

## Human-Elephant Conflict References (By date; most recent first)

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Accessed 24 July 2023

Von Hagen, L., C. A. LaDue and B. A. Schulte (2023). "Elephant Scar Prevalence in the Kasigau Wildlife Corridor, Kenya: Echoes of Human-Elephant Conflict." *Animals (Basel)* 13(4).

Human-elephant conflict (HEC) compromises crop security and threatens elephant conservation. Most commonly, HEC manifests as crop-foraging as elephants modify natural foraging strategies to incorporate crops. Farmers may retaliate by frightening or harming elephants, leaving scars from inflicted wounds. We assessed the prevalence and distribution of scars on the bodies of African savanna elephants (*Loxodonta africana*) observed in the Kasigau Wildlife Corridor (KWC), part of the Greater Tsavo Ecosystem of Kenya, where conflict is prevalent. We surmised that scars on the body are largely a result of HEC as opposed to scars on the rump or head, which we attributed primarily to elephant-elephant conflict. We hypothesized that: (1) male elephants would have more scars than females; (2) older males would be more likely to have scars than younger males; and (3) most scars would be located on the bodies of elephants. We assessed scars from a photographic catalogue of elephants from the KWC. In line with our hypotheses, male elephants were more likely to have scars than females (32% of males compared to 6% of females); older males had significantly more scars than younger males (61% compared to 24%); and the majority of scars (89%) were located on the body. Scar presence may be useful as an animal-centered indicator to estimate the prevalence and demographic patterns of HEC.

Montero Botey, M., M. Soliño, R. Perea and M. Martínez-Jauregui (2022). "Let Us Give Voice to Local Farmers: Preferences for Farm-Based Strategies to Enhance Human-Elephant Coexistence in Africa." *Animals (Basel)* 12(14).

Local communities surrounding wildlife corridors and natural reserves often face challenges related to human-wildlife coexistence. To mitigate the challenges and ensure the long-term conservation of wildlife, it is important to engage local communities in the design of conservation strategies. By conducting 480 face-to-face interviews in 30 villages along and adjacent to the Selous-Niassa Wildlife Corridor (Tanzania), we quantified farmers' preferences for farm-based measures to mitigate African elephant damage using choice experiments. Results show that farmers considered no action the least preferred option, revealing that they are open to trying different measures. The most preferred management strategy matched with the preferences of wildlife rangers in the area, suggesting low concern about the potential conflicts between stakeholders. However, a latent class model suggests that there are significant differences among responses triggered by farmers' previous experience with elephants, the intensity of the elephant damage, and the socioeconomic situation of the farmer. Results show a

marked spatial distribution among respondents, highlighting the benefits of zone management as conflicts were found to be highly context dependent. Understanding the human dimension of conservation is essential for the successful planification and implementation of conservation strategies. Therefore, the development and broad utilization of methodologies to gather specific context information should be encouraged.

Makecha, R. N., S. Phalke and Y. Nakai (2022). "Assessing the Effects of a Cognition-Based Education Program on Attitudes of Villagers Toward Asian Elephants (*Elephas maximus*) in Conflict-Prone Areas." *J Appl Anim Welf Sci* 25(4): 368-381.

A vital role in mitigating human-elephant conflict (HEC) involves conservation education programs in local communities. It is therefore important to assess the types of information that make conservation education programs effective. Given the public's fascination with animal minds, the elephant being a cognitively complex species, and the high occurrence of HEC surrounding Asian elephants, the current research assessed whether using information on elephant cognition in a conservation education program increased positive attitudes toward elephants/elephant conservation in Bannerghatta National Park (BNP). BNP, located in Karnataka, India, is an area reporting high HEC. Results indicated no significant difference in adult male villagers' attitudes toward elephants/elephant conservation when exposed to one of two educational programs, one of which included information on elephant cognition. However, a significant difference in attitudes between the two programs and a control group was discovered, suggesting the importance of an educational intervention in the communities surrounding BNP.

Hahn, N. R., J. Wall, K. Denninger-Snyder, M. Goss, W. Sairowua, N. Mbise, A. B. Estes, S. Ndambuki, E. E. Mjingo, I. Douglas-Hamilton and G. Wittemyer (2022). "Risk perception and tolerance shape variation in agricultural use for a transboundary elephant population." *J Anim Ecol* 91(1): 112-123.

To conserve wide-ranging species in human-modified landscapes, it is essential to understand how animals selectively use or avoid cultivated areas. Use of agriculture leads to human-wildlife conflict, but evidence suggests that individuals may differ in their tendency to be involved in conflict. This is particularly relevant to wild elephant populations. We analysed GPS data of 66 free-ranging elephants in the Serengeti-Mara ecosystem to quantify their use of agriculture. We then examined factors influencing the level of agricultural use, individual change in use across years and differences in activity budgets associated with use. Using clustering methods, our data grouped into four agricultural use tactics: rare (<0.6% time in agriculture; 26% of population), sporadic (0.6%-3.8%; 34%), seasonal (3.9%-12.8%; 31%) and habitual (>12.8%; 9%). Sporadic and seasonal individuals represented two-thirds (67%) of recorded GPS fixes in agriculture, compared to 32% from habitual individuals. Increased agricultural use was associated with higher daily distance travelled and larger home range size, but not with age or sex. Individual tactic change was

prevalent and the habitual tactic was maintained in consecutive years by only five elephants. Across tactics, individuals switched from diurnal to nocturnal activity during agricultural use, interpreted as representing similar risk perception of cultivated areas. Conversely, tactic choice appeared to be associated with differences in risk tolerance between individuals. Together, our results suggest that elephants are balancing the costs and benefits of crop usage at both fine (e.g. crop raid events) and long (e.g. yearly tactic change) temporal scales. The high proportion of sporadic and seasonal tactics also highlights the importance of mitigation strategies that address conflict arising from many animals, rather than targeted management of habitual crop raiders. Our approach can be applied to other species and systems to characterize individual variation in human resource use and inform mitigations for human-wildlife coexistence.

Dai, Y. (2022). "The overlap of suitable tea plant habitat with Asian elephant (*Elephus maximus*) distribution in southwestern China and its potential impact on species conservation and local economy." *Environ Sci Pollut Res Int* 29(4): 5960-5970.

The expansion of land being used for cash crop cultivation has threatened wildlife in recent decades. Tea has become the dominant cash crop in southwestern China. Unfortunately, tea plantations may threaten Asian elephant (*Elephus maximus*) populations via habitat loss and fragmentation. Identifying areas of suitable habitat for tea plant cultivation, and where this habitat overlaps with Asian elephant distribution, is vital for planning land use, managing nature reserves, shaping policy, and maintaining local economies. Here, we assess the potential impact of tea plantations on Asian elephants in southwestern Yunnan province, China. We used MaxEnt modeling with bioclimatic and environmental variables to identify suitable habitat for tea plant cultivation under the current climate scenario, and then overlapped this habitat with 9 known Asian elephant distribution areas (G1-G9) to determine "threatened areas." Our results showed that (1) annual precipitation (48.1% contribution), temperature constancy (29 % contribution), and slope (8.7 % contribution) were key in determining suitable habitat for tea plants; (2) the cumulative area of suitable habitat for tea plants was 13,784.88 km<sup>2</sup>, mainly distributed in Menghai (3934.53 km<sup>2</sup>), Lancang (3198.67 km<sup>2</sup>), and Jinghong (2657.74 km<sup>2</sup>); (3) the distribution area of elephants was 943.75 km<sup>2</sup>, and these areas overlapped with suitable tea plant habitat primarily located in G4 (379.40 km<sup>2</sup>), G3 (251.18), and G7 (168.03 km<sup>2</sup>); and (4) threatened areas in G1 and G7 were predominately located along the periphery of current nature reserves. Win-win solutions that work for elephant conservation and economic development include rescoping nature reserve boundaries, strengthening management on the periphery of nature reserves, establishing ecological corridors and new nature reserves within regions where elephants are currently distributed, planting alternative cash crops, and financial subsidies to farmers. This study improves understanding of human-elephant coexistence, and will assist in guiding land use policy for the future conservation outcomes seeking to promote responsible and profitable cash crop farming and elephant conservation.

Baral, K., S. Bhandari, B. Adhikari, R. M. Kunwar, H. P. Sharma, A. Aryal and W. Ji (2022). "Anthropogenic mortality of large mammals and trends of conflict over two decades in Nepal." *Ecol Evol* 12(10): e9381.

Wildlife conservation in human-dominated landscapes faces increased challenges due to rising conflicts between humans and wildlife. We investigated the human and wildlife loss rates due to human-wildlife conflict between 2000 and 2020 in Nepal. We concentrated on Asian elephant (*Elephas maximus*), greater one-horned rhino (*Rhinoceros unicornis*), tiger (*Panthera tigris*), and leopard (*Panthera pardus*) mortality, as well as human mortality caused by these species. Over the 21-year period, we recorded 1139 cases of wildlife mortality and 887 cases of human mortality. Leopard mortality was the highest, followed by that of greater one-horned rhinos, tigers, and Asian elephants. Overall, the rate of wildlife mortality has been increasing over the years. Asian elephants were found to be more responsible for crop damage than greater one-horned rhinos, while leopards were found to be more responsible for livestock depredation than tigers. The generalized linear model indicated that the mortality of wildlife in the districts is best predicted by the additive effect of human mortality, the proportion of agricultural land, and the literacy rate of the districts. Retaliatory wildlife mortality was the most challenging issue for wildlife conservation, especially for the large mammals. Findings from this study are important for mitigation of human-wildlife conflicts, controlling retaliatory killing, and conserving these threatened large mammals.

Nair, R. P. and E. A. Jayson (2021). "Estimation of economic loss and identifying the factors affecting the crop raiding behaviour of Asian elephant (*Elephas maximus*) in Nilambur part of the southern Western Ghats, Kerala, India." *Current Science* 121(4): 521-528.

The crop damage by the Asian elephant (*Elephas maximus*) on the livelihood of farmers is a major impediment to the conservation of the endangered mammals. The study was carried out in Malappuram district, Kerala, India from January 2013 to May 2016, to estimate the extent of crop damage by Asian elephants and to identify the factors affecting human-elephant conflict. To estimate the monetary loss, the method of running quadrats was employed. The major cash-crops destroyed by the Asian elephant were plantain (*Musa paradisiaca*), rubber (*Hevea brasiliensis*), areca nut (*Areca catechu*) and coconut (*Cocos nucifera*). A potential loss of Rs 5,076,827 (US\$ 72,948) per annum (Rs 2,217,363 (US\$ 31,861) (other crops) + Rs 2859,464 (US\$ 41,087) (rubber)) was estimated. Fifty per cent of the encounters occurred at early midnight. The presence of areca nut cultivation and distance to the Reserve Forest were identified as the two factors affecting crop raiding. The damage to rubber trees by feeding on the bark has also been reported.

LaDue, C. A., I. Eranda, C. Jayasinghe and R. P. G. Vandercone (2021). "Mortality Patterns of Asian Elephants in a Region of Human-Elephant Conflict." *Journal of Wildlife Management* 85(4): 794-802.

Many wildlife species suffer from human-wildlife conflict, especially crop-raiding. Long-term analyses of mortality patterns are needed to assess the efficacy of management strategies that address this issue. We report mortality patterns from necropsies of 498 Asian elephants from 2009-2018 in an area of northwestern Sri Lanka. Deaths were lowest in July and highest in October, a period of peak crop availability. Most (about 70%) deaths were human-related, and males were killed in these incidents more frequently than females. As gunshot deaths decreased, other forms of human-related deaths increased. Additionally, causes of death differed between districts, with more intentional human-related mortality observed in the district with the highest percent of protected land. These results highlight the importance of understanding the long-term spatial and temporal variation in wildlife mortality to effectively address human-wildlife conflict. (c) 2021 The Wildlife Society.

Gulati, S., K. K. Karanth, N. A. Le and F. Noack (2021). "Human casualties are the dominant cost of human-wildlife conflict in India." *Proc Natl Acad Sci U S A* 118(8).

Reducing the costs from human-wildlife conflict, mostly borne by marginal rural households, is a priority for conservation. We estimate the mean species-specific cost for households suffering damages from one of 15 major species of wildlife in India. Our data are from a survey of 5,196 households living near 11 wildlife reserves in India, and self-reported annual costs include crop and livestock losses and human casualties (injuries and death). By employing conservative estimates from the literature on the value of a statistical life (VSL), we find that costs from human casualties overwhelm crop and livestock damages for all species associated with fatalities. Farmers experiencing a negative interaction with an elephant over the last year incur damages on average that are 600 and 900 times those incurred by farmers with negative interactions with the next most costly herbivores: the pig and the nilgai. Similarly, farmers experiencing a negative interaction with a tiger over the last year incur damage that is on average 3 times that inflicted by a leopard and 100 times that from a wolf. These cost differences are largely driven by differences in the incidence of human death and casualties. Our estimate of costs fluctuates across reserves, mostly due to a variation of human casualties. Understanding the drivers of human casualties and reducing their incidence are crucial to reducing the costs from human-wildlife conflict. Most of the tales were about animals, for the Jungle was always at their door. The deer and the pig grubbed up their crops, and now and again the tiger carried off a man at twilight, within sight of the village gates. "Tiger! Tiger!" (Rudyard Kipling, *The Jungle Book*, Collins Classics, 2010).

Fernando, P., M. K. C. R. De Silva, L. K. A. Jayasinghe, H. K. Janaka and J. Pastorini (2021). "First country-wide survey of the Endangered Asian elephant: Towards better conservation and management in Sri Lanka." *Oryx* 55(1): 46-55.

The Endangered Asian elephant *Elephas maximus* comes into widespread conflict with agrarian communities, necessitating active management. The species' distribution is of primary importance for management planning. However, data-based countrywide distribution maps have not been available for any of the 13

Asian elephant range states. We conducted a 5 × 5 km grid-based questionnaire survey in Sri Lanka to produce an island-wide elephant distribution map. Elephants occur over 59.9% of Sri Lanka and people are resident in 69.4% of elephant range, indicating the challenge of separating people and elephants at a landscape scale. Elephants in Sri Lanka have lost 16.1% of their range since 1960 but their current distribution remains largely contiguous. We found the range of adult males was 15.1% greater, and less seasonal, than that of herds, possibly because males have a higher tolerance for conflict with people. The distribution of conflict coincided with the co-occurrence of humans and elephants. We conclude that a human-elephant coexistence model is the only viable option for effectively mitigating human-elephant conflict and conserving elephants in Sri Lanka. The findings are currently being used to effect a paradigm change in elephant conservation and management in the country. Copyright © 2019 Fauna & Flora International.

Dai, Y. (2021). "The overlap of suitable tea plant habitat with Asian elephant (*Elephus maximus*) distribution in southwestern China and its potential impact on species conservation and local economy." *Environ Sci Pollut Res Int*.

The expansion of land being used for cash crop cultivation has threatened wildlife in recent decades. Tea has become the dominant cash crop in southwestern China. Unfortunately, tea plantations may threaten Asian elephant (*Elephus maximus*) populations via habitat loss and fragmentation. Identifying areas of suitable habitat for tea plant cultivation, and where this habitat overlaps with Asian elephant distribution, is vital for planning land use, managing nature reserves, shaping policy, and maintaining local economies. Here, we assess the potential impact of tea plantations on Asian elephants in southwestern Yunnan province, China. We used MaxEnt modeling with bioclimatic and environmental variables to identify suitable habitat for tea plant cultivation under the current climate scenario, and then overlapped this habitat with 9 known Asian elephant distribution areas (G1-G9) to determine "threatened areas." Our results showed that (1) annual precipitation (48.1% contribution), temperature constancy (29 % contribution), and slope (8.7 % contribution) were key in determining suitable habitat for tea plants; (2) the cumulative area of suitable habitat for tea plants was 13,784.88 km<sup>2</sup>, mainly distributed in Menghai (3934.53 km<sup>2</sup>), Lancang (3198.67 km<sup>2</sup>), and Jinghong (2657.74 km<sup>2</sup>); (3) the distribution area of elephants was 943.75 km<sup>2</sup>, and these areas overlapped with suitable tea plant habitat primarily located in G4 (379.40 km<sup>2</sup>), G3 (251.18), and G7 (168.03 km<sup>2</sup>); and (4) threatened areas in G1 and G7 were predominately located along the periphery of current nature reserves. Win-win solutions that work for elephant conservation and economic development include rescoping nature reserve boundaries, strengthening management on the periphery of nature reserves, establishing ecological corridors and new nature reserves within regions where elephants are currently distributed, planting alternative cash crops, and financial subsidies to farmers. This study improves understanding of human-elephant coexistence, and will assist in guiding land use policy for the future conservation

outcomes seeking to promote responsible and profitable cash crop farming and elephant conservation.

Allen, C. R. B., D. P. Croft and L. J. N. Brent (2021). "Reduced older male presence linked to increased rates of aggression to non-conspecific targets in male elephants." *Proc Biol Sci* 288(1965): 20211374.

Males in many large mammal species spend a considerable portion of their lives in all-male groups segregated from females. In long-lived species, these all-male groups may contain individuals of vastly different ages, providing the possibility that behaviours such as aggression vary with the age demographic of the social environment, as well as an individual's own age. Here, we explore social factors affecting aggression and fear behaviours in non-musth male African elephants (*Loxodonta africana*) aggregating in an all-male area. Adolescent males had greater probabilities of directing aggressive and fearful behaviours to non-elephant targets when alone compared to when with other males. All males, regardless of age, were less aggressive towards non-elephant targets (e.g. vehicles and non-elephant animals) when larger numbers of males from the oldest age cohort were present. The presence of older males did not influence the probability that other males were aggressive to conspecifics or expressed fearful behaviours towards non-elephant targets. Older bulls may police aggression directed towards non-elephant targets or may lower elephants' perception of their current threat level. Our results suggest male elephants may pose an enhanced threat to humans and livestock when adolescents are socially isolated, and when fewer older bulls are nearby.

van de Water, A., L. E. King, R. Arkajak, J. Arkajak, N. van Doormaal, V. Ceccarelli, L. Sluiter, S. M. Doornwaard, V. Praet, D. Owen and K. Matteson (2020). "Beehive fences as a sustainable local solution to human-elephant conflict in Thailand." *Conservation Science and Practice* 2(10).

As human-elephant conflict (HEC) increases, a better understanding of the human dimensions of these conflicts and non-violent mitigation methods are needed to foster long-term coexistence. In this study, we conducted household questionnaires (n= 296) to assess the prevalence of HEC and attitudes towards elephants in four rural villages in Thailand. In addition, we evaluated a pilot beehive fence as a sustainable solution for HEC. The majority of the households reported seeing or hearing elephants near their property at least once a week (84.9%) and experienced negative impacts from elephants in the last 5 years, (81.0%). The beehive fence deterred 88.4% of individual elephants (n= 155) and 64.3% of elephant groups (n= 28) that approached the fence. Most elephants (70.7%) exhibited behaviors suggesting heightened attentiveness or alarm. The farm owner reported economic and social benefits of the beehive fence. By contributing to farmer income and reducing crop damage caused by wild elephants, beehive fencing may provide an important locally-managed complement to regional HEC mitigation methods.

Tang, R., W. Li, D. Zhu, X. Shang, X. Guo and L. Zhang (2020). "Raging elephants: effects of human disturbance on physiological stress and reproductive potential in wild Asian elephants." *Conserv Physiol* 8(1): coz106.

Human disturbance has become a widespread threat to wildlife viability. The Asian elephant (*Elephas maximus*), an endangered and disturbance-prone species, is under severe threat from habitat loss and fragmentation, human-elephant conflict and poaching. Establishing connections between human disturbance, stress responses and reproduction is crucial for assessing the long-term survivability of a species and will provide critical information for conservation management. The current study investigated the effects of human disturbance on population-level stress responses and stress-related effects on reproductive potential of wild Asian elephants in Xishuangbanna Dai Autonomous Prefecture, China. We used a radioimmunoassay to measure the concentration of fecal cortisol and estradiol in 257 samples collected from five local populations at 15 sites over 4 years. Human disturbance in Xishuangbanna was quantified based on the Ecological-Niche Factor Analysis model. We found that fecal cortisol concentrations were strongly positively correlated with the degree of human disturbance and increased markedly with the expansion of tea plantations. Percentage of non-stressed individuals in a population was higher depending on the extend of undisturbed area in their home ranges. Fecal estradiol concentrations decreased significantly with increasing stress levels. Our results suggest that human disturbance poses environmental challenges to wild Asian elephant populations, and chronic exposure to human disturbance could lead to population decline. The study demonstrates the efficacy of non-invasive endocrine monitoring for further informing management decisions and developing conservation strategies.

Su, K., J. Ren, J. Yang, Y. Hou and Y. Wen (2020). "Human-Elephant Conflicts and Villagers' Attitudes and Knowledge in the Xishuangbanna Nature Reserve, China." *Int J Environ Res Public Health* 17(23).

In this study, we analyzed the accidents associated with the Asian elephant (*Elephas maximus* Linnaeus) and issues pertaining to compensation in Xishuangbanna Nature Reserve from 2011 to 2018. We conducted interviews and a questionnaire survey with 217 villagers. The results show that: (1) the main Asian elephants damage is crop loss (more than 95% of the total damage), and the villagers suffer economic losses; (2) through the influence of traditional culture and natural education, the majority of local villagers still have a favorable impression of Asian elephants; (3) female respondents, those engaged in agricultural production, those who had experienced crop loss and those who had never seen Asian elephants had more negative attitudes toward Asian elephants; (4) most villagers believe that the Asian elephant population has increased in the past decade; and (5) the villagers are quite passive in the human-elephant conflict, and most of them do not take action. Finally, based on the research results, this paper discusses the causes of human elephant conflict and proposes targeted mitigation measures.



Saif, O., R. Kansky, A. Palash, M. Kidd and A. T. Knight (2020). "Costs of coexistence: understanding the drivers of tolerance towards Asian elephants *Elephas maximus* in rural Bangladesh." *Oryx* 54(5): 603-611.

Habitat degradation and fragmentation have heightened the importance of understanding human tolerance towards wildlife, as the fate of wildlife in multi-use landscapes depends on people's capacity for coexistence. We applied the wildlife tolerance model to examine drivers of tolerance towards Asian elephants *Elephas maximus* in rural Bangladesh, interviewing local people in 17 villages. We used structural equation modelling to identify causal pathways in which elephant-related exposure, positive and negative interactions, costs and benefits (tangible and intangible) contributed to tolerance. Contrary to expectations, monetary costs were non-significant in shaping tolerance despite major impacts on livelihoods. Instead, intangible costs and intangible benefits were significant factors determining tolerance. Furthermore, reducing people's exposure to elephants would not necessarily affect tolerance, nor would increasing positive interactions. We discuss how the socio-economic and bio-cultural dynamics of local communities can explain these results, and demonstrate how our model can be used to incorporate such complexities into conservation decision-making. For instance, compensation schemes aim to recompense monetary losses and direct damages, to improve tolerance, whereas our results suggest a more effective approach would be to enhance resilience to non-monetary costs and improve perceived benefits. We conclude that future studies should pay increased attention to intangible costs and consider the less direct drivers of tolerance. Through repeated testing of universal models such as that presented here, broad trends may emerge that will facilitate the application of policies across contexts and landscapes.

Ruda, A., J. Kolejka and A. T. Silwal (2020). "Spatial Concentrations of Wildlife Attacks on Humans in Chitwan National Park, Nepal." *Animals (Basel)* 10(1).

The study was conducted within and adjacent to Chitwan National Park in Nepal (CNP), where several wildlife species are involved in conflicts with humans. We assessed the spatial relationships between the number of victims/km<sup>2</sup> (=victim density or VD) of attack by wildlife (elephant, rhino, wild boar, sloth bear, leopard or tiger) versus landscape features, including both natural habitat type and land use by humans (e.g., nursery, orchard or cultivated). We identified four levels of VD, ranging from <1 V (victim)/4 km<sup>2</sup> to >1 V/2 km<sup>2</sup> for each land use zone, then tested for correlations at one or more of those VD between each pair of wildlife species across different land use types. Our results high correlation for sloth bear and leopard ( $r \approx 0.8$ ), for all species except elephant and wild boar at  $VD > 1 V/4 km^2$  ( $r > 0.9$ ) and for leopard vs. rhinoceros ( $r = 0.99$ ) across land use types at  $1 V/4 km^2$ ) indicate some risk-reduction measures. One of them would be division of each buffer zone into three concentric rings, for instance ranging from high-risk adjacent areas to areas of high use by humans, to low-risk where human use is low. This revision would facilitate giving local people more voice in implementing conservation measures and reducing risks.

Karanth, K. K. and A. Vanamamalai (2020). "Wild Seve: A Novel Conservation Intervention to Monitor and Address Human-Wildlife Conflict." *Frontiers in Ecology and Evolution* 8.

Human-wildlife interactions resulting in conflict remains a global conservation challenge, requiring innovative solutions to ensure the persistence of wildlife amidst people. Wild Seve was established in July 2015 as a conservation intervention program to assist people affected by conflict to file and monitor claims and receive ex-gratia payments from the Indian government. In 48 months of operation, Wild Seve filed and tracked 13,808 claims on behalf of those affected from 19 forest ranges around the Bandipur and Nagarahole National Parks in Karnataka, India. This included 10,082 incidents of crop loss, 1,176 property damage incidents, and 1,720 incidents where crop and property loss occurred together. Wild Seve also filed claims for 782 livestock predation incidents, and assisted in 45 human injury incidents and three human fatalities. Elephant related losses comprised 93.9%, and big cat losses comprised 5.5% of reported cases. Wild Seve provides an immediate response to human-wildlife conflict incidents and improves access to ex-gratia payment schemes. Wild Seve is a low cost intervention that uses open-source technology and leverages existing policies to facilitate ex-gratia payments. The Wild Seve model of monitoring and addressing human-wildlife conflict is adaptable and scalable to high conflict regions globally, to the benefit of people and wildlife. © Copyright © 2020 Karanth and Vanamamalai.

Dharmarathne, C., C. Fernando, C. Weerasinghe and R. Corea (2020). "Project orange elephant is a conflict specific holistic approach to mitigating human-elephant conflict in Sri Lanka." *Commun Biol* 3(1): 43.

Human-wildlife conflicts are an increasing problem as human land use encroaches on wildlife habitats. Augmenting farmers' crops with orange trees through Project Orange Elephant has proven to be a simple and effective method for mitigating human-elephant conflicts in Sri Lanka. Similar endeavours could be applied elsewhere in the world.

Chathuranga Dharmarathne et al. discuss an innovative conservation project to reduce human-elephant conflict in Sri Lanka. This project uses citrus trees to repel elephants from farms, thereby reducing crop loss among farmers and providing additional income.

eng for the Sri Lanka Wildlife Conservation Society.

Puyravaud, E.-P., S. Gubbi, H. C. Poornesha and P. Davidar (2019). "Deforestation Increases Frequency of Incidents With Elephants (*Elephas maximus*)."  
*Tropical Conservation Science* 12.

Damages by the Asian elephant (*Elephas maximus*) range from crop raiding to loss of human lives, and understanding the underlying causes thereof could help reduce such incidents. Land-use change could be among the major causes of elephant incidents since they are long-lived and tend to have particular home ranges. To test this hypothesis, we assessed deforestation rates in sites between the Nilgiris Biosphere Reserve and the Bhadra Tiger Reserve, Western Ghats of

India between the 1960s and 2000s. Deforestation was calculated in windows of varying sizes to account for spatial scale responses. The locations of 624 incidents between April 2008 and March 2011 were used, and a database of 20,000 random locations provided contrasts. We used sets of 250 logistic regressions at each scale of deforestation to ensure that the significance of deforestation was independent of the randomly sampled contrast locations. A total of 6,761 km<sup>2</sup> of forest and scrubland have disappeared from private forests in 50 years, with an average deforestation rate of  $-0.85\% \cdot y^{-1}$ . The distribution of incidents followed an exponential decay with increasing distance from protected areas and a beta distribution against deforestation. Logistic regressions indicated a significant effect of deforestation at the small scale (1 km<sup>2</sup> particularly and 4 km<sup>2</sup>). These results show that (a) incidents occur mostly near protected areas, and barriers or adaptation of livelihoods could address this problem and (b) deforestation is associated with increasing incidents with elephants. Avoiding deforestation and maintaining elephant population connectivity may help avoid incidents.

Othman, N., B. Goossens, C. P. I. Cheah, S. Nathan, R. Bumpus and M. Ancrenaz (2019). "Shift of paradigm needed towards improving human-elephant coexistence in monoculture landscapes in Sabah." *International Zoo Yearbook* 53(1): 161-173.

This article outlines the contemporary situation of the Bornean elephant *Elephas maximus borneensis* in Sabah (Malaysian Borneo), and focuses on the existing challenges that need to be addressed to enable people and elephants to coexist, particularly in man-made landscapes dominated by oil-palm plantations. Bornean elephants are confined mostly to Sabah, to the north-east 5% of the Borneo Island. Sabah started to expand its commercial plantation sector in the early 1980s and is the largest producer of palm oil in Malaysia, contributing c. 10% of global output for this commodity. The rapid pace of plantation expansion has resulted in the loss of the majority of lowland areas that are also needed by large mammal species to sustain breeding populations. Elephants are extreme lowland/floodplain specialists, and they still attempt to use their former and preferred habitat, which is now mostly dominated by oil-palm plantations. At the time of writing, the land-use planning system favoured by the government insufficiently incorporates the ecological and management needs for elephants across the entire landscape. This article also highlights the need for better collaboration and coordination between stakeholders to address the increasing rate of human-elephant conflicts in Sabah.

Naha, D., S. Sathyakumar, S. Dash, A. Chettri and G. S. Rawat (2019). "Assessment and prediction of spatial patterns of human-elephant conflicts in changing land cover scenarios of a human-dominated landscape in North Bengal." *PLoS ONE* 14(2): e0210580.

It is of utmost importance to research on the spatial patterns of human-wildlife conflicts to understand the underlying mechanism of such interactions, i.e. major land use changes and prominent ecological drivers. In the north eastern part of India there has been a disparity between nature, economic development and fragmentation of wildlife habitats leading to intense conflicts between humans

and Asian elephants (*Elephas maximus*) in recent times. Both the elephant and human population have increased in the past few decades with large tracts of forests converted to commercial tea plantations, army camps and human settlements. We analyzed data maintained by the wildlife department on human deaths and injuries caused by elephant attacks between 2006-2016 to understand spatial and temporal patterns of human-elephant conflict, frequency and distribution. The average annual number of human deaths and injuries to elephant attacks between 2006 to 2016 was estimated to be 212 (SE 103) with the highest number of such incidents recorded in 2010-2011. Based on a grid based design of 5 km<sup>2</sup> and 25 km<sup>2</sup> resolution, the main spatial predictors of human-elephant conflicts identified through Maxent presence only models are annual mean precipitation, altitude, distance from protected area, area under forests, tea plantations and agriculture. Major land use changes were assessed for this region from 2008 to 2018 using satellite imageries in Arc GIS and a predicted imagery of 2028 was prepared using Idrisi Selva. Based on the 2018 imagery it was found that forest area had increased by 446 km<sup>2</sup> within 10 years (2008-2018) and the annual rate of change was 12%. Area under agriculture had reduced by 128 km<sup>2</sup> with an annual (-) rate of change of 2.5%. Area under tea plantation declined by 307 km<sup>2</sup> with an annual (-) rate of change of 12% whereas area under human settlements increased by 61 km<sup>2</sup> with an annual (-) rate of change of 44%. Hotspots of human-elephant conflicts were identified in an east west direction primarily around protected areas, tea plantations and along major riverine corridors. During informal interactions with farmers, tea estate labors it was revealed that local community members chased and harassed elephants from agriculture fields, human settlements under the influence of alcohol and thus were primary victims of fatal interactions. Our analytical approach can be replicated for other species in sites with similar issues of human-wildlife conflicts. The hotspot maps of conflict risk will help in developing appropriate mitigation strategies such as setting up early warning systems, restoration of wildlife corridors especially along dry river beds, using deterrents and barriers for vulnerable. Awareness about alcohol related incidents and basic biology of elephants should be organized regularly involving non-governmental organizations targeting the marginalized farmers and tea estate workers.

Mukul, S. A., S. Huq, J. Herbohn, A. Nishat, A. A. Rahman, R. Amin and F. U. Ahmed (2019). "Rohingya refugees and the environment." *Science* 364(6436): 138.

Fernando, P., M. K. C. R. De Silva, L. K. A. Jayasinghe, H. K. Janaka and J. Pastorini (2019). "First country-wide survey of the Endangered Asian elephant: Towards better conservation and management in Sri Lanka." *Oryx*: 1-10.

The Endangered Asian elephant *Elephas maximus* comes into widespread conflict with agrarian communities, necessitating active management. The species' distribution is of primary importance for management planning. However, data-based countrywide distribution maps have not been available for any of the 13 Asian elephant range states. We conducted a 5 × 5 km grid-based questionnaire

survey in Sri Lanka to produce an island-wide elephant distribution map. Elephants occur over 59.9% of Sri Lanka and people are resident in 69.4% of elephant range, indicating the challenge of separating people and elephants at a landscape scale. Elephants in Sri Lanka have lost 16.1% of their range since 1960 but their current distribution remains largely contiguous. We found the range of adult males was 15.1% greater, and less seasonal, than that of herds, possibly because males have a higher tolerance for conflict with people. The distribution of conflict coincided with the co-occurrence of humans and elephants. We conclude that a human-elephant coexistence model is the only viable option for effectively mitigating human-elephant conflict and conserving elephants in Sri Lanka. The findings are currently being used to effect a paradigm change in elephant conservation and management in the country. © 2019 Fauna & Flora International.

Branco, P. S., J. A. Merkle, R. M. Pringle, J. Pansu, A. B. Potter, A. Reynolds, M. Stalmans and R. A. Long (2019). "Determinants of elephant foraging behaviour in a coupled human-natural system: Is brown the new green?" *J Anim Ecol* 88(5): 780-792.

Crop raiding by wildlife poses major threats to both wildlife conservation and human well-being in agroecosystems worldwide. These threats are particularly acute in many parts of Africa, where crop raiders include globally threatened megafauna such as elephants, and where smallholder agriculture is a primary source of human livelihood. One framework for understanding herbivore feeding behaviour, the forage-maturation hypothesis, predicts that herbivores should align their movements with intermediate forage biomass (i.e., peak green-up); this phenomenon is known as "surfing the green wave." Crop-raiding elephants, however, often consume not just foliage, but also fruits and tubers (e.g., maize and potatoes), which generally mature after seasonal peaks in photosynthetic activity. Thus, although elephants have been reported to surf the green wave in natural habitats, they may utilize a different strategy in cultivated landscapes by selecting crops that are "browning down." We sought to understand the factors that underpin movement of elephants into agricultural landscapes. In Mozambique's Gorongosa National Park, we used movement data from GPS-collared elephants, together with precipitation records, remotely sensed estimates of landscape greenness (NDVI), DNA-based diet analysis, measurements of plant nutritional quality and survey-based metrics of crop availability to understand spatiotemporal variation in elephant crop-raiding behaviour. Elephants tracked peak NDVI while foraging inside the Park. During the dry season, however, when NDVI within the Park declined and availability of mature crops was high, crop raiding increased dramatically, and elephants consistently selected crop plants that were browning down while foraging in cultivated landscapes. Crops contained significantly higher digestible energy than wild food plants, but comparable (and sometimes lower) levels of digestible protein, suggesting that this foraging strategy maximized energy rather than protein intake. Our study is the first to combine GPS tracking data with high-resolution diet analysis and community-based reporting of crop availability to reveal fine-scale plasticity in foraging

behaviour of elephants at the human-wildlife interface. Our results extend the forage-maturation hypothesis by showing that elephants surf waves of plant brown-down in cultivated landscapes. These findings can aid efforts to reduce human-elephant conflict by enabling wildlife managers to prioritize mitigation actions in time and space with limited resources.

Wright, M. G., C. Spencer, R. M. Cook, M. D. Henley, W. North and A. Mafra-Neto (2018). "African bush elephants respond to a honeybee alarm pheromone blend." *Curr Biol* 28(14): R778-r780.

We here report the responses of African bush elephants (*Loxodonta africana*) to a crude approximation of the honeybee alarm pheromone blend. We show that the elephants had an avoidance response to the semiochemical blend. The use of honeybee alarm pheromones to manage elephant movements in a non-invasive manner, using natural cues to which elephants may have an evolved response, holds potential for development of new options for an integrated system for elephant movement management and protection.

Suba, R. B., J. van der Ploeg, M. van't Zelfde, Y. W. Lau, T. F. Wissingh, W. Kustiawan, G. R. de Snoo and H. H. de Iongh (2017). "Rapid Expansion of Oil Palm Is Leading to Human-Elephant Conflicts in North Kalimantan Province of Indonesia." *Tropical Conservation Science* 10: 1-12.

Crop raiding by Bornean elephants (*Elephas maximus borneensis*) is increasing rapidly in North Kalimantan, mainly due to a rapid conversion of swiddens and secondary forest into oil palm plantations. In the Tulin Onsoi subdistrict, the area used by oil palm plantations has grown from 3,302.71 ha in 2001 to 21,124.93 ha in 2014. Particularly from 2006 to 2010, the area covered by oil palm plantations increased rapidly (418%). Preventing further encroachment of oil palm plantations in elephant habitat and regulating land use change are keys to stop further population declines and make way for the reestablishment of a viable elephant population in Kalimantan. Crop raiding is a strong determinant of the local people's perceptions of elephants and risks eroding cultural values that enabled people to coexist with elephants. People's perception and attitude toward elephants are generally negative. Nevertheless, negative attitudes have not led to cases of retaliation in the Tulin Onsoi subdistrict. Public education at the community level could strengthen cultural values and foster coexistence between humans and elephants.

Smit, J., R. A. Pozo, J. J. Cusack, K. Nowak and T. Jones (2017). "Using camera traps to study the age-sex structure and behaviour of crop-using elephants *Loxodonta africana* in Udzungwa Mountains National Park, Tanzania." *Oryx*: 1-9.

Crop losses to foraging elephants are one of the primary obstacles to the coexistence of elephants and people. Understanding whether some individuals in a

population are more likely to forage on crops, and the temporal patterns of elephant visits to farms, is key to mitigating the negative impacts of elephants on farmers' livelihoods. We used camera traps to study the crop foraging behaviour of African elephants *Loxodonta africana* in farmland adjacent to the Udzungwa Mountains National Park in southern Tanzania during October 2010–August 2014. Camera traps placed on elephant trails into farmland detected elephants on 336 occasions during the study period. We identified individual elephants for 126 camera-trap detections. All were independent males, and we identified 48 unique bulls aged 10–29 years. Two-thirds of the bulls identified were detected only once by camera traps during the study period. Our findings are consistent with previous studies that found that adult males are more likely to adopt high-risk feeding behaviours such as crop foraging, although young males dispersing from maternal family units also consume crops in Udzungwa. We found a large number of occasional crop-users (32 of the 48 bulls identified) and a smaller number of repeat crop-users (16 of 48), suggesting that lethal control of crop-using elephants is unlikely to be an effective long-term strategy for reducing crop losses to elephants. Copyright © Fauna & Flora International 2017

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.

Songhurst, A., M. Chase and T. Coulson (2015). "Using simulations of past and present elephant (*Loxodonta africana*) population numbers in the Okavango Delta Panhandle, Botswana to improve future population estimates." *Wetlands Ecology and Management* 23(4): 583-602.

An ability to reliably estimate population numbers, trends and densities of wildlife has a prominent role in conservation and management of wetlands. We use aerial surveys and simulation techniques to explore the results of past and

present elephant population surveys in the Okavango Delta Panhandle, Botswana, and use these to propose a technique of simulation to improve counts in the future. Population numbers and density estimates from past survey results show large fluctuations, which are unlikely to come from reproduction. Reasons for such variations could be attributed to imprecision in survey techniques or may be because only part of the elephant range is being surveyed. Simulated surveys of hypothetical elephant populations were used to explore the effect of different survey techniques, spatial distributions of animals and spatial scale on the precision of aerial survey population estimates and trends. Our study reveals the usefulness of using simulations to test the reliability of survey data and plan more efficient surveys. We also find that while there may be some uncertainty in individual population estimates, there is more certainty in the recorded trends. These findings reinforce the need to address elephant management in the Okavango and surrounding wetland systems and call for the urgent consideration of management strategies such as fence realignments to affect the objectives of the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA) initiative, which will help relieve elephant population pressure.

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.

Bond, J. (2015). "Making Sense of Human-Elephant Conflict in Laikipia County, Kenya." *Society & Natural Resources* 28(3): 312-327.

This article proposes sensemaking theory to understand human-elephant interactions. The article draws on a case study of human-elephant interaction in Laikipia County, Kenya, to understand how farmers make sense of elephants in their crops. Drawing on eight interviews, the analysis showed that respondents rely on various environmental and social cues to perceive an elephant in their crop and select a plausible course of action. The article illustrates that actors' degree of ecological embeddedness will influence their sensemaking processes and supports



the argument for the inclusion of ecological materiality within sensemaking studies. The article also argues for further research into the interactions of humans and elephants, including the gender and institutional dimensions of farmers' sensemaking processes.

Alamgir, M., S. A. Mukul and S. M. Turton (2015). "Modelling spatial distribution of critically endangered Asian elephant and Hoolock gibbon in Bangladesh forest ecosystems under a changing climate." *Applied Geography* 60: 10-19.

The Asian elephant (*Elephas maximus*) and Hoolock gibbon (*Hoolock hoolock*) are two globally endangered wildlife species limited to only tropical Asian forests. In Bangladesh both species are critically endangered and distributed mainly in the northeast and southeast hilly regions bordering neighboring India and Myanmar. Using existing distribution data, land-use/land cover, elevation and bio-climatic variables, we modeled the likely distribution of Asian elephant and Hoolock gibbon in Bangladesh for 2050 and 2070. We used the IPCC's Representative Concentration Pathways (RCPs) - RCP6.0 and RCP8.5 and Maximum Entropy algorithm for our modelling. Our study indicated that the Asian elephant will be more resilient to climate change compared with the Hoolock gibbon. Habitat loss for the Asian elephant is also expected to remain constant (i.e. 38%) throughout the period, whilst Hoolock gibbon habitat will be more sensitive to climatic variations, with the species predicted to be extirpated from the country by 2070. Being highly exposed to climate change with ever increasing land use pressures, we believe our study in Bangladesh can be used to enhance our understanding of future vulnerabilities of wildlife in a rapidly changing climate. A trans-boundary conservation program with greater attention to the species that are less resilient to climate change is also essential. © 2015 Elsevier Ltd.

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.

Wierer, M., A. K. Schrey, R. Kuhne, S. E. Ulbrich and H. H. Meyer (2012). "A single glycine-alanine exchange directs ligand specificity of the elephant progesterin receptor." *PLoS ONE* 7(11): e50350.

The primary gestagen of elephants is 5 $\alpha$ -dihydroprogesterone (DHP), which is unlike all other mammals studied until now. The level of DHP in elephants equals that of progesterone in other mammals, and elephants are able to bind DHP with similar affinity to progesterone indicating a unique ligand-binding specificity of the elephant progesterin receptor (PR). Using site-directed mutagenesis in combination with *in vitro* binding studies we here report that this change in specificity is due to a single glycine to alanine exchange at position 722 (G722A) of PR, which specifically increases DHP affinity while not affecting binding of progesterone. By conducting molecular dynamics simulations comparing human and elephant PR ligand-binding domains (LBD), we observed that the alanine methyl group at position 722 is able to push the DHP A-ring into a position similar to progesterone. In the human PR, the DHP A-ring position is twisted towards helix 3 of PR thereby disturbing the hydrogen bond pattern around the C3-keto group, resulting in a lower binding affinity. Furthermore, we observed that the elephant PR ligand-binding pocket is more rigid than the human analogue, which probably explains the higher affinity towards both progesterone and DHP. Interestingly, the G722A substitution is not elephant-specific, rather it is also present in five independent lineages of mammalian evolution, suggesting a special role of the substitution for the development of distinct mammalian gestagen systems.

Walker, K. L. (2012). "Labor costs and crop protection from wildlife predation: The case of elephants in Gabon." *Agricultural Economics* 43(1): 61-73.

Crop raiding by wildlife decreases agricultural productivity and hinders efforts to reduce poverty throughout the world and especially in Africa. Efforts to reduce crop raiding in developing countries generally involve prescriptive "low-cost" protection methods at the level of the individual farm, under the assumption that monetary capital and knowledge are the principal limiting factors in farmers' adoption of protection methods. This article highlights the importance of considering labor costs in addition to monetary costs when assessing the adoptability of protection strategies. Benefit-cost analysis is used to inform a theoretical model of the likelihood of farmer adoption of methods to protect crops against elephants in Gabon. Supported by empirical findings from a binomial logit model of farmers' protection decisions, this analysis elucidates the low rate of

adoption for known protection methods in Gabon. While the empirical data are specific to Gabon, this analysis frames a reflection process regarding labor optimization and alternative strategies that applies broadly. © 2011 International Association of Agricultural Economists.

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-km<sup>2</sup> 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. © 2012 Srinivasaiah et al.

Ghosal, R., P. B. Seshagiri and R. Sukumar (2012). "Dung as a potential medium for inter-sexual chemical signaling in Asian elephants (*Elephas maximus*)." Behavioural Processes 91(1): 15-21.

Chemical signaling is a prominent mode of male-female communication among elephants, especially during their sexually active periods. Studies on the Asian elephant in zoos have shown the significance of a urinary pheromone (Z7-12:Ac) in conveying the reproductive status of a female toward the opposite sex. We investigated the additional possibility of an inter-sexual chemical signal being conveyed through dung. Sixteen semi-captive adult male elephants were

presented with dung samples of three female elephants in different reproductive phases. Each male was tested in 3 separate trials, within an interval of 1-3 days. The trials followed a double-blind pattern as the male and female elephants used in the trials were strangers, and the observer was not aware of the reproductive status of females during the period of bioassays. Males responded preferentially ( $P < 0.005$ ), in terms of higher frequency of sniff, check and place behavior toward the dung of females close to pre-ovulatory period (follicular-phase) as compared to those in post-ovulatory period (luteal-phase). The response toward the follicular phase samples declined over repeated trials though was still significantly higher than the corresponding response toward the non-ovulatory phase in each of the trials performed. This is the first study to show that male Asian elephants were able to distinguish the reproductive phase of the female by possibly detecting a pre-ovulatory pheromone released in dung. © 2012 Elsevier B.V.

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.

Lindsell, J. A., E. Klop and A. M. Siaka (2011). "The impact of civil war on forest wildlife in West Africa: Mammals in Gola Forest, Sierra Leone." *Oryx* 45(1): 69-77.

Human conflicts may sometimes benefit wildlife by depopulating wilderness areas but there is evidence from Africa that the impacts tend to be negative. The forested states of West Africa have experienced much recent human conflict but there have been no assessments of impacts on the wildlife. We conducted surveys of mammals in the 710-km<sup>2</sup> Gola Forest reserves to assess the impact of the 1991-2001 civil war in Sierra Leone. Gola is the most important remaining tract of lowland forest in the country and a key site for the conservation of the highly threatened forests of the Upper Guinea region. We found that Gola has survived well despite being in the heart of the area occupied by the rebels. We recorded 44 species of larger mammal, including 18 threatened, near-threatened and endemic species, accounting for all species recorded in pre-war surveys and adding several more (African buffalo *Syncerus caffer nanus* and water chevrotain *Hyemoschus aquaticus*). Populations of primates were healthy with little evidence of decline. Duiker detection rates were low and further work is required to confirm their numbers as they include five species endemic (or near endemic) to the Upper

Guinea region, three of which are threatened. However, the population of African forest elephants *Loxodonta cyclotis* has collapsed, with only a few individuals remaining from c. 110 in the mid 1980s. We conclude that peacetime pressures from the bushmeat trade, clearance for agriculture, logging and mining are likely to be far greater for Gola than the pressures from the civil war. © 2011 Fauna & Flora International.

Kuntner, M., L. J. May-Collado and I. Agnarsson (2011). "Phylogeny and conservation priorities of afrotherian mammals (Afrotheria, Mammalia)." *Zoologica Scripta* 40(1): 1-15.

Phylogenies play an increasingly important role in conservation biology providing a species-specific measure of biodiversity - evolutionary distinctiveness (ED) or phylogenetic diversity (PD) - that can help prioritize conservation effort. Currently, there are many available methods to integrate phylogeny and extinction risk, with an ongoing debate on which may be best. However, the main constraint on employing any of these methods to establish conservation priorities is the lack of detailed species-level phylogenies. Afrotheria is a recently recognized clade grouping anatomically and biologically diverse placental mammals: elephants and mammoths, dugong and manatees, hyraxes, tenrecs, golden moles, elephant shrews and armadillo. To date, phylogenetic studies have focused on understanding higher level relationships among the major groups within Afrotheria. Here, we provide a species-level phylogeny of Afrotheria based on nine molecular loci, placing nearly 70% of the extant afrotherian species (50) and five extinct species. We then use this phylogeny to assess conservation priorities focusing on the widely used evolutionary distinctiveness and global endangeredness (EDGE) method and how that compares to the more recently developed PD framework. Our results support the monophyly of Afrotheria and its sister relationship to Xenarthra. Within Afrotheria, the basal division into Afroinsectiphilia (armadillo, tenrecs, golden moles and elephant shrews) and Paenungulata (hyraxes, dugongs, manatees and elephants) is supported, as is the monophyly of all afrotherian families: Elephantidae, Procaviidae, Macroscelididae, Chrysochloridae, Tenrecidae, Trichechidae and Dugongidae. Within Afroinsectiphilia, we recover the most commonly proposed topology (Tubulidentata sister to Afroscorica plus Macroscelidea). Within Paenungulata, Sirenia is sister to Hyracoidea plus Proboscidea, a controversial relationship supported by morphology. Within Proboscidea, the mastodon is sister to the remaining elephants and the woolly mammoth sister to the Asian elephant, while both living elephant genera, *Loxodonta* and *Elephas* are paraphyletic. Top ranking evolutionarily unique species always included the armadillo, followed by several species of elephant shrews and tenrecs. For conservation priorities top ranking species always included the semi-aquatic Nimba otter shrew, some poorly known species, such as the Northern shrew tenrec, web-footed tenrec, giant otter shrew and Giant golden mole, as well as high profile conservation icons like Asian elephant, dugong and the three species of manatee. Conservation priority analyses were broadly congruent between the EDGE and PD methodologies. However, for certain species EDGE overestimates conservation urgency as it,

unlike PD, fails to account for the status of closely related, but less threatened, species. Therefore, PD offers a better guide to conservation decisions. © 2010 The Authors. *Zoologica Scripta* © 2010 The Norwegian Academy of Science and Letters.

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.

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.

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.

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.

Rabanal, L. I., H. S. Kuehl, R. Mundry, M. M. Robbins and C. Boesch (2010). "Oil prospecting and its impact on large rainforest mammals in Loango National Park, Gabon." *Biological Conservation* 143(4): 1017-1024.

Resource extraction is increasingly affecting protected areas worldwide. However, aside from studies on logging, limited information is available about the effect this has on wildlife, which may be of great consequence, especially when endangered species could be affected. Specifically, the effect of intense human-induced noise during oil exploration on wildlife is poorly understood. We explore the effect of seismic oil exploration on large mammal distribution in an 80 km<sup>2</sup> area of Loango National Park, Gabon. Following the ecological theory of habitat disturbance, we predicted that changes in habitat use in response to noise disturbance would scale with the body/home range size of each species examined. Our study was conducted over six months before, during and after low-impact seismic operations. We recorded counts along transects of indirect signs of elephants (*Loxodonta africana cyclotis*), chimpanzees (*Pan troglodytes troglodytes*), gorillas (*Gorilla gorilla gorilla*), duikers (*Cephalophus* spp.), and the vocalizations of five monkey species (*Cercocebus torquatus*, *Cercopithecus cephus*, *C. nictitans*, *C. pogonias* and *Lophocebus albigena*) and modeled seismic impact over different spatial scales (small, intermediate and large). We found that elephants avoided seismic activity on all three spatial scales, apes avoided on the intermediate and small scales, and there was no effect for duikers and monkeys. We conclude that low-impact seismic operations can cause considerable temporary habitat loss for species with large ranges and suggest that the impact on those endangered species can be minimized by adequately spacing seismic lines and activity in space and time to enable species to move away from the progressive noise disruption. © 2010 Elsevier Ltd. All rights reserved.

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. © 2009 Fauna & Flora International.

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 Africa's 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.

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.

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.

Tripp, K. M., M. Dubois, P. Delahaut and J. P. Versteegen (2009). "Detection and identification of plasma progesterone metabolites in the female Florida manatee (*Trichechus manatus latirostris*) using GC/MS/MS 54." *Theriogenology* 72(3): 365-371.

Florida manatees (*Trichechus manatus latirostris*) have relatively low peripheral concentrations of progesterone (P4). The objective of this study was to determine if these relatively low P4 concentrations are associated with a high ratio of progestin metabolites and to document metabolite concentrations from individual blood samples obtained from manatees during diestrus or pregnancy. Metabolites known to exist in elephants—terrestrial manatee relatives—were targeted. These included 5 $\alpha$ -reduced progestins (5 $\alpha$ -pregnane-3,20-dione [5 $\alpha$ -DHP] and 3 $\alpha$ -hydroxy-5 $\alpha$ -pregnan-20-one [5 $\alpha$ -P3-OH]) and 17 $\alpha$ -hydroxyprogesterone (17 $\alpha$ -OHP), which occurs in Asian elephants. An additional, inactive metabolite, 20 $\alpha$ -hydroxyprogesterone (20 $\alpha$ -OHP), indicative of P4 overproduction, was also targeted. Progesterone itself was the predominant progestin detected in pregnant and nonpregnant manatee plasma (n = 10) using gas chromatography-mass spectrometry with tandem quadrupole detectors (GC/MS/MS). Progesterone concentrations in pregnant females varied from early (moderate to high) through mid and late (low) pregnancy. Progesterone concentrations ranged from low to high in nonpregnant, nonlactating females. The most commonly detected metabolite was 5 $\alpha$ -P3-OH (n = 7),

which occurred in pregnant (lower limit of detection [LLOD] to high) and nonpregnant (trace to high) females. The 5alpha-DHP metabolite was also detected in pregnant (LLOD to moderate) and nonpregnant (low) females. The 17alpha-OHP metabolite was not detected in any tested female. The 20alpha-OHP metabolite was detected in one nonpregnant, nonlactating, captive female (LLOD). Metabolites were most prevalent during early pregnancy, concurrent with maximum P4 concentrations. Based on their concentrations in peripheral circulation, we inferred that these metabolites may have, opposite to elephants, a limited physiologic role during luteal, pregnant, and nonpregnant phases in the manatee

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. © 2008 Elsevier Ltd. All rights reserved.

Liu, A. G. S. C., E. R. Seiffert and E. L. Simons (2008). "Stable isotope evidence for an amphibious phase in early proboscidean evolution." *Proceedings of the National Academy of Sciences of the United States of America* 105(15): 5786-5791.

The order Proboscidea includes extant elephants and their extinct relatives and is closely related to the aquatic sirenians (manatees and dugongs) and terrestrial hyracoids (hyraxes). Some analyses of embryological, morphological, and paleontological data suggest that proboscideans and sirenians shared an aquatic or semiaquatic common ancestor, but independent tests of this hypothesis have proven elusive. Here we test the hypothesis of an aquatic ancestry for

advanced proboscideans by measuring  $\delta^{18}\text{O}$  in tooth enamel of two late Eocene proboscidean genera, *Barytherium* and *Moeritherium*, which are sister taxa of Oligocene-to-Recent proboscideans. The combination of low  $\delta^{18}\text{O}$  values and low  $\delta^{18}\text{O}$  standard deviations in *Barytherium* and *Moeritherium* matches the isotopic pattern seen in aquatic and semiaquatic mammals, and differs from that of terrestrial mammals.  $\delta^{13}\text{C}$  values of these early proboscideans suggest that both genera are likely to have consumed freshwater plants, although a component of  $\text{C}_3$  terrestrial vegetation cannot be ruled out. The simplest explanation for the combined evidence from isotopes, dental functional morphology, and depositional environments is that *Barytherium* and *Moeritherium* were at least semiaquatic and lived in freshwater swamp or riverine environments, where they grazed on freshwater vegetation. These results lend new support to the hypothesis that Oligocene-to-Recent proboscideans are derived from amphibious ancestors. © 2008 by The National Academy of Sciences of the USA.

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 current and 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.

Hill, R. A., R. A. Bentley and R. I. Dunbar (2008). "Network scaling reveals consistent fractal pattern in hierarchical mammalian societies." *Biol Lett* 4(6): 748-751.

Recent studies have demonstrated that human societies are hierarchically structured with a consistent scaling ratio across successive layers of the social network; each layer of the network is between three and four times the size of the preceding (smaller) grouping level. Here we show that similar relationships hold

for four mammalian taxa living in multi-level social systems. For elephant (*Loxodonta africana*), gelada (*Theropithecus gelada*) and hamadryas (*Papio hamadryas hamadryas*) baboon, successive layers of social organization have a scaling ratio of almost exactly 3, indicating that such branching ratios may be a consistent feature of all hierarchically structured societies. Interestingly, the scaling ratio for orca (*Orcinus orca*) was 3.8, which might mean that aquatic environments place different constraints on the organization of social hierarchies. However, circumstantial evidence from a range of other species suggests that scaling ratios close to 3 may apply widely, even in species where hierarchical social structures have not traditionally been identified. These results identify the origin of the hierarchical, fractal-like organization of mammalian social systems as a fundamental question.

Carter, A. M., M. A. Miglino, C. E. Ambrosio, T. C. Santos, F. C. Rosas, J. A. Neto, S. M. Lazzarini, A. F. Carvalho and V. M. da Silva (2008). "Placentation in the Amazonian manatee (*Trichechus inunguis*)." *Reprod. Fertil. Dev* 20(4): 537-545.

Evidence from several sources supports a close phylogenetic relationship between elephants and sirenians. To explore whether this was reflected in similar placentation, we examined eight delivered placentae from the Amazonian manatee using light microscopy and immunohistochemistry. In addition, the fetal placental circulation was described by scanning electron microscopy of vessel casts. The manatee placenta was zonary and endotheliochorial, like that of the elephant. The interhaemal barrier comprised maternal endothelium, cytotrophoblasts and fetal endothelium. We found columnar trophoblast beneath the chorionic plate and lining lacunae in this region, but there was no trace in the term placenta of haemophagous activity. The gross anatomy of the cord and fetal membranes was consistent with previous descriptions and included a four-chambered allantoic sac, as also found in the elephant and other afrotherians. Connective tissue septae descended from the chorionic plate and carried blood vessels to the labyrinth, where they gave rise to a dense capillary network. This appeared to drain into shorter vessels near the chorionic plate. The maternal vasculature could not be examined in the same detail, but maternal capillaries ran rather straight and roughly parallel to the fetal ones. Overall, there is a close resemblance in placentation between the manatee and the elephant

Asher, R. J. and T. Lehmann (2008). "Dental eruption in afrotherian mammals." *BMC Biol* 6.

Background: Afrotheria comprises a newly recognized clade of mammals with strong molecular evidence for its monophyly. In contrast, morphological data uniting its diverse constituents, including elephants, sea cows, hyraxes, armadillos, sengis, tenrecs and golden moles, have been difficult to identify. Here, we suggest relatively late eruption of the permanent dentition as a shared characteristic of afrotherian mammals. This characteristic and other features (such as vertebral anomalies and testicondy) recall the phenotype of a human genetic pathology (cleidocranial dysplasia), correlations with which have not been explored previously in the context of character evolution within the recently established

phylogeny of living mammalian clades. Results: Although data on the absolute timing of eruption in sengis, golden moles and tenrecs are still unknown, craniometric comparisons for ontogenetic series of these taxa show that considerable skull growth takes place prior to the complete eruption of the permanent cheek teeth. Specimens showing less than half (sengis, golden moles) or two-thirds (tenrecs, hyraxes) of their permanent cheek teeth reach or exceed the median jaw length of conspecifics with a complete dentition. With few exceptions, afrotherians are closer to median adult jaw length with fewer erupted, permanent cheek teeth than comparable stages of non-afrotherians. Manatees (but not dugongs), elephants and hyraxes with known age data show eruption of permanent teeth late in ontogeny relative to other mammals. While the occurrence of delayed eruption, vertebral anomalies and other potential afrotherian synapomorphies resemble some symptoms of a human genetic pathology, these characteristics do not appear to covary significantly among mammalian clades. Conclusion: Morphological characteristics shared by such physically disparate animals such as elephants and golden moles are not easy to recognize, but are now known to include late eruption of permanent teeth, in addition to vertebral anomalies, testicondy and other features. Awareness of their possible genetic correlates promises insight into the developmental basis of shared morphological features of afrotherians and other vertebrates. © 2008 Asher and Lehmann; licensee BioMed Central Ltd.

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.

Redi, C. A., S. Garagna, M. Zuccotti and E. Capanna (2007). "Genome size: A novel genomic signature in support of Afrotheria." *Journal of Molecular Evolution* 64(4): 484-487.

Molecular phylogenetic analyses suggest an emerging phylogeny for the extant Placentalia (eutherian) that radically departs from morphologically based constructions of the past. Placental mammals are partitioned into four supraordinal clades: Afrotheria, Xenarthra, Laurasiatheria, and Euarchontoglires. Afrotheria form an endemic African clade that includes elephant shrews, golden moles, tenrecs, armadillos, hyraxes, elephants, dugongs, and manatees. Datamining databases of genome size (GS) shows that till today just one afrotherian GS has been evaluated, that of the armadillo *Orycteropus afer*. We show that the GSs of six selected representatives across the Afrotheria supraordinal group are among the highest for the extant Placentalia, providing a novel genomic signature of this enigmatic group. The mean GS value of Afrotheria,  $5.3 \pm 0.7$  pg, is the highest reported for the extant Placentalia. This should assist in planning new genome sequencing initiatives. © 2007 Springer Science+Business Media, LLC.

Pardini, A. T., P. C. O'Brien, B. Fu, R. K. Bonde, F. F. Elder, M. A. Ferguson-Smith, F. Yang and T. J. Robinson (2007). "Chromosome painting among Proboscidea, Hyracoidea and Sirenia: support for Paenungulata (Afrotheria, Mammalia) but not Tethytheria." *Proc. Biol. Sci* 274(1615): 1333-1340.

Despite marked improvements in the interpretation of systematic relationships within Eutheria, particular nodes, including Paenungulata (Hyracoidea, Sirenia and Proboscidea), remain ambiguous. The combination of a rapid radiation, a deep divergence and an extensive morphological diversification has resulted in a limited phylogenetic signal confounding resolution within this clade both at the morphological and nucleotide levels. Cross-species chromosome painting was used to delineate regions of homology between *Loxodonta africana* ( $2n=56$ ), *Procavia capensis* ( $2n=54$ ), *Trichechus manatus latirostris* ( $2n=48$ ) and an outgroup taxon, the armadillo (*Orycteropus afer*,  $2n=20$ ). Changes specific to each lineage were identified and although the presence of a minimum of 11 synapomorphies confirmed the monophyly of Paenungulata, no change characterizing intrapaenungulate relationships was evident. The reconstruction of an ancestral paenungulate karyotype and the estimation of rates of chromosomal evolution indicate a reduced rate of genomic repatterning following the paenungulate radiation. In comparison to data available for other mammalian taxa, the paenungulate rate of chromosomal evolution is slow to moderate. As a consequence, the absence of a chromosomal character uniting two paenungulates (at the level of resolution characterized in this study) may be due to a reduced rate of chromosomal change relative to the length of time separating successive divergence events

Kellogg, M. E., S. Burkett, T. R. Dennis, G. Stone, B. A. Gray, P. M. McGuire, R. T. Zori and R. Stanyon (2007). "Chromosome painting in the manatee supports Afrotheria and Paenungulata." *BMC. Evol. Biol* 7: 6.

**BACKGROUND:** Sirenia (manatees, dugongs and Stellar's sea cow) have no evolutionary relationship with other marine mammals, despite similarities in adaptations and body shape. Recent phylogenomic results place Sirenia in Afrotheria and with elephants and rock hyraxes in Paenungulata. Sirenia and

Hyracoidea are the two afrotherian orders as yet unstudied by comparative molecular cytogenetics. Here we report on the chromosome painting of the Florida manatee. RESULTS: The human autosomal and X chromosome paints delimited a total of 44 homologous segments in the manatee genome. The synteny of nine of the 22 human autosomal chromosomes (4, 5, 6, 9, 11, 14, 17, 18 and 20) and the X chromosome were found intact in the manatee. The syntenies of other human chromosomes were disrupted in the manatee genome into two to five segments. The hybridization pattern revealed that 20 (15 unique) associations of human chromosome segments are found in the manatee genome: 1/15, 1/19, 2/3 (twice), 3/7 (twice), 3/13, 3/21, 5/21, 7/16, 8/22, 10/12 (twice), 11/20, 12/22 (three times), 14/15, 16/19 and 18/19. CONCLUSION: There are five derived chromosome traits that strongly link elephants with manatees in Tethytheria and give implicit support to Paenungulata: the associations 2/3, 3/13, 8/22, 18/19 and the loss of the ancestral eutherian 4/8 association. It would be useful to test these conclusions with chromosome painting in hyraxes. The manatee chromosome painting data confirm that the associations 1/19 and 5/21 phylogenetically link afrotherian species and show that Afrotheria is a natural clade. The association 10/12/22 is also ubiquitous in Afrotheria (clade I), present in Laurasiatheria (clade IV), only partially present in Xenarthra (10/12, clade II) and absent in Euarchontoglires (clade III). If Afrotheria is basal to eutherians, this association could be part of the ancestral eutherian karyotype. If afrotherians are not at the root of the eutherian tree, then the 10/12/22 association could be one of a suite of derived associations linking afrotherian taxa

Sitati, N. W. and M. J. Walpole (2006). "Assessing farm-based measures for mitigating human-elephant conflict in Transmara District, Kenya." *Oryx* 40(3): 279-286.

Crop raiding by elephants is widespread across Africa and Asia. Although many traditional and novel methods are used to defend farms there have been few rigorous tests of their efficacy. We provide a comparative quantitative assessment of a range of farm-based mitigation methods implemented during a 4-year project in Transmara District, Kenya. Five experimental trials were established to measure changes in crop raiding after the application of mitigation methods on treatment farms compared with control farms. A combination of early warning to detect elephants before they entered farms, coupled with a front line communal guarding strategy, proved most successful. Non-electrified barriers were expensive and generally ineffective. However, chilli *Capsicum* spp. grease applied to rope barriers encircling farms completely deterred elephants. Although encouraging, these results require more widespread testing and demonstration to ensure their effectiveness at broader scales. © 2006 FFI.

Natiello, M., P. Lewis and D. Samuelson (2005). "Comparative anatomy of the ciliary body of the West Indian manatee (*Trichechus manatus*) and selected species." *Vet. Ophthalmol* 8(6): 375-385.

OBJECTIVE: To examine the anatomy of the ciliary body in the West Indian manatee (*Trichechus manatus*), paying close attention to its vascularization and to



compare to those of its distant relative, the African elephant (*Loxodonta africana*), the amphibious hippopotamus (*Hippopotamus amphibius*) and the aquatic short-finned pilot whale (*Globicephala macrorhynchus*). **PROCEDURE:** Specimens from each species were preserved in 10% buffered formalin, and observed stereomicroscopically before being embedded in paraffin, sectioned and stained by Masson trichrome, hematoxylin and eosin, and periodic acid-Schiff for light microscopic evaluation. **RESULTS:** The network of blood vessels in the ciliary processes of the West Indian manatee appear to have an intricate pattern, especially with regard to venous outflow. Those of the elephant are slightly less complex, while those of the hippopotamus and whale have different vascular patterns within the ciliary body. Musculature within the ciliary body is absent within the manatee and pilot whale. **CONCLUSIONS:** In general, there appears to be a direct relationship between the increased development of vasculature and the loss of musculature within the ciliary bodies of the aquatic and amphibious mammals presently studied. Specifically, the ciliary body of the West Indian manatee has a comparatively unique construction, especially with regard to its vasculature.

Agnew, D. W., L. Hagey and J. Shoshani (2005). "The elephants of Zoba Gash Barka, Eritrea: Part 4. Cholelithiasis in a wild African elephant (*Loxodonta africana*)." *Journal of Zoo and Wildlife Medicine* 36(4): 677-683.

A 4.0-kg cholelith was found within the abdominal cavity of a dead wild African elephant (*Loxodonta africana*) in Eritrea. Analysis of this cholelith by histochemistry, electron microscopy, electrospray mass spectroscopy, and energy-dispersive x-ray spectroscopy revealed it was composed of bile alcohols but no calcium, bilirubin, or cholesterol. Bacteria were also found in the cholelith. Similar, but smaller, bile stones have been identified previously in other wild African elephants and an excavated mammoth (*Mammuthus columbi*). Choleliths have been reported only once in a captive Asian elephant (*Elephas maximus*). Elephants, along with hyraxes (*Procavia capensis*) and manatees (*Trichechus manatus*), are unique among mammals in producing only bile alcohols and no bile acids, which may predispose them to cholelithiasis, particularly in association with bacterial infection. Dietary factors may also play an important role in cholelith formation. Copyright 2005 by American Association of Zoo Veterinarians.

Hoffmann, J. N., A. G. Montag and N. J. Dominy (2004). "Meissner corpuscles and somatosensory acuity: The prehensile appendages of primates and elephants." *Anatomical Record - Part A Discoveries in Molecular, Cellular, and Evolutionary Biology* 281(1): 1138-1147.

Meissner corpuscles (MCs) are specialized mechanoreceptors located exclusively in the papillae of glabrous skin. They are confined largely to cutaneous pads of the extremities and respond to transient, phasic, or vibratory stimuli. Though absent in most eutherian taxa, MCs are reported in all primates studied, being most developed in modern humans. The location of MCs between the internal ridges of the epidermis indicates they are well situated to detect friction or deformation at the external surface. Accordingly, MCs are hypothesized to provide

primates generally with an enhanced tactile perception. However, the selective pressures favoring greater somatosensory acuity in primates are seldom considered. Interestingly, primate digital dexterity varies greatly. In general, dexterity improves with the extent to which foraging requires food manipulation or textural evaluation. This observation implies that MC density could vary accordingly. Here we report on the density of MCs in five anthropoid taxa selected to represent diverse dietary regimes. Results show that greater MC density correlates with the extent to which primates are frugivorous; however, locomotor and/or phylogenetic effects cannot be discounted. © 2004 Wiley-Liss, Inc.

Greenwood, A. D., C. C. Englbrecht and R. D. MacPhee (2004). "Characterization of an endogenous retrovirus class in elephants and their relatives 667." *BMC. Evol. Biol* 4(1): 38.

**BACKGROUND:** Endogenous retrovirus-like elements (ERV-Ls, primed with tRNA leucine) are a diverse group of reiterated sequences related to foamy viruses and widely distributed among mammals. As shown in previous investigations, in many primates and rodents this class of elements has remained transpositionally active, as reflected by increased copy number and high sequence diversity within and among taxa. **RESULTS:** Here we examine whether proviral-like sequences may be suitable molecular probes for investigating the phylogeny of groups known to have high element diversity. As a test we characterized ERV-Ls occurring in a sample of extant members of superorder Uranotheria (Asian and African elephants, manatees, and hyraxes). The ERV-L complement in this group is even more diverse than previously suspected, and there is sequence evidence for active expansion, particularly in elephantids. Many of the elements characterized have protein coding potential suggestive of activity. **CONCLUSIONS:** In general, the evidence supports the hypothesis that the complement had a single origin within basal Uranotheria

Hatfield, J. R., D. A. Samuelson, P. A. Lewis and M. Chisholm (2003). "Structure and presumptive function of the iridocorneal angle of the West Indian manatee (*Trichechus manatus*), short-finned pilot whale (*Globicephala macrorhynchus*), hippopotamus (*Hippopotamus amphibius*), and African elephant (*Loxodonta africana*)." *Veterinary Ophthalmology* 6(1): 35-43.

The iridocorneal angles of prepared eyes from the West Indian manatee, short-finned pilot whale, hippopotamus and African elephant were examined and compared using light microscopy. The manatee and pilot whale demonstrated capacity for a large amount of aqueous outflow, probably as part of a system compensating for lack of ciliary musculature, and possibly also related to environmental changes associated with life at varying depths. The elephant angle displayed many characteristics of large herbivores, but was found to have relatively low capacity for aqueous outflow via both primary and secondary routes. The hippopotamus shared characteristics with both land- and water-dwelling mammals; uveoscleral aqueous outflow may be substantial as in the marine mammals, but the angular aqueous plexus was less extensive and a robust pectinate ligament was present. The angles varied greatly in size and composition

among the four species, and most structures were found to be uniquely suited to the habitat of each animal.