FAUNA & FLORA INTERNATIONAL CONSERVATION REPORTS

FAUNA & FLORA International
Conserving wildlife since 1903

Mitigating Human-Elephant Conflict: Case Studies from Africa and Asia

Matt Walpole and Matthew Linkie (Eds)

Published by Fauna & Flora International, Cambridge, UK

Citation: Walpole, M & Linkie, M (2007, eds) *Mitigating Human-Elephant Conflict: Case Studies from Africa and Asia*. Fauna & Flora International (FFI), Cambridge, UK.

ISBN: 9-781903703-26-7

Produced by: Fauna & Flora International, Cambridge, UK

Layout by: Page Bros., Norwich

Cover photos: Matt Walpole

Printed by: Page Bros:, Norwich

Available from: Fauna & Flora International
Jupiter House
Station Road
Cambridge CB1 2JD, UK
Tel: + 44 (0)1223 571000
Fax: + 44 (0)1223 461481
publications@fauna-flora.org

This document is printed on 100% recycled paper.

Mitigating human-elephant conflict in a human dominated landscape: Challenges and lessons from Transmara District, Kenya

6

Noah Sitati, Nigel Leader-Williams, P.J. Stephenson and Matt Walpole

Summary

From 1998–2006, the Transmara human-elephant conflict (HEC) project in Kenya has conducted research and identified and tested cost-effective mitigation strategies. Among its objectives, the project has sought to: build local and government capacity in monitoring and mitigating HEC; implement a HEC monitoring and research programme to identify trends, causal factors and predictor variables; identify, test and implement successful short-term HEC mitigation strategies; identify means to provide benefits for local communities from elephants in conflict areas by exploring alternative land-use practices to those currently being promoted; and finally, raise local, national and international awareness of HEC issues and solutions. This chapter discusses the genesis and development of the HEC project in Transmara District and shares experiences and lessons learnt. We argue that a successful HEC project should involve local people and all stakeholders, and employ a multi-disciplinary approach while identifying economic incentives and alternative land-use options for local people incurring the costs of living with elephants. We discuss the key elements that can help HEC projects succeed.

Introduction and study area

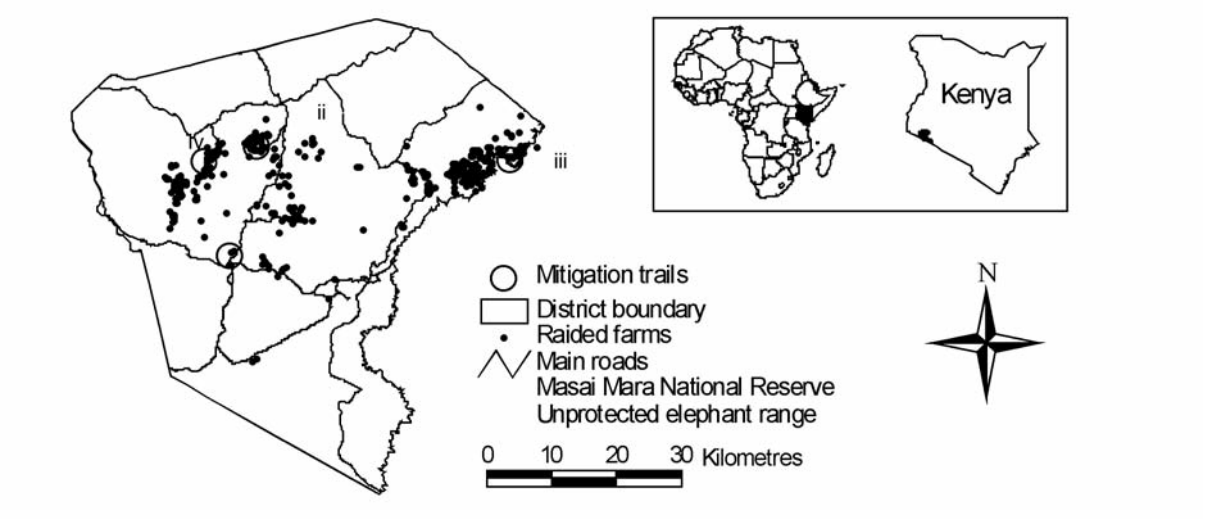
HEC is a problem that poses serious challenges for wildlife managers, local communities and elephants alike. Mitigating HEC requires well-tested and cost-effective strategies, which in turn rely on accurate information regarding patterns of HEC and an understanding of causal factors. Transforming elephants from a liability to an asset for local communities is likely to be critical for increasing their tolerance of elephants and thereby improving the species' conservation status.

This chapter describes an ongoing research and development project that has attempted to systematically address these issues and find solutions to HEC in a high-conflict area in southwest Kenya. After describing the study area and the history of the project, we discuss the approach and methods used, outline some of the key findings and explore the lessons learnt and their implications for HEC mitigation elsewhere.

The Transmara District covers 2,900 km^2, and lies adjacent to, and includes a portion of, the world famous Masai Mara National Reserve (MMNR) (Figure 6.1). Approximately 2,200 km^2 of Transmara is separated from the MMNR by a steep escarpment, and remains unprotected and inhabited by over 168,000 people (1999 census figure). An estimated 1,600 elephants also reside within and around MMNR (Blanc *et al.*, 2003), some of which seasonally migrate up the escarpment into the unprotected part of Transmara (Sitati, 2003). This unprotected part of Transmara also supports a resident elephant population estimated at *c.* 200–300 individuals (Wamukoya *et al.*, 1997).

The natural vegetation in Transmara is a mosaic of Afro-montane, semi-deciduous and dry-deciduous forests and *Acacia* savanna woodlands (Kiyiapi *et al.*, 1996). Many parts of Transmara receive high

Figure 6.1: Transmara District, south-west Kenya, showing location of mitigation trials: i – Watchtowers, frontline communal guarding and chilli rope, ii – Thunder flashes, iii – Smooth wire barriers, iv – Front line chilli rope



annual rainfall (1200–1500 mm) and so are of high agricultural potential. Consequently, much of Transmara has been converted for maize and sugarcane cultivation. However, the central part of Transmara is of lower agricultural potential and so remains forested. Nevertheless, these forests are increasingly threatened by slash-and-burn cultivation and by charcoal production. The traditional, pastoralist Maasai inhabitants have been joined by an influx of other ethnic groups, many of whom are agriculturalists. Land outside MMNR is primarily communally owned (Sitati, 2003), but is being increasingly sub-divided into individual small-holdings.

HEC in Transmara can take many forms, from crop-raiding and infrastructural damage, though disturbance of normal activities such as travel to work and school, to injury or death of people and elephants. HEC has increased as human populations have expanded from 2.00 persons/km^2 in 1948 to 58.16 persons/km^2 in 1999. Elephant populations are also expanding with better protection, and consequently the number of people killed or injured by elephants has increased (Sitati *et al.*, 2003). Because agricultural expansion has reduced elephant habitat and range from 2900 km^2 to *c.* 1000 km^2, crop-raiding is the most widespread form of HEC.

The impact of crop damage on local livelihoods results in negative attitudes towards elephants (Sitati, 2003). Elephants are regarded as the most problematic wildlife species in Transmara because the amount of damage inflicted per conflict incident is often severe, and can destroy entire fields of crops. Consequently, local people kill elephants in retribution and destroy their habitat to keep the elephants away.

In 1989, the Government of Kenya abolished compensation schemes for crop-raiding, although limited compensation remains for human deaths and injuries, equivalent to ≈ £230 and £115, respectively. However, the Kenya Wildlife Service (KWS), the custodian of wildlife on behalf of the government, has limited financial and human resources, and only 18 rangers are deployed in Transmara to protect the property and lives of local people. Thus, most farmers in Transmara are left to defend their farms themselves, using various traditional mitigation strategies.

For relatively low income local farmers, the financial and non-financial costs of establishing mitigation methods inevitably leads to a lack of overnight vigilance, poor application of methods and an inability to develop and test novel methods to

counter elephant habituation. Local people originally had little confidence in the effectiveness of these methods (Sitati, 2003). Consequently, this project sought to demonstrate and evaluate the role of simple, cost effective and locally driven mitigation methods, through the input of low levels of financial and technical support.

History of the Transmara project

The Transmara HEC project began as part of a wider large mammal research programme in and around MMNR (Walpole *et al.*, 2003). However, it has subsequently grown into a major programme of applied conservation research and practice in its own right. The project has evolved through three phases. Phase I ran from 1998–2000 and explored and quantified the problem and possible solutions (Sitati 2003; Sitati *et al.*, 2003, 2005). Phase II ran from 2001–2003 and undertook pilot field trials of different mitigation measures (Sitati and Walpole 2004, 2006; Sitati *et al.*, 2005). Phase III ran from 2003–2006 and scaled-up successful mitigation trials across the District. Beyond these immediate efforts to reduce HEC, the longer-term strategy of the project was to investigate ways to generate benefits for elephants and local communities, by securing habitat for elephant-based tourism.

Phase I of the project explored the history of HEC in Transmara and undertook research to quantify HEC, explain its distribution in space and time, explore local perceptions towards elephants and began to examine the efficacy of local HEC coping strategies. The research began with an extended period of local consultation including interviews, focal group discussions, various PRA methodologies and a questionnaire survey. Together with archival research this provided much of the contextual and historical detail and an insight into local attitudes and practices regarding elephants and HEC (Sitati 2003). Vitally, it also enabled the development of systematic community-based HEC monitoring that has continued throughout subsequent phases and that provides the foundation for HEC mitigation trials conducted in Phases II and III.

Phase I culminated in a series of workshops with local communities and other stakeholders where recommendations were made for mitigating HEC and increasing wildlife-related benefits to communities (Walpole *et al.*, 2003). Phase II of the programme was designed to implement some of these recommendations with a particular focus on:

- Building local and government capacity in monitoring and mitigating human elephant conflict;
- Testing and implementing successful short-term HEC mitigation strategies;
- Identifying means to provide benefits for local communities from elephants in conflict areas; and,
- Raising local, national and international awareness of HEC issues and solutions.

The project aimed to place responsibility for HEC mitigation with communities themselves. Therefore, the project sought to assist communities in implementing simple, cost-effective, farm-based measures that were perceived to be most sustainable. Since farmers usually have an opinion about which methods are most effective (Hill, 2000; Nyhus *et al.*, 2000), many of the methods were based on their local knowledge, but some novel methods were introduced from elsewhere.

Methods for monitoring HEC and measuring the effectiveness of mitigation trials

The systematic monitoring and enumeration of crop raiding incidents lies at the heart of the Transmara project, and has run almost continuously from March 1999 to October 2006. Data were collected on crop-raiding incidents, and on both human and elephants deaths and injuries, from March 1999 to August 2000 (Phase I), November 2001–October 2003 (Phase II) and November 2003–October 2006 (Phase III). A team of eleven community members were selected at local community *barazas* (meetings) and trained to enumerate crop-raiding incidents. Enumerators were each stationed in different areas within the elephant range previously identified as being subject to high conflict. The details of any crop-raiding incident within an enumerator's area were recorded on standardised reporting forms (Hoare, 1999a), including: date and time of incident, elephant

group size and composition, and location using a global positioning system GPS unit. The UTM coordinates of each conflict incident were imported into the ArcView v.3.2 geographical information system (GIS) software package for spatial analysis.

The ongoing monitoring data provided the basis to more rigorously explore temporal and spatial patterns of HEC, and also comprised a baseline against which to measure the impact of different mitigation methods. During Phase I, logistic and linear regression analyses were used to identify differences in the characteristics of 224 raided farms and a sample of 157 non-raided farms. This analysis highlighted factors, including mitigation methods used, that might account for a particular farm being raided or not (Sitati *et al.*, 2005).

Such comparative analyses provide valuable insights, but cannot 'prove' that particular mitigation methods were effective. Thus, during Phase II, a more 'experimental' test of potentially useful mitigation methods was undertaken. In our experimental research design, we monitored and compared 'treatment' plots, where mitigation methods were applied, versus nearby 'control' plots where there was no additional mitigation effort. Five geographically separate trial sites were established, each to test a different mitigation method (Figure 6.1). Plots were monitored continuously for two years and any attempt by elephants to challenge trial farms was recorded. The trials included:

- **Front line early warning and communal guarding:** farmers in the same vicinity first formed and registered organised groups. Watchtowers were erected and farmers were encouraged to communally guard their crops on a rotational basis using powerful torches trained on forest margins. People living in an elephant corridor beyond the front line farms used flashlights and whistles as an additional early warning system to alert farmers. Approaching elephants were repulsed using flashlights, whistles and drums.
- **Thunder flashes:** these were supplied by KWS and used to scare away elephants at night, reinforced with a watchtower and powerful torches to provide early warning.
- **Barriers on elephant routes:** non-electrified wire fences were erected in the elephant crossings along the banks of the Mara River, and farmers equipped with torches recorded any attempts by elephants to challenge these barriers.
- **Chilli grease deterrent:** a chilli-tobacco-engine oil grease was applied on nylon rope of 10 mm diameter that was set at a height of 1.5 m, with cowbells fixed to the rope at 100 m intervals as an early warning system. The grease mix was applied to the rope three times a week. Rope was either deployed as a perimeter barrier between the forest and farm edge, or completely encircled the farm. Farmers were equipped with powerful torches and were organised into communal guarding teams to respond to elephant approaches. Attempts by elephants to crop-raid were observed and recorded by a trained guard.

The long-term HEC monitoring that began before the trails started, and the inclusion of control farms during the trial, meant that we could analyse how crop raiding changed on trail farms once mitigation methods were deployed, and compare that to change on non-trial control farms. This enabled us to take account of any background change in the level of HEC that would not have been possible without the long-term monitoring and control plots. The effectiveness of mitigation methods was measured in three ways (Table 6.1):

- the proportion of elephant crop-raiding attempts that were successfully repelled during the trial period;
- the comparative change in number of events on trial and non-trial farms within a conflict zone, before and after the introduction of trials; and,
- the comparative change in average crop losses during each crop-raiding event on trial and non-trial farms within a conflict zone, before and after the introduction of trials.

Results of monitoring and mitigation trials

In total, 329 crop-raiding incidents were recorded between 1998 and 2000, 618 incidents between 2001 and 2003 and 842 incidents between 2003 and 2006. This is equivalent to an average of around 300 incidents per year, or one incident per 3–4 km^2

of elephant range per year. Although conflict occurred year-round, there were two peaks that coincided with two planting seasons as a result of the bimodal rainfall pattern in Transmara. However, peak crop-raiding seasons varied somewhat between years, perhaps as a result of annual weather patterns that can either extend or shorten the planting time.

Incidents were spatially clustered, primarily on the edge of the resident elephant range but also in some more centrally located areas where agriculture was encroaching the forest. The clustered pattern of high conflict zones has persisted throughout the project, although new conflict sites have emerged that were mainly related to high cultivation or high elephant density. Both the occurrence and intensity of crop raiding could be predicted on the basis of the area under cultivation (Sitati *et al.*, 2003).

Local mitigation strategies included: simple non-electrified barriers, such as dry brush, pole fences and barbed wire; guarding and the use of fires; and banging tins and drums (Sitati et al., 2003). The comparative analysis of raided and non-raided farms found that a combination of early detection of elephants before they entered fields, increased guarding effort and use of fire and noise increased the success of defending farms (Sitati *et al.*, 2005). We used these findings, and the end of Phase I workshop recommendations, to choose which mitigation methods to test in Phase II.

Between project Phases I and II, overall crop-raiding across Transmara district declined by 37.7%. Crop-raiding on farms with frontline early warning and communal guarding declined by 93%, compared with a 32% decline on control plots. Thunder flashes, which are expensive and dangerous to use, were effective when available but did not significantly reduce HEC. The wire barriers were often damaged by hippos and were generally ineffective. Finally, chilli ropes that completely encircled farms were 100% effective in stopping elephant crop-raiding. However, farms with a chilli rope along the front line were raided at the open ends because elephants simply walked around the

Table 6.1: A comparative assessment of four mitigation trials over two years. Statistics for thunder flashes relate to periods when they were available. The apparent reduction in crop raiding with barriers was likely due to associated guarding (from Sitati & Walpole, 2006)

TRIAL	SUCCESS RATE (%)	RELATIVE REDUCTION IN CROP RAIDING EVENTS (%)	RELATIVE REDUCTION IN AVERAGE CROP DAMAGE (%)	PRACTICALITY OF METHOD
Early warning	90	90	100	Lowest cost, but requires significant manpower
Thunder flashes	80	18	50–99	Expensive, requires license, more effective with early warning
Barriers on elephant routes	0	76	0	Expensive to construct, disruptive to other wildlife, and did not physically prevent elephant incursions
Chilli rope	100	100	100	Chillies expensive to buy, requires regular re-application of grease

rope to enter the maize fields. In this site the rope and cowbells were subsequently vandalised by cattle rustlers (Sitati & Walpole, 2006).

Project scaling up

Successful trials in Phase II were expanded over the wider Transmara District in Phase III. These included chilli ropes, watchtowers, communal and frontline guarding and bright torches. Twelve experimental sites were established for further monitoring. The preliminary findings uphold those of Phase II and showed that elephants still could not pass through chilli ropes, and detailed analysis of these data is now underway.

Key project achievements

The Transmara HEC project is notable in a number of respects besides the long-running maintenance of the community-based HEC monitoring. It has succeeded in building local capacity to monitor and mitigate HEC, and in raising awareness of the issue and how to tackle it locally, nationally and internationally. It has followed a rigorous, scientific approach that is providing unequivocal tests of a range of mitigation methods. Not only has this influenced the approach of other projects in Kenya but the project has also encouraged Transmara farmers to adopt methods of which they were previously skeptical. As a result, farmers in several areas are experiencing reduced crop losses to elephants and consequent livelihoods gains.

Of particular note is the novel use of chilli grease on a perimeter rope around farms. Although the use of chilli has received much recent coverage and is now widespread amongst HEC projects in Africa (e.g. Osborn 2002, Osborn & Parker 2002, Stephenson 2005), there has been little formal testing of its efficacy. The trials in Phases II and III of the project suggest that elephants do respond to chilli ropes, and fully enclosed farms remained free of crop-raiding throughout. However, recent work in south east Asia has suggested that chilli ropes added no additional benefit when applied to communally-guarded farms with early warning mechanisms (Gunaryadi and Hedges, 2006). Nevertheless, the results of the Transmara trials, behavioural observations of Mara elephants encountering the chilli ropes, and the uptake of the method by Transmara farmers outside of the formal trials all point to a measurable effect. There may be differences between Asian and African elephant, the types of chillies used, and the prevailing climatic conditions, that account for the different experiences in Kenya and south east Asia. This clearly represents an area for further comparative research.

Repeat questionnaire surveys undertaken in 1999 and 2004 also show evidence of improved local tolerance towards elephants and conservation in areas where mitigation trials have taken place compared with elsewhere in the elephant range (Kanton, 2004). The project has also provided the foundation for the development of local Maasai community organizations that are working towards greater security of land tenure, forest conservation, wildlife protection and the development of sustainable tourism within Transmara.

Challenges experienced during project implementation

Inevitably, the project faced many challenges during its implementation. Human conflicts, whether caused by politics, tribal conflict and violence or cattle rustling, dramatically affect the ability of communities to mitigate HEC. Such insecurity leads people to abandon their efforts to protect farms, and even to abandon farms entirely. Moreover, the roads in Transmara are impassable during the rainy season because black cotton soils cover most parts of the District. This hindered the supply of materials needed by field scouts. Materials such as ropes, wires and poles were often vandalized and needed replacement each year. Under these circumstances it can be almost impossible to effectively monitor or mitigate HEC.

During the project there was increased immigration of non-Maasai who leased land for farming and/or provided cheap labour for farming or charcoal burning. Transmara is viewed as an untapped land-grabbing opportunity for immigrants who have moved in to unsustainably exploit its natural resources. Land tenure patterns have changed from primarily communal to increasing numbers of individual small-holdings. In turn, this has

encouraged the selling, fencing and clearing of land for settlements and other activities. Settlements that were once clumped are now scattered, which brings people and elephants into more direct contact and, therefore, increases HEC. Areas of subdivided land are no longer preferred by elephants. Moreover, the changing Maasai lifestyle from pastoralism to sedentary farming, and their shift in dietary habits from milk, meat and blood to maize and other cereals, is encouraging many Maasai to start small farms. This has further accelerated land transformation and increased HEC. Although many of these new farmers lack experience and do not defend their farms well, the increased uptake of successful mitigation methods could backfire on elephant conservation if it encourages more farming.

Elephant attacks on humans, often as a result of people pursuing stolen cattle at night and accidentally encountering elephant herds, has always resulted in either retribution killings or KWS shooting an elephant to appease the local people. Furthermore, the delays in government awarding compensation for elephant attacks have usually generated hostility between the local people and the project. Even though such compensation awards are out of project control, this has required the project to work hard to maintain good public relations. The situation is not helped by the lack of tangible benefits from elephants. Benefit-sharing from MMNR has not materialized despite the promise of distributing 19% of tourism revenues to local communities (Walpole & Leader-Williams, 2001). At the same time efforts to develop community-based tourism have been slowed by a lack of funding and the complex series of steps required before enterprise development can succeed. Without tangible benefits from elephants and elephant habitat, the sustainability of HEC efforts and the future of elephants outside protected areas will remain in doubt.

Lessons learnt from the project

The project has identified successful mitigation methods and shown how small-scale trials with a few farmers over several years can achieve real impact. Farmers can protect their crops using simple, active deterrents and increased guarding, particularly if they detect and deter elephants before they enter their fields. More broadly, there are a number of lessons which may be relevant to the development of HEC projects elsewhere.

1) Sustainable solutions to HEC problems are owned by the community.
   Communities routinely invented, improved and adapted existing practices or technologies to fit their own situations and needs. They are the people that ultimately, and often with little support from government, must live with and solve the problem of HEC. Any HEC mitigation project should be a tool for mentoring and capacity development, which encourages communities to think about their HEC problems in order to find solutions that are appropriate for their context. These projects constitute natural laboratories for experimentation. Paternalism should be replaced by handing responsibility to farmer organizations, which have been shown to work very well. The provision of improved HEC mitigation strategies is the main incentive for people's engagement with HEC projects.

2) Simple solutions are best.
   Methods such as electric fencing, that rely on expensive technology or require specialist skills, are unlikely to be successful among smallholder farmers. Experience shows that mitigation can fail if no local capacity or resources exist to fix newly emerging technical problems. Where new mitigation methods are introduced to local farmers, changes from traditional to improved technologies should not be too drastic, to improve their chances of adapting to the new technology. A good example is chilli. Simple chilli rope methods worked well, but encouraging farmers to grow their own chillies as a cash crop proved more difficult, as this was not a crop or a market with which they were familiar.

3) Capacity development promotes integration and sustainability of HEC mitigation.
   Capacity development within the context of HEC mitigation projects is complex, occurring

across different levels and sectors. For example, where a community undertakes chilli-based HEC mitigation, the capacity of individual members and the management team may need to be strengthened to ensure maintenance of the group and to develop standard methods of monitoring. Equally, at the societal level, the entire local community may need to understand better the linkages between effective management of group members and HEC mitigation operations, and be able and willing to adapt their daily activities and traditions to mitigate conflict. "Learning by doing" enhances HEC management and ownership. This depends on the capacity of project partners to collect, analyze and store information at every stage of implementation, and to manage and share the knowledge generated in the process. Therefore, an effective participatory monitoring, evaluation and learning framework is critical. Failures and mistakes often provide the richest source of lessons and should be seen as important steps towards success. HEC mitigation programmes implemented across the elephant range have accumulated substantial knowledge. These programmes should use the lessons and experiences from previous projects to feed and inform the design of new projects.

4) Communication is crucial.
A good HEC mitigation project involves a long-term process of monitoring. So, in order to be effective, a project needs to be participatory, integrative and interactive. A range of partners, including government, community, civil society and private sector representatives, must establish relationships and communicate to discuss challenges, to identify problems and to correct courses of action. These tasks depend critically on awareness, trust, coordination and dialogue. Without communication to strengthen cooperation and collaboration, the reach and impact of a project will be compromised. On another level, the press and media can play an important role in supporting the activities of various HEC mitigation projects by raising awareness of available technologies and techniques, building support for project activities, and lobbying for policy or legislative change.

5) Complementary partnerships in HEC mitigation are important but challenging
Although communities are at the heart of HEC mitigation, it is a multi-sectoral process with solutions that lie in agriculture, land use planning and enterprise development. Therefore, HEC mitigation requires the support of different development sectors, including land, health, water, agriculture, tourism and micro-finance. Other partners include national and local government agencies, the private sector, the media, bilateral donors, universities and research institutions, conservation non-governmental organisations (NGOs) and national environment funds. Encouraging partners to participate in the design, implementation and evaluation of projects catalyzes the important process of learning-by-doing. Partnerships should hence stand at the core of any HEC project. However, this is challenging to achieve and manage. Even getting an over-stretched wildlife agency like KWS to begin to deal with HEC locally can be very difficult, and to a large extent depends on both the availability of resources and the personalities involved. The Transmara project provided resources to support KWS engagement with communities, but the extent to which this engagement will continue when such resources are no longer provided remains unclear.

6) Generating tangible benefits takes time.
HEC mitigation approaches are enhanced, not only when the costs of HEC are reduced, but when local benefits are also generated. The greater the options for better lives and livelihoods, the greater the importance attached to HEC mitigation by a community. It must be remembered that defending crops from elephants is not without cost, both in terms of the human resources required and the potential risk involved in dealing with elephants up close and at night. Yet as noted, even in areas as

heavily visited by tourists as MMNR, benefits do not flow easily to local communities. In this project we began to explore the potential for communities to generate direct benefits from tourism in their own, unprotected elephant landscapes rather than waiting for handouts from MMNR. Although it is clear that there is real tourism potential in Transmara (Stewart-Cox, 2003), establishing a viable enterprise involves myriad steps and the buy-in of local leadership as well as the commercial sector. Facilitating such a process takes time and funding which is not necessarily core to a HEC mitigation project. We struggled to fund the development of benefits, beyond initial feasibility studies in the Transmara project. As a result, we have not proceeded far with this critical aspect, five years on from the start of Phase II. However, achieving real benefits will be vital to prevent the increasing tolerance of elephants, and support for the project, eroding. Nevertheless, the development of community structures dedicated to pursuing this has a strong foundation and remains a valuable legacy of the project.

Future directions

This chapter describes a HEC project that has sought to enable elephant conservation by reaching out to, and empowering, communities. Locally led initiatives have been the driving force of change, and HEC mitigation projects such as this can serve as important and unique mechanisms for supporting grass-roots action to respond to conflict. The project has also shown that HEC activities can serve as an important entry point for interventions designed to help communities and elephant range states fulfill their international commitments. HEC projects help communities meet their basic need for food, education, forest and habitat conservation and enterprise development, thereby preparing the ground for the achievement of the Millennium Development Goals and related UN environment conventions.

Two areas for future development are paramount. Firstly, engaging more partners from different development sectors in community projects in order to serve a broader range of community needs (Walpole, 2006). Local benefits are manifested largely in the form of social services or livelihood benefits, but usually require the participation of stakeholders from other development sectors to provide complementary services that are important for sustainability, such as credit, or some type of financial support to make a HEC project commercially viable. However, such integration requires the involvement of many more partners and consequent tight coordination.

Secondly, breaking down barriers to community engagement at national and international levels by creating the appropriate enabling policy environment. HEC mitigation activities that can bring benefits at the community level may be vulnerable to national and international policies and events. For example, as elephant populations increase locally, there may be need to re-consider policy and legislative barriers that prevent local communities deriving benefits from some forms of use. Likewise, systems of benefit that depend on international tourism may be subject to global events well outside local community control. Therefore, so as not to compromise any local protection provided to elephant populations and ecosystems, it will be imperative to develop a diverse suite of benefits that operate at different levels as part of any HEC mitigation strategy (Leader-Williams & Hutton, 2005; Walpole & Thouless, 2005).

Acknowledgements

The Transmara HEC project was initiated at the Durrell Institute of Conservation and Ecology (DICE). We are grateful to all those within DICE and the University of Kent who have supported and contributed to the project. Generous early financial support was received from the Darwin Initiative for the Survival of Species (Grant nos. 162/6/131 and 162/10/003) and the KWS Elephant Research Fund. Subsequent phases of the project have been entirely funded by the World Wide Fund for Nature African Elephant Programme (WWF AEP Grant no.9F0727.01) with support from WWF-Netherlands and WWF-UK. We are grateful to WWF-EARPO for technical and logistical support,

and to the community scouts and other residents of Transmara for their support, hard work and contribution to the project. We are also grateful to numerous colleagues for their varied inputs and advice, including Holly Dublin, Patrick Omondi, Richard Hoare, Loki Osborn, Chris Thouless, Richard Barnes, Leo Niskanen, Julian Blanc, Jethro Odanga, Guy Parker and Belinda Stewart-Cox.

References

Adams, J.S. & McShane, T.O. 1992. *The myth of wild Africa*. W.W. Norton, New York, USA.

Aouade, J.A.A. 1979. Traditional Beekeeping in Nigeria-Editorial Summary from "Beekeeping Among the Tiv'." Beekeeping in Rural Development: Unexploited Beekeeping Potential in the Tropics with Particular reference to the Commonwealth. Commonwealth Secretariat and the International Bee Research Association, London. pp. 23.

Bailey, K.D. 1982. *Methods of social research*. The Free Press, New York, USA.

Barnes, R.F.W. 2002. Treating crop-raiding elephants with aspirin. *Pachyderm* 33: 96–99.

Barnes, R.F.W., Boafo, Y., Nandjui, A., Dubiure, U.F., Hema, E.M., Danquah, E. & Manford, M. 2003. *An overview of crop raiding by elephants around the Kakum conservation area*. Part 2: Technical report. Elephant Biology and Management Project, Africa Program, Conservation International. Washington DC, USA.

Bekhuis, P. & Prins, H.H.T. 2003. Forest elephant density and distribution in the southern part of Campo Ma'an National Park, Cameroon. *Pachyderm* 35: 37–42.

Bell, R.H.V. 1984. The man-animal interface: an assessment of crop damage and wildlife control. In: R.H.V. Bell & E. McShane-Caluzi (eds), *Conservation and Wildlife Management in Africa*. Proceedings of a workshop held at Kasungu National Park, Malawi, October 1984, US Peace Corps, Lilongwe, Malawi. pp. 387–416.

Berube, C. 2002. *War and bees, military applications of apiculture*. Island Crop Management, http://www.beekeeping.com; http://www3.telus.net/conrad [accessed 06-05-2003].

Blanc, J.J., Thouless, C.R., Hart, J.A., Dublin, H.T., Douglas-Hamilton, I., Craig, G.C. & Barnes, R.F.W. 2003. *African elephant status report 2002: An update from the African Elephant Database*. IUCN/SSC, Gland & Cambridge, Switzerland and UK.

Bromenshenk, J. 2004. Can honey bees assist in landmine detection? Division of Biological Sciences, University of Montana, Missoula, MT 59812, USA.

Coe, M.J., Cumming, D.H. & Phillipson, J. 1976. Biomass and production of large African herbivores in relation to rainfall and primary production. *Ocecologica* 22: 341–354.

Cumming, D.H.M. & Lynam, T. 1997. *Land use changes, wildlife conservation and utilisation, and the sustainability of agro-ecosystems in the Zambezi Valley*. Unpublished report, WWF MAPs Project, WWF, Harare, Zimbabwe.

Cunliffe, R.N. 1992. *An ecological resource survey of the communal lands of Centenary District*. WWF MAPS Project paper No. 26. WWF, Harare, Zimbabwe.

Douglas-Hamilton, I., Malpas, R.C., Edroma, E., Holt, P., Laker-Ojok, G. & Weyerhauser, R. 1980. *Uganda elephant and wildlife survey*. Unpublished Uganda Institute of Ecology report to IUCN. Uganda.

Dublin, H.T. & Douglas-Hamilton, I. 1987. Status and trends of elephant in the Serengeti-Mara ecosystem. *African Journal of Ecology* 25: 19–33.

Edroma, E.L. 1984. Drastic decline in the numbers of animals in Uganda National Parks. In: P.J., Joss, P.W., Lynch & O.B., Williams (eds) *Rangelands: A resource under siege*. Australian Academy of Science, Canberra, Australia. Pp. 546–548.

Eltringham, S.K. 1977. The numbers and distribution of elephants Loxondata africana in the Rwenzori and Chambura Game Reserve, Uganda. *East African Wildlife Journal* 15: 19–39.

Eltringham, S.K. 1991. *African elephant action plan for Uganda*. Unpublished report. Agriconsulting, Rome, Italy.

Eltringham, S.K. & Malpas, R.C. 1980. The decline of elephant numbers in Rwenzori and Kabalega Falls National Parks, Uganda. *African Journal of Ecology* 18: 73–86.

GoK. 1994a. An analysis of food security situation in Kenya. Ministry of Planning and Economic Development, Nairobi, Kenya.

GoK. 1994b. *Forecast of food production in Kenya*, 1994–1996. Ministry of Agriculture, Nairobi, Kenya.

Gunaryadi, D. & Hedges, S. 2006. *Protecting Sumatran Elephant Populations and Resolving Human–Elephant Conflicts in Way Kambas National Park, Sumatra, Indonesia*. A report to USFWS and WCS, July 2006. Wildlife Conservation Society, Bronx, New York, USA.

Hedges, S. & Lawson, D. 2006. *Monitoring the Illegal Killing of Elephants: Dung survey standards for the MIKE programme*. The MIKE Programme, CITES. Nairobi, Kenya.

Hill, C.M. 2000. Conflict of interest between people and baboons: crop raiding in Uganda. *International Journal of Primatology* 21: 299-315.

Hill, C.M., Osborn, F.V. & Plumptre, A.J. (eds) 2002. *Human wildlife conflict: Identifying the problem and possible solutions*. Wildlife Conservation Society, New York.

Hillman-Smith, K., De Merode, E., Smith, F., Mushenzi, N., Banza, P., Bro-Jorgensen, J., Gray, M., Mboma, G. & Watkin, J. 2003. *An aerial sample count of Virunga National Park Democratic Republic of Congo*. Report to the Congolese Institute for the Conservation of Nature. Democratic Republic of Congo.

Hoare, R.E. 1999a. *A standardized data collection and analysis protocol for human-elephant conflict situation in Africa*. IUCN/SSC African Elephant Specialist Group, Nairobi, Kenya.

Hoare R.E. 1999b. *Training package for enumerators of elephant damage*. IUCN/SSC African Elephant Specialist Group, Nairobi, Kenya.

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

Hoare, R. 2000. Humans and elephants in conflict: the outlook for coexistence. *Oryx* 34: 34–38.

Hoare, R.E. 2001. A decision support system for managing human-elephant conflict situations in Africa. IUCN/SSC African Elephant Specialist Group, Nairobi, Kenya.

Jayewardene, J. (ed) 2004. Endangered elephants past, present and future. Proceedings of the symposium on human elephant relationships and conflicts, Sri Lanka, September 2003. Biodiversity & Elephant Conservation Trust, Colombo, Sri Lanka.

Jenkins, P.R. & Hamilton, P.H. 1982. *The Laikipia elephant problem*. Nairobi, Wildlife Conservation and Management Department, Ministry of Tourism and Wildlife. Nairobi, Kenya.

Kaltenborn, B.P., Nyahongo, J.W. & Mayengo, M. 2003. *People and wildlife interaction around Serengeti National Park, Tanzania*. Norwegian Institute for Nature Research (NINA) Project Report No.22. Lillehammer, Norway.

Kanton, B.L. (2004) *Changing Attitudes and Perceptions of Local Communities towards elephant conservation and Masai Mara National Reserve, Kenya*. MSc Thesis, University of Kent, Canterbury, UK.

Karidozo, M. & Osborn, F.V. 2005. Can bees deter elephants from raiding crops? An experiment in the communal lands of Zimbabwe. *Pachyderm* 39: 26–32.

Kiyiapi, J., Ochieng-Obando, E.A. & Otieno-Odek, J. 1996. Forest inventory and legal basis of forest resource conservation and management. GTZ, Transmara, Kenya.

Kongrit, C., Siripunkaw, C., Akkarapatumwong, V., Brockelman, W.Y., Srikosamatara, S., Teerakiatipisarn, P., Indarabhut, P. & Eggert, L.S. 2007. *Individual identification of wild Asian elephants using non-invasive genotyping*. Paper presented at the 2nd International Field Ecology Symposium: Biodiversity Management King Mongkut University of Technology Thonburi, Bangkok 25–28 January 2007. Bangkok, Thailand.

Lamprey, R.H. & Michelmore, F. 1996. *Surveys of protected areas, Phase 1 and Phase 2*. Ministry of Tourism, Wildlife and Antiquities, Kampala, Uganda.

Laws, R.M., Parker, I.S.C. & Johnstone, R.C.B. 1970. Elephants and the habitats in north Bunyoro, Uganda. *East African Wildlife Journal* 8: 163–180.

Leader-Williams, N. & Hutton, J. 2005. Does extractive use provide opportunities to offset conflicts between people and wildlife? In: R., Woodroffe, S.J., Thirgood & A., Rabinowitz (eds) *People and Wildlife: Conflict or Coexistence?* Cambridge University Press, Cambridge, UK. pp. 140–161.

Malima, C., Hoare, R. & Blanc, J. 2004. Systematic recording of human-elephant conflict: a case study in south-eastern Tanzania. *Pachyderm* 38: 29–38.

Marschner, C. 1970. Qualitative und quantitative Untersuchungen am Bulbus olfactorius des Elefanten im Vergleihch mit dem des Menschen und des schweines. *Acta Anatomica* 75: 578–595.

May, R.M. 1977. Elephants in Uganda. *Nature* 268: 196.

Mehta, J.N. & Kellert, R. 1998. Local attitudes towards community-based conservation policy and programmes in Nepal: a case study in Makalu-Barun Conservation Area. *Environmental Conservation* 25: 320-333.

Mwenge International Ltd. 1979. Report on the Laikipia elephant drive, Appendix III-1. In: [eds] *Herbivores: a study on the management of very large herbivores in Kenya*, Vol II. Mwenge International Ltd, Nairobi, Kenya.

Nakhasathien, S. & Stewart-Cox, B. 1990. *Thailand's Nomination for the Thung Yai-Huai Kha Khaeng Wildlife Sanctuary to be a UNESCO World Heritage Site*. Thai Royal Forest Department and Ministry of Education. Thailand.

Naughton-Treves, L. 1997. Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda. *Geographical Review* 57: 27–46.

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

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

O'Connell-Rodwell, C.E., Rodwell, T., Rice, M. & Hart, L.A. 2000. Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? *Biological Conservation* 93: 381–391.

Olivier, R.C.D., Edroma, E.L & Campbell, K.L.I. 1989. *Aerial monitoring of large mammal populations in the Queen Elizabeth National Park, Uganda*. Unpublished Report. Uganda National Parks, Uganda.

Olivier, R.C.D. & Abe, E.L. 1992. *Aerial total counts in Uganda National Parks, February – October 1992*. EDF/Uganda National Parks, Kampala, Uganda.

Osborn, F.V. 2002. Capsicum oleoresin as an elephant repellent: field trials in the communal lands of Zimbabwe. *Journal of Wildlife Management* 66: 674–677.

Osborn, F.V. & Parker, G. 2002. Community-based methods to reduce crop loss to elephants: experiments in the communal lands of Zimbabwe. *Pachyderm* 33: 22–31.

Osborn, F.V. & Parker, G.E. 2002. *Living with Elephants II: a manual for implementing an integrated programme to reduce crop loss to elephants and to improve livelihood security of small-scale farmers*. Mid-Zambezi Elephant Project, Harare, Zimbabwe.

Osborn, F.V. & Parker, G.E. 2003. Towards an integrated approach for reducing the conflict between elephants and people: a review of current research. *Oryx* 37: 80–84.

Parker, G.E. 2006. *The costs and benefits of elephants: Communities and the CAMPFIRE programme in Zimbabwe*. PhD Thesis, University of Kent, UK.

Parker, G.E. & Osborn, F.V. 2006. Investigating the potential for chilli Capsicum spp. to reduce human-wildlife conflict in Zimbabwe. *Oryx* 40: 343–346.

Parry, D. & Campbell, B. 1992. Attitudes of rural community to animal wildlife and its utilisation in Chobe Enclave and Madabe Depression, Botswana. *Environmental Conservation* 19: 245–252.

Petrides, G.A. & Swank, W.G. 1963. Population densities and range carrying capacities for large mammals in QENP, Uganda. Zool. Afri. 1: 209–225.

Purseglove, J.W. 1972. *Tropical Crops*. Longman, London, UK.

Ritthirat, J. & Stewart-Cox, B. 1999. *Preparatory survey report*. Western Forest Elephant Conservation Project. Seub Nakhasathien Foundation, Bangkok, Thailand.

Ritthirat, J., Boontua, P. & Stewart-Cox, B. 2001. *Interview survey report, Salakpra Wildlife Sanctuary and Chalerm Rattanakosin National Park*. Elephant Conservation Network, Kanchanaburi, Thailand.

Rwetsiba, A., Lamprey, R.H., Tumweisigye, C. & Aleper, D. 2002. *Aerial total counts of elephants in Queen Elizabeth Conservation Area and Murchison Falls Conservation Area, Uganda*. Unpublished report, Uganda.

Seidenstecker, J. 1984. *Managing elephant depredations in agricultural and forestry projects*. Technical Report, The World Bank, Washington DC, USA.

Siex, K.S. & Struhsaker, T.T. 1999. Colobus monkeys and coconuts: a study of perceived human–wildlife conflicts. *Journal of Applied Ecology* 36: 1009–1020.

Siripunkaw, C., Kongrit, C., Eggert, L., Akkarapatumwong, V., Srikosamatara, S., Teerakiatipisarn, P., Indarabhut, P. & Brockelman, W.Y. 2007. *DNA markers and their potential application in studying the behavioural ecology of wild Asian elephants*. Presented at 2nd International Field Ecology Symposium: Biodiversity Management. King Mongkut University of Technology Thonburi, Bangkok 25–28 Jan 2007, Thailand.

Sitati, N.W. 2003. *Human-elephant conflict in Transmara District adjacent to Masai Mara National Reserve*. PhD Thesis. University of Kent, Canterbury, UK.

Sitati, N.W. 2004. Traditional human-elephant conflict mitigation measures in Transmara, Kenya. In: Jayewardene, J. (ed), Endangered elephants past, present & future. Proceedings of the Symposium on Human Elephant Relationships and Conflicts, Sri Lanka, September 2003. Biodiversity & Elephant Conservation Trust, Colombo, Sri Lanka. pp. 128–132.

Sitati, N.W., Walpole, M.J., Smith, R.J. & Leader-Williams, N. 2003. Predicting spatial aspects of human-elephant conflict. *Journal of Applied Ecology* 40: 667–677.

Sitati, N.W. & Walpole, M.J. 2004. *Mitigating Human-Elephant Conflict in the Mara Ecosystem, Kenya. Final report (Phase II)*. Unpublished report, DICE, University of Kent, UK.

Sitati, N.W., Walpole, M.J. & Leader-Williams, N. 2005. Factors affecting susceptibility of farms to crop raiding by African elephants: using a predictive model to mitigate conflict. Mitigating crop raiding by African elephant. *Journal of Applied Ecology* 42: 1175–1182.

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

Sitati, N.W. & Ipara, H. 2007. The role of tourism development and benefit sharing in mitigating human-elephant conflict in the Mara ecosystem, Kenya. In: E.M., Kloek & R., van der Dium (eds) *Tourism and nature in Africa*. Thematic proceedings of Association for Tourism and Leisure Education (ATLAS) Africa conferences, ATLAS 1: 71–80.

Srikrajang, M. 2003. *Conservation and Management of Elephants in Thailand*. PhD Thesis, Mahidol University, Bangkok, Thailand.

Srikrajang, M. 2005. Elephant crop raiding problems and their solutions at Kuiburi National Park, southwest Thailand. *Natural History Bulletin of the Siam Society* 53: 87–109.

Stephenson, P.J. 2005. *African elephant update number 5*. WWF, Gland, Switzerland.

Stewart-Cox, B. 2003. A pre-feasibility investigation for a community-based ecotourism venture in Transmara. In: M. Walpole (ed), *A participatory evaluation of the potential for community-based tourism in two areas of the Greater Mara ecosystem*. DICE, University of Kent, UK.

Taylor, R.D. 1999. *A review of problem elephant policy and management in southern Africa*. Report for the Human-Elephant Conflict Task Force. IUCN/SSC African Elephant Specialist Group, Nairobi, Kenya.

Thouless, C. 1993. *Laikipia elephant project: Final report*. Report to KWS and WWF Eastern African Regional Office. Kenya Wildlife Service, Nairobi, Kenya.

Thouless, C.R. 1994. Conflict between humans and elephants on private land in northern Kenya. *Oryx* 12: 119–127.

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

Thouless, C., Georgiadis, N. & Olwero, N. 2002. *A wildlife fencing strategy for Laikipia*. Laikipia Wildlife Forum. Laikipia, Kenya.

Vollrath, F. & Douglas-Hamilton, I. 2002. *African bees to control African elephants*. htttp://www.savetheelephants.org/publications [accessed 10/03/2003].

Wafula, J. 1998. *Towards a wildlife fencing master plan for Laikipia District. Priority areas of human-wildlife conflict.* Mpala Research Centre/ASAL Development Programme Laikipia. Laikipia, Kenya.

Walpole, M.J. 2006. Partnerships for conservation and poverty reduction. *Oryx* 40: 245–246.

Walpole, M.J. & Leader-Williams, N. 2001. Masai Mara tourism reveals partnership benefits. *Nature* 413: 771.

Walpole, M.J., Karanja, G.G., Sitati, N.W. & Leader-Williams, N. 2003. *Wildlife & People: Conflict and Conservation in Masai Mara, Kenya*. Wildlife and Development Series No.14, International Institute for Environment and Development (IIED), London.

Walpole, M.J., Ndoinyo, Y., Kibasa, R., Masanja, C., Somba, M. & Sungura, B. 2004. *Assessment of HEC in Western Serengeti*. Unpublished Report, Frankfurt Zoological Society, Arusha, Tanzania.

Walpole, M.J. & Thouless, C.R. 2005. Increasing the value of wildlife through non-consumptive use? Deconstructing the myth of ecotourism and community-based tourism in the tropics. In: R., Woodroffe, S.J., Thirgood & A., Rabinowitz. (eds), *People and Wildlife: Conflict or Coexistence?* Cambridge University Press, Cambridge, UK. pp. 122–139.

Walpole, M., Sitati, N., Stewart-Cox, B., Niskanen, L. & Stephenson, P.J. 2006. Mitigating human-elephant conflict in Africa: a lesson-learning and network development meeting. *Pachyderm* 41: 95–99.

Wamukoya, R., Njaka, N. & Too, D. 1997. *A survey of the Transmara forest elephant population*. Report to KWS, Nairobi, Kenya.

WWF. 1997. Conserving Africa's elephants: current issues and priorities for action. WWF, Gland, Switzerland.