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Assessing tolerance for wildlife: human-elephant conflict in Chimanimani, Mozambique

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ABSTRACT
Human–elephant conflict (HEC) is a common problem for rural populations in sub-Saharan Africa. Recent studies have shown that willingness to tolerate wildlife is largely a function of perceived risks and benefits, but most technical assessments are limited to the immediate cause of the conflict and neglect the broader socioeconomic and political contexts. Based on two sets of interviews, this article provides a socioeconomic analysis of HEC in the buffer zone of Chimanimani National Reserve in Mozambique. Although traditional methods to scare off elephants were found to have little effect, a beehive fence introduced in 2016 initially appeared to be successful. However, follow-up three years later showed that results were controversial and HEC was even more acute. Underlying factors include the failure to establish a common understanding between the local population and authorities about the risks versus benefits involved and the elements for an acceptable solution.

KEYWORDS
Human–elephant conflict; tolerance for wildlife; protected areas; Africa

Introduction

Human–wildlife conflict (HWC) is a common problem for rural populations in many parts of sub-Saharan Africa, including Mozambique where recorded incidents of HWC increased from 74 in 2006 to more than 300 by 2010 (Le Bel et al., 2011). Elephants were the species most often involved in such conflicts, especially in crop-raiding where elephants were involved in two-thirds of the cases (Le Bel et al., 2011). This species has suffered from the loss and fragmentation of its natural habitats due to conversion for agricultural use that is driven by human population growth and poaching (Ministry for the Coordination of Environmental Affairs, 2014). In addition, because of indiscriminate hunting during its civil war (1978–1992), Mozambique's elephant population fell from an estimated 50,000 in 1974 to approximately 13,000 in 1990 (Ntumi, 2012). Intensified conservation efforts in the postwar decade increased the number to approximately 22,000 by 2008 (Agreco Consulting, 2008), but a subsequent upsurge in elephant poaching reduced the population again to approximately 11,000 elephants by 2016 (Thouless et al., 2016). Mozambique's vision for conserving and managing elephants (Ministry of Tourism (MIT), 2010) is that elephants and people should provide mutual benefits to each other, meaning that elephant

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populations should be effectively protected and local communities' tolerance for elephants should be increased by creating a situation where the benefits that elephants bring to local communities are sufficient to offset the costs they incur for living with elephants.

This article provides an analysis of human–elephant conflict (HEC) in the buffer zone of the Chimanimani National Reserve (ChNR) in Mozambique that – together with the Chimanimani National Park in Zimbabwe – forms a transfrontier conservation area (TFCA). A relatively densely forested area within the buffer zone hosts a small, isolated elephant population that has increased over the last decade, but faces reduction of its habitat due to conversion for agricultural production by the increasing human population. Local communities perceive HEC as a major threat to agricultural production. The dense forest is atypical for a savanna elephant (*Loxodonta africana*) habitat. Except for two academic theses (Buddiger, 2012; Goba, 2018), limited research has been published focusing on HEC in this area. Therefore, the current study, conducted by a cross-disciplinary team, provides a valuable addition to understanding Mozambique's diverse elephant population and related conflicts. The research question is: what can be done to reduce HEC and improve tolerance for elephants among local communities in this area? The primary data consist of two sets of interviews in the ChNR buffer zone during 2016 and 2019.

Conceptual Approach

The aim of this study is to identify ways for improving tolerance for elephants among the local human population, but instead of measuring physical damage, the focus is on local perceptions that are considered crucial for effective mitigation of HWC (Hill, 2004). Tolerance is understood here as "the ability and willingness of an individual to absorb the extra potential or actual costs of living with wildlife" (Kansky et al., 2016, p. 138). A parsimonious measure for tolerance is the preferred population size of the subject species relative to current population size as perceived by respondents (Inskip et al., 2016; Riley & Decker, 2000).

Although "tangible" (defined as monetary) costs are often presumed as the main cause for low levels of tolerance, recent studies on HWC have shown that these costs were insignificant in shaping tolerance in some cases (Kansky et al., 2016; Saif et al., 2020). Although this may apply to specific contexts, such as societies dominated by a fatalistic acceptance due to religion (Saif et al., 2020) or where the subject population is not economically dependent on the resources threatened by wildlife (Kansky et al., 2016), it may not be the case in other contexts. Moreover, the results of these studies suggesting insignificance of costs might be influenced by the narrow definition of "tangible" as monetary costs and benefits, whereas "tangible" can also be understood more broadly as something material or physically existing. It is actually difficult to separate "tangible" costs, such as the loss of crops or the risk of physical injury, from related "intangible" costs or risks, such as feelings of fear or stress caused by "tangible" costs (Hill, 2004). However, the observation that the causal chain is likely to be indirect, so that the risks and benefits a person associates with a hazard such as HWC are mainly a function of subjective perceptions (Hill, 2004; Inskip et al., 2016; Kansky et al., 2016), is likely to be more generally valid.

Bruskotter and Wilson (2014) highlighted three subjective factors contributing to tolerance for wildlife, namely social trust, perceived control, and emotive relation with the

species. If a person trusted the agency charged with managing wildlife, they were more likely to believe the information being provided and to follow instructions (Needham & Vaske, 2008). Greater trust in the agency has been reflected in lower perceived risks and higher perceived benefits associated with the species, which, in turn, lead to greater tolerance for wildlife (Riley & Decker, 2000). The second key variable was self-efficacy, meaning the confidence in one's ability to avoid negative outcomes through one's actions. As the individual's perceived ability to control a situation increased, they were likely to be more tolerant (Kansky et al., 2016). Finally, a person's instinctual and emotive response to a specific species could also have a direct effect on tolerance – in addition to its indirect effect mediated by perceived risks and benefits (Bruskotter & Wilson, 2014; Kansky et al., 2016).

Although perceived risks and benefits associated with the species in question are broadly recognized key factors in explaining an individual's willingness to tolerate wildlife, there tends to be a significant mismatch between the local population's perceptions of risk and the technical assessments of risk conducted by external experts (Bruskotter & Wilson, 2014; Dickman, 2010). Technical assessments are usually limited to the immediate cause (e.g., crop damage) of the HWC, but neglect the broader socioeconomic and political contexts. Yet, HWC typically comprises of two components: (a) a direct human–wildlife interaction, and (b) a conflict among humans over the way that impacts of HWC are managed (Kansky et al., 2016; Madden & McQuinn, 2014). Others have highlighted the influence of more deep-seated factors and underlying old disputes on the perceptions of the conflict (Dickman, 2010; Hill, 2004).

Methods

Study Area

The focus area of the study lies to the east of the Chimanimani Highlands on the southeastern edge of the Manica Plateau in central Mozambique (Figure 1). This area has two main seasons: (a) the hot and wet season from November to March, and (b) the cool and dry season from April to October. The mean average temperature ranges from 22°C in the southeastern lowlands to below 18°C in the high mountains in the west. Differing from typical habitats of savanna elephants, this area is hilly, with elevations ranging between 250 and 1,000 meters. The slopes and gullies support a mosaic of relatively dense and moist semi-deciduous forest, whereas more-open woodland with a dense grass cover is found on drier elevations (Ghiurghi et al., 2010). A network of brooks and rivers traverse the area and swamp grasslands dissect the forested areas in some parts (Timberlake et al., 2016).

The home range of Chimanimani's elephant population includes the dense forest in the northeastern section of the ChNR buffer zone (1,723 km^2), which lies at a lower elevation than the core reserve (634 km^2) situated mainly above the 1,000 meter contour line (Ghiurghi et al., 2010). The study area falls within two traditional communities, those of Chief Mpunga and Chief Mahate. The first community largely overlaps an old Forest Reserve (Moribane) created by the Portuguese colonial government during the 1950s (Gomes E Sousa, 1968). According to data from 2007, Mpunga included some 440 households with approximately 2,500 inhabitants and a population growth rate of almost 20% during 10 years. Mahate comprised some 190 households that – presuming a similar

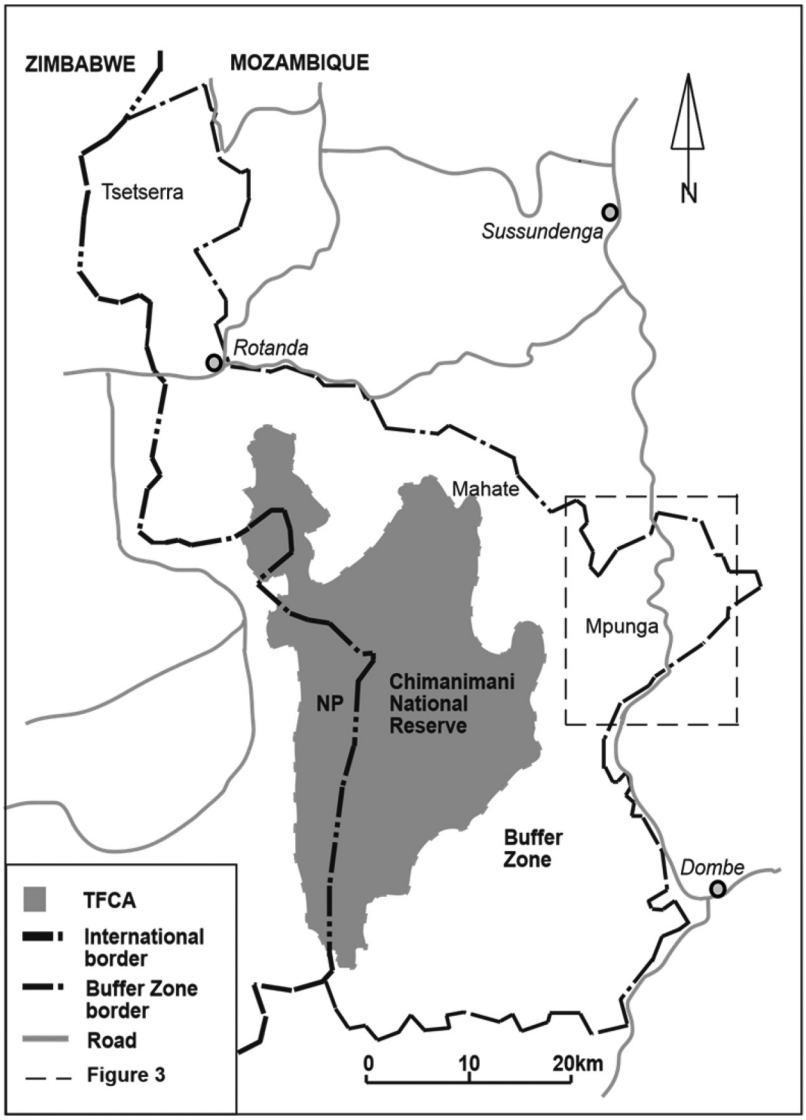

Figure 1. Chimanimani National Reserve in Central Mozambique.

average size of household – would result in slightly more than 1,000 inhabitants (Ghiurghi et al., 2010; Goba, 2018).

The main livelihood of the population is subsistence agriculture. In Mpunga, practically all households cultivated maize, whereas banana and sesame were the main cash crops. Sales of surplus maize provided an important source of additional income. Few households had cattle, whereas chicken and goats were common. Given the unimodal seasonal pattern of rainfall, there was only one annual cropping season. The main food crops, maize and sorghum, were planted at the beginning of the rainy season (October–November) and harvested at the end of the season (April–May). Shifting cultivation was still common, and different fruits and vegetables were produced throughout the year (Leonardo et al., 2015).

Oral accounts confirmed the prevalence of elephants in the study area during colonial times when some problem animals were culled by government hunters. During the civil war, Chimanimani became a stronghold of the Renamo guerrillas, and the local elephant population declined drastically with most elephants being shot or taking refuge in other areas. However, after the war, their numbers started to increase and the human population also grew as both war refugees and newcomers moved to the area. This led to conflicts between elephants and humans, especially for people who had opened fields inside the dense forest of Mpunga (Serra, 2001). During 1998, the conflict escalated into a violent confrontation between: (a) members of the local population who wanted the government to send hunters to conduct problem-animal control as had been done during the colonial period, and (b) government representatives who – backed by some members of the local community, including Chief Mpunga – refused to kill the elephants because they were considered valuable for the conservation effort (Schafer & Bell, 2002). The argument was never properly resolved, but gradually most farmers living deep inside the forest agreed to move out (Serra, 2001) and the government made several conciliatory gestures such as providing famine relief (Schafer & Bell, 2002) and shooting one problem elephant during 2000 (interview with the head of Moribane Rangers' Post, May 21, 2019).

There are no fully reliable data about the size of the elephant population in Chimanimani, but a study conducted during 2001–2002 based on a survey of dung and other physical traces of their presence estimated the number to be 22 (Sitoe, 2003). Although such indirect estimates are somewhat unreliable, they provide a usable survey technique for elephant populations that live in dense woodlands and forests (Olivier et al., 2009). No recent studies are available, but a plausible estimate of the total population is probably between 50 and 60 elephants (interview with the administrator of ChNR, May 24, 2019). However, even without definitive knowledge about the population number, it appears that the elephant population and the prevalence of HEC have increased considerably in the study area.

Although official records from the ChNR administration indicated only relatively few major cases of HEC from 2016 to 2019 (two human deaths, both during 2017, and 10 cases of destroyed granaries or more than one hectare of crop fields), the risks perceived by community members are much more prominent. The problem was already evident during 2011 when local communities reportedly felt powerless to deal with the perceived hazard and insisted that the government intervene. The solution put forward by the affected communities was the building of a continuous electrified fence to keep elephants away from where people live (Buddiger, 2012).

The national elephant strategy recommends a move from current short-term, ad-hoc measures implemented at conflict sites to broader mitigation measures based on integrated land-use planning. The strategy also recognizes the importance of local perceptions about costs versus benefits of wildlife and recognizes that "wildlife must provide added value if behavioral responses to wildlife are to change for the better" (Ministry of Tourism (MIT), 2010, p. 41). However, the landscape approach and a related target of "megaparks" adopted by the strategy do not foresee fences as a means to enclose wildlife into separate conservation areas, but rather as a means to separate consolidated sites of human habitation and arable holdings from the surrounding wildlife areas – and even that only in extreme cases (Ministry of Tourism (MIT), 2010). As the electrified fence initiative did not advance in the ChNR despite local demands, the stakeholders – together with the Mozambican NGO MICAIA –

have started to construct beehive fences on the border as an alternative way to keep elephants away from areas occupied by homesteads and crop fields (Timberlake et al., 2016).

Data Collection

The primary data were from two sets of interviews, one using a quantitative questionnaire conducted during April 2016 and another using a semi-structured qualitative approach conducted during May 2019. The interviews were conducted in Portuguese or the local language (ChiNdau) either by a team member who speaks the language or with the assistance of a local interpreter. Two community members were trained as assistants for the interviews. With the training, the members became familiar with the interview questions and facilitated the work of translating them into the local language. Before beginning, the interviewers explained the objective of the study to respondents and asked their permission to conduct the interview. The primary data were complemented by satellite-tracking data of two collared elephants (one cow representing a herd and one bull) from 2011 to 2013, and human population mapped in 2014 from Google Earth images (Macandza et al., 2014; Figure 2).

The questionnaire during 2016 was administered in two sub-communities under Chief Mpunga, Mukawaia (area 1) and Mpunga Centro (area 2), which are separated by approximately 9 km along the main road. Both communities are situated in areas of high HEC. In the former, a 3.2-kilometer-long beehive fence consisting of 375 hives had recently been set up, whereas in the latter, the farmers still relied on traditional methods (guarding fields at night and using fire, noise, and torches) to scare off elephants. The fence, which was intended to prevent elephants from invading the crop fields and homesteads, was built by community members with the initiative and financial support of MICAIA, a national NGO, and Eduardo Mondlane University under the guidance of the ChNR administration. The fence followed a standard model comprising beehives at 8.6-meter intervals suspended from trees with galvanized wire approximately 1.25 meters above the ground (King et al., 2009; Ngama et al., 2016). Based on consensus among the stakeholders, it was built inside the forest at least 200 meters from areas frequently used by the community. The beehives for the fence were distributed to selected community members who are also responsible for their maintenance.

A total of 120 farmers were interviewed. All farmers (80) affected by elephants were listed in the sub-community protected by the beehive fence (area 1). Of these, 34 farmers (43%) were involved in erecting the fence and their fields were used for assessing crop raiding, whereas 46 farmers (57%) were not involved. In the sub-community protected by traditional methods (area 2), all farmers (92) affected by elephants were listed. Of these, 34 farmers (37%) were involved in erecting the fence in area 1 and their fields were used to assess crop raiding, whereas 58 (63%) were not involved in erecting the fence. Based on quota sampling (Hill & Hill, 2009; Reja et al., 2003), 60 farmers from each sub-community were interviewed in the same proportion as there were participants in the erection of the fence in each sub-community. To ensure that all questions were answered, a face-to-face interview with multiple choice questions in the questionnaire was used (Reja et al., 2003; Thayer-Hart et al., 2010). Questions with alternative answers were read in Portuguese by the enumerator and translated into the local language by the previously trained community members.

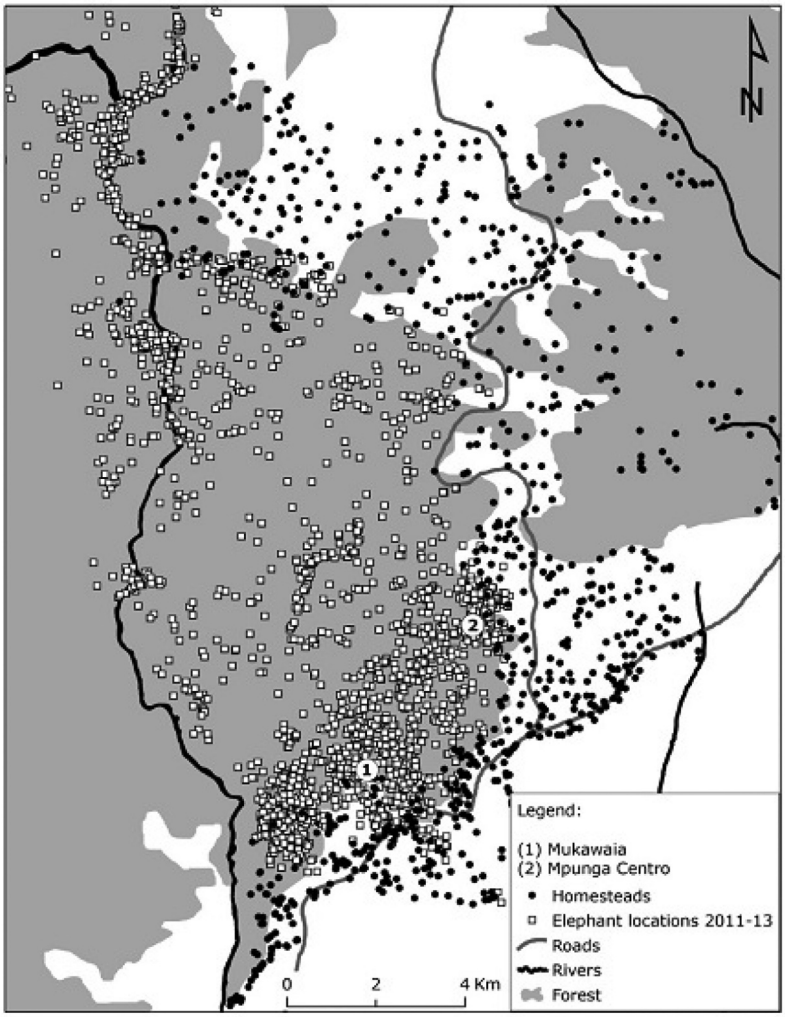

Figure 2. Use of habitat by elephants and distribution of human population in Mpunga (Adapted from Macandza et al., 2014).

The target of this 2016 questionnaire was to record the perceptions of farmers about the effectiveness and their acceptance of the recently established beehive fence. Issues covered included the occurrence of elephants raiding crop fields, satisfaction with the mitigation methods used (traditional or beehive fence), the need to spend nights outside protecting crops, whether the mitigation method has any economic benefits, whether the person intends to use the method in the future, and the need to find additional mitigation methods. A likelihood ratio chi-squared (LR) test at a 5% significance level in SPSS version 20 was applied to compare the frequency of responses to each question between those sub-communities using and those not using beehive fences to deter elephants from entering crop fields.

The qualitative interviews conducted in 2019 included the same two sub-communities under Chief Mpunga (Mukawaia [17 households[1]] and Mpunga Centro [16]), as the 2016

data. In addition, several interviews were conducted in the area of Chief Mahate (8) and sub-Chief Goto Goto (3), which lie outside the home range of the three elephants tracked in the 2011–2013 study, but suffer from a high prevalence of HEC. Four of the interviews were conducted in households not (yet) affected by HEC (three in Mpunga and one in Goto Goto). The interview teams started off at points roughly equidistant along the main road or track and approached to interview an adult person present in the households encountered when moving away from the road/track. In Mpunga, the interviews were administered at different distances from the main road and toward the border of the community conservation area (close to the beehive fences). In Mahate and Goto Goto, the track leading to Mahate Camp served as the starting point.

Taken together, 48 members of local communities (27 men and 21 women) were reached, representing 44 households. Aside from ordinary farmers, these included five representatives of traditional authority, two ChNR scouts, the vice-president of a local association (Kubatana Moribane), a school teacher, and a neighborhood secretary. In addition, the administrator of the ChNR and the head of the Moribane Rangers' Camp, as well as the government hunter (a member of the local community who was allocated a rifle to scare off elephants) were interviewed separately. The data also include group interviews, one with a group of women (4), another with a group of men (5), and one mixed group (8 men, 2 women) consisting of members of the local management committee. New data were discussed daily between the research teams. In addition, a field visit to the two beehive fences to check their current condition was conducted during November 2019.

As the same sub-communities were included in both sets of interviews, it was possible to assess possible changes in perceptions toward the main external intervention (i.e., beehive fence) after three years. Thematic coding based on Bruskotter and Wilson (2014) hazard-acceptance model was used, focusing on perceived risks and benefits, trust in the management institutions, one's own capacity for controlling elephant hazards, attitudes toward elephants and the conservation area, and actions intended and/or already taken toward elephants. Both attitudinal and behavioral factors were explored, as the latter can provide additional information about tolerance (Bruskotter et al., 2015). As the data were relatively straightforward and easy to interpret, one of the authors conducted the coding. The emerging results were shared regularly with the other authors for review and confirmation. The themes were further refined during the process of data review to align with those codes that were salient to the research question.

Results

Quantitative Data from 2016

The 2016 data were collected during April when the farmers were active in the fields. The questionnaire included eight questions (five of which are reported here) and the responses were measured with three categories (yes, no, indifferent). The objective was to compare the perceived efficacy of the beehive fence (area 1) versus traditional mitigation methods (area 2) for reducing HEC. Cases reported by farmers in the HEC-affected areas of Mpunga indicated that the maize and banana fields of approximately 47% of the interviewed households were raided during January–March 2016.

Results showed a statistically significant difference according to the likelihood ratio chi-square test (LR) between the study areas for the five aspects studied. The village with beehive fences (area 1) had fewer people suffering from crop raiding compared to the village under traditional methods (area 2). In area 1, almost two-thirds (63%) of the interviewed households were spared from damage, whereas in area 2 only 42% escaped damage (LR = 5.693; df = 1; p =.017; phi effect size = .217). This was also reflected in the perceived need to spend nights outside guarding crop fields where area 1 had fewer people who needed to spend nights guarding fields compared to area 2. In area 2, most households (88%) reported guarding fields at night, but in area 1, the percentage had dropped to 60% (LR = 5.693; df = 1; p = .017; phi effect size = .324). More households from area 1 (73% yes, 17% no, 10% indifferent) than from area 2 (42% yes, 38% no, 20% indifferent) reported some economic benefits (e.g., crops not lost, honey gained from beehives) derived from the mitigation method use (beehive fence vs. traditional methods) (LR = 12.602; df = 2; p = .002; Cramer's V effect size = .321).

Area 1 had more people willing to use beehives in the future compared to area 2. All 60 households interviewed in area 1 indicated that they would like to use the same method (beehive fence) during the next agricultural campaign. Only 15% of the households in area 2 indicated an intention to use the same traditional methods during the next season, whereas 60% said they would not and 25% were indifferent (LR = 112.920; df = 2; $p < .001$; Cramer's V effect size = .860). On the other hand, all 60 households from area 2 said they would like to try new methods to mitigate HEC and slightly more than one-third specified that they would like to try the beehive fence. Interviewees in area 2 also referred to being tired of guarding the fields at night, which increased the likelihood for injuries or even death caused by elephants and other animals (e.g., poisonous snakes). In area 1, only one-quarter of the households stated a need to try alternative methods, whereas 57% said "maybe" alternatives would be useful and 18% indicated that the beehive fence provided sufficient protection against elephants (LR = 91.295; df = 2; $p < .001$; Cramer's V effect size = .775).

Qualitative Data from 2019

Control over Hazard

In the May 2019 semi-structured interviews, respondents were asked about the type of damage they had suffered during the previous year and the means they personally use for scaring elephants away from the fields and homesteads (i.e., the so-called traditional methods). They were also probed about the new beehive fences. After 2016, a second fence had been built in the forest in the other main HEC area at Mpunga Centro (Figure 2). As some respondents were involved in the construction of the fences, collected honey from the hives, and participated in their maintenance, the fences were considered to be a mitigation means that was at least partially under local control.

The general observation was that elephants invade the crop fields at night, typically between 6 pm and 5 am, and are, therefore, more difficult to control or scare away. Most invasions take place between October and May, targeting fruits from October to December and focusing on maize and other crops from January onward. However, it was also noted that "the period from January to [the] end of April is the worst, but

elephants raid all year, just less often" (middle-aged man, Mpunga). Respondents said that elephants will eat all kinds of cultivated crops and fruits, and they further highlighted that elephants are particularly fond of sorghum, maize, millet, banana, mango, yam, and pumpkin. In the study area, HEC was not perceived as related to sources of water.

One respondent stated that she "goes to fields to scare animals and even sleeps nights there to scare elephants" (middle-aged woman, Mpunga). The same practice was reported by a few others as well, particularly during the harvest season, and it was observed that, in general, people had to be vigilant at night. Almost all households that had suffered HEC indicated that to ward off elephants, they lighted fires, flashed torches, or made noise by beating drums, tins, or other metal objects. Some respondents also threw stones or used slingshots. Several respondents said these methods were more efficient if done jointly with neighbors. Overall, traditional methods were not perceived as sufficient to ward off elephants.

The households interviewed during 2019 were less positive about the effectiveness of the beehive fence compared to those interviewed during 2016. Of those who had an opinion, only one believed the fence was effective, whereas a few others believed it works if the fence is maintained and the hives have bees. However, of those who did not believe the fence works, most based their opinions on secondhand information, whereas those who gave a more positive assessment also had personal experience. It should be noted that visits to the sites of the beehive fences in Mukawaia (November 12, 2019) and Mpunga Centro (November 14, 2019) by one of the team members indicated that the fences lacked maintenance, as there were several hives without bees, the undergrowth was not cleared, some hives had fallen or had been removed, and the connecting wire was broken or had been stolen.

Social Trust

Most households perceived the control of elephants to be the responsibility of government authorities. However, their trust in the government's ability to control elephants was low. As one respondent explained, he "complains to Régulo, who complains to administration, but they do not do anything – even when a woman died there was no response" (middle-aged man, Mpunga). Perceptions about the capacity of the ChNR scouts was more positive. Although only a few respondents perceived them as really effective, several others said the scouts' attempts to ward off the elephants by shooting in the air often work, but they usually arrive too late. In addition, most respondents acknowledged that the scouts lacked a means of transport and were posted too far from the principal sites of HEC.

The majority of respondents considered the separation of elephants and humans to be the best solution to the problem, and shared the view that "elephants should stay on their side" (middle-aged woman, Mpunga). Often, respondents specified that separation should be accomplished with electrified fencing. Several also expressed the belief that the authorities had already promised to build such fencing, but a lack of funding had caused a delay, thus placing direct responsibility for failure to provide adequate mitigation measures on government authorities and indirectly on MICAIA. Traditional authorities were recognized as the main representatives of the communities to government, and many respondents hesitated to express their own views directly.

Emotive and Cultural Ties to Elephants

A few respondents expressed that elephants are part of the landscape and belong to the area, but most others were either openly hostile or indifferent. The following comment reflects the majority view: "Elephants are good only when they are separated from the people because without it they kill and spoil the fields" (young woman, Mpunga). Those who represented traditional authorities from Mpunga explained that elephants sometimes hosted spirits, and their attacks may have been caused by people's failure to respect traditional norms of behavior. The ceremonial role of elephants, however, was limited to rites that were performed if elephants were killed and the meat was then distributed among the community. For most respondents, the value, if any, of elephants was in attracting tourists.

Perceptions of Risks

"You go to sleep at night, and when you wake up, you wake up without your maize crop" (young woman, Mpunga). According to interviewees, elephants represent a serious risk to humans. Although human casualties are relatively rare, two people trying to scare off elephants have been killed over the last five years and at least one person has been severely injured. In addition, most respondents shared the view that "elephants are the biggest agricultural problem" (middle-aged woman, Mpunga). Most families had suffered destruction of crop fields and elephants had even destroyed the granaries of some households. A few households reported that crop losses had forced them to buy basic foodstuffs to survive. Fear of elephants had caused one household to move their homestead and several others to open new fields in different place to avoid HEC. Recurrent crop losses had caused many households to stop cultivating certain crops and fruit trees preferred by elephants, such as sorghum, yam, and banana, but also vegetables and others.

Perceptions of Benefits

One respondent asked "who would like elephants?" (young woman, Mpunga) and she, like the other respondents, could not name any direct benefits from elephants. The only indirect benefit respondents mentioned was attracting tourists. Therefore, the question was broadened to include benefits provided by institutions related to the conservation area (ChNR administration, donors, and "government"). In general, the interviewed community members were not aware of which institution was the source of the perceived benefits. For donors, only one respondent was aware that World Bank projects had financed some of the activities, whereas most respondents were aware of MICAIA's role. The benefit that was listed most frequently by the households was beehives followed by seeds and support to local school buildings, whereas a few mentioned health services and support for transportation (donations of bicycles and a motorbike). As for training and jobs, the latter were mentioned by those whose households had benefited directly. In general, sales of honey from the beehives were well appreciated, albeit some concerns were raised about irregularity in collecting the honey. There were several complaints about the quality and timely delivery of seeds. Although several respondents mentioned seeing tourists in the area, only a few in leadership positions were aware of specific benefits they have brought.

Tolerance

Preference for the future elephant population size, relative to perceived current size, was asked to measure tolerance. However, when asked what would be an acceptable number of elephants in the area, several respondents refused to answer, saying that only the chief or the government authorities can decide that. Of those who answered, a substantial number wanted to remove all elephants or at least reduce their number. This was often linked to deep frustration about lack of influence: "we do not want elephants here, but have no power to decide" (elderly woman, Mahate). Others accepted the view that elephants "are local species and there could be more; the problem is raiding the fields and even killing some people" (middle-aged man, Mpunga). For them, an increase in numbers would be acceptable on the condition that elephants were effectively kept away from the areas where people live.

In general, there was a perception that the number of elephants had increased considerably over the last decade and had become like "rats" or "cows" in the fields; they were "everywhere," causing substantial damage. One community member even stated, "Now there is a war between elephants and humans" (older man, Mpunga).

Discussion

Why Is the Tolerance for Elephants Low?

The Moral Narrative of Protection

According to Hill (2004), to be effective, HWC mitigation strategies must take into consideration not only direct physical impacts, but also how the population perceives the conflicts, what they expect from mitigation activities, and who should take responsibility. As noted by Bruskotter and Wilson (2014), the perceived ability to avoid negative outcomes through one's own actions tends to decrease the feeling of risk and perceived level of conflict. However, similar to other studies (Sitati & Walpole, 2006; Sitati et al., 2005), the interviewees found the traditional methods commonly used in the study area to scare off elephants only moderately effective and they increase the households' workload considerably (Graham & Ochieng, 2008). On the other hand, the authorities have prohibited the use of more drastic measures, such as lethal management of crop-raiding elephants. In such a context, the local population typically expects government agencies to assume responsibility for managing the conflict (Hill, 2004).

The perception of risk, therefore, depends on social trust in the management authority's capacity to resolve the problem by providing adequate protection against wildlife (Bruskotter & Wilson, 2014; Hill, 2004). In the study area, the interviewees' trust in the authorities seemed to be generally weak. Although the effort of the ChNR scouts to scare off elephants by shooting in the air was found to be relatively effective, the interviewees complained that, due to lack of transportation, the scouts tend to come too late, and their camp is situated too far from area 1. Despite recurrent complaints by the population to both traditional and government authorities, more efficient solutions have not been implemented. Meanwhile, the idea of an electrified fence to separate elephants from humans seems to have become a symbol of the "moral narrative of protection" (Witter, 2013, p. 406) entertained by the population. Although the expectation of the fence seems to arise from misunderstanding

(Buddiger, 2012) and previous experience shows that electrified fences are expensive to build and maintain and do not guarantee full protection (Fernando et al., 2008; Kioko et al., 2008), it was the solution favored by most interviewees.

Unrealistic Expectations

Misunderstanding, disagreement, and disappointment often stem from unrealistic expectations about HWC mitigation methods. If the local communities' expressed needs and their preferences for the solution to the problem are not met, any alternative mitigation method may be resented by them irrespective of its relative merits. This is especially the case if the alternative is imposed from above (e.g., government agencies) without active local participation and consent, the communities often fail to implement it correctly or maintain it, and some individuals may steal parts to use for other purposes (Hill, 2004; Madden & McQuinn, 2014). This appears to be the case with the beehive fences in the study area.

Similar to other short-term experiments in Mozambique (Branco et al., 2020) and elsewhere in Africa (e.g., King et al., 2011), the findings of the 2016 questionnaire were positive with regard to the local population's acceptance of the beehive fence method. However, three years later, the initial optimism had largely vanished and most respondents were skeptical about the effectiveness of beehives as a deterrent to elephants. Several other field experiments have revealed similar doubts. Although most studies showed that elephants tend to avoid occupied beehives (e.g., Ngama et al., 2016; Scheijen et al., 2019), they are not always effective and the construction and maintenance of long stretches of beehive fences is a demanding task (Hoare, 2015; Karidozo & Osborn, 2005). In the study area, *in situ* inspection of both beehive fences set inside the forest indicated a lack of maintenance that had reduced their effectiveness considerably. Arguably, the neglected condition reflects a lack of trust in the method, which was not the choice of those affected. The mistrust was further reinforced by the fact that the incomplete fence has not stopped elephants from raiding crop fields.

Several studies have highlighted the importance of diligent maintenance of beehive fences (Ngama et al., 2016; Scheijen et al., 2019). In most successful experiments, the fences have been built on relatively open and flat woodlands, often close to homesteads and fields. However, the study area is characterized by broken terrain intersected by deep ravines and covered with dense forest, which makes both building and maintenance of the fences challenging (Fernando et al., 2008). The fences are also situated relatively far from inhabited areas (more than a two-hour walk from the road on difficult paths), which means that maintenance or even collecting honey is time-consuming. Although the fences could probably be located closer to homesteads, the difficult overall conditions are likely to reduce the motivation of the community to assume responsibility for maintenance, which is often a problem even under more favorable conditions (Fernando et al., 2008; Kioko et al., 2008).

Perception of Costs Vs. Benefits

Although a central goal of the national elephant strategy in Mozambique is that "costs of local communities living with elephants (are) offset by the benefits elephants bring" (Ministry of Tourism (MIT), 2010, p. 48), the goal seems far from being achieved in the study area. The 2016 questionnaire results showed that more than 70% of respondents reported economic benefits from the use of beehive fences (not directly from elephants), but

even these benefits currently appear to be rather marginal given that the fences are not properly maintained. Few of the 2019 interviewees believed that the beehive fences are effective, and those who received direct benefits, such as seeds or beehives for honey production, did not necessarily link them to HEC or even to broader conservation objectives. Tourism, in particular, was perceived as bringing direct benefits to the community by only a few members in leadership positions.

At the same time, most respondents considered elephants, along with drought, the principal risk to agricultural production. Several respondents had suffered substantial losses, such as the destruction of a granary, and had been forced to buy basic foodstuffs to survive. The negative impact of such cases is amplified as the damage sustained by one household elevates the fear of damage among others, even if they have not experienced it directly (Dickman, 2010). And, although personal injuries have been relatively few, it should be noted that people's perceptions of risk are strongly influenced by the worst cases, such as two people killed by elephants in the study area, even though such incidents are rare (Bruskotter & Wilson, 2014; Hill, 2004).

The resulting low level of tolerance is also reflected in the behavior of respondents who complain regularly to both traditional and government authorities. Although there are local traditional beliefs and taboos about different elements of the landscape, including wild animals such as elephants (e.g., Chemhuru & Masaka, 2010), cultural reasons for protecting elephants were mentioned by only a few individuals holding positions in the traditional hierarchy. The other interviewees did not express any particular cultural or emotional ties to elephants.

How to Reduce HEC and Improve Tolerance

Although direct wildlife damage is usually the main reason cited for low tolerance (e.g., de Boer & Baquete, 1998) and perceived costs from wildlife typically exceed the benefits (Ministry of Tourism (MIT), 2010; Tchamba, 1998), the analysis should not be limited to species-based conflicts. Rather, the conflicts must be assessed in their wider socioeconomic, ecological, and cultural contexts. Often, an instance of HWC has a contentious history that adds meaning and emotion to the dispute where perceived inequalities and imbalances of power can play an important role (Dickman, 2010; Madden & McQuinn, 2014). In such contexts, the resources allocated by the public authorities and NGOs to wildlife protection may be perceived by local communities as indifference to their own physical and social needs (Nsonsi et al., 2018).

The resolution to an occurrence of HWC requires compromises between competing objectives, and parties to a conflict are more likely to accept such compromises if they feel genuinely recognized as equal partners in the decision-making process (Madden & McQuinn, 2014). In this context, Hill (2004) emphasized that if the initial expectations of a party, such as the local community, are unrealistic, then the deliberative process should focus on ensuring that all stakeholders have a realistic vision of what can be achieved and defining the role of each party in the operation.

In the ChNR, the interviewed community members identified the separation of wildlife from humans as a key strategy for mitigating HEC. For them, this can be achieved by building an electrified fence to separate the protected area of the reserve from the inhabited areas, which is an idea that the authorities consider unrealistic (interview with the administrator of ChNR, May 24, 2019). According to the national strategy, even fencing off

selected agricultural enclaves can be considered only in the case of particularly intensive raiding (Ministry of Tourism (MIT), 2010). The persistent misunderstanding concerning the building of electrified fencing reflects the serious communication problems between the authorities and the local population.

Instead of reliance on a single approach, such as full separation that appears unrealistic, some experts (e.g., Hoare, 2015; Sitati & Walpole, 2006; Sitati et al., 2005) have recommended a shifting combination of different methods to counter the threat that elephants may habituate to any recurrently used method. But, what methods are effective in the study area? The killing of problem animals is recognized as one option in the national strategy (Ministry of Tourism (MIT), 2010; but see Hoare, 2015), but would probably be untimely in the study area considering the relatively small size of the elephant population. The beehive fences are likely to provide some protection if properly maintained, but this would require more resources and better monitoring. Chili fences have been effective in several studies (Chang'a et al., 2016; Sitati & Walpole, 2006), but they face the same practical problems as beehive fences in the study area and they may be less effective (Branco et al., 2020). The alternative method of burning chili briquettes (Karidozo & Osborn, 2015) could be tried as a supplementary measure for protecting individual farms. Although some households have been encouraged to abandon several of the crops favored by elephants, it is unrealistic to expect that they will stop growing key subsistence crops such as maize (Nsonsi et al., 2018). Improving the mobility of the ChNR scouts by providing at least motorcycles and possibly an additional (at least seasonal) post closer to the key problem areas would improve the local population's trust in the authorities.

The main focus should, however, be placed on improving communication among the stakeholders and involving the local population as equal partners in the planning and implementation of mitigation activities, as recommended in the national elephant strategy (MIT, 2010). Currently, most interviewees had only a vague idea about the benefits they receive from ecotourism by living in the same space with elephants. However, although ecotourism remains small-scale in the study area and the planned cultural tourism activities have not been realized, the community lodge does bring tangible local benefits, such as some jobs and a regular monetary income for the community association.

Overall, a perfect solution for the prevention of HEC does not exist at the present time. Short of complete seclusion by electrified fencing that also has various negative effects, crop raiding by elephants cannot be fully precluded. In this context, reaching the goal of Mozambique's elephant strategy that strives for a situation where the benefits to local communities from (or related to) elephants are sufficient to offset the costs they incur for living with elephants requires genuine listening to local communities and a stronger commitment with significantly more resources from the government.

References

Agreco Consulting. (2008). *National census of wildlife 2008: Final report*. Ministry of Agriculture.

Branco, P., Merkle, J., Pringle, R., King, L., Tindall, T., Stalmans, M., & Long, R. (2020). An experimental test of community-based strategies for mitigating human-wildlife conflict around protected areas. *Conservation Letters*, *13*(1), e12679. https://doi.org/10.1111/conl.12679

Bruskotter, J., Singh, A., Fulton, D., & Slagle, K. (2015). Assessing tolerance for wildlife: Clarifying relations between concepts and measures. *Human Dimensions of Wildlife*, *20*(3), 255–270. https://doi.org/10.1080/10871209.2015.1016387

Bruskotter, J., & Wilson, R. (2014). Determining where the wild things will be: Using psychological theory to find tolerance for large carnivores. *Conservation Letters*, *7*(3), 158–165. https://doi.org/10.1111/conl.12072

Buddiger, M. (2012). *When human-elephant conflict causes frames to collide: The case of Moribane Forest Reserve, Mozambique* [Unpublished master's thesis]. Wagenigen University & Research.

Chang'a, A., de Souza, N., Muya, J., Keyyu, J., Mwakatobe, A., Malugu, L., Ndossi, H. P., Konuche, J., Omondi, R., Mpinge, A., Hahn, N., Palminteri, S., & Olson, D. (2016). Scaling-up the use of chili fences for reducing human-elephant conflict across landscapes in Tanzania. *Tropical Conservation Science*, *9*(2), 921–930. https://doi.org/10.1177/194008291600900220

Chemhuru, M., & Masaka, D. (2010). Taboos as sources of Shona people's environmental ethics. *Journal of Sustainable Development in Africa*, *12*(7), 121–133.

de Boer, W., & Baquete, D. (1998). Natural resource use, crop damage and attitudes of rural people in the vicinity of the Maputo Elephant Reserve, Mozambique. *Environmental Conservation*, *25*(3), 208–218. https://doi.org/10.1017/S0376892998000265

Dickman, A. (2010). Complexities of conflict: The importance of considering social factors for effectively resolving human-wildlife conflict. *Animal Conservation*, *13*(5), 458–466. https://doi.org/10.1111/j.1469-1795.2010.00368.x

Fernando, P., Kumar, M., Williams, A., Wikramanayake, E., Aziz, T., & Singh, S. (2008). *Review of human-elephant conflict mitigation measures practiced in South Asia*. World Wildlife Fund.

Ghiurghi, A., Dondeyne, S., & Bannerman, J. (2010). *Chimanimani National Reserve management plan, Vol. I-II*. Agriconsulting.

Goba, P. (2018). *Uso da Abelha Africana na mitigação do conflito homem elephante (CHE) na Reserva Florestal de Moribane (RFM) [Use of African honey-bee in the mitigation of human-elephant conflict (HEC) in the Moribane Forest Rerve (RFM)]* [Unpublished master's thesis]. Eduardo Mondlane University.

Gomes E Sousa, A. (1968). *Reservas florestais de Moçambique [Forest reserves in Mozambique]* Maputo: Instituto de Investigação Agronómica de Moçambique.

Graham, M., & Ochieng, T. (2008). Uptake and performance of farm-based measures for reducing crop raiding by elephants *Loxodonta Africana* among smallholder farms in Laikipia District, Kenya. *Oryx*, *42*(1), 76–82. https://doi.org/10.1017/S0030605308000677

Hill, C. (2004). Farmers' perspectives of conflict at the wildlife-agriculture boundary: Some lessons learned from African subsistence farmers. *Human Dimensions of Wildlife*, *9*(4), 279–286. https://doi.org/10.1080/10871200490505710

Hill, M., & Hill, A. (2009). *Investigação por questionário [Investigation by questionnaire]*. Edicões SÍLABO.

Hoare, R. (2015). Lessons from 20 years of human-elephant conflict mitigation in Africa. *Human Dimensions of Wildlife*, *20*(4), 289–295. https://doi.org/10.1080/10871209.2015.1005855

Inskip, C., Carter, N., Riley, S., Roberts, T., & MacMillan, D. (2016). Toward human-carnivore coexistence: Understanding tolerance for tigers in Bangladesh. *PloS One*, *11*(1), e0145913. https://doi.org/10.1371/journal.pone.0145913

Kansky, R., Kidd, M., & Knight, A. (2016). A wildlife tolerance model and case study for understanding human wildlife conflicts. *Biological Conservation*, *201*, 137–145.http://dx.doi.org/10.1016/j.biocon.2016.07.002

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

Kariodzo, M., & Osborn, F.. (2015). Community based conflict mitigation trials: Results of field tests of chili as an elephant deterrent. *Biodiversity & Endangered Species, 3*(1). http://dx.doi.org/10.4172/2332–2543.1000144

King, L. E., Lawrence, A., Douglas-Hamilton, I., & Vollrath, F. (2009). Beehive fence deters crop-raiding elephants. *African Journal of Ecology*, *47*(2), 131–137. https://doi.org/10.1111/j.1365-2028.2009.01114.x

King, L. E., Lawrence, A., Douglas-Hamilton, I., & Vollrath, F. (2011). Beehive fences as effective deterrents for crop-raiding elephants: Feld trials in northern Kenya. *African Journal of Ecology*, *49*(4), 431–439. https://doi.org/10.1111/j.1365-2028.2011.01275.x

Kioko, J., Muruthi, P., Omondi, P., & Chiyo, P. (2008). The performance of electric fences as elephant barriers in Amboseli, Kenya. *South African Journal of Wildlife Research*, *38*(1), 52–58. https://doi.org/10.3957/0379-4369-38.1.52

Le Bel, S., Murirwa, A., Mukamuri, B., Czudek, R., Taylor, R., & La Grange, M. . Human wildlife conflicts in southern Africa: Riding the whirl wind in Mozambique and Zimbabwe. In J. López-Pujol (Ed.), *The importance of biological interactions in the study of biodiversity* ; 2011: 283–322. InTech.

Leonardo, W., van de Ven, G., Udo, H., Kanellopoulos, A., Sitoe, A., & Giller, K. (2015). Labour not land constrains agricultural production and food self-sufficiency in maize-based smallholder farming systems in Mozambique. *Food Security*, *7*(4), 857–874. https://doi.org/10.1007/s12571-015-0480-7

Macandza, V., Mamugy, F., & Lichuge, J. (2014, April). *Uso de espaço e habitat pelo elefante na Reserva de Moribane, ACTF de Chimanimani [Use of space and habitat by elephant in the Moribane Reserve, Chimanimani TFCA]*. Paper presented at the conference on conservation science, Maputo.

Madden, F., & McQuinn, B. (2014). Conservation's blind spot: The case for conflict transformation in wildlife conservation. *Biological Conservation*, *178*, 97–106. https://doi.org/10.1016/j.biocon.2014.07.015

Ministry for the Coordination of Environmental Affairs. (2014). *Fifth national report on the implementation of Convention on Biological Diversity in Mozambique*. MICOA.

Ministry of Tourism (MIT). (2010). *Strategy and action plan for the conservation and management of elephants in Mozambique, 2010-2015*. National Directorate of Conservation Areas.

Needham, M., & Vaske, J. (2008). Hunter perceptions of similarity and trust in wildlife agencies and personal risk associated with chronic wasting disease. *Society & Natural Resources*, *21*(3), 197–214. https://doi.org/10.1080/08941920701816336

Ngama, S., Korte, L., Bindelle, J., Vermeulen, C., & Poulsen, J. (2016). How bees deter elephants: Beehive trials with forest elephants (*Loxodonta Africana cyclotis*) in Gabon. *PloS One*, *11*(5), 1–12. https://doi:10.1371/journal.pone.0155690.

Nsonsi, F., Heymans, J.-C., Diamouangana, J., Mavinga, F., & Breuer, T. (2018). Perceived human-elephant conflict and its impact for elephant conservation in northern Congo. *African Journal of Ecology*, *56*(2), 208–215. https://doi.org/10.1111/aje.12435

Ntumi, C. (2012). *A landscape approach to elephant conservation in Mozambique* [Unpublished doctoral dissertation]. University of Pretoria.

Olivier, P., Ferreira, S., & van Aarde, R. (2009). Dung survey bias and elephant population estimates in southern Mozambique. *African Journal of Ecology*, *47*(2), 202–213. https://doi.org/10.1111/j.1365-2028.2008.00983.x

Reja, U., Manfreda, K., Hlebec, V., & Vehovar, V. (2003). Open-ended vs. closed-ended questions in web questionnaires. In A. Ferligoj & A. Mrvar (Eds.), *Developments in applied statistics* (pp. 159–177). FDV.

Riley, S., & Decker, D. (2000). Risk perception as a factor in wildlife stakeholder acceptance capacity for cougars in Montana. *Human Dimensions of Wildlife*, *5*(3), 50–62. https://doi.org/10.1080/10871200009359187

Saif, O., Kansky, R., Palash, A., Kidd, M., & Knight, A. (2020). Costs of coexistence: Understanding the drivers of tolerance towards Asian elephants *Elephas maximus* in rural Bangladesh. *Oryx*, *54*(5), 603–611. . https://doi.org/10.1017/S0030605318001072

Schafer, J., & Bell, R. (2002). The state and community-based natural resource management: The case of the Moribane forest reserve, Mozambique. *Journal of Southern African Studies*, *28*(2), 401–420. https://doi.org/10.1080/03057070220140775

Scheijen, C., Richards, S., Smit, J., Jones, T., & Nowak, K. (2019). Efficacy of beehive fences as barriers to African elephants: A case study in Tanzania. *Oryx*, *53*(1), 92–99. https://doi.org/10.1017/S0030605317001727

Serra, A. (2001). Legitimacy of local institutions for natural resource management: The case of M'Punga, Mozambique. *Marena Working Paper No. 3*. Sussex: School of African and Asian Studies, University of Sussex, United Kingdom.

Sitati, N., & Walpole, M. (2006). Assessing farm-based measures for mitigating human-elephant conflict in Transmara District, Kenya. *Oryx*, *40*(3), 279–286. https://doi.org/10.1017/S0030605306000834

Sitati, N., Walpole, M., & Leader-Williams, N. (2005). Factors affecting susceptibility of farms to crop raiding by African elephants: Using a predictive model to mitigate conflict. *Journal of Applied Ecology*, *42*(6), 1175–1182. https://doi.org/10.1111/j.1365-2664.2005.01091.x

Sitoe, S. (2003). *Distribuição e uso de habitat pelo elefante na Reserva Florestal de Moribane, Província de Manica [Distribution in and use of the habitat by elephant in the Moribane Forest Reserve, Manica Province]* [Unpublished licentiate's thesis]. Eduardo Mondlane University.

Tchamba, M. (1998). Habitudes migratoires des éléphants et interactions homme-éléphant dans la région de Waza-Logone (Nord-Cameroun) [Migratory habits of elephants and human-elephant interaction in the Waza-Logone region (North-Cameroun)]. *Pachyderm*, *25*, 53–66.

Thayer-Hart, N., Dykema, J., Elver, K., Schaeffer, N., & Stevenson, J. (2010). *Survey fundamentals: A guide to designing and implementing surveys*. University of Wisconsin Survey Center.

Thouless, C., Dublin, H., Blanc, J., Skinner, D., Daniel, T., Taylor, R., … Bouché, P. (2016). African elephant status report 2016: An update from the African elephant database. *Occasional Paper No. 60*. Gland, Switzerland: IUCN.

Timberlake, J., Darbyshire, I., Cheek, M., Banze, A., Fijamo, V., Massunde, J., … Muassinar, D. (2016). *Plant conservation in communities on the Chimanimani footslopes, Mozambique* (Report for the Darwin Initiative Award 2380). Royal Botanical Gardens, Kew.

Witter, R. (2013). Elephant-induced displacement and the power of choice: Moral narratives about resettlement in Mozambique's Limpopo National Park. *Conservation and Society*, *11*(4), 406–416. https://doi.org/10.4103/0972-4923.125756

Note

1. In the case of polygamous marriage, the family unit of each wife was considered as a household.