Human-Elephant Conflict References (by date; most recent first)
(Searched title, abstract, keywords for "conflict")
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Gross, E. M., N. Drouet-Hoguet, N. Subedi and J. Gross (2017). "**The potential of medicinal and aromatic plants (MAPs) to reduce crop damages by Asian Elephants (Elephas maximus)**." Crop Protection **100**: 29-37.

In all 13 Asian range countries of the wild Asian elephant (Elephas maximus L.), farmers suffer from crop damages caused by this endangered and highly protected species. As elephants are lured by highly nutritional crop types into agricultural lands, measures to deter or repel them from the high attraction will always be costly and labour intensive. The cultivation of crops, which are less attractive to elephants, yet economically viable for local farmers could lead to a new direction of land-use and income generation in human-elephant conflict areas. In this study, seven medicinal and aromatic plants (MAPs) containing higher amounts of specific plant secondary compounds were explored for their attractiveness to wild Asian elephants against a control of rice (Oryza sativa L.) and maize (Zea mays L.). The results show that chamomile (Matricaria chamomilla L.), coriander (Coriandrum sativum L.), mint (Mentha arvensis L.), basil (Ocimum basilicum L.), turmeric (Curcuma longa L.), lemon grass (Cymbopogon flexuosus (Nees ex Steud.) W. Watson) and citronella (Cymbopogon winterianus Jowitt.) were less attractive and were not consumed by elephants compared to rice. Damages to the MAPs occurred only through trampling, with mint being most prone to being trampled. Other wildlife species, however, were observed to feed on lemon-grass. Long-term learning effects and the eventual palatability of crops with less efficient antifeedants need to be further explored. This study, however, gives first evidence that MAPs bear a high potential for a secure income generation in and close to Asian elephant habitats. Furthermore, the strategic plantation of crops unattractive and attractive to elephants could lead to new land-use strategies and improve functionality of elephant corridors. © 2017 Elsevier Ltd

Gunaryadi, D., Sugiyo and S. Hedges (2017). "**Community-based human-elephant conflict mitigation: The value of an evidence-based approach in promoting the uptake of effective methods**." PLoS ONE **12**(5): e0173742.

Human-elephant conflict (HEC) is a serious threat to elephants and can cause major economic losses. It is widely accepted that reduction of HEC will often require community-based methods for repelling elephants but there are few tests of such methods. We tested community-based crop-guarding methods with and without novel chili-based elephant deterrents and describe changes in farmers' willingness to adopt these methods following our demonstration of their relative effectiveness. In three separate field-trials that took place over almost two years (October 2005 -May 2007) in two villages adjacent to Way Kambas National Park (WKNP) in Indonesia, we found that community-based crop-guarding was effective at keeping Asian elephants (Elephas maximus) out of crop fields in 91.2% (52 out of 57), 87.6% (156 out of 178), and 80.0% (16 out of 20) of attempted raids. Once the method had been shown to be effective at demonstration sites, farmers in 16 villages around WKNP voluntarily adopted it during the July 2008 to March 2009 period and were able to repel elephants in 73.9% (150 out of 203) of attempted raids, with seven villages repelling 100% of attempted raids. These 16 villages had all experienced high levels of HEC in the preceding years; e.g. they accounted for >97% of the 742 HEC incidents recorded for the entire park in 2006. Our work shows, therefore, that a simple evidence-based approach can facilitate significant reductions in HEC at the protected area scale.

Gupta, S. K. and V. Minhas (2017). "**Wildlife population management: Are contraceptive vaccines a feasible proposition?**" Frontiers in Bioscience - Scholar **9**(3): 357-374.

To minimize human-animal conflicts for habitation and burden of zoonotic diseases, it is imperative to develop new strategies for wildlife population management. In this direction, contraceptive vaccines eliciting immune

response against hormones/proteins critical for reproduction have emerged as one of the promising options. Contraceptive vaccines based on neutralization of gonadotropin releasing hormone (GnRH) have been used for inhibition of fertility in various species such as wild horses, white-tailed deer, pigs, cats, dogs etc. It has been used for immunocastration of male pigs to improve meat quality. However, additional safety studies of GnRH vaccine will be needed in light of presence of its receptor at extra-pituitary sites. Native porcine zona pellucida (PZP)-based contraceptive vaccines have shown their utility in the management of the population of both captive and free-ranging wild horses and white-tailed deer. Long-term use of the PZP-based contraceptive vaccines has also demonstrated their safety. Ideally single injection of the contraceptive vaccine should elicit long lasting immune response and desired contraceptive efficacy, which will require development of novel vaccine delivery platforms and more potent adjuvants.

King, L. E., F. Lala, H. Nzumu, E. Mwambingu and I. Douglas-Hamilton (2017). "**Beehive fences as a multidimensional conflict-mitigation tool for farmers coexisting with elephants**." Conserv Biol.

Increasing habitat fragmentation and human population growth in Africa has resulted in an escalation in human-elephant conflict between small-scale farmers and free-ranging African elephants (Loxodonta Africana). In 2012 Kenya Wildlife Service (KWS) implemented the national 10-year Conservation and Management Strategy for the Elephant in Kenya, which includes an action aimed at testing whether beehive fences can be used to mitigate human-elephant conflict. From 2012 to 2015, we field-tested the efficacy of beehive fences to protect 10 0.4-ha farms next to Tsavo East National Park from elephants. We hung a series of beehives every 10 m around the boundary of each farm plot. The hives were linked with strong wire. After an initial pilot test with 2 farms, the remaining 8 of 10 beehive fences also contained 2-dimensional dummy hives between real beehives to help reduce the cost of the fence. Each trial plot had a neighboring control plot of the same size within the same farm. Of the 131 beehives deployed 88% were occupied at least once during the 3.5-year trial. Two hundred and fifty-three elephants, predominantly 20-45 years old entered the community farming area, typically during the crop- ripening season. Eighty percent of the elephants that approached the trial farms were kept out of the areas protected by the beehive fences, and elephants that broke a fence were in smaller than average groups. Beehive fences not only kept large groups of elephants from invading the farmland plots but the farmers also benefited socially and financially from the sale of 228 kg of elephant-friendly honey. As news of the success of the trial spread, a further 12 farmers requested to join the project, bringing the number of beehive fence protected farms to 22 and beehives to 297. This demonstrates positive adoption of beehive fences as a community mitigation tool. Understanding the response of elephants to the beehive fences, the seasonality of crop raiding and fence breaking, and the willingness of the community to engage with the mitigation method will help contribute to future management strategies for this high human-elephant conflict hotspot and other similar areas in Kenya.

MacKenzie, C. A., J. Salerno, J. Hartter, C. A. Chapman, R. Reyna, D. M. Tumusiime and M. Drake (2017). "**Changing perceptions of protected area benefits and problems around Kibale National Park, Uganda**." J Environ Manage **200**: 217-228.

Local residents' changing perceptions of benefits and problems from living next to a protected area in western Uganda are assessed by comparing household survey data from 2006, 2009, and 2012. Findings are contextualized and supported by long-term data sources for tourism, protected area-based employment, tourism revenue sharing, resource access agreements, and problem animal abundance. We found decreasing perceived benefit and increasing perceived problems associated with the protected area over time, with both trends dominated by increased human-wildlife conflict due to recovering elephant numbers. Proportions of households claiming benefit from specific conservation strategies were increasing, but not enough to offset crop raiding. Ecosystem services mitigated perceptions of problems. As human and animal populations rise, wildlife authorities in Sub-Saharan Africa will be challenged to balance perceptions and adapt policies to ensure the continued existence of protected areas. Understanding the dynamic nature of local people's perceptions provides a tool to adapt protected area management plans, prioritize conservation resources, and engage local communities to support protected areas.

Pozo, R. A., T. Coulson, G. McCulloch, A. L. Stronza and A. C. Songhurst (2017). "**Determining baselines for human-elephant conflict: A matter of time**." PLoS ONE **12**(6): e0178840.

Elephant crop raiding is one of the most relevant forms of human-elephant conflict (HEC) in Africa. Northern Botswana holds the largest population of African elephants in the world, and in the eastern Okavango Panhandle, 16,000 people share and compete for resources with more than 11,000 elephants. Hence, it is not surprising this area represents a HEC 'hotspot' in the region. Crop-raiding impacts lead to negative perceptions of elephants by local communities, which can strongly undermine conservation efforts. Therefore, assessing trends in conflict levels is essential to developing successful management strategies. In this context, we investigated the trend in the number of reported raiding incidents as one of the indicators of the level of HEC, and assessed its relationship to trends in human and elephant population size, as well as land-use in the study area. For each of these factors, we considered data spanning historical (since the 1970s) and contemporary (2008-2015) time frames, with the aim of comparing subsequent inferences on the drivers of crop raiding and predictions for the future. We find that the level of reported crop raiding by elephants in the eastern Panhandle appears to have decreased since 2008, which seems to be related to the reduction in agricultural land allocated to people in recent years, more than with human and elephant population size. We show that inferences regarding the drivers of HEC and predictions for the future are dependent on the time span of the data used. Although our study represents a first step in developing a HEC baseline in the eastern Panhandle, it highlights the need for additional multi-scale analyses that consider progress in conservation conflict to better understand and predict drivers of HEC in the region.

Acharya, K. P., P. K. Paudel, P. R. Neupane and M. Kohl (2016). "**Human-Wildlife Conflicts in Nepal: Patterns of Human Fatalities and Injuries Caused by Large Mammals**." PLoS ONE **11**(9): e0161717.

Injury and death from wildlife attacks often result in people feeling violent resentment and hostility against the wildlife involved and, therefore, may undermine public support for conservation. Although Nepal, with rich biodiversity, is doing well in its conservation efforts, human-wildlife conflicts have been a major challenge in recent years. The lack of detailed information on the spatial and temporal patterns of human-wildlife conflicts at the national level impedes the development of effective conflict mitigation plans. We examined patterns of human injury and death caused by large mammals using data from attack events and their spatiotemporal dimensions collected from a national survey of data available in Nepal over five years (2010-2014). Data were analyzed using logistic regression and chi-square or Fisher's exact tests. The results show that Asiatic elephants and common leopards are most commonly involved in attacks on people in terms of attack frequency and fatalities. Although one-horned rhinoceros and bears had a higher frequency of attacks than Bengal tigers, tigers caused more fatalities than each of these two species. Attacks by elephants peaked in winter and most frequently occurred outside protected areas in human settlements. Leopard attacks occurred almost entirely outside protected areas, and a significantly greater number of attacks occurred in human settlements. Attacks by one-horned rhinoceros and tigers were higher in the winter, mainly in forests inside protected areas; similarly, attacks by bears occurred mostly within protected areas. We found that human settlements are increasingly becoming conflict hotspots, with burgeoning incidents involving elephants and leopards. We conclude that species-specific conservation strategies are urgently needed, particularly for leopards and elephants. The implications of our findings for minimizing conflicts and conserving these imperiled species are discussed.

Breuer, T., F. Maisels and V. Fishlock (2016). "**The consequences of poaching and anthropogenic change for forest elephants**." Conserv Biol **30**(5): 1019-1026.

Poaching has devastated forest elephant populations (Loxodonta cyclotis), and their habitat is dramatically changing. The long-term effects of poaching and other anthropogenic threats have been well studied in savannah elephants (Loxodonta africana), but the impacts of these changes for Central Africa's forest elephants have not been discussed. We examined potential repercussions of these threats and the related consequences for forest elephants in Central Africa by summarizing the lessons learned from savannah elephants and small

forest elephant populations in West Africa. Forest elephant social organization is less known than the social organization of savannah elephants, but the close evolutionary history of these species suggests that they will respond to anthropogenic threats in broadly similar ways. The loss of older, experienced individuals in an elephant population disrupts ecological, social, and population parameters. Severe reduction of elephant abundance within Central Africa's forests can alter plant communities and ecosystem functions. Poaching, habitat alterations, and human population increase are probably compressing forest elephants into protected areas and increasing human-elephant conflict, which negatively affects their conservation. We encourage conservationists to look beyond documenting forest elephant population decline and address the causes of these declines when developing conversation strategies. We suggest assessing the effectiveness of the existing protected-area networks for landscape connectivity in light of current industrial and infrastructure development. Longitudinal assessments of the effects of landscape changes on forest elephant sociality and behavior are also needed. Finally, lessons learned from West African elephant population loss and habitat fragmentation should be used to inform strategies for land-use planning and managing human-elephant interactions.

Chen, Y., J. Marino, Y. Chen, Q. Tao, C. D. Sullivan, K. Shi and D. W. Macdonald (2016). "**Predicting Hotspots of Human-Elephant Conflict to Inform Mitigation Strategies in Xishuangbanna, Southwest China**." PLoS ONE **11**(9): e0162035.

Research on the spatial patterns of human-wildlife conflict is fundamental to understanding the mechanisms underlying it and to identifying opportunities for mitigation. In the state of Xishuangbanna, containing China's largest tropical forest, an imbalance between nature conservation and economic development has led to increasing conflicts between humans and Asian elephants (Elephas maximus), as both elephant numbers and conversion of habitable land to rubber plantations have increased over the last several decades. We analyzed government data on the compensation costs of elephant-caused damage in Xishuangbanna between 2008 and 2012 to understand the spatial and temporal patterns of conflict, in terms of their occurrence, frequency and distribution. More than 18,261 incidents were reported, including episodes involving damage to rubber trees (n = 10,999), damage to crops such as paddy, upland rice, corn, bananas and sugarcane (n = 11,020), property loss (n = 689) and attacks on humans (n = 19). The conflict data reconfirmed the presence of elephants in areas which have lacked records since the late 1990s. Zero Altered Negative Binomial models revealed that the risk of damage to crops and plantations increased with proximity to protected areas, increasing distance from roads, and lower settlement density. The patterns were constant across seasons and types of crop damaged. Damage to rubber trees was essentially incidental as elephants searched for crops to eat. A predictive map of risks revealed hotspots of conflict within and around protected areas, the last refuges for elephants in the region, and along habitat corridors connecting them. Additionally, we analyzed how mitigation efforts can best diminish the risk of conflict while minimizing financial costs and adverse biological impacts. Our analytical approach can be adopted, adjusted and expanded to other areas with historical records of human-wildlife conflict.

Ndlovu, M., E. Devereux, M. Chieffe, K. Asklof and A. Russo (2016). "**Responses of African elephants towards a bee threat: Its application in mitigating human-elephant conflict**." South African Journal of Science **112**(1-2).

Human settlement expansion into elephant ranges, as well as increasing elephant populations within confined areas has led to heightened levels of human-elephant conflict in southern African communities living near protected areas. Several methods to mitigate this conflict have been suggested including the use of bees as an elephant deterrent. We investigated whether bee auditory and olfactory cues (as surrogates for live bees) could be used to effectively deter elephants. We evaluated the responses of elephants in the southern section of the Kruger National Park to five different treatments: (1) control noise, (2) buzzing bee noise, (3) control noise with honey scent, (4) honey scent, and (5) bee noise with honey scent. Elephants did not respond or displayed less heightened responses to the first four treatments. All elephants exposed to the bee noise with honey scent responded with defensive behaviours and 15 out of 21 individuals also fled. We concluded that buzzing bees or honey scent as isolated treatments (as may be the case with dormant beehives) were not effective elephant deterrents, but rather an active beehive emitting a combination of auditory and olfactory cues was a viable

deterrent. However, mismatches in the timing of elephant raids and activity of bees may limit the use of bees in mitigating the prevailing human-elephant conflict. © 2016. The Author(s). Published under a Creative Commons Attribution Licence.

Sarkar, D., C. A. Chapman, W. Kagoro and R. Sengupta (2016). "**Countering elephant raiding with Short Message Service: Challenges of deploying public participation-based systems in a setting with sparse Information Communication Technologies resources**." Canadian Geographer **60**(4): 493-504.

Dwindling animal habitat and burgeoning human settlements have made managing human-animal conflict a critical problem in conservation of protected areas, particularly in the biodiversity-rich tropics. In this paper, we present a system aimed at leveraging public participation from affected communities to help effectively manage the conflict in both the short and long term. However, deploying a system that depends on volunteered information has its challenges in the unique settings of a national park where Information Communication Technologies infrastructure is sparse. The specific requirements of the system being easy to use and having automatic geocoding, coupled with the lack of internet access, made it impossible to deploy traditional crisis mapping software such as Ushahidi. We highlight the unique challenges of deploying a system that relies on volunteered information for managing human-animal conflict in a technology resource sparse environment and how the challenges were surpassed. Our system aims at streamlining the process of reporting cases of elephant raiding to the forest officials so as to elicit quick support. The long-term aim is to use the data collected through the system for spatio-temporal analysis to better understand elephant raiding patterns so that the parks services can be effectively deployed. La lutte contre le braconnage d'éléphant à l'aide du service de messagerie SMS : les défis du déploiement de systèmes basés sur la participation publique dans un milieu disposant de peu de ressources en technologies de l'information et de la communication: La perte de l'habitat faunique et l'expansion des établissements humains aggravent les enjeux de gestion des conflits entre les humains et les animaux pour la sauvegarde des aires protégées, notamment en zone tropicale de forte biodiversité. Dans cet article, nous présentons un système visant à tirer parti de la participation du public provenant des communautés touchées afin d'élaborer un mode de gestion plus efficace du conflit à court et à long terme. Cependant, l'exploitation d'un système qui dépend d'informations fournies sur une base volontaire soulève des défis dans le contexte particulier d'un parc national disposant de peu d'infrastructures en technologies de l'information et de la communication. Considérant que le système recherché devait être convivial et permettre le géocodage automatique, et que l'Internet n'était pas disponible, les logiciels traditionnels de cartographie des crises tels que Ushahidi ne pouvaient pas être utilisés. Nous soulignons les défis à relever dans l'exploitation d'un système reposant sur des informations fournies sur une base volontaire pour assurer la gestion des conflits entre les humains et les animaux dans un contexte marqué par la pénurie de ressources technologiques, et la manière dont ces défis ont été surmontés. Notre système vise à simplifier le processus de déclaration des incidents de braconnage d'éléphant aux agents forestiers en vue d'obtenir un soutien rapide. l'objectif à long terme est d'utiliser les données recueillies par le système d'analyse spatio-temporelle pour mieux comprendre les profils de braconnage d'éléphant, permettant ainsi aux directions des parcs de réaliser leur plein potentiel. © 2016 Canadian Association of Geographers / L'Association canadienne des géographes

Wijayagunawardane, M. P. B., R. V. Short, T. S. Samarakone, K. B. M. Nishany, H. Harrington, B. V. P. Perera, R. Rassool and E. P. Bittner (2016). "**The use of audio playback to deter crop-raiding Asian elephants**." Wildlife Society Bulletin **40**(2): 375-379.

Human–elephant conflict (HEC) and poaching are the foremost threats to the survival of elephants (African, Loxodonta africana; Asian, Elephas maximus) in their natural environments. Reducing HEC has the potential to save hundreds of elephant and human lives annually across Asia and Africa. Lone adult male elephants are the principal crop raiders; therefore, we investigated the effectiveness of a variety of audio playbacks at deterring 22 wild adult male Asian elephants from food sources in a wildlife reserve in southern Sri Lanka in January, 2011. Food was provided ad libitum, and the reactions of the elephants in response to various stimuli were recorded and analyzed. Vocalizations from a wild Asian elephant matriarchal group resulted in a flight response in 65% of trials conducted, in contrast to a control sound, a chainsaw, which produced no flight responses from any adult

male. We demonstrated that audio playbacks could be used as a short-term deterrent to wild adult male Asian elephants from crop raiding; thus, providing a simple, natural, cost-effective, and humane way of mitigating HEC. © 2016 The Wildlife Society. © The Wildlife Society, 2016

Goswami, V. R., K. Medhi, J. D. Nichols and M. K. Oli (2015). "**Mechanistic understanding of human-wildlife conflict through a novel application of dynamic occupancy models**." Conserv Biol **29**(4): 1100-1110.

Crop and livestock depredation by wildlife is a primary driver of human-wildlife conflict, a problem that threatens the coexistence of people and wildlife globally. Understanding mechanisms that underlie depredation patterns holds the key to mitigating conflicts across time and space. However, most studies do not consider imperfect detection and reporting of conflicts, which may lead to incorrect inference regarding its spatiotemporal drivers. We applied dynamic occupancy models to elephant crop depredation data from India between 2005 and 2011 to estimate crop depredation occurrence and model its underlying dynamics as a function of spatiotemporal covariates while accounting for imperfect detection of conflicts. The probability of detecting conflicts was consistently <1.0 and was negatively influenced by distance to roads and elevation gradient, averaging 0.08-0.56 across primary periods (distinct agricultural seasons within each year). The probability of crop depredation occurrence ranged from 0.29 (SE 0.09) to 0.96 (SE 0.04). The probability that sites raided by elephants in primary period t would not be raided in primary period t + 1 varied with elevation gradient in different seasons and was influenced negatively by mean rainfall and village density and positively by distance to forests. Negative effects of rainfall variation and distance to forests best explained variation in the probability that sites not raided by elephants in primary period t would be raided in primary period t + 1. With our novel application of occupancy models, we teased apart the spatiotemporal drivers of conflicts from factors that influence how they are observed, thereby allowing more reliable inference on mechanisms underlying observed conflict patterns. We found that factors associated with increased crop accessibility and availability (e.g., distance to forests and rainfall patterns) were key drivers of elephant crop depredation dynamics. Such an understanding is essential for rigorous prediction of future conflicts, a critical requirement for effective conflict management in the context of increasing human-wildlife interactions.

Jasmine, B., D. Ghose and S. K. Das (2015). "**AN ATTITUDE ASSESSMENT OF HUMAN-ELEPHANT CONFLICT IN A CRITICAL WILDLIFE CORRIDOR WITHIN THE TERAI ARC LANDSCAPE, INDIA**." Journal of Threatened Taxa **7**(2): 6843-6852.

This study entails an attitude assessment of the local people living at Mankanthpur Village, one of the bottlenecks in the Bailparao-Kotabagh corridor, Terai West Forest Division, on the issue of elephant conservation, human-(wildlife) elephant conflict, and the measures to mitigate it. Data was collected through a questionnaire survey and several group discussions among the villagers. The frequency of crop raids and group size of elephants were calculated. Sixty-two crop raids took place during the study period (February-April 2010), and a mean sighting of 1.08 elephants per day was recorded. Data from the survey reflects that about 3.53ha of crop land was damaged by the elephants during the survey period. The people residing on the fringes of the park and in the villages along the Bailparao-Kotabagh Corridor were surveyed about the conflict impact. Survey results indicate that the most effective management measures used were a combination of loud noise and scaring away elephants using fire. Local peoples' views regarding the current status of elephant raids and conservation were also documented. Peoples' reaction to compensation schemes was studied; 89% of the respondents feel an effective approach to compensation is a way to reduce sufferings due to conflict with wildlife. Attempts to reduce the conflict by forming local elephant control teams and enclosing the affected village with a tall cemented wall are under trial. The underlying assumption in this study is that if damage severely affects the livelihood of local communities, getting their active support, which is essential for conservation, will be difficult.

Kahler, J. S. and M. L. Gore (2015). "**Local perceptions of risk associated with poaching of wildlife implicated in human-wildlife conflicts in Namibia**." Biological Conservation **189**: 49-58.

Human-wildlife conflict (HWC) includes how people perceive risks associated with negative interactions with wildlife. Risk perceptions are important for conservationists to understand because perceptions can influence

human behaviors in response to HWC, such as tolerance or poaching specific species. Our study site, the Zambezi region of Namibia, is renowned for diverse wildlife that come into conflict with humans and are vulnerable to poaching. Our study objectives were: (1) quantify local perceptions of risk associated with species-specific HWC and poaching, (2) examine the relationship between species-specific HWC and poaching risks, and (3) characterize economic costs, benefits and perceptions of the ecological values (e.g., disease vector) of the top four species implicated in HWCs and poaching. The species that were perceived to be at greatest risk from poaching were characterized as posing high ecological risks (e.g., disease vectors) and livelihood risks (e.g., crop damage) and were economically valuable for local subsistence and trade. Species perceived to pose high risk to livelihoods were moderately correlated with increasing perceived poaching vulnerability ($r = 0.53$, $p = 0.04$, $df = 14$). All but one of the top four species most vulnerable generated greater average annual revenue from legal hunting than average annual damage to crops. However, a majority of participants stated that conservancy benefits were not equitably distributed. Quantifying and characterizing how stakeholders perceive poaching-related risks can complement risk assessment data and result in more robust conservation planning. These findings have implications for risk communication, distribution of wildlife-related risks and benefits and more nuanced management of the most vulnerable species. (C) 2015 Elsevier Ltd. All rights reserved.

Khumalo, K. E. and L. A. Yung (2015). "**Women, Human-Wildlife Conflict, and CBNRM: Hidden Impacts and Vulnerabilities in Kwandu Conservancy, Namibia**." Conservation & Society **13**(3): 232-243.

Community-based natural resource management (CBNRM) programmes are designed to ensure that rural residents benefit from conservation initiatives. But where human-wildlife conflict threatens life and livelihood, wildlife impacts can undermine the goals of CBNRM. Based on research on women's experiences in Namibia's Kwandu Conservancy, we examine both the visible and hidden impacts of human-wildlife conflict. In Kwandu Conservancy, the effects of human-wildlife conflict are ongoing, reaching beyond direct material losses to include hidden impacts such as persistent worries about food insecurity, fears for physical safety, and lost investments. Existing vulnerabilities related to poverty and marital statuses make some women more susceptible to wildlife impacts, and less able to recover from losses or to access compensation. This process may actually deepen the vulnerability of women whose economic status is already marginal. Because the benefits of wildlife conservation accrue at multiple scales, we recommend that the cost of human-wildlife conflict be better distributed, with additional resources for prevention and compensation made available for conservancy residents.

Nath, N. K., B. P. Lahkar, S. K. Dutta and J. P. Das (2015). "**Human-Elephant Conflict around Manas National Park, India: Local People's Attitudes, Expectations and Perceptions**." Gajah **42**: 15-21.

We conducted a study on local peoples' attitudes, expectations and perceptions of human-elephant conflict in fringe areas of Manas National Park. A questionnaire was administered to 563 residents in 24 villages during 2007-09. We found the respondents had positive attitudes towards elephants. Support for elephant conservation was significantly associated with gender, age and education of the respondents. We also found significant differences between actual and perceived frequency of conflict incidents, with respondents quoting far higher numbers of conflicts than what occurred.

Wakoli, E. N., H. Ipara, N. Sitati and P. Odwori (2015). **Causes and mitigation measures of Elephant (Loxodonta Africana) mortality in Narok County, Kenya**. 36th Asian Conference on Remote Sensing: Fostering Resilient Growth in Asia, ACRS 2015, Asian Association on Remote Sensing.

Narok County supports a large number of elephants both in the protected area and the adjacent dispersal areas. Despite this, the ecosystem is undergoing a tremendous transformation that may be detrimental to the survival and conservation of elephants. Incidences of increasing elephant deaths are common. This study therefore aimed at identifying the causes of elephant mortality, rank these causes and find out the possible mitigation measures. Data were collected from field monitoring of elephant death incidences, questionnaire surveys, focus group discussion and interviews. Statistical Package for Social Sciences (SPSS Version 18) was used during data analysis. In this study, a 0.05 level of significance was used to determine the relationship between various data

categories. The results showed that the total number of elephants that died between September 2010 and October 2011 due to trophy poaching, conflicts, unknown reasons, euthanasia, natural cause, control, and accidents were significantly different ($\chi 2 = 35.161$, df = 6, p < 0.001). More elephant deaths were as a result of trophy poaching (45%) followed by conflict (29%); natural (10%), accident (7%) and the least were control, euthanasia and accidents (3%), respectively. We conclude that trophy poaching is the main cause of elephant mortality. Hence, stringent anti-poaching measure should be employed including regular patrols as well as incorporating local communities in elephant conservation. Appropriate conflict mitigation strategies should be employed among other strategies like benefit sharing, awareness raising through education and extension, fencing of intensive farming areas, compensation, among other strategies.

Wilson, S., T. E. Davies, N. Hazarika and A. Zimmermann (2015). "**Understanding spatial and temporal patterns of human-elephant conflict in Assam, India**." Oryx **49**(1): 140-149.

Large-scale forest encroachment in Assam, India, has led to increasing levels of human-elephant conflict. Conflict mitigation is a priority for the survival of Asian elephants Elephas maximus throughout Asia. We analysed a 3-year dataset of elephant occurrence and related instances of human-elephant conflict, from two sites in Assam, and explored the relationships between the various effects of elephants on human communities and factors influencing the spatial and temporal occurrence of these effects (proximity to water, refuge areas and villages, and human and crop density). The landscapes at both study sites have been transformed by forest loss, with large areas converted to agriculture. Remaining forest patches, which are mostly small, disconnected and degraded, as well as tea plantations, provide refuge areas for elephants as they move through the region. We found that crop depredation and property damage caused by elephants showed well-defined seasonal trends. They also showed a clear diurnal pattern, mostly occurring between 18.00 and 22.00. Small communities within 700 m of a refuge were most affected. In the management of human-elephant conflict in Assam we need to consider the refuge patches used by elephants as they move through the region, the peripheries of which are likely to be conflict hotspots. Small villages on the edges of refuges should be a priority for conflict mitigation assistance, with strategies taking into account seasonal and diurnal variation in elephant behaviour, as well as the socio-economic and cultural composition of communities.

Zeppelzauer, M., S. Hensman and A. S. Stoeger (2015). "**Towards an automated acoustic detection system for free-ranging elephants**." Bioacoustics-the International Journal of Animal Sound and Its Recording **24**(1): 13-29.

The human-elephant conflict is one of the most serious conservation problems in Asia and Africa today. The involuntary confrontation of humans and elephants claims the lives of many animals and humans every year. A promising approach to alleviate this conflict is the development of an acoustic early warning system. Such a system requires the robust automated detection of elephant vocalizations under unconstrained field conditions. Today, no system exists that fulfils these requirements. In this paper, we present a method for the automated detection of elephant vocalizations that is robust to the diverse noise sources present in the field. We evaluate the method on a data-set recorded under natural field conditions to simulate a real-world scenario. The proposed method outperformed existing approaches and robustly and accurately detected elephants. It thus can form the basis for a future automated early warning system for elephants. Furthermore, the method may be a useful tool for scientists in bioacoustics for the study of wildlife recordings.

Zeppelzauer, M. and A. S. Stoeger (2015). "**Establishing the fundamentals for an elephant early warning and monitoring system**." BMC research notes **8**(1).

Background: The decline of habitat for elephants due to expanding human activity is a serious conservation problem. This has continuously escalated the human-elephant conflict in Africa and Asia. Elephants make extensive use of powerful infrasonic calls (rumbles) that travel distances of up to several kilometers. This makes elephants well-suited for acoustic monitoring because it enables detecting elephants even if they are out of sight. In sight, their distinct visual appearance makes them a good candidate for visual monitoring. We provide an integrated overview of our interdisciplinary project that established the scientific fundamentals for a future early warning and monitoring system for humans who regularly experience serious conflict with elephants. We

first draw the big picture of an early warning and monitoring system, then review the developed solutions for automatic acoustic and visual detection, discuss specific challenges and present open future work necessary to build a robust and reliable early warning and monitoring system that is able to operate in situ. Findings: We present a method for the automated detection of elephant rumbles that is robust to the diverse noise sources present in situ. We evaluated the method on an extensive set of audio data recorded under natural field conditions. Results show that the proposed method outperforms existing approaches and accurately detects elephant rumbles. Our visual detection method shows that tracking elephants in wildlife videos (of different sizes and postures) is feasible and particularly robust at near distances. Discussion: From our project results we draw a number of conclusions that are discussed and summarized. We clearly identified the most critical challenges and necessary improvements of the proposed detection methods and conclude that our findings have the potential to form the basis for a future automated early warning system for elephants. We discuss challenges that need to be solved and summarize open topics in the context of a future early warning and monitoring system. We conclude that a long-term evaluation of the presented methods in situ using real-time prototypes is the most important next step to transfer the developed methods into practical implementation. © 2015 Zeppelzauer and Stoeger.

Massei, G. and D. Cowan (2014). "**Fertility control to mitigate human-wildlife conflicts: A review**." Wildlife Research **41**(1): 1-21.

As human populations grow, conflicts with wildlife increase. Concurrently, concerns about the welfare, safety and environmental impacts of conventional lethal methods of wildlife management restrict the options available for conflict mitigation. In parallel, there is increasing interest in using fertility control to manage wildlife. The present review aimed at analysing trends in research on fertility control for wildlife, illustrating developments in fertility-control technologies and delivery methods of fertility-control agents, summarising the conclusions of empirical and theoretical studies of fertility control applied at the population level and offering criteria to guide decisions regarding the suitability of fertility control to mitigate human-wildlife conflicts. The review highlighted a growing interest in fertility control for wildlife, underpinned by increasing numbers of scientific studies. Most current practical applications of fertility control for wild mammals use injectable single-dose immunocontraceptive vaccines mainly aimed at sterilising females, although many of these vaccines are not yet commercially available. One oral avian contraceptive, nicarbazin, is commercially available in some countries. Potential new methods of remote contraceptive delivery include bacterial ghosts, virus-like particles and genetically modified transmissible and non-transmissible organisms, although none of these have yet progressed to field testing. In parallel, new species-specific delivery systems have been developed. The results of population-level studies of fertility control indicated that this approach may increase survival and affect social and spatial behaviour of treated animals, although the effects are species- and context-specific. The present studies suggested that a substantial initial effort is generally required to reduce population growth if fertility control is the sole wildlife management method. However, several empirical and field studies have demonstrated that fertility control, particularly of isolated populations, can be successfully used to limit population growth and reduce human-wildlife conflicts. In parallel, there is growing recognition of the possible synergy between fertility control and disease vaccination to optimise the maintenance of herd immunity in the management of wildlife diseases. The review provides a decision tree that can be used to determine whether fertility control should be employed to resolve specific human-wildlife conflicts. These criteria encompass public consultation, considerations about animal welfare and feasibility, evaluation of population responses, costs and sustainability. © CSIRO 2014.

Mutinda, M., G. Chenge, F. Gakuya, M. Otiende, P. Omondi, S. Kasiki, R. C. Soriguer and S. Alasaad (2014). "**Detusking fence-breaker elephants as an approach in human-elephant conflict mitigation**." PLoS ONE **9**(3): e91749.

BACKGROUND: Human-elephant conflict (HEC) is a recurring problem that appears wherever the range of elephants and humans overlap. Different methods including the use of electric fences are used worldwide to mitigate this conflict. Nonetheless, elephants learn quickly that their tusks do not conduct electricity and use them to break down fences (fence-breakers). METHODOLOGY/PRINCIPAL FINDINGS: In Lewa Wildlife

Conservancy, Kenya, destructive elephants (Loxodonta africana) were monitored between 2010 and 2013. The fence-breaking rate reached four incidents (fence-breaking) per elephant per 100 days. Ten bull males and 57 females were identified as fence-breakers. The bulls were involved in 85.07% and the females in 14.93% of incidents. The Kenya Wildlife Service approved detusking (partial cutting of tusks) in four of the 10 fence-breakers as a way of preventing them from breaking down fences, thereby mitigating HEC in the Conservancy. The result of the detusking was a drastic six-fold reduction in damage to fences (range: 1.67 to 14.5 times less fence-breaking) by the four worst fence-breaker elephants, because with trimmed tusks elephants lack the tools to break down fences. Detusking could not totally eliminate fence destruction because, despite lacking their tools, elephants can still destroy fences using their heads, bodies and trunks, albeit less effectively. On the other hand, apart from inherent aesthetic considerations, the detusking of elephants may have certain negative effects on factors such as elephants' social hierarchies, breeding, mate selection and their access to essential minerals and food. CONCLUSIONS: Elephant detusking seems to be effective in drastically reducing fence-breaking incidents, nonetheless its negative effects on behaviour, access to food and its aesthetical consequences still need to be further studied and investigated.

Songhurst, A. and T. Coulson (2014). "**Exploring the effects of spatial autocorrelation when identifying key drivers of wildlife crop-raiding**." Ecol Evol **4**(5): 582-593.

Few universal trends in spatial patterns of wildlife crop-raiding have been found. Variations in wildlife ecology and movements, and human spatial use have been identified as causes of this apparent unpredictability. However, varying spatial patterns of spatial autocorrelation (SA) in human-wildlife conflict (HWC) data could also contribute. We explicitly explore the effects of SA on wildlife crop-raiding data in order to facilitate the design of future HWC studies. We conducted a comparative survey of raided and nonraided fields to determine key drivers of crop-raiding. Data were subsampled at different spatial scales to select independent raiding data points. The model derived from all data was fitted to subsample data sets. Model parameters from these models were compared to determine the effect of SA. Most methods used to account for SA in data attempt to correct for the change in P-values; yet, by subsampling data at broader spatial scales, we identified changes in regression estimates. We consequently advocate reporting both model parameters across a range of spatial scales to help biological interpretation. Patterns of SA vary spatially in our crop-raiding data. Spatial distribution of fields should therefore be considered when choosing the spatial scale for analyses of HWC studies. Robust key drivers of elephant crop-raiding included raiding history of a field and distance of field to a main elephant pathway. Understanding spatial patterns and determining reliable socio-ecological drivers of wildlife crop-raiding is paramount for designing mitigation and land-use planning strategies to reduce HWC. Spatial patterns of HWC are complex, determined by multiple factors acting at more than one scale; therefore, studies need to be designed with an understanding of the effects of SA. Our methods are accessible to a variety of practitioners to assess the effects of SA, thereby improving the reliability of conservation management actions.

Barua, M., S. A. Bhagwat and S. Jadhav (2013). "**The hidden dimensions of human-wildlife conflict: Health impacts, opportunity and transaction costs**." Biological Conservation **157**: 309-316.

The impact of conservation policies on human wellbeing is critical to the integration of poverty alleviation and biodiversity conservation. In many low-income countries, human-wildlife conflict adversely affects wellbeing of communities that closely interface with wildlife. Approaches to framing and mitigating conflict emphasize its visible costs. Hidden impacts, i.e. costs that are uncompensated, temporally delayed, or psychosocial in nature, remain poorly addressed. This paper examines the hidden impacts of human-wildlife conflict in low-income countries. It presents an account of the known and potential hidden impacts, investigating their effects on rural communities. Hidden impacts of human-wildlife conflict include diminished psychosocial wellbeing, disruption of livelihoods and food insecurity. Considerable opportunity costs are incurred through crop and livestock guarding. When seeking compensation for damage, bureaucratic inadequacies result in added transaction costs. Even though communities may be tolerant of wildlife, the hidden impacts of conflict jeopardize various components of global wellbeing. The paper concludes by identifying gaps in knowledge and outlining areas for future research that better address hidden dimensions of human-wildlife conflict. Crown Copyright (C) 2012

Baskaran, N., G. Kannan, U. Anbarasan, A. Thapa and R. Sukumar (2013). "**A landscape-level assessment of Asian elephant habitat, its population and elephant-human conflict in the Anamalai hill ranges of southern Western Ghats, India**." Mammalian Biology **78**(6): 470-481.

Spatial information at the landscape scale is extremely important for conservation planning, especially in the case of long-ranging vertebrates. The biodiversity-rich Anamalai hill ranges in the Western Ghats of southern India hold a viable population for the long-term conservation of the Asian elephant. Through rapid but extensive field surveys we mapped elephant habitat, corridors, vegetation and land-use patterns, estimated the elephant population density and structure, and assessed elephant-human conflict across this landscape. GIS and remote sensing analyses indicate that elephants are distributed among three blocks over a total area of about 4600km2. Approximately 92% remains contiguous because of four corridors; however, under 4000km2 of this area may be effectively used by elephants. Nine landscape elements were identified, including five natural vegetation types, of which tropical moist deciduous forest is dominant. Population density assessed through the dung count method using line transects covering 275km of walk across the effective elephant habitat of the landscape yielded a mean density of 1.1 (95% CI=0.99-1.2)elephant/km2. Population structure from direct sighting of elephants showed that adult male elephants constitute just 2.9% and adult females 42.3% of the population with the rest being sub-adults (27.4%), juveniles (16%) and calves (11.4%). Sex ratios show an increasing skew toward females from juvenile (1:1.8) to sub-adult (1:2.4) and adult (1:14.7) indicating higher mortality of sub-adult and adult males that is most likely due to historical poaching for ivory. A rapid questionnaire survey and secondary data on elephant-human conflict from forest department records reveals that villages in and around the forest divisions on the eastern side of landscape experience higher levels of elephant-human conflict than those on the western side; this seems to relate to a greater degree of habitat fragmentation and percentage farmers cultivating annual crops in the east. We provide several recommendations that could help maintain population viability and reduce elephant-human conflict of the Anamalai elephant landscape. © 2013 Deutsche Gesellschaft für Säugetierkunde.

Chen, S., Z.-F. Yi, A. Campos-Arceiz, M.-Y. Chen and E. L. Webb (2013). "**Developing a spatially-explicit, sustainable and risk-based insurance scheme to mitigate human-wildlife conflict**." Biological Conservation **168**: 31-39.

Insurance may encourage coexistence between farmers and wildlife by reimbursing farmers' losses. China introduced an insurance scheme to mitigate human-elephant conflict in Xishuangbanna Dai autonomous prefecture in Yunnan Province, where elephants cause damage to rubber plantations. However, recent experience has suggested that the present insurance system exhibits poor performance related to funding shortfalls, undervaluing of plantations and insufficient payouts, and by limiting community involvement. To address these shortcomings we conducted attitude surveys with farmers, and developed an actuarial (risk-based) insurance model for rubber loss that incorporated spatially-explicit risk of depredation and net present value of rubber at damage, in order to calculate fair payouts at village and town levels for the year 2011. Farmers were largely dissatisfied with the current insurance system, and their level of satisfaction was associated with the compensation ratio (percentage of lost rubber reimbursed by insurance). The illustrative results based on 2011 rubber loss data revealed high variability in risk and therefore payouts (and further, premiums) and that fair insurance payouts would be approximately five times the current levels. To improve compensation and support long-term program sustainability, we considered an insurance cost-sharing mechanism that incorporated shared payments from government, rubber farmers, and Chinese tourists. We found that multiple stakeholders were willing to pay for elephant conservation, which could make significant contributions to insurance premiums over the long term. Importantly, this proposed insurance model could be broadly applicable to livestock and long-lived cash crop compensation systems. (C) 2013 Elsevier Ltd. All rights reserved.

Datiko, D. and A. Bekele (2013). "**Conservation challenge: human-herbivore conflict in Chebera Churchura National Park, Ethiopia**." Pak J Biol Sci **16**(23): 1758-1764.

An investigation on human-herbivore conflict was carried out in CCNP between 2011 and 2012 in seven randomly selected villages (Chebera, Serri, Yora, Shita, Delba, Chuchra, Chewda) around the Park. A total of 312 household samples were identified for interview. Group discussion and field observation were also carried out. Among the respondents, the majority (83.9%) faced crop damage. African elephant (Loxodonta africana), Hippopotamus (Hippopotamus amphibious), African buffalo (Syncerus caffer), Desert warthog (Phacochoerus aethiopicus), Wild pig (Sus scrofa), Porcupine (Hystrix cristata), Vervet monkey (Cercopithecus aethiops) and Anubis baboon (Papio anubis) were identified as the most problematic animals in the area. However, buffalo, monkey and warthog were considered as the notorious pest. Crop damage and threats to human safety were the major problems encountered resulting in conflict between human and wildlife. Most respondents had a negative attitude towards the problem-posing animals. This will lead to a change in public attitude from one that supports wildlife conservation to sees wild herbivores as a threat and a potential negative consequence for wildlife conservation. Active measures have to be implemented to solve the problems and safeguard the future of the wildlife management in the park.

Harich, F. K., A. C. Treydte, J. Sauerborn and E. H. Owusu (2013). "**People and wildlife: Conflicts arising around the Bia Conservation Area in Ghana**." Journal for Nature Conservation **21**(5): 342-349.

Human-wildlife conflicts have drastically increased around conservation areas in Africa over the last decades. Underlying causes are similar across regions and can most often be attributed to land-use changes and increasing human populations. However, wildlife species composition involved in conflicts can vary tremendously across sites. Conflict assessment often focuses on prominent species such as elephants or other large mammals, and information on smaller wildlife species involved in conflicts is often lacking. We conducted 100 interviews in 10 communities around the Bia Conservation Area (BCA), Ghana, to address the type and extent of damage as well as possible factors influencing the risk of crop-raids. We assessed wildlife presence and relative densities through indirect observations on transects and spoor-plots in the transition zone between BCA and agricultural land. Crop-raiding was present across all communities interviewed but was more than twice as high in the north compared to the south. Squirrels (Sciuridae spp.) were the most frequent crop-raiding species (92% of farmers experienced damage), but elephants (Loxodonta africana cyclotis [Matschie, 1900]) were nevertheless the major conflict generating species (84% of farmers experienced damage). Squirrel signs were 75 times as frequent as any other species recorded in the farmland. Cocoa (Theobroma cacao) was most frequently raided (99%), followed by cassava (Manihot esculenta) and yam (Dioscorea spp.). Raiding might have been promoted through inappropriate agricultural practices while only few current mitigation strategies have been successful so far. Promising strategies include chili fences and buffer zones, in which less susceptible crops such as chili pepper are planted. Further education of farmers on mitigation measures is needed, including training on improved farming practices.

Hazarika, R. and A. Saikia (2013). "**The pachyderm and the pixel: an assessment of elephant habitat suitability in Sonitpur, India**." International Journal of Remote Sensing **34**(15): 5317-5330.

Remote sensing and geographic information systems (GISs) are increasingly being used in protected area monitoring and habitat suitability studies. In this article, Erdas Imagine's Expert Classifier tool was used to assess the specific trajectories of habitat suitability change during 1994-2007 in the Sonitpur elephant habitat, India. Sonitpur has been witness to increasing human-elephant conflict in the past decade. The suitability analysis took into account information relating to forest type and density, elevation, slope, source of water, human activities in terms of settlement, agriculture, tea plantations, roads, and railways. Satellite imagery, data from topographical maps, digital elevation data, and global positioning system readings formed the major data inputs that were incorporated into a GIS. Various decision rules were created and confidence levels assigned to the input layers to generate high, medium, and low habitat suitability. The area witnessed a sharp decline in suitability from 63% in 1994 to less than 38% by 2007. The high-suitability area declined by more than 50% during this period. The unique natural protected areas of Sonitpur, which are a mix of reserved forests, wildlife sanctuaries, and a national park, urgently need to be protected from further habitat degradation.

Sugumar, S. J. and R. Jayaparvathy (2013). "**An early warning system for elephant intrusion along the forest border areas**." Current Science **104**(11): 1515-1526.

Man-animal conflict has been on the rise in the forest border areas with herds of wild pachyderms straying into human habitation. The surveillance and tracking of elephant herds are difficult due to their size and nature of movement. In this article, we present an analytical procedure to study the behaviour of elephants along forest border areas by taking migration data into consideration using a three-state Markov chain. The migration data over the whole year is divided into four different periods for the study. We also develop an intrusion detection system to detect the intrusion of herds of wild elephants from the forests into the human habitation and to send an early warning through SMS to the forest officials to take necessary action. We validate the analytical results in comparison with the data obtained from the Forest Department. We also present a multi-class classification algorithm for providing zero false alarm rate. Species classification accuracy percentage is found to be 91.25.

Wakoli, E. N., H. Ipara, N. Sitati and P. Odwori (2013). **Spatial and temporal patterns of elephant mortality in Narok County, Kenya**. 34th Asian Conference on Remote Sensing 2013, ACRS 2013, Bali, Asian Association on Remote Sensing.

This study aimed at determining the spatial temporal patterns of elephant mortality in Narok County using data from Kenya Wildlife Service (KWS) and World Wide Fund for Nature- Human-elephant Conflict (WWF-HEC) project compiled over the last 11 years. Field monitoring for one year was also carried out and any dead elephant was identified and details recorded to determine causes of mortality and distribution. Data were entered in an Excel spreadsheet and then converted into dBASE IV format and imported to ArcGIS to create a point shape file of elephant mortality and associated attribute data. Graphs and map were generated linking mortality with other aspects. Data obtained using qualitative research method was analysed using the Statistical Package for Social Sciences (SPSS). Frequencies obtained were calculated, and where appropriate, a chi-square test was used. A 0.05 level of significance was used to determine existing relationships between data categories. Results showed that most elephant mortality occurred outside the protected area (MMNR) and were due to trophy poaching (61.5%, n=13) which occurred during long rainy seasons and in dense bush lands. There was a significant difference in mortality cases during the short rain season ($\chi 2=4.500$, df=1, p=0.034). Kernel density analysis depicted Olesentu and Sitoka in TM as hotspot area for elephant mortality due to trophy poaching. Elephant mortality due to conflicts occurred mostly on agricultural land with 10 (50%) cases. From the results, it was evident that elephant the distribution and pattern of elephant mortality is determined by several factors among them, Rainfall, vegetation cover, proximity to water source, roads and human settlement.

Zeppelzauer, M., A. S. Stöger and C. Breiteneder (2013). **Acoustic detection of elephant presence in noisy environments**. 2nd ACM International Workshop on Multimedia Analysis for Ecological Data, MAED 2013, Barcelona, Association for Computing Machinery.

The automated acoustic detection of elephants is an important factor in alleviating the human-elephant conflict in Asia and Africa. In this paper, we present a method for the automated detection of elephant presence and evaluate it on a large dataset of wildlife recordings. We introduce a novel technique for signal enhancement to improve the robustness of the detector in noisy situations. Experiments show that the proposed detector outperforms existing methods and that signal enhancement strongly improves the robustness to noise sources from the environment. The proposed method is a first step towards an automated detection system for elephant presence.

Fernando, P., P. Leimgruber, T. Prasad and J. Pastorini (2012). "**Problem-Elephant Translocation: Translocating the Problem and the Elephant?**" PLoS ONE **7**(12).

Human-elephant conflict (HEC) threatens the survival of endangered Asian elephants (Elephas maximus). Translocating "problem-elephants" is an important HEC mitigation and elephant conservation strategy across elephant range, with hundreds translocated annually. In the first comprehensive assessment of elephant translocation, we monitored 16 translocations in Sri Lanka with GPS collars. All translocated elephants were

released into national parks. Two were killed within the parks where they were released, while all the others left those parks. Translocated elephants showed variable responses: "homers" returned to the capture site, "wanderers" ranged widely, and "settlers" established home ranges in new areas soon after release. Translocation caused wider propagation and intensification of HEC, and increased elephant mortality. We conclude that translocation defeats both HEC mitigation and elephant conservation goals.

Graham, M. D., W. M. Adams and G. N. Kahiro (2012). "**Mobile phone communication in effective human elephant-conflict management in Laikipia County, Kenya**." Oryx **46**(1): 137-144.

Human-elephant conflict is a significant problem in Africa, undermining biodiversity conservation and development efforts. Early warning of crop raiding and a coordinated response from landholders and wildlife authorities are important for effective management of this conflict. Mobile phones have spread rapidly in rural Africa and could potentially be used to improve communication and increase the effectiveness of responses to crop raids by elephants. We analyse changes in patterns of communication around human-elephant conflict incidents before and after the arrival of mobile phone technology in Laikipia County in north-central Kenya, and the performance of mobile phone communication in a trial at three sites. We show that mobile phones can improve communication and reduce human-elephant conflict where there is good mobile coverage and widespread adoption. Conservation projects have much to gain from engaging with mobile phone technology. © 2012 Fauna & Flora Internationa.

Guo, X. M., Q. He, L. X. Wang, Z. B. Yang, Z. Y. Li and Z. Y. Zhu (2012). "**Effects of Asian elephant food source base on the mitigation of human-elephant conflict in Xishuangbanna of Yunnan Province, Southwest China**." Chinese Journal of Ecology **31**(12): 3133-3137.

Establishing food source base for Asian elephants is to attract them returning to the depths of nature reserve, and to reduce the human-elephant conflict (HEC). In 2005-2010, a statistical analysis was made on the monitoring data about the activities of Asian elephants in the Mengyang sub-reserve food source base of Xishuangbanna to analyze the activity rhythms of the elephants in the base, and, in combining the cause troubles of the Asian elephants in the surrounding villages of the base, the influences of the food source base on the Asian elephants and surrounding villages were studied, aimed to approach the mitigation effect of the food source base on human-elephant conflict. The food source base supplied large amount of foods to attract Asian elephants, playing definite roles in mitigating the HEC. The monthly and diurnal activity rhythms of the Asian elephants in the base were almost synchronous with the sowing and maturing periods of local crops and the time sequence of the farmers' routine work. During the period of food shortage, the elephants mainly fed on king grass, a kind of introduced alien plants, or raided into villages to feed crops. The nearer the distance between the food source base and the villages, the more Asian elephant-related cause troubles happened. Therefore, great attentions should be paid to the location layout and the appropriate plant species combination in the establishment of food source base for Asian elephants.

Hoare, R. (2012). "**Lessons from 15 years of human elephant conflict mitigation: Management considerations involving biological, physical and governance issues in Africa**." Pachyderm **51**(1): 60-74.

The systematic study of human-elephant conflict (HEC) and its mitigation began in the mid-1990s. The IUCN African Elephant Specialist Group and its Human-Elephant Conflict Working Group took the lead in research required and the subsequent dissemination of tools to manage the problem. Over 15 years we have now seen widespread application of HEC mitigation methods by wildlife practitioners and affected communities all over the African elephant range. This paper re-evaluates and refines some established mitigation methods and introduces innovations that have appeared recently. The evolution of the arsenal of HEC mitigation methods suggests that currently relevant developments fall into three categories: biological, physical and governance. These broadly reflect new knowledge about problem animals themselves, better application of fencing and olfactory deterrents, and evaluation of options for damage compensation and land-use policy. We now have a much-improved understanding of the behaviour of 'problem' elephants which points to the futility of killing them. Credible evaluation of the use of fencing models and designs is now possible. The package of low-tech and

sustainable defences based around the olfactory deterrent of chilli is well established and producing good results in smallholder agricultural situations. The deterrent potential of bees is assessed. Recommendations for the critical area of HEC mitigation through new official policy and governance initiatives are mostly in the proposal or experimental stage; this relates to political rights and land use and is the most urgent and crucial part of containing the problem across the continent. It is being marketed to elephant range States under an umbrella term - the Vertical Integration Model. Effective HEC mitigation is difficult to understand and problematic to implement; it remains a complex package of apparently disparate measures that have to be used in combination and flexibly, at different scales. Future HEC mitigation will be as much an art as a science, but since we now have a solid research foundation, we can proceed with some confidence to address the inherent socio-political difficulties.

Jadhav, S. and M. Barua (2012). "**The Elephant Vanishes: impact of human-elephant conflict on people's wellbeing**." Health Place **18**(6): 1356-1365.

Human-wildlife conflicts impact upon the wellbeing of marginalised people, worldwide. Although tangible losses from such conflicts are well documented, hidden health consequences remain under-researched. Based on preliminary clinical ethnographic inquiries and sustained fieldwork in Assam, India, this paper documents mental health antecedents and consequences including severe untreated psychiatric morbidity and substance abuse. The case studies presented make visible the hidden mental health dimensions of human-elephant conflict. The paper illustrates how health impacts of conflicts penetrate far deeper than immediate physical threat from elephants, worsens pre-existing mental illness of marginalised people, and leads to newer psychiatric and social pathologies. These conflicts are enacted and perpetuated in institutional spaces of inequality. The authors argue that both wildlife conservation and community mental health disciplines would be enhanced by coordinated intervention. The paper concludes by generating questions that are fundamental for a new interdisciplinary paradigm that bridges ecology and the clinic.

Srinivasaiah, N. M., V. D. Anand, S. Vaidyanathan and A. Sinha (2012). "**Usual populations, unusual individuals: Insights into the behavior and management of Asian elephants in fragmented landscapes**." PLoS ONE **7**(8).

Background: A dearth in understanding the behavior of Asian elephants (Elephas maximus) at the scale of populations and individuals has left important management issues, particularly related to human-elephant conflict (HEC), unresolved. Evaluation of differences in behavior and decision-making among individual elephants across groups in response to changing local ecological settings is essential to fill this gap in knowledge and to improve our approaches towards the management and conservation of elephants.
Methodology/Principal Findings: We hypothesized certain behavioral decisions that would be made by Asian elephants as reflected in their residence time and movement rates, time-activity budgets, social interactions and group dynamics in response to resource availability and human disturbance in their habitat. This study is based on 200 h of behavioral observations on 60 individually identified elephants and a 184-km2 grid-based survey of their natural and anthropogenic habitats within and outside the Bannerghatta National Park, southern India during the dry season. At a general population level, the behavioral decisions appeared to be guided by the gender, age and group-type of the elephants. At the individual level, the observed variation could be explained only by the idiosyncratic behaviors of individuals and that of their associating conspecific individuals. Recursive partitioning classification trees for residence time of individual elephants indicated that the primary decisions were taken by individuals, independently of their above-mentioned biological and ecological attributes.
Conclusions/Significance: Decision-making by Asian elephants thus appears to be determined at two levels, that of the population and, more importantly, the individual. Models based on decision-making by individual elephants have the potential to predict conflict in fragmented landscapes that, in turn, could aid in mitigating HEC. Thus, we must target individuals, in addition to populations, in our efforts to manage and conserve this threatened species, particularly in human-dominated landscapes.

Ahlering, M. A., J. J. Millspaugh, R. J. Woods, D. Western and L. S. Eggert (2011). "**Elevated levels of stress hormones in crop-raiding male elephants**." Animal Conservation **14**(2): 124-130.

Crop raiding is one of the most common forms of human-elephant conflict. Deterring elephants from raiding crops requires an understanding of the factors influencing the behavior of the individuals involved. We collected fecal samples from five group ranches in southern Kenya where crop-raiding incidents had occurred (n=10) and two protected areas, Amboseli National Park (n=24) and Maasai Mara National Reserve (n=20). We used molecular sexing to sex the individuals and radioimmunoassay kits to determine the level of glucocorticoid metabolites (i.e. stress hormones) in their dung. All crop-raiding individuals were male and had a significantly elevated concentration of glucocorticoid metabolites as compared with the Amboseli elephants (W=12, P=0.0005). We detected no significant difference between Maasai Mara elephants and either Amboseli or the crop-raiding elephants when just males were compared. Our results suggest that crop raiding may be related to stress in elephants. © 2010 The Authors. Animal Conservation © 2010 The Zoological Society of London.

Areendran, G., K. Raj, S. Mazumdar, M. Munsi, H. Govil and P. K. Sen (2011). "**Geospatial modeling to assess elephant habitat suitability and corridors in northern Chhattisgarh, India**." Tropical Ecology **52**(3): 275-283.

We used remote sensing data and geospatial modeling techniques to assess the elephant habitat suitability and dispersal corridor in northern parts of Chhattisgarh, Central India. This region is frequently visited by elephants from the neighboring states of Orissa and Jharkhand in search of better habitat and often enter human habitations and agricultural fields resulting in conflicts with humans. Satellite images and ground information were used for land use/ land cover mapping and identification of conflict zones. Analytic Hierarchy Process (AHP) was used to assign weights to the three factors, viz., type of vegetation cover, proximity to water body and proximity to human habitation. Based on the analysis a corridor for elephant movement and migration has been identified which could be notified and managed by the state government in order to minimize human - elephant conflicts in the region. © International Society for Tropical Ecology.

Bal, P., C. D. Nath, K. M. Nanaya, C. G. Kushalappa and C. Garcia (2011). "**Erratum to: Elephants also like coffee: Trends and drivers of human-elephant conflicts in coffee agroforestry landscapes of Kodagu, Western Ghats, India**." Environ Manage **48**(2): 263-275.

Kodagu district produces 2% of the world's coffee, in complex, multistoried agroforestry systems. The forests of the district harbour a large population of the Asian elephant (Elephas maximus). The combined effects of high elephant density and major landscape changes due to the expansion of coffee cultivation are the cause of human-elephant conflicts (HEC). Mitigation strategies, including electric fences and compensation schemes implemented by the Forest Department have met with limited success. Building on previous studies in the area, we assessed current spatial and temporal trends of conflict, analysed local stakeholders' perceptions and identified factors driving elephants into the estates. Our study, initiated in May 2007, shows that the intensity of HEC has increased over the last 10 years, exhibiting new seasonal patterns. Conflict maps and the lack of correlation between physical features of the coffee plantations and elephant visits suggest elephants move along corridors between the eastern and western forests of the district, opportunistically foraging when crossing the plantations. Dung analyses indicate elephants have selectively included ripe coffee berries in their diet. This is, to our knowledge, the first report of wild elephants feeding on coffee berries. If this new behaviour spreads through the population, it will compound an already severe conflict situation. The behavioural plasticity, the multiplicity of stakeholders involved, the difficulty in defining the problem and the limits of technical solutions already proposed suggest that HEC in Kodagu has the ingredients of a "wicked" problem whose resolution will require more shared understanding and problem solving work amongst the stakeholders.

Bal, P., C. D. Nath, K. M. Nanaya, C. G. Kushalappa and C. Garcia (2011). "**Elephants also like coffee: Trends and drivers of human-elephant conflicts in coffee agroforestry landscapes of Kodagu, Western Ghats, India**." Environmental Management **47**(5): 789-801.

Kodagu district produces 2% of the world's coffee, in complex, multistoried agroforestry systems. The forests of the district harbour a large population of the Asian elephant (Elephas maximus). The combined effects of high elephant density and major landscape changes due to the expansion of coffee cultivation are the cause of human-elephant conflicts (HEC). Mitigation strategies, including electric fences and compensation schemes

implemented by the Forest Department have met with limited success. Building on previous studies in the area, we assessed current spatial and temporal trends of conflict, analysed local stakeholders' perceptions and identified factors driving elephants into the estates. Our study, initiated in May 2007, shows that the intensity of HEC has increased over the last 10 years, exhibiting new seasonal patterns. Conflict maps and the lack of correlation between physical features of the coffee plantations and elephant visits suggest elephants move along corridors between the eastern and western forests of the district, opportunistically foraging when crossing the plantations. Dung analyses indicate elephants have selectively included ripe coffee berries in their diet. This is, to our knowledge, the first report of wild elephants feeding on coffee berries. If this new behaviour spreads through the population, it will compound an already severe conflict situation. The behavioural plasticity, the multiplicity of stakeholders involved, the difficulty in defining the problem and the limits of technical solutions already proposed suggest that HEC in Kodagu has the ingredients of a "wicked" problem whose resolution will require more shared understanding and problem solving work amongst the stakeholders. © 2011 Springer Science+Business Media, LLC.

Beyers, R. L., J. A. Hart, A. R. Sinclair, F. Grossmann, B. Klinkenberg and S. Dino (2011). "**Resource wars and conflict ivory: the impact of civil conflict on elephants in the Democratic Republic of Congo--the case of the Okapi Reserve**." PLoS ONE **6**(11): e27129.

Human conflict generally has substantial negative impacts on wildlife and conservation. The recent civil war (1995-2006) in the Democratic Republic of Congo (DRC) resulted in a significant loss of wildlife, including elephants, due to institutional collapse, lawlessness and unbridled exploitation of natural resources such as minerals, wood, ivory and bushmeat. We used data from distance sampling surveys conducted before and after the war in a protected forest, the Okapi Faunal Reserve, to document changes in elephant abundance and distribution. We employed Generalized Additive Models to relate changes in elephant distribution to human and environmental factors. Populations declined by nearly fifty percent coinciding with a major increase in elephant poaching as indicated by reports of ivory trade during the war. Our results suggest that humans influenced elephant distribution far more than habitat, both before and after the war, but post-war models explained more of the variation. Elephant abundance declined more, closer to the park boundary and to areas of intense human activity. After the war, elephant densities were relatively higher in the centre of the park where they were better protected, suggesting that this area may have acted as a refuge. In other sites in Eastern DRC, where no protection was provided, elephants were even more decimated. Post-war dynamics, such as weakened institutions, human movements and availability of weapons, continue to affect elephants. Survival of remaining populations and recovery will be determined by these persistent factors and by new threats associated with growing human populations and exploitation of natural resources. Prioritizing wildlife protection, curbing illegal trade in ivory and bushmeat, and strengthening national institutions and organizations in charge of conservation will be crucial to counter these threats.

Chartier, L., A. Zimmermann and R. J. Ladle (2011). "**Habitat loss and human-elephant conflict in Assam, India: Does a critical threshold exist?**" Oryx **45**(4): 528-533.

Human-elephant conflict in India, driven by habitat loss and an expanding human population, is a complex challenge for biodiversity conservation. Determining if, how and why this conflict has changed over time will be an important step towards managing landscapes where people and elephants Elephas maximus coexist. This study combines social surveys and remote sensing data to analyse patterns in human-elephant conflict and land-use change over time. The reported experience of conflict increased dramatically in the early 1980s, with 85% of those surveyed indicating that conflict began after 1980. The expansion of conflict showed a significant southward trend and was associated with forest cover dropping below 30-40%. Based on our results we propose that a critical habitat threshold for human-elephant conflict may exist at 30-40% forest cover. Below this level, conflict expanded across the landscape. The existence of such a deforestation threshold may have important implications for landscape management in elephant range states that seek to avoid or mitigate further conflict. Maintenance of remaining forest areas, reforestation, and the creation of habitat corridors are strategies that could help prevent further expansion of conflict. © 2011 Fauna & Flora International.

Chiyo, P. I., C. J. Moss, E. A. Archie, J. A. Hollister-Smith and S. C. Alberts (2011). "**Using molecular and observational techniques to estimate the number and raiding patterns of crop-raiding elephants**." Journal of Applied Ecology **48**(3): 788-796.

1. Conflict between humans and animals, generated by behaviours like crop raiding, can represent a major threat to the survival and conservation of protected species. Crop raiding is an example where the conflict is assumed to be attributable to a small number of habitually raiding animals. No studies have systematically tested this assumption on African elephants Loxodonta africana. 2. In the greater Amboseli basin, in southern Kenya, we determined the number of elephants that come into conflict with humans through crop raiding, their gender, and their patterns of raiding. We tracked footprints, and observed elephants after they raided farms, and genotyped DNA extracted from faeces collected from raided farms. Using these data, we estimated the number of raiders with asymptotic regression and count models. 3. We found that 241 elephants from several elephant populations in the Amboseli basin raided farms. Raiders were independent males; we detected no females raiding crops. Approximately 35% of the raiders were from the Amboseli elephant population, representing about 1/3 of the independent males in that population. Approximately 12% of raiders from the Amboseli elephant population were habitual and were responsible for 56% of elephant raiding events. 4. Synthesis and applications. Our results suggest that targeted elimination of habitual raiders could in theory reduce crop raiding. However, the large pool of occasional raiders, the availability of palatable crops in areas of conflict, and the link between crop-raiding and natural male foraging tactics, indicates great potential for recruitment of habitual raiders from this pool of occasional raiders. Furthermore, shooting of raiders as a strategy for reducing crop raiding carries a high risk of misidentifying habitual raiders. We suggest instead an ethical management strategy that uses remote monitoring of raiders as an early warning system for crop protection, and longitudinal studies to evaluate the development of habitual raiding. © 2011 The Authors. Journal of Applied Ecology © 2011 British Ecological Society.

Chiyo, P. I., P. C. Lee, C. J. Moss, E. A. Archie, J. A. Hollister-Smith and S. C. Alberts (2011). "**No risk, no gain: Effects of crop raiding and genetic diversity on body size in male elephants**." Behavioral Ecology **22**(3): 552-558.

Body size is an important influence on the life history of males of polygynous mammals because it is usually highly correlated with fitness and is under intense selection. In this paper, we investigated the effect of high-risk foraging behavior (crop raiding) and genetic heterozygosity on male body size in a well-studied population of African elephants. Crop raiding, the foraging on cultivated food crops by wildlife is one of the main causes of wildlife human conflict and is a major conservation issue for many polygynous mammals that live in proximity to agriculture or human habitation. Body size was estimated using hind foot size, a measure strongly correlated with stature and mass. Crop raiding predicted male size in adulthood, with raiders being larger than nonraiders. However, elephants that became raiders were neither larger nor smaller for age when young. Enhanced growth rates and size among raiders suggest that taking risks pays off for males. Lastly, genetic heterozygosity had no effect on size for age in male elephants, most likely because low-heterozygosity males were rare. Risky foraging behavior can evolve as a result of strong sexual selection for large size and condition-dependent mating success in males. We discuss the implications of these results for managing human-wildlife conflict. © The Author 2011.

Das, S. K. and S. Chattopadhyay (2011). "**Human fatalities from wild elephant attacks - A study of fourteen cases**." Journal of Forensic and Legal Medicine **18**(4): 154-157.

Human-wild elephant conflicts are frequently reported from various parts of the country. Encroaching of animal habitat by human civilization is a primary reason for this. The present study comprises of fourteen autopsy cases conducted at the department of Forensic Medicine, B.S Medical College, Bankura, West Bengal, India over a period of three years. The study attempts to find out the nature of injuries caused by wild elephant attack and the common factors contributing to human-wild elephant conflict so that vulnerable population can be cautioned to avoid conflicts. A distinct seasonal as well as diurnal variation of attack incidences was noted. Attacks were sudden and unprovoked. Killer elephants were wild tuskers in all the cases. Victims were from the low socioeconomic group and the cause of death was due to trampling on the vital organs like chest and head.

Davies, T. E., S. Wilson, N. Hazarika, J. Chakrabarty, D. Das, D. J. Hodgson and A. Zimmermann (2011). "**Effectiveness of intervention methods against crop-raiding elephants**." Conservation Letters **4**(5): 346-354.

The raiding of crops by elephants is one of the major components of human-elephant conflict, causing loss of livelihood and retaliation against elephants. To mitigate this conflict, various intervention methods are in use by farmers across Africa and Asia; yet there have been few rigorous assessments of their effectiveness. We provide an assessment of the efficacy of interventions in use by communities in Assam from a 3-year survey dataset using Generalized Linear Mixed Modeling. We found spotlights, chili fences, and electric fences to be highly effective at preventing crop damage by elephants when used in isolation, but when used in combination with noise their efficacy was compromised. Our study highlights the importance of evaluating intervention methods to determine their effectiveness. We propose the use of fences and spotlights be promoted in Assam, in conjunction with long-term habitat protection and restoration strategies. ©2011 Wiley Periodicals, Inc.

Hartter, J., A. Goldman and J. Southworth (2011). "**Responses by households to resource scarcity and human-wildlife conflict: Issues of fortress conservation and the surrounding agricultural landscape**." Journal for Nature Conservation **19**(2): 79-86.

Although protected areas have become the primary mechanism for biodiversity conservation, their establishment can have long-term impacts on land use, land cover, and livelihoods of people living near them. Where land use and resource extraction is severely limited, local people turn to resource pools outside parks. Kibale National Park in western Uganda is a remnant of a previously larger, mid-altitude forest region surrounded by dense agricultural settlement. We combine remote sensing techniques and household surveys to examine landscape change and fragmentation and the implications for securing rural livelihoods. Forests and wetlands outside the park provide important resources such as fuelwood, building poles, and water, but they are also problematic for local farmers since crop raids by primates and elephants emanate from these fragments. Our analysis shows that since 1984 forests and wetlands have decreased in size and number and those that remain have become increasingly isolated within the agricultural mosaic. Farmers have adapted to resource shortages and human-wildlife conflict in different ways. Our results suggest that wealth, ethnicity, and distance from the park are important factors in determining responses to these issues. © 2010 Elsevier GmbH.

He, Q., Z. Wu, W. Zhou and R. Dong (2011). "**Perception and attitudes of local communities towards wild elephant-related problems and conservation in Xishuangbanna, Southwestern China**." Chinese Geographical Science **21**(5): 629-636.

The problem of wild elephants, or human-elephant conflict (HEC), influences the daily life of local communities and hinders the conservation of wild elephants. The perception and attitudes of local communities who inhabited the frontiers between human activities and wild elephant movement are important to the mitigation of the HEC and conservation of wild elephants. To analyze the perception and attitudes of local communities, the Participatory Rural Appraisal (PRA) was used in the investigation of 423 interviewees from 22 villages in Xishuangbanna from July 2009 to February 2010. The results indicated that local communities had their views on the elephant-related problems. In field survey, we found that 66.5% of interviewees were willing to support, participate in, and assist in the conservation of wild elephants; 33.5% of interviewees were opposed or indifferent to such conservation, because their livelihoods and even their lives were endangered by wild elephants. These views and attitudes were influenced by local communities' perception of HEC, education level, gender and self-interest. Therefore, it is necessary to analyze the diverse views among local communities and balance profits and costs in addressing HEC. © 2011 Science Press, Northeast Institute of Geography and Agroecology, CAS and Springer-Verlag Berlin Heidelberg.

Ishida, Y., T. K. Oleksyk, N. J. Georgiadis, V. A. David, K. Zhao, R. M. Stephens, S. O. Kolokotronis and A. L. Roca (2011). "**Reconciling apparent conflicts between mitochondrial and nuclear phylogenies in african elephants**." PLoS ONE **6**(6).

Conservation strategies for African elephants would be advanced by resolution of conflicting claims that they

comprise one, two, three or four taxonomic groups, and by development of genetic markers that establish more incisively the provenance of confiscated ivory. We addressed these related issues by genotyping 555 elephants from across Africa with microsatellite markers, developing a method to identify those loci most effective at geographic assignment of elephants (or their ivory), and conducting novel analyses of continent-wide datasets of mitochondrial DNA. Results showed that nuclear genetic diversity was partitioned into two clusters, corresponding to African forest elephants (99.5% Cluster-1) and African savanna elephants (99.4% Cluster-2). Hybrid individuals were rare. In a comparison of basal forest "F" and savanna "S" mtDNA clade distributions to nuclear DNA partitions, forest elephant nuclear genotypes occurred only in populations in which S clade mtDNA was absent, suggesting that nuclear partitioning corresponds to the presence or absence of S clade mtDNA. We reanalyzed African elephant mtDNA sequences from 81 locales spanning the continent and discovered that S clade mtDNA was completely absent among elephants at all 30 sampled tropical forest locales. The distribution of savanna nuclear DNA and S clade mtDNA corresponded closely to range boundaries traditionally ascribed to the savanna elephant species based on habitat and morphology. Further, a reanalysis of nuclear genetic assignment results suggested that West African elephants do not comprise a distinct third species. Finally, we show that some DNA markers will be more useful than others for determining the geographic origins of illegal ivory. These findings resolve the apparent incongruence between mtDNA and nuclear genetic patterns that has confounded the taxonomy of African elephants, affirm the limitations of using mtDNA patterns to infer elephant systematics or population structure, and strongly support the existence of two elephant species in Africa.

King, L. E., I. Douglas-Hamilton and F. Vollrath (2011). "**Beehive fences as effective deterrents for crop-raiding elephants: Field trials in northern Kenya**." African Journal of Ecology **49**(4): 431-439.

Increasing elephant populations in Kenya since 1989 have been widely praised as a conservation success story. However, where elephants and agricultural land overlap, incidents of human-elephant conflict are on the increase. Wildlife managers and farmers are now trying different farm-based deterrents to keep elephants out of crops. Here, we present data on the effectiveness of a novel beehive fence deployed in a Turkana community of 62 communally run farms in Kenya. Specifically, 1700m of beehive fences semi-surrounded the outer boundaries of seventeen farms, and we compared elephant farm invasion events with these and to seventeen neighbouring farms whose boundaries were 'protected' only by thorn bush barriers. We present data from 45 farm invasions, or attempted invasions, recorded over 2years. Thirteen groups of elephants approached the beehive fences and turned away. Of the 32 successful farm invasions, only one bull elephant broke through the beehive fences. These results demonstrate that beehive fences are more effective than thorn bush barriers at deterring elephants and may have a role to play in alleviating farmer-elephant conflict. Additionally, the harvesting of 106kg of honey during the trial period suggests that beehive fences may also improve crop production and enhance rural livelihoods through honey sales. © 2011 Blackwell Publishing Ltd.

Barua, M. (2010). "**Whose issue? representations of human-elephant conflict in indian and international media**." Science Communication **32**(1): 55-75.

The media play a key role in communicating conservation issues such as human-wildlife conflict, but corresponding literature on how issues are represented is limited. This article traces the depiction of human-elephant conflict in the media by examining (a) how conflicts are framed and (b) how ultimate and proximate causes are communicated in Indian and international newspapers. Issues were often polarized or framed in dramatic terms, and consonance in reporting causes was lacking. Active engagement with the media is needed to produce a nuanced debate on conflict, for which recognizing the role of different actors and working closely with individual journalists are vital. © 2010 SAGE Publications.

Barua, M., J. Tamuly and R. A. Ahmed (2010). "**Mutiny or clear sailing? Examining the role of the asian elephant as a flagship species**." Human Dimensions of Wildlife **15**(2): 145-160.

Flagship species are used to leverage public support for conservation. The success of a flagship is potentially determined by its popularity and ability to foster conservation intentions among a target audience. When flagships come into conflict with people, however, it is likely that conservation intentions get negatively

affected. By examining peoples' exposures to the Asian elephant-a global conservation flagship-this study sought to (a) identify exposures that enable conservation intentions and (b) test whether human-elephant conflict undermines them. Survey results showed that exposure to wild elephants negatively affected intentions to conserve elephants, while specific concern for the elephant and direct involvement in conservation activities led to positive intentions. These results suggest that the effective use of the Asian elephant as a flagship may be contingent on mitigating human-elephant conflict, for which engagement with concerned local actors and initiation of participatory conservation frameworks need to be considered. © Taylor & Francis Group, LLC.

Chelliah, K., G. Kannan, S. Kundu, N. Abilash, A. Madhusudan, N. Baskaran and R. Sukumar (2010). "**Testing the efficacy of a chilli-tobacco rope fence as a deterrent against crop-raiding elephants**." Current Science **99**(9): 1239-1243.

Chilli-based repellents have shown promise as deterrents against crop-raiding elephants in Africa. We experimented with ropes coated with chilli-based repellent as a cheap alternative to existing elephant cropraid deterrent methods in India. Three locations (Buxa Tiger Reserve, Wyanad Wildlife Sanctuary and Hosur Forest Division) representing varying rainfall regimes from high to low, and with histories of intense elephant-agriculture conflict, were selected for the experiments that were conducted over 2-3 months during the preharvest period of the kharif season in late 2006. Chilli and tobacco powder mixed with waste oil was applied to ropes strung around agricultural fields of 1.4-5.5 km perimeter and elephant approaches were monitored. Elephants breached the rope fences a few times at all three study sites. Female-led herds were far more deterred (practically 100% reduction) than were solitary males (c. 50%) by the chilli-tobacco rope. Efficacy of this method as a deterrent was significantly better in the low-rainfall regime relative to medium and high-rainfall regimes. The initial promising results present a case for more rigorous experimentation; these would help determine if the elephants avoiding the rope are responding physiologically to the chilli-tobacco smell or merely reacting cautiously to a novel substance in their environment.

Dunham, K. M., A. Ghiurghi, R. Cumbi and F. Urbano (2010). "**Human-wildlife conflict in Mozambique: A national perspective, with emphasis on wildlife attacks on humans**." Oryx **44**(2): 185-193.

Human-wildlife conflicts are common across Africa. In Mozambique, official records show that wildlife killed 265 people during 27 months (July 2006 to September 2008). Crocodile Crocodylus niloticus, lion Panthera leo, elephant Loxodonta africana and hippopotamus Hippopotamus amphibius caused most deaths but crocodiles were responsible for 66%. Crocodile attacks occurred across Mozambique but 53% of deaths occurred in districts bordering Lake Cabora Bassa and the Zambezi River. Hippopotamus attacks were also concentrated here. Lion attacks occurred mainly in northern Mozambique and, while people were attacked by elephants across the country, 67% of deaths occurred in northern Mozambique. Attacks by lions, elephants or hippopotamuses were relatively rare but additional data will probably show that attacks by these species are more widespread than the preliminary records suggest. Buffalo Syncerus caffer, hyaena Crocuta crocuta and leopard Panthera pardus were minor conflict species. Good land-use planning, a long-term solution to many conflicts, is particularly relevant in Mozambique, where the crocodile and hippopotamus populations of protected areas are often in rivers that border these areas, and cause conflicts outside them, and where people commonly live within protected areas. Poverty may prompt fishermen to risk crocodile attack by entering rivers or lakes. The high incidence of conflicts near Limpopo and South Africas Kruger National Parks (both within the Great Limpopo Transfrontier Conservation Area) highlights the problems created for people by facilitating the unrestricted movement of wildlife between protected areas across their land. Copyright © 2010 Fauna & Flora International.

Graham, M. D., B. Notter, W. M. Adams, P. C. Lee and T. N. Ochieng (2010). "**Patterns of crop-raiding by elephants, Loxodonta africana, in Laikipia, Kenya, and the management of human-elephant conflict**." Systematics and Biodiversity **8**(4): 435-445.

Recorded incidence of conflict between humans and elephants, in particular crop-raiding, is increasing in rural Africa and Asia, undermining efforts to conserve biological diversity. Gaining an understanding of the underlying determinants of human-elephant conflict is important for the development of appropriate management tools.

This study analysed crop-raiding by African elephants (Loxodonta africana) in Laikipia District, covering 9700 km2 in north-central Kenya to identify spatial determinants of crop-raiding by elephants at different spatial extents. On average crop-raiding incidents occurred within 1.54 km of areas of natural habitat where elephants could hide by day undisturbed by human activities ('daytime elephant refuges'). The occurrence of crop-raiding was predicted by settlement density, distance from daytime elephant refuges and percentage of cultivation. However the relationship between crop-raiding and six candidate variables varied with sampling extent, with some variables diminishing in importance at a finer spatial scale. This suggests a tiered approach to human-elephant conflict management, with different interventions to address factors important at different spatial scales. Our results show that small-scale farms are particularly vulnerable to crop-raiding at settlement densities below approximately 20 dwellings per km2, above which crop-raiding declines. Land-use planning is therefore critical in preventing settlement patterns that leave farms vulnerable to crop-raiding by elephants. Where human-elephant conflict exists, efforts should focus on identifying and managing elephant refuges, through the use of electrified fences where resources are sufficient to construct, maintain and enforce them. This approach has been adopted for mitigating human-elephant conflict in Laikipia and with a major investment in resources and human capital it has been successful. Where such resources and human capital are not available then efforts should instead focus on the application of farm-based deterrents among vulnerable farms.

Hedges, S. and D. Gunaryadi (2010). "**Reducing human-elephant conflict: Do chillies help deter elephants from entering crop fields?**" Oryx **44**(1): 139-146.

Crop raiding by elephants is the most prevalent form of human-elephant conflict and can result in devastating economic losses for farmers, loss of human lives and the killing or capture of elephants. Chilli (capsaicin)-based elephant deterrents have been promoted as tools for reducing such conflict but have been little tested. From October 2005 to April 2006 we tested crop-guarding systems around Way Kambas National Park in Indonesia. We evaluated the effectiveness of community-based guarding using traditional tools (e.g. noise-makers) at one site and community-based guarding plus chilli-grease- covered fences and tripwire-triggered sirens at another site. We monitored human-elephant conflict rates around the Park to assess the effectiveness of our mitigation trials. Over the trial period there were 34 attempts by elephants to enter crop fields at the chilli and sirens site and 57 attempts to enter fields at the conventional site but 91.2% of attempts were repelled successfully at both sites. Over the same period there were 401 crop-raiding incidents elsewhere around the Park. In 2007 farmers at both our former sites voluntarily adopted the methods that had been used at the conventional site, but not at the chilli and sirens site, and were able to repel 156 of 178 (87.6%) attempted elephant raids. We conclude that community-based guarding using conventional tools is the key to keeping elephants out of crops and that chilli-grease fences (and sirens) do not add any significant deterrent effect but do add expense and create additional work. However, other chilli-based deterrents may be effective and chillies have value as elephant-resistant cash crops.

Hock, K., K. L. Ng and N. H. Fefferman (2010). "**Systems approach to studying animal sociality: Individual position versus group organization in dynamic social network models**." PLoS ONE **5**(12).

Social networks can be used to represent group structure as a network of interacting components, and also to quantify both the position of each individual and the global properties of a group. In a series of simulation experiments based on dynamic social networks, we test the prediction that social behaviors that help individuals reach prominence within their social group may conflict with their potential to benefit from their social environment. In addition to cases where individuals were able to benefit from improving both their personal relative importance and group organization, using only simple rules of social affiliation we were able to obtain results in which individuals would face a trade-off between these factors. While selection would favor (or work against) social behaviors that concordantly increase (or decrease, respectively) fitness at both individual and group level, when these factors conflict with each other the eventual selective pressure would depend on the relative returns individuals get from their social environment and their position within it. The presented results highlight the importance of a systems approach to studying animal sociality, in which the effects of social

behaviors should be viewed not only through the benefits that those provide to individuals, but also in terms of how they affect broader social environment and how in turn this is reflected back on an individual's fitness. © 2010 Hock et al.

Rood, E., A. A. Ganie and V. Nijman (2010). "**Using presence-only modelling to predict Asian elephant habitat use in a tropical forest landscape: Implications for conservation**." Diversity And Distributions **16**(6): 975-984.

Aim Asian elephants, Elephas maximus, are threatened throughout their range by a combination of logging, large scale forest conversion and conflict with humans. We investigate which environmental factors, both biotic and abiotic, constrain the current distribution of elephants. A spatially explicit habitat model is constructed to find core areas for conservation and to assess current threats.Location Ulu Masen Ecosystem in the province of Nanggroe Aceh Darussalam on the island of Sumatra, Indonesia.Methods A stratified survey was conducted at 12 sites (300 transects) to establish the presence of elephants. Presence records formed the basis to model potential habitat use. Ecological niche factor analysis (ENFA) is used to describe their niche and to identify key factors shaping elephant distribution. An initial niche model was constructed to describe elephant niche structure, and a second model focused on identifying core areas only. To assess the threat of habitat encroachment, overlap between the elephants' optimal niche and the occurrence of forest encroachment is computed.Results Elephants were recorded throughout the study area from sea level to 1600 m a.s.l. The results show that the elephant niche and consequently habitat use markedly deviates from the available environment. Elephant presence was positively related to forest cover and vegetation productivity, and elephants were largely confined to valleys. A spatially explicit model showed that elephants mainly utilize forest edges. Forest encroachment occurs throughout the elephants range and was found within 80% of the elephants' ecological niche.Main conclusions In contrast to general opinion, elephant distribution proved to be weakly constrained by altitude, possibly because of movement routes running through mountainous areas. Elephants were often found to occupy habitat patches in and near human-dominated areas. This pattern is believed to reflect the displacement of elephants from their former habitat. © 2010 Blackwell Publishing Ltd.

Santiapillai, C., S. Wijeyamohan, G. Bandara, R. Athurupana, N. Dissanayake and B. Read (2010). "**An assessment of the human-elephant conflict in Sri Lanka**." Ceylon Journal of Science Biological Sciences **39**(1): 21-33.

The association between man and elephant in Sri Lanka is ancient. Elephants being the largest terrestrial herbivores require relatively large areas and diversity of environments to forage. With the increase in human population density and changes in the land-use patterns, elephant habitat is being continuously reduced. As a result, much of the present day elephant range extends into and overlaps with agricultural lands resulting in conflict with man. The assessment of the human-elephant conflict was carried out from January to March 2008 through the use of a questionnaire in 100 villages selected randomly from five provinces whose combined extent is 42,559 km2 which amounts roughly to 65% of the total land area of Sri Lanka. 65% of the respondents identified crop depredations with bull elephants, both young and old. At least 13 food items have been identified by the villagers as preferred by wild elephants in agricultural areas. Crop damage to paddy accounted for 69% of the complaints. At the same time, most of the farmers identified citrus trees as the most likely crop to be avoided by elephants. Failure to recognize the significance of the human-elephant conflict can result in a negative attitude to elephants and apathy or indifference to conservation initiatives. Although it is unlikely that the human-elephant conflict can be eliminated altogether, yet every effort must be taken to reduce it to tolerable levels.

Santiapillai, C. and B. Read (2010). "**Would masking the smell of ripening paddy-fields help mitigate human-elephant conflict in Sri Lanka?**" Oryx **44**(4): 509-511.

Despite its small size and high human population Sri Lanka is home to c. 4,400 wild Asian elephants Elephas maximus. Human-elephant conflict around agriculture is severe, with > 100 elephants and c. 50 people killed annually. Elephants appear to be able to time their raiding of paddy-fields in Sri Lanka with the harvesting of the rice, as if they are responding to an olfactory trigger. It is the elephants sophisticated chemosensory system that may hold the key to resolving human-elephant conflict. Research is required to determine the odours associated

with the various development stages of rice, using gas chromatography, and to find a suitable substance that could be used to mask the specific odour of ripening rice. The use of chemosensory-based methods, if feasible, will not be a universal panacea for the mitigation of human-elephant conflict but, in combination with other methods, could reduce conflict and make it easier for farmers to harvest their crops in safety. Such a combination of methods could be useful across the range of both Asian and African elephants. © 2010 Fauna & Flora International.

Thapa, S. (2010). "**Effectiveness of crop protection methods against wildlife damage: A case study of two villages at Bardia National Park, Nepal**." Crop Protection **29**(11): 1297-1304.

Conflicts due to damage caused by wildlife pose serious threats to conservation. In addition, wildlife damage incurs severe economic loss to communities living in the close vicinity of the park, affecting the livelihoods and well-being of locals. While different studies have emphasised identification and quantification of crop damage problems, studies highlighting the means used for crop protection and their effectiveness are limited. This study aimed to examine the effectiveness of means used by communities to protect their crops against wildlife. 117 households were visited at two Buffer Zone villages of Bardia National Park, Nepal. Findings suggested that crop depredation by wildlife was a function of several factors, such as the distance of the farmland from the park, the size of the crop raiding animals and the frequency of attacks on the farmland, and the type of crops. Ten different means were identified by communities which were used regularly to prevent crop damage. Households combined both traditional and modern means to guard their crop against the wild animals. Means differed according to the animals as well as crops being protected. Among all these means, Machan (i.e. watch towers) combined with other means such as throwing flaming sticks and group shouting were the most effective and safest modes of crop guarding for all kinds of animals and crops. Trench and Bio-fencing were effective mostly for deer species. However, crop guarding was an intensive process and no means were able to completely prevent crop damage. Problem animals differed according to the villages and crops being damaged, which suggests that employment of single means would be ineffective. Site-specific management strategies and economic as well as technical support from funding organisations would be most useful to minimise crop loss. In addition information exchange and learning between farmers and the park management about different mitigating means could support and prepare farmers for improvement in the means. © 2010 Elsevier Ltd.

Datta-Roy, A., N. Ved and A. C. Williams (2009). "**Participatory elephant monitoring in South Garo Hills: Efficacy and utility in a human-animal conflict scenario**." Tropical Ecology **50**(1): 163-171.

We evaluate the efficacy of community based elephant monitoring programme in South Garo Hills, Meghalaya (India). Major objectives of the programme are to understand the ranging and habitat utilization patterns of free ranging Asian elephants in a human interspersed habitat with frequent human - elephant conflicts. We collected information on elephant presence in the landscape through participatory wildlife monitoring techniques by modifying an existing model for African elephants from six 'akings' or clan villages which are worst affected by human-elephant conflict (HEC). A total of 201 visits were recorded in six 'akings' during June 2005 to July 2006, of which solitary elephants accounted for 100 visits. The visits were found to peak during the two main harvesting periods in the Garo hills indicating a definite seasonality pattern in the visits. Information from individual 'akings' also indicate that some 'akings' were particularly prone to visits by solitary animals indicating the complexity in the dynamics of elephant ranging patterns within the landscape. We note that participatory elephant monitoring can be a useful tool to collect basic data on elephant presence in tropical ecosystems where traditional line transect method is restricted by considerations of terrain, access and resources. Other advantages, limitations and conservation implications are discussed. © International Society for Tropical Ecology.

Graham, M. D., I. Douglas-Hamilton, W. M. Adams and P. C. Lee (2009). "**The movement of African elephants in a human-dominated land-use mosaic**." Animal Conservation **12**(5): 445-455.

Land outside of gazetted protected areas is increasingly seen as important to the future of elephant persistence in Africa. However, other than inferential studies on crop raiding, very little is understood about how elephants

Loxodonta africana use and are affected by human-occupied landscapes. This is largely a result of restrictions in technology, which made detailed assessments of elephant movement outside of protected areas challenging. Recent advances in radio telemetry have changed this, enabling researchers to establish over a 24-h period where tagged animals spend their time. We assessed the movement of 13 elephants outside of gazetted protected areas across a range of land-use types on the Laikipia plateau in north-central Kenya. The elephants monitored spent more time at night than during the day in areas under land use that presented a risk of mortality associated with human occupants. The opposite pattern was found on large-scale ranches where elephants were tolerated. Furthermore, speed of movement was found to be higher where elephants were at risk. These results demonstrate that elephants facultatively alter their behaviour to avoid risk in human-dominated landscapes. This helps them to maintain connectivity between habitat refugia in fragmented land-use mosaics, possibly alleviating some of the potential negative impacts of fragmentation. At the same time, however, it allows elephants to penetrate smallholder farmland to raid crops. The greater the amount of smallholder land within an elephant's range, the more it was utilized, with consequent implications for conflict. These findings underscore the importance of (1) land-use planning to maintain refugia; (2) incentives to prevent further habitat fragmentation; (3) the testing and application of conflict mitigation measures where fragmentation has already taken place. © 2009 The Authors. Journal compilation © 2009 The Zoological Society of London.

Nath, N. K., B. P. Lahkar, N. Brahma, S. Dey, J. P. Das, P. K. Sarma and B. K. Talukdar (2009). "**An assessment of human-elephant conflict in Manas National Park, Assam, India**." Journal of Threatened Taxa **1**(6): 309-316.

An assessment of human-elephant conflict was carried out in the fringe villages around Manas National Park, Assam during 2005- 06. The available forest department conflict records since 1991 onwards were also incorporated during analysis. Conflict was intense in the months of July-August and was mostly concentrated along the forest boundary areas, decreasing with distance from the Park. Crop damage occurred during two seasons; paddy (the major crop) suffered the most due to raiding. Crop maturity and frequency of raiding were positively correlated. Single bull elephants were involved in conflicts more frequently (59%) than female herds (41%), while herds were involved in majority of crop raiding cases. Of the single elephants, 88% were makhnas and 11.9% were tuskers. The average herd size recorded was 8 individuals, with group size ranging up to 16. Mitigation measures presently adopted involve traditional drive-away techniques including making noise by shouting, drum beating, bursting fire crackers and firing gun shots into the air, and using torch light, pelting stones and throwing burning torches. Kunkis have been used in severe cases. Machans are used for guarding the crops. Combinations of methods are most effective. Family herds were easily deflected, while single bulls were difficult to ward off. Affected villagers have suggested methods like regular patrolling (39%) by the Forest Department officials along the Park boundary, erection of a concrete wall (18%) along the Park boundary, electric fencing (13%), simply drive away (13%), culling (11%) and lighting the Park boundary during night hours (6%). Attempts to reduce conflict by changing the traditional cropping pattern by introducing some elephant-repellent alternative cash crops (e.g. lemon and chilli) are under experiment.

Ogra, M. (2009). "**Attitudes toward resolution of human–wildlife conflict among forest-dependent agriculturalists near Rajaji National Park, India**." Attitudes toward resolution of human-wildlife conflict among forest-dependent agriculturalists near Rajaji National Park, India **37**: 161-177.

Understanding local attitudes towards human-wildlife conflict (HWC) is key to developing successful conflict mitigation strategies. In this paper, in-depth interview and questionnaire data about resolution of HWC in Uttarakhand, India are examined from both qualitative and quantitative approaches (n = 70). Responses are differentiated between and within three subgroups: gender, literacy status, and relative wealth. Overall, the plurality of respondents said that fencing is the best solution, that the Forest Department should take leadership, and that villagers would be willing to participate in a cooperative management institution. However, cooperative action was only actively supported by 27.4% of respondents, suggesting that comanagement of this protected area will require significant capacity building and trust building activities. Intragroup differences show that all three factors are significant, and underscore the importance of addressing gender differences in

attitudes about HWC in particular. Women were less likely than men to support compensation, more likely to prefer that the village take leadership, and less willing to participate in a cooperative management institution. The study illustrates the value of mixed-method research, and suggests a number of specific entry points for action.

Bechert, U., S. Southern and M. Chase (2008). **Minimally invasive molecular health analysis in elephants**. Proc American Associaton of Zoo Veterinarians and Assoc of Reptile and Amphibian Veterinarians.

This paper describes the application of a new assay platform called Stress Response Profiling (SRP) to the analysis of health status in elephants. SRP assays use a large biomarker panel as an indicator of chronically perturbed physiologic homeostasis ("chronic stress"),1,2 which is a known predictor of increased morbidity, infertility and mortality rates.3-8 SRP assays have a broad-based sensitivity to diverse types of stressors in multiple species of vertebrates.2 A minimally invasive SRP assay is based on skin microsamples obtained using routine biopsy procedures.9 The skin SRP assay was applied to captive African elephants with clinically diagnosed gastrointestinal infections and to healthy wild elephants.10 The elephant health status was classified using a reference database of SR biomarker profiles corresponding to eight species of normal and stressed animals. The biomarker profiles were converted into pathway profiles indicating that the molecular mechanism of the elephant gastrointestinal infections preferentially involved responses to misfolded proteins and DNA lesions. To rapidly and economically screen samples from 70 free-ranging African elephants sampled in Northern Botswana, we used a multiplexed SRP assay called multi-SRP.1,2 Statistical analysis of the multi-SRP scores showed correlations with population density, movements, and human-elephant conflict reports. In summary, this paper documents that SRP and multi-SRP assays are suitable for the elephant skin and relevant to both symptomatic diseases and asymptomatic effects of environmental and anthropogenic stressors. We anticipate that the SRP technology might have a wide range of potential applications in veterinary medicine and ecosystem conservation.

LITERATURE CITED

1. Southern, S.O., A.C. Allen, and N. Kellar. 2002. Molecular signature of physiological stress in dolphins based on protein expression profiling of skin. Administrative Report LJ-02-27, National Marine Fisheries Service, SW Fisheries Science Center, La Jolla, California.
2. Southern, S.O., and G.W. Lilienthal. 2008. New technology for early detection of health threats. Proc. SPIE 69450F.
3. Camougrand, N., and M. Rigoulet. 2001. Aging and oxidative stress: studies of some genes involved both in aging and in response to oxidative stress. Respir. Physiol. 128:393-40.
4. Epel, E.S., J. Lin, F.H. Wilhelm, O.M. Wolkowitz, R. Cawthon, N.E. Adler, C. Dolbier, W.B. Mendes, and E.H. Blackburn. 2006. Cell aging in relation to stress arousal and cardiovascular disease risk factors. Psychoneuroendocrinology. 31:277-87.
5. Feder, M.E., and G.E. Hofmann. 1999. Heat-shock proteins, molecular chaperones, and the stress response: evolutionary and ecological physiology. Ann. Rev. Physiol. 61:243-82.
6. Kapahi, P., M.E. Boulton, and T.B.L. Kirkwood. 1999. Positive correlation between mammalian life span and cellular resistance to stress. Free Radical Biol. Med. 26:495-500.
7. Selye, H.A. 1936. Syndrome produced by diverse nocuous agents. Nature 138:32.
8. Wilson, J.F., and E.J. Kopitzke 2002. Stress and infertility Curr. Womens Health Rep. 2: 194

Graham, M. D. and T. Ochieng (2008). "**Uptake and performance of farm-based measures for reducing crop raiding by elephants Loxodonta africana among smallholder farms in Laikipia District, Kenya**." Oryx **42**(1): 76-82.

Human-elephant conflict, in particular the damage caused by elephants to smallholder crops, is a major challenge to the conservation of African elephant Loxodonta africana. Conventional tools used to address this problem are capital intensive and require high levels of expertise. In recent years simple, affordable farm-based elephant deterrents, using locally available materials, have been encouraged by a number of human-elephant conflict researchers. There are very few published studies demonstrating the performance of these deterrents, however, and little is known about levels of uptake among smallholder farmers. We trialled a number of such farm-based elephant deterrents with local farmers in three sites within Laikipia District, Kenya. Levels of crop

raiding declined after the introduction of treatments but not significantly when compared with control farms. Variable levels of uptake among the participating farmers made it difficult to draw clear conclusions from the trials. However, participating farmers were positive about the deterrent effect of the tools introduced, corroborated by their willingness to make financial commitments towards sustaining future trials. Availability of household labour, local politics, and insecurity were identified as important barriers to uptake of some of the deterrents introduced. Household labour availability should be a key consideration in future endeavours to trial farm-based elephant deterrents. © 2008 Fauna and Flora International.

Jackson, T. P., S. Mosojane, S. M. Ferreira and R. J. Van Aarde (2008). "**Solutions for elephant Loxodonta africana crop raiding in northern Botswana: Moving away from symptomatic approaches**." Oryx **42**(1): 83-91.

Conflict between people and elephants in Africa is widespread yet many solutions target the symptoms, rather than the underlying causes, of this conflict. To manage this conflict better the underlying causes of the problem need to be examined. Here we examine factors underlying spatial use by elephants and people along the Okavango Panhandle in Ngamiland, northern Botswana, to provide ways to address the causes of the conflict between elephants and people. We found that (1) elephant spatial use was a function of season, (2) spatial use did not differ between breeding herds and bull groups, (3) spatial use by elephants and people only overlapped significantly at night, during the dry season, (4) crop raiding by elephants was a function of season and social grouping, and (5) crop raiding by elephants had social and economic implications. Based on these results we suggest measures to manipulate elephant spatial use to reduce the causes of this conflict. We also reflect on present compensation measures for elephant crop damage and advocate that a more direct performance payment approach may benefit both the Botswana Government and local farmers. © 2008 Fauna and Flora International.

Kioko, J., P. Muruthi, P. Omondi and P. I. Chiyo (2008). "**The performance of electric fences as elephant barriers in Amboseli, Kenya**." African Journal of Wildlife Research **38**(1): 52-58.

Electric fencing is increasingly used as a tool for elephant (Loxodonta africana) conservation in human-dominated landscapes and there are few empirical studies to demonstrate that electrified barriers are effective in deterring elephants from raiding crops. The factors determining the effectiveness of electric fences are not fully understood. We assessed the performance of Namelok and Kimana fences in reducing human-elephant conflict by comparing the frequency of crop-raiding by elephants and the perceptions of farmers on the effect of the fences in reducing elephant crop-raiding within fenced and adjacent unfenced farmlands. We also examined the effect of intact fence wires, presence of currentand amount of voltage on fence breakage by elephants. Electric fencing reduced elephant crop-raiding and other forms of human-elephant conflicts. Namelok fence was not broken by elephants whereas Kimana fence was broken several times probably because it borders Kimana Sanctuary which provided cover where elephants could retreat after crop-raiding. The mere presence of current did not minimize fence breakage by elephants. Elephants entered fenced areas more frequently when the fence wires were broken than when wires were intact. Our results suggest that, location of fences in relation to landscape factors, maintenance of effective non-electrified fences and proximity of fences to areas of high elephant concentration are significant determinants of fence performance in mitigating elephant crop-raiding.

Ogra, M. V. (2008). "**Human-wildlife conflict and gender in protected area borderlands: A case study of costs, perceptions, and vulnerabilities from Uttarakhand (Uttaranchal), India**." Geoforum **39**(3): 1408-1422.

Human-wildlife conflict (HWC) is a growing problem for communities located at the borders of protected areas. Such conflicts commonly take place as crop-raiding events and as attack by wild animals, among other forms. This paper uses a feminist political ecology approach to examine these two problems in an agricultural village located at the border of Rajaji National Park in Uttarakhand (formerly Uttaranchal), India. Specifically, it investigates the following three questions: What are the "visible" and "hidden" costs of such conflict with wildlife? To what extent are these costs differentially borne by men and women? How do villagers perceive any such differences? Survey and interview data were collected from over 100 individuals in the study site over a

period of 9 months in 2003-2004. It was found that for participants in this study, costs of HWC included decreased food security, changes to workload, decreased physical and psychological wellbeing, economic hardship, and at times an increase in illegal or dangerous activities. The research also showed that although women in the study area bore a disproportionate burden of these effects, roughly half of survey respondents perceived that men and women were equally affected. A possible explanation for this gap considers the relationships between gendered uses of space, work, status, and identity. The findings illustrate the importance of addressing both visible and hidden costs of HWC for members of park communities and support a call for increased gender-sensitivity in HWC research.

Okello, M. M. and D. E. D'Amour (2008). "**Agricultural expansion within Kimana electric fences and implications for natural resource conservation around Amboseli National Park, Kenya**." Journal of Arid Environments **72**(12): 2179-2192.

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Fencing has become a key strategy in mitigating human-wildlife coflicts and promoting agricultural production in Kenya. However, it can have negative long-term consequences for wildlife conservation as well as human development, especially if the fence is poorly maintained. Such is the case of the Kimana and Namelok fences in the Kimana Group Ranch. This study assessed the influence of fences on agricultural expansion, environmental and wildlife conservation. In both fences, irrigated agriculture was a dominant land use and occurred along riverbanks, causing drying downstream. Most farmers in both fences were noticing a decline in water quantity and time of access to it, as well as increasing human-wildlife conflicts. Wildlife sightings within both fences provided evidence that the inadequate fence maintenance allows wildlife to freely access the fenced areas. Both wildlife and humans were blamed for fence deterioration in both fences. Irrigated agriculture inside both fences is expanding at an unmanageable rate. While the fences have spurred socio-economic activities in the area, they are not only ineffective in reducing human-wild life coflicts but have given rise to other critical conflicts. Fencing appears to be a short-term remedy for human-wildlife conflicts and it is crucial to explore other mitigation strategies.

Varma, S., N. X. Dang, T. Van Thanh and R. Sukumar (2008). "**The Asian elephants Elephas maximus of Cat Tien National Park, Vietnam: Status and conservation of a vanishing population**." Oryx **42**(1): 92-99.

This study updates the status and conservation of the Endangered Asian elephant Elephas maximus in Cat Tien National Park, Vietnam. Line transect indirect surveys, block surveys for elephant signs, village surveys of elephant-human conflict incidents, guard-post surveys for records of sightings, and surveys of elephant food plants were undertaken during the dry and wet seasons of 2001. A minimum of 11 elephants and a maximum of 15-17 elephants was estimated for c. 500 km2 of the Park and its vicinity. The elephants are largely confined to the southern boundary of the Park and make extensive use of the adjoining La Nga State Forest Enterprises. During the dry season the elephants depend on at least 26 species of wild and cultivated plants, chiefly the fruits of cashew. Most of the villages surveyed reported some elephant-human conflict. Two adult male elephants seem to cover a large area to raid crops, whereas the family groups restrict themselves to a few villages; overall, the conflict is not serious. Since 2001 there have been no reports of any deaths or births of elephants in the Park. We make recommendations for habitat protection and management, increasing the viability of the small population, reducing elephant-human conflicts, and improving the chances of survival of the declining elephants of this Park. The Government has now approved an Action Plan for Urgent Conservation Areas in Vietnam that calls for the establishment of three elephant conservation areas in the country, including Cat Tien National Park.

Webber, A. D., C. M. Hill and V. Reynolds (2007). "**Assessing the failure of a community-based human-wildlife conflict mitigation project in Budongo Forest Reserve, Uganda**." Oryx **41**(2): 177-184.

Primate crop raiding is a major cause of human-wildlife conflict around the forests of western Uganda. In an attempt to ameliorate the situation a conflict mitigation strategy was established in villages around the Budongo Forest Reserve in 2001. Live-traps were constructed that allowed the identification of crop raiding animals; pest

species could be disposed of and threatened species released unharmed. However, by 2004 none of the traps in the study area were functioning and interviews were conducted to assess the reasons for their decline and local people's acceptance of the intervention. Forty-one percent of respondents did not believe the strategy was effective and the majority of local farmers did not accept responsibility for the traps. This was because of operational failures in four areas: (1) the identification of key stakeholders, (2) objective evaluation to assess the efficacy and benefit of the intervention, (3) participatory monitoring and evaluation, and (4) long-term funding commitment by conservation agencies. We examine the impact of these four elements upon the sustainability of the live-trap programme and stress the importance of recognizing and reporting failures to develop effective and acceptable mitigation strategies. © 2007 FFI.

Lee, P. C. and M. D. Graham (2006). "**African elephants (Loxodonta africana) and human-elephant interactions: implications for conservation**." International Zoo Yearbook **40**: 9-19.

African elephants face an uncertain future. Politics, war, sustained media campaigns, corrupt, weak or absent institutions supporting conservation, land-use planning or general governance, and greed ar all bringing elephants into direct conflict with humans. Although elephant populations have declined considerably relative to their historical size and range, human populations have expanded to occupy and intensively use remaining elephant areas. Strategies to minimize perceptions of conflict and the implementation of land-use planning with biodiversity protection as its goal could help to sustain at least some populations of elephants. Here, we review threats to elephants, with an emphasis on those resulting from human perceptions of conflict, and suggest some mechanisms for grappling with these threats.

Parker, G. E. and F. V. Osborn (2006). "**Investigating the potential for chilli Capsicum spp. to reduce human-wildlife conflict in Zimbabwe**." Oryx **40**(3): 343-346.

Human-wildlife conflict has negative implications for wildlife conservation, and current crop protection methods are not sufficient to address the problem. Alternative livelihood strategies may provide the ultimate solution to this conflict but they are not always feasible in the short-term. We test the viability of using chilli Capsicum spp. as an unpalatable cash crop to

reduce human-wildlife conflict. Our trials indicate that chilli is less vulnerable to wildlife than other crops and is also economically viable.

Deem, S. L., J. L. Brown, L. Eggert, C. Wemmer, W. Htun, T. Nyunt, S. Murray and P. Leimgruber (2005). **Health and management of working elephants in Myanmar (Burma).** Procedings American Association of Zoo Veterinarians.

Myanmar has approximately 6,000 working elephants. Remaining wild elephants are declining, partly because of live-capture for captivity. Through health and reproductive assessments, genetic analyses and GPS tracking of captive and wild elephants, we are exploring linkages between the two populations and conducting studies to reduce morbidity and mortality of captive elephants. Captive elephants live and work in Myanmar's forests in close proximity and contact to the remaining wild herds. We propose that reducing morbidity and mortality in the captive elephants will decrease the need for live-capture, and the risk of disease transmission, to wild elephants.

Introduction

There are an estimated 6,000 working elephants in Myanmar - half owned by the government operated Myanmar Timber Enterprise (MTE) and half owned privately.[5] This may be one of the largest captive elephant populations in the world and its management will have a significant impact on remaining wild herds in Myanmar.[4,6,8] With mortality rates higher than birth rates, the working population is probably maintained by supplementing it with elephants captured from the wild.[5] There is evidence that continued harvest of wild elephants may have reduced the remaining wild populations of Myanmar. Recent surveys of wild populations in two of Myanmar's protected elephant ranges revealed extremely low dung counts, indicative of small and declining herds. Constant contact with captive elephants in Myanmar's forests may exacerbate the threat to Myanmar wild elephants by increasing the transmission of disease between these two groups. For both the above reasons, we believe that the conservation of wild elephants in Myanmar will require significant improvements in the care

and management of currently existing captive populations.

Elephants owned by MTE receive veterinary care from the Burmese veterinarians that work for the timber company and travel extensively throughout the country to sites were the elephants are located.[1] There is a dire need for veterinary supplies and laboratory capabilities in the country. Currently, veterinary practices are based on the extensive field experience of lead MTE veterinarians. However, MTE veterinarians frequently rely on older published work [3,7] and would benefit significantly from training that incorporates new insights into elephant health and new veterinary techniques. Similarly, because of their close-up experience of elephant health problems in the forests, MTE veterinarians may be able to make important new contributions to the care and management of elephants elsewhere.

The overall objective of our study is to work jointly with MTE veterinarians to develop long-term captive population management strategies to reduce mortality and increase births in the working timber elephants and stop the continued off-take of animals from the wild to supplement captive herds.

Methods

The health component of this study has five major objectives. These are to:

1 Conduct a training workshop, in conjunction with MTE veterinarians, on elephant management and veterinary care.

2 Develop protocols so that the MTE veterinarians can collect samples for reproductive, genetic, and health status assessments.

3 Analyze samples and provide data to MTE veterinarians to improve husbandry, preventive care and disease treatment of working elephants.

4 Develop a comprehensive bibliography of all published information on the health and management of Myanmar elephants.

5 Perform an epidemiologic evaluation of records available on the historic and current working elephant population.

Specific steps to achieve these objectives include:

1 Determine causes and rates of morbidity and mortality of captive MTE elephants.

2 Determine causes of low rates of reproduction in captivity.

3 Develop a genetic profile of the captive herds.

4 Develop a protocol to assess oozies-Burmese mahout-expertise in parallel with endocrine and health assessments to determine quality of care and potentially related stress.

5 Develop small population viability models to assess how current mortality effects long-term survival of the captive population and what supplementation from the wild is needed for short- and long-term sustainability.

6 Use population viability models to demonstrate how supplementation from the wild will negatively affect that population.

7 Get baseline health parameter data on free-ranging elephants.

8 Quantify habitat/space use using GPS and satellite tracking of captive and wild elephants.

Results and Discussion

During an initial exploratory visit in November 2004, we learned that the annual mortality rate for MTE working elephants was 2.4% (66) in 2003. Deaths occurred in all age groups (>18 yr, n = 40; 4 - 17 yr, n = 11; <4 yr, n = 15) and included preventable diseases (i.e., poor nutrition, heat stroke, diarrhea, dystocia, infectious and parasitic agents). Additionally, we collected samples for performing health, genetic and endocrine analyses of 22 elephants maintained in one of the working camps (results to be presented). A relationship also was established with the veterinary staff at the Yangon Zoo, including follow up donations of veterinary literature and journals to the zoo. We provided medical advice for the care of an orphaned elephant calf and other animals housed at the zoo during our brief visit. We are seeking funds for a training course to be conducted in late 2005 and hope to perform health evaluations on a larger number of zoo and working elephants during that visit.

The National Zoo already has an extensive conservation program for wild elephants in Myanmar.[4,6,8] This program has focused on assessing wild elephant populations in protected areas and satellite-tracking of four wild elephants to learn more about their conservation status and ecology in Myanmar. Currently this work is being extended

to a national elephant survey. Part of this work included collecting fecal samples for genetic and health assessments**.**

The Smithsonian team of researchers involved in this project includes a veterinarian, reproduction physiologist, geneticist, conservation biologist, and landscape ecologist. All members of this multidisciplinary team have extensive experience working with elephants and together provide the necessary expertise to study and understand the numerous factors affecting Myanmar's captive elephants and the long-term survival of elephants in Myanmar. These challenges range from human land use and elephant population fragmentation, human-elephant conflict, poor reproduction and health care of captive elephants and lack of information on the health status of the wild elephants. A viable conservation initiative for the elephants of Myanmar requires that health issues be addressed as one component of a comprehensive program to address the anthropogenic pressures on both working and wild elephants.[2]

The elephants of Myanmar are an excellent example of the fine line that exists between captive and wild animals, especially as it relates to health. Captive and wild elephants are regularly in direct and indirect contact. The working elephants live with their oozies who may expose them to diseases, such as tuberculosis. The working elephants in turn may encounter wild elephants at night in the forests where they forage and live during non-working hours. In fact, the majority of captive born calves are said to be sired by wild bulls. Potentially, the use of working elephants in selectively extracting valuable timber provides new strategies for the conservation of elephants and forests. Most likely, "elephant-logging" is less damaging than machine-operated timbering projects that tend to clear-cut areas and also damage the soil and streams. However, decreasing the negative impact of such practices (i.e., minimizing off-take of elephants from the wild, decreasing disease risks to the wild elephants) is imperative.

LITERATURE CITED

1 Aung, T., and T. Nyunt. 2002. The care and management of the domesticated Asian elephant in Myanmar. *In:* Baker, I., and M. Kashio (eds.): Giants on our hands. Proc. Int. Workshop Domesticated Asian Elephant. Dharmasarn Co., Ltd. Bangkok, Thailand. Pp. 89 - 102.

2 Deem, S.L., W.B. Karesh, and W. Weisman. 2001. Putting theory into practice: wildlife health in conservation. Conserv. Biol. 5: 1224-1233.

3 Evans, G.H. 1910. Elephants and Their Diseases. Government Printing. Rangoon. 323

4 Kelly, D.S. 2005. Habitat selection in declining elephant populations of Alaungdaw Kathapa National Park. Masters Thesis. George Mason University.

5 Lair, R.C. 1997. Myanmar. *In:* Gone Astray: The Care and Management of the Asian Elephant in Domesticity. FAO Regional Office for Asia and the Pacific, Thailand. RAP Publication. Pp. 99-131

6 Leimgruber, P., and C. Wemmer. 2004. National elephant symposium and workshop. Report to the USFWS and the Myanmar Forest Department.

7 Pfaff, G. 1930. Reports on Diseases of Elephants. Government Printing. Rangoon. 91

8 Wemmer, C., P. Leimgruber and D. S. Kelly. 2005. Managing wild elephants in Alaungdaw Kathapa National Park and Htamanthi Wildlife Sanctuary. Report to the USFWS and the Myanmar Forest Department.

Fernando, P., E. Wikramanayake, D. Weerakoon, L. K. A. Jayasinghe, M. Gunawardene and H. K. Janaka (2005). "**Perceptions and patterns of human-elephant conflict in old and new settlements in Sri Lanka: Insights for mitigation and management**." Biodiversity and Conservation **14**(10): 2465-2481.

Human-elephant conflict poses a major threat to elephants in many parts of Asia, including Sri Lanka. We studied human-elephant conflict in two areas with contrasting scenarios of landuse and conflict, Kahalle and Yala. Kahalle was developed and settled under the Mahaweli irrigation project and the main agricultural practice was irrigated agriculture, with two annual growing seasons. The area was a mosaic of settlements, agriculture, and small forest patches with ill defined human- and elephant-use areas. Elephants ranged within the habitat mosaic year round, occupying remnant forest patches and raiding adjacent crops at night. In contrast, Yala was dominated by a large protected area complex, and the main agricultural methods were slash-and-burn agriculture and rain-fed paddy cultivation. Human- and elephant-use areas were well defined and segregated. The protected area provided elephants with a refuge and food during the rainy season, when the single annual

crop was grown. During the dry season, elephants moved into slash-and-burn areas and utilized leftover crops and pioneer vegetation in fallow fields. The landuse pattern and agricultural practices in Yala facilitated co-existence, whereas that in Kahalle led to year round conflict. We suggest that areas managed according to traditional landuse practices should be part of an elephant conservation strategy, where people and elephants have to share resources.

Sitati, N. W., M. J. Walpole and N. Leader-Williams (2005). "**Factors affecting susceptibility of farms to crop raiding by African elephants: Using a predictive model to mitigate conflict**." Journal of Applied Ecology **42**(6): 1175-1182.

1. Crop raiding by African elephants Loxodonta africana erodes local tolerance for elephants and thereby impedes conservation efforts, so solutions are urgently required. Within conflict zones, crop raiding is not distributed equally amongst farms, which may be a result of variation in local physical or geographical factors, or in farmers' efforts to defend their fields. Understanding the efficacy of local conflict mitigation methods is important, but few quantitative evaluations exist. 2. Using a comparative survey of raided and non-raided farms in Transmara District, Kenya, and multivariate logistic and linear regression analyses, we explored a range of factors affecting (i) the susceptibility of farms to elephant crop raiding and (ii) the amount of crop damage once elephants had entered a field. 3. The results revealed that farms that had been habitually raided in the past were more likely to be raided during the study period, as were those that were larger and bordered by hedges or fences. Greater guarding effort increased the likelihood that elephants were detected prior to entry and decreased the likelihood of successful crop raiding, as did the use of fire and noise. 4. However, there was an interaction between physical and human factors; larger farms used more advanced barrier methods at the expense of guarding effort. Farmers' efforts did not appear to diminish the damage inflicted once elephants had entered a field. 5. A subsequent experimental test confirmed these results; the application of enhanced early warning and guarding effort on previously raided farms reduced incidents of crop raiding by 89.6% over 2 years in comparison with a control group of farms. 6. Synthesis and applications. These results suggest that early detection of elephants approaching fields, increased guarding effort, and the use of active deterrents could form the basis of an effective mitigation strategy regardless of location and the physical attributes of a farm. Validating the results of predictive models through participatory mitigation trials serves to demonstrate effective solutions to farmers themselves. Researchers and practitioners should be encouraged to replicate such field trials over broader spatial and temporal scales and to find means to encourage farmers to take up appropriate solutions. © 2005 British Ecological Society.

Venkataraman, A. B., R. Saandeep, N. Baskaran, M. Roy, A. Madhivaran and R. Sukumar (2005). "**Using satellite telemetry to mitigate elephant-human conflict: An experiment in northern West Bengal, India.**" Current Science **88**(11): 1827-1831.

Satellite tracking of animals has advantages in the study of species that migrate across international borders, have large home ranges and occupy remote and inaccessible areas. The efficacy of this technology in dense tropical forests may, however, be limited. At the same time, its use in mitigating wildlife-human conflict has not been examined so far. Here we report the movement patterns and habitat utilization of an adult male Asian elephant, and a preliminary assessment of the potential use of satellite technology as an 'early warning system' for conflict mitigation. Data on the location of the animal were obtained from a Platform Transmitter Terminal mounted on an elephant in Jaldapara, West Bengal, the first if its kind used on this species in India. We found that the animal preferred forest and forest plantations during the day, making visits to cultivated lands at night. There was some predictability, in the movement of this animal, suggesting that,similar technologies such as the more advanced Global Positioning System can be used for near 'real-time tracking' of problem elephants.

Venkataraman, A. B., R. Saandeep, N. Baskaran, M. Roy, A. Madhivanan and R. Sukumar (2005). "**Using satellite telemetry to mitigate elephant-human conflict: An experiment in northern West Bengal, India**." Current Science **88**(11): 1827-1831.

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tropical forests may, however, be limited. At the same time, its use in mitigating wildlife-human conflict has not been examined so far. Here we report the movement patterns and habitat utilization of an adult male Asian elephant, and a preliminary assessment of the potential use of satellite technology as an 'early warning system' for conflict mitigation. Data on the location of the animal were obtained from a Platform Transmitter Terminal mounted on an elephant in Jaldapara, West Bengal, the first if its kind used on this species in India. We found that the animal preferred forest and forest plantations during the day, making visits to cultivated lands at night. There was some predictability in the movement of this animal, suggesting that similar technologies such as the more advanced Global Positioning System can be used for near 'real-time tracking' of problem elephants.

Bandara, R. and C. Tisdell (2004). "**The net benefit of saving the Asian elephant: A policy and contingent valuation study.**" Ecological Economics **48**: 93-107.

Reports results from a contingent valuation (CV) survey of willingness to pay (WTP) for the conservation of the Asian elephant of a sample of urban residents living in three selected housing schemes in Colombo, the capital of Sri Lanka. Face-toface surveys were conducted using an interview schedule (IS). A non-linear logit regression model is used to analyse the respondents' responses for the payment principle questions and to identify the factors that influence their responses. We investigate whether urban residents' WTP for the conservation of elephants is sufficient to compensate farmers for the damage caused by elephants. We find that the beneficiaries (the urban residents) could compensate losers (the farmers in the areas affected by human-elephant conflict, HEC) and be better off than in the absence of elephants in Sri Lanka. Therefore, there is a strong economic case for the conservation of the wild elephant population in Sri Lanka. However, we have insufficient data to determine the optimal level of this elephant population in the Kaldor-Hicks sense. Nevertheless, the current population of elephant in Sri Lanka is Kaldor-Hicks preferable to having none.

Horan, R. D. and E. H. Bulte (2004). "**Optimal and open access harvesting of multi-use species in a second-best world**." Environmental and Resource Economics **28**(3): 251-272.

Expansion of human populations and activities has caused increased conflicts between wildlife and humans. As a result, the distinction between resource and pest species has become blurry. We propose an economically-based classification of species based on a multi-use bioeconomic model. The classification of the steady state population of a species is shown to depend on both species' density and economic factors. We extend earlier work on multi-use (resource-pest) species by applying the theoretical model to a developing country context where property rights to wildlife are imperfectly enforced, so that second-best trade measures are often applied by the international community to promote conservation. Upon calibrating the model using data for the African elephant, we derive three further results. First, when comparing the optimal stock of a multi-use species to the open access stock, we find that the ranking in terms of abundance is ambiguous. Second, and consistent with existing literature on resource management in a second-best world, our case study supports the idea that trade bans have ambiguous effects on wildlife abundance. Third, due to a bifurcation effect characterizing the multi-use model's solution, strategic and temporary subsidizing by the North may enable them to free ride on conservation efforts of the South henceforth.

Osborn, F. V. (2004). "**Seasonal variation of feeding patterns and food selection by crop-raiding elephants in Zimbabwe.**" African Journal of Ecology **42**(4): 322-327.

Elephants and humans are increasingly coming into conflict because of the conversion of elephant habitat into agricultural areas. In order to identify trends that influence raiding behaviour, the nutritional makeup of food items consumed by crop-raiding elephants over a 2-year period were analysed and a trigger for crop raiding was identified. The point at which the quality of wild grasses declines below the quality of crop species corresponded to the movement of bull elephants out of a protected area and into fields. This finding may have wider implications for developing predictive models of elephant/human interactions.

Madhusudan, M. D. (2003). "**Living amidst large wildlife: livestock and crop depredation by large mammals in the interior villages of Bhadra Tiger Reserve, South India**." Environ Manage **31**(4): 466-475.

Conflict with humans over livestock and crops seriously undermines the conservation prospects of India's large and potentially dangerous mammals such as the tiger (Panthera tigris) and elephant (Elephas maximus). This study, carried out in Bhadra Tiger Reserve in south India, estimates the extent of material and monetary loss incurred by resident villagers between 1996 and 1999 in conflicts with large felines and elephants, describes the spatiotemporal patterns of animal damage, and evaluates the success of compensation schemes that have formed the mainstay of loss-alleviation measures. Annually each household lost an estimated 12% (0.9 head) of their total holding to large felines, and approximately 11% of their annual grain production (0.82 tonnes per family) to elephants. Compensations awarded offset only 5% of the livestock loss and 14% of crop losses and were accompanied by protracted delays in the processing of claims. Although the compensation scheme has largely failed to achieve its objective of alleviating loss, its implementation requires urgent improvement if reprisal against large wild mammals is to be minimized. Furthermore, innovative schemes of livestock and crop insurance need to be tested as alternatives to compensations. Centre for Ecological Research and Conservation, 3076/5, IV Cross, Gokulam Park, Mysore 570 002, India. mdm@ncf-india.org

Mikota, S. K., H. Hammatt and M. Finnegan (2003). **Occurrence and prevention of capture wounds in Sumatran elephants (*Elephas maximus sumatranus*)**. Proc Amer Assoc Zoo Vet.

The capturing of elephants in Indonesia began in 1986 as an attempted solution to human-elephant conflict. The intent was to train "problem" elephants for use in agriculture, logging and tourism. The initial captures were conducted under the guidance of Thai mahouts and Thai koonkie elephants (trained elephants used for capture). A number of the Indonesians that were originally trained in capture techniques still work for the government forestry department (KSDA). The younger pawangs (elephant handlers) that participate in captures have learned from their peers. There is no formal training program. The actual mortality rate associated with elephant captures in Sumatra is unknown as official reports are lacking. The age structure of the existing ~ 400 captive elephants is young (most under 25) which suggests that smaller, younger elephants are preferentially captured and / or that adult elephants do not survive the capture and training processes. Our personal experiences (Mikota and Hammatt) in Sumatra show that mortality in newly captured elephants is high.In 2001, with endorsement from the World Wide Fund for Nature-Indonesia (WWF), the Wildlife Conservation Society (WCS), Fauna and Flora International (FFI), and the International Elephant Foundation (IEF), we requested a two-year Moratorium on elephant captures during which time capture techniques would be improved and alternative conflict mediation techniques evaluated.

A Moratorium against placing additional elephants into the Elephant Training Centers has been issued by the central government, however capture for translocation is still sanctioned. Unfortunately, the provincial governments have increasingly acted in their own interests since the government of Indonesia began a de-centralization process a few years ago. Riau Province is thought to have the largest remaining populations of wild Sumatran elephants.Fifty-seven, human-elephant conflicts occurred in Riau between 1997-2000. Although Riau is a hotbed of conflict, problems are occurring throughout Sumatra and we are aware of conflicts and captures in Bengkulu and North Sumatra. In October 2002, we were invited by KSDA (the provincial forestry department) to accompany their team into the field as they attempted to capture a large bull that had been raiding a palm oil plantation. This opportunity was invaluable as we were able to observe first hand the techniques being used and where improvements were needed. As a result of this and other experiences with newly captured elephants we observed: ·Equipment (Palmer) is old, poorly maintained, and used improperly. ·Essential supplies are lacking or homemade substitutes are used.

·The dose of xylazine is very high compared to wild elephant capture doses used in India and Malaysia. The same dose is often used regardless of the size of the elephant. ·The needles are too short to reach muscle; open-ended needles are used which can become plugged with tissue, thus preventing injection. ·Neither the correct charge nor the correct load is selected. We observed that many darts bounced making it difficult to ascertain the amount of drug injected or its depth of penetration. Selection of an inappropriate charge results in unnecessary trauma. ·The preparation and use of darts, needles, and syringes lacks basic hygiene. ·Dart wounds are not treated and antibiotics are not administered. ·There is no understanding of stress or capture myopathy. ·The capture team was not aware that sternal recumbency severely compromises respiration in

elephants and that they can quickly die in this position. ·It is believed that elephant restraints must inflict pain to prevent wild elephants from escaping once captured. ·There is no veterinarian on the capture team. The current capture techniques result in leg wounds from unprotected chains, neck wounds from "kahs" (neck yokes made of wood and wire), and abscesses from inappropriately administered darts. Leg and neck wounds often become maggot infested. Infections from dart wounds are, however, the primary cause of capture-related mortality. These abscesses can drain for several months, even with treatment, and often progress to a necrotizing fasciitis, acute sepsis, and death. The Riau Province KSDA Team has been receptive to suggested changes to minimize wounds. Provision of heavier chains has alleviated the fear that elephants will escape. Covering the chains with fire hose or heavy plastic minimizes injuries to legs and use of the kah has been discontinued. A basic dart wound treatment protocol has been established. In June 2003, a comprehensive Elephant Immobilization and Translocation Workshop for Sumatra is planned to retrain all of Sumatra's field teams and to upgrade equipment. Sumatra's wild elephant population probably numbers fewer than 3000 and is under continued threat. With so few elephants left, the preservation of as many viable herds as possible takes on increased urgency. The Moratorium achieved in 2001 has set the groundwork for KSDA to choose translocation of wild elephants rather than capture and placement into already over-crowded and under-resourced Elephant Training Centers. We cannot guarantee that Sumatra will capture elephants only for translocation, and it is inevitable that many more elephants will end up in captivity. Regardless, all of the elephants that must suffer the interruption of their lives at the hand of man deserve, at the very least, humane treatment. Translocations are neither simple nor a complete panacea. Identifying suitable translocation areas and insuring that elephants remain there are significant challenges. WWF-Indonesia is continuing its efforts to secure the lowland forest of Tesso Nilo in Riau Province as a "safe haven" for at least some of Sumatra's wild elephants (see WWF AREAS Program – Riau, Sumatra: http://www.worldwildlife.org/species/attachments/riau_profile.pdf). The identification of interim release sites, together with improved capture techniques, offers the hope that fewer elephants will be removed from the wild. ACKNOWLEDGMENTS: Our work in Sumatra has been supported by the Guggenheim Foundation, a CEF grant from the American Zoo and Aquarium Association, the International Elephant Foundation, Oregon Zoo, Columbus Zoo, Disney, Peace River Refuge, the Elephant Managers Association, the Riddles Elephant and Wildlife Sanctuary, Tulsa Zoo, Toronto Zoo, Niabi Zoo, San Antonio Zoo, Denver Zoo (AAZK Chapter), Milwaukee Zoo (AAZK Chapter), the Audubon Nature Institute (Youth Volunteers), Buttonwood Park Zoo, Melbourne Zoo, and private donors. Special thanks to Harry Peachey, John Lehnhardt, Holly Reed, Kay Backues, Mike Keele, Steve Osofsky, and Heidi and Scott Riddle.

Osborn, F. V. and G. E. Parker (2003). "**Towards an integrated approach for reducing the conflict between elephants and people: a review of current research**." Oryx **37**(1).

Managers attempting to reduce crop damage by elephants encounter a range of complex technical and social issues. Subsistence farmers bear the costs associated with maintaining wild elephant populations and this can confound interventions designed to improve the livelihood security of farmers. We present a review of the issues that influence the success and failure of methods used to reduce crop damage, and suggest that an integrated, community-based, low-tech approach will be the most sustainable solution to this conflict.

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

Human-elephant conflict (HEC) in Africa occurs wherever these two species coincide, and poses serious challenges to wildlife managers, local communities and elephants alike. Mitigation requires a detailed understanding of underlying patterns and processes. Although temporal patterns of HEC are relatively predictable, spatial variation has shown few universal trends, making it difficult to predict where conflict will take place. While this may be due to unpredictability in male elephant foraging behaviour (the male behaviour hypothesis) it may also be due to variations in the data resolution of earlier studies. This study tested the male behaviour and data resolution hypotheses using HEC data from a 1000-km2 unprotected elephant range adjacent to the Masai Mara National Reserve in Kenya. HEC incidents were divided into crop raiding and human

deaths or injuries. Crop raiding was further subdivided into incidents involving only male elephants or family groups. A relatively fine-resolution, systematic, grid-based method was used to assign the locations of conflict incidents, and spatial relations with underlying variables were explored using correlation analysis and logistic regression. Crop raiding was clustered into distinct conflict zones. Both occurrence and intensity could be predicted on the basis of the area under cultivation and, for male elephant groups, proximity to major settlements. Conversely, incidents of elephant-induced human injury and death were less predictable but were correlated with proximity to roads. A grid-based geographical information system (GIS) with a 25-km2 resolution utilizing cost-effective data sources, combined with simple statistical tools, was capable of identifying spatial predictors of HEC. At finer resolutions spatial autocorrelation compromised the analyses. Synthesis and applications. These results suggest that spatial correlates of HEC can be identified, regardless of the sex of the elephants involved. Moreover, the method described here is fully transferable to other sites for comparative analysis of HEC. Using these results to map vulnerability will enable the development and deployment of appropriate conflict mitigation strategies, such as guarding, early warning systems, barriers and deterrents. The utility of such methods and their strategic deployment should be assessed alongside alternative land-use and livelihood strategies that limit cultivation within the elephant range.

Weladji, R. B. and M. N. Tchamba (2003). "**Conflict between people and protected areas within the Benoue Wildlife Conservation Area, North Cameroon**." Oryx **37**(1): 72-79.

Knowledge of conflicts between people and protected areas is required for the design of sustainable conservation strategies for the management of most protected areas. This study identifies the causes of conflicts between local people and the Benoue Wildlife Conservation Area (BWCA), which includes the Benoue National Park, in northern Cameroon. Informal interviews and questionnaires were administered to 114 households in three communities, and to 17 park staff and 7 professional hunting guides from July-October 1997. Crop damage affected 86% of the surveyed households, with 31% of crop income lost on average, and with the damage varying significantly between communities. Elephants, baboons, patas monkeys, warthogs and green parrots accounted for 97% of crop damage, with the staple foods maize and millet being most affected. Of the respondents, 28% experienced livestock depredation, with 18% of livestock income lost on average. The civet cat was the main predator. The involvement of local people in illegal activities, their lack of access to natural resources, and damage by wildlife were identified as principal causes of conflicts. Local people, park staff and professional hunting guides had diverse and differing perceptions about the causes of the conflicts, and made various suggestions for reduction of wildlife damage including animal scaring and controlled shooting. We conclude that, under current wildlife policy, conflict between people and BWCA is difficult to resolve. To reduce conflicts and promote sustainable conservation, we suggest co-management of wildlife involving all stakeholders, establishment of crop damage control teams, and promotion of tangible benefits to local people. There may be a requirement for site-specificity in management strategies.

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

Crop raiding by wild elephants is one of the most significant sources of park-people conflict in Sumatra, Indonesia. The distribution, impact and conservation implications of elephant crop-raiding in 13 villages that border Way Kambas National Park in southern Sumatra were studied for 18 months. The data are based on rapid village and field assessments, data logs maintained by village observers and a quantitative household survey. Elephants raided crops year-round at a mean rate of 0.53 elephants per day for the entire study area. The frequency of crop raiding was related to vegetation type along the park border, the size and presence of rivers, and the distance to the park's Elephant Training Center (ETC), which houses about 150 captive elephants. Wild elephants damaged at least 450,000 sq m of corn, rice, cassava, beans and other annual crops, and close to 900 coconuts, banana and other perennial trees in the area surveyed. Elephants killed or injured 24 people over a 12-year period in villages near the park. Villagers try to reduce elephant damage by guarding fields, digging trenches between the park and their fields, and modifying their cropping patterns. Elephant-human conflict decreases the probability of support from local people for conservation efforts. We suggest methods to improve

the effectiveness of existing elephant trenches, the need to consider electric fences, external support to affected villages, and compensation to villagers for any damage caused.

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

1. The resolution of direct conflict between humans and elephants in Africa has become a serious local political issue in recent years, and a continental conservation problem. 'Problem elephants' damage crops, food stores and water sources, and sometimes threaten human life. 2. Eighty per cent of the African elephant's range lies outside formally protected areas, and inadequate management of human-elephant conflict is frequently a precursor to further decline in the numbers and distribution of elephants. Conflict appears to be increasing in an assortment of African ecosystems as the agricultural interface with elephant range expands. 3. The present study recorded incidents by problem elephants in small subdivisions of a 15 000km2 elephant range. The level of problem elephant activity over 3 years showed huge variation and could not be explained by elephant density, proximity of a protected area, area of human settlement, human density or local rainfall. 4. It is proposed that the irregular and unpredictable nature of human-elephant conflict incidents in the study area mainly depended upon the behavioural ecology of individual elephant bulls. 5. This study proposes a statistic to quantify problem elephant activity in Africa which can be used to compare the intensity of problem incidents between different ecosystems at different times: 'elephant incidents per square kilometre of human settlement area per year'. Spatial analyses of appropriate data at the human-elephant interface may yield a more predictive understanding of the conflict process.

Hoare, R. (1995). "**Options for the Control of Elephants in Conflict with People**." Pachyderm **19**: 54-63.

With increasing frequency, the management of elephants outside protected areas in Africa has to address the problem of conflict between elephants and people in rural, agricultural situations. In the last decade, three major changes have occurred in the process of human-elephant interaction: the conflict interface has generally increased, even where the elephant range has contracted; elephants have acquired a much greater economic value; and wildlife management is becoming decentralised, with emphasis on utilisation for economic benefit. In Zimbabwe's unprotected areas, elephants are now simultaneously the most valuable wildlife resource and the greatest wildlife pest species. This paper outlines a systematic, more efficient approach to dealing with the problem of conflict, while still conserving elephant populations. It involves a simple system of assessing problem elephant activity over large areas, and using the information to formulate a district strategy which ameliorates, but does not eliminate, the burden of "problem" elephants. The relative merits and disadvantages of various traditional and contemporary methods of dealing with problem elephants are also discussed. Mention is made of research being conducted on the ecological nature of the interactive processes between human and elephant populations.

Santiapillai, C. and W. S. Ramono (1993). "**Reconciling Elephant Conservation with Economic Development in Sumatra**." Gajah **10**: 11-18.

The Sumatran elephant (*Elephas maximus sumatranus*) is the smallest of the three subspecies of the Asian elephant. Its numbers are estimated to be anything between 2,800 and 4,800 (Blouch & Haryanto 1984; Blouch & Simbolon 1985). Once widely distributed throughout the eight provinces of Sumatra, the animal has almost disappeared from two provinces and is under threat in the rest of the island from a host of development programmes such as logging, human resettlement, establishment of large-scale plantation estates, oil exploration, mining, irrigation and agriculture. The conversion of primary forest into agricultural holdings has been one of the causes of conservation problems in Sumatra and the elephant has been among the large mammals most seriously affected by it. Development programmes have led to the annual elimination of tens of thousands of hectares of elephants habitat. As their traditional migratory routes are blocked, habitats fragmented, the elephants are becoming increasingly confined to patches of forests that are surrounded by cultivated land. As Laws (1981) points out in the situation in East Africa, the situation in Sumatra too is reversing gradually "from one in which human islands existed in a sea of elephants, to a sea of people with elephant

islands." These conditions have led to a dramatic increase in the scale of elephant depredations in Sumatra. In some cases the success of the development programmes has been threatened as a result of which, there has been a change in attitude by the planners in recognizing the need to take into consideration the ecological requirements of the elephant during the planning stage of any development programme. In return, the Directorate of Forest Protection and Nature Conservation (PHPA) which is primarily responsible for the conservation of elephant must match this recognition by the planners with realistic proposals to ensure the conservation of the species without leading to unacceptable conflicts. This paper is an attempt to reconcile elephant conservation with economic development in Sumatra.