Human-Elephant Conflict Mitigation Meeting

Sharing Lessons and Experiences from across East Africa

31 August to 01 September, 2009

Mpala Research Centre, Laikipia District, Kenya

Proceedings compiled by

Max Graham & Moses Litoroh

October 2009

Acknowledgements

Table of Contents

List of Appendices

Citation

1. INTRODUCTION

Human-elephant conflict, in particular damage by elephants to crops, is a large and growing problem across East Africa. Rising human populations, rising elephant populations, changing patterns of land-use and land tenure, democratisation and the growing penetration of the media, are all contributing to this trend. Wildlife authorities, originally geared up to focus primarily on the problem of poaching, rampant between the 1970s and early 1990s, are struggling to cope with human-elephant conflict. Due to its complexity, human-elephant conflict requires a cross-sectoral and multi-disciplinary approach, which is a challenge for all organisations concerned.

This meeting on human-elephant conflict mitigation was organised by the University of Cambridge Darwin Initiative project *Building Capacity to Alleviate Human-Elephant Conflict in North Kenya* (http://www.geog.cam.ac.uk/research/projects/heccapacity/), and the Kenya Wildlife Service). The meeting was held directly prior to, and was designed to inform, another three-day workshop to develop Kenya's national elephant conservation strategy. The meeting was funded by the UK Darwin Initiative (Grant 15/040), the Centre for Training and Integrated Research for ASAL Development, and the Kenya Wildlife Service.

The objective of the meeting was to share lessons and experiences on human-elephant conflict mitigation among practitioners across Eastern Africa, though building on the experience generated by the Darwin project in Laikipia through the activities of the university of Cambridge and local partners.

Moses Litoroh asked Margaret Kinnaird, the director of Mpala Research Centre, to open the meeting. Margaret welcomed everyone to Mpala and gave some history that led to the creation of the research centre. Dickson Too, the KWS Warden for the Laikipia region, informed participants that human-elephant conflict in his area was particularly severe and requested that suggestions be tabled to help address the problem.

2. UNDERSTANDING HUMAN-ELEPHANT CONFLICT AND ITS DETERMINANTS
(Max Graham, Laikipia Elephant Project/University of Cambridge)

What is human-elephant conflict?

Human-elephant conflict includes the direct impacts elephants have on people such as crop damage, damage to property and human deaths and injuries, as well as indirect impacts such as the curfews imposed because of their presence in settlement areas, exposure to diseases because of guarding at night and the conflict between local communities and government. People respond to these costs through protests or by burning elephant habitat or by directly injuring and killing elephants. People also have indirect impacts on elephants such as habitat fragmentation and by impeding access to resources such as water and forage. It may also be that the consistent killing of animals involved in HEC is affecting the gene pool of elephant populations, possibly resulting in the disappearance of traits that are important for persistence. Elephants can respond to negative interactions through retaliatory injuring or killing of people.

Human elephant conflict across East Africa appears to be increasing: Why?

- Numbers of elephants in East Africa are increasing

Since the widespread poaching that decimated elephant populations across the region in the 1970s and 1980s, elephant numbers have steadily increased, thanks largely to the ban in the trade in ivory and improved law enforcement by the wildlife authorities. As elephant numbers have increased, so has their range expanded, appearing in areas where they occurred historical but are now occupied by people.

- The human population is increasing

The human population has also increased, in some cases dramatically over this period. For example Kenya's human population has increased five fold since the creation of the first national park in 1947 to between approximately 35 and 40 million people today.

- Changes in land use and land tenure

- Traditional methods for mitigating HEC no longer practiced

Rural communities once had traditional methods for dealing with human-elephant conflict. For example Louis Leakey writes about the Kiyuyu before 1903. In his book, he describes how the Kikuyu had their own guild of hunters who would kill crop-raiding elephants. Of course such practices are discouraged under current wildlife law and policy, and while it may be easy to kill small crop-raiding pests such as monkeys, porcupines and birds discretely, killing elephants is not likely to go unnoticed. So those who are victims of human-elephant conflict have little recourse but to report incidents and request for support and if this is not forthcoming then protests and forms of resistance are likely to become prevalent.

- Limited opportunity to derive benefits from wildlife outside of parks

There are limited opportunities to derive benefits from wildlife outside of parks. Therefore there are limited opportunities for local people to develop positive attitudes towards elephants.

- Democratisation and increase in media coverage

There is also growing democratisation across the region. Increasingly people's votes count and therefore their voices and concerns matter to the region's political leaders. The media are also increasingly active and so incidents of human-elephant conflict get far more attention than they would have previously.

Management of human-elephant conflict is not easy: Why?

- Human-elephant conflict is widespread and unpredictable across time and space and yet responsibility to manage the problem is vested in a centralised wildlife authority

- Individual mitigation tools do not seem to be effective and are often reactive rather than preventative

- Negative politics

The use of the issue of human-elephant conflict by politicians to gain political support among their constituents makes the work of the wildlife authorities on the ground incredibly difficult. Public meeting often involve the lambasting of wildlife authorities which is humiliating and undermines morale.

- No compensation for damage to crops and infrastructure.

This means that local people tend to resent, enormously, the presence of elephants and are difficult to engage with over the issue of human-elephant conflict

- Lack of capacity and resources.

Many national wildlife authorities were created with the aim of law enforcement and in particular anti-poaching. However as has been described here, human-elephant conflict is such a complex issue, involving problems of land-use, politics, wildlife management, animal welfare, community engagement, policy, law etc. These problems are well beyond the scope of the activities that wildlife authorities were involved with when they were first set up and quite frankly the major challenge in the 1980s and 1990s was how to stop our elephants being slaughtered for the ivory trade. This may still become an issue again in future but now the challenge is how can we in East Africa address human-elephant conflict?

Ecological determinants of human-elephant conflict

Temporal determinants of crop-raiding

The main work into the timing of human-elephant conflict, in particular crop-raiding, suggests a clear seasonal pattern. Dr Loki Osborn did quite a lot of work on this in Zimbabwe and his theory is that crop-raiding is triggered by nutritional stress, caused by a decline in the quality of natural forage during the dry season. In and around Kibale National Park in Uganda, crop-raiding also coincides with the dry season, when maize is ripening. However in forest environments the dry season is a time when the quality of natural forage is extremely high, as there is a prevalence of young leaves and fruit. In both cases, local cropping patterns appear to be the key determinant, particularly of maize. We have found similar patterns here in Laikipia.

Spatial determinants of crop-raiding

The spatial patterns of human-elephant conflict, in particular crop-raiding are less well understood. The most recent published research on human-elephant conflict, published by Noah Sitati on HEC in Transmara found crop-raiding to be highly clustered in relation to cultivation and distance from settlements. Here in Laikipia we have found crop-raiding by elephants to be strongly predicted by distance from elephant refuges, these are places where elephants live during the day, in this case large-scale ranches where elephants are tolerated and forest reserves where elephants can hide even if they are not tolerated. We have also found that crop-raiding is strongly related to settlement patterns, with higher rates of raiding at relatively lower settlement densities and decreasing as settlement density increases. This underscores the need for land-use planning in preventing human-elephant conflict in future.

Noah Sitati and his colleagues working in Transmara District found that human injury and death by elephants was correlated to distance from roads. Based on our experiences here, we can say with some confidence that incidents where people have been killed by elephants here in Laikipia mostly occur on or near roads and on most of these occasions the victims are drunk.

Behavioural components of human-elephant conflict

There are three elements of elephant behaviour that are relevant for understanding human-elephant conflict

• The adaptability of elephants.

Elephants use areas of high risk, such as smallholder areas, at night and alter their speed of movement so as to move quickly across and within such areas. This adaptability is remarkable and an admirable trait in any species having to cope with the challenges posed by human land use change. Indeed it is this adaptability that is helping elephants to survive in human-dominated landscapes. This adaptable behaviour allows elephants to live in human-dominated landscapes but has implications for human-elephant conflict. Among

elephants tracked with GPS collars, a strong positive relationship was found between the amount of smallholder land in an elephant's home range and the amount of time spent elephants spend in smallholder land at night. This suggests that habitat fragmentation leads to increasing levels of human-elephant conflict.

- Risk-taking

Male elephants take greater risks than female elephants. In Laikipia male elephants tracked spent more time in small-scale farms and other areas of high risk of mortality than did female elephants. It is believed that a strategy of risk taking maximises nutrient intake, allowing males to better compete for rank and therefore access to female elephants in oestrus. This is called the male behaviour hypothesis.

This may explain the preponderance of males involved in human-elephant conflict incidents in Laikipia and Transmara Districts in Kenya, though there are records where cows and calves are involved in crop-raiding. But in particular this behaviour is manifested in the breaking of electrified fences as males have been found to be almost exclusively involved in this activity.

The implications of this behaviour are that human-elephant conflict management, that is the treatment of human-elephant conflict, rather than its prevention, is about creating risk to a level where it will deter most elephants from damaging infrastructure and raiding crops.

- Socially learned behaviour

Elephants are not born crop-raiding just as they are not born to know where all the water sources are within their territories. So fence breaking and crop-raiding are possibly patterns of behaviour that are learned through social transmission of knowledge between elephants.

In September 2005 two elephants with GPS collars, a male and a female moved with a herd of approximately 80 elephants north into the Ol Pejeta Conservancy from a smaller ranch to the south. Ol Pejeta management drove the elephants into the conservancy and prevented them from returning from where they had come with the use of electrified fences and guns. However a few elephants refused to be driven into Ol Pejeta, including the cow elephant that we had fitted with a GPS collar. Now if you look at the amount of time she spent in small-scale farms before these elephants were trapped in Ol Pejeta and the amount of time she spent afterwards it is evident that with the absence of certain elephants in that group she virtually stopped raiding crops. The implication here is that there are potentially problem elephants within the population that teach others to raid crops. In this case it may have been male elephants that were in the group.

Social Dimensions of Human-Elephant Conflict

Tolerance of elephants is low

There are a range of reasons for decreased tolerance of elephants such as centralised ownership of wildlife, the prohibition of traditional Problem Animal Control such as hunting, and the absence of meaningful compensation for crop loss means that the benefits are accrued centrally but the costs are experienced locally.

The individualisation of land tenure means that responsibility for deterrence and absorbing impacts of human-wildlife conflict now increasingly occur at the individual level where as customary land-tenure arrangements would have ensured collective deterrence and sharing of costs and benefits of farming.

The penetration of a cash economy means that men are increasingly absent from farms in the rural African context due to the search for wages in exchange for their labour. In addition increasing access to education means that children are less available for crop protection.

Perceptions of risk of HEC and actual damage are not always consistent

The other major social issue in human-elephant conflict alluded to by HEC practitioners is that the perceptions of the level of damage that elephants cause are often quite different to the actual level of damage. Farmers fear infrequent though catastrophic events more than common, persistent small losses that may be cumulatively much greater. In Laikipia over 50% of 356 households interviewed ranked elephants as a significant wildlife pest. The key factors that contributed to this perception were: 1) land use, in particular whether or not a household grows crops; 2) if the respondent knew of anybody who had been injured or killed by an elephant and; 3) previous experience of having to scare an elephant away; 4) perception of who 'owned' the elephants with negative perceptions highest where outsiders are perceived to own elephants, then the government but more positive attitudes if the community are perceived to own the elephants themselves.

Vulnerability to human-elephant conflict

Vulnerability is an important consideration both in terms of exposure to risk of human-elephant conflict and the capacity to absorb that risk. Together these can be thought of in terms of the potential for loss.

At the household level vulnerability is largely determined by access to land, labour and capital. Under situations of individual land-tenure, the wealthiest households have access to greater areas of land so can be creative with their cropping patterns, leaving buffer areas between their farms and elephant refuges, diversifying the crops that they grow and employing labour.

But among communities where there is some cohesion and a culture of social reciprocity, then individuals can access land, labour and capital without necessarily being wealthy and

this can allow them to better absorb costs. Clearly individual farmers who are either poor or live in communities with poor social cohesion will be the most vulnerable to human-elephant conflict. Therefore the socio-economic status and social context of households is an important consideration in planning appropriate human-elephant conflict mitigation.

3. BUILDING CAPACITY TO ALLEVIATE HUMAN-ELEPHANT CONFLICT IN NORTH KENYA
(Professor Bill Adams, University of Cambridge)

This is a three year project being implemented by the University of Cambridge with a UK Darwin Initiative grant (grant 15/040). The project began in October, 2006 and will end in October 2009. Professor Bill Adams and Dr Max Graham are the co-principal investigators. The project is being implemented in Laikipia District in north-central Kenya and was originally designed to include the following components: Tracking elephant movement; developing early warning systems for human-elephant conflict; community-based elephant deterrence; and training.

The project involved a range of partners including the Centre for Training and Integrated Research in ASAL Development, The Elephant Pepper Development Trust, Kenya Wildlife Service (KWS), Laikipia Wildlife Forum (LWF), Mpala Research Centre (MRC), Ol Pejeta Conservancy, Rivercross Technologies, Save the Elephants (STE) and The Symbiosis Trust.

Laikipia is a mosaic of different land-use types with small-scale farming in the more arable areas to the south and west and large-scale ranching and pastoral activities in the more arid central and northern areas. After independence many of the large-scale properties in Laikipia were broken up into smallholder plots for settlement. Some of these plots were settled but many were abandoned and are now occupied by pastoralists. Elephants and other species of wildlife occur across much of Laikipia but are only tolerated on large-scale ranches. The consequence of people and elephants sharing the landscape is human-elephant conflict, in particular the problem of crop-raiding and associated negative politics.

The aim of this project is to enhance the conservation and management of Kenya's second largest elephant population (over 5,000 animals) and the ecosystem they inhabit through the implementation of an integrated and sustainable community based approach for alleviating human-elephant conflict (HEC)

The project supported local partners to:

• **Undertake research into systems that provide early warning of HEC**:

The first system assessed in partnership with Mpala Research Centre was based on NDVI data, which provides a greenness index from satellite images. The concept here was that if the relationship between crop-raiding and the greenness index of cultivation relative to natural habitat could be identified, then early warning maps could be created and distributed to the wildlife authorities for appropriate action. Preliminary results were encouraging but were not conclusive and the resources required to make this system work made it impractical.

The second system developed, this time in partnership with Save the Elephants, was the E-Fence, whereby a GPS/GSM collar is fitted on an elephant and programmed to send an early warning text message to someone who can take action when an elephant approaches a designated boundary. Once again this system showed potential but there were problems

experienced with its management. For example the wrong map was used for programming the collar so false text messages were sent out. But because of its expense and the resources required to provide an effective response such as a vehicle full of armed guards to scare the elephant away, this tool is not really applicable to many sites across Africa.

The third system trialled, discussed in more detail later, was Push to Talk, which is an application on a mobile phone that allows users to use their phones like hand held radios, communicating with a group. The idea here was to improve collective reporting and cooperative action to human-elephant conflict incidents. More will be said on this later.

- **Disseminate information on elephant conservation and HEC management among vulnerable communities and local conservation organisations and land managers**

Here we trialled, while at the same time, disseminated information on farm-based deterrents such as chilli grease fences, noise makers, watchtowers etc. This was achieved through field days, a comic book and a local drama group and there are now many farmers in areas that are vulnerable to HEC that know about these methods.

- **Assess the feasibility of establishing economic activities that promote sustainable livelihoods and reduce HEC**

We worked with five community groups across Laikipia to trial three livelihood activities: chilli farming, honey production and dung paper production. All have potential to provide a supplementary income source but do not represent viable alternatives to current livelihoods. We have now handed over this programme to the Laikipia Wildlife Forum who will be undertaking a large and well funded bioenterprise programme in Laikipia.

- **Promote the development of a strategy and revenue streams to support long term HEC management in Laikipia**

When the LWF secured funding to construct the West Laikipia Fence our project had to adapt and we revised our logframe to help provide support for this fence. The LWF have committed two more years of funding to see the fence project through to completion and to ensure that there is local ownership of the fence so that it is sustained and maintained into the future.

- **Development of the institutional capacity to manage the West Laikipia Elephant Fence**

We helped Tobias Ochieng to receive training through a master's degree course at Cambridge University under this project. He is now the Fence Officer for the Laikipia Wildlife Forum. We have also put in place a system, comprised of scouts, fence committees and local managers to monitor, report and respond to issues of fence performance.

4. HUMAN-ELEPHANT CONFLICT, ITS DETERMINANTS AND MANAGEMENT ACROSS EASTERN AFRICA (All participants)

Mozambique

The techniques used to address human-elephant conflict in Mozambique are similar to those of Kenya. There are fenced conservation areas and there is a fence being constructed in northern Mozambique, through funding provided by WWF. Existing fences are being broken and it is important to consider some of the underlying reasons for this. If the enclosed area does not have enough water or pasture then the elephants will break out of the fenced area. No single method works alone and it is instead best to try a suite of methods

Uganda

There is a growing problem of human-elephant conflict in Uganda. Uganda doesn't have the resources to construct electrified fences around protected areas. However there are some community owned fences. The main method for addressing human-elephant conflict is the construction of moats.

Sudan

Sudan has just emerged from a civil war and the country's priority is with helping its people but steps are being taken towards supporting wildlife conservation. Many of the country's animals were killed during the civil war though are coming back now, sometimes from neighbouring countries (e.g. Uganda). There is some human-elephant conflict. Where this is occurring and how big a problem it is, is not entirely clear. There is currently no government level approach for addressing human-elephant conflict and there is a clear need for resources to help with building capacity for dealing with this problem in future.

Tanzania

There are an estimated 150,000 elephants in Tanzania, which means that Tanzania has more elephants than any other country in Africa, including Botswana and Namibia. The country does not have a policy of erecting electrified fences and elephants are not restricted in their movement. Currently the biggest source of human-elephant conflict is elephants moving from Amboseli in Kenya to Kilimanjaro, damaging crops on their way. This is due to the prevailing drought in the area.

There is no compensation for human-wildlife conflict incidents though Tanzania does allow sport hunting which provides benefits to local communities. Currently there is a fee of US $20,000 per elephant shot and a proportion of this money goes back to the community where the animal was shot which helps local people to tolerate elephants.

5. MONITORING AND REPORTING HUMAN-ELEPHANT CONFLICT
(Max Graham and Tobias Ochieng, Laikipia Elephant Project)

Why is monitoring human-elephant conflict important?

We need to know where and when human-elephant conflict occurs. This information helps with planning where to allocate resources in time and space. However this information doesn't just exist, it needs to be collected and analysed.

How is information currently collected?

The Kenya Wildlife Service collects information on human-elephant conflict incidents through its occurrence books. Information from the public and from rangers on the ground is reported and entered at each KWS station. The latter are fairly well distributed throughout the country. However these data are incomplete because:

- There is no real incentive for reporting human-elephant conflict incidents by members of the public as there is no compensation and the wildlife authorities often do not have the resources to respond to reports.
- KWS stations and outposts are not everywhere

The emergence of mobile phone technology in East Africa has the potential to make reporting by the public relatively simple and cheap where mobile phone coverage exists.

Because of the absence of systematic data on human-elephant conflict the IUCN African Elephant Specialist Group has greatly promoted and encouraged the use of a standardised data collection and reporting system across elephant range states.

From 2002, adapted versions of the IUCN HEC data collection and reporting protocols were used to systematically collect information on human-elephant conflict in Laikipia with 10 enumerators working across the district. The form used was quite detailed and complex because it was primary purpose was to collect a range of information for a PhD study. Clearly the type of form used will vary depending on the needs of the end user. However for the purpose of the management of human-elephant conflict, the form used should be short and simple, perhaps even more so than the current form recommended by the IUCN. The information collected in Laikipia that was of importance for management was where and when human-elephant conflict occurred. This was turned into a map. The map created has been an extremely powerful tool for raising funds and planning human-elephant conflict mitigation.

In 2008 the human-elephant conflict monitoring system used in Laikipia was adapted to monitor the performance of the West Laikipia Fence. The information reported is now used by local actors to locate and address problems of fence performance.

The resources required for monitoring human-elephant conflict in Laikipia were:

1) Scouts at approximately $100 per person per month

2) Regular supervision of scouts (supervisor with a motorbike)
3) GPS units
4) Paper forms
5) Computer
6) Database and person to enter data on a monthly basis
7) Some GIS software and knowledge.

While some GIS capacity is needed for mapping it should be noted that free GIS training and software is available to conservation projects through ESRI (*ESRI Nonprofit/Conservation Grants Program*)

Discussion Themes

In Transmara District Dr Noah Sitati and his colleagues created a scouts association to employ scouts because of issues over tax implications of employing scouts directly. When funding to employ scouts ended, the association continued and was provided with support for income generating activities (land and beehives). The association now receives in kind support to assist with wildlife monitoring in the area.

Participants agreed that for the monitoring of human-elephant conflict to be both useful and effective as a management tool then it needs to be accessible and shared among all relevant stakeholders including the community on the ground. Such information can be used to evaluate the success or otherwise of the interventions introduced.

6. WHOSE RESPONSIBILITY IS HUMAN-ELEPHANT CONFLICT?
(Moses Litoroh, Kenya Wildlife Service)

In Kenya the government, through the KWS, owns all wildlife and is mandated to protect the lives and property of Kenyans from wildlife.

Historically there was compensation for loss of property but the problem of gross abuse of the system resulted in this being abandoned. Today there is still compensation for loss of life. This is ethically challenging as how does one place a value on a human life? However a contribution is seen as a palliative. Previously the amount paid was Ksh 30,000 but this was recently reviewed and now it is Ksh 200,000

It is very challenging for the Kenya government to meet its commitment for several reasons:

- Land use change and the absence of a land policy for areas where wildlife occurs means that people are moving into elephant ranges, resulting in human-elephant conflict. Who then is responsible for causing this problem?

- The KWS have limited resources to attend to all incidents of human-elephant conflict in time and space and preventative action, such as fencing and translocation, are expensive.

- Politicians incite communities over the issue of human-elephant conflict, making it a hot issue to address.

Discussion themes

- Farmers are likely to be more motivated than wildlife authority rangers in HEC mitigation because they have the most to lose from crop-raiding and the most to gain from its prevention. If this is the case should farmers not be better supported to implement HEC mitigation measures?
- The issue of land and land policy is really important for preventing human-elephant conflict but is explosive in the Kenyan context where land is such a sensitive issue. In Tanzania the government owns all land and people are granted leases over this land. Therefore land use planning for conservation and the prevention of human-elephant conflict is more straightforward.

- In Uganda land was acquired for gorilla conservation. Cannot the same strategy be pursued for mitigating human-elephant conflict?

7. OVERVIEW OF HUMAN-ELEPHANT CONFILCT MITIGATION
(Max Graham, Laikipia Elephant Project, University of Cambridge)

Richard Hoare has done a great deal of research on human-elephant conflict for the IUCN elephant specialist group. He describes 10 different human-elephant conflict mitigation categories, with 16 method variations. These include site specific measures such as monitoring, lethal control, translocation, fences and farm-based deterrents. Beyond the site level human-elephant conflict mitigation options include financial incentives for conservation of elephants such as photographic tourism or trophy hunting, and land-use planning.

The management of human-elephant conflict can be thought of as having gone through several phases:

- **Pre-colonial**: Where there were indigenous systems of crop-protection such as hunting problem animals

- **Colonial**: Military style game eradication programme by colonial game departments where thousands of animals were destroyed to protect crops and make way for settlement. For example in the 1950s 11,019 elephants were killed on control in Kenya. In the Makueni area alone in Kenya 996 rhinos were killed between 1944 and 1946 to open up 50,000 acres for settlement. Similar programmes of game eradication occurred in Uganda.

- **1960s to 1970s**: With expanding human settlements into areas of high elephant density, control shooting alone became less effective and efforts were invested in barriers. In Kenya early experiments with electrified fences in Nairobi, Tsavo and Aberdares were failures. So attention was turned to building ditches and moats. These were constructed around the Aberdares, Mt Kenya, the Marallel Forest Reserve and Meru National Park. These worked where well maintained but the walls were eroded by rain and elephants learned how to push down the banks and climb over.

- **1980s to 1990s**: The first major electrified fencing projects undertaken. New electrified fences to stop elephant movement were constructed in the 1980s and are still considered one of the best solutions to the problem. Elephant fences were built in Malawi, Zimbabwe, Sri Lanka, India, Malaysia, China and South Africa. However these fences have not always worked and in some cases have been completely abandoned. The decimation of elephants for the ivory trade meant that anti-poaching was a far higher priority than human-elephant conflict management during this time.

- **2000-2010**: Emergence of community-based HEC management and natural resource management as tools for human-elephant conflict management. Over the last decade, there has been growing interest and support for community-based HEC management. This approach is concerned with supporting and improving simple and affordable farm-based deterrents that farmers can use themselves, and embodies the concept of decentralising management of HEC to communities. This approach really began with the pioneering work of Loki Osborn in Zimbabwe. Since his research in the late 1990s, there

17

have been other attempts at trialling and assessing farm-based deterrents in a number of countries now, including Kenya and even Indonesia. These trials have shown that there are definitely merits in the approach used though the effectiveness of individual deterrents introduced remains unclear. Furthermore we are also beginning to understand the barriers to uptake among individual farmers with labour in particular being a constraint.

- **Beyond 2010**: Perhaps this will be a period of integrated human-elephant conflict management and land-use planning. Clearly there has been a great deal invested in human-elephant conflict mitigation in the past. The challenge now is to learn from our experiences and lessons from the past, so that we can better plan for the future.

8. REDUCING HUMAN-ELEPHANT CONFLICT: THE NEED FOR EVIDENCE BASED APPROACHES
(Simon Hedges, Wildlife Conservation Society)

WCS carried out a comparative assessment of traditional vs. new farm-based elephant deterrents among smallholder farms adjacent to Way Kambas National Park in Indonesia. Traditional farm defence involved coordinated guarding of a 2km hard boundary using watchtowers occupied by 2-3 guards, spotlights and noise makers. New farm based defence was exactly the same, in an adjacent area but also included chilli-grease fences and early warning system comprised of trip wires and sirens. In both cases guards were paid to defend the hard boundary separating cultivation from the national park. Over 140 days, from October 2005 to April 2006, there were 34 attempts by elephants to enter the crop-fields at the chilli and siren site and of these only 3 were successful. Over this same time period there were 57 attempts by elephants to enter fields at the traditional site but only 5 were successful. In both sites 91.2% of raids were successfully repelled. So chillies and sirens appeared to add no significant deterrent effect but added expense and created additional work.

Between January and May 2007 the same comparative experiment was carried out but this time also included a traditional site where labour for guarding was voluntary rather than paid. Over this period 34 out of 62 raid (55%) were repelled at the new chilli and siren site, 16 out of 20 raids (80%) were repelled at the traditional site with paid guards and 156 out of 178 raids (88%) were repelled at the traditional site with voluntary guarding.

Adding chilli-based deterrents in this case either added no deterrent effect or achieved worse results than coordinated low-tech methods. Between July 2008 and February 2009 16 villages adopted low-tech coordinated guarding methods voluntarily and an average of 74% of raids were successfully repelled.

In conclusion:

- Improved guarding through a higher investment and better coordination of labour determined effective deterrence of elephants, rather than chilli-based and other higher tech methods (trip wires and sirens).
- There is a need for evidence-based approaches for HEC management, rather than the promotion of methods that have not been properly assessed

Further discussion of this topic is available in:
Hedges, S. and Gunaryadi, D. (2009). Reducing human-elephant conflict: Do chillies help deter elephants from entering crop fields? Oryx (in press)

9. UPTAKE AND PERFORMANCE OF FARM-BASED DETERRENTS IN LAIKIPIA DISTRICT, KENYA
(Tobias Ochieng, Laikipia Elephant Project)

Trials of farm-based treatments for deterring crop-raiding elephants, adapted from those promoted by the Elephant Chilli Pepper Development Trust, were undertaken between June 2002 and November 2005.

The first trial was carried out in Mutara between June and December 2002. Farm-based treatments were applied to an area measuring 0.03 km^2, with a nearby area of a similar size used as a control. Treatments applied included chilli rope fences, cow bells, chilli dung briquettes, noise makers, a watchtower and spotlight. Within the trial area crop-raiding reduced from 92 raids over the same period a year before to 26 raids during the trial, and the amount of damage per raid reduced from 585m^2 to 375m^2 per incident. Within the control area the number of raids increased from just 17 to 166 incidents, and the area damaged per incident increased from 328 m^2 to 421 m^2.

The second trial occurred among 20 farms in west Laikipia between February and November 2005. Crop-raiding declined on most of these farms, compared with over the same period in 2004 as did the average area damaged. However the same trend was recorded among the 20 farms monitored to provide a control.

Uptake of the deterrents provided was highly variable among the trial farms which may have affected the results. The labour requirements of the individual deterrents determined their uptake, with chilli fences being abandoned while burning chilli dung was taken up. Even control farms that had not been introduced to chilli dung, too this deterrent up.

Perceptions of the farm-based deterrents were generally positive with most respondents from trial farms reporting that the deterrents had helped protect crops. Those involved in the trials were more willing to contribute financially to sustaining these deterrents, than were those not involved in the trials.

Conclusions:

- Due to the nature of the trials undertaken the performance of individual deterrents remains unclear and requires further research. However collectively these deterrents do appear to help with crop protection.

- Labour constraints should be a key consideration in the trial or promotion of farm-based measures to mitigate human-elephant conflict.

10. MITIGATING HUMAN-ELEHPANT CONFLICT IN THE MARA ECOSYSTEM: LESSONS LEARNT
(Dr Noah Sitati, WWF)

Human-elephant conflict is a major threat to elephants. HEC is also driven by other threats to elephants including poaching and habitat loss. To effectively mitigate human-elephant conflict, all of these factors must be addressed. There have been many different types of mitigation measured tried across the African elephant range but with varying success which is why it is so important to share lessons and experiences among practitioners.

This project area covers 6000km^2 and includes the Masai Mara National Reserve (1500km^2). Rainfall in the study area increases from 500 mm per annum in the East to 1500m m in the West. The area contains a mixture of Masai people and other ethnic groups. There are 2,500 elephants in this area. There is also a large tourism industry. The human population within Transmara has increased dramatically since 1950 with the area under cultivation increasing and the area under forest cover decreasing. Total livestock numbers have also increased.

This project has been implemented in three phases. The first phase involved research, undertaken between 1989 and 2000. Over this period traditional measures were found to be ineffective. During the second phase of the project, undertaken between 2001 and 2003, human-elephant conflict mitigation strategies were tested. In the third phase of the project, undertaken between November 2003 and October 2006, the project was scaled up across the entire range. The project has been implemented through the Durrel Institute for Conservation Ecology, at the University of Kenya with support from the UK Darwin Initiative, the Kenya Wildlife Service and WWF. In 2007 the WWF took over the management of the project and have been developing a species action plan for African Elephants in the Mara-Serengeti landscape.

There are several categories of human-elephant conflict that occur in Transmara. The first is elephant attacks on people and property and this includes damage to crops, human deaths and injuries and a general curfew on people. This negatively impacts people's livelihoods and wellbeing. People respond to this conflict by clearing elephant habitat and directly killing elephants which has a negative impact on conservation.

The mitigation measures put in place or tests in the Transmare including: 1) The creation of the Transmara Wildlife Scouts Association; 2) Support to Community Based Organisations; 3) The trialling and promotion of farm-based deterrents such as fireworks, torches and chillies mixed with tobacco.; 4) Creating awareness among local communities with film and; 5) An education programme among local schools through the medium of sports and drama competitions.

What lessons have we learned in Transmara:

- Community participation in human-elephant conflict mitigation does work. However the upsurge in new cultivated farms that result from improved crop defence can threaten elephant habitat. Therefore alternative land use options need to be explored such as for example eco-tourism, bee keeping, livestock keeping etc.

- Human-human conflict can undermine any human-elephant conflict mitigation strategies.
- High expectations among local communities can be difficult to manage.
- Community scouts can and do play a huge role in human-elephant conflict monitoring and mitigation
- Local Masai community were slow to adopt farm-based deterrents compared with immigrants. This is because the Masai are traditionally pastoralists while the immigrants are farmers.
- Elephants will adapt to a farm-based deterrent and so a combination of deterrents is critical
- The lack of benefits and incentives from conservation ultimately undermines attempts to address human-elephant conflict
- A human-elephant conflict strategy for Transmara is needed and an associated human-elephant conflict management plan which needs land use planning and the creation of community conservation areas.
- Farmers will eventually become complacent after they have had several successful harvests so that eventually they become vulnerable to having their farms raided again.
- The first experimental plots are no longer relevant as new farms have appeared so that the old farms are no longer on the 'front line'.

In addition to these lessons learned, we have also identified a number of major challenges to resolving human-elephant conflict in Transmara. These include:

- Cattle rustling
- Ethnic fighting
- Increasing human population
- Increasing elephant population
- Changes in land tenure from communally owned land to individually owned land and changes in land use from traditional livestock keeping to cultivation.
- Increasing poaching incidents
- Post election violence affected tourism, further undermining conservation efforts
- Corruption and mismanagement of tourism revenue by the county councils

11. LETHAL CONTROL OF PROBLEM ELEPHANTS
(Max Graham, Laikipia Elephant Project and Moses Litoroh, Kenya Wildlife Service)

The justification for the use of lethal control in the management of human-elephant conflict is: 1) It is relatively cheap and easy to carry out; 2) It is popular with people affected by HEC and 3) It is the best solution to the theory of *habitual problem elephants*

Habitual problem elephants are believed to be individuals within an elephant population that cause a disproportionate amount of damage to crops and property relative to their numbers. However there is some debate over whether such individuals actually exist.

Richard Hoare undertook a survey across 22 human-elephant conflict sites in Africa and found little evidence to support the theory of habitual problem elephants. He argued that as the shooting of such animals never totally eliminates the problem means there is a high probability of replacement and so there is likely to always be a problem component within a population. He therefore argues that the destruction or removal of problem elephants should be very carefully evaluated on a case by case basis.

In Laikipia of the eight male elephants I fitted with GPS collars, six used smallholder areas more than 10% of the time at night. These elephants were fitted with collars across the district and not just next to smallholder settlement. Based on these results we would cautiously suggest that all elephants, in particular males, have the potential to raid and destroy crops. Some maybe better at this than others but all have the potential to be crop-raiders.

However our experience here in Laikipia also suggests that elimination of identified individuals can be effective in reducing crop-raiding, where this is carried out to enforce electrified fences or demarcate no-go zones. The point here is to demarcate zones of risk in a landscape to mitigate the number of elephants moving into land-use types that are not compatible with elephants. This is not that simply to carry out. There are several requirements for lethal control to be effective:

- Proper identification of elephants that are consistently destroying electrified fences and entering smallholder farms to raid crops
- Destroying elephants in the act; that is as they are breaking the actual fence to enter smallholder land.
- Have a clear understanding of when to kill an elephant after is has been identified as a fence breaker/crop-raider
- Having the skill to kill an elephant cleanly (i.e. with a single bullet)
- Systematic monitoring before and after to evaluate the impact of the management intervention

There are several problems associated with the current use of lethal control of elephants as a management tool:

- Often carried out in response to political pressure

- There is not often a system of identification and monitoring in place so it is not entirely clear that the elephant killed is the main culprit
- Absence of skill level among some (but not all) of those involved in killing elephants, resulting in multiple bullets being used, cruelty to the elephants involved and sometimes failure to kill the animal targeted, resulting in an animal being wounded.
- Poor or non-existing follow up monitoring to evaluate the impact of the management intervention carried out.

Discussion Themes

- The issue over the provision of an elephant carcass to a community, after a control operation generated a great deal of discussion. It seems that the expectation of elephant meat among some communities can create additional pressure on the wildlife authorities to kill an elephant, regardless of its status as a 'problem animal'.

- **Kenya:**
In Kenya a dedicated problem animal control unit exists for the management of human-wildlife conflict. This unit is comprised of specially selected rangers with specialist training for the management of human-wildlife conflict, in particular the management of problem elephants. The problem that this unit faces is that is it is very small and cannot respond to all cases across the country. In Kenya the KWS must give authority for the killing of a problem elephant and this is unlikely to be given unless the culprit is properly identified. However every KWS ranger is authorised to eliminate a problem animal under situations where human life is threatened. The provision of the meat to the community from an animal killed on control is not the official policy of the KWS, though the community often does access the meat. Under some circumstances the community apply pressure on the KWS to eliminate an elephant under the pretence that the animal is threatening lives and property but in reality the community are hoping to have access to meat. Approximately 40 elephants are killed every year by the KWS to manage human-elephant conflict

- **Tanzania:**
In Tanzania the official policy is to use lethal control as a last resort. Elephants are shot to appease the community suffering from human-elephant conflict. If a ranger is left to his own devices at night then he is more often than not going to make a decision that favours the community over the elephant. The meat from an elephant shot on control is given to the community. Approximately 100 elephants are shot every year on control in southern Tanzania.

- **Other East African Countries**
In Mozambique lethal control is also used as a tool for the management of human-elephant conflict. Approximately 20 elephants are killed every year under control. In Uganda lethal control is not an option for the wildlife authorities and victims of human-elephant conflict are instead offered cows as compensation. In Sudan lethal control is also available as a management option though it isn't clear under what circumstances this is used at present if at all.

12. THE ROLE OF COMMUNICATION IN HUMAN-ELEPHANT CONFLICT MANAGEMENT: EXPERIENCES WITH MOBILE PHONES
(Professor Bill Adams, University of Cambridge)

This presentation refers to the work carried out and written up by the Laikipia Elephant Project in a working paper: Max Graham, Christine Greenwood, Gabriel Kahiro & Bill Adams (2009) *The Use of 'Push to Talk' Mobile Phone Technology to Reduce Human Elephant Conflict, Laikipia District, Kenya*, Working Paper 2, Laikipia Elephant Project, Nanyuki,

This paper can be accessed through a free download at:
www/geog.cam.ac.uk/research/projects/heccapacity/

Human-elephant conflict is a significant problem in Kenya, as in many other parts of Africa and Asia where wild elephant populations persist outside protected areas. Various methods have been tried to reduce human-elephant conflict, ranging from traditional farm-based deterrence to electrified fences. The success of all forms of deterrence depends on the effectiveness of collaboration among farmers and wildlife management authorities. In particular, early-warning of crop raiding is important in successful raid deterrence. The rapid spread of mobile phone technologies in rural Africa is changing patterns of communication among local actors. This presentation reported a study of the effectiveness of mobile phone technology in tackling human-elephant conflict in Laikipia District, north-central Kenya. Mobile phone use has grown dramatically in Africa. The penetration rate of mobile phones (no. of phones per 100 people) for Africa as a whole was 6% in 2005 (36% in South Africa) with the number of subscribers rising by 35% per year. Penetration in Kenya in 2002 was 1.9%, compared with 1% for landlines. Actual mobile phone use is probably much higher. This has led to the rapid spread in changing communication patterns, creating a platform for novel commercial applications based on the 'bottom of the pyramid' market of the rural poor. Such commercial applications include the payment service, M-PESA, launched by Safaricom and Vodafone in Kenya in 2005, and other services such as election monitoring, the provision of market prices and crowd sourcing

In 2007 the Laikipia Elephant Project carried out a trial with a view to improving communication between smallholder farmers, large landowners and wildlife conservancies and their fence management teams, and the Kenya Wildlife Service. The trial was a collaboration between the GSMA Development Fund, Safaricom Ltd, Wireless ZT, Nokia, the Nokia Siemens Networks and the Laikipia Wildlife Forum.

The technology tested in Laikipia was 'Push to Talk over Cellular' Technology. This enables communication between two individuals, or among a group of people, combining the functionality of a two-way radio with a mobile phone. Push to Talk users can make standard phone calls and send SMS. Push to Talk technology requires less airtime, demands less energy, and is less costly than a conventional phone call.

Mobile phones are widely distributed in Laikipia, and network coverage is extensive. Push to Talk was trialed in three locations with a long-standing history of crop-raiding by elephants, and where local farmers were engaged in attempts to defend their field, Mwenje, Rumuruti and Ex-Erok.

In all three areas Push to Talk technology improved coordination of responses to human elephant conflict, bridging problematic relationships between the different stakeholders (the Kenya Wildlife Service, the smallholder farming community, private landowners and police). Push to Talk also helped address security incidents such as livestock theft.

This trial suggests that Push to Talk technology can make mobile phone use more affordable and accessible to poorer communities, and also make group communication possible. This has a number of potential applications. Push to Talk, and mobile phones technology more generally, is relevant to community-based human-elephant conflict mitigation where there is good mobile coverage and widespread adoption.
.
Human-Elephant Conflict and Mobile Phones

- This trial demonstrated that the key to mitigating human-elephant conflict in a range of situations is effective communication and not necessarily the specific technology used. Mobile phone technology may be relevant for addressing a range of conservation challenges worldwide.

Discussions themes

- Currently trials are being undertaken in South-East Asia with new mobile phone technology whereby a fence is fitted with sensors so that when an elephant approaches a response is triggered that sends a text message to designated mobile phones to create an early warning.

13. A HUMAN-ELEPHANT CONFLICT MITIGATION PLAN FOR NAROK
(Kenneth Nashuu, Kenya Wildlife Service)

A human-elephant conflict mitigation plan was needed in Narok for several reasons: 1) Human-elephant conflict has been escalating and it is not expected to decrease unless a strategy is put in place and implemented; 2) Extensive drought has placed a strain on the natural habitat of elephants over the last year, placing even more pressure on cultivated lands; 3) Habitat for wildlife is decreasing due to increasing cultivation; 4) This will place human lives at risk as elephants increasingly move into settled areas.

There are several types of human-elephant conflict in Narok District. This includes damage to crops, damage to property, competition over pasture and water, livestock killed, people injured and killed and the threats that elephants pose to human life.

Human-elephant conflict in Narok District is caused by: 1) The absence of a land use and tenure policy; 2) An increasing human population which is limiting the space available to both wildlife and people and; 3) Human encroachment and cultivation in wildlife areas.

A short term human-elephant conflict management strategy was put in place to address the immediate problem of crop-raiding. The first step was to identify the main HEC hot spots. The following areas were identified as HEC hotspots: 1) Siyapei; 2) Ntulele and; 3) Lemek. To address HEC in these areas, rangers were posted to strategic locations to monitor elephant movement and a problem animal management unit was resourced to provide a rapid response in the even of elephants being sighted. In addition improved communication between the community and KWS was promoted. To do this a committee was elected and authorised to communicate with the KWS on behalf of the community.

Once the drought has ended and elephants move, barriers will be put in place to stop elephants from coming back to these settled areas. If elephants do not move off then an elephant drive will be organised.

A longer term mitigation plan is also being developed. This will involve: 1) The formation of conflict management committees; 2) The identification of potential tourist circuits; 3) Seeking support from communities and their leaders for conservation activities; 4) Identify community scouts; 5) Identify potential investors to help establish community conservancies; 6) Identify potential community development programmed (for example the construction of community dams; 7) Carry out research on sites with potential for development of conservancies; 8) Education of the community on conservation; 9) Encourage the planting of trees; 10) The creation of forums for addressing land issues in Narok; 11) As a last resort, translocation of elephants to another area

The impact of the short term strategy activities has been improved harvest of crops, reducing suffering and enhanced livelihoods. The efficiency of the problem animal management units has improved, with less fuel used and a bigger impact achieved in terms of keeping elephants away from farms and settlement. The relationship between the KWS and the local community has also improved. Lastly wildlife is less threatened by local people than it was.

Some of the challenges to implementing the short term mitigation strategy were inadequate aerial monitoring, inadequate funding for public meetings, the impact of the persistent drought and lastly insufficient resources for scaring elephants away such as thunderflashes and guns.

14. TOOLS FOR ENGAGING THE COMMUNITY IN HEC MITIGATION
(Tobias Ochieng, Laikipia Elephant Project)

The management of human-elephant conflict is often centralised and top-bottom and therefore rarely if ever involves local communities. However, as has been shown in the previous presentations, current approaches to the management of human-elephant conflict are not always effective because human-elephant conflict occurs widely and is unpredictable in time and space and is therefore beyond the means of a centralised wildlife authority with limited resources. Under these circumstances efforts to engage and encourage community members in human-elephant conflict management are obviously needed. However these are often hampered because of enormous resentment over the costs incurred by crop-raiding elephants and the absence of compensation over such losses. For example meetings between communities and the wildlife authorities to discuss human-elephant conflict can be very tense. Furthermore communities have little access to information on elephant behaviour and ecology or the benefits that wildlife provides which allows political leaders to easily politicise the problem of human-elephant conflict.

Drama performances provide a tool for engaging communities under such circumstances. The Laikipia Elephant Project recruits a team of players to perform interactive plays with communities as a means of dissipating mistrust and anger, building trust and getting a message as well as educational information across. Plays are humorous and fun so that different stakeholders laugh and bond with one another. The plays are also informative, so that complex issues can be explored and presented to build understanding among local people. Once plays have been performed, the atmosphere they create provides a platform for discussing specific issues in relation to community involvement in the prevention or management of human-elephant conflict.

The Laikipia Elephant Project has also used community orientated comic books to make complex information on human-elephant conflict and its management accessible to local farmers and the general public, through a fun and humorous medium. One of these comic books, 'Kuishi Pamoja' provides specific instructions on a range of simple farm-based deterrents.

Lastly the Laikipia Elephant Project has also organised an essay competition among schools in human-elephant conflict hotspots across the district. This was carried out in partnership with the government district education officer and involved 240 participants from 30 schools. Eight winning essays were chosen by the national examination board and the three top winners were taken on an educational trip to learn about elephants. The reason for this prize was to provide an incentive for all participants and to encourage them to think about and understand issues concerning elephant conservation.

15. A STRATEGY FOR THE MITIGATION OF HUMAN-WILDLIFE CONFLICT IN MOZAMBIQUE
(Roberto Corriea and Zara Merah, Aga Khan Foundation)

Human-wildlife conflict in Mozambique is a major problem involving a range of species from small to large animals. This conflict is increasing with people being killed and property destroyed. In response in the last year 119 wild animals were shot. Historically there were rangers available to help defend farms. Elephants contribute to 20% of reported cases of human-wildlife conflict. However crocodiles are the species that cause the greatest problems, involved in 64% of reported cases of conflict.

The causes of human-wildlife conflict in Mozambique include cultivation, the excessive burning of grasslands which results in a reduction in food sources available for mammals, the reduction in natural predators and excessive fishing of rivers.

Human-wildlife conflict in Mozambique needs to be addressed through the creation of barriers, land-use planning and the creation of protected areas. However the challenge is that there are currently no land use plans, existing protected areas contain human settlement and there are insufficient resources to address human-wildlife conflict.

In planning human-wildlife conflict alleviation, there need to be agreed areas where people and wildlife can share resources, depending on the species of wildlife concerned, though land zonation of multiple use areas and in some cases there can only be areas for wildlife. This strategy is based on mitigation and prevention.

The next steps for Mozambique are improving the database on human-wildlife conflict, carry out a wildlife census, zoning of agricultural areas, developing a land use plan and training and equipping field staff for human-wildlife conflict mitigation.

16. THE USE OF ELECTRIFIED FENCES TO CONTROL ELEPHANT MOVEMENT
(Max Graham, Laikipia Elephant Project)

Electrified fences are often considered the ultimate solution to addressing human-elephant conflict, despite their considerable expense. Enormous amounts of money have been spent on electrified fences across the continent but there is very little documentation of their success and/or failure. There are several factors important in determining the effectiveness of fences.

Institutional arrangements

The construction of a fence is the easy part and it is the ongoing maintenance and management where the challenge lies and it is where this challenge cannot be met that the electrified fences fail to deter elephants or are completely abandoned by the intended beneficiaries. This is more of an institutional problem rather than an issue of design. Who owns the fence? Are they committed to its upkeep and maintenance? Do they have the resources to do this? Do they have the capacity to do this? It is these questions that need to be asked very early on in the planning stages of an electrified fence, together with an assessment of the costs and benefits of the fence. It is important to recognise that in this day and age, politics are a strong driving force for fence construction but if politics override the institutional arrangements necessary for fences to be maintained then those fences will fail.

Fence Alignment (*Pressure* by elephants on the fence)

Where the fence is constructed determines the level of pressure it will experience in terms of how often it will be challenged by elephants. Obviously fences separating elephant habitat from elephant habitat will be under a great deal less pressure than fences constructed along hard boundaries separating elephant habitat from intense cultivation. It is also important to establish the movement of elephants in the area so as to avoid putting a fence up where it will be placed under a great deal more pressure or where it might interrupt important seasonal movements.

The alignment of fences is clearly important. How are fences shaped relative to the cultivated land they intend to protect from elephants? Crudely there are three alignments we can consider here. The first is a simple straight line with a start and a finish. Where these have been constructed, such as in Tsavo National Park elephants sometimes simply walk along the fence to where it ends and then walk around it to the cultivated area. The second type of alignment is a fence created to contain elephants in a single area. This will inevitably be extremely large and is perhaps best represented by the fences we have in Kenya surrounding Aberdares and Shimba Hills National Parks. The last alignment to consider is that which surrounds cultivation. These fences have the potential for being the smallest and most cost-effective but are probably the least used among fencing projects. It is not entirely clear why this is the case.

Fence Design (*Configuration*)

In Laikipia there has been a great deal of experimentation with fence design. The first electrified fences here were simply livestock fences where the top wire was electrified, and bottle tops were used as insulators. With human-elephant conflict and wildlife conservations gaining in importance for the area, more sophisticated fence designs have been constructed. For example there are fences on the Ol Pejeta Conservancy, in south-central Laikipia, that are seven feet tall, with 13 strands, 9 of which are live ,and mesh wire, designed to keep in predators. There are also very simple fences, comprised of just two live wires strung loosely between large trees which are very effective. Another fence that seems to have had a great deal of success is under three feet n height and includes outriggers that project outwards and upwards in the direction of elephant pressure. The idea here is to prevent elephants from getting close enough to the fence to short it by either using its tusks or feet.

We have found in Laikipia that fence voltage is critical to ensuring an electrified fence presents a deterrent. The rule of thumb here has been to maintain fence voltage above 7kv (7,000 volts) which is achieved by ensuring that an energiser supplies no more than 7km of fencing and that the fence is well maintained which will be discussed further.

The other area that seems to be important is whether or not the wires travel on the outside of the fence post or inside the fence post. The problem with having insulators on the outside of the fence post is that they are easily pulled off by elephants tugging at the fence wire with their tusks which is harder to do when the wires travel through the fence post.

Fence Maintenance

Poor maintenance is the single greatest source of failure among electrified fencing projects. First of all fence components are vulnerable to theft and if they aren't replaced quickly then the boundary quickly becomes porous to elephant movement. In addition fences are often vandalised by local people who want to gain access to resources within the area that is fenced, such as for example, grazing or firewood. When elephants break fences they must be quickly repaired so that they do not become porous to all elephant movement the following evening.

Clearing of vegetation beneath the fence is always a challenge in the wet season but is important because vegetation can cause power leakage. While the use of chemicals is sometimes encouraged to clear vegetation, it is better to clear vegetation manually so that some vegetation cover is retained to prevent soil erosion along fence lines.

Clearly all of this maintenance costs time and money, up to 10% of the cost of fence construction per annum, depending on circumstances. This is why it is critical to ensure that pressure on fences are kept to an absolute minimum, otherwise costs will spiral out of control, quickly outstripping budgets.

Fence Enforcement

Fence enforcement involves the active defence of electrified fences to discourage elephants from challenging them. Within the Ol Pejeta Conservancy in Laikipia enforcement involves a rapid response vehicle which goes out with a powerful torch and scares elephants away from the electrified fence before they have a chance to break it. In the case of Ol Pejeta, enforcement also involves the identification and occasional elimination of elephants that persistently break electrified fences and raid crops. The combination of good fence design and enforcement has had a dramatic impact on human-elephant conflict on community land around the Ol Pejeta Conservancy.

Ol Pejeta Ranch was purchased in 2005 by an international conservation organisation, Fauna and Flora International and was turned into a wildlife conservancy. Prior to 2005 part of the ranch was fenced as a wildlife sanctuary but much of the property was surrounded by a very simple electrified perimeter fence. After 2005 all the conservancy's perimeter fences were substantially upgraded to become more effective barriers to elephant movement. In addition fence breaking elephants were identified and seven were eliminated by the Kenya Wildlife Service. The identification of the right individuals is believed to have been critical for making this management intervention effective, with a specially trained researcher employed to identify and monitor fence breaking elephants. Crop-raiding on cultivated farms along the eastern boundary of Ol Pejeta, previously very intense, was almost completely eliminated. Crop-raiding also reduced along the southern and western boundaries, though in the north-west it remained significant. The reason for the latter is more likely due to elephant movement from the neighbouring ranch which was unfenced at the time.

The Ol Pejeta Conservancy is a well resourced privately run organisation and so is not representative of many of the circumstances under which fencing projects are undertaken. The resources required for fence enforcement in particular may be beyond the means of some institutions involved in fencing projects. However in this part of Kenya we also have an example of a highly successful community owned and managed elephant fence in Sagana, which is in the south-western part of Mt Kenya.

17. THE CASE OF THE SAGANA COMMUNITY FENCE
(Mr Gerald Ngatia, Sagana Wildlife Protection Self-Help Group)

The Sagana settlement scheme covers a 500 hectare area, involving around 1000 households. The scheme was created in 1962 to settle landless families from Nyeri District and involved the degazettement of part of the Mt Kenya Forest Reserve. The scheme is almost surrounded by the Mt Kenya Forest Reserve. Human-wildlife conflict was a major problem from the outset with large mammals including rhino, elephants and buffalo raiding crops. The government constructed a moat in 1966 to separate the indigenous forest from plantation forest and any wildlife that crossed the moat were driven back or occasionally shot dead. After hunting was banned in 1977 animals were shot less frequently. The Forest Department ran out of resources to maintain the moat and human-wildlife conflict became a major problem again. In 1990 access to water was provided through funding by the European Union so that farmers could irrigate their crops. The species grown include maize, snow peas, potatoes, sweet potatoes, passion fruit, cabbages, carrots and beans. However crop-raiding by wildlife, in particular elephants, was such a problem that by 1998 some farmers within the Sagana settlement scheme relied on food aid to survive, despite the availability of irrigated arable land. Between 1997 and 1999 six people from the Sagana settlement scheme were injured and two people were killed by elephants and buffaloes. There were also 542 cases of crop-raiding by wildlife over this period. Over and above these direct costs, there were also indirect problems of curfews being imposes and damage to human health as a result of night guarding.

In 1998 members of the Sagana Settlement Scheme worked with the Kenya Wildlife Service to form the Sagana Wildlife Protection Self-Help Group with the following objectives:

- Safeguard the community and properties against any invasions from wildlife
- Enhance conservation of the biological resources of Mt Kenya
- Erect and maintain a solar powered electrified fence
- Work with the government on all aspects of conservation

In 2000 a five strand solar powered electric fence was constructed along 10km by the Sagana community with a Ksh 1.6 million grant from the Kenya government's community development trust fund. The remaining Ksh 900,000 required for construction was contributed by community members. Community members cover all costs and provide all labour associated with fence maintenance. The impact of the fence has been a dramatic reduction in human-elephant conflict, improved crop production and associated income generation, improved relations with the Kenya Wildlife Service and improved engagement of the community in conservation.

Discussion themes

- The community in this case cover all costs and provide all labour for fence maintenance. A bank account is held by the self-help group to which members contribute so that fence components can be replaced

- One of the reasons that this community fencing project is successful is that the farmers are relatively well off, with access to irrigated crops which generate surplus income. Good organisation and cohesion within the community is another factor.

18. BEES AS AN ELEPHANT DETERRENT
(Lucy King, Oxford University and Save the Elephants)

There are a range of human-elephant conflict deterrents that exist including electrified fences, simple traditional barrier fences made out of brush, noise makers, dogs and chilli-based deterrents. All of these deterrents have had mixed results. There are several reasons for exploring the option of using bees as an elephant deterrent:

- Previous research has shown that elephants avoid foraging on acacia trees with beehives
- The harvesting of honey is a widespread traditional livelihood activity in Kenya
- Beekeeping is socially accepted
- The use of bees as a deterrent also has added economic benefits, as there is a large domestic and international market for honey

However before moving forward to trialling bees as a farm-based deterrent we decided to first establish if elephants were actually scared of them. We did this through playback experiments using a wireless speaker placed between 10 and 12 metres from an elephant herd. Thirty-two elephant herds were involved in these experiments. Bee noises were played to 17 herds. Natural white noise was played to 15 herds and both bee noises and white noise was played to 9 herds. Responses to these noises were filmed and subsequently analysed. Of those herds that bee noises were played to, 70% moved off within 20 seconds while just 7% of those herds to which white noises were played moved away after 7 seconds. After four minutes 94% of the elephant herds to which bee noises had been played move off in contrast to only 46.7 % of the elephant herds that had heard white noise. The elephants that heard bee noises moved significantly further away from the source of the sound than did the elephants that heard white noise.

On the basis of these results, it was decided that bees did offer potential as a farm-based deterrent. Therefore a trial was undertaken in a human-elephant conflict hotspot known as Ex-Erok in southern Laikipia. Two farms, located close together, were identified as being highly vulnerable to crop-raiding in this site. Along part of the perimeter of one of these farms a beehive fence was erected, with the aim of cutting off the main entrance to crop-raiding elephants. Nine beehives were used in this fence, of a traditional barrel shaped design, with each suspended by wire beneath a thatched hut. Each beehive was connected to the next by fence wire so that if an elephant tried to walk through the fence, the beehives would shake. The beehives were unoccupied over the trial period.

Over the six week trial period between August and September 2007 elephants successfully raided the farm with the beehive fence seven times as compared to thirteen times on the control farm. In total there were 38 elephants involved in crop-raids on the farm with the beehive fence, compared with 95 elephants involved in crop raids on the control farm. It therefore appears that the beehive fence did have some deterrent effect. However further trials are needed, under a range of different circumstances to establish the effectiveness of using bees as a crop-raiding deterrent.

A much larger trial of beehives fences has been organised in an area called Chuviyere, in Meru North District and close to Samburu and Buffalo Springs National Reserves. However a persistent drought in the region has delayed the implementation of this trial.

Discussions themes

- Can bees be an effective deterrent if they are less active at night than during the day?
- There are many potential advantages to using bees as farm-based deterrent including their usefulness as pollinators, honey producers and they can be relatively cost effective
- The limitation with the use of bees is that they require water and plants in blossom

Further discussion of this topic is available in:
King, L., Lawrence, A., Douglas-Hamilton, I. and Vollrath, F. (2009). Beehive fence deters crop-raiding elephants. African Journal of Ecology 47, 131-137

19. NON-LETHAL MANAGEMENT OF PROBLEM ELEPHANTS
(Max Graham, Laikipia Elephant Project and Moses Litoroh, Kenya Wildlife Service)

Translocation

In Kenya translocation of elephants is one of the more expensive official approaches used for alleviating human-elephant conflict. The movement of elephants from sites of human-elephant conflict to areas where there is more space for elephants and less cultivation is a management approach embedded within the KWS management plan and fits within the overall KWS policy framework. Other than reducing human-elephant conflict, translocation is believed to also alleviate the problems of habitat degradation associated with elephant compression in isolated reserves/parks. There have been two major translocation exercises carried out in Kenya in recent years. The first of these was the transportation of elephants from Sweetwaters Sanctuary in Laikipia to Meru National park. The second larger operation was the transportation of elephants from Shimba Hills National Park to Tsavo National Park.

Discussion themes

- Translocation of elephants is very expensive. Is it really a feasible option in future given increasing fragmentation of elephant habitat in Kenya?
- The timing of translocation is important as for example elephants are adapted to their area of origin so taking elephants from wetter areas to dry areas can place the translocated animal stress.
- Some translocated elephants returned to their area of origin.

The E-Fence

A new generation of GPS collars contain a mobile phone sim card and use the GSM network to transfer data stored in the collar so that it can be downloaded onto a computer remotely. These collars can also be programmed so that when a collared animal approaches a designated boundary, a text message is sent to a mobile phone.

Cambridge University supported Save the Elephants to carry out a trial of this system, called the E-Fence with two elephants fitted with GPS collars on the Ol Pejeta Conservancy in southern Laikipia. The system was designed so that if one of these elephants approached the perimeter electrified fence that protects small-scale farms, a text message was sent to a manager who could then mobile a rapid response team could to scare the elephant away before it broke the fence.

The technology worked in that the GPS collars sent text messages and initially these were accurate. However the wrong digital layers of the fence were used so that text messages were sent when they shouldn't have been, leading a large number of false alarms. This undermined confidence in the system among Ol Pejeta Conservancy staff so that eventually the text messages were ignored completely by management.

The problem here was with the management of the technology which needs to be monitored and refined constantly. The other major issue with the application of this tool for

HEC mitigation is the cost of collars and their deployment (around $2,000 per collar) and the requirement of some rapid response capability (a vehicle with rangers, spot lights, guns, radio communication etc). Therefore even if the system was made to work, it would only be applicable where there exist well resourced conservation land units, such as the Ol Pejeta Conservancy.

De-Tusking

The Ol Pejeta Conservancy, together with the Kenya Wildlife Service, have de-tusked persistent fence breaking elephants. This involves immobilising the target animal and removing the distal third of their two tusks, below the nerve. The rationale behind this approach is that as elephants use their tusks, which do not conduct electricity, to break electrified fences, and so the removal of their tusks may reduce fence breaking.

Detusking trials have been carried out in Ol Pejeta Conservancy on seven elephants between January 2008 and August 2009. All of these elephants were monitored by a trained researcher to establish the number of times they broke fences. Six of the seven elephants detusked continued to be involved in fence breaking (i.e. were present in fence breaking groups) after they had their tusks removed. However five of the seven elephants were involved in fewer fence breaking incidents after they had their tusks removed compared with before. In conclusion while there appears to have been some deterrent effect, this did not eliminate the problem entirely and further research is required to establish the impact of detusking.

Logistical challenges in the continual identification and monitoring of persistent fence breakers means that the specific individual involved in fence breaking may not always be positively identified. In many cases the individuals involved within a group of elephants that broke a fence were identified but the specific animal that broke the fence was not known. Therefore future efforts to establish the impact of de-tusking may require the use of GPS collars, fitted on elephants that are to be de-tusked, combined with direct monitoring of these animals.

Discussion themes

- Ethical implications of de-tusking: does this affect their ability to feed and fight?
- Detusking an elephant in Asia made it more of a problem rather than less

20. COUNTRY PRESENTATIONS ON ADDRESSING HUMAN-ELEPHANT CONFLICT IN FUTURE

At the end of the two day meeting, participants were grouped into their respective countries, with some countries grouped due to numbers, to identify the major human-elephant conflict problems in their areas, the causes and potential solutions.

Kenya

<u>What are the main types of human-elephant conflict and their causes?</u>

The greatest human-elephant conflict problems in Kenya are:

- Crop-raiding
- Loss of human life and elephants injured or killed through conflict
- Property destruction (fences, stores, watering points and housing)
- Threats to day to day life (curfew)

These problems are caused by:

- Habitat loss due to human encroachment
- An increasing human population
- Climate change
- Incompatible land use
- Inadequate awareness of the determinants of human-elephant conflict and mitigation measures
- Mismatch between those who benefit from wildlife conservation and those who bear the costs

<u>What is the best way to address human-elephant conflict?</u>

- Review the land use and wildlife policies
- Integrate land use policies across the following government sectors: KWS, Agriculture, Forestry and Water
- Encourage community involvement in conservation
- Foster a feeling of ownership over wildlife through the creation of direct benefits to communities
- Family planning to curb the ever rising human population
- Strengthen the capacity of small-scale farmers to deter crop-raiding
- Manage elephant populations in accordance with the carrying capacity of the land
- Secure elephant corridors
- Information sharing in terms of successful and unsuccessful HEC mitigation

<u>What more do we need to know to address HEC?</u>

- Identify the location of elephant corridors and dispersal areas

- Identifying all areas where elephants are distributed and the main human-elephant conflict hotspots
- Need to understand elephant carrying capacity of the places they are currently found
- Explore uses for elephants other than just photographic safaris
- Better understand the relationship between different stakeholders in human-elephant conflict management and their respective roles.

Uganda and Sudan

<u>What are the main types of human-elephant conflict and their causes?</u>

- Crop-raiding. This affects human welfare and livelihoods, creating negative attitudes towards elephant conservation

<u>What is the best way to address human-elephant conflict?</u>

- Use an integrated mitigation approach and involve communities in the planning, implementation and management of the interventions.

<u>What more do we need to know to address HEC?</u>

- We need to know more about elephant behaviour
- We need to know which intervention methods work best under which circumstances
- We need to understand what kind of incentives will encourage communities to take responsibility for addressing human-elephant conflict

Tanzania and Mozambique

<u>What are the main types of human-elephant conflict and their causes?</u>

The greatest human-elephant conflict problems are:

- Crop-raiding
- Loss of human life and human injuries
- Contribution to poverty through loss of livelihoods
- Food insecurity
- Interference with day to day activities (going to school, fetching water etc)

These problems are caused by:

- Increasing human population
- Expansion of cultivation, leading to habitat fragmentation and an increase in the interface between humans and elephants
- Changing land use patters
- Poverty

- Increasing number and severity of droughts leading to competition over water resources
- In Mozambique there is lack of capacity to implement human-elephant conflict mitigation measures and uncertainty among institutions as to their roles and responsibilities in HEC mitigation
- In Mozambique local communities bear the cost of elephant conservation but do not receive the benefits. In cases where there are benefits such as 20% of the revenue from hunting and tourism, community members do not understand the connection between the presence of elephants and the benefits they have received.
- In Tanzania elephant corridors are being settled by people, despite the existence of legislation to prevent this
- In Tanzania there is a large elephant population that has grown beyond the carrying capacity of the places where they live

What is the best way to address human-elephant conflict?

- In Mozambique: human and financial resources are needed to implement a human-wildlife conflict mitigation strategy and evaluate the performance of interventions implemented
- In Mozambique: When implementing the human-wildlife conflict strategy adopt the principle of open communication with communities and the use of science to identify the correct mitigation measures and assess their effectiveness
- In Tanzania: Finalise and implement an elephant management strategy, ensuring it includes human-elephant conflict mitigation.
- In Tanzania: Secure the political will to resettle communities away from elephant corridors through the provision of direct benefits to these communities
- In Tanzania: Speed up the empowerment of communities to manage community wildlife management areas (WMAs)
- In Tanzania: Promote greater collaboration with neighbouring countries for the management of transboundary elephant populations.

What more do we need to know to address HEC?

- In Tanzania: Better understanding of the effectiveness of lethal and non-lethal mitigation measures
- In Tanzania: Greater understanding of transboundary elephant populations, their movements and their contribution to human-elephant conflict
- In Tanzania: Greater understanding of the drivers of tolerance among communities
- In Mozambique: Information of elephant migratory patterns, behaviour and the landscapes where people and elephants share space

APPENDIX I: List of Participants

	Name	Institution	E-mail Address
1	Moses Litoroh	Kenya Wildlife Service	mlitoroh@kws.go.ke
2	Erasmus Tarimo	Tanzania Wildlife Division	audrey.traimo@gmail.com
3	Alex Lobora	Tanzania Wildlife Research Institute	carnivores@habari.co.tz
4	Moses Dhabasada	Uganda Wildlife Authority	dhabasadha05@ayahoo.co.uk
5	John Muya	Tanzania Wildlife Division	muyajohn@yahoo.com
6	Edward Asalu	Uganda Wildlife Authority	edwardasalu@yahoo.com
7	Bintoora Adonia	Uganda Wildlife Authority	bintoora@yahoo.com
8	Max Graham	Laikipia Elephant Project	lerp@wananchi.com
9	Dickson Too	Kenya Wildlife Service	toodickson@yahoo.com
10	Aggrey Maumo	Kenya Wildlife Service	shimbahills@kws.go.uk
11	Korir Dickson	Kenya Wildlife Service	dkpkorir@yahoo.com
12	Bakari Chongwa	Kenya Wildlife Service	
13	Benard Koruta	Kenya Wildlife Service	bkorut@kws.go.uk
14	Kimani Ndiku	Kenya Wildlife Service	
15	Moses Omurambi	Kenya Wildlife Service	intenstn@kws.go.ke
16	Munira Anyonge	Kenya Wildlife Service	
17	Tuqa Jirmo	Kenya Wildlife Service	
18	Lucy King	Save the Elephants	lucy.king@zoo.ox.ac.uk
19	Helen Kazengwa	KWS	species@kws.go.ke
20	Monica Chege	KWS	carnivore@kws.go.ke
21	Diane Skinner	IUCN	diane.skinner@iucn.org
22	Noah Sitati	WWF	
23	Martine Ring Malek	Southern Sudan Wildlife Authority	ringmalek@yahoo.com
25	Tobias Ochieng	Laikipia Elephant Project	t.ochieng@gmail.com
26	Zara Merali	Aga Khan Foundation	zara.merali@akf-mz.org
27	Roberto Corriea	Aga Khan Foundation	roberto.correia@akf-mz.org
28	Xavier Simba	Aga Khan Foundation	xavier.simba@akf-mz.org
30	Batian Craig	Ol Pejeta Conservancy	wildlife@olpejetaconservancy.org
31	Professor Bill Adams	University of Cambridge	wa12@cam.ac.uk
32	Dr Victor Runyoro	Ngorongoro Conservation Area Authority	vrunyoro@yahoo.com
33	Mr Robert Mande	Ngorongoro Conservation Area Authority	mande2tz@yahoo.com
34	Mr Jared Lumbasi	Kenya Wildlife Service	jlumbasi@kws.org
35	Simon Hedges	Wildlife Conservation Society	shedges@wcs.org
36	Gerald M. Ngatia	Sagana Wildlife Protection Self Help Group	ngatiagerald@yahoo.com

APPENDIX II: Meeting Programme

Day 1	Activity	Speakers	Chair
8.30	Tea/Coffee/Registration		
9.10	Session 1: Understanding human-elephant conflict and its determinants	Max Graham	Moses Litoroh
10.00	Tea/Coffee		
10.15	Introduction to the UK Darwin Initiative Project 15/040: Building capacity to alleviate human-elephant conflict in north Kenya	Bill Adams	Max Graham
10.30	Group Exercise: Identifying determinants of HEC in participants' home countries and regions		Max Graham
11.15	Session 2: Monitoring and reporting human-elephant conflict	Max Graham Tobias Ochieng Noah Sitati	Bill Adams
12.30	Session 3: Whose responsibility is human-elephant conflict?	Moses Litoroh Max Graham	Bill Adams
13.00	Lunch		
14.00	Overview: Human-Elephant Conflict Mitigation	Max Graham	Tobias Ochieng
14.30	Session 4: Farm-Based Deterrents	Noah Sitati Tobias Ochieng Lucy King	Max Graham
16.00	Session 5: Lethal management of problem elephants	Max Graham Moses Litoroh	Bill Adams
17.00	Finish		
Day 2			
8.15	Tea/Coffee		
8.30	Session 6: The Role of communication in HEC Management ; experience with mobile phones	Bill Adams Max Graham	Moses Litoroh
9.00	Session 7: Human-elephant conflict strategy for Narok	Kenneth Nashuu	Bill Adams
9.30	Session 8: Strategy for human-wildlife conflict mitigation in Mozambique	Roberto Corriea	Max Graham
10.00	Tea/Coffee		

10.15	Session 7: Tools for engaging the community in human-elephant conflict mitigation	Tobias Ochieng	Max Graham
11.45	Session 8: The use of electrified fences to control elephant movement	Max Graham	Moses Litoroh
13.00	Lunch		
14.00	Session 9: Non-lethal management of problem elephants	Moses Litoroh Max Graham Festus Ihwagi	Bill Adams
15.15	Group Exercise: Identifying appropriate tools for human-elephant conflict mitigation across the East African region		Max Graham
16.30	Wrap up and close		Erasmus Tarimo Moses Litoroh Max Graham

Appendix III: FUTHER READING

Free downloads from the internet

www.african-elephant.org
Hoare, R. (1999). *A Standard Data Collection and Analysis Protocol for Human-Elephant Conflict Situations in Africa*. IUCN African Elephant Specialist Group, Nairobi, Kenya
Hoare, R. (2001) *A decision support system for managing human-elephant conflict stations in Africa*. IUCN African Elephant Specialist Group, Nairobi, Kenya.
Naughton, L., Rose, R. and Treves, A. (1999). *The social dimensions of human-elephant conflict in Africa: A literature review and case studies from Uganda and Cameroon. A report to the African Elephant Specialist Group, Human-Elephant Conflict Task Force of IUCN, Glands, Switzerland*. Glands, Switzerland: IUCN
Parker, G.E., Osborn, F.V., Hoare R.E. and Niskanen, L.S. (eds.) (2007): *Human-Elephant Conflict Mitigation: A Training Course for Community-Based Approaches in Africa. Trainers' Manual*. Elephant Pepper Development Trust, Livingstone, Zambia and IUCN/SSC AfESG, Nairobi, Kenya.
Smith, R.J. and Kasiki, S., M. (2000). *A spatial analysis of human-elephant conflict in the Tsavo ecosystem, Kenya*. Gland, Switzerland: African Elephant Specialist Group, Human-Elephant Conflict Task Force.

www.geog.cam.ac.uk/research/projects/heccpacity/
Graham, M.D., Gichohi, N., Kamau, F. Aike, G., Craig, B., Douglas-Hamilton, I. and Adams, W.M. (2009). *The Use of Electrified Fences to Reduce Human-Elephant Conflict: A Case Study of the Ol Pejeta Conservancy, Laikipia District, Kenya*. Working Paper 1, Laikipia Elephant Project, Nanyuki, Kenya
Graham, M.D., Wren, S. and Adams, W.M. (2009). *An Assessment of Elephant-Compatible Livelihoods: Trials of Beekeeping, Chilli Farming and the Production of Dung Paper in Laikipia, Kenya*, Working Paper 3, Laikipia Elephant Project, Nanyuki, Kenya.
Graham, M.D., Greenwood, C., Kahiro, G., and Adams, W.M. (2009). *The Use of 'Push to Talk' Mobile Phone Technology to Reduce Human-Elephant Conflict, Laikipia District, Kenya*, Working Paper 2, Laikipia Elephant Project, Nanyuki, Kenya

Published References

Chiyo, P.I., Cochrane, E.P., Naughton, L. and Basuta, G.I. (2005). Temporal patterns of crop raiding by elephants: a response to changes in forage quality of crop availability? African *Journal of Ecology* 43, 48-55
Graham, M.D. (2007). *Coexistence in a land use mosaic? Land use, risk and elephant ecology in Laikipia District, Kenya*. PhD thesis, University of Cambridge, Cambridge, UK.
Graham, M.D. and Ochieng, T. (2008). Uptake and performance of farm-based measures for reducing crop-raiding by elephants *Loxodanta africana* among smallholder farms in Laikipia District, Kenya. *Oryx* 42, 76-82.

Graham, M.D., Douglas-Hamilton, I., Adams, W.M. and Lee, P.C. (2009). The movement of African elephants in a human-dominated land-use mosaic. Animal Conservation 12, 445-455.

Hedges, S. and Gunaryadi, D. (2009). Reducing human-elephant conflict: Do chillies help deter elephants from entering crop fields? Oryx (in press)

Hoare, R. (1992). Present and future use of fencing in the management of larger African mammals. *Environmental Conservation* 19(2): 161-164.

Hoare, R. (1995). Options for the control of elephants in conflict with people. *Pachyderm* 19, 54-63.

Hoare, R. (1999). Determinants of human-elephant conflict in a land-use mosaic. *J. Appl. Ecol.* 36, 689-700.

Hoare, R. (2001). Management implications of new research on problem elephants. *Pachyderm* 30, 44-48.

King, L.E., Douglas-Hamilton, I. and Vollrath, F. (2007) African elephants run from the sound of disturbed bees. Current Biology 17, R832-R833

King, L., Lawrence, A., Douglas-Hamilton, I. and Vollrath, F. (2009). Beehive fence deters crop-raiding elephants. African Journal of Ecology 47, 131-137.

Lee, P.C and Graham, M.D. (2006). African elephants and human-elephant interactions: implications for conservation. *Int. Zoo Yb.* 40, 9-19

Naughton-Treves, L. (1997). Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda. *Geog. Rev.* 87**,** 27-46.

Osborn, F.V. (2004). Seasonal variation of feeding patterns and food selection by crop-raiding elephants in Zimbabwe. African Journal of Ecology 42, 322-327

Sitati, N.W., Walpole, M.J. Smith, R.J. and Leader-Williams, N. (2003). Predicting spatial aspects of human-elephant conflict. *J. Appl. Ecol.* 40, 667-677.

Sitati, N.W. & Walpole, M.J. (2006) Assessing farm-based measures for mitigating human-elephant conflict in Transmara District, Kenya. *Oryx* 40, 279-286

Sitati, N.W., Walpole, M.J. and Leader-Williams, N. (2005). Factors affecting susceptibility of farms to crop raiding by African elephants: using a predictive model to mitigate conflict. Journal of Applied Ecology 42, 1174-1182

Sukumar, R. (1991). The management of large mammals in relation to male strategies and conflict with people. *Biol. Conserv*. 55, 93-102.

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

Vollrath, F. and Douglas-Hamilton, I. (2002). African bees to control African elephants. *Naturwiss* 89, 508-511.

The Raukati Theatre group perform their drama about human-elephant conflict at the workshop

Building Capacity to Alleviate Human-Elephant Conflict in North Kenya
DEFRA Darwin Initiative Grant 15/040

The purpose of this project is to alleviate human-elephant conflict and promote tolerance of elephants in Laikipia District, Kenya. The project's partners are:
* Centre for Training and Integrated Research in ASAL Development
* Elephant Pepper Development Trust
* Kenya Wildlife service
* Laikipia Wildlife Forum
* Mpala Research Centre
* Ol Pejeta Conservancy
* Rivercross Technologies.
* Save the Elephants
* Symbiosis Trust

http://www.geog.cam.ac.uk/research/projects/heccapacity/