should be dealt with and why do they think this?</li> <li>• According to local communities who should be responsible for protecting crops/property/people against the activities of wildlife?</li> <li>• Do local communities consider conservation to be an important issue locally and if so, why?</li> </ul>
<b>Community/local expectations</b>	<ul style="list-style-type: none"> <li>• Local expectations of benefits from conservation of wildlife</li> </ul>
<b>Information to facilitate arriving at an acceptable solution</b>	<ul style="list-style-type: none"> <li>• Details of any risk sharing systems/strategies already in place that might be adapted to cope with the problems associated with crop raiding by wildlife?</li> <li>• What if any are the possibilities for alternative income generating sources appropriate to the area so that people can adopt an alternative subsistence strategy to agriculture</li> </ul>

### *Local perceptions of damage*

As well as having detailed information about the nature of the conflict, it is useful to have knowledge of local perceptions of the severity of damage, how and whether people use particular strategies to try to minimise the levels of crop damage occurring and who actually makes formal complaints about crop raiding by wildlife. Such information will help identify whether crop damage *per se* is the important issue or whether it is a proxy for another issue. In addition, this information will help to identify target groups for consultation in any intervention programme.

### *Understanding of the law*

Depending on the purpose and focus of the investigation, it is advantageous to have information about local people's understanding of national wildlife laws. This, in conjunction with information about their expectations of local wildlife authority personnel and conservation agencies, can help explain why crop raiding is such an emotive issue, even for those members of a community who are at very little risk of losing their crops to wild animals. This is important particularly when thinking about possible intervention strategies – different types of intervention may be appropriate to different sectors of the affected community as a consequence of having different experiences of crop raiding, particularly where not all complainants necessarily experience frequent or extensive crop loss or damage.

For an intervention strategy to be successful it needs to be appropriate in its aims and the manner in which it is implemented. Thus it is essential that such strategies be developed in consultation with all stakeholders, hence the need to identify appropriate sections of a community or local population, timing of possible labour bottlenecks, people's expectations with respect to responsibility and outcomes, and the presence of traditional risk-sharing strategies.

### **Degree of detail needed and useful strategies for collecting data**

The level of detail needed will depend on a number of factors including (i) the purpose of the study, i.e. whether the research is planned to be a forerunner to the implementation of an intervention programme, (ii) the time-scale within which the researchers have to operate, and (iii) the budget. Given that most crop raiding research is intended to inform planning for future interventions, the emphasis is likely to be on producing adequate and appropriate information within the minimum amount of time possible, prior to developing and testing intervention strategies. Thus, researchers and managers need to prioritise with respect to the

types of data collected. However, evidence suggests (Hill 1998; Conover 1994) that to concentrate solely on an ecological or economic evaluation of the situation is not appropriate because the way people understand and perceive issues influences their responses to particular situations. Certainly, where there are time and budgetary constraints, it may be tempting to reduce or proposed research on the social dimension to crop raiding, or eradicate it completely from the project. However, omitting this aspect may compromise an intervention because a good understanding of the social context is likely to be vital to devising strategies that will be acceptable to the people they are being aimed at. To a certain extent the minimum information necessary to gain some understanding of the social context of a conflict situation will depend on the type, extent and duration of the conflict, the degree of dependence on agriculture amongst the local communities, and the degree of homogeneity amongst those people affected in terms of wealth, education, ethnicity, political power etc. However, where there are time, labour or financial constraints information on people's degree of dependence on agriculture, traditional institutions if any for controlling crop raiding, uses of and value of different crops to households, local perceptions of the severity of damage and which species are thought to be responsible, and some indication of the local view as to the most effective/acceptable strategies for dealing with crop raiding by wildlife are likely to provide a useful backdrop against which to analysis data on crop losses and species responsible.

Having determined the types of information and level of detail required, an important consideration is how to obtain that information. There was much discussion of this during the workshop and the following is a summary of the main points included in that discussion.

RRA/PRA<sup>2</sup> techniques offer a range of data collection tools that are likely to be highly appropriate and useful given time and funding constraints. (For a more detailed description and discussion of PRA techniques (see Adams and Megaw 1997, Chambers 1992, Leurs 1996, and Mason and Danso 1995). Alternative strategies such as questionnaire surveys may yield some basic background information relatively rapidly (providing they are administered by interviewers), but generally they are unable to provide adequate or accurate information relating to potentially sensitive topics such as people's perceptions of their risk of suffering crop damage by wildlife. The types of data collection strategies that could be used to gather information about the social aspects of crop raiding by wildlife are summarised in Table 4.2.

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<sup>2</sup> Rapid Rural Appraisal and Participatory Rural Appraisal

**Table 4.2; Summary of useful data collection techniques and strategies**

Appropriate data collection strategies
<ul style="list-style-type: none"> <li>• Secondary sources of information – reports etc.</li> <li>• Appropriate RRA/PRA techniques – mapping and transect walks, ranking or scoring matrices, historical matrices, time lines, daily schedules and seasonal calendars, institutional analysis and linkage diagrams.</li> <li>• Participant observation</li> <li>• Semi-structured interviews with random individuals and key informants (specific identified individuals)</li> <li>• Discussions with focus groups (with specific common interests) and mixed groups (formed at random)</li> </ul> <p><i>Ad hoc</i> reports from villagers &amp; verification by project staff – incidence and degree of damage to crops, animal spp. responsible, etc.</p>

There are many advantages to using PRA techniques. Where time and/or funding permits a more detailed study of the social aspects of crop raiding, PRA techniques are a useful set of tools for getting a quick insight into areas worthy of more detailed investigation, using perhaps participant observation or semi-structured interviews over a more extensive time period.

They are particularly well designed to facilitate researchers gaining an ‘insider perspective’ on specific issues, and they also provide a good way of starting to build up a rapport between the researchers/project personnel and local residents.

The degree of rapport between researchers and the community is dependent, at least in part, on the length of time the researchers are within a community and the type of interaction that ensues between members of the local community and project personnel. Obviously a good relationship between project personnel and a community is important when trying to collect information of a sensitive nature such as people’s understanding of the crop raiding situation, and their expectations as to whose responsibility it is to deal with wildlife that crop raid. Many of the techniques used in PRA have been designed with this in mind, i.e. to facilitate an ethos of trust and sharing between the parties involved.

Overall, these techniques are very useful for exploring particular issues relating to local communities, the way they access and value local natural resources, how they prioritise particular decisions with respect to livelihood, household economic security, access to and distribution of resources, and how they perceive particular conflict issues. However, there are constraints to their usefulness and it is important that investigators be aware of the limitations of their use. For example, PRA techniques are now very familiar to many rural and urban groups in the developing world because these methods have been used very frequently as forerunners to health care, agriculture and marketing development projects. Understandably therefore people have the expectation that the use of these methods signifies the onset of a related development project. Thus, by using such a set of research tools researchers may, inadvertently, set up inappropriate expectations amongst members of the local community. Another drawback to using just PRA techniques is that while they are very useful for determining how local people perceive an issue/problem, they are not designed to gather independent/objective information such as the frequency of crop raiding events, and the proportion of crops damaged. A further point for consideration is that it is inappropriate to use PRA techniques more than once to investigate a particular issue with any group of people.

For questions relating to people's understanding of conservation it is important to use interviewers who are not automatically identified as being part of a particular conservation programme/project. And where one uses structured or semi-structured interviews, or perhaps on occasions questionnaires, it is very important that people's responses are checked for accuracy, either by including some contradictory questions or repeating the same question in several different formats within the interview session. This triangulation, or crosschecking, is important for verifying information and should always be included when carrying out social research of this nature. There are a number of different ways of doing this:

- (i) use a range of methods to explore the same issue,
- (ii) use similar methods with a range of different groups, or
- (iii) when using PRA techniques, use a number of facilitators from different disciplinary backgrounds.

**Summary**

- 1) It is important to consider the social costs of crop damage to farming households as well as the economic costs and ecological or biological aspects.
- 2) The level of detail re data collection needs careful consideration. It will be affected by factors such as the purpose of the data collection, as well as time, human resources, and budgetary constraints
- 3) It is important to identify issues pertinent to a conflict situation prior to devising or implementing intervention.





## Section 5: conflict resolution



*Annoyed farmers complaining to Park Manager, F. Osborne, WCS*

### **Introduction**

Human-wildlife conflict situations often have a long history. Past efforts to resolve the conflict may have failed or there may be political issues that exacerbate the situation. No solution will work without site-specific knowledge of what is possible, practical, or acceptable in any particular area. Unfortunately human-wildlife conflict situations are often complex so are unlikely to be resolved quickly and cannot be solved solely by technical means. A common problem to date is that most interventions have been planned and implemented by organisations from outside an affected community without clearly defined goals and objectives. This section addresses some of the problems faced when developing schemes to reduce crop loss to wildlife. The main group of points that need to be considered prior to any study and/or intervention programme is;

1. Should a study be undertaken if there is no practical intervention planned?
2. Is one raising expectations for a solution by conducting a study and
3. What will be the tangible benefits for the farmers?

### **Goals of an intervention**

It is important to identify the project's goals prior to the development of any form of intervention. For instance, is the goal of an intervention to resolve the conflict by just reducing crop loss or might there be other, equally appropriate goals? These other goals may include increasing farmers' tolerance to crop raiding by wildlife by developing ways in which local communities might stand to benefit financially through living alongside wildlife. A further, important consideration is whether managers are interested in, or able to provide a

short or long term solution to a conflict situation. It is also necessary to consider whether the research goals and management goals concur.

Once a conflict area has been identified and it has been agreed with local people that some type of intervention should be made, the goal of any intervention should be decided upon before field work begins. The specific goals of any particular intervention scheme are likely to vary depending on the details of the situation concerned, but possible goals for conflict resolution schemes include:

- Reducing the amount of crop losses to wildlife
- Improving local people's attitudes towards, and perceptions of, a protected area and its wildlife
- Helping affected farmers to improve agricultural production
- Increasing the amount of crops being harvested locally, through improved local yields (via improved cultivation & plant husbandry techniques, use of different crop types, improved harvesting and/or storage techniques for example)
- Reducing levels of poaching

Each of these aims requires different approaches, tools, and budgets, but as outlined on the previous page, the ultimate goal of any intervention should be to improve the livelihood security of the farmers concerned.

### **Community involvement**

Once the individual goals have been established and the availability of the necessary resources ascertained, then discussion with the communities can begin. Communities living around protected areas are different from those in other areas as they often receive a disproportionate amount of interest from the conservation and development donors (due to the desire to conserve a protected area or a rare or endangered animal). In many such areas a 'culture of dependency' has developed due to the often-competing motivations of these organisations. This can influence people's expectations with respect to who should take responsibility for developing, implementing and/or maintaining any control scheme, thus it is very important that farmers be involved in the process of developing new solutions from the beginning. Not only does this foster a sense of commitment and involvement amongst them, but it is also vital that they be involved from very early on because they understand how the situation affects them and what kinds of intervention are likely to be acceptable and feasible within the local culture, providing there is adequate representation from the different types of

stakeholder involved (for example, women-headed households, poorer households, farming households from minority ethnic groups).

### **Reducing crop losses**

Table 5.1 gives a brief overview of different pest species commonly encountered around agricultural areas in Africa. A problem animal can be repelled, removed or tolerated. In some cases, for large valuable animals, live removal is an option, but this will never be cost effective. The most viable options include:

- (i) Increasing vigilance by farmers – this has been shown to make a considerable difference in the amount of crops lost,
- (ii) Increasing farmer tolerance for a pest species and lost crops – but where losses are high, tolerating crop losses may result in increasing poverty and hardship for the farming community,
- (iii) Increasing the ability of farmers to repel crop pests using existing local methods – this has a number of obvious benefits,
- (iv) If these methods do not make a considerable impact on crop loss, then larger impact interventions such as electric fencing, lethal control of pest animals or moving farmers from the conflict zone can be considered.

Many traditional repelling techniques are fairly effective if formalised, but are labour intensive and in certain circumstances are perceived locally as being increasingly ineffective and therefore no longer appropriate or adequate. But where an animal can be repelled adequately using these methods, then it seems inappropriate, and certainly not particularly cost effective, to try to introduce more expensive techniques, or strategies requiring greater technological input or backup.

Table 5.2 is presented as an example to show different methods for reducing crop loss to elephants. It is apparent from this table that there are both advantages and disadvantages associated with different crop protection strategies, therefore any manager needs to carry out a careful and thorough cost/benefit analysis to identify the most effective short and long-term strategies/options for reducing conflict.

**Table 5.1: Some pests, which raid crops in Africa**

<b>Crop pests</b>	(Viruses, mites, slugs, snails, etc., are beyond the scope of this paper and are the responsibility of a country's agricultural extension programme)
<b>Insects</b>	Insects are the most widespread and destructive of the crop pests. A vast amount of literature exists on this subject which can help in this discussion. It is difficult to deal with insect pests 'by hand' as they tend to invade in large numbers and reproduce quickly. Most control efforts have focused on chemical controls to reduce their numbers.
<b>Rodents</b>	Rodents have similar characteristics as insects in that they reproduce quickly and can invade in large numbers but they can be controlled by poison (which is expensive and renders the meat useless) or by traps.
<b>Wild Pigs</b>	Natural barriers such as Mauritius thorn and or Sisal/cactus can deter wild Pigs and warthogs. Hunting is also an option where they are classified as a pest species.
<b>Birds</b>	Damage by grain-eating birds is also a considerable problem to food crops such as millet and sorghum. Noisemakers and scarecrows can help, but are very time consuming.
<b>Small Mammals</b>	Smaller ungulates cause damage to crops and can be trapped and used for meat; however, in many areas they have protected status. (E.g. Duiker, impala, etc.). Barriers are often quite effective for these species
<b>Primates</b>	Primates are particularly difficult to control because they are intelligent and fast. Fortunately the species that raid are diurnal. They can be chased using simple techniques such as slingshots or rocks, and, in most cases, are not dangerous. Children and old women can chase them. Research indicates that primates tend not to not move more than a couple of hundred meters away from the forest boundary. Loss is regular and can be substantial over a season. Considerable time/energy costs in constant patrolling are needed to keep primates at bay. Killing is not very effective unless you kill the alpha male and this may have an impact on troop viability.
<b>Large Mammals</b>	Animals such as elephants, buffalo, and hippo are the most dangerous of pests and require a considerable amount of planning if an intervention is to be considered (see Table 5.2).

**Table 5.2: The advantages and disadvantages of different methods to reduce conflict between elephants and people**

METHOD	ADVANTAGES	DISADVANTAGES
Working with affected farmers	<ul style="list-style-type: none"> <li>Necessary to solve problem</li> <li>Good public relations</li> <li>Get ideas for new methods</li> </ul>	<ul style="list-style-type: none"> <li>Raise expectations</li> <li>Create trouble for managers</li> <li>Misuse of methods</li> </ul>
Killing problem elephants	<ul style="list-style-type: none"> <li>Good public relations</li> <li>Remove problem animal</li> <li>Compensation for loss of crops through meat</li> <li>Revenue for community</li> </ul>	<ul style="list-style-type: none"> <li>Drain on a natural resource</li> <li>Ineffective for stopping other crop-raiders</li> <li>Open to abuse</li> </ul>
Translocation	<ul style="list-style-type: none"> <li>Removes the 'problem'</li> </ul>	<ul style="list-style-type: none"> <li>Problem moved to another area</li> <li>Expensive equipment and personnel</li> </ul>
<b>Fences</b> Traditional fences (branches, sticks or strings )	<ul style="list-style-type: none"> <li>Inexpensive to erect</li> <li>Easy to maintain</li> <li>Psychological barrier</li> </ul>	<ul style="list-style-type: none"> <li>Not very effective</li> <li>Requires cutting bushes/trees</li> </ul>
Standard fences (Cable wire fences)	<ul style="list-style-type: none"> <li>Maintenance cost is low</li> </ul>	<ul style="list-style-type: none"> <li>Expensive to erect</li> <li>Not always effective</li> <li>Must be maintained</li> <li>Forms a 'hard edge'</li> <li>Theft of wire for poaching</li> </ul>
Electric Fences	<ul style="list-style-type: none"> <li>Can be very effective</li> <li>Good for public relations</li> </ul>	<ul style="list-style-type: none"> <li>Expensive to install and maintain</li> <li>Usually funded by donors</li> <li>Forms a hard edge</li> <li>Ineffective if not maintained daily</li> <li>Theft of wire for poaching</li> </ul>
Vegetation barriers e.g. Mauritius thorn	<ul style="list-style-type: none"> <li>Inexpensive to erect</li> <li>Can act as a cash crop</li> <li>Spreads easily</li> <li>Psychological barrier</li> </ul>	<ul style="list-style-type: none"> <li>Effectiveness not documented</li> <li>Spreads easily</li> </ul>
Trenches	<ul style="list-style-type: none"> <li>Some effectiveness reported</li> <li>Material costs low</li> </ul>	<ul style="list-style-type: none"> <li>Limited effectiveness if not maintained</li> <li>Expensive to maintain</li> <li>Can cause erosion</li> </ul>
<b>Sounds</b> gunfire	<ul style="list-style-type: none"> <li>Can have short term effect</li> <li>Easy to train people</li> <li>Good public relations</li> </ul>	<ul style="list-style-type: none"> <li>Expensive</li> <li>Dangerous</li> <li>Open to abuse</li> <li>Elephants habituate to the gunfire</li> </ul>
Fire crackers	<ul style="list-style-type: none"> <li>Can have short term effect</li> <li>Easy to train people</li> <li>Good public relations</li> <li>Inexpensive</li> </ul>	<ul style="list-style-type: none"> <li>Dangerous</li> <li>Can cause fires</li> <li>Elephants habituate to fire crackers</li> <li>Labour intensive</li> </ul>
Drums/tins/whips	<ul style="list-style-type: none"> <li>Can have short term effect</li> <li>Easy to train people</li> <li>Good public relations</li> <li>Inexpensive</li> <li></li> </ul>	<ul style="list-style-type: none"> <li>Elephants habituate to noisemakers</li> <li>Labour intensive</li> <li>Access to material can be limited</li> </ul>
<b>Experimental</b> Sirens and infra sound	<ul style="list-style-type: none"> <li>Effectiveness not proven, but may be useful (more research needed)</li> </ul>	<ul style="list-style-type: none"> <li>Elephants may habituate</li> <li>Expensive</li> <li>Theft of equipment</li> </ul>
Dried pepper (burned)	<ul style="list-style-type: none"> <li>Extremely irritating to elephants</li> <li>history of use by rural farmers</li> </ul>	<ul style="list-style-type: none"> <li>Winds dependant</li> <li>Access to pepper</li> <li>Irritating to farmers</li> </ul>

METHOD	ADVANTAGES	DISADVANTAGES
<b>Experimental (contd)</b>  Capsaicin spray	<ul style="list-style-type: none"> <li>• Extremely irritating to elephants</li> <li>• Application technology available</li> <li>• Proven effective as a repellent</li> </ul>	<ul style="list-style-type: none"> <li>• Wind dependant</li> <li>• Expensive (imported)</li> </ul>
Dogs	<ul style="list-style-type: none"> <li>• Could be useful for guarding if trained well but untried</li> </ul>	<ul style="list-style-type: none"> <li>• danger they may attract elephants towards dog owner when dog flees</li> </ul>
Elephant pheromones	<ul style="list-style-type: none"> <li>• Could be effective</li> </ul>	<ul style="list-style-type: none"> <li>• Untried, expensive</li> </ul>

### Implementation of an intervention

Before developing and implementing an intervention a number of points need to be addressed. The reasons for the conflict must be considered in the context of other issues of protected area management. Second, information needs to be gathered about the type of conflict issue, farmers' perceptions of the situation, and perhaps their expectations as regards a potential intervention programme. Third, the manager should understand the ecology of the pest species. Fourth, as already outlined, the goals of the intervention must be clearly defined. Fifth, a decision should be made regarding the deterrence or removal of the crop pest and finally, farmers need to be involved to ensure their support for and acceptance of the intervention. In conclusion, these points are discussed further below:

#### *Social context*

Prior to developing an intervention programme it is vital that the complexity of the situation be recognised and considered in adequate detail. For instance, it is important that the people assigned to resolving any conflict situation have the necessary expertise. Other factors that also need to be considered at the very early stages in any procedure include whether the particular conflict issue could be described as a crisis situation therefore creating great pressure to react. A further point that must be considered early on is whether the conflict issue is linked politically to other issues regarding protected area management (e.g. poaching, hostility toward other aspects of conservation efforts). Furthermore, it is very valuable to know whether the farmers feel powerless to deal with the problem, or whether they are using the crop raiding issue to achieve other goals. Information such as this will help a manager to determine the appropriate goals and priorities in any consequent intervention strategy? A final area to think about prior to the onset of any project is whether the local politics, and history of development in the area, affect the issue because this may have significant implications for understanding and identifying areas for possible conflict between members of the local community, political authorities, and Wildlife Authority and Parks personnel. Such

information may prove invaluable when trying to negotiate with local farmers as well as local political figures.

As outlined in earlier sections of this document information is needed in regard to the actual crop losses, farmers' perceptions of the problem, and what they would like to see implemented. It may also be relevant to determine the way people dealt with the problem in the past; such information may provide ideas about possible ways in which to intervene, or may help explain why the issue has become more pressing in recent years, if that is the case

#### *Ecology of pest species*

Information about the ecology of the pest species concerned is vital prior to beginning any intervention. Having some understanding of why animals crop raid is useful when trying to devise ways of reducing crop damage. For example, are crops attractive to pest species because they need them nutritionally or is it because they are an easy, nutritious, energy dense, source of food? Factors such as seasonally, feeding, breeding and movement patterns may also need to be taken into consideration to help build up a useful behaviour profile of the species concerned. This information can then be used during the design phase of the intervention programme to facilitate the development of effective intervention options.

#### *Crop protection strategy*

Once an understanding of the pest species has been developed options that are effective against that species can be implemented. The type of crop protection strategy a farmer or community can adopt from either an ethical or logistical point of view must then be considered. In order to make this decision a manager will have to consider a wide range of issues from both an economic and food security perspective. As lethal control or removal of pest species is not an option in most situations, farmers will have to depend on a range of deterrence methods. Table 5.2 gives an outline of a range of traditional and experimental methods used against elephants. Some of these methods may be useful against other pest species, but new research will need to be carried out to find methods useful for crop pests such as primates.

It is apparent that there are both advantages and disadvantages associated with different crop protection strategies; therefore any manager needs to carry out a careful and thorough cost/benefit analysis to identify the most effective short and long term options for reducing conflict.

**Summary**

- Any intervention strategy must have clearly defined goals
- The resources needed to carry out an intervention must be secured before the introduction of any programme to affected communities
- Any intervention must incorporate wide ranging community consultation and support before any programme is embarked on
- Methods used should first include the most basic methods (vigilance and traditional methods) before any more technological methods are introduced.



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## APPENDIX 1: CASE STUDIES THE MANAGERS PERSPECTIVE



*Gorilla on wall separating park from farms, Rwanda. A.Plumptre, WCS*

### **Introduction**

The first two papers focus on the management of crop raiding by wildlife. The first paper presents a breakdown of Kenya's recently developed Conflict Resolution Concept. The author (Kagiri) identifies the source of conflict as being competition between people and wildlife for various resources including land. He suggests this conflict is confounded by the colonial legacy of a 'wildlife preservation policy' that has "succeeded in alienating people and wildlife to the detriment of the latter.". This theme of alienation of rural people and wildlife runs through several of the presentations, including Biryahwaho and Hill, and has been discussed at greater length by various authors including (Anderson, 1987) and (Naughton-Treves, 1999).

According to Kagiri Kenya is advocating a multi-pronged approach – where possible promoting wildlife as a source of revenue for rural populations through wildlife tourism, and the development of Problem Animal Control (PAC) measures, including use of honorary game wardens to assist in dealing with life-threatening problem animals, game-proof barriers, and restructuring of compensation schemes where appropriate. These measures will be developed and implemented at the regional level in recognition of the fact that there may be locally specific conditions/requirements with respect to PAC.

The second paper in this section by Biryahwaho outlines the management process being developed to reduce the impact of crop raiding by wildlife on local farmer's living alongside Bwindi Impenetrable National Park and Mgahinga Gorilla National Park, southwestern Uganda. This project was in the early stages of consultation and development at the time of

the workshop. However, initial signs suggest that while certain planned interventions such as stone wall barriers can be successful deterrents for some crop raiding species, encouraging local long-term commitment to maintenance of such structures depends on good collaboration between the Parks, the local communities, and supporting institutions.

These two contributions highlight some of the issues that are central to this workshop document, namely the development of successful management strategies and the need to involve local communities in the development and maintenance of crop protection systems.

Anderson, D. and Grove, R. (1987). The Scramble for Eden: past present and future in African conservation. In: *Conservation in Africa: people, policies and practice*. Eds: D.Anderson & R.Grove. Cambridge University Press, Cambridge.

Naughton-Treves, L. (1999). "Whose animals? A history of property rights to wildlife in Toro, Western Uganda." *Land Degradation & Development* **10**: 311-328.

## **Human – Wildlife Conflicts in Kenya: A Conflict Resolution Concept**

**Joachim Kagiri**  
Kenya Wildlife Service

### **Source of conflict**

The resource base for Kenya is shrinking at a fast rate due to the accelerated growth in the human population. Combined with this, there is a general population movement trend from the predominantly high potential areas to the relatively drier and ecologically more fragile environments. There has also been a remarkable transition from semi-nomadism to sedentary semi-agricultural settlements, and the development of small-scale farming in areas that have historically been known to be prime wildlife habitats, migration corridors or natural wildlife buffer zones. In an endeavour to get enough food, water, shelter (habitat) and space, both people and wildlife have found themselves in competition for the aforementioned resources. This competition has given rise to an unprecedented conflict: a conflict for survival. The colonial legacy of adopting a “wildlife preservation policy” only succeeded in alienating people and wildlife to the detriment of the latter. Consequently, wildlife has been largely viewed as the property of the state.

### **Results of the conflict**

The end result of this conflict of interest has far reaching economic and social effects. The problems associated with wildlife include:

- loss of human life
- injury to human beings
- destruction of crops
- destruction of farm infrastructure
- creation of an environment of fear

Wildlife is a major foreign exchange earner at the national level. However, it is perceived by some disadvantaged communities as a cause of poverty and a source of hunger and disease for livestock. There is no doubt therefore that wildlife related costs, outside the National Parks, Reserves, and the gazetted forests, should be reduced significantly.

Human-wildlife conflict is, in most aspects, a land use conflict which spills across and beyond the jurisdiction of the Kenya Wildlife Service (KWS). In this regard, effective conflict resolution strategies will use “dialogue” as a major tool between various stakeholders. To this

end, ways and means are being explored in an attempt to effectively involve landowners and other interested groups in the process of identification, planning, and decision making in the management of wildlife outside the protected areas. The time has come to appreciate that people are the solution to the conflict rather than the problem.

With this in mind, the process of forming village and sub-locational wildlife management committees has already started. Formation of partnerships and grass-root capacity building is being given more attention than ever before. The training of community game scouts is a move in the right direction. In addition, the establishment of community-based conservation units (sanctuaries), and the promotion of commercial activities accruing from tourism, are sure and modern ways of changing the wildlife related liability to a source of income. In this latter case the problem automatically becomes an opportunity. In addition, there is adequate evidence to support the fact that the promotion of wildlife is a viable and competitive land use strategy within the savannah zone in Kenya.

#### **Problem Animal Control (PAC)**

Upon zonation of the entire country one recognizes the impracticability of mixing wildlife and arable farming in the high potential areas. Conflict resolution in the agricultural and heavily settled areas is achieved through scaring the animals, shooting them, translating or driving them away, or restricting their invasions through the creation of game-proof barriers. It is the policy of the conflict resolution office to remove or destroy dangerous and destructive animals from the midst of people. Local communities will be encouraged to deal with small and illusive pest species through trapping, though the use of poison will be discouraged.

In view of the magnitude of the problem, and taking cognisance of the fact that KWS resources are limited, reputable honorary game wardens will be encouraged to deal with life-threatening problem animals. The honorary game wardens will work closely with the Area Partnership Officers.

At locations where communities border the conservation areas the option of creating game-proof barriers will be explored. The type and magnitude of the barrier will be determined by:

- problem animalspecies
- type of land use
- social - political set up
- climatic conditions

- funding
- ability to sustain the barrier

Priority will be given to areas or districts with the most severe human-wildlife conflict problems. Indeed, every region is presently working out a conflict resolution strategy based on the prevailing local peculiarities. Emphasis will be placed on the management of individual “conflict cells”. The region strategy should be simple, attainable, and socially and environmentally acceptable. Each regional strategy will include monitoring and evaluation systems.

Animal movement calendars, conflict seasons, and crop ripening periods will be monitored and assessed over time. Each region will have a fully trained and well equipped PAC unit. The burden of compensation for damages accruing from wildlife will, upon approval of the proposed wildlife management bill, be passed to a third party - preferably a reputable insurance firm. It is envisaged that this will enhance the efficiency of the compensation process and remove the delays that are presently being experienced by claimants.

### **Capacity building**

In order to fulfil effectively the broader objective of protecting people and their property from wildlife, a training curriculum has been formulated for different classes of problem animal control cadre.

The curriculum targets the following groups of people:

- game scouts
- wildlife management committees
- association/forum members
- partnership rangers
- community fence attendants
- KWS fence attendants/technicians
- partnership officers
- forest guards
- other stakeholders

With the formation of a fully pledged partnership department, and through the restructuring process where the focus for wildlife management is at regional level, human-wildlife conflict is expected to be reduced to lower, manageable and acceptable levels.

## **Community Perspectives Towards Management of Crop raiding Animals: Experiences of Care – DTC with Communities Living Adjacent to Bwindi Impenetrable and Mgahinga Gorilla National Parks, Southwest Uganda**

**Byamukama Biryahwaho,**  
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### **Introduction**

Bwindi Impenetrable National Park (BINP) and Mgahinga Gorilla National Park (MGNP) are of high conservation value as rare examples of afro-montane rainforest and most especially, as home to half the world's population of the highly endangered mountain gorilla (CARE, 1997). As such the Government of Uganda, NGOs and the local community are interested in the long-term conservation of the two parks. A number of innovative conservation initiatives are being implemented by a variety of stakeholders with a view to the sustainable management of the two parks.

CARE's Development Through Conservation (DTC) project supports the management of BINP and MGNP to meet some of the management objectives as provided for in the management plans of each park. The project's park management and community conservation section co-ordinates the program of support while park staff implement it with the communities concerned. The project's objective under this section is to ensure that a framework for effective and sustainable park management is established which involves the active participation of all relevant stakeholders and the equitable sharing of costs and benefits between parks and local communities. One of the outputs of this project is that management systems for problem animal control are developed and operational in affected communities.

Before Bwindi and Mgahinga were gazetted as national parks in 1991, local communities had almost unlimited access to forest resources notably timber, bee-keeping and wild honey collection, gold mining and harvesting of non-timber forest products (NTFPs). This was

stopped when the forests were gazetted as national parks, creating a great deal of tension between the people and park authorities. Some local communities have been allowed access to park resources through the innovative multiple use programs. This is where community members, organised into forest societies, enter into collaborative management arrangements with park authorities and, in return, are allowed to harvest NTFPs. This has improved community-park relationships with those communities that are benefiting already. Besides being denied access to forest resources, local communities were stopped from practising some of the traditional ways of controlling crop-raiding animals, presumably because these were conflicting with conservation principles.

In our experience community perspectives towards the parks stem from a variety of contributing factors including loss of access to resources and income generated from the parks, crop depredations by wild animals, exclusion from participation in decision making, planning and management, and low levels of awareness concerning the importance of wildlife conservation (Kiss, 1990). While the depredation of crops by wildlife serves as a contributing factor to the generation of local community hostility towards wildlife, it warrants consideration as a major problem to wildlife managers in its own right due to its magnitude and complexity. Raiding of crops is a burden to farmers adjacent to BINP and MGNP where the economic damage from crop raiding probably exceeds potential benefits from the parks to individuals, which has resulted in heightened community attitudes towards crop raiders (UNP, 1995; UNP, 1996).

The impacts of crop depredations are not only restricted to economic losses on the part of the farmers but also carry a high social component in terms of time and labour expended. For example school aged children are involved in crop guarding, physical insecurity is caused by animals themselves, and in severe instances there is migration by entire families due to persistent and severe crop depredations. It is important to realise that dissatisfaction among local communities is based on the perception that authorities are not adequately addressing community concerns about crop raiding. Communities advocate for direct monetary compensation to individuals who lose their crops, but this is not a sustainable option at the present time.

The costs of conservation paid by individual households in the form of damage to crops are great. It is often assumed that communities benefit from community development programs but the benefit may not be significant to individual households. The distinction between



returns to the community and to the individuals within the community is often lost, even though this may determine the individual's attitudes to wildlife conservation. During our interactions with communities adjacent to the two parks it has been established that individuals differ in the share of community benefits they receive, or they have different priorities, which determines individuals' participation in the implementation of crop raiding control measures. It is the individual's perception of crop raiders that collectively form community perspectives. Therefore, individuals' views and suggestions, based on local experience, have an important function in developing crop raiding control methods suitable to the local conditions, and helping to enlist community support during their implementation.

### **Uganda's legislation on the management of problem animals**

National policies and practices towards local communities can directly or indirectly influence the success of long term conservation efforts. The Uganda Wildlife Statute (1996) guides the implementation of crop raiding control measures at both BINP and MGNP. The statute is a piece of legislation guiding the management of all wildlife in the country within and outside protected areas. Section 3 (1) (f) calls for the promotion of ecologically acceptable control of problem animals. The statute calls for the conservation of wildlife throughout Uganda so that their abundance and diversity are maintained at optimum levels commensurate with other forms of land use, in order to support sustainable utilisation of wildlife for the benefit of the people of Uganda.

Section 6 of the statute on functions of the Uganda Wildlife Authority (UWA) charges the Authority with the responsibility of monitoring and controlling problem animals, and to provide technical advice on the control of vermin. Section 59 (2) states that where the vermin animal(s) are of value the Executive Director shall at all times advise the local communities about the value of the animal(s), and recommend the appropriate methods for controlling such animal(s). Section 15 (1) provides that the Executive Director, with the approval of the UWA Board of Trustees, can enter commercial or collaborative arrangements with any person for the management of a species or a class of species of animals or plants. The statute further states that for the better achievement of the purposes of the statute UWA, and every person responsible for the administration of the statute, it shall ensure that any measures taken or instituted under the statute are based on results of scientific investigation in as far as it is economical, including the monitoring of species status and habitat condition, as well as taking into account the views of the affected community.

The Uganda Local Government Act (1996) gives the responsibility of managing crop raiding animals that have been declared as vermin by the UWA to the districts in which the animal(s) fall. However, until recently, no such animals have been declared as vermin around the two parks, therefore UWA management still maintains the overall responsibility of managing all crop raiding animals. At the same time the districts are still reluctant to take up this responsibility. This further complicates the implementation of crop raiding control measures. Communities end up feeling that they are neglected and their concerns are not adequately addressed, which further influences their attitudes. Therefore designing measures for the management of crop raiding animals around BINP and MGNP requires careful consideration of the policy guidelines, the conservation status of the two parks, and the biodiversity therein.

The Ugandan parliament has not yet enacted the statute to put in place laws and clear guidelines for the implementation of the police on management of problem animals and crop raiders in particular. Once the laws and guidelines are in place it is hoped that there will be smooth implementation of crop raiding control measures, with no contradictions, at different sites within the country.

#### **Crop raiding situation around BINP and MGNP**

Crop raiding animals presenting significant problems to communities and park management at MGNP include buffaloes (*Syncerus caffer*) and porcupines (*Hystrix africaeaustralis*). Crop raiding by buffaloes has, however, been contained with the construction of a stone wall. Baboons (*Papio anubis*), elephants (*Loxodonta africana cyclotis*) and bushpigs (*Potamochoerus porcus*) present significant problems to Bwindi communities and park management. Records of crop raiding by L'Hoest monkeys (*Cercopithecus lhoesti*), chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla beringei*) around Bwindi exist but are infrequent, and present a minor problem relative to the other species named above. All major food crops suffer damage from crop raiding animals to varying degrees. The majority of crop depredations occur during the day; exceptions include crop losses to the nocturnal bushpig, elephants and buffaloes that may forage into the night. Seasonal raiding by elephant is known to occur in certain sectors of the community (UNP 1995; UNP 1996).

Studies conducted around BINP and MGNP, and field experience, reveal that in some cases local community claims of crop damage are frequently inaccurate and exaggerated. Similar studies elsewhere have come up with the same conclusions (see for example Mwathe, 1992 and Wakely, 1981). Other studies suggest that while naming the crop raiding animals that

inflict the greatest damage, big animals such as elephants, buffaloes, wild pigs and baboons receive disproportionately large amounts of blame for the damage caused. On the other hand, smaller animals such as rodents and birds, which cause the greatest cumulative damage over time, are less frequently complained about. Similarly, domestic animals may cause considerable damage to crops yet the damage does not elicit strong community resentment (Graham 1992).

In a recent knowledge and attitude survey that was conducted by CARE – DTC in parishes adjacent to the two parks, 75% of the respondents (n = 124) indicated that the most pressing problem from the parks is crop raiding. In the same study 44.3% of the respondents indicated that the benefits from the park are greater than the problems, while 54% indicated that the problems are more than the benefits. However, when asked to compare themselves with people living far away from the park, the majority (50.9%) of the respondents indicated that they were better off, with only 45.7% indicating that they were worse off. It was noted that there were some contradictions among respondents (18.5%), where respondents would indicate that the benefits from the parks were more than the problems faced, yet on being asked whether they were better off than people living far away from the park boundary, their response would be that s/he was worse off. This contradiction could be attributed to crop raiding, and the fact that some indicated that it was their place of birth and therefore they did not have any other place to live. However, the survey covered the entire parish, therefore there is need to treat such results with caution since it is usually community members who live right at the park boundary that are mainly affected by crop raiding animals. Most community members feel that the parks are not giving them enough help, considering the problems caused by the crop raiders.

### **Crop raiding situation in community gardens adjacent to MGNP and management actions undertaken**

#### *Crop raiding by buffaloes*

When Mgahinga was gazetted as a national park there were a number of evictions for those community members that had encroached on the then Forest Reserve. Due to this encroachment, animals had been driven into the Democratic Republic of Congo (DRC) but soon they returned in big numbers. Buffaloes were major crop raiders and communities raised this issue with park staff authorities. Park authorities hoped that scare shooting would scare them and control the problem. This proved to be ineffective. In 1995, with support from CARE – DTC project, the local communities, supervised by park staff, constructed a stone

wall (4km long) along the northern park boundary from the Congo border. Community leaders, through the local council, mobilised community members. The wall proved very effective against crop raiding by buffaloes and an additional 5km was constructed. Planting *Erythrina abyssinica* and *Solanum species* reinforced some sections of the stone wall. Construction of the stone wall stopped at the gully from Mt. Muhabura since buffaloes could not cross the steep cliff.

Responsibility for maintaining the stone wall was left to the community since they were the primary beneficiaries. This has been achieved through the formation of stone wall maintenance committees, comprised of the local councils (LCs) of the villages bordering the park. However, no formal agreement on stone wall maintenance was put in place. As time went by crop raiding by buffaloes was no longer a problem to the communities and eventually maintenance of the stone wall was no longer a priority, resulting in some of the sections collapsing. During our discussions with community members it was evident that the stone wall is perceived as being more beneficial to the park, and therefore there is limited willingness amongst some sections of the community to maintain it without payment. Some look at it as a barrier to them accessing the park for grazing, firewood and herbal medicine collection, and as a permanent boundary for the park. With support from CARE – DTC discussions between the communities and park staff are going on with the aim of developing formal arrangements for stone wall maintenance.

At the beginning of the first week of January 2000, about 60 buffaloes crossed over from the DRC and raided farmers' gardens. Maize gardens were most severely hit. Most buffaloes crossed through the Uganda-Congo border area where there is no stone wall. However, a few of them crossed through sections of the stone wall that had collapsed. In response to this communities have repaired those sections through which the buffaloes crossed. While they did take action they still feel that park management should pay them for repairing the stone wall, provide compensation for the crops lost, and provide them with food supplements.

#### *Crop raiding by porcupines*

The porcupine (*Hystrix africaeaustralis*) remains a major crop raiding animal that is raising a lot of complaints from the local community. In response to this and in line with principles of good conservation practice, CARE – DTC has supported a study to investigate the extent of crop damage by porcupines. A consultant (Andama Edward) undertook this study with supervision from the Institute of Tropical Forest Conservation (ITFC). One of the major

findings of the study is that while incidences of crop raiding were recorded where the stone wall was not constructed, no crop raids were recorded at sites bordering the stone wall. Community members reported buffaloes, porcupines and birds as the worst crop raiders respectively. These findings contradict community claims that crop raiding by porcupines occurs throughout the entire park boundary region. The study has thus recommended the extension of the stone wall to cover the entire park boundary as a solution to minimise crop raiding by porcupines.

Assigning blame to particular crop raiders corresponded to the perceived origin of the raiding animal rather than the amount of crop lost or frequency of raiding incidences. For instance, porcupines were perceived as causing more crop damage yet study findings indicate that birds caused more damage (Andama, 1999). Secondly, porcupines cause intensive damage to crops and mainly raid Irish potatoes, which is a major crop grown in the area for both domestic use and for income. This study has produced interesting findings and MGNP management, CARE- DTC and ITFC will review the recommendations, and appropriate management actions will be implemented.

#### *Challenges and lessons learnt*

It is important to note that constructing the stone wall has proved to be a good action to mitigate the extent of crop damage at MGNP. This measure has restored hope amongst community members who perceive park management as willing to address their concerns. It is worth noting that there is a need to constantly remind the communities of their role in managing crop raiding animals so as to sustain the measures already in place. The major challenge with crop raiding by buffaloes at MGNP is how to deal with buffalo incursions through the DRC border. This is an international issue that can not be addressed by park management and the local communities but rather by the ministries of foreign affairs for the respective countries.

#### **Crop raiding situation in community gardens adjacent to BINP and management actions undertaken**

Crop raiding is one of the sources of the poor community-park relations at BINP. In a study that was conducted in parishes bordering BINP, 20% of the households reported crop raiding (n=402) with each household affected losing an average of 36% of the crop (n=62). Nine percent of the respondents indicated that the park was not of value to them because of crop

damage by wild animals (MUIENR, 1993). Communities allege that the extent of crop raiding has increased since Bwindi was gazetted as a national park.

Crops raided around Bwindi are millet, sorghum, sweet potatoes, Irish potatoes, cassava, peas, beans, bananas, coffee, yams, cabbages, passion fruits, ground nuts, tobacco, wheat, sugarcane, pumpkins, pineapples and sunflowers. Baboons are the most destructive crop raiding animals around BINP. In a study that was conducted in communities around the park, 84.9% of crop raiding incidences were reportedly caused by baboons (n =2065) and baboons were mentioned as causing the most intensive crop damage (Mwesigye, 1996).

Various forums have been organised by UWA and attended by all the interested partners, including the affected communities, to address the issue of crop depredations by wildlife around BINP. As of 1995 there were growing demands around Bwindi, from some sections of the communities, that if park management could not provide a viable alternative to traditional practices of controlling crop raiding, then the community should be allowed to return to their old measures (UNP, 1995).

#### *Collaborative management arrangement between UWA and the communities*

The management plan of BINP recognises the need for park authorities to take action in order to safe-guard community property and well being. It further points out that any action must either be consistent with a long term strategy to resolve the otherwise chronic problem, or be recognised as a short term policy enacted while other long term solutions are being sought (UNP, 1996). This was discussed in a crop raiding workshop, organised by BINP management and supported by CARE – DTC, where strategies and designs for control measures were suggested. Present were representatives of the local communities, district authorities and institutions supporting the two parks, namely CARE – DTC, Mgahinga and Bwindi Impenetrable Forest Conservation Trust (MBIFCT), ITFC and International Gorilla Conservation Program (IGCP). The workshop participants recommended that a pilot problem animal control program be initiated and implemented in selected communities, where alternative control measures would be tried, and their effectiveness in reducing damage to crops monitored and evaluated.

In accordance with section 15 (1) of the Uganda Wildlife Statute (1996), the program is to be implemented through collaborative arrangements between UWA and the districts of Kabale, Kisoro and Rukungiri, represented by the local communities in respective parishes. The five

pilot parishes are Rubuguri, Kashasha, Muramba of Kayonza, Bushura and Karangara. A series of community consultation meetings have been held in order to get recommendations of the appropriate control measures from the communities. These have resulted in draft Memoranda of Understanding (MoUs) between UWA and each of the parishes involved in the pilot collaborative management of problem animals. The MoUs have been reviewed by the interested stakeholders and are awaiting approval by UWA head quarters. The process has been necessarily slow and some communities have complained about this. However, DTC project and park staff alike are always updating the communities on the progress and reaffirming to them UWA's commitment to the implementation of the program. This has kept the communities hopeful and confident that the MoUs will be approved and the proposed measures implemented.

Planting of live fencing alongside the park boundary on community land, using *Ceasalpinia decapetala*, has been suggested, and is being carried out by some community members in Rubuguri and Mpungu parishes. However, Rushaga community in Rubuguri has been reluctant to maintain it, citing the absence of an approved MoU as a problem. Initially, some community members thought that they would get paid for establishing and maintaining the live fence but when it was made clear to them that it was for their own benefit there was laxity in maintaining it. This is a clear indication that community members consider their participation in the management of crop raiding animals to be an extra cost that should not be met by them. Communities argue that it should be park management and supporting institutions that meet the cost of controlling crop raiders, rather than the affected communities.

Research on ecology and crop raiding behaviour of baboons (by Mwesigye, 1996) and the population status and distribution of bush pigs (by Musasizi, 1999) has been conducted around Bwindi. The studies adopted a participatory research approach with the active involvement of community members. Their findings and recommendations therefore include substantial inputs from the communities in as far as community perspectives are concerned, and will be useful in the implementation of the recommended control measures. Research findings indicate that community members are hostile towards baboons and bush pigs because they are considered the most notorious crop raiders. Farmers in one of the communities ran out of sympathy for baboons and in October 1999 four adult baboons were killed! Park management took quick action and the culprits were arrested and tried according to the law.

### *Challenges and lessons learnt*

It has been established that research into crop raiding is very important in developing appropriate control measures. Control of crop raiding is a very delicate issue that should not be handled by park management alone, but requires substantial input by the affected communities and supporting partners. The community consultation process raised a lot of expectations in the proposed pilot collaborative management of problem animals. These expectations have not been met so far, and some community members have lost trust in the process, which has increased the strained community attitudes. The delay in approving the MoUs has complicated the problem, and communities feel that park management is not committed to solving the crop-raiding problem.

### **Conclusion**

CARE – DTC's experience in working with communities living adjacent to BINP and MGNP shows that crop raiding remains a major problem to address if improved community attitudes towards the conservation of the two parks are to be encouraged and maintained. As a general observation, community perceptions towards crop raiders will change as long as the communities feel that there is deliberate action to address the problem. The only problem is that the communities want immediate action, which may not necessarily be sustainable in the long term. Management and supporting institutions at the two parks are interested in identifying long term solutions to crop raiding, but at the same time are being very cautious of the measures implemented. It may take some time to evaluate the effectiveness of particular control measures, and therefore the negative community attitudes to crop raiders may equally take a long time to change.

It is important to note that there is a need to involve community members in the design and implementation of any crop raiding control program. It is when the communities meet the challenges involved in the implementation that they will understand the magnitude of the problem, and appreciate efforts being undertaken. This is because they will own the process, and therefore be willing to sustain the control measures.

Implementation of the control measures should be done in a systematic way developed by all the stakeholders concerned. A memorandum of understanding where the roles and responsibilities of the interested parties are clearly spelt out should guide the implementation of crop raiding control measures. This is important in order to build trust and confidence



among community members, that will in turn affect the way in which they perceive the crop raiders.

Community awareness created during community consultation meetings, and other conservation awareness programs around the two parks, have helped communities to understand the importance of protecting all the wildlife, including crop raiders. It is hoped that community perspectives will increasingly change in favour of crop raiders as some of the control measures are implemented. It has been established that a community's attitudes towards crop raiders are selective. Some crop raiders are perceived as of more importance than others, and community attitudes towards these are not so bad. We should build from this and help the communities to develop positive attitudes towards all crop raiders.

### **Acknowledgements**

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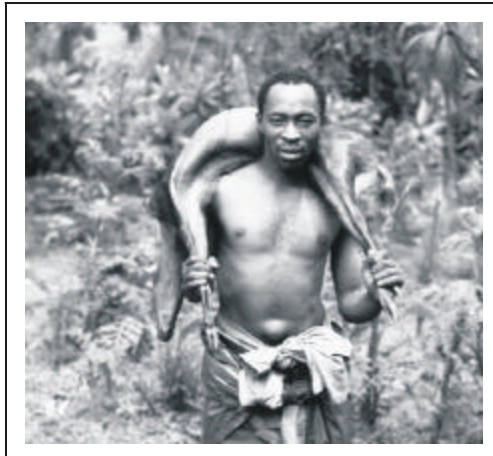
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## APPENDIX 1: THE FARMERS PERSPECTIVE



*Crop raiding can lead to hunting. A. Plumptre, WCS*

### **Introduction**

The following four case studies (Hill, Nchanji, Rose, and Plumptre) focus on the degree of crop damage farmers experience, factors that might be useful in predicting which farms or farmers are likely to be most vulnerable to crop damage by wildlife, and farmers' coping strategies.

The first paper (Hill) presents data from a study carried out in Uganda amongst farmers living around the edge of a Forest Reserve. The author outlines the species responsible for the majority of crop raiding incidents at this site, gives an indication of the range of crop losses farmers experience locally, and indicates factors likely to render individual farms/farmers vulnerable to crop damage by wildlife. However, the main focus of the paper is that it is not only important to have knowledge of how much farmers lose, when they might lose it, and the animals responsible; it is also important to understand how farmers view such conflict issues in order to help explain why people consider it to be such an important issue, even when they may not lose much in the way of standing crops.

In the second and third papers Nchanji and Rose present data collected during part of a study of farming within the Banyang-Mbo Wildlife Sanctuary, Cameroon. The physical situation here is very different to that described in the previous paper where there is a hard boundary between the forest edge and people's farmlands. In Banyang-Mbo people develop farms within the forest which means there is not necessarily a recognisable boundary between forest and farm. Although these two sites in Uganda and Cameroon are both forested sites different

wildlife species are reported to cause crop damage<sup>3</sup>. This, in addition to the fact that there is a rather different spatial arrangement of farms in relation to tree habitats, is likely to present farmers with different problems across the two sites when trying to defend crops against wildlife. This helps illustrate the point that possible intervention initiatives may need to be site-specific, though a comparative approach should yield interesting and potentially useful information.

The work presented by Rose was carried out in the same region as that by Nchanji and these studies complement one another well. Nchanji's paper focuses on the methods for quantifying crop damage sustained on forest farms. Rose presents a different data collection protocol designed specifically to investigate particular factors associated with farm location with respect to human habitation and vegetation types as predictors of risk of crop damage by wildlife. An interesting and very pertinent point highlighted by this paper is that under certain circumstances it can be difficult to predict from one season to another the level of damage crops might receive – this is an important point from the researcher's perspective as well as that of the farmer.

The final paper included here (Plumptre) reports on data collected from people living around the Parc National des Volcans, Rwanda. This paper documents the farmers' views rather than an independent assessment of crop damage, degree of vulnerability of different fields, etc. However, the results are consistent with those from other studies, including reports presented here, that farm location with respect to Protected Area boundary/'natural' habitat boundary, is a good predictor of degree of vulnerability to different wildlife species. In addition there is some evidence to suggest a possible link between crop raiding activities and poaching, whereby those individuals farming closest to the park boundary are most vulnerable to crop losses from wildlife but they are also the people most likely to poach animals from the park. Whether this is because they are generally poorer households with fewer resources or, because of their location, poaching is an easier option for them as compared with others living further away, is unclear. Notwithstanding this it is important to try to understand how the experience of losing crops to wildlife, be they heavy losses occurring regularly or small losses that occur only infrequently, can and does influence people's perceptions, attitudes and behaviour towards wildlife.

<sup>3</sup> Around the Budongo Forest Reserve baboons and bush pigs are reported to cause most crop damage; within the Banyang-Mbo Wildlife Sanctuary the species responsible for most of the recorded damage are cane rats, bush pig, buffalo, bushbuck and monkey.

## **People, Crops and Wildlife: A Conflict of Interests**

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### **Introduction**

Crop raiding by wildlife is neither a new phenomenon or a rare one, and in many parts of rural Africa and Asia is perceived to be an increasingly important issue by farmers, people working in resource management, conservation and development. Until relatively recently there has been little attention given to vertebrate species that damage crops, with the exception of elephants and rodents (Damiba and Ables 1993; Thouless 1994; Sukumar 1990; Mill 1993). Most notably, there has been little emphasis on the impact of wildlife on small-scale farmers. Instead, research and intervention programmes have concentrated on trying to reduce the threat to wildlife from local communities, encouraging the view that wildlife are a valuable resource that can attract revenue through wildlife tourism, and thus should be protected. Something that is missing from many of these programmes is an understanding of the relevant issues from the farmers' perspective.

Perhaps not surprisingly, results from a number of relatively recent studies looking at local people's attitudes towards National Parks and conservation programmes suggest that crop raiding conflict issues in particular, reinforce the attitude amongst farmers that conservation programmes and conservation areas actually contribute to their subsistence problems rather than benefit them (Infield 1988). These findings are not just pertinent for studies from tropical regions; they have also been shown to hold in studies of farmers' attitudes to wildlife and conservation within the US (Conover and Decker 1991). Such a perspective is likely to alienate local people with detrimental effects on their support for, and co-operation with, conservation policy and practice. In addition, in recent years the emphasis within conservation policy is for a more participatory approach, taking account of local people's needs and perspectives. Thus in any study of human-wildlife conflict issues it is important that local people's perspectives and understanding of the situation be explored to obtain a more comprehensive picture of the situation under investigation.

### **Methods**

The data I present here were collected during a 12 month study (September 1993 - August 1994 inclusive) of the impact of crop raiding by wildlife on subsistence farmers living around the edge of the Budongo Forest Reserve in Masindi District, Uganda. There is a high degree

of dependence on agriculture for subsistence within this community, with approximately 70% of people reporting it as their sole, or main, source of livelihood (Hill 1997).

A variety of crops are grown locally including carbohydrate staples such as maize (*Zea mays*), cassava (*Manihot esculenta*), sweet potatoes (*Ipomoea batatas*), taro (*Colocasia esculenta*) and finger millet (*Eleusine coracana*), legumes such as beans (*Phaseolus vulgaris*) and groundnuts (*Arachis hypogaea*), and some vegetables and fruits. There are two growing seasons during the agricultural year. The first season extends from March to July, and the second, shorter, season from July through October, with the main maize crop being planted in March/April and harvested during June and July. Cassava is grown throughout the year and has no particular harvest period. I visited a sample of 37 farms at monthly intervals to carry out farm surveys with two field assistants. During the initial visit a farm was mapped and its size calculated. Farm size ranges from 0.15 - 14.58 ha; the median value is 0.7 ha. The distance from the edge of the farm to the forest boundary, and plantation boundaries was estimated. We compiled a list of crops already present, and noted the number of stands planted of each of the main staple crops.

During each monthly visit we asked people to report any instances of crop damage and whether they had observed the animal(s) responsible at the time. I and/or the field assistants viewed all instances of crop damage to make an independent assessment of the likely species responsible for the damage. This was done using visual assessment of bite size, and spoor. A note was made of the type of crop, the plant part/stage of development attacked, and where possible, a quantitative estimate of the degree of damage was conducted. It was not always possible to estimate the degree of damage sustained because (i) the damage was too old for the recorder to be confident that the species responsible could be identified, (ii) the damage had occurred too long ago for the recorder to be able to make an accurate estimate of the degree of damage, and (iii) on two occasions the damage was so severe that the farmer concerned had already re-ploughed and re-planted the field with a different crop. On such occasions a note to that effect was made, but no estimates of the degree of damage were calculated, and the data were not included in the analyses<sup>4</sup>. It is recognised that because of the relatively infrequent visits made to individual farms the estimates of degree of damage, and frequency of crop damage by wildlife, are likely to be conservative estimates of what actually did occur during the study period.

<sup>4</sup> No estimates of amount of damage were made for 20 of the 70 recorded instances of crop damage, either because of not being able to identify the animal responsible, or because the damage had occurred too long ago to be able to make an adequate assessment of the degree of crop loss.

To assess the degree of damage we sampled five quadrats, 2m by 10m, from each affected crop stand. Quadrats were placed randomly within the crop stand. The proportion of crop damaged was calculated having counted the number of damaged or missing plants or plant parts. The mean of the five quadrat values for each damaged stand was taken as a measure of the proportion of crop damage sustained in any one sample. I estimated mean percentage crop losses for each farm, taking into account the number of stands planted of each crop and the proportion of stands that sustained crop damage. Where the same crop stand sustained losses in more than one month this was accounted for within the calculation of mean percentage losses.

## **Results**

### *Wildlife as crop raiders*

There were a total of 70 recorded instances of crop damage by wildlife over the 12 months of the study. A summary of the animals identified as causing crop damage, and the amount of damage ascribed to each species, is presented in Table 1. There were a number of different species recorded raiding crops from the study farms, but between them baboons and wild pigs were responsible for approximately 83% of all damage events recorded. While other animal species could cause significant amounts of damage on particular farms, it is apparent that baboons caused a much greater degree of damage locally than any other species.

**Table 1: Crop raiding by wildlife**

<b>Animal</b>	<b>No. raiding events</b>	<b>% raiding events</b>	<b>Mean % crop losses</b>
Baboon	49	70.0	24.9
Wild pig	9	12.9	13.9
Porcupine	3	4.3	14.3
Bushbuck	2	2.9	8.4
Chimp	1	1.4	3.4
Blue monkey	1	1.4	1.9
Cane rat & squirrel	2	4.3	13.2

The degree of damage sustained by five staple crops is summarised in Table 2. It is apparent that maize and cassava stands were damaged most frequently, and a greater degree of losses were recorded for these species, as compared with other crops. Across the whole sample the level of crop losses (at approximately just over 10 - 13%) are comparable with losses deemed acceptable within highly mechanised farming systems. However, when we look at the sub-

sample of farmers who actually experience losses we can see that these losses can be very substantial indeed, and obviously potentially devastating to individual households.

**Table 2: Summary of crop losses across the year**

Crop	No. raiding events	Mean % loss on farms experiencing damage	Mean % loss (whole sample)
Maize	25	26.8	10.1 [0 – 59.3]
Cassava	27	36.0	12.7 [0 – 60.7]
Sweet potatoes	4	14.2	0.8 [0 – 23.6]
Beans	6	22.0	2.4 [0 – 43.3]
Groundnuts	4	43.0	3.5 [0 – 58.8]

Are all farmers equally vulnerable to wildlife crop raiding activities? During the pilot study over 90% of people interviewed claimed that their fields suffered crop damage as a consequence of crop raiding by wildlife (Hill 1997). However, not all farms were equally at risk from crop damage by wildlife. Approximately 40% of the sample did not experience any crop raiding by wildlife during the period the farms were monitored. It is also important to note that wild animals did not visit all affected farms equally frequently.

Previous work at this site has shown that factors likely to affect vulnerability to crop raiding include (i) the distance from farm to forest edge and (ii) the number of other farms lying between any field and the forest (Hill 1997; Hill 2000). There was no damage by baboons recorded from farms lying further than 450m from the forest edge, and no damage by wild pigs recorded beyond 300m from the forest edge. The majority of farms experiencing any damage by either of these species lay at the forest edge and/or had no neighbours farming the area between them and the forest boundary. Thus proximity of farm to forest boundary and the presence/absence of neighbours farming the intervening land, are good predictors of vulnerability to raiding behaviour by wildlife. Other studies also confirm that it is those people closest to forest or Park boundaries that are at greatest risk from larger bodied animals, but the actual distance from the boundary beyond which farms are not likely to be raided varies according to the species responsible for crop damage (Naughton-Treves 1996; Plumptre and Bizumuremyi 1996).



Locally people acknowledge that proximity to the forest edge is potentially risky, but a more frequent observation refers to the fact that having neighbouring farms between your land and the forest edge is beneficial in reducing the likelihood of crop damage. People frequently commented that if you had a ‘good’ neighbour you were unlikely to suffer crop raiding by forest animals. In this context ‘good neighbour’ referred to a Zairois family – considered good or helpful neighbours because they are regarded as skilled hunters, thus few, if any, animals are thought to escape the family cooking pot.

#### *Crop protection strategies and coping strategies*

The main method used locally to protect crops from wildlife is by patrolling the fields and chasing out intruding animals - particularly groups of baboons. This is done mostly by the women and children, even though people comment that baboons are far less fearful of women and children than they are of men (this is substantiated by personal observation). People sometimes use dogs, spears, bows and arrows, and bells to help scare away raiding primates and pigs, and people work co-operatively, helping to chase away intruders from their neighbours’ fields as well as their own. People are aware that killing wildlife (other than ‘vermin’ or pest animals) is illegal. However, “not killing any animals under any circumstances” seems to be the message that local people have acquired from various talks and meetings they have had with local forestry and conservation personnel – so, although baboons are killed occasionally, this is generally a rare event.

#### **Can farmers predict when crops are most at risk from baboons or pigs?**

An important consideration is how crop damage is distributed across the agricultural year. Does damage occur seasonally or year round – because this may have an impact on how people cope. The results of this study confirm that baboons are likely to visit fields all year round, and while they eat maize preferentially, they will also feed on cassava. Thus farmers, whose farms are located close to the forest boundary, are potentially at risk of losing staple crops year round (Hill, 2000).

Although pigs eat cassava preferentially, and it is available all year, they do not cause damage year round. Crop damage coincides with the maize harvest time (June - August) and in December. An important point with respect to wild pig raiding activity is that these animals forage at night, so fields have to be protected at night. Guarding against pigs is men’s work because it requires people to spend the night near the bush, away from the village. Bush spirits are a particular threat to women and children who are therefore encouraged to stay

within the confines of the village once night falls. Families that can afford to will hire a guard to protect their fields at night; otherwise adult male members of the household do the job. This leaves women-headed households particularly vulnerable to crop damage by wild pigs – not only are they unable to supply their own male labour from the household but they are generally poorer so are unable to hire extra labour. It is unclear as yet whether the apparent seasonal pattern seen in pig damage to crops is a reflection of wild pig raiding activity being seasonal in nature. Alternately it may be more to do with the fact that during December and June through August it is difficult to guard at night, either because people are away (this includes hired labour) for the Christmas holiday period or, during the harvest time everyone, including men, are required to work hard during the day either harvesting maize or preparing it for storage, so people are unable to also stay awake at night to guard fields. This is an area that will be investigated further in a future study.

Certainly guarding can help reduce crop losses but given the nature of raiding activity, people would need to guard throughout much of the year to protect their crops adequately from the raiding activities of baboons. Increasing the amount of time that people invest in guarding their crops is not necessarily a practical solution – particularly as certain households may already be facing labour bottlenecks, without investing extra time and labour in guarding fields.

### **Discussion**

While wildlife crop raiding can pose a significant threat to field crops, and thus farmer's livelihoods, not all farms are equally vulnerable, and for some people the potential risks are not as great as they claim. Certainly where there is a potential risk the effects can be extremely costly to the farmer both in actual crop losses and the economic (and energetic) costs of protecting crops. However, I would argue that people's actual perception of risk is perhaps as important an issue as the actual losses incurred by some individuals. People's decisions about how to behave are, at least in part, influenced by the way they perceive the problem, and if this is an issue that is going to influence people's views about the value of conservation programmes locally, then their concern over crop raiding is going to be an important factor for such programmes, irrespective of whether they have actually suffered severe crop losses or not.

Given that farmers have been coping with the problem of competition with wildlife for many years why do people feel so strongly that it is becoming increasingly hard to cope with?

From numerous discussions it is clear that people consider that nowadays they have little control over the situation, yet they say that this was not always so. In the past there were organised village hunting parties that occurred just prior to, or around the beginning of the planting season(s). People thought that by having extensive, organised hunting parties at this time, it maintained animal populations at levels that kept crop losses low, and warned animals away. This was thought to be an effective method of reducing crop losses, and provided a source of bushmeat, i.e. a form of compensation for any losses that occurred. Up until the time of Independence there were also game guards posted locally whose job was to chase troublesome wildlife back in to the forest. Although the game guards were primarily concerned with elephant control, to protect tree stands and local plantations, local small-scale farmers also benefited because villages would get the carcass of any animal killed on their land (sold or eaten). Additionally, local district records suggest that the guards regularly shot baboons which was viewed favourably by the local farmers.

To illustrate what I mean by people's perception of their degree of control of the situation I want to use an example comparing people's responses to birds and baboons. Weaver birds are common pests of grain crops throughout Africa. I frequently observed flocks of weaver birds feeding on rice, millet and young maize crops, yet when I asked about them people claimed that they were not a particular problem, unlike baboons. This was explained as follows: "birds come to the fields early in the morning and again late in the afternoon/early evening – these are times when the children are free from school so can be sent to the fields to scare the birds". But when people talk of baboons they present a very different picture. Baboons are considered to be unpredictable - they can come at any time and they will eat whatever is in the field, and what they do not eat they destroy. My data certainly confirms that crop damage attributed to baboons did not occur seasonally - maize and cassava crops are potentially vulnerable to damage at all times when they are present in the fields – providing the fields are close to the forest. People think they can predict when birds are likely to damage fields and consider their coping strategy to be an effective one. However, they cannot predict when baboons are likely to appear, and they do not consider guarding to be an effective strategy against them. The key point here is that in addition to baboons causing more damage than other species, they are also considered very difficult to deal with because 1. people cannot necessarily predict when or whether they will visit an individual farm, and 2. the protection methods available are not considered adequate.

To conclude, I suggest that while wildlife locally certainly does cause considerable damage to some farms, it is not just actual losses that impact on these farmers – while individuals carry the direct costs of crop losses the wider group of farmers also perceive themselves to be at risk from wildlife – this is at least in part influenced by the fact that they feel they have lost what few effective means of control they ever had, combined with a compensatory source of meat. When viewed in this way perhaps it is not so surprising that wildlife and crop raiding is an issue that concerns more than just those who are directly affected by it. If the issue of reducing farmer-wildlife conflict is to be addressed, and from a conservation perspective as well as an agricultural development perspective, it would seem imperative that it is taken notice of, then it is important to understand how and why this problem affects more than just those who suffer serious crop losses.

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# **Crop damage around Northern Banyang-Mbo Wildlife Sanctuary**

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WCS Cameroon

## **Introduction**

Around Banyang-Mbo Wildlife Sanctuary, especially in the northern part, complaints of crop damage by wildlife have continued to come to the project and government offices from the bordering villages. Some of these complaints are so lauded that without quantitative data to raise reasonable arguments and sensitise the people, they may not only strain the relationship between the local communities and the project, but also will influence and mislead policy makers at all levels. Often these complaints are against the larger mammals (elephants and buffaloes) that inflict more noticeable damage to crops in the gardens during a single foray. There may be other raiders that are usually more frequent visitors throughout the growing period of the crops and may cause more damage on aggregate in the final analysis.

Crop damage in the Banyang-Mbo Sanctuary area at the moment, like elsewhere, does not seem to have any immediate solution. Solutions offered so far are either temporary or experimental, and sometimes unrealistic. A better understanding of the facilitating factors, as well as ecology of the various raiders, will certainly contribute to the development of measures that may assist in the management of the problem and reduce the conflicts.

This project was initiated with the aim to:

- identify the different raider species around the northern part of the Sanctuary,
- quantify the losses to principal crops caused by the different raiders,
- investigate major possible facilitating factors to crop raiding,
- and investigate existing crop protection methods used in the area and their effectiveness.

## **Methods**

### **Study area and site**

This study was carried out in the northern part of the Sanctuary because of the frequent wildlife crop damage complaints that come from that area. In addition, communities in this area, to date, have a good social relationship with the project and are more co-operative than other communities around the Sanctuary. This section of the Sanctuary is also easily

accessible by vehicle throughout the year, an important consideration given the amount of detail needed and the limited time we had to concentrate effort to a limited area.

A reconnaissance survey was conducted in all 16 villages in this area and only those with farmlands towards the Sanctuary (9) were pre-selected for secret ballot to randomly select three villages for the study sites. Because the conditions were very similar we presumed that this number was the optimum for a realistic detailed monitoring exercise. Defang, Fotabe and Tali 1 were eventually chosen.

### **Sampling sites**

Within each of these villages, the area towards the Sanctuary with the highest concentration of food crop gardens and/or cocoa plantations was pre-selected. The land tenure system in the area permits farming along corridors with no clear demarcation for food crops and cash crop limits. An approximate line transect was made from the village through these gardens/plantations to the one nearest the Sanctuary. Starting with the first garden encountered along this transect, moving from the village towards the Sanctuary, we selected newly made gardens at approximately 200m intervals. Each garden contained maize, cocoyams, cassava and melons, or at least two of these crops. New gardens were selected to enable us to monitor crops at stages of growth from sowing to maturity. Similarly, active cocoa plantations were selected along the same, or similar, transect at approximately 400m intervals because these were usually larger than the gardens. This method of selection gave us a sample size of 13 of 29 food crop gardens in Defang, 13 of 32 gardens in Tali 1, 14 of 27 gardens in Fotabe and 8 of 19 cocoa plantations in Defang, 7 of 17 plantations in Fotabe, and 5 of 11 plantations in Tali 1.

We also undertook opportunistic observations and assessments of reported cases of crop damage by wildlife, especially those cases attributed to the larger mammals (elephants, buffaloes and bush pigs), in all the villages in the north of the Sanctuary to supplement the data systematically collected at the study sites.

### **Crops to monitor, land tenure and farming practice**

We used Participatory Rapid Appraisal (PRA) and interpersonal discussions to ascertain the most important crops grown, the land tenure system and farming practices in the area. This was supplemented with field observations. The most important crops were cocoa and coffee for cash crops; maize, cassava, cocoyams, melons, oil palms, plantains and banana for food

crops. With the exception of melons, other vegetables were not considered in this study because they are cultivated in very small quantities locally, as was the case for oil palms, plantains, bananas and coffee.

### **Estimating initial stock on garden/plantation**

#### *Food crops*

The approximate size of each garden selected was estimated by determining the area of its best-fit polygon using a hip-chain and compass. In April, when crops were fully sprouted, we determined mean number of mounds (cultivation units in the area), and each crop per mound, by counting the number of mounds in randomly selected 10m x 10m plots placed throughout the garden at 15m intervals, starting from the south-east corner of the garden. The slots were located along gridlines superimposed at 10m intervals along the southern edge of the garden, using the hip-chain and compass. The number of these plots varied from 10-25, depending on the size of the garden, and covered about 15% of the estimated area of each garden. Garden size ranges from 282.4 – 4,815.2m<sup>2</sup> with a mean size of 1,472.7m<sup>2</sup>. As crops reached maturity we randomly harvested a certain number (10 cobs of maize, 30 coco-yam tubers and 15 cassava tubers) from each garden and converted to tonnage by weighing using a 10kg spring balance.

#### *Cash crops (cocoa)*

When cocoa pods were fully established (in July), we determined the mean number of mature cocoa trees by making total enumeration on 50m x 50m plots placed at 30m from the south eastern corner of the plantation, along gridlines superimposed at 50m, using the hip chain and compass. Plantation size ranged between 3,108.6 – 62,425.3 m<sup>2</sup>, the average plantation being 20,760.02m<sup>2</sup>. The number of plots varied from 3 – 15 depending on the size of the plantation, and covered about 10% of the estimated area. This was used to calculate the total number of cocoa trees in the plantation. Starting from the south eastern corner of the plantation, the mean number of cocoa pods per tree was determined by recording the number of pods on cocoa trees at approximately 10m intervals, on gridlines superimposed on the plantation at 20m intervals from a base line in the southern edge. The number of trees enumerated varied from 100 to 1200 trees, and included about 10% of the total number of estimated trees in the plantation. This was used to extrapolate the total number of cocoa pods in the plantation.

When cocoa pods were ripe (in September), we used a 10kg spring balance to measure the mean dry weight of beans extracted from 30 randomly selected pods in each plantation. This

value was later used to convert pods into tonnage (kilograms), i.e. the estimated number of pods in a plantation, divided by 30, multiplied by the estimated weight of beans from the 30 pods.

### **Monitoring and quantifying damage**

We revisited the garden/plantation every two weeks to monitor damage by wild animals and collected data as follows:

#### *Food crops*

During each visit 4–6 people spread out along the southern edge of the garden starting from the south-eastern corner. They slowly walked a straight path through the garden, using a compass to align themselves each time, and recorded any crop damage observed. Cumulative records of each visit were determined to obtain total crop damage. Plants only partially damaged (in the case of cassava and coco-yams) were marked and not scored again for damage unless they were observed to have been totally destroyed in subsequent visits. The difference in yield between non-destroyed crop and a partially destroyed crop is equal to the quantity damaged when both are harvested at maturity, while yield of totally destroyed crop is assumed equivalent to that of non-destroyed crop harvested at maturity. I estimate percentage crop loss by taking into account the final yield of each crop and the initial stock in the garden.

#### *Cash crop (cocoa)*

During each visit 4–6 people spread out from the south-eastern corner of the plantation along a base line cut in the plantation's southern edge. They walked through the plantation, along the centre of a transect line, observing a strip of plantation of standard width, and recorded any pods damaged. Observers were careful and methodical, and it is assumed that very few or no damaged pods in the strip were unnoticed during observations. Again percentage cocoa loss was estimated, taking into account final estimated yield and the proportion of pods damaged.

### **Facilitating factors**

Facilitating factors investigated included age of crops:

- maize: shoots, tassels, immature and mature cobs
- cassava: shoots, young tubers, mature tubers
- cocoyam: as for cassava
- melon: shoots, creeping, young fruits, mature fruits
- cocoa: okra sized fruits, immature fruits, ripe fruits.



Farming and land tenure systems, crop associations, distances of gardens or plantations *vis-a-vis* the villages and forest, hygiene of gardens (clean, dirty, very dirty) and the vegetation surrounding the gardens and plantation (other crops, fallow, secondary forest, virgin forest) were also investigated.

### **Identification of raiders**

Crop raiding commonly occurred at night, and animals were rarely observed raiding. I identified raiders by using signs left behind such as footprints, teeth impressions, dung, hairs, etc. Where signs were similar and confusing for two or more raider species (e.g. feeding signs of porcupine and civet cats on cocoa pods), I spent nights in the field until the raiders were observed directly with the aid of searchlights, and the typical micro distinguishing signs were established.

### **Protection of gardens/plantation**

Fencing, trapping hunting, mounting scarecrows, guarding, drumming in the farms and the use of fire and smoke are some methods commonly used to protect crop gardens/plantations against wildlife damage. I recorded the presence or absence of these and any other methods of crop protection observed in the gardens/plantation. Where a protection method was present we also noted whether it was effective or not in keeping away the raiders.

## **Results**

### **Land tenure and farming practices in the study area**

Land in northern Banyang-Mbo is communally owned and under the control of the village head and the traditional council. Any indigene wishing to own forested land simply chooses a suitable area, starts cultivating it, and notifies the village authority. There is no limit to the amount owned until some other person(s) join him in the area, and then both parties agree the amount each can own. Once this has been determined, the area becomes private land inheritable by a person's children. He practices a 4 – 5 year fallow within this piece of land for food crop production, and can also put part under cash crop production. Farming here is characterised by mixed cropping in small gardens that are encircled by different vegetation types that range from complex fallows to mature secondary forests (virgin forest). The machete and hoe are the main tools used in forest clearing and land preparation for crop production.

## **Crop production in study sites**

### *Food crops*

Food crops are produced on small gardens (size range 387.6m<sup>2</sup> to 4080.9m<sup>2</sup>) which are characterised by a high level of mixed crops (3 – 5 crop species) of no regular pattern. The total cultivated land included in this study was 16,387m<sup>2</sup> in Defang and 24,915m<sup>2</sup> and 14,172m<sup>2</sup> in Fotabe and Tali 1 respectively. The total estimated crop production was 2,133.2 kg of maize, 13,096 kg of cocoyams, 8,789 stems of cassava, and 39,702 stems of melons in Defang; 2,798 kg of maize, 10,977 kg of cocoyams, 13,040 stems of cassava, and 43,736 stems of melons in Fotabe, and 2,240 kg of maize, 12,544.7 kg of cocoyams, and 8,056 stems of cassava in Tali 1.

### *Cash crop (cocoa)*

Cocoa plantations were larger than food crop gardens. Mean plantation sizes were 20,982.6m<sup>2</sup>; 17,458.5m<sup>2</sup> and 25,070.5m<sup>2</sup> respectively in Defang, Fotabe and Tali 1. Total estimated cocoa production was 10,579 kg in Defang, 7,734.7 kg in Fotabe and 13,078.1 kg in Tali 1.

## **Crop loss**

### *Food crops*

Loss of maize to wildlife ranged from 1.9% in Fotabe to 21.9% in Tali 1. However, stunting was the main cause of maize loss, and accounted for about 22.5% - 25.1% loss of the total estimate. Cassava loss to wildlife was 2.4% - 15.1%. Generally loss of food crops to wildlife was greatest in Tali 1.

Cane rats and birds were common raiders at all study sites, but cane rats were the most notorious, causing the greatest loss of maize and cassava in all villages. The impact was greatest in Tali 1, where cane rats accounted for about 20.5% loss of the total maize and 15.1% of total cassava, and more than 85% of maize in some individual gardens. Birds, monkeys, and bushbuck were not observed to raid cassava. Bugs defoliated much of the melons shortly after germination, and unpredictable rainfall caused melon rot in more than 95% of the gardens in the area, thus monitoring was stopped.

During this study we did not observe any damage to cocoyams from wildlife other than bushbuck that nibbled the leaves occasionally. However, farmers reported that francolins, cane rats and buffaloes sometimes damage their cocoyams. Bush pig destruction has not yet

been observed in gardens being monitored but it has been observed opportunistically to cause 15.8%, 27.4%, 40.2%, 92.4% and 100% damage, in 5 respective instances, to available mature stock of cassava during single forays in Tali 1. Monkeys and cane rats were opportunistically observed to raid plantains and bananas in all the villages.

### **Food crop raiding by stages of growth**

The degree of damage to various crops varied widely according to their stage of maturity. Cane rats raided maize and cassava at all stages of maturity. Cane rats' damage to maize crops peaked during the time when immature cobs were available, and then declined as the cobs matured. Other raiders damaged crops only at specific stages.

### **Food crop damage and distances from the villages**

Gardens were located at a distance of 70m – 4,213m from the village of Defang, 225m – 1,893m from Fotabe and 244m – 2,550m from Tali 1. Cane rats raided crops to almost the same magnitude at all distances from the villages. Bush pig, buffalo, bushbuck and monkey raided crops beyond 1,000m distance from villages. Birds occurred haphazardly and raided at random.

### **Vegetation surrounding gardens and crop raiding**

Birds raided crops in 30% of the gardens in the area and these were mostly surrounded by fallow and young secondary forest. However, they were not observed to raid crops in gardens surrounded by other crops or mature secondary forest (virgin forest). Monkeys raided only in one garden and this was bordered by mature secondary forest. Cane rats occurred and raided in all vegetation types, but the degree of damage they caused was more (mean loss of maize 14.5%) in gardens surrounded by fallow and young secondary forest compared to 4.7% in all the others.

### *Cash crop (cocoa) loss*

Cocoa loss to wildlife was between 0.97% in Defang and 5.05% in Tali 1. However, it was observed that more than 30% loss of cocoa in the area was due to black pod disease. The monkey, squirrel and porcupine were the most notorious cocoa raiders in all the villages, accounting for 3.16%, 3.03% and 1.77% of total cocoa loss in the area. Squirrels raided cocoa in all plantations. Elephants and buffalo were observed to raid in one plantation in Tali 1, and two plantations in Fotabe, and accounted for about 0.32% and 0.01% of cocoa loss in these villages. The most surprising cocoa raider was the civet cat, an animal that is known to

be an omnivore. It accounted for about 0.63% loss of cocoa raided in the sites observed during the study. Farmers also reported that black snakes (cobra) raid cocoa but we neither observed this nor have sufficient evidence to prove it.

### **Cocoa raiding and distance from the villages**

Plantations were located at a distance of 756m – 4,634m from Defang, 87m – 3,051m from Fotabe and 1,171m – 5,132m from Tali 1. Squirrels, porcupines and civet cats damaged cocoa in all plantations irrespective of distance from the village. Elephant and buffalo raided plantations lying beyond 2,000m from the village, and monkeys caused damage to crops beyond 1,000m from the village.

### **Cocoa raiding and stages of pod maturity**

Duiker and buffalo were observed to raid cocoa pods only when they were of okra size. Squirrel, porcupine, monkey and civet cat raided pods when they were mature or approaching maturity. Elephants caused damage at all stages of maturity.

### **Cocoa raiding and surrounding vegetation of the plantation**

Buffalo, elephant and monkey raided mostly in plantations surrounded by matured secondary or virgin forest. Squirrel, porcupine and civet raided in all vegetation types, but caused more damage to plantations surrounded by fallow and secondary forest.

### **Crop protection**

We observed only five attempts made to fence the gardens to prevent cane rat damage when maize was tasseling. These were two each in Defang and Tali 1, and one in Fotabe. One of these was inter-spaced with snares to trap cane rats. One lady laid fresh banana/plantain leaves along the garden edge, and another person used fresh palm fronds to prevent cane rat damage to their crops. Bunches of bananas/plantains were observed covered with old clothes to prevent monkey raids. One cocoa farmer occasionally drummed in his plantation to scare away monkeys. A few snares set by hunters who were not farmers were observed in the farmland vicinity. These were not specifically for defence of crops against animals, but were mainly for trapping meat. No other attempts to defend crops from other raiders were observed.

## **Discussion**

The difficulty faced in using the machete and hoe to fell big trees and prepare the ground prevents people from cultivating large tracts of land. The need to have many crops, despite having a small garden, accounts for the high crop mixture. The land tenure system is simple and straightforward to allow individuals to acquire land fast. Unfortunately, people have tended to amass large areas of land and impose restrictions, which prevents uniform agricultural development. This farming system promotes the presence of secondary forest that is a preferred habitat for small mammals, even when close to human settlements. This in turn encourages crop damage. Young men returning to farming from the cities because of the present economic conditions, have to go far from the village to acquire land. This means moving into areas occupied by the larger mammals that will raid almost all crops once they visit these farms. This situation does not seem to give any hope for a successful solution to the issue of crop damage in the area.

This study has also shown that the greatest and most regular raiders of principal food and cash crops in the area are small mammals, especially rodents (cane rat, porcupine, squirrel) and the civet cat, and not the large mammals (elephant and buffalo) which people often complain about. These smaller species are less well studied, and even the farmers have often underrated their impact, maybe because of their small size.

It was observed and recorded on several occasions that buffalo, bushbuck and duiker walked through several gardens/plantations in Defang and Fotabe without raiding any crops. However, the presence of these large mammals, especially buffalo, in farmlands was a source of fear in farmers, especially women, and they would run back home with complaints of insecurity after observing fresh footprints. In Tali 1, five cocoa plantations located beyond 3 km from the village have been abandoned by their owners because they dreaded attack by elephant or buffalo that they believe are unpredictable visitors though the movement of these animals into the area is apparently seasonal.

Maize and cassava are among the most intensively raided crops while cocoyams do not seem to be vulnerable to damage while in the garden. In almost all the gardens more monitored maize was lost to stunting than from damage by wildlife. This may be due to poor soil conditions and much shade on the maize from the trees in the area. It would be interesting to encourage the farmers to grow more cocoyam in preference to maize, which is most vulnerable to damage and does not do very well in the area.

It was surprising to find that few people took measures to protect their crops, especially against the notorious raiders – cane rat, porcupine and bush pig. These species are not totally protected by the conservation laws of Cameroon and could be killed. However these animals do not provide much meat or trophies that can be sold, unlike the elephant and buffalo.

In the next phase of this study we will experiment by fencing some gardens, and trialing several trapping methods to evaluate them as potential management strategies to cope with troublesome raiders in gardens and plantations in the area.

### **Acknowledgements**

We thank all the farmers who allowed us to use their gardens and plantations for our study. We also thank the village authorities and village people in the area for their collaboration and hospitality during this study. The Dutch Government funds this work.

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## **Crop raiding around the Parc National des Volcans, Rwanda: Farmer's attitudes and possible links with poaching.**

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### **Introduction**

The Parc National des Volcans in NW Rwanda is known for its mountain gorillas and the tourism associated with these animals. More than forty years of research in this park, much of it based from the Karisoke Research Centre, has focussed on the mountain gorillas but little is known about the broader ecology of the park. There has not been much work on the other animals that occur in this park, although a study of the larger mammals was undertaken in the late 1980s (Plumptre 1991, Plumptre & Harris, 1995). This research showed that buffalo and bushbuck densities were high in the park and that these two species formed the bulk of the large mammal biomass (Plumptre & Harris, 1995). At this time, buffaloes were being cited as a problem by the people living around the park because they came into their fields to raid crops. Between 1990 and 1994 the civil war in Rwanda, that eventually led to the genocide, prevented further work on these animals. During 1996 I carried out a survey of the impact of the Rwandan civil war and genocide on the ungulate populations and, at the same time, interviewed households living around the park about crop raiding problems and hunting of the animals for meat (Plumptre and Bizumuremyi, 1996; Plumptre *et al.*, 1997). This survey

raised some interesting questions about the potential link between crop raiding and poaching, and a summary of the findings is presented here.

### **Methods**

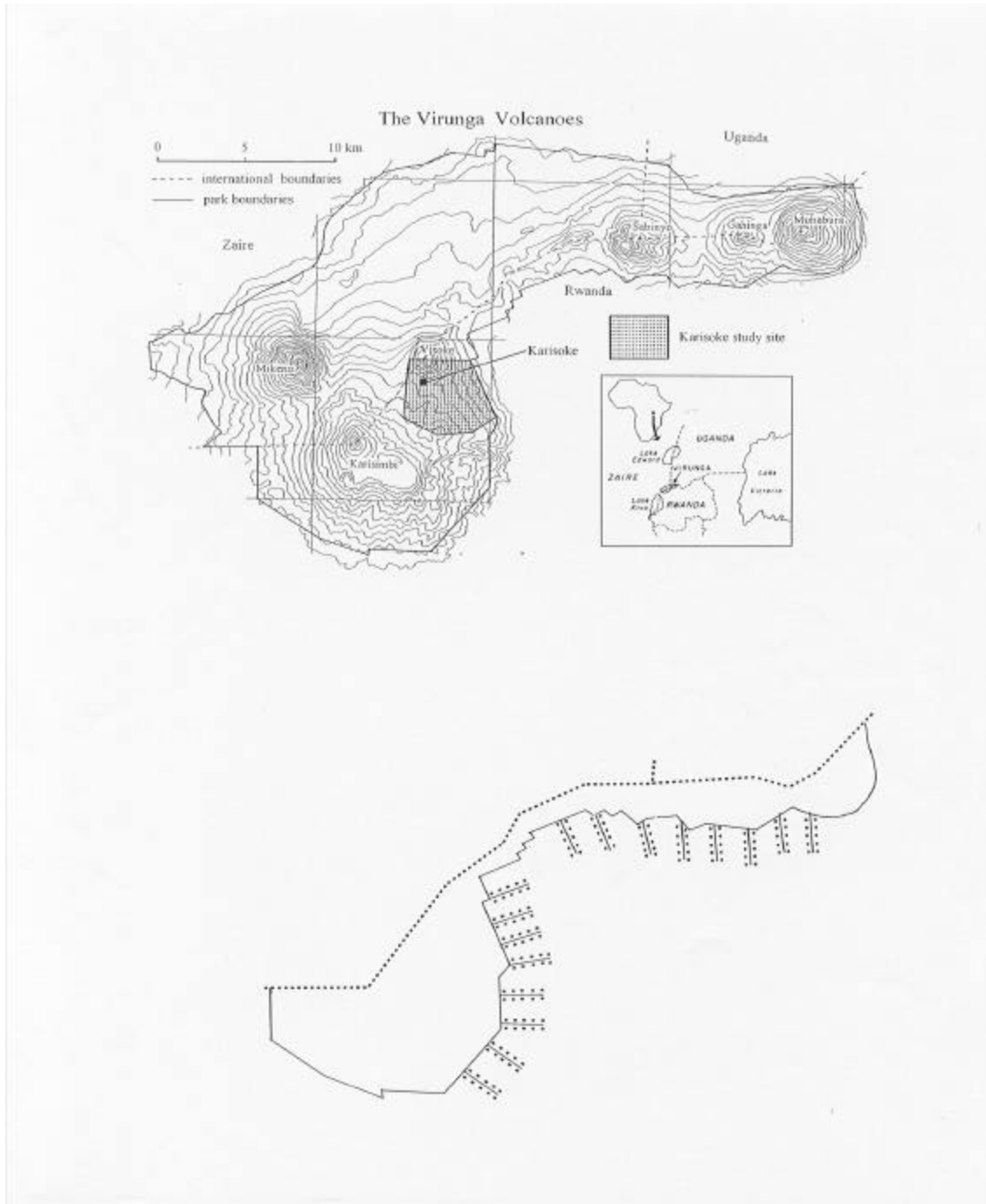
Two people were identified (one living near the western part of the park and one near the eastern half) who were not employed by the Karisoke Research Centre, or the park authorities. These two were trained to carry out a questionnaire survey amongst the people living around the PNV. The advantage of using such Research Assistants was that they came from the local community, knew who many of the hunters were, and could more easily approach people to ask them delicate questions about any illegal activities they might undertake. The questionnaire aimed to investigate three main subjects:

1. Provide a breakdown of the economic status of people living around the park.
2. Estimate the frequency with which animals from the park raid crops.
3. Determine the extent to which people hunt animals on their land or in the park.

The order of the questions was designed to lead the interviewee through the first two subjects in a way that aimed to encourage the interviewee into responding to questions about the last subject (i.e. if the interviewer did not express concern/surprise following the admission of a minor offence the interviewee might be encouraged to admit to more major offences). Nobody accompanied the interviewers because we did not want any person associated with the park to be present. Not all people interviewed were prepared to answer questions about hunting however, and some may have replied that they were not involved when they were. It is likely therefore that the results presented here are minimum estimates. Any questions that people refused to answer were recorded as missing values in the data. The questionnaires were practised with several households in the village of Bisate before the Research Assistants went off on their own.

The two Research Assistants each walked 8 transects of 2.5 km length perpendicular to the park edge (Fig. 1). Two houses were selected for the questionnaire within each 500 metre interval along these transects so that the effects of distance from the edge of the park could be analysed on crop raiding and hunting. In addition extra houses were visited where it was known that people involved in hunting lived. A total of 181 households were visited by both assistants.





**Figure 1.** A map of the Virunga volcanoes with a second outline of the Parc National des Volcans showing the location of the transects used to survey the 181 households.

The human population density around the PNV is between 300-600 people per square kilometer, and consequently the park has a very definite edge separating the forest from cultivation. It was therefore possible to investigate the effects of distance from the park boundary on people's perceptions of the crop raiding problem.

**Results**

*Measures of wealth and crops grown*

Several measures of wealth were made when interviewing each household to enable later analyses of the differences between richer and poorer households' responses; area of land cultivated, livestock owned, regular income from employment and ownership of a bicycle or a radio were all recorded (Table 1). This analysis showed that in general people living to the east of the park were wealthier than those living in the west. Three main crops are grown in this part of Rwanda: potatoes, sorghum and wheat. These were the only crops identified by the households as being their most abundant crop. These three crops with tobacco and maize were identified as being the most valuable crops and this is probably because these five fetch high prices away from the area. Potatoes in particular fetch a high price if sold in Ruhengeri (nearest town to the park) or Kigali, the capital city.

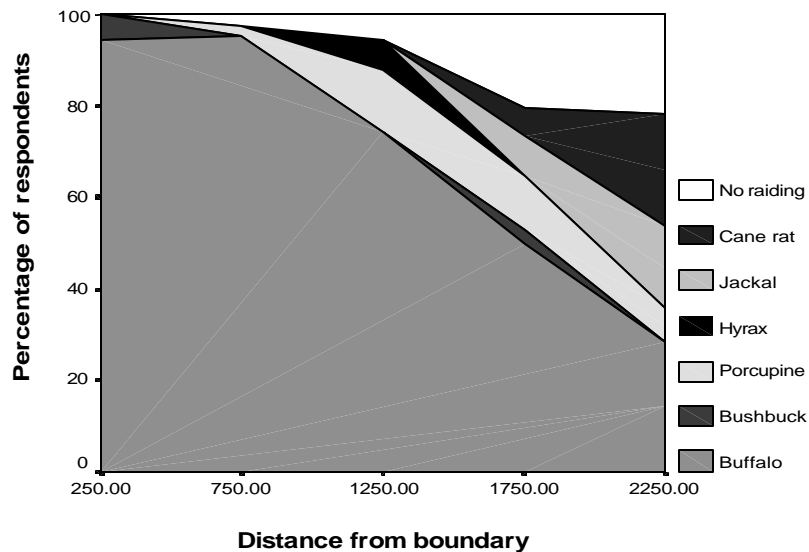
**Table 1. A breakdown of the community, its composition and measures of wealth, in the west and east of the park and for all respondents combined. The percentage involved in hunting in their fields and in the park and the percentage buying meat are also given.**

	West of park	East of park	Combined
Number interviewed	90	91	181
Mean no. adults/house	2.3	2.7	2.5
Mean no. children/house	4.4	5.3	4.8
Mean no. years lived here	23.4	32.5	28.0
Mean no. goats/house	1.7	1.6	1.6
Mean no. sheep/house	2.2	1.0	1.6
Mean no. cows/house	1.4	0.8	1.1
Mean area of land (ha)	1.3	1.5	1.4
% with employment	3.3	18.7	11.0
% with bicycle	4.4	31.9	18.2
% with radio	35.6	57.1	46.4
% hunting in fields	20.0	37.4	28.7
% hunting in park	7.8	14.3	11.0
% buying wild meat	18.9	47.3	33.1

*Crop raiding animals and distance from the park boundary*

Almost all respondents (91.2%) faced problems from crop damage caused by wild animals. The vast majority of respondents (71.3%) claimed that the buffalo was the worst offender

followed by the bushbuck as the second worst offender (40.3%). Responses changed however with distance from the park boundary (Fig. 2). Buffalo, bushbuck, duikers and porcupines (those animals that crop raid most frequently) all showed strong negative correlations (Spearman rank:  $P < 0.001$  for all species) between crop raiding frequency and distance from the park boundary. Both potatoes and wheat plants are consumed by buffalo and bushbuck; however sorghum tends not to be consumed except by cane rats.



**Figure 2.** Variation in household responses with distance from the park boundary to the question of which animal is considered by them to be the worst for crop raiding in their fields.

#### Percentage of community involved in hunting

A reasonably large percentage (28.7%) of people admitted to killing animals that venture out of the park into their fields, and more people admitted to doing so near the eastern half of the park (Table 1). 11% of people interviewed admitted to hunting in the park. 33% of interviewees admitted to buying meat from hunters.

#### *Hunting in fields*

Bushbuck and buffalo were the two most commonly caught species in farmer's fields although their contribution has declined over the period of the war (Plumptre *et al.* 1997). The methods used to hunt animals in fields is by snare or pitfall trap, although farmers will opportunistically hunt with spears or even throw rocks to try to kill a crop raider.

*Hunting in the park*

All of the hunting admitted to in the park was by the use of snares. The only animals that hunters admitted to catching by trapping were bushbuck and duiker. It is known that buffalo traps<sup>5</sup> are also set in the park, but these animals are rarely caught.

*Who hunts?*

What type of people become involved in hunting? In an attempt to answer this question the measures of wealth in Table 1 and the distance the farmer lived from the park edge, were tested to see if there was a difference between those that admitted to and those that denied hunting in their fields and hunting in the park. People hunting in the park were significantly poorer (had fewer livestock, and less land) and lived close to the park boundary (Table 2). Although 11% of people questioned admitted to hunting in the park this rises to 27% for households within 1 km of the park.

**Table 2. The mean values of measures of wealth for people who admitted and those who denied hunting in the park.**

	Non-hunters	Hunters	Significance
Distance from park (m)	1,166	695	**
No. children	4.9	4.2	Ns
No. sheep	1.7	1.0	*
No. goats	1.7	1.0	*
No. cattle	1.1	0.9	Ns
Livestock biomass (kg)	300	225	*
Area of fields (ha)	1.5	1.0	**
Time lived there (yr.)	28	29	Ns
With employment (%)	12	0	-
With radio (%)	47	45	Ns
With bicycle (%)	19	10	ns

Livestock biomass was calculated as: no.cows\*200 kg +no.sheep\*25 kg + no.goats\*20 kg. The results of Mann-Whitney tests and Chi<sup>2</sup> tests (employment, radio) are given (ns=no significant difference. \*=P<0.05; \*\*=P<0.01; - = untestable because of 0 score).

People hunting in fields were those who had significantly more children (mean of 5.4 vs. 4.6; P<0.05) and had lived longer in the region (mean of 32 years Vs 27 years; P<0.05). Number of children was correlated with the time spent living at a house, however (r=0.31, P<0.001). Interestingly there was no difference for these categories in any measure of wealth and even people who were employed hunted an animal if it strayed onto their land. There were no

<sup>5</sup> A buffalo trap consists of a circular ring of spikes attached to a large log which traps the leg of the animal and the weight of the log prevents it from moving away, rather than a wire or rope noose on a tensioned piece of bamboo.

significant correlations between farm area and distance from the park edge or time spent living there.

*Buying and selling of bushmeat*

The mean frequency of buying bush meat in June 1996 was 3.5 days/year for all households asked. However some people may have been reluctant to admit to buying at present. A more realistic figure of buying may be 7.4 days/year which was the mean number admitted to during the period of the civil war. If only those people who admitted to buying meat are analysed then the rates increase to 10.7 or 22.3 days/year. By comparison, on average people ate goat 3.0 days/year; mutton 4.2 days/year and beef 2.9 days/year or a total of 10.1 times a year. Consequently bushmeat consumption, for those who buy, doubles their annual intake of meat and may triple it.

The price of meat has decreased significantly for bushmeat and increased significantly for domestic meat following the war (Plumptre et al. 1997). The animal most commonly bought as bushmeat is the bushbuck (77% of respondents) followed by the duiker (23%).

*Who buys bushmeat?*

Households that bought bushmeat were those that had fewer domestic animals (Table 3). All other tests of wealth were not significant. People with some form of employment showed a greater tendency to buy bushmeat (50% vs. 31%) than those who only farmed their fields ( $\text{Chi}^2=2.89$ ,  $\text{df}=1$ ,  $P=0.09$ ).

**Table 4. The mean values for measures of variables that differ significantly between households who buy bushmeat and those who do not.**

	Do not buy	Buy	Mann-Whitney U
No. cows/house	1.26	0.75	$P<0.05$
No. sheep/house	1.84	1.08	$P<0.05$
Biomass of stock	333.8	205.8	$P<0.01$

**Discussion**

Great care must be taken when interpreting questionnaire data, particularly when questions are fairly sensitive as was the case here. It is probable that estimates of hunting frequencies are on the low side in this study because the two trained interviewers reported that some people questioned were not keen to continue the questionnaire once questions about hunting were asked. However, the two trained interviewers were requested to ask these questions

from anyone who they knew to be a hunter operating in the park and consequently for these people it is likely that answers were true.

### *Crop raiding*

The local community interviewed around the PNV were mainly subsistence farmers (89% of people interviewed). They concentrated their agricultural production on crops that were not only valuable for feeding their families but also were valuable economically should they produce excess. As so many of the people were reliant on their crops for their livelihood they were, not surprisingly, concerned about crop raiding by animals from the park. Buffalo were considered the major pest as they were in 1984 (Towner 1985; RRAM 1987) but whereas in 1984 elephant was considered the next most important pest, nowadays these animals are not mentioned in this context, indicating a probable decline in their numbers. Elephants are often perceived to be the major crop pest where they occur in other parts of Africa (Thouless & Sakwa 1995; Lahm 1996; Tchamba 1996) indicating that in the PNV their population must be very low.

Whether the animals perceived to be the worst crop raiders actually cause the most damage needs further study. Buffalo are large and can be dangerous, and may be considered to be "bad" because people are afraid of them rather than because they cause more damage (Hill 1997). Animals can pass through their fields on most nights for those farmers living adjacent to the park boundary although this does not necessarily mean that they cause damage in their fields. A system of compensation to farmers for crop damage used to exist in theory around the PNV, but many people who were talked to claimed that they never received anything when they tried to claim this compensation. Often in the past, damage to crops was exacerbated by people trying to kill animals entering their fields (either to deter them or to obtain meat), and sometimes damage was increased in order to try and claim compensation (A. Plumtre pers. obs. 1988/89). Consequently it was often difficult for the park authorities to determine who to give compensation to. It is recommended that a study is carried out of current crop raiding levels and the actual damage measured on farms at different distances from the park to assess how much impact and economic loss is actually faced by the local population. Farmers around the park are never going to look favourably on the park if the perceived level of crop raiding found in this study continues, unless some form of compensation is received, or unless they can benefit from it in some way. One possibility might be to allow people to kill ungulates in their fields for domestic consumption (not for sale). This type of hunting (which already goes on) will have some impact on the ungulate

populations, and will reduce the crop raiding but would not wipe out the population. However, it may be difficult to monitor this type of hunting as proving that an animal was killed on a farm and not in the forest would be difficult.

### *Hunting*

Crop raiding and hunting may be closely linked. A large percentage of people interviewed admitted to hunting crop raiding animals and expressed great dissatisfaction with the park authorities for not doing anything to prevent crop raiding. People who admitted to hunting in the park have small farms located near the park edge and are consequently likely to be most affected economically by crop raiding animals. This is because their farms will be visited regularly by animals, due to the proximity to the park edge, and because losses from their farms have a relatively greater impact because the owners rely on a greater percentage of the crops in order to survive. The loss of domestic animals during the civil war (either stolen, killed by feral dogs or died of starvation) has probably contributed to the increase in hunting in the PNV following the war (Plumptre *et al.* 1997), although this is also due to the difficulties the parks staff currently face in patrolling the park and arresting hunters (Plumptre 1996). Domestic animals are used as insurance around the PNV and in other African communities to pay fines, marriage costs and school fees (J.B. Bizumuremyi pers. comm.). Therefore, hunting in the PNV may be used as a fallback means of survival when economic losses are too great.

### **Conclusion**

The setting of snares in the PNV was carried out by the poorest households living adjacent to the park boundary. These were the people who were probably most affected by crop raiding animals. This hunting may be a direct result of their economic status and it is recommended that future community development projects focus on helping these people. Households that buy bushmeat tended to have some employment but few domestic animals. Therefore care must be taken with any community development project that increased economic wealth does not lead to an increased demand for bushmeat.

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## A Spatial Analysis of Wildlife Crop Raiding Around the Banyang-Mbo Wildlife Sanctuary, Cameroon

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### Introduction

Located in the south-west Province of Cameroon, the Banyang-Mbo forest is a biologically-rich mix of lowland rain forest to sub-montane savanna. It provides habitat for a relatively high density of forest elephants (*Loxodonta africana cyclotis*) and forest buffalo (*Syncerus caffer nanus*), as well as threatened species including chimpanzee (*Pan troglodytes*), Preuss' monkey (*Cercopithecus preussi*) and drill (*Mandrillus leucophaeus*) (Powell, 1994). This region contains 70,000 of Cameroon's estimated 20 million ha of remaining forest (Besong, 1992), and is an important conservation area for both biological and cultural diversity. In March of 1996, Cameroon's Ministry of Environment and Forest (MINEF) officially designated the Banyang-Mbo Forest as a wildlife sanctuary, the first of its kind in Cameroon (Nchanji and Lawson, 1998). The "wildlife sanctuary" designation protects endangered species from hunting and restricts logging, but allows local communities to hunt non-endangered species, gather forest resources, and participate in the management of the sanctuary. This designation follows Cameroon's national forest use policy to protect soils, habitats and the environment, and provide rural communities with economic benefits deriving from non-timber resource extraction (Besong, 1992). In contrast, a "national park" designation would restrict all use by local communities. Following the designation, MINEF invited the Wildlife Conservation Society (WCS) to assist in the formation of a management plan for the sanctuary and to perform all relevant field research. Currently, teams of WCS staff are gathering social and ecological data to support a community-based management plan. They are surveying the flora and fauna within the sanctuary, measuring the impact of local resource use (including bush meat hunting), and assessing the impact of the creation of the sanctuary on local communities.

A key local concern in Banyang-Mbo's management is human-wildlife conflicts, particularly between humans and large mammals. To manage and ameliorate human-wildlife conflicts, field assessments of the pattern and amount of crop damage caused by wildlife are underway, with special emphasis on destruction caused by forest elephants and buffalo. The present human-wildlife conflict study began with field visits and informal interviews conducted in seven villages around the sanctuary between January and April 1999. Following this pilot

survey, an intensive crop monitoring study was initiated in five of the seven villages. The study will extend through December 2000. The long-term study uses both opportunistic and systematic data collection schemes. The opportunistic data collection depends on farmers' reports of recent elephant and buffalo damage, while the systematic data collection regularly monitored three to four fields in each village for damage by any animal.

The underlying hypothesis of the monitoring program was that two factors led to higher incidences of elephant crop raiding: 1) field distance from the village, and 2) vegetation surrounding the field. Specifically, fields farther than 2km from the village and surrounded by secondary forest were expected to experience higher incidences of elephant and buffalo crop damage than those closer to the village or surrounded by other fields or young fallow areas. The goal of the monitoring is to validate the influence of these two spatial variables and ultimately develop a predictive model of elephant crop raiding.

The field monitoring study at Banyang-Mbo, along with a previous crop raiding study by WCS field biologist Anthony Nchanji and Dwight Lawson (1998), show four compelling results about the pattern and amount of crop raiding by elephants and buffalo. First, damage is seasonal, occurring mainly during the rainy season from August to October. Second, damage is concentrated on particular fields and villages due to their location and surrounding vegetation. For example, fields close to the sanctuary edge (and thereby close to secondary forests) or those surrounded by old fallow were more prone to elephant damage. Third, the data show that the pattern of land-use for farming is pushing new fields closer to the sanctuary edge, leading to more incidents of elephant and buffalo crop raiding. Finally, while damage on an individual field may be quite high, and in some cases may force the farmer to abandon the field (Nchanji and Lawson, 1998), the majority of crop destruction was caused by large rodents, such as cane rats (*Thryonomys sp.*), domestic goats and grasshoppers. This result contradicts the views held by local farmers who complain most bitterly about elephants (Nchanji and Lawson, 1998). Perceptions held by local farmers have resulted in elephant crop raiding becoming a highly politicized issue that threatens the relationship between conservation authorities and local communities.

## **Methods**

The villages selected for this study were Tali I, Fotabe, Akiriba, Defang and Sumbe. All five villages were located within a three-hour drive from the WCS research station and could be reached throughout the rainy season. Farmers in these villages followed similar farming

practices and all granted approval for the study during community meetings. Finally, these five villages were thought to be equally representative of the human-elephant conflicts around the sanctuary. This was based on results from the pilot study during which all villages complained of recent elephant damage and were able to guide researchers to previously damaged fields.

The research design depended on two types of data collection: systematic and opportunistic. The systematic data collection used a matched-pair design to isolate important variables within a highly varying agroecosystem. In a farming system with numerous variables, the matched-pair sampling design helps control for the variability in the agroecosystem which otherwise might confound our analysis. Within each village, pairs of fields were selected that matched in age, type, and size, but differed in one factor, either surrounding vegetation or distance from village. For example, two fields of similar age, type and size were selected, one located close to the village and one located far from the village. The matched pair design enabled the use of a paired ANOVA to assess the effects of the independent variables on crop damage.

In the systematic survey, three to four fields within each village were selected and monitored once a month for crop damage. Field selection was based on three criteria:

1. location from the village (near and far from village),
2. vegetation surrounding field (field/young fallow enclave and old fallow/secondary forest enclave), and
3. type of field (the main crops monitored were maize, cocoa yams, and melons).

For each village, researchers selected two fields near the village and two fields far from the village (closer to the sanctuary). Researchers used a hand-held GPS to determine the distance from the field to the village. Of the two fields near the village, one was predominantly surrounded by other fields or young fallow (*field/young fallow enclave*), and the other was predominantly surrounded by old fallow and secondary forest (*old fallow/secondary forest enclave*). Similar to the fields close to the village, one distant field was a field/young fallow enclave and the other was an old fallow/secondary forest enclave. All fields selected for systematic monitoring were mixed food fields (cassava, cocoa yam, maize, and melon). Except for Akiriba, all village fields selected were located between the village and the sanctuary. Akiriba has taken some steps to reduce the impact of crop raiding by locating all food fields on the non-sanctuary side of the village. Therefore, the fields selected are located

on the opposite side of the village and only three were selected due to a lack of secondary growth near the village.

For the nineteen fields (five villages) selected for systematic monitoring:

- field size ranged from 218.7m<sup>2</sup> to 2808m<sup>2</sup> with an average size of 1221m<sup>2</sup>,
- all fields contained the same crops (maize, cocoa yam, melon),
- fields varied by proximity to village (close fields averaged 631m from village, distant fields averaged 2380m from village), and
- fields varied by surrounding vegetation (field/young fallow enclave or old fallow/secondary forest enclave).

During the first season of systematic crop monitoring, these 19 fields were monitored on a monthly basis for crop damage by any mammal greater than 2 kg. A WCS field assistant (Arrey Walters) along with village guides assessed the amount of damage by counting the number of stems damaged per field. Field assistants used tracks and teeth marks to determine the wildlife species that caused the damage. The data were then analyzed according to wildlife species, crop species and field condition, with the results presented below.

Given the unpredictable nature of elephant and buffalo crop raiding, the systematic sampling was supplemented by opportunistic observations. The opportunistic data collection was designed to collect data on any elephant or buffalo damage occurring in the five study villages. The data collection depended on a reporting system set up with each village in which any occurrences of damage over the past month were reported to the village chief. Each month, when the researchers arrived in the village, a guide took them to the fields that suffered crop damage and measurements, such as GPS location, type of field damaged, size of field, amount of damage and vegetation along the edge of the field, were made. The results were incorporated into a GIS for final analysis.

Phase One of this study collected data from June 1999 through October 1999. This time frame corresponded to the local rainy season which is the only time elephants reportedly enter crops around the sanctuary. The second phase is scheduled to occur during the rainy season of 2000. Preliminary results from the first season of crop monitoring are presented in the following section.

### Results of the first season of crop monitoring

Overall, five different wildlife species damaged crops. Cane rats damaged more stems on more fields than any other animal, followed by buffalo and porcupines. Elephants did not cause any damage to the fields selected for systematic sampling. This was unexpected, given farmers' reports of repeated damage in every preceding year. Table 1 shows the amount of damage, the frequency of damage per month and the number of different fields damaged by each species. The total number of stems was determined by multiplying the average planting densities for the three main crops damaged (cocoa yam, melons and maize) by the area of each field and summing for all fields (N=19) in the study. The average frequency of damage represents the number of fields damaged by a given wildlife species divided by five months.

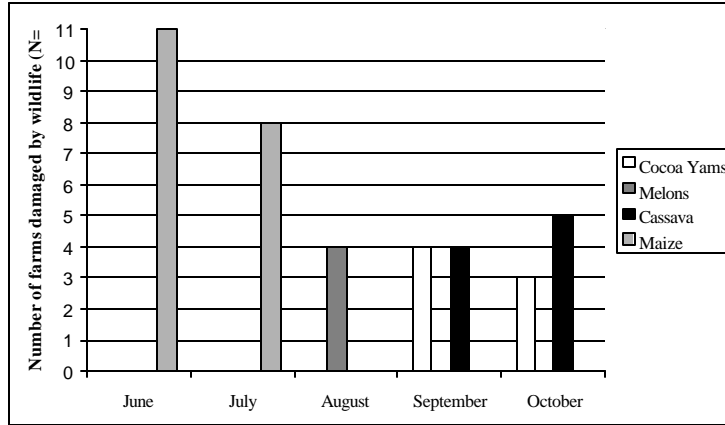
**Table 1: Crop damage by wildlife around Banyang-Mbo Wildlife Sanctuary, June - October 1999**

Animal	Total Stems Damaged	Percent Damaged (n=284488)	Frequency of Damage (avg. # of fields/month)	Number of Different Fields Damaged
Cane rat	1293	0.455%	6.0	13
Buffalo	168	0.059%	0.6	2
Porcupine	43	0.015%	1.0	3
Antelope	20	0.007%	0.6	2
Bush pig	6	0.002%	0.2	1
Forest elephant	0	0.000%	0	0

The number of stems damaged per field for each month was recorded and the results were summed for all nineteen fields in the five-month period (Table 2). Although all crop types were planted at the same time, maize matures first and is usually planted a second time during the season. Therefore, it was a more readily available target for crop raiders, especially early in the growing season (Figure 1).

**Table 2: Amount of damage by crop type, Banyang-Mbo Wildlife Sanctuary, June 1999 – October 1999**

Crop	Number of Stems Damaged	% Damaged	# of Fields Damaged (N=19)	Frequency (avg. # of fields damaged/month)
Maize	1253	1.26%	13	3.4
Melons	200	0.54%	3	0.8
Cocoa yams	85	0.08%	5	1.4



**Figure 1: Monthly pattern of wildlife damage to crops at Banyang-Mbo Wildlife Sanctuary, Cameroon (June – October 1999)**

The data were grouped by field condition (field enclave close to village, secondary forest enclave close to village, field enclave far from village, secondary forest enclave field from village) with the results presented in Table 3.

**Table 3: Crop damage according to field condition, Banyang-Mbo Wildlife Sanctuary, June – October 1999**

	Fields Close to Village		Fields Far from Village		ANOVA
	Field Enclave	Secondary Forest	Field Enclave	Secondary Forest	
	Enclave		Enclave		
# of stems damaged	411(0.51%)	406 (0.56%)	366 (0.50%)	200 (0.34%)	ns
# fields per month	2.6	1.8	1.8	1	ns
Total Number of Fields Damaged	4 (n=5)	4 (n=5)	4 (n=4)	2 (n=5)	

Using a factorial ANOVA test on both distance from village and surrounding vegetation, both variables were shown to be non-significant in predicting crop damage. However, there is a trend toward greater crop damage by cane rats close to villages, and greater crop damage by larger animals further from villages. Also, all buffalo damage occurred in the “distant - field enclave” category. This result suggests that larger mammals may avoid areas of high human densities.

Turning to the opportunistic data, there were no reported incidences of elephant damage in any of the 5 villages over the 5 month study, but 9 events of buffalo damage were recorded in 3 villages (Table 4). Of the nine events, 6 were found >2km from the village and 8 were surrounded by secondary forest. All damage occurred on either cocoa or mixed cocoa/food fields. This confirms expectations regarding the spatial distribution of large mammal crop damage in that the majority of the fields damaged were distant cocoa fields surrounded by secondary forest. Without any data on elephants it was impossible to draw the same conclusions about the patterns of elephant crop damage.

**Table 4: Crop damage by buffalo gathered during the opportunistic data collection, Banyang-Mbo Wildlife Sanctuary, June – October 1999**

Village	Animal	Field Type	Surrounding Vegetation	Amount of Damage
Sumbe	buffalo	Cocoa	Field	1 plantain tree
Fotabe	buffalo	cocoa/plantain	secondary forest	3 plantain trees
Fotabe	buffalo	cocoa/plantain	secondary forest	1 banana tree
Fotabe	buffalo	cocoa/food	secondary forest	25 cocoa yam stems
Tali I	buffalo	Unknown	secondary forest	unknown
Tali I	buffalo	Cocoa	secondary forest	20 cocoa pods
Tali I	buffalo	Cocoa	secondary forest	2 cocoa pods
Tali I	buffalo	cocoa/coffee	secondary forest	52 cocoa pods
Tali I	buffalo	Cocoa	secondary forest	7 cocoa pods

### Discussion/Conclusion

While the systematic data show a relatively even distribution of damage across all farms the opportunistic data on buffalo also suggests confirmation of the pattern of large mammal (buffalo) crop damage. During the crop monitoring study, locations of buffalo damage were consistently reported on fields farther from the village surrounded by secondary forest. However, the results of elephant damage were contrary to expectations. According to farmers' reports, elephant damage had been so severe in the study villages it was forcing people off their fields. Yet no incidents were recorded during the predicted peak five months of raiding. This discrepancy is likely a result of the unpredictable nature of elephant raiding, as well as the tendency for local communities to inflate damage reports, and /or to feel heightened vulnerability to elephants due to other factors. Perceived vulnerability likely reflects the dangerous nature of elephants, the large amount of damage an elephant can cause in one foray, and promises of compensation for elephant damage made by local government officials.

The integration of spatial data was an important aspect of this project. A handheld GPS allowed researchers to quickly identify locations of farms, measure distances between features and prepare data for inclusion within a GIS. Once collected the data were analyzed within a GIS. The GIS helped visualize the relationship between the damaged farms and the spatial predictor variables. Furthermore, the GIS was and will continue to be an integral part in the management of the spatial data obtained through the study.

Further research should include continued systematic field monitoring in the study villages. Opportunistic data collections should also continue in the selected villages and incorporate other villages around the sanctuary. Finally, remote sensing data may be used to describe the land use patterns around the sanctuary and determine the influence of land use on locations of buffalo and elephant damage.

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APPENDIX 1:  
Elephants - a special case



*Elephants crossing fence, Zimbabwe. F. Osborn, WCS*

### **Introduction**

The papers in this section are case studies of crop loss to elephants and other species. They highlight the usefulness of intensive research into crop loss from the perspective of the pest species. These studies also highlight the need for comparable data collection protocols. Once the conflict situation has been identified and quantified, interventions aimed at reducing the conflict can be implemented.

In the first paper, Hoare presents the IUCN taskforce paper on human/elephant conflict and their efforts to standardise data collection protocol. This system will aid efforts to compare data by collecting various indices that can be compared between different bio-geographical regions. The methods have been adopted by a number of researchers across Africa and the data are being mapped with an eye toward developing predictive models of conflict sites.

The study by Ilukol examines the ecology and spatial raiding patterns of elephants around Kibale Nation Park in Uganda. Crop preferences are also examined. This detailed study of seasonal movement patterns shows why understanding the basic ecology of the species that raid crops is important for developing interventions.

Experiments with methods to reduce crop loss to elephants were examined in the paper on problem animal control (Osborn & Parker). This overview shows that loss to elephants can be reduced using community-based methods of problem animal control. Various traditional

and experimental methods were tested and results from observation and farmers' perceptions were combined to develop this system to reduce crop loss to wildlife.

The paper by Kamisse & Turkalo gives an example of the problems of crop raiding by elephants and other animals in the rain forest of CAR. This study shows that loss to wildlife has a serious impact on the livelihoods and perceptions of the locals toward the reserve. This theme is also found in Sam *et al* in their study of crop damage by elephants in Ghana. Sam *et al* stresses the pressing need for farmers to address this problem and develop their own tactics to repel elephants.

## **Towards a Standardized Data Collection Protocol for Human-Elephant Conflict Situations in Africa**

**Richard Hoare,**  
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### **Assessing losses due to elephants in general terms**

In general terms, known characteristics of elephant damage resulting from a number of well-conducted studies of elephant problems in Africa are:

- Elephants are never the most frequent crop raiding species. Elephant damage is more localized but more severe per raid than that of smaller pest species. Typically a few farms are seriously affected by elephants while many others are often only lightly affected.
- Elephants are only one of a spectrum of agricultural pests that afflict African farmers. Primates, suids, rodents, birds or insects are often the more important taxa of agricultural pests. It is suspected that the level of complaint about elephant damage is often in disproportion (i.e. far greater) to its relative contribution to farming problems.
- Subsistence agriculture is the sector most prone to conflict with elephants. Many agricultural zones where farmers suffer damage by elephants, especially those in semi-arid and arid savanna areas and parts of the rain forest region, are climatically and edaphically unsuitable for subsistence agriculture, even in the absence of pests.
- Socio-economic 'opportunity costs' are borne by rural people living in proximity to elephants. These are important but are difficult to quantify and exist as a result of

‘problem elephants’ being potentially dangerous and difficult to deter. Opportunity costs may outweigh the direct costs of agricultural damage and be a major component of the perceived conflict. Examples of such costs are restriction on people’s movement (especially at night), competition for water sources, loss of sleep or reduced school attendance while guarding crops or property, and employment opportunities being prejudiced. These factors definitely contribute towards peoples’ negative attitude to elephants.

### **Assessing losses due to elephants in quantitative terms**

Elephant problems in any area are thought of as the net result of a number of individual damage incidents occurring over a given period of time (e.g. a season, a year, a period of years). Comparing elephant damage between well-conducted studies is made difficult by the use of different sampling strategies. Three types of sampling approaches have emerged where damage incidents have been quantified on the basis of:

- Method 1: number of “damage events” or elephant incidents reported to an authority.
- Method 2: actual losses to crops due to elephants (measured and quantified by an enumerator or researcher).
- Method 3: perceived losses due to elephants (derived from interviews with farmers).

#### *Method 1*

This gives a good general idea of problem elephant activity and thus allows comparisons to be made about the intensity of such activity between areas. There is, however, little distinction between ‘visits’ and ‘raids’ by problem elephants, so there may be an inherent bias. Visits are cases where elephants traverse the field and do little damage; what damage there is may be from trampling only, whereas raids are cases where crops are fed on. Where Method 1 has been actively carried out by a researcher, this logically leads to the descriptive summary sometimes called a “raid frequency index”. Raid frequency indices (RFI) incorporate spatial and temporal dimensions e.g.:

- elephant raids per village per month
- elephant raids per growing season
- elephant raids per household per month
- elephant raids per km<sup>2</sup> of human settlement per year

Use of a simple RFI avoids the pitfalls of assessing economic damage (e.g. varying crop quality; different assessors) and the statistical problems of comparing different farms (e.g. different acreages; different crop combinations).

#### *Method 2*

It is desirable, if possible, not just to record an elephant damage incident but to quantify what was damaged. Method 2 is ideal for assessing the real impact of elephants. Unfortunately it is logistically difficult over the large areas affected by elephants. It has tended to be applied by researchers working in small areas of relatively high elephant challenge.

Very few studies record what proportion of farms or fields in a given area are affected by elephant damage. For a rigorous analysis this information is needed since presenting an overall level of elephant damage which is applicable only to the affected farms is somewhat misleading. The overall level of damage in the whole farming area is what really needs to be quantified. This relies on what can be termed “the proportional availability of different crops”. Proportional availability needs to be assessed so that (i) the total amount of damage in the area can be objectively quantified and an economic loss estimate worked out and (ii) elephant preferences for different crops can be critically evaluated. The compiling of data on proportional availability is a demanding and very time-consuming job, which can only be done by a full-time researcher in a relatively small site. A number of well quantified (“actual loss”) studies assessing damage to farms in relatively small study areas across Africa have revealed a range of levels of crop damage generally between limits of 5% and 10%.

#### *Method 3*

Perceived losses are those obtained from interviews with farmers who supply details of damage events and estimate their own losses. This method is good for investigations where it is particularly important to assess either (1) the species mix of animal pests affecting farms and the distribution of damage or (2) attitudes of affected people (i.e. the method of choice if the research is orientated towards a ‘sociological’ approach). With this method, the frequency and severity of damage is less accurately evaluated because of the loss of detail in peoples’ memory over time and the tendency to exaggerate losses from damage incidents to any outside interviewer. Examples of the Method 3 type of study are:

- Interviews in 218 villages across seven provinces of Gabon
- Interviews in five villages around Shimba Hills National Reserve, Kenya
- Interviews with 1396 people living adjacent to seven protected areas in Tanzania.

### **Standardised data protocol for human-elephant conflict sites**

Valid comparisons about levels of human-elephant conflict both within and across different bio-geographical regions of Africa can only be made if a standardized system is employed that guarantees the consistency and quality of data.

#### *Primary data*

The present study proposes using a combination of the three sampling methods above to obtain the primary data from fairly large areas of conflict. This involves reporting of the incident to a trained and paid enumerator who then visits the site of the incident and interviews the affected person as soon as possible after the occurrence of the problem. The enumerator makes his own assessment of the incident but asks the affected person (complainant) to provide him with retrospective extra details about the incident.

This approach yields good distribution and frequency information, allows adequate severity assessment and also provides for some of the ‘social dimension’ of elephant problems to be included. The practical advantages of this approach are that it involves local people, provides employment and does not rely only on the complainant. It has the disadvantage that enumerators have to be trained and engaged in paid employment, which requires some administration of finance and personnel. For the returns, however, it is a relatively inexpensive and simple scheme to set up and run.

#### *Secondary data and analysis*

A hierarchy of data collection and analysis is involved in this protocol. The second level involves a researcher who trains enumerators according to a recommended format or ‘training package’ and condenses data from their reports into an annual summary for the conflict zone in which they were deployed. Annual reports are designed to show the distribution, frequency and severity of elephant damage and consist of:

- (i) spreadsheet summaries of incidents (to act as a permanent record)
- (ii) graphical illustrations of these spreadsheet summaries (to make large amounts of numerical data in spreadsheets easy to understand)
- (iii) scoring of damage incidents and ranking of problems according to area (to assist in making management decisions on elephants).

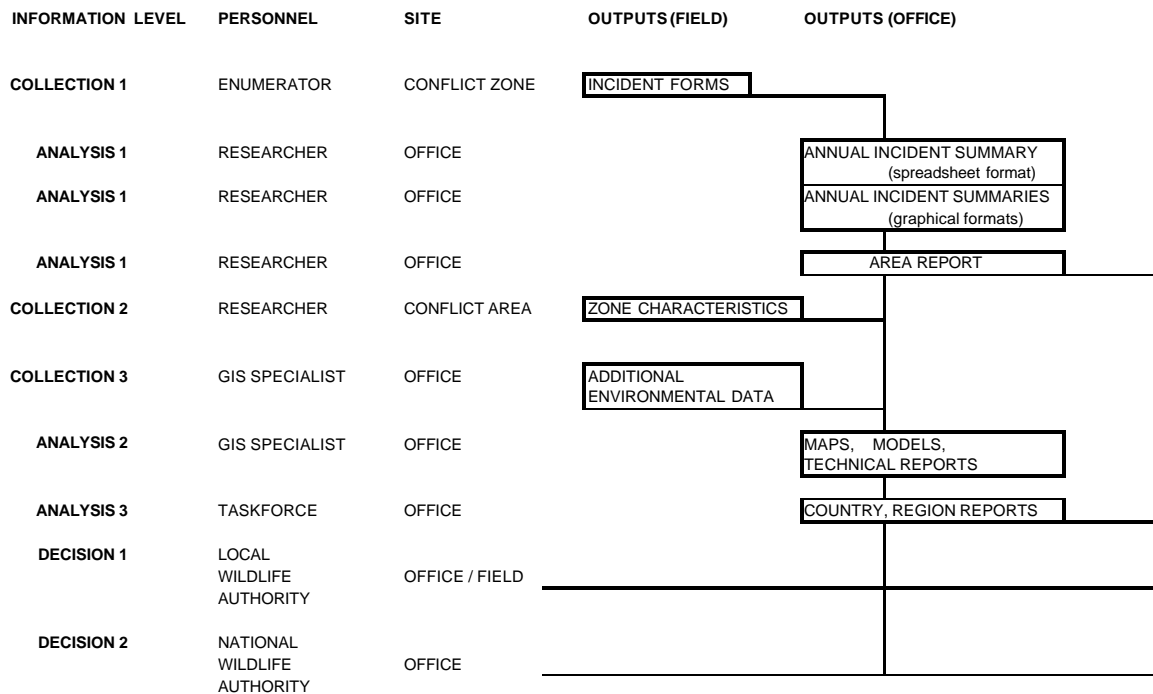
Annual reports are sufficient for local level management decisions (e.g. where to deploy scouts to scare elephants, how to distribute revenue on the basis of the level of problems, where to plan fencing projects).

*Tertiary data and analysis*

This level involves the input of additional “site characteristics” data by the researcher. Some of these are drawn from a wider area around the conflict zone referred to as the “conflict area”. The reason for this is so that incident data can be linked to environmental variables in the conflict area and used in research-orientated analyses at a third level, the Geographic Information System (GIS) level. A specialized level of spatial analyses in a larger sample of compared sites should be able to synthesize the findings into more meaningful management recommendations at a national level.

The data protocol is illustrated below in diagrams and tables:

**FIGURE** SCHEMATIC OF PROPOSED HUMAN ELEPHANT CONFLICT DATA COLLECTION AND ANALYSIS PROTOCOL



A flow chart depicts the hierarchy and linkages in the data collection and analysis protocol (Fig. 1). An elephant damage report form is shown (Form 1). Forms, containing the primary data, are filled in by enumerators after visiting incidents of elephant damage. Each incident is a data record and data records for an area can be summarized in columns and rows of a computer spreadsheet. In the example (Table 1) an annual summary is shown for a 'ward' which is the administrative subdivision of a district in Zimbabwe within which one enumerator is employed. The ward summary incorporates a very simple damage scoring system to quantify the seriousness of incidents (based on adding crop age and quality to damage level). Scores of individual incidents can be summed in the ward to give a damage score for the ward. Finally, wards situated in one district are ranked against each other (Table 2) using different criteria. Management decisions can be prioritized according to the desired rank.

**FORM 1. ELEPHANT DAMAGE REPORT FORM**

REGION ..... **FORM No.** .....

DISTRICT .....

SUBDIVISION .....

VILLAGE ..... **MAP GRID REFERENCE**.....

ENUMERATOR NAME ..... **DATE OF INCIDENT** .....

COMPLAINANT(S) NAME(S) .....

DATE OF COMPLAINT .....

CROP	DAMAGE TYPE	QUALITY	BEFORE	DAMAGE	AGE	OF	CROP
		(Tick GOOD	one MEDIUM	category) POOR	(Tick SEEDLING	one INTERM.	category) MATURE
CROP 1	.....	.....	.....	.....	.....	.....	.....
CROP 2	.....	.....	.....	.....	.....	.....	.....
CROP 3	.....	.....	.....	.....	.....	.....	.....
CROP 4	.....	.....	.....	.....	.....	.....	.....
CROP 5	.....	.....	.....	.....	.....	.....	.....

**DIMENSIONS (Paces) OF TOTAL FIELD WHERE DAMAGE OCCURRED**

LENGTH ..... PACES

WIDTH ..... PACES

**DIMENSIONS (Paces) OF ACTUAL DAMAGED PORTION OF FIELD**

LENGTH ..... PACES

WIDTH ..... PACES

**OTHER DAMAGE TICK AND SPECIFY DETAIL**

FOOD STORE .....

WATER SUPPLY .....

THREAT TO LIFE .....

HUMAN INJURY .....

HUMAN DEATH .....

OTHER SPECIFY .....

<b>ELEPHANTS INVOLVED</b>	NUMBER	VISUAL ID (Tick)	TRACK ID
GROUP SIZE (TOTAL)	.....	.....	.....
Adult Male	.....	.....	.....
Adult Female	.....	.....	.....
Subadult / Calf	.....	.....	.....

**YOUR COMMENTS:** .....

.....

.....

**Was This Report Forwarded?**

To Whom? ..... Where? .....

When? ..... How? .....



**Table 1 EXAMPLE OF ANNUAL SUMMARY OF PROBLEM ELEPHANT INCIDENTS IN SPREADSHEET FORMAT WITH DAMAGE SCORES CALCULATED FOR EACH INCIDENT AND SUMMED FOR THE AREA**

**KEYS**

CROP TYPE	CROP AGE	CROP QUALITY	DAMAGE CATEGORY	DAMAGE SCORE	ELEPHANTS INVOLVED	GROUP TYPE
1=MAIZE						
2=COTT			1=<5%			
3=GNUTS			2=6-10%			
4=MILLET			3=11-20%			M=BULL
5=VEG	1=SEEDL	1=POOR	4=21-50%	<5 = LOW		MM=BULLS
6=MASAU	2=INTER	2=MED	5=51-80%	6 - 8 = MED		CC=COWS
7=OTHER	3=MATURE	3=GOOD	6=>80%	>9 = HIGH		MH=MIXED

**AGE + QUALITY + DAMAGE = SCORE**

**DATA EXAMPLE**

DATE OF INCIDENT	VILLAGE NAME	MAP REFERENCE	CROP TYPE	CROP AGE	CROP QUALITY	DAMAGE CATEGORY	DAMAGE SCORE	NUMBER ELEPHANT	GROUP TYPE
31-Jan-98	Mufudzi	878064	2	2	2	1	5/L	2	MM
31-Jan-98	Mufudzi	878064	1	2	2	1	5/L	2	MM
31-Jan-98	Mufudzi	878064	1	3	1	1	5/L	3	MM
06-Feb-98	Budzinike	872048	7	3	2	1	6/M	2	MM
06-Feb-98	Budzinike	872048	1	2	3	1	6/M	2	MM
06-Feb-98	Budzinike	872048	1	2	1	1	4/L	2	MM
06-Feb-98	Budzinike	872048	1	3	1	1	5/L	2	MM
06-Feb-98	Budzinike	872048	3	2	2	1	5/L	2	MM
07-Feb-98	Budzinike	875045	2	2	3	1	6/M	2	MM
04-Mar-98	Budzinike	875045	1	3	1	1	5/L	1	M
04-Mar-98	Budzinike	879049	1	3	1	1	5/L	1	M
04-Mar-98	Budzinike	875045	2	3	2	1	6/M	1	M
31-Mar-98	Kayongo	844016	2	3	1	1	5/L	1	M
31-Mar-98	Kayongo	844016	1	3	1	1	5/L	1	M
18-Jun-98	Gamanya		1	2	1	3	6/M	2	MM
18-Jun-98	Gamanya		1	2	1	3	6/M	11	MH
23-Jun-98	Gamanya		1	3	1	4	8/M	6	MH
23-Jun-98	Gamanya		1	3	1	4	8/M	6	MH
23-Aug-98	Kayongo	836012	5	3	1	1	5/L	4	MM
24-Aug-98	Budzinike	883039	5	3	1	1	5/L	6	MM
26-Aug-98	Kayongo	834012	5	3	2	3	8/M	3	MM
26-Aug-98	Kapenyongc	833012	5	3	2	3	8/M	4	MM
26-Aug-98	Kayongo	834012	5	3	2	5	10/H	3	MH
26-Aug-98	Kayongo	833012	5	3	1	3	7/M	2	MM

**SCORES**

SCORE TOTALS FOR WARD

LOW = 14  
 MED = 9  
 HIGH = 1

DAMAGE POINTS FOR 1998 IN THIS WARD

144

**Table 2: An example of problem elephant activity summarized for one district (Muzarabani District, Zimbabwe in 1998).**

WARD	Total Incidents (No.)	Serious Incidents (No.)	Damage Score POINTS	Total Incident RANK	Serious Incident RANK	Damage Score RANK	MEAN RANK
Kapembere*	24	3	144	1	3	1	1
Muringazowa	23	1	103	2	4	2	2
Gutsa	18	4	78	3	2	6	4
Dambakurima	17	1	88	4	4	5	5
Chadereka	15	5	90	5	1	4	3
Chiweshe	14	0	95	6	5	3	6
Hoya	12	0	51	7	5	8	8
Chawarura	12	1	63	7	4	7	7
Hwata	9	1	48	8	4	9	9
Machaya	1	0	5	9	5	10	10
<b>TOTALS</b>	<b>145</b>	<b>16</b>	<b>765</b>				

- for a breakdown of incidents in this ward, see Table 1
- Wards are ranked according to various criteria of problem elephant activity: (i) total number of incidents (ii) number of serious incidents (iii) overall damage score of incidents (see Table 2). A mean of the three ranks is given. Management decisions can be prioritized according to the desired rank

Graphical summaries, which are far more ‘user friendly’ than the above tables and diagrams can be produced from any of the above data. If data is stored in electronic format this is a rapid, simple process. In area reports, common graphical summaries produced are:

- Monthly distribution of problem elephant incidents
- Selection of crops by problem elephants
- Group sizes of problem elephants
- High, moderate and low levels of damage incidents.

If the same geo-referenced incident data are then transferred onto a GIS, detailed distribution maps can be produced. If these data are cross-referenced to a number of attributes, the possibility for numerical and spatial analyses increases considerably.

### Acknowledgement

I am indebted to researchers of the Mid-Zambezi Elephant Project in Zimbabwe (Loki Osborn, Guy Parker, Kinso Mariba and Ignatius Masarirevhu) for the raw data on crop damage in Muzarabani district.

# Elephant Crop Raiding Patterns in Areas around Kibale National Park (KNP), Uganda

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## Introduction

Reduction in elephant habitat, and consequent isolation of protected areas maintaining elephants by landscapes dominated with agriculture, are often cited as the ultimate cause of increase in elephant-human conflict (Bell, 1980; Barnes, 1996; Seidensticker, 1984; Sukumar, 1990), yet not much is known about the proximate causes or factors that influence the patterns of elephant crop depredation. Any attempt to manage or control crop damage by elephants should be based on the knowledge of causes or factors that influence crop depredation by elephants (Naughton-Treves, 1998; Santiapillai, 1993). This creates an urgent need to examine the patterns of elephant crop depredation and how these relate to elephant ecology and land-use patterns.

Elephants have been observed to display preference for certain crops (Bell, 1984; Naughton-Treves, 1996; Smith *et al.*, 1995). It was observed that banana, and sweet potatoes were the most preferred crop species by elephants in areas around KNP (Naughton-Treves, 1996). However there is lack of information on whether the abundance and distribution of preferred crop species determine the intensity and patterns of crop depredation. This will be important in predicting spatial patterns and intensity of crop damage, especially in the culturally and ecologically heterogeneous environment surrounding KNP (Naughton-Treves, 1996).

## Methods and analyses

Crop depredation was monitored in four administrative areas (Parishes) abutting the park boundary. These locations were chosen on the basis of previous records of elephant crop damage and were then spatially stratified in to North, East, South and West, to examine spatial patterns in crop depredation. Two methods were employed for monitoring crop raiding patterns. The first involved establishing an information system within the administrative areas using the Park Management and Advisory Committees' (PMAC) representatives to collect basic information on the frequency and timing of the raids, the crops damaged, and elephant group size (whenever possible). The second method involved systematic monitoring of the perimeter of the Park boundary in each of these administrative

areas. Monitoring was done once every two weeks, or more frequently when the raids began, in order to confirm elephant incursions into cultivated land.

When incursions were confirmed, the path of the group was traced into cultivated land and all the affected fields counted. The date of the raiding event, name of the village, number of fields raided, distance of each field from the Park boundary, field size, proportion of field with damage, crops damaged and a visual estimate of elephant group size from paths in and out of the fields was recorded. In addition, information about elephant group size for every raiding incident was obtained by interviewing the farmers. Some of fields were then randomly selected for damage assessment. For the selected gardens, field size and the area of seriously damaged portions was estimated using the method of polygons (Casely, 1988).

Elephant path follows were undertaken for some crop raiding groups during studies of forage selection. Diameters of a maximum of two intact boli per elephant dropping were measured to the nearest millimeter to obtain age estimates of the raiders. The composition and presence of crop remnants in elephant dung were recorded for each dung pile encountered to establish the presence of habitual crop raiders.

Land-use was assessed in a 2 by 0.5 kilometer area from the Park boundary into cultivated land using a grid sampling technique. One hundred meter grid squares were superimposed on this area. Twenty percent of the plots were randomly selected for land use assessment. The following land use categories were identified and measured; cultivated land (crop specified), pasture land/grazing land, forest patch, swamp and settlement.

Rainfall records were maintained daily at Kanyanchu and Kanyawara by KNP and Makerere University Biological Field Station (MUBFS) staff respectively during the study period. The monthly rainfall totals given are an average total from these two sites.

A rough index of assessing elephant food quality using the frequency of plant parts eaten was employed during this study. The proportions (from frequency records of feeding) of foliage, stemmy or woody material, and fruits in the diet were estimated. Supporting tissues such as stems, twigs, wood, roots and bark are high in indigestible fiber, while fruits contain stores of soluble carbohydrates, and leaves contain photosynthetic enzymes and are highest in protein and minerals (Bell, 1980; Owen-Smith, 1988). The monthly percentage frequency of foliage and fruits was taken as a food quality index (FQI).

## Results

### *Frequency and quantities of damage to crops*

In a period of 13 months, raiding incidences for all study sites pooled occurred during 87 nights. Mean number of fields damaged per raid in a night was about  $3.28 \pm 0.64$ . Mean area of damage per field per raid for the five most commonly damaged crops is given in Table 1. Elephants damaged most of the crops cultivated except tea and coffee. Other crops like groundnuts, Irish potatoes and soybeans were mainly trampled upon as elephants were foraging on other crops. No evidence of direct consumption of any part of these plants was observed during the course of this study.

**Table 1: Mean field size and damage for five common crops per raid per night (with 95% Confidence intervals).**

Crop	Mean field size in m <sup>2</sup>	Mean area of damage in m <sup>2</sup>	Mean % of field damaged
Bananas	5,190.81 $\pm$ 2,170.55	1,483.73 $\pm$ 514.29	28.6
Maize	1,463.70 $\pm$ 425.48	561.50 $\pm$ 315.86	38.4
Sweet Potatoes	711.50 $\pm$ 429.58	197.43 $\pm$ 141.44	27.7
Sorghum	935.00 $\pm$ 489.43	199.86 $\pm$ 147.50	21.4
Beans	2,971.55 $\pm$ 1,429	581.00 $\pm$ 388.06	19.6

### *Group size and behavior of crop raiders*

Mean group size of crop raiding elephants was  $4.22 \pm 0.53$  (n = 67 groups). The number of elephants raiding on any one night in KNP varied from 1 to 15 individuals. A group size of 3 elephants was the most commonly observed pattern.

For the eight crop raiding groups that were followed the spoor of infants and juveniles below five years of age was not encountered. This implies that family groups rarely raid crops in Kibale. Evidence of habitual raiding was observed from follows of crop raiding groups. All the groups followed from the fields had crops in their dung, an indication that they were previously involved in raiding. Four of the elephant groups were followed from crop field to the forest and back into crop fields, travelling a distance of 1.6 - 3.0 kilometers in a day and concentrating their foraging activity within two kilometers of the Park boundary. Of the four groups that were followed back into the fields, one group (consisting of a sub-adult of 13 years and an adult of 22 years) visited crop fields for more than three nights in a row.

Of the eight groups followed all, except two, included at least one adult above 20 years of age. The latter groups consisted of sub adults with ages ranging from >5 - 12 years old. One group of sub adults was observed to raid for more than two nights in a row.

*Temporal patterns in crop damage and forage quality*

Monthly raiding frequency pooled for all the study sites was negatively correlated with rainfall of the first preceding month ( $r = -0.56$ ,  $p < 0.05$ ,  $d.f. = 11$ ). However there was no significant difference between mean raiding frequency for dry months (mean = 7.5) and rainy months (mean = 6) ( $t = 0.548$ ,  $d.f. = 10$ ,  $p = 0.298$ ). There was no significant correlation between the intensity of raiding on the banana crop with rainfall in either the current month or the first and second preceding months ( $r_s = -0.175, -0.372, -0.49$ ;  $d.f. = 9$ ;  $P < 0.1$  respectively). For the maize crop, which is seasonally available, there was a significant negative correlation with rainfall of the current month ( $r_s = -0.61$ ,  $d.f. = 9$ ,  $p < 0.05$ ). The mean FQI recorded during the study period was 62%. There was no significant difference between the FQI for wet and dry months ( $T = 2.1$ ,  $d.f. = 11$ ,  $P = 0.06$ ), with the mean being 65.7% and 58.6% for dry and wet months respectively. There was no significant correlation between the frequency of raids and FQI for the current months ( $r_s = 0.036$ ,  $df = 13$ ,  $p > 0.05$ ).

*Spatial patterns in crop damage and land-use*

Crop depredation took place in all study sites during the period of study. The northern and western areas were raided during the period from January to May, whereas the eastern and southern parishes experienced raiding during June to November. The occurrence of elephant raids in the four study sites falls within the general observation of park-wide timing of elephant raids.

The average number of nights in which raids occurred in each of the study sites was significantly different ( $X^2 = 17.83$ ,  $d.f. = 3$ ,  $p < 0.01$ ). However when the average number of nights in which raiding occurred in each study site is corrected for Park boundary perimeter, the difference is non significant ( $X^2 = 6.13$ ,  $d.f. = 3$ ,  $p > 0.05$ ). Within each study site elephant crop raiding patterns were spatially localized to certain spots (villages); sometimes there was foraging concentrated on specific farms, before animals shifted to other fields. Most incidences of raiding took place within 0.5 km (90%) from the Park boundary for data pooled from all study sites.

Land use studies within 500 meters from the boundary reveal that a diversity of crops are grown around KNP. The principal crops grown include bananas, maize, Irish and sweet potatoes, sorghum, beans and groundnuts. Coffee and tea are grown to a limited extent. The proportions of crops grown at different sites in a 0.5 kilometer perimeter around the study sites did not influence crop raiding patterns. There was no significant correlation between proportion of land under each land-use category (cultivation, forest, swamp and pastureland) in the three study sites ( $w = 0.063$   $p > 0.05$ , Kendall's coefficient of concordance). Proportions of various crops cultivated in a single season differed significantly for the three study sites ( $X^2 = 1.554$ ,  $d.f. = 7$ ,  $p > 0.05$ , Kendall's coefficient of concordance). Similarly, the proportion of various crops raided in the four sites were not significantly correlated ( $X^2 = 4.844$ ,  $d.f. = 7$ ,  $p < 0.05$ , Kendall's coefficient of concordance). However, there was a significant positive correlation between proportion of each crop raided and proportion of land under the respective crop (Table 2), implying that elephants had no preferences for particular crops but raided according to crop availability.

**Table 2: Correlation between relative percent of land cultivated with maize, bananas, legumes, cassava, sorghum, sweet potatoes, Irish potatoes, and other crops, and the relative percent of these specific crops raided.**

Study site	$\tau$ (Kendall's Tau)	N	Probability
Busiriba	0.794	8	< 0.05
Kahangi	0.722	8	< 0.05
Kiko	0.036	8	> 0.05

## Discussion

The level of elephant-human conflict in Kibale is moderate compared to that observed in most parts of Africa and Asia (Bhima, 1998; Ngunjiri, 1995). The mean percentage damage per raid per field ranged from 19.6%, to 38.4% for bean and maize fields respectively. This is relatively moderate when compared with mean percent field damage reported in southern Ghana and around the Liwonde National Park in Malawi. Mean percent damage per field of crop incurred in southern Ghana ranged from 43%, 68% and 76% for bananas, maize and yam respectively (Barnes, 1995). In the Liwonde National Park, Malawi, the mean percent area damaged per field varied from 2.3% to 22.3% (Bhima, 1998). There were no human deaths or human injury reported as caused by elephants over the entire Park during the study period, as reported in other elephant-human conflict sites in Africa (Ngunjiri, 1995; Tschamber, 1995). The relatively moderate level of elephant conflict is due to the medium elephant density and the low numbers of males. There is also an abundance of forage within the Park which reduces pressure to forage in fields.

Findings from this study accord with observations elsewhere (Sukumar, 1988; Sukumar, 1990; Hoare, 1995; Bhima, 1998), where male elephants, either singly, or in groups, are primarily responsible for most damage to crops. Single adult bulls (>25 years old) were a frequently observed group size in Southern India and Gabon (Sukumar, 1989; Lahm, 1996), yet this was rarely the case in this study, or the observations in areas adjacent to the Liwonde National Park, Malawi (Bhima, 1998), where males between the 12-25 years of age were commonly noted to raid. The high frequency of young bulls recorded raiding is related to the lack of adult bulls above the age of 25.

The group size observed in KNP is similar to that observed in Malawi (Bhima, 1998). Mean group size of raiding elephant in Liwonde, Malawi was  $7.64 \pm 4.02$ . The most frequent group size of elephants raiding in Liwonde was 3 individuals. These observations however contrast with the findings from India, where the number of elephants raiding each night varied between 1 to 25, whilst single elephants were more frequently observed to raid. There are two possible explanations for the former grouping pattern (Sukumar, 1989):

1. Adult bulls >25 years of age are lacking in both KNP and Liwonde (Bhima, 1998), and young inexperienced bulls, invariably need the company of one or more younger bulls to raid successfully. Sukumar (1989) in India has made a similar observation. He noticed that young elephants between 15-20 years always came in groups of 4 when entering fields to crop raid whereas solitarily raiding bulls were usually >25 years old.
2. Secondly, crops are abundantly available in fields abutting the boundaries of KNP and cooperation rather than competition is a pre-requisite for obtaining crop forage (Sukumar, 1988).

Documented observations on the temporal patterns of elephant crop depredation indicate that most crop damage occurs during the rainy season with a peak towards the end of the rains (Bell, 1984; Sukumar, 1986; Barnes, 1995; Hoare, 1995; Smith *et al.*, 1995; Lahm, 1996). Elephant crop raiding peaks often co-occur with peaks in the flowering or ripening of crops. These often coincide with the decline in quality or nutritive value of natural forage (Sukumar, 1990). Accordingly, crop damage has been regarded as an optimal foraging strategy geared towards maximizing nutrient intake in a period of scarcity (Bell, 1984; Sukumar, 1989). In KNP elephant crop damage was sporadic. If food quality and nutritional stress were triggers for crop raiding in KNP, an inverse correlation would be expected between FQI and the frequency of raids. This was however not the case, an indication that nutritional stress does



not trigger elephant crop raiding in KNP. However its occurrence at low to moderate levels throughout the year maintains a sporadic pattern of crop damage.

The lack of a clear-cut seasonality in raiding could be related to the presence of perennial crops, low to moderate FQI, or to the limited scale in spatial sampling. Crop deprecations by elephants in Kibale tend to occur throughout the year with raids spatially distributed in the northern half of the Park. The sampling scale used in this study is likely to have been insufficient to capture seasonal patterns.

Wildlife species have preferences for certain cultivated crops (Bell, 1984; Naughton-Treves, 1996), and areas with a concentration of such highly preferred crops often experience intense depredation (Bell, 1984). In areas surrounding KNP, the percentage contribution of the various crops to cultivated land varied spatially. At each site, crop category damaged was in proportion to availability. This observation is supported by the observation made by Parker and Graham (1989). They stated that elephants have catholic diets and that there is no human food plant that African elephants do not eat. It is apparent from this study that the relative ratios of food crops grown do not influence spatial variation in raiding intensity.

Although crop raiding incidences were recorded in all the parishes during the study period, there was an apparent localization of raiding incidents at village level as observed by Naughton-Treves (1996). This pattern has been observed elsewhere in Africa (Bell, 1984; Smith *et al.*, 1995; Lahm, 1996). Three scenarios explain such localized crop raiding patterns. These include the location of certain sites along bull ranges, elephant migration routes and historic foraging areas (Bell, 1984; Sukumar, 1989; Sukumar, 1990; Santiapillai, 1993; Hoare, 1995).

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## Elephant Crop Raiding in the Dzanga-Sangha Reserve

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### Introduction

Situated in south western Central African Republic (CAR), the area of the Dzanga-Ndoki National Park and Special Forest Reserve has long been known as a region abundant in forest wildlife. Forest elephant (*Loxodonta africana cyclotis*) and other mammal species such as bongo (*Tragelaphus euryceros*), sitatunga (*Tragelaphus spekei*), giant forest hog (*Hylochoerus meinertzhageni*), red river hog (*Potamochoerus porcus*), forest buffalo (*Syncerus caffer nanus*), western lowland gorilla (*Gorilla gorilla gorilla*), as well as monkey and duiker species, occur in high densities. In 1981 the Central African government recognised this faunal and floral diversity by creating a forest elephant and bongo sanctuary, and formally ending hunting in the area.

In 1988 further protection was afforded when the government designated two areas of the sanctuary as national parks: the Dzanga Ndoki National Park, consisting of the Dzanga sector in the north (495 km<sup>2</sup>) and the Ndoki sector in the south (725 km<sup>2</sup>). Serving as a buffer zone to these two national park sectors, the Dzanga-Sangha Special Dense Forest Reserve comprises 3359 km<sup>2</sup>. The national park and reserve are administered collaboratively by the Central African Ministry of Environment, Water, Forests, Hunting and Fishing and the World Wildlife Fund. This collaborative project includes conservation, and rural development, as well as ecotourism and environmental education sectors.

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This area of the extreme south western CAR was originally inhabited by three ethnic groups: the Aka Pygmies, whose survival depended on hunting and gathering, and the Ngoundi and Sangha-Sangha, both Bantu groups, whose livelihood focused upon fishing. Before the 1970s these three ethnic groups dominated this sparsely populated area, with access being limited by navigation of the Sangha River. Beginning in the early 1970s this situation changed dramatically with the establishment of large scale logging in the area by the company Slovenia Bois. The logging opened up the region by establishing road access to the area to the north, and served as an economic magnet attracting a mixture of ethnic groups from other parts of the country. This resulted not only in a population increase but now enabled easy access to a previously isolated area, drastically changing the lifestyles of its original inhabitants. People were drawn to the area not only by the economic possibilities offered by employment at the sawmill but other activities such as diamond mining, agriculture and hunting.

Forest elephant densities have always been high in this area of the CAR and are estimated to be amongst the highest in the Central Africa region:  $>1/\text{km}^2$  (Carroll 1989, Blom et al. Pers. com.). The Dzanga Bai, located in the heart of the Dzanga sector of the Dzanga-Ndoki National Park, has been continually monitored for the last ten years. Estimates of 3000+ elephants frequent the clearing, with an additional 1000+ present in the area which is contiguous with the Republic of the Congo to the south and the Republic of Cameroon to the west (Turkalo 1995, 1996).

At present the human population of the DSSFR is estimated to be about 4500 or 2.5 inhabitants/ $\text{km}^2$ . The biggest village in the area is Bayanga with an estimated population of 3000, and the smaller villages are Lindjombo, Babongo, Moussapoula, Kunda Papaye, and Yobe. Given the high elephant densities and low human population density crop raiding had never been a major problem in the area. When people and elephants did come into conflict hunting was usually the solution, discouraging continued crop predation by large mammals.

With the establishment of the Dzanga-Sangha Project in 1989, the fauna, particularly the elephant population, was afforded protection in the hope of developing an ecotourism industry, thus enhancing the economic situation of the local people. With this increased protection elephants, which had previously been hunted, began to feel no fear of human populated areas, particularly in the area of Bayanga where the conservation project was based.

Within the last ten years, with a human population increase leading to increased agriculture, elephants are slowly becoming a liability in the minds of the local inhabitants.

Since the inception of a conservation project in the area the situation of human-elephant conflict has never formally been addressed, although the local inhabitants have complained about elephant damage in the hope of receiving compensation. In the past the project addressed the problem by trying to discourage elephants from the fields by firing blanks, but this action has a limited and temporary effect. In 1992 an administrative order was issued for the culling of two elephants which failed when the assigned hunter tried killing an elephant near the village of Moussapoula. The elephant escaped and the project was accused of using blanks. Many believed that the elephant was a Bangombe pygmy who are reputed to possess unusual transformation powers (Fay 1993).

### **Agricultural background**

Due to dense forest vegetation most agricultural activity in the Dzanga Sangha Dense Forest Reserve occurs along the main north-south axis road connecting Lidjombo in the far south to villages north of Bayanga. Cultivation is found on the road edge in the vicinity of villages with the areas between villages left uncultivated. The only exception is the road between the villages of Bayanga and Moussapoula, which is cultivated along approximately 4 kilometres of road edge, with mostly cassava and coffee fields. The management plan of the Dzanga-Sangha project stipulates the limitation of agriculture to within 100 metres of the road. In a few areas this rule has not been observed, i.e. Yandoumbe, but in most areas it has occurred naturally without enforcement because of the difficulty in clearing thick forest vegetation. The estimated surface area of the reserve under cultivation is less than 2% of the total land surface area. The same fields are cultivated on average for a period of several years and then abandoned for a few years because of soil infertility. Cultivation is then resumed.

Agricultural activity in the area consists mostly of subsistence farming. Cultivated crops include cassava (*Manihot esculens*), both sweet and bitter varieties: the bitter variety is the preferred carbohydrate source and the leaves are also eaten. Ground cassava tuber (bitter variety) is the one crop which is sold commercially by village women throughout the area. Corn is also cultivated for food consumption and is also used in the manufacture of an indigenous alcoholic drink, *mbako*. Peanuts are cultivated to a lesser extent than cassava and corn and are also imported from other areas of the country to meet local consumption needs.

This area was once one of the largest robusta coffee producing areas of the CAR. It still retains an impressive acreage of coffee trees but, due to the vagaries in the world price for robusta (lowland) coffee, groves often go neglected for several seasons because of poor prices. Coco yams, bananas and papayas are also cultivated but are rarely found being sold in the market, being consumed by the cultivator's household. Other food products consist of wild foods derived from the forest. These non-cultivated foods are generally collected in the forest by the Aka Pygmies and sold to the Bantus, who either consume them or sell them in the market. The main forest product is the koko leaf (*Gnetum africana*) which forms a staple food product in the local diet, and which generates income for both the Aka and Bantu in the area.

Precipitation in this area of CAR averages 1200 mm per year. The yearly weather pattern consists of two dry seasons: an extended dry season from December to March and a shorter one occurring in July to August. Interspersed between these two dry seasons are two wet seasons: a long wet season occurring in September through November with the shorter wet season taking place in April through June. With such a favourable climatic condition of abundant rain agricultural activity is a year-round occupation. Cassava is planted all year around and takes approximately two years to produce mature tubers. Corn and peanuts are planted twice a year in May and September (sometimes with a third crop in December). Coffee beans are harvested between the months of November and December (Table 1).

**Table 1: Principal Crops Cultivated in the Dzanga-Sangha Reserve**

<b>Crop</b>	<b>Cultivation Period</b>	<b>Harvest</b>
Cassava	All year	All year
Corn	May, September, December	
Peanuts	May, September, December	
Coffee	Non-seasonal	November-December

### **Methods**

In March of 1999 Amis Kamisse, a sociologist working in the rural development sector of the GTZ portion of the WWF project, started collecting information on crop damage and raiding. The information was collected using a modified questionnaire developed by IUCN. The original form was in English with a translation into French developed for use in the Dzanga-Sangha Reserve.

During this period (March to November 1999) Kamisse requested that villagers in the Reserve inform him of any crop damage they incurred, at which time he would try to visit the area to inspect the damage and complete a questionnaire.

### **Results**

A total of five questionnaires were completed during the period covering 1<sup>st</sup> March to 30<sup>th</sup> November 1999. Four of these questionnaires were collected during the month of March and one questionnaire was collected in July. In all cases mature cassava (bitter) was damaged by elephants. Coffee trees were also damaged on two occasions. In only one of the questionnaires were other crops recorded as being damaged; corn and peanuts in an area of cassava were damaged (Table 2).

In the case of cassava damage, the elephants uproot the entire plant but generally do not eat the tuber: they prefer the sweet variety when they find it. Coffee trees are not consumed but are usually pushed over by the elephants as they travel through coffee plantations. Elephants consume both the stalks and ears of corn. Peanuts are uprooted and eaten during crop raiding.

Because no direct observations were made while crops were being raided, due either to nocturnal activity or no humans being present, the number of individual elephants causing the damage was estimated based on the measurements of rear footprints found in the field. In all cases inventoried the raiding was done by a group; the minimum number of individuals being two, and the maximum four.

**Table 2: Elephant Crop Damage**

<b>Crop</b>	<b>Location</b>	<b>Date</b>	<b>Maturity stage<sup>1</sup></b>	<b>Degree of damage<sup>2</sup></b>	<b>Size of elephant group</b>
Cassava	Moussapoula	March 12	3	2	3
Coffee	Moussapoula	March 12	1	4	3
Cassava	Moussapoula	March 12	3	2	2
Cassava	Moussapoula	March 12	3	2	3
Coffee	Moussapoula	March 12	1	4	3
Cassava	Moussapoula	March 16	3	2	3
Corn	Bayanga	July 27	1	2	4 (approx.)
Cassava	Bayanga	July 27	1	2	4 (approx.)
Peanuts	Bayanga	July 27	1	2	4 (approx.)

<sup>1</sup>Maturity stages: 1 = immature, 2 = intermediate, 3 = mature

<sup>2</sup>Degree of damage: 1 = very high, 2 = high, 3 = medium, 4 = low, 5 = very low

## **Discussion**

### *Current sample size*

There was a low response to the questionnaire for several reasons.

1. Elephants occur in high densities in this region but this, combined with low human population density, makes up an ideal scenario for low rates of crop raiding.
2. Since the inception of the WWF conservation project the problem of crop raiding has never been formerly addressed, with the exception of an attempted administrative cull in 1993 which failed. Because of this history the local people feel that the project is reluctant to accept complaints about crop damage. When informed that the project was now interested in collecting information, without mention of compensation, villagers were reluctant to make the effort to inform the project of damage, especially in areas far from the project headquarters in Bayanga.
3. A third reason for not informing the project about crop raiding is that in certain areas villagers have found their own solutions to elephant damage which includes poaching. In one village where this is the case poaching is a lucrative industry.

### *Traditional deterrence*

The most effective deterrence to elephant damage is the grouping of fields along the main road. As mentioned before, this is stipulated in the management plan of the park and occurs naturally because of thick forest vegetation. Fields, however, are not generally guarded on a 24 hour basis, being tended only during the daylight hours. Therefore most of the raiding takes place at night.

Another traditional elephant deterrence observed is the erection of “fences” around fields. These fences consist of a string mounted around the cultivated area with various objects such as cans, discarded plastic bags, etc. suspended from the string, the perception being that the motion of the objects frightens the elephants from the area. Some of the objects such as milk tin lids make a noise when moved by the wind, which is also thought to deter elephants. Whether this is an effective means of deterring elephants from fields is doubtful.

A further deterrence is the burning of Chinese bamboo near the fields. The closed cavities in the bamboo stems “explode” when burned. This frightens the elephants away, but only for short periods of time.



### *Other pests*

As in all areas of Africa elephants are always perceived as the main crop raider where present. In the area of Bayanga primates as well as rodents are also considered pests. Monkey species, and particularly the crested mangabey (*Cercocebus galeritus agilis*) eat bitter cassava in the fields, and also as the tubers are being soaked in water to remove poisons prior to consumption. Other foodstocks destroyed by mangabeys in this area include papayas, corn and peanuts. Three rodent species are also noted for crop damage. They include cane rats (*Thryonomys sp.*), giant rats (*Cricetomys emini*) and porcupines (*Hystrix sp.*). All of these species damage cassava fields as well as corn and peanut fields.

### **Recommendations**

With the continuing influx of human population into this area, elephant crop raiding will become a more prominent problem and one that will have to be addressed if elephants are to be effectively protected in this region. At present the inhabitants of the Reserve perceive the elephants as agricultural pests and not as a natural resource.

## **An integrated approach toward problem animal management**

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### **Summary**

Crop damage by elephants has a major impact on the livelihoods of rural farmers in communal lands of Zimbabwe where elephants are common. In the mid Zambezi Valley, Rural District Councils are tasked with managing this conflict by employing control units and conducting disturbance shooting in an effort to reduce crop loss. Farmers attempt to limit loss using traditional methods. Due to a lack of resources and the ineffectiveness of any single method, farmers lose considerable food and cash crops to elephants every year. To address these issues with Problem Animal Control (PAC), the Mid Zambezi Elephant Project (MZEP) has developed a two-stage integrated approach to increase the livelihood security of farmers. The first aspect builds on experimental crop protection schemes that can be administered by farmers. The second aims to reorganise crops currently grown and to introduce a cash crop that is unpalatable to wildlife.

## **Background**

Conflict between humans and elephants is a growing concern across Africa where the rangeland of the elephant is being rapidly converted to farmland. Crop damage in the communal lands of Zimbabwe is particularly severe: elephants have been responsible for up to 75% of all crop damage in some districts (WWF, 1996). In some CAMPFIRE (Communal Areas Management Programme for Indigenous Resources) districts, crop damage by wildlife is perceived as the major problem facing farmers and threatens to undermine the whole programme (Van der Wittenboren 1999). A direct link has been made between crop damage and the levels of poaching and wounding of animals in the mid-Zambezi (CIRAD, 1997).

MZEP was established in 1997 to examine the ecology of elephants in the Muzarabani and Guruve districts and, in collaboration with the Zambezi Society, identified seasonal inter-district movement of elephants. Based upon this research, MZEP is developing a corridor for elephants between the two districts. The project has also designed and established a crop damage reporting scheme and implemented community-based methods to reduce the impact of wildlife crop damage on rural farmers.

### *Study area*

The Zambezi valley is dominated by *mopane-terminalia* woodland, with dense riverine thicket of mixed species along the major rivers. Most farming is small-scale dry land cultivation and the main wet season crops include maize, ground nuts and cotton. These rain-fed crops are planted in November and harvested between April and June. Agriculture is concentrated on wide bands of alluvial soil bordering the major rivers, and in isolated settlements within the dry forest. Agricultural activities are expanding rapidly due to the profitability of cotton and the associated clearance of new land, and the resettlement of people from other parts of the country.

Elephants move extensively through the communal lands, making use of dense thickets as temporary refuges. The elephant population of the three districts (Guruve, Muzarabani and Magoe district in Mozambique), estimated at approximately 3000 individuals (Davies 1999), is contiguous and as such needs to be managed as a common resource (MZEP and ZamSoc, 2000).

### *Study Villages*

Five villages were selected that experienced high levels of crop loss to elephants, based on information gathered by the MZEP reporting scheme. Museruka village was used as a study site for testing an integrated approach toward PAC. Crop damage incidents and traditional methods of PAC were monitored in Chombe, Gonono, Chadope and Bwazi villages as a comparison to tests in Museruka.

### **Problems with current responses to crop raiding**

Crop damage is a widespread and common problem in the mid-Zambezi region. There are a number of factors that compound the effects of crop loss upon rural farmers besides the direct impact on their livelihood. These are described below in brief.

### *Problem Animal Control*

Farmers generally perceive the control of ‘problem elephants’ as the responsibility of the council central units. Crop damage is at its height during the wet season when the majority of crops are grown (December-April), and the PAC units do not have the human or financial resources to attend to most incidents. The most common PAC method used is disturbance shooting, firing shots over the raiding animal’s head, but this becomes ineffective over time and often an animal has to be shot. Communal farmers commonly resort to their own methods to defend their fields by burning fires, beating drums and throwing stones, but these also become less effective as the season progresses.

### *Vigilance and co-operation between farmers*

Elephants enter fields that are poorly defended and crop loss is correlated to a farmers’ vigilance (Osborn, 1998). We found that farmers did not regularly defend their fields during the night when most raiding occurs. Lahm (1996) found that 36% of farmers in Gabon, whose crops were destroyed by elephants, did nothing to deter them. Being aware of the presence of elephants is therefore a key component toward improving the effectiveness of PAC.

### *Agriculture organisation*

The majority of crop raiding incidents involve elephants eating mature food crops which are highly nutritious and palatable to elephants. In Guruve district 73% of damage incidents were to food crops, including maize, sorghum and groundnuts (MZEP, 2001). In many communities maize and sorghum crops are grown in newly cleared fields abutting the forest.

These crops are particularly vulnerable to elephant damage as they grow over two meters tall and conceal elephants as they enter the fields.

### **Project strategy**

The project aimed to improve the livelihood security of communal land farmers in wildlife conflict areas, first through the development of an effective PAC methodology, and second through the establishment of wildlife resistant crops. To overcome the problem of elephants habituating to any single method, we used a combination of methods and ensured that all farmers took part in PAC activities. To address the issue of vulnerable crops, MZEP reorganised food crops and introduced chillies as a cash crop; chillies are unpalatable to mammals. The methods are separated into two approaches, the first deals with PAC and the second addresses the introduction of a new growing plan.

#### *Farmer-based PAC*

Meetings were conducted throughout the year and all farmers in the affected areas discussed the problem and formulated plans for PAC. Central to these discussions was encouraging farmers to acknowledge that they have to take responsibility for their own crop protection and that co-operation between farmers is essential for deterring elephants.

The PAC methods were divided into three categories. First, vigilance methods were designed to alert the farmers to approaching elephants and increase the chance of farmers spotting elephants as they approached the fields. Second, passive systems were designed to impede a crop raiding elephant's passage into the field using simple physical barriers and deterrents. These were established at the onset of the rains and required no attention other than maintenance. Third, active PAC methods were developed to be used by farmers to chase crop raiding elephants; they included chilli-based chemical deterrents and noisemakers.

#### *Vigilance methods*

- **Buffer Zones:** Farmers were asked to clear a five metre wide buffer zone around their fields (or in some cases along the edge of the whole village) to increase sightings of advancing elephants.
- **Watchtowers:** Farmers with fields on the forest boundary built watchtowers at approximately half-kilometre intervals to increase their vigilance capacity.
- **Whistles** were distributed to farmers along the boundary so they could alert other farmers when elephants were approaching the fields.

- **Fires** were kept burning all night in areas where elephants came regularly. These fires were also used to burn the pepper dung (see below).
- **Cowbells** were placed at 30m intervals along a string fence (see below) to alert farmers when elephants came to the fields.

*Passive methods*

- **String fences:** Farmers cut three metre poles and placed them at 30 metre intervals along the buffer zone. Bailing twine was strung between them and squares of burlap were tied at 5 metre intervals along the string.
- **Grease and hot pepper oil** were mixed together and applied to the string. As elephants made contact with the string, the grease caused irritation to their skin.

*Active methods*

- **Pepper dung:** Elephant dung was mixed with ground chillies by the farmers then dried in the sun. These bricks were burned in fires along the field boundaries to create a noxious smoke.
- **Whips** made of bark were made by the farmers that, when used properly, made a loud 'crack' similar to a gunshot.
- **Fire crackers** were used by farmers to chase elephants from the fields by throwing them above the animals.
- **Pepper spray** was used on occasions when the elephants did not respond to bangers (Osborn 2000).

**PAC evaluation**

The passive deterrents on their own were effective at keeping elephants out of the fields. A number of incidents occurred where elephants entered the buffer zone, contacted the fence, and turned away back to the bush. The cowbells played a crucial role in alerting the farmers to the elephants, and farmers agreed this was a key element to improving PAC. Making fires and co-ordinating vigilance efforts also reduced fear among farmers and improved efficiency by allowing some farmers to sleep while others patrolled. The active methods implemented by farmers were more successful at chasing elephants from the fields than traditional methods. Combinations of active and passive PAC methods used in Museruka were effective at reducing overall crop loss and this village experienced very little damage during the 2001 season. The other villages, where traditional PAC methods were used, suffered losses similar

to previous years. A full quantitative assessment of the methods and results of this study are available from MZEP.

### **Crops**

Chilli peppers contain capsaicin, the chemical which makes them hot, and as such are generally unpalatable to mammals. MZEP introduced chillies to farmers in Museruka as a wildlife resistant cash crop. The chillies were planted at the edges of the fields, forming a buffer of low growing crops in a 10-20m wide strip. Food crops, such as maize and sorghum, were planted away from the edges of the fields and therefore were less accessible to crop raiding elephants.

#### *Crop evaluation*

While the buffer crops did not restrict the movement of elephants into fields they were not attractive to raiding elephants. Chillies were found to be less palatable to mammals than maize, sorghum and cotton and were also more resistant to trampling damage by wildlife. As a cash crop, chillies have a market value that is double that of cotton (per kg) and the input costs are similar. Therefore, they have real potential as a competitive cash crop. Over half the farmers of Museruka reorganised their crops in the manner we suggested. The overall damage to food crops was lower than in other villages, but it is difficult to assess the actual benefit of this method. It is however a logical way of protecting the most vulnerable crops.

### **Conclusions**

The methods presented are effective, cheap and can be implemented by rural farmers. They are designed to be used in combination with each other to reduce the impact of crop raiding elephants and provide an alternative cash crop. Developing an efficient and affordable community-based system of PAC not only allows farmers to protect their own crops, but also reduces the management pressures upon the RDCs.

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## **Crop Damage by Elephants in the Red Volta Area During the 1997 Harvesting Season**

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### **Introduction**

In the northern savannahs of Ghana elephants (*Loxodonta africana africana*) are found in Mole National Park, Upper West Region and the Red Volta valley. The first study of the latter was made by Jamieson (1972), who noted that there were about 25 in the valley of Red Volta/White Volta/Morago rivers. No further surveys were undertaken until that of Sam (1994) in response to complaints of crop damage. Two years later Sam *et al.* (1996) made a survey of the elephants of north eastern Ghana and northern Togo.

Sam *et al.* (1996) learnt that crop raiding by elephants was a serious problem for the rural population in the Red Volta valley. The local people claim that crop raiding had increased during the preceding five years. Sam *et al.* (1996) deduced that this was as a consequence of events over the border in Togo. In 1990-92 there was a period of civil disturbance in Togo. The opposition targeted the national parks and reserves as symbols of the government and urged the populace to invade the protected areas. The rural people did so, and killed most animals. The elephants that survived fled into Burkina Faso, Benin and Ghana.

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Sam *et al.* (1996) mentioned that the most severe crop damage period was around harvest time, i.e. between September and December. Therefore we undertook the study described here during the 1996 harvest period. The goal was to understand the crop raiding phenomenon so that effective deterrence methods could be employed. Specifically, we were to:

1. determine the distribution of elephants within the forest reserve and cultivated lands outside the forest reserve;
2. determine the distribution and extent of crop raiding;
3. identify the individuals, social groups, or age-sex classes responsible for crop raiding;
4. determine the efficacy of the usual method employed by Wildlife Division (WD), to drive away elephants, i.e. firing shots in the air;
5. test the efficacy of capsicum pepper spray, and formulate a means of deploying it under local conditions.

(This paper will deal with objectives 2 and 3 only.)

### **Description of study area**

The study area is located in the Upper East Region of Ghana, between long. 0° 24' and 0° 46' W and lat. 10° 33' and 11° N. The Red Volta is the main river running southwards from Burkina Faso, through the middle of the area to its confluence with the White Volta river. Its banks are lined with forest reserves. It falls in the Guinea savannah zone with very low numbers of animal species. The area falls under two major edaphic zones - savannah ochrosols to the west of the river and groundwater laterites to the east. These types of soils are poorly drained and two of the poorest soils in Ghana (Boateng, 1970). According to Sam *et al.* (1996) soil fertility is on the decline.

The average annual rainfall is below 1,000mm with one wet season, from May to November. The temperature in the dry season is about 39° C. Sam *et al.* (1996) reported a downward trend and irregular fluctuations in the rains. They also reported higher temperatures for the last three decades in north eastern Ghana.

Agriculture is the mainstay of the local economy. The average land holding is 2.12 ha per family-compound. Human population density is about 118 per sq. km (Sam *et al.* 1996).



## **Methods**

In each village a volunteer was given the task of recording all incidents of crop raiding. Afflicted farmers were asked to report to the registrar the following details: date of raid, location of farm, crops damaged, and estimate of damage.

Later we went to the village and visited each damaged farm. The name of the farmer, the crop types, the type of damage, and the GPS reading were noted. Ideally one should measure the damage for every field, but time was limited. Therefore out of every five damaged farms, one was selected at random and measured. The following records were made: number of fields in the farm; for each field that had been damaged, the size of the field itself was measured using a tape measure or a road runner. The number of damaged stems were then counted.

Each time a clear hind footprint of an elephant was found in a field, it was measured with a tape measure. There is a strong relationship between age and the length of the hind footprint (Western *et al.*, 1983; Lee and Moss, 1995). One can also obtain a rough estimate of the age of an elephant from measuring the circumference of the dung boli (Jachmann and Bell, 1984).

## **Results**

### *Severity of crop damage*

We were not able to count the total number of fields for each village. Hence, though we know roughly how many fields were damaged, we do not know how many were spared, and thus cannot calculate the percentage of fields that were damaged in the area.

A total of 133 farms that had been damaged were examined. The number of damaged stems was counted in 27 fields; the percentage of stems that were damaged ranged from 0.1% to 100%. The median was 8.6%. In other words, half the fields suffered less than 10% damage. Three-quarters of the fields suffered less than 30% damage (Fig. 1). Five fields (i.e. about a fifth of the sample) suffered very high rates: more than 70% damage (Fig. 1). Only two fields experienced medium damage (between 30% and 70% of the stems damaged (Fig.1). Therefore these limited data suggest that if elephants visit a farmer's field, then it is most likely to be lightly damaged. But there remains a 20% risk that it will be very badly damaged.

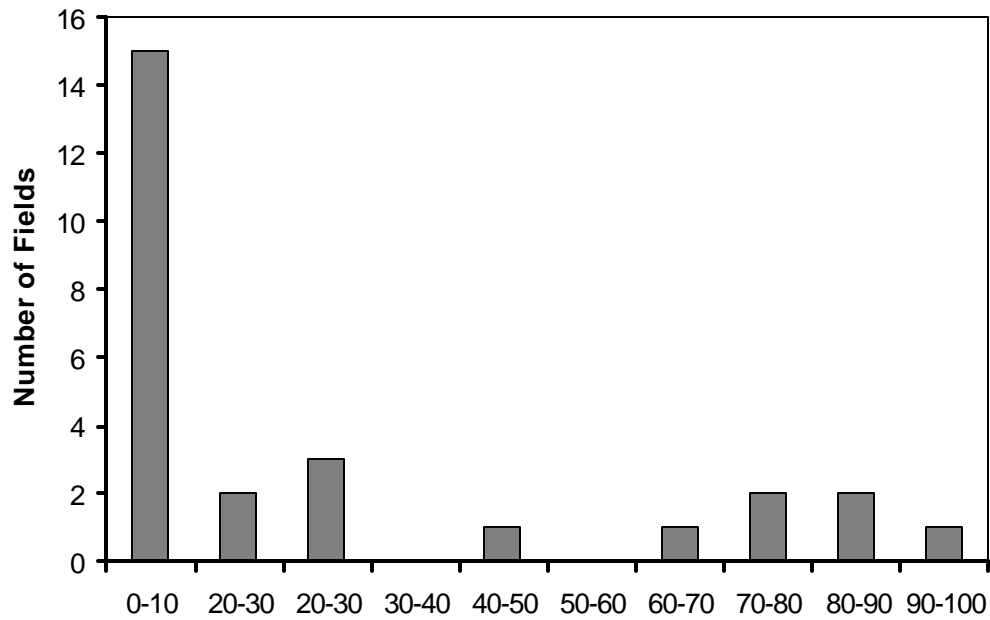


Figure 1: The frequency distribution of crop damage (n=27 fields).

Table 1: Comparison of damage between the East and West sides of the River Volta. The median percent damaged and its range are shown.

Category	Median	Range	N
East	7.5	0.1 - 85.3	20
West	13.0	0.2 - 100.0	7

Table 2: Comparison of damage between villages. The median percent damage and its range are shown.

Village	Median	Range	N
Tilli	5.9	0.9 - 74.6	6
Kusanaba	4.7	0.1 - 14.6	6
Widenaba	1.9	0.5 - 80.0	5
Others	21.5	0.2 - 100	10

**Table 3: Comparison of damage between crop types. The median per cent damage and its range are shown.**

<b>Crop Type</b>	<b>Median</b>	<b>Range</b>	<b>N</b>
Guinea corn	4.1	0.1 - 100	10
Rice	22.5	9.8 - 74.6	6
Others	0.5	0.5 - 80.0	11

In each of the above tables, the range is so great that there will be no significant differences in damage rates between east and west, or between villages, or between crop types.

### **Distribution of crop damage**

The spatial distribution of fields raided by elephants is shown in Fig. 2. Not all raids were reported to us, and we were not able to visit all the raided farms. Nevertheless, Fig. 2 probably gives a reasonable picture of the distribution of raiding activity.

Most raided farms were on the east side of the river, with the villages of Widenaba, Tilli, Shiega, and Kusanaba being the most affected. Sekoti and Kongo (Nangodi) were the worst affected villages of the west side. The concentrations of crop raiding incidents correspond to the high elephant densities on transects 2E, 3E, 7E, 5W and 6W.

### **Elephant footprint and dung measurements**

In the fields we found 22 footprints that were clear enough to measure. Two of these were 19cm, and represent very young infants. Ten were between 20cm and 29cm, representing calves aged between about one and six years old.

Twenty-three dung boli were measured in the fields. Ten of these were <30cm in circumference, and therefore represent calves less than three years old (see Table 4 in Jachmann and Bell, 1984). Another six were between 30 and 39cm, representing animals between about three and six years old.

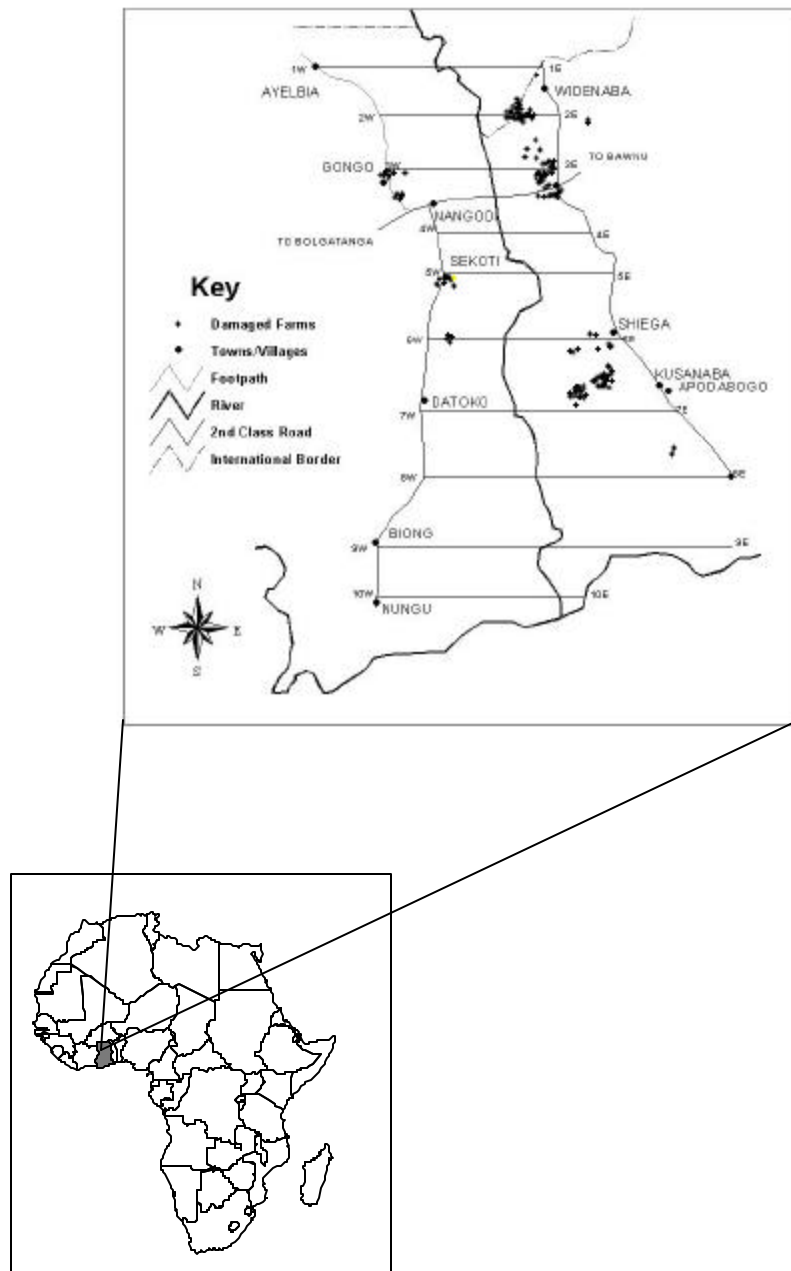


Figure 2: The spatial distribution of reported crop raiding incidents.

There is of course considerable variation in growth rates between the elephants in Ghana and those in the countries where the growth curves were calculated. Therefore the growth curves in Jachmann and Bell (1984) can give only a very rough indication of the ages of the animals in the Red Volta Valley. The main point to be made through the footprint and dung measurement data is that we found signs of many very young elephants in the fields. Both the footprint and the dung boli measurement show that families with very young elephants participate in crop raiding.

## **Discussion**

### *Intensity of crop damage*

Damage was light (less than 10% of the stems damaged) for most raided fields. But damage was severe in about a quarter of the fields that were raided: they lost 70% or more of their crop. Only a small number of fields suffered intermediate levels of loss. This is a peculiar distribution; one might have expected a sort of bell curve, with most farmers suffering about the average, a few suffering less, and a similar number suffering more. The sample size is too small to give a clear picture, but the bimodal distribution suggests two types of behaviour. The left hand part of the histogram (Fig. 1) may represent elephants that cause incidental damage while simply passing through on their way to some other place (“collateral damage” in military parlance). The right hand part of the histogram may represent groups that decided to stop and feed in that particular spot.

Ramachandran and Eastman (1997) have classified Upper East Region as having “very high vulnerability” to food insecurity. This is the most severe of their four classes of food security. In this very poor area the people live on the brink of food shortage even when there are no elephants. To suffer losses from elephants as well is an especially cruel burden.

The cost to the farmers living near elephants is very great. Even 10% of the standing crop must be a grievous loss to a subsistence farmer, while 70% or more can barely be imagined. One farmer told us how he arrived early one morning to harvest, only to see a group of elephants feeding in his field and said “I wept”. His field was almost completely destroyed.

It is not just the loss which is painful; there is also the fear of loss. For example, we saw that farmers in Kusanaba and other villages started to bring in the harvest earlier than usual, because they feared that if they did not do so, the elephants would get it first. This means that the quality of the harvest was sub-optimal because the grain had not fully ripened. But there is more to it than that. Even if a family was able to bring in the harvest safely, all through the

growing season was the fear that any night the elephants might strike and rob the family of the fruits of its labours. This fear, year after year, must make a big difference to the quality of life.

#### *Deterrence tactics*

Deterrence falls into two categories: strategic and tactical. Strategic methods are those which aim to deny part of the landscape to elephants. They include electric fencing (see Hoare, 1995 for a description of different arrangements). Fencing the entire forest reserve boundary would require high capital cost of constructing over 150km of fence, and regular patrolling and maintenance. Furthermore, long fences enclosing small areas have a high perimeter to area ratio and are very cost-inefficient. Fencing the elephants into the reserves would restrict their range especially during the dry season. The option recommended for this area is one that will enclose fields to keep out elephants. Hence it is crucial that the villagers see it as their fence from the very beginning. If the fences are seen as belonging to the government or some other organisation, which is therefore responsible for its maintenance, there is a higher probability of it failing. Sam (1998) estimated the cost of establishing a pilot 2km experimental electric fence and maintaining it for the first year in the Red Volta Valley at US\$3,278/km. While this is lower than one in Tsavo NP (US\$10,800) it is higher than Hoare (1992) reported in Zimbabwe (US\$500-1,500).

It has been estimated that in its 10th and 20th years, the cost of the fence would have fallen to US\$54/ha and \$44/ha respectively. According to Sam (1998) a 2km fence around a rice field in the Red Volta Valley would be economically worthwhile in the first year, while a Guinea cornfield would break even. However, a millet field would break even in the second year.

Tactical methods are those which aim to drive elephants away, or to discourage them from approaching the fields. They include the traditional methods such as banging drums, lighting fires, firing shots etc. They also include newer methods such as capsicum spray (red pepper). Shooting crop-raiders falls into this category. The goal should be to change elephants' perception of crop raiding as a low or risk-free activity. If one could frighten family groups enough, so they learn that approaching cultivation puts their calves at risk, then a large sector of the elephant population would refrain from crop raiding.

The first step must be for the villagers to do more to protect their crops. One suggestion is for the men in each village to organise themselves, and take turns to watch their fields during the

late growing season. However, this is not a risk-free undertaking for the farmers, because a large elephant can be invisible at 10 metres in a mature stand of Guinea corn, even in daylight. Note, however, that if elephants are harassed or associate certain places with risk, they will become more aggressive when they do come into contact with people. Thus if these tactics are successful, one might have fewer, but more aggressive, elephants indulging in crop raiding. Second, the WD could organise two or three teams on the east side, and one on the west. Each team would station itself in a central village. When villagers heard elephants approaching their fields, they could send a runner (possibly on a bicycle) to summon one of these teams.

The tactical methods of deterrence can start immediately. Fence construction may take a couple of years. In combination, electric fences and organised deterrent tactics should make a large reduction to crop raiding and thereby improve the lot of the valley people.

### **Acknowledgements**

WWF International sponsored the fieldwork through their Africa and Madagascar programme. Mr James Braimah and Sylvester Dapkui were our field assistants. We benefited considerably from the presence of the 9member Crop Protection Team. We will not forget the willingness of the Chiefs, Assembly members, and local guides of the Red Volta Valley who helped us.

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## APPENDIX 2: Participant list



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The Wildlife Conservation Society (WCS) is dedicated to saving wildlife and wildlands to assure a future for threatened species such as elephants, gorillas, chimpanzees, cheetahs, tigers, sharks or lynx. That mission is achieved through a conservation program that protects some 50 living landscapes around the world, manages more than 300 field projects in 53 countries, and supports the largest system of living institutions in the USA: the Bronx Zoo, the New York Aquarium, the Wildlife Centres in Central Park, Queens and Prospect Park, and the Wildlife Survival Centre on St. Catherine's Island, Georgia. We are developing and maintaining pioneering environmental education programmes that reach more than three million people in the New York metropolitan area as well as in all 50 United States and 14 other countries. We are working to make future generations inheritors, not just survivors.

To learn more about WCS visit: [www.wcs.org](http://www.wcs.org)

WCS has been a driving force in conservation in Africa since the 1920s when the Bronx Zoo's first president, William Hornaday, initiated a programme to save the white rhinos of South Africa. Since this time the WCS Africa Programme has been characterised by pioneering conservation work such as the first field studies and census of the mountain gorillas by George Schaller in Congo (1959), creation of the Nouabale-Ndoki national park in Congo Republic (1993), Masoala park in Madagascar (1956), and Nyungwe National Park in Rwanda (2001), applied research and monitoring of wildlife in many sites such as Amboseli park (Kenya), Luwangwa Valley (Zambia), Virunga Volcanoes (Rwanda, Uganda and Congo), Kibale park (Uganda), Nouabale-Ndoki park (Congo Republic), Banyang-mbo Wildlife Sanctuary (Cameroon), and Lopé reserve (Gabon), and initiatives with the private sector to reduce impacts on the environment (eg. Logging companies in Congo and Gabon; oil companies in Gabon), and working with communities to develop sustainable use programmes (Bushmeat hunting in Cameroon, Gabon, Congo Republic and Congo; Sport hunting in Zambia; harvesting medicinal plants and NTFPs in Uganda, Cameroon, Madagascar and sustainable logging practices in Uganda, Congo Republic and Gabon). WCS focuses on the use of good scientific information to manage conservation areas and as such has more field scientists on the ground than any other conservation organisation on the world. Currently the WCS Africa Programme works in 14 countries protecting a range of spectacular and diverse ecosystems across the continent. These include the vast savannas of east and southern Africa, the equatorial rainforest of central Africa, the spiny deserts and forests of Madagascar and the montane ecosystems of Cameroon and the Albertine Rift. While Africa has some of the richest landscapes of the natural world it also faces extreme challenges of poverty, high human population growth and rapidly changing political systems. WCS Africa programme recognises these challenges and the subsequent pressures on biodiversity. Throughout its field-based programmes WCS works with governments, national institutions and local communities to conserve Africa's natural heritage for both Africans and the world at large.

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The conflict that occurs between people and wildlife when animals leave protected areas and raid their crops is becoming one of the largest problems for conservation managers around the world. This is particularly so in Africa where there are still many large mammals such as elephant, buffalo and rhino which not only eat large amounts of crops but also are dangerous to people. Much of the current thinking about conservation strategies advocates a dual approach to conserving protected areas law enforcement combined with working with local communities to reduce their impacts on the protected area. However, crop raiding by wildlife can completely undo initiatives that work with local people as it is a source of great friction. Many studies are carried out that attempt to assess the problem with crop raiding wildlife but they often address only one aspect of the crop-raiding problem. This subject is a complex issue and has to be understood as such if any meaningful solutions are to be developed. Often local farmers may complain about one animal when in fact it does not cause the most damage in fact insects and rodents probably cause the most damage to crops in many places rather than the large animals. Therefore simply measuring the damage and compensating people in some way may not in fact solve the problem in some areas. It is very important to understand what the real 'problem' is before trying to find solutions otherwise you end up finding solutions to something that wasn't really the problem in the first place. This report is the result of a workshop that brought together people from across Africa who have been addressing crop-raiding and trying to find solutions in a wide variety of cultural settings and habitats. The report synthesizes what these people have learnt through their experience in dealing with this issue and provides guidelines for protected area managers and researchers when facing this problem. The appendices provide several case studies which give more detail as to how crop-raiding has been tackled in various countries.

### **Author biographies**

Kate Hill is a lecturer at Oxford Brookes University, in the UK. She has been undertaking research on the impacts of crop raiding on local farmers for 11 years. She has focussed her research in Uganda where baboons and bushpigs are a particular problem around the Budongo Forest Reserve. She is a strong proponent of the need to understand the farmer's perspective before trying to tackle crop raiding problems. She has organised many seminars that have looked at this problem, particularly in relation to primate crop raiding.

Ferral (Loki) Osborne has been developing techniques to tackle crop-raiding problems by elephants in Zimbabwe for 8 years now. He has devised several methods that involve the use of capsicum pepper to drive off elephants and has had considerable success in reducing crop damage in northern Zimbabwe where he works. Loki is supported in part by the Wildlife Conservation Society for his work in Zimbabwe.

Andrew Plumtre was the Assistant Director for the WCS Africa Programme at the time this workshop was held. He now directs the WCS Albertine Rift Programme. As part of his work he has been looking at the links between crop raiding and poaching in the Parc National des Volcans in Rwanda.

