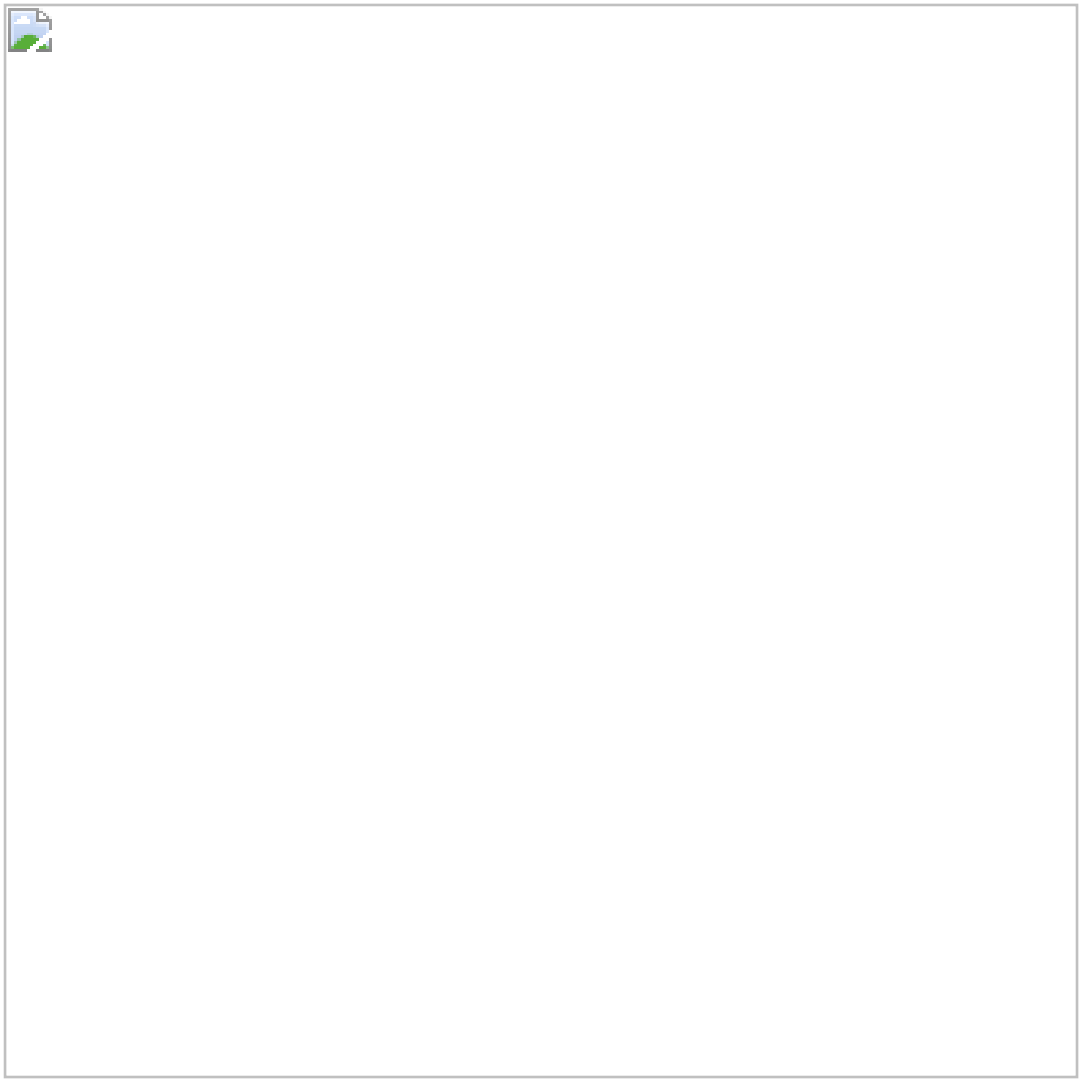

Perception of Human–Elephant Conflict and Conservation Attitudes of Affected Communities in Myanmar

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Abstract

Myanmar is an ideal location for Asian elephant (*Elephas maximus* L.) conservation because it still contains large expanses of elephant habitat. However, increasing human–elephant conflict (HEC) threatens to derail ongoing elephant conservation programs. We conducted 303 interviews in rural communities living near elephants to help inform long-term management strategies to conserve this endangered species. We sought to understand the main challenges that people in these communities face in improving their quality of life, as well as the types and levels of HEC they experience and their attitudes toward elephant conservation. Poverty, not conflict with elephants, was the greatest obstacle reported by our participants. However, HEC was deemed a moderate to major problem, with 38% of farmers indicating they lost half or more of their crops to elephants the previous year. Our results showed that communities living in proximity to and often harmed by elephants were nevertheless supportive of elephant conservation and willing to contribute to conservation efforts. This result offers hope in the quest to maintain elephant populations in Myanmar. We conclude that conservation policies that also address societal challenges such as poverty may be more effective in protecting elephants than policies that address HEC alone.

Keywords

human–elephant conflict, mitigation, conservation attitudes, community engagement, land cover change

Introduction

Socioeconomic advancement in developing countries is often tied to the expansion of agriculture and the conversion of natural landscapes into areas for industry or settlement (Maitima et al., 2009; Nyamasyo & Kihima, 2014). Development of natural lands often intensifies habitat fragmentation and loss, bringing humans and wildlife into closer proximity and escalating human–wildlife conflict (HWC; Johnson, Vongkhamheng, Hedemark, & Saithongdam, 2006; Mbora & McPeek, 2009; Parker & Osborn, 2006). HWC with wildlife species that raid crops, prey on livestock, or endanger humans can impose substantial costs on local people and their livelihoods (Karanth, Gopalaswamy, Prasad, & Dasgupta, 2013; Madhusudan, 2003). As a result, one key challenge in garnering community support for the conservation of megafauna is managing HWC in the face of growing human populations and expanding development.

The Asian elephant (*Elephas maximus* L.) range includes countries with some of the highest human population densities globally (Fernando & Leimgruber, 2011). Asian wildlands that previously comprised prime elephant habitat are increasingly being developed to accommodate the needs of a growing human

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Figure 1. Common examples of human–elephant conflict (HEC) in Myanmar include crop raiding of rice paddies (left) and property destruction (right top and bottom). In addition, death and injury can result from HEC, such as when a monk was killed when an elephant knocked over the support beams in his home (top right). Photo credit: Christie Sampson.

population (Bhagwat et al., 2017; Leimgruber et al., 2003). Development is necessary to improve the livelihoods and socioeconomic conditions of local communities, but is often difficult to balance with the conservation of surrounding ecosystems and biodiversity, including elephants. One of the most visible ways this imbalance is expressed is through human–elephant conflict (HEC; Figure 1), which is a direct result of habitat loss, and the subsequent conversion of natural lands into agriculture, leading to increasing interactions between humans and elephant.

HEC can result in the injury and death of humans and threatens the survival of the Asian elephant throughout their range (Fernando & Leimgruber, 2011; Fernando et al., 2005; Sukumar, 1989, 2003). Consequently, understanding the socioeconomic context of HEC is essential when designing efficient, long-term conservation and management plans and policies for Asian elephants. Active involvement of local people can help ensure that such programs are sustainable (Bruskotter & Wilson, 2013; Carter, Shrestha, Karki, Pradhan, & Liu, 2012; Ripple et al., 2014; Treves & Bruskotter, 2014) and that local needs and concerns are heard and incorporated into these efforts.

The extent and consequences of HEC can vary among communities depending on crop type, farming practices, differences in growing season, environmental conditions, habitat characteristics, resource availability for both

human and wildlife populations, and local variation in elephant behavior such as learnt responses to management (Dickman, 2010; Fernando et al., 2008). In addition, the local perception of HEC can also vary depending on cultures and traditions (Dickman, 2010; Skogen, Mauz, & Krange, 2009). A persistent issue in developing and applying conservation policies is finding ways to gain the support of local communities and engage them in collaborative conservation efforts (Borgerhoff Mulder & Coppolillo, 2005), because it requires a sufficient understanding of the complex HEC issues they face before initiating HEC mitigation programs. Interviews within local communities may reveal core issues associated with HEC that are unique to their locations and assist researchers in developing more effective elephant conservation programs.

Myanmar has some of the largest remaining areas of unfragmented habitat for Asian elephant populations (Leimgruber et al., 2003) and offers a model location for long-term elephant conservation efforts. The wild elephant population in Myanmar has declined from 10,000 elephants in the 1940s to an estimated 1,430 in the 2000s (Leimgruber et al., 2008; Leimgruber & Wemmer, 2004) primarily due to elephant capture for use as draft animals in the logging industry (Leimgruber et al., 2008); habitat loss (Songer, Aung, Allendorf, Calabrese, & Leimgruber, 2016); HEC (Leimgruber, Oo, et al., 2011, Santiapillai & Jackson, 1990), and, more recently, excessive poaching for elephant skin (Sampson et al., 2018). Understanding how local communities experience and view HEC, and their attitudes toward Myanmar's wild elephant population is essential to organizations working to reduce HEC and gain these communities' support for conservation.

To assess the importance of socioeconomics in determining local people's perception of HEC, we conducted oral interviews in rural communities in Myanmar. Our main objectives were to

1. determine major obstacles rural communities face to improving their quality of life, and whether this differs among villages with and without HEC;
2. identify the types and severity of HEC;
3. assess general attitudes toward elephant conservation; and
4. identify which mitigation strategies are most supported by the communities and more likely to be successfully implemented.

We hypothesized that rural communities would identify HEC as a major challenge to improving their quality of life, and that farmers in particular experience more HEC due to crop raiding by elephants than their non-farmer neighbors (i.e., grocery store owners, forest product collectors; henceforth referred to as non-farmers). We hypothesized that farmers perceive the challenges posed by environmental factors, such as drought or animal presence, to be greater than those posed by socioeconomic factors, such as unemployment or inadequate infrastructure, relative to non-farmers. We integrated responses from the interview survey with a land cover analysis to determine if people in villages predominately surrounded by resources utilized by elephants (e.g., forests or agricultural areas) perceive elephants to be a greater problem than people in villages lacking these resources. Finally, we expected that people who experienced higher levels of HEC express lower levels of support for elephant conservation.

Methods

Study Sites

Working with wildlife officials from the Myanmar Ministry of Natural Resources and Environmental Conservation, we identified two areas with high HEC, Taikkyi and Hlegu townships, where we conducted our study (Figure 2). Both townships are located south of the Bago Yoma mountains in the Yangon region of south-central Myanmar, are surrounded by forest reserves used for timber extraction, and have rural human populations estimated at 189,268 and 230,663 people, respectively (Department of Population, 2017).

We conducted interviews with 14 villages or village complexes (henceforth "villages") within Taikkyi Township and 17 within Hlegu Township. These 31 villages accounted for all the permanent settlements that experienced HEC in our study townships. The primary occupations in the area are farming, collecting forest products such as thatch and firewood, and daily labor including construction and harvesting. As a control, we also conducted surveys in two villages, Hlae Hlaw Inn and Haing Ku in Hlegu Township, that had not experienced HEC for the previous 10 years or more, as confirmed by the village headmen and Myanmar Ministry of Natural Resources and Environmental Conservation.

Conducting the Survey

We contacted each village headman prior to arriving in the village to request permission to interview community members. The headman arranged for our team to conduct interviews in a central location, usually the schoolhouse, monastery, or community center, and he informed the community of the date and time of our visit and encouraged villagers to attend. We visited each village once to interview adults who were available and willing to participate in the study at the time of our visit.

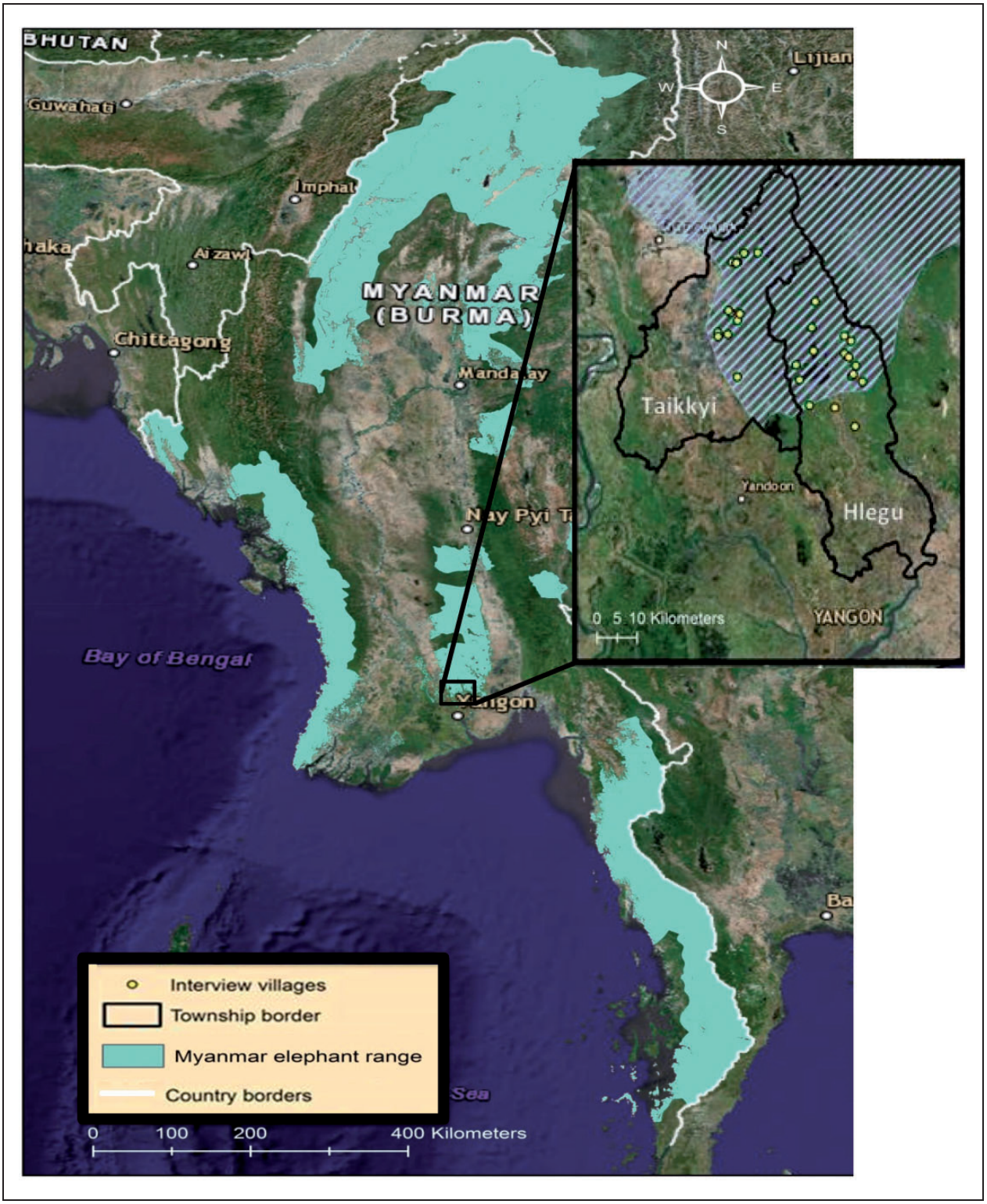


Figure 2. Locations of the study sites in Myanmar. Dots indicate villages where interviews were conducted in Taikkyi and Hlegu townships (July 2014). Myanmar elephant range adapted from Songer et al. (2016). Image source: World Imagery: Esri, DigitalGlobe, Earthstar Geographics, CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community (accessed November 2017).

We conducted interviews with both men and women between the age of 18 and 77 years, between July 8 and July 28, 2014. Each interview lasted 15 to 30 minutes and responses to the questions (Appendix A) were recorded on a survey form. We conducted individual interviews separating participants as much as possible during the questioning process to reduce external influences and potential biases in the answers provided. We adapted interview questions from a questionnaire previously developed by the Elephant Conservation Group (Leimgruber, Azmi, et al., 2011).

Interviews were conducted orally in the Myanmar language by interviewers who had participated in a half-day training session addressing interview methodology (i.e., interviews and recording of responses on the questionnaire response form). During this training session, the interviewers also received specific instructions on how to categorize responses from each open-ended question, utilizing keywords spoken by each person participating in the survey. If the participant's response did not fit into one of the predetermined categories, the interviewer recorded the response as "other" on the survey form. The study design and questionnaire were approved by the institutional review boards at both Clemson University and the Smithsonian Institution (IRB20014-187 and HS15051, respectively).

Questionnaire Design

After recording sociodemographic data (gender, age, and occupation), we asked participants, "What are the main obstacles to improving your life?" (Objective 1). Responses were categorized into the following: (a) lack of capital or funds or poverty, (b) unemployment, (c) limited infrastructure (e.g., roads, medical clinics, schools, and electricity), (d) lack of land or access to land for farming, (e) the drought or flood water cycle, (f) natural disasters, (g) financial or opportunity costs due to the presence of domestic or wild animals, or (h) other. Individuals who identified as farmers were asked additional questions about the issues they faced cultivating crops within the elephant range. We tested for significance between farmers' and non-farmers' responses using a two-proportion Z test in JMP (SAS Institute Inc., 2017). To quantify the specific impacts of HEC on farmers, we asked, "What are the top three problems for your cultivation?" response categories were the following: (a) water availability, (b) land availability, (c) domestic and wild animals, (d) natural disasters, (e) plant diseases, (f) money, or (g) other issues. We also asked participants to indicate what kinds of animals caused damage to their crops.

To determine the severity of HEC experienced in the communities (Objective 2), we asked all participants to indicate one of four responses to assess how they perceived elephants: Elephants are (a) not a problem, (b) a minor problem, (c) a moderate problem, or (d) a major problem. Participants who said that elephants posed a problem (i.e., answered b, c, or d) were subsequently asked why they believed elephants were a problem, and to identify from a set of multiple-choice responses, the specific types of conflict they or their household members had experienced over the previous 5 years. These participants were further asked a series of multiple-choice questions to determine if they believed HEC was seasonal, when HEC occurred over a 24-hour period, and why they believed elephants attacked people. To identify underlying structures in the data, and evaluate the relationship between the severity of HEC experienced by participants and sociodemographic variables such as age, sex, and occupation, we conducted a multiple correspondence analysis (Le Roux & Rouanet, 2004) in JMP (SAS Institute Inc., 2017).

To estimate crop damage caused by elephants relative to other sources, we asked farmers to specify the percent of crops lost to HEC in the previous year, compared with factors such as drought, plant diseases, or insects. Visual aids depicting a field with differing percentages of crop loss were used by the interviewers to assist the participants in estimating damage to their annual harvest if measurements were not taken at the time of loss (Appendix B).

To assess elephant conservation attitudes within the local communities (Objective 3), we asked community members if it was important for Myanmar to have elephants in the future. If they said yes, we asked them to indicate either yes or no on why they are important: (a) because they are part of nature, (b) for religious reasons, (c) for tourism, or (d) for other reasons. We also asked two multiple-choice questions to determine whom they believed should be responsible for HEC management, and if the participant, personally, would be willing to contribute to HEC mitigation initiatives. Finally, we asked two open-ended questions to identify what actions participants were currently taking to prevent elephant damage (Objective 4), and what they believed should be done in the future to reduce HEC.

Interviews Conducted in Areas Without HEC

In the villages without recent HEC, we collected the same sociodemographic data on occupation, gender, and age. We also inquired what the major challenges the villagers faced in bettering their quality of life to determine if there was a difference outside of the elephant range. We asked the farmers to identify the most prevalent issues they encountered for cultivation, which animal species damaged their crops, and to estimate the amount of crops lost. We also inquired why they believed elephants attacked people, and if it was

important for Myanmar to have wild elephants in the future and why. All questions posed to participants in nonconflict areas were asked using the same format as that used for the participants in areas with conflict.

Land Cover Analysis

We developed a land cover map utilizing satellite data and the randomForest package (Breiman & Cutler, 2007) in R (R Core Team, 2013) to quantify the amount of forest, sugarcane, and rice paddies in our study area. In ESRI ArcGIS 10 (Environmental Systems Research Institute, 2011), we created 1 km buffers surrounding the GPS point recorded at the center of each village. The 1 km buffers were chosen to minimize overlap between nearby villages while still encompassing relevant surrounding land cover. We then determined the percent of forest, sugarcane plantations, and rice paddies within each of those 1 km buffers. We chose these land cover types because sugarcane and rice represent the primary food crops raided by local elephants, and forests provide shade and other resources often used by elephant populations.

Results

From the 31 villages subject to HEC, we interviewed 229 males and 59 females; the average age in our HEC sample was 46 ($SD = 12.2$). Of these, 205 (71%) stated their primary occupation was farming, while the remaining 83 (29%) non-farmers indicated that their primary occupation was working as daily labors or gathering forest products. In the two non-conflict villages, we surveyed 15 males who were all farmers; the average age in our non-HEC sample was 46 ($SD = 9.4$).

Determining Major Challenges Experienced by Rural Communities Facing HEC

Among villages facing HEC, a similarly high percentage of farmers (75%) and non-farmers (84%) said that a lack of capital or funds or poverty was the primary obstacle they faced to improving their quality of life (Table 1; Appendix C). The majority of farmers (67.5%) indicated that wild or domestic animals were the second greatest obstacle, while almost all non-farmers found them to be inconsequential (98.8%). Instead, non-farmers reported that the lack of employment opportunities (60%) was their second-greatest obstacle (Appendix C). More generally, non-farmers were more likely than farmers to indicate that unemployment, land availability, and natural disasters posed obstacles to improving their lives ($p < .001$; Table 1). Eighty-three percent of farmers responded that conflict with wild animals was the most prevalent issue for their cultivation, followed by lack of money (59%), and plant diseases (32%, Appendix C). Most of the farmers (95%) cited elephants as one of the main animal species that cause crop damage, followed by wild pigs (16%) and insects (14%).

Table 1. Obstacles to Improving the Lives of Farmers and Nonfarmers in Taikkyi and Hlegu Townships, Myanmar in June and July 2014.

	Farmers (n=205)	Non-farmers (n=83)
Capital or funds	75.2%	84.1%
Land*	18.9%	48.8%
Water	27.2%	18.3%
Natural disaster*	3.9%	35.4%
Infrastructure	50.0%	59.8%
Unemployment*	19.9%	51.2%
Animal*	67.5%	1.2%
Other	1.9%	1.2%
Missing	0.0%	1.2%

*$p < .001$.

Identifying the Intensity and Types of HEC

For farmers living in the elephant conflict area, 54% reported that elephants were a major problem, with an additional 24% reporting elephants as a moderate problem (Appendix C). Further analysis indicated that older farmers (51–77 years old) were most closely associated with reporting the most severe level of HEC, while younger participants were more closely associated with reporting only minor levels of HEC (Figure 3, Appendix D). For non-farmers in these areas, 30% reported elephants were a major problem with another 30% indicating elephants posed a moderate problem (Appendix C). Farmers indicated crop and property damage as the main concerns when living with elephants, while non-farmers in elephant range cited property damage and personal or family safety as their most prevalent concerns. Most farmers had experienced crop loss due to elephants, with 38% reporting that they lost half or more of their crop in the 2013 growing season. More than two thirds of farmers reported that elephants were the only animal that caused crop damage in 2013.

Although we predicted that communities surrounded by greater percentages of both rice and sugarcane would report higher levels of HEC, results suggest that only people in villages surrounded by greater amounts of sugarcane perceived greater levels of conflict (Figure 4). Both farmers and non-farmers indicated more severe amounts of HEC when their villages were surrounded by lower percentages of rice in comparison to higher percentages (Figure 4). In forested areas, we found that farmers reported a lower severity of HEC in areas

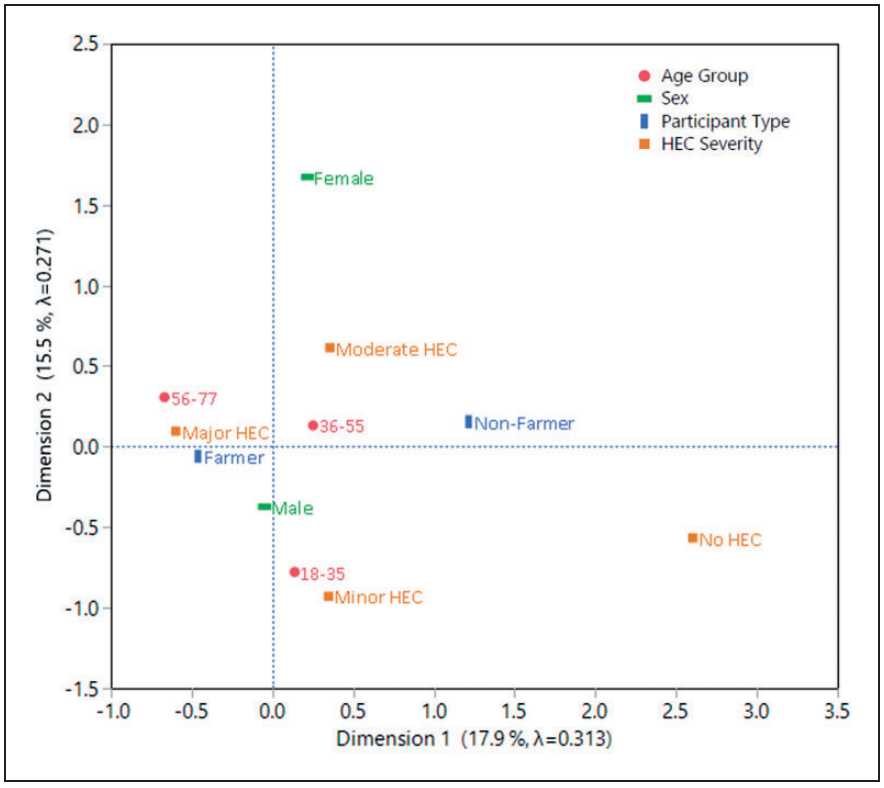


Figure 3. Multiple correspondence analysis of participants' age, sex, occupation type, and degree of human–elephant conflict they experience in Myanmar (June and July 2014).
HEC = human–elephant conflict.

with greater percentages of forest surrounding their village; however, the trend was not clear for non-farmers.

Assessing How Locals Perceive the Risks From HEC and Their More General Conservation Attitudes

Both farmers (87%) and non-farmers (93%) indicated support for the conservation of Myanmar's wild elephant population (Appendix C). The reasons they gave for their support included that they perceived that elephants were an important part of nature (farmers = 63%, non-farmers = 79%), and elephants were an important part of the local religion (farmers = 37%, non-farmers = 48%). Both groups believed that attacks on people by elephants occurred accidentally during the elephants' effort to get to food in agricultural fields or food that is stored in homes (farmer= 90% and non-farmer= 83%) or because human communities were encroaching on the elephant habitat (farmer= 50% and non-farmer= 63%).

Identifying Which Mitigation Strategies Are Most Supported by the Communities

To reduce HEC, and the associated damage and death, 41% of the farmers indicated that they try to discourage wild elephants from remaining in an area by driving them away with loud noise, lights, tractors, or captive elephants. Some farmers (33%) indicated that they spend the nights in tree huts in or near their crops and use noise or lights to try to scare away elephants. Non-farmers used physical barriers and deterrents (e.g., fencing, reflective lights, and noisemakers) to reduce conflicts with elephants (Appendix C). Nearly all community members indicated they would be willing to assist with some form of future HEC mitigation, with 87% of farmers and 77% of non-farmers indicating they would donate time and labor, while less than 10% of both farmers and non-farmers were willing to provide in-kind materials or to donate money (Appendix C). The strategies most preferred by farmers to reduce HEC in the future included removing all elephants from the area (49%) and implementing more physical barriers (45%; Appendix C).

Non-farmers supported the use of more physical barriers (54%) and improving deterrents such as noisemakers and motion sensor lights and sounds (39%), while only one participant responded that they would prefer to kill elephants (1%; Appendix C). Community members generally believed that the Myanmar government should be primarily responsible for HEC

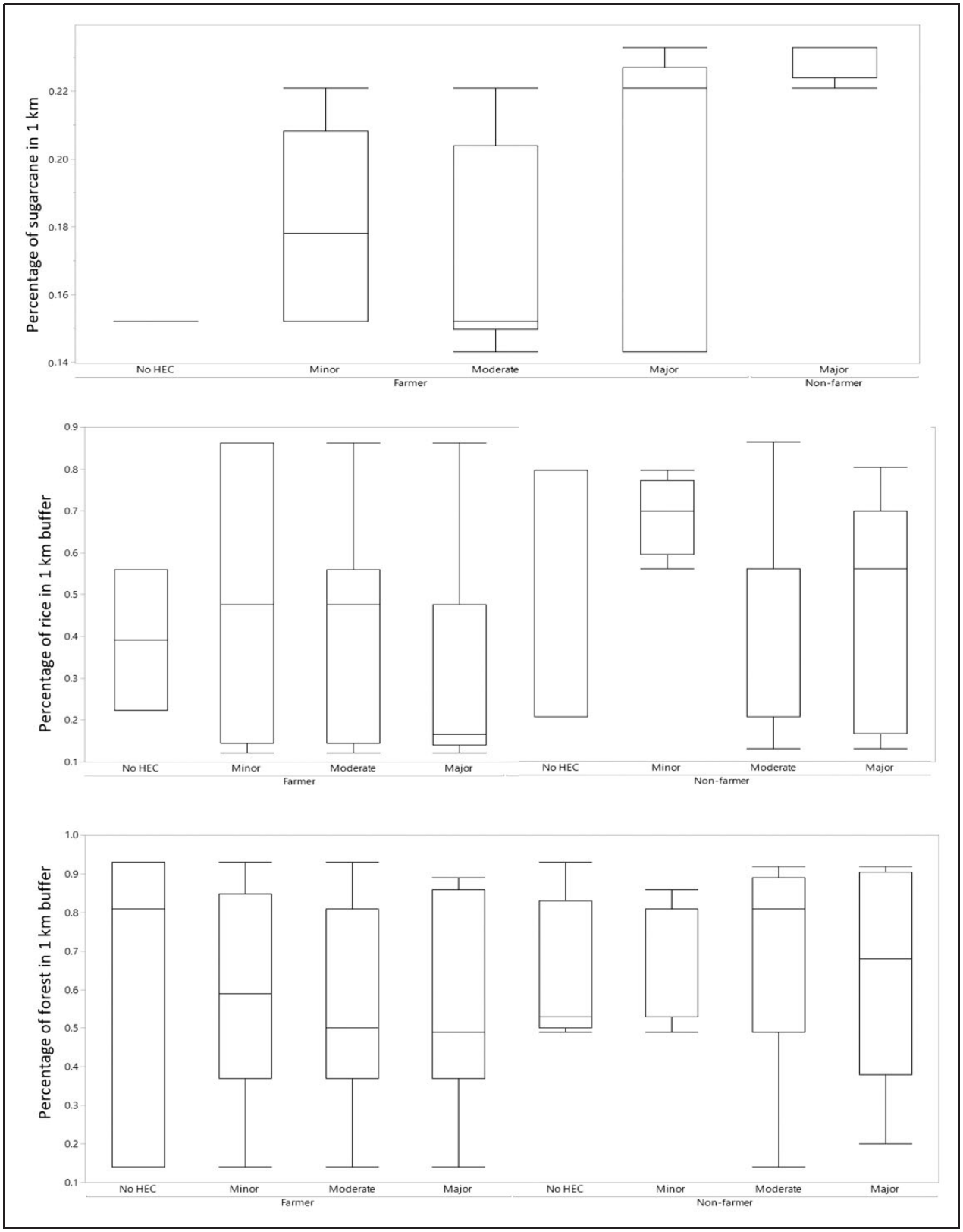


Figure 4. Severity of human–elephant conflict (HEC) reported by participants in villages with 10% or more forest (top; farmer: $n = 90$, non-farmer: $n = 49$), sugarcane (middle; farmer: $n = 42$, non-farmer: $n = 4$), and rice (bottom; farmer: $n = 95$, $n = 28$) land cover in the 1 km buffer around each village center. Interviews conducted in Myanmar in June and July 2014.
HEC = human–elephant conflict.

mitigation, although individual households and community organizations were also named as responsible parties (Appendix C).

Interviews Conducted Outside of the Elephant Range

Participants outside of the elephant range reported that the main obstacles they faced to improving their socioeconomic status were the lack of capital or funds or poverty (73%) and water availability (73%; Appendix C). Their three most prevalent issues for cultivation were perceived to be crop diseases (73%), lack of money (53%), and natural disasters (53%). Most farmers (83%) reported that crops were damaged more by insects than by any other taxon. Twenty-seven percent reported losing half of their crop in the 2013 growing season, and that their losses were due to reasons other than elephants.

All participants supported keeping wild elephants in Myanmar because the animals were important for religious reasons, and 80% supported keeping wild elephants because they are an essential part of the ecosystem. As with the participants surveyed that experienced HEC, the nonconflict farmers believed that elephants primarily attacked people either accidentally while getting to food (58%) or because humans were encroaching on their habitat (66%).

Discussion

The consequences of living alongside wildlife can be extensive (Hoare, 1999). However, assuming that HWC is the only or primary challenge for rural communities may prevent researchers from identifying management strategies that would more effectively, even if indirectly, address conflict with wildlife. We found that HEC is one of many, often interconnected, challenges facing the people of Myanmar. Despite these challenges, the participants overwhelmingly supported elephant conservation, in contrast to other studies that have revealed feelings of helplessness and bitterness toward species involved in HWC (e.g., Mwangi et al., 2016).

The identification of poverty as the most prevalent concern with respect to improving quality of life allows researchers and other stakeholders involved in elephant management to focus on improving conservation success by providing economic opportunities that support conservation efforts, potentially through community-based programs (Borgerhoff Mulder & Coppolillo, 2005). Previous research has demonstrated that rural communities value the economic potential elephants may provide to the community (Bauer, 2003; Naughton-Treves, 1998; Newmark, Leonard, Sariko, & Gamassa, 1993). Thus, community-based programs that provide compensation in excess of the cost incurred by HWC (Kaltenborn, Bjerke, & Nyahongo, 2006; Li, Xiaowei, Chuanlin, & Wei, 2010) and reinforce traditional conservation values are often more effective than standard deterrent-based strategies because they can help improve the perception of the conflict species (Kuriyan, 2002).

We are not surprised that farmers perceived the presence of both domestic and wild animals to be the second greatest impediment to improving their quality of life, as income generation for farmers is highly dependent on their ability to grow crops free from destruction by animals (e.g., Mwangi et al., 2016). Costs incurred by rural communities due to HWC can be substantial (Dickman, Macdonald, & Macdonald, 2011; Hulme & Murphree, 1999; Salerno, Borgerhoff Mulder, Grote, Ghiselli, & Packer, 2016) and have potentially lasting negative implications for households that share the landscape with conflict species.

Limited livelihood opportunities have been shown to be a consequence of loss of access to land or resources as a result of HWC (Coad, Campbell, Miles, & Humphries, 2008; Salerno et al., 2016; West, Igoe, & Brockington, 2006). For example, rates of unemployment may be exacerbated by the presence of elephants if potential farmers among this group are deterred from raising crops due to the expectation of crop raiding, or if farmers do not hire daily laborers to harvest because elephants destroyed their crops. However, few non-farmers reported that animals, including elephants, posed barriers to improving their quality of life, which could indicate that they may not associate HEC with poverty or a lack of employment opportunities.

Although HEC was not named the leading cause preventing rural communities from improving their lives, both farmers and non-farmers within the elephant range perceived elephants to be a moderate or major problem. While elephant damage can be devastating, particularly when considering the collateral damage from trampling that can exceed the amount actually consumed by the elephants (Naughton-Treves, 1998; Parker & Osborne, 2006) was thought to occur infrequently (Naughton-Treves, 1998). In contrast to this, a third of the farmers in our study site reported losing half or more of their crops due to elephants in 2013. This substantial amount of conflict is reflected in the multiple correspondence analysis which associated farmers with reporting the greatest severity of HEC. This analysis also closely associated older participants with reporting major levels of HEC and younger participants with minor levels, perhaps because older participants may feel they would be unable to escape a potential elephant attack (e.g., climb a tree to avoid a charging elephant) as well as a younger person could.

These findings are also seen in the severe HEC reported in areas with higher percentages of sugarcane as the participants interviewed were primarily farmers.

Reports of more severe conflict in these areas could be due to sugarcane's longer growing season which may provide a more continuous food source for elephants, and more potential crop raiding, resulting in higher levels of HEC over the year. For villages near rice paddies; however, we found that even participants with low percentages of rice near their village reported severe HEC. This difference could be because sugarcane plantations tend to be larger and owned by wealthier community members in comparison to rice farmers. The threat of crop destruction may make rice farmers more sensitive to HEC if they are unable to endure significant crop losses as well as their richer neighbors. In contrast to the two crop resources we analyzed, the low severity of HEC reported by farmers in areas with more forest is in line with our earlier finding that this group of participants primarily regards elephants as a danger to crops and by extension their livelihood.

It is important to note that farmers in Hlae Hlaw Inn, a village with no HEC, lost 50% or more of their crops to insects, plant disease, and drought. Thus, it is possible that much of crop loss blamed on elephants in villages within elephant range may instead be due to insects, disease, or drought. Further, some individuals within the elephant range reported losses due to other animals, including domesticated animals and wild pigs, comparable to the amount others lost and attributed to elephant crop raiding (Appendix C).

Quantifying the amount of damage done by elephants in comparison to other species is imperative (Lahm, 1996) so that wildlife managers can determine if damage is correctly attributed to elephants. Naughton-Treves (1998) found that crop damage due to livestock was as great or exceeded the damage caused by some wildlife species, and that the number of individual crop raiding occurrences by livestock far exceeded the number of crop raiding occurrences by elephants. Working with local communities to improve their understanding of the types of damage done by elephants and having community experts such as mahouts (i.e., captive elephant caretakers and trainers) examine suspected elephant crop raiding sites may help communities to discern actual elephant damage from damage caused by other species or events. More accurate reporting of HEC will allow clarification of links between perceived and actual HEC events and will allow for the deployment of more effective mitigation strategies (Dickman, 2010).

Maintaining or increasing the tolerance levels for HEC observed in this study is critical to long-term conservation sustainability (Behdarvand et al., 2014; Behr, Ozgul, & Cozzi, 2017; Suryawanshi, Bhatia, Bhatnagar, Redpath, & Mishra, 2014). It is essential for researchers to understand if perceived causes of conflict are rooted in superstition or more scientifically based reasoning to ensure that they do not also need to address societal or cultural beliefs in order to develop effective mitigation. Participants' identification of the reasons why elephants injured humans as (a) it was done accidentally when they were trying to get to food resources or (b) because the human population had moved into elephant habitat, align with past studies attributing an increase in HEC to human expansion into wildlands (e.g., Fernando et al., 2005, Kioko, Kiringe, & Omondi, 2006; Okello, 2005). However, other studies (e.g., Prokop, Fančovičová, & Kubiatko, 2009) found community members facing HWC can believe that wildlife attacks were motivated primarily by cultural superstitions rather than ecological drivers. Our conversations with community members revealed that some believed that a recent HEC event which resulted in a woman's death was perpetrated by a "vampire elephant" that was killing people to drink their blood. Still, as a majority of the participants attributed the drivers of HEC to ecological factors rather than superstitious motivations, the responses in our study support an optimistic view for continued conservation efforts in this area.

Other studies have concluded that people who have experienced HEC are more likely to engage in HEC mitigation to prevent future damage (Fernando et al., 2005; Karanth & Kudalkar, 2017). Rural communities in Myanmar rely principally on reactive mitigation strategies (e.g., physical barriers, deterrents, or driving away elephants) to combat HEC, although it has been suggested that these methods may be ineffective over the long term (Fernando et al., 2008). In addition, these disruptive and at times aggressive techniques can actually result in an increase of HEC and may potentially increase the number of attacks on humans by elephants (Fernando et al., 2008).

Identifying participants' favored mitigation strategies allows local conservationists to address community expectations, the feasibility of implementation, and the necessary community input expected for the success of such mitigation strategies. Such information allows conservationists to make adjustments as needed based on what is realistically achievable. Erecting physical barriers and improving deterrents have proven successful in preventing elephants from causing damage in other countries (Fernando et al., 2008) and can be adapted for use by local communities. Barriers such as electric fences, however, may merely displace the conflict (Hill & Wallace, 2012) and create tensions with neighboring farms or villages (U Khin Muang Gyi, personal communication). In addition, these mitigation methods can be

expensive to implement and can bring further inequality to the poorest members of the community who are unable to invest in or maintain effective barriers (Barua, Bhagwat, & Jadhav, 2013; Naughton-Treves, 1998). Other strategies such as educational outreach programs focus on best practices when confronted with elephants and behavioral modification to avoid HEC (e.g., keeping rice and other attractants away from the home, phone, or other alert systems for approaching elephants). These efforts were initiated by the research team and collaborators in 2015 and provided at no cost to communities through Myanmar's rural schools and community centers in the study area, and on national television.

Although preferences for moving elephants to other locations was expressed as an HEC mitigation method, permanent translocation of elephants is expensive and hard to achieve as elephants often return to the areas from which they were taken (Fernando et al., 2008; Fernando, Leimgruber, Prasad, & Pastorini, 2012). Even if successful, translocation can simply move the conflict from one location to another. However, because we have identified this as the most desirous action, conservationists can incorporate a detailed explanation on the improbability of translocation as an effective management solution into future communication (i.e., town halls with local councilmen, community meetings) to demonstrate to the community that their concerns and wishes are being assimilated into the management plan.

Even though few participants advocated for the killing of elephants to reduce HEC, it should be noted that the study site and areas across central Myanmar experienced high levels of poaching during the course of this research (Sampson et al., 2018) which may be leading to further population declines. The degree of involvement in poaching activities by local community members is unclear, though several people in the area were arrested on poaching related charges between 2014 and 2017. Local informants have also provided details of a sophisticated logistic network for moving poached elephant products out of Myanmar, indicating the presence of organized international criminal groups. This poaching seems to be mostly driven by financial interests, specifically supplying elephant skins to the Chinese traditional medicine market (Nijman & Shepherd, 2014) and not by local people retaliating against crop raiding elephants.

Implications for Conservation

This study has answered critical questions including what challenges are faced by the residents within our study area and their conservation attitudes. The widespread support for the conservation of Asian elephants provides great hope for potential and continued collaboration with local communities. However, adapting conservation efforts so that they consider the primary socioeconomic challenges expressed by our sample may help to increase the effectiveness of such conservation efforts by facilitating a stronger connection between conservation and human well-being. Future studies that assess the most effective means of including socioeconomic considerations into conservation planning are recommended.

Appendix A.

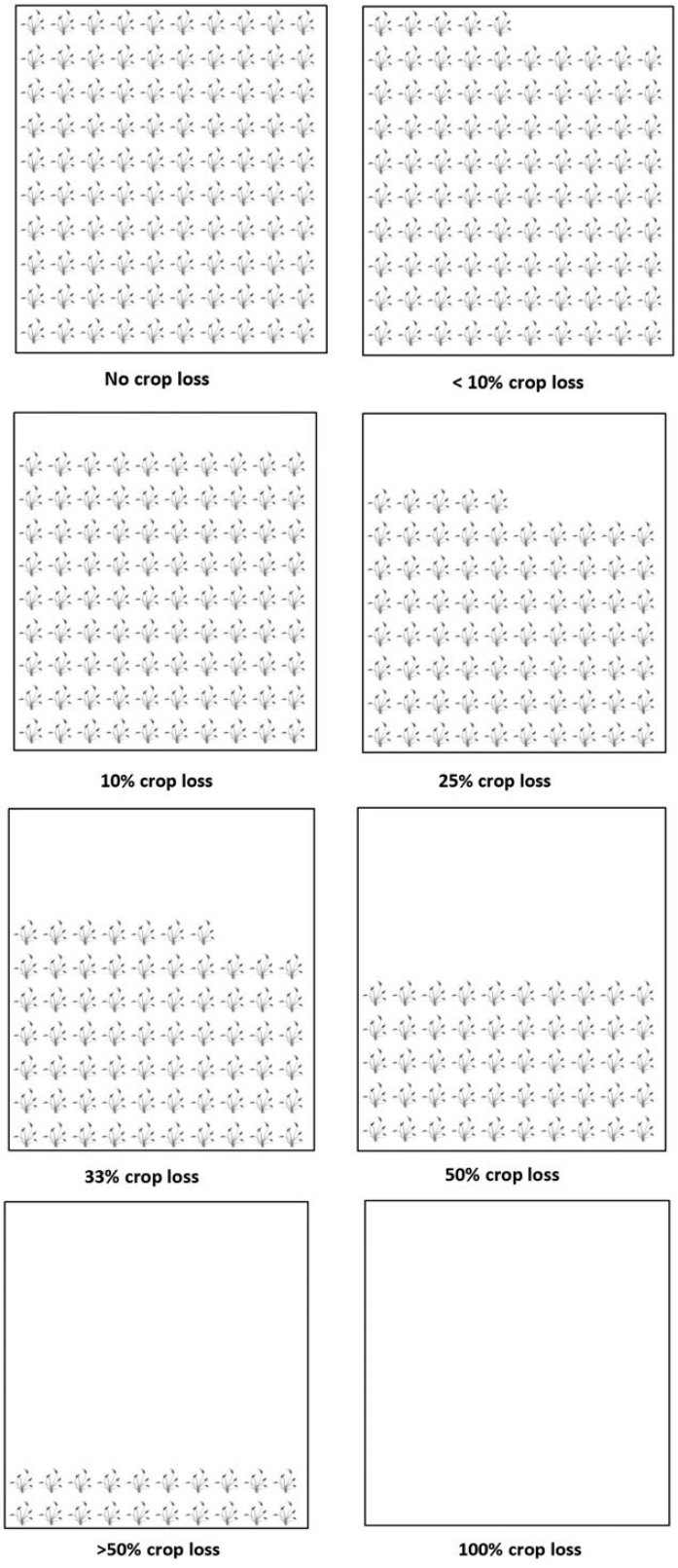
Table A1. Complete List of Questions Asked During the Interview Survey in June and July 2014 in Myanmar.

What are the main obstacles you have to improving your life?
What are the top three problems for your cultivation?
What animals cause damage to your crops?
How much of a problem are elephants?
If elephants are a problem, why?
*What time of day do you have problems with elephants?
Have you or anyone in your household experienced any of the following threats from wild elephants in the past 5 years?
Why do elephants attack people?
How much of your harvest did you lose to elephants last year?
How much of your entire harvest did you lose for other reasons?
*Which type of elephant groups are in this area?
*Which type of elephant groups cause crop damage?
*Which type of elephant groups cause property and human damage?
At what time of the year does damage from elephants occur?
Who should be responsible for mitigating HEC?
What actions do you currently take to prevent elephant damage?
*If you are driving elephants from the area, do you think this is an effective mitigation method?
What should be done about the elephant problem?
Would you be willing to contribute to community initiatives for HEC mitigation? If yes, how?
Where should the elephant live?
Is it important that Myanmar have wild elephants in the future?

Note. Questions with "*" were not included in the analyses for this study.

Appendix B.

Visual guide to assist farmers quantify crop loss due to elephants and other factors. The guide served as a tool to help farmers estimate crop damage and did not accurately reflect the pattern of crop loss. Crop loss percentages were chosen to allow for greater definition of damages at the finer scale due to potential multiple sources (i.e., drought, insects, and animals) after informal discussions with stakeholders prior to the survey. Participants were asked to indicate the closest percentage that represented their loss.



Appendix C

Table C1. Responses From Farmers and Non-Farmers in 31 Villages Inside of the Elephant Range.

Question	Response	Farmers (*n*)	% of Farmers	Non-farmers (*n*)	% of Non-farmers
What are the main obstacles you have to improving your life?	Capital or funds	155	75	69	84
	Land	39	19	40	49
	Water	56	27	15	18
	Natural disaster	8	4	0	0
	Infrastructure (e.g., roads, clinics, schools, and electricity)	103	50	29	35
	Employment	41	20	49	60
	Animals	139	67	42	51
	Other	4	2	1	1
What are the top three problems for your cultivation?	Water availability	50	24	–	–
	Land availability	26	13	–	–
	Animals	170	83	–	–
	Natural disaster	12	6	–	–
	Plant disease	65	32	–	–
	Money	122	59	–	–
	Other	2	1	–	–
What animals cause damage to your crops?	Domestic animals (cattle, pigs, goats, sheep, chicken, etc.)	16	8	–	–
	Wild pigs	32	16	–	–
	Deer	0	0	–	–
	Monkeys	2	1	–	–
	Insects	28	14	–	–
	Elephants	196	95	–	–
	Wild birds (e.g., peafowl)	22	11	–	–
	Other	5	2	–	–
How much of a problem are elephants?	None	4	2	6	7
	Minor	37	18	19	23
	Moderate	50	24	25	30
	Major	111	54	25	30
	No elephants	1	0	1	1
If elephants are a problem, why?	Crop damage	188	91	20	24
	Property damage	124	60	47	57
	Safety (Injury or death)	46	22	25	30
	Damage to livestock	10	5	5	6
	Other	3	1	6	7
	Elephants are not a problem	2	1	5	6
Have you or anyone in your household experienced any of the following threats from wild elephants in the past 5 years?	Crop damage	179	87	12	15
	Property damage	103	50	40	49
	Fear for personal safety	108	52	38	46
	Physical injury	17	8	11	13
	Death of a family member	17	8	6	7
	Damage to livestock	5	2	1	1
	Other	4	2	4	5
Why do elephants attack people?	Purposely because people are protecting their food or crops	10	5	3	4
	Accidentally when elephants are trying to get to human food	185	90	68	83
	They are afraid of humans	17	8	5	6

(continued)

Table C1. Continued

Question	Response	Farmers (*n*)	% of Farmers	Non-farmers (*n*)	% of Non-farmers
	They do not like humans	17	8	4	5
	Because humans kill elephants	0	0	0	0
	Because humans encroach on elephant land	102	50	52	63
	Other	6	3	1	1
	Elephants do not attack people	3	1	6	7
How much of your harvest did you lose to elephants last year?	Entire harvest	16	8	–	–
	More than half (>50%)	35	17	–	–
	One half (50%)	27	13	–	–
	One third (33%)	43	21	–	–
	One quarter (25%)	18	9	–	–
	One tenth (10%)	31	15	–	–
	Less than one tenth (<10%)	20	10	–	–
	None (0%)	14	7	–	–
How much of your entire harvest did you lose for other reasons?	Entire harvest	1	0	–	–
	More than half (>50%)	1	0	–	–
	One half (50%)	6	3	–	–
	One third (33%)	9	4	–	–
	One quarter (25%)	9	4	–	–
	One tenth (10%)	12	6	–	–
	Less than one tenth (<10%)	20	10	–	–
	None (0%)	140	68	–	–
At what time of the year does damage from elephants occur?	All year	13	6	3	4
	Seasonally	184	89	78	95
			0		0
Who should be responsible for mitigating HEC?	Government	196	90	72	88
	Individual farmer	102	47	38	46
	Community organizations	109	50	34	41
	NGOs	41	19	7	9
	Other	2	1	2	2
What actions do you currently take to prevent elephant damage?	Use of physical barriers	70	32	38	46
	Deterrents (smoke, bees, fire crackers, . . .)	62	29	21	26
	Confrontation	28	13	12	16
	Use alternative crops or alternative livelihood	12	6	7	9
	Driving elephant from this area	89	41	17	21
	Kill elephants	0	0	1	1
	Moving people from this area	5	2	8	10
	Living in tree huts	74	34	17	21
	Nothing	29	13	19	23
	Other	4	2	2	2
What should be done about the elephant problem?	Use of physical barriers (electric fences, trenches, biofences. . .)	97	45	44	54
	Improving deterrents (smoke, bees, fire crackers, ...)	71	33	32	39
	Compensation	25	12	3	4
	Use alternative crops/alternative livelihood	21	10	17	21
	Move all the elephant from this area	106	49	22	27
	Move all the conflict elephants from this area	65	30	19	23
	Help people to move from this area	3	1	9	11

(continued)

Table C1. Continued

Question	Response	Farmers (*n*)	% of Farmers	Non-farmers (*n*)	% of Non-farmers
	Kill elephants	0	0	1	1
	Nothing	17	8	10	12
	Other	2	1	1	1
Would you be willing to contribute to community initiatives for HEC mitigation? If yes, how?	Time or labor	189	87	77	77
	Money	14	6	5	5
	In kind or materials	14	6	9	9
	No	5	2	3	3
Where should the elephant live?	In this part of this forest reserve	12	6	4	4
	In a different part of this forest reserve	36	17	27	27
	In a different forest reserve	148	68	51	51
	Don't know	14	6	10	10
	Other	6	3	2	2
	All wild elephants should be removed	28	13	10	10
Is it important that Myanmar have wild elephants in the future?	Yes, they are part of nature	137	63	65	65
	Yes, they are important for tourism	30	14	13	13
	Yes, they are important for religious reasons	80	37	39	39
	Yes, other	52	24	9	9
	No, all wild elephants should be removed from Myanmar	29	13	6	6

HEC = human–elephant conflict; NGO = non-governmental organizations.

Appendix D.

Table D1. Summary of Variables Included in Multiple Correspondence Analysis.

Variable	Category	*N*	No HEC	Minor	Moderate	Major
Age-group	18–35	52	3 (1%)	9 (3%)	15 (6%)	25 (10%)
	36–55	150	8 (3%)	33 (13%)	39 (15%)	70 (27%)
	56–77	67	1 (0%)	13 (5%)	20 (8%)	33 (13%)
Sex	Female	49	2 (1%)	7 (3%)	15 (6%)	25 (10%)
	Male	220	10 (4%)	48 (18%)	59 (23%)	103 (40%)
Occupation	Farmer	195	5 (2%)	37 (14%)	49 (19%)	104 (40%)
	Non-farmer	74	7 (3%)	18 (7%)	25 (10%)	24 (9%)

HEC = human–elephant conflict.

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References

Barua, M., Bhagwat, S. A., & Jadhav, S. (2013). The hidden dimensions of human-wildlife conflict: Health impacts,

opportunity and transaction costs. *Biological Conservation*, *157*, 309–316. doi:10.1016/j.biocon.2012.07.014

Bauer, H. (2003). Local perceptions of Waza National Park, northern Cameroon. *Environmental Conservation*, *30*(2), 175–181. doi:10.1017/S037689290300016X

Behdarvand, N., Kaboli, M., Ahmadi, M., Nourani, E., Mahini, A. S., & Aghbolaghi, M. A. (2014). Spatial risk model and mitigation implications for wolf-human conflict in a highly modified agroecosystem in Western Iran. *Biological Conservation*, *177*, 156–164. doi:10.1016/j.biocon.2014.06.024

Behr, D. M., Ozgul, A., & Cozzi, G. (2017). Combining human acceptance and habitat suitability in a unified socio-ecological suitability model: A case study of the wolf in Switzerland. *Journal of Applied Ecology*, *54*(6), 1919–1929. doi:10.1111/1365-2664.12880

Bhagwat, T., Hess, A., Horning, N., Khaing, T., Thein, Z. M., Aung, K. M., …Leimgruber, P. (2017). Losing a jewel—Rapid declines in Myanmar's intact forests from 2002-2014. *PloS One*, *12*(5), e0176364. doi:10.1371/journal.pone.0176364

Borgerhoff Mulder, M., & Coppolillo, P. (2005). *Conservation: Linking ecology, economics, and culture*. Princeton, NJ: Princeton University Press.

Breiman, L., & Cutler, A. (2007). *Random forests-classification description*. Berkeley, CA: Department of Statistics.

Bruskotter, J., & Wilson, R. (2013). Determining where the wild things will be—Using psychological theory to find tolerance for large carnivores. *Conservation Letters*, *7*(3), 158–165.

Carter, N. H., Shrestha, B. K., Karki, J. B., Pradhan, N. M. B., & Liu, J. (2012). Coexistence between wildlife and humans at fine spatial scales. *Proceedings of the National Academy of Sciences*, *109*(38), 15360–15365. doi:10.1073/pnas.1210490109

Coad, L., Campbell, A., Miles, L., & Humphries, K. (2008). *The costs and benefits of forest protected areas for local livelihoods : A review of the current literature*. Working Paper. Cambridge, UK: UNEP World Conservation Monitoring Centre.

Department of Population. (2017). *Overview and results of 2014 census*. Retrieved from http://www.dop.gov.mm/en/publication-category/2014-reports

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

Dickman, A. J., Macdonald, E. A., & Macdonald, D. W. (2011). A review of financial instruments to pay for predator conservation and encourage human-carnivore coexistence. *Proceedings of the National Academy of Sciences*, *108*(34), 13937–13944. doi:10.1073/pnas.1012972108

Environmental Systems Research Institute. (2011). *ArcGIS desktop: Release 10*. Redlands, CA: Author.

Fernando, P., Kumar, M. A., Williams, A. C., Wikramanayake, E., Aziz, T., & Singh, S. M. (2008). *Review of human-elephant conflict mitigation measures practiced in South Asia. AREAS technical support document submitted to World Bank. WWF-World Wide Fund for nature*. Retrieved from http://sa.indiaenvironmentportal.org.in/files/review_of_human_elephant_final_reduced_01.pdf

Fernando, P., & Leimgruber, P. (2011). Asian elephants and dry forests. In W. J. McShea, S. J. Davies, & N. Bhumpakphan (Eds.), *The ecology and conservation of seasonally dry forests in Asia* (pp. 151–163). Washington, DC: Smithsonian Institution Scholarly Press.

Fernando, P., Leimgruber, P., Prasad, T., & Pastorini, J. (2012). Problem-elephant translocation: Translocating the problem and the elephant? *PLoS One*, *7*(12), e50917. doi:10.1371/journal.pone.0050917

Fernando, P., Wikramanayake, E., Weerakoon, D., Jayasinghe, L. K. A., Gunawardene, M., & Janaka, H. K. (2005). Perceptions and patterns of human–elephant conflict in old and new settlements in Sri Lanka: Insights for mitigation and management. *Biodiversity & Conservation*, *14*(10), 2465–2481. doi:10.1007/s10531-004-0216-z

Hill, C. M., & Wallace, G. E. (2012). Crop protection and conflict mitigation: Reducing the costs of living alongside non-human primates. *Biodiversity and Conservation*, *21*(10), 2569–2587. doi:10.1007/s10531-012-0318-y

Hoare, R. E. (1999). Determinants of human-elephant conflict in a land-use mosaic. *Journal of Applied Ecology*, *36*(5), 689–700. Retrieved from http://www.jstor.org/stable/2655942

Hulme, D., & Murphree, M. (1999). Communities, wildlife and the 'new conservation' in Africa. *Journal of International Development*, *11*(2), 277–285. doi:10.1002/(SICI)1099-1328(199903/04)11:2<277::AID-JID582>3.0.CO;2-T

Johnson, A., Vongkhamheng, C., Hedemark, M., & Saithongdam, T. (2006). Effects of human-carnivore conflict on tiger (Panthera tigris) and prey populations in Lao PDR. *Animal Conservation*, *9*(4), 421–430. doi:10.1111/j.1469-1795.2006.00049.x

Kaltenborn, B. P., Bjerke, T., & Nyahongo, J. (2006). Living with problem animals—Self-reported fear of potentially dangerous species in the Serengeti Region, Tanzania. *Human Dimensions of Wildlife*, *11*(6), 397–409. doi:10.1080/10871200600984323

Karanth, K. K., Gopalaswamy, A. M., Prasad, P. K., & Dasgupta, S. (2013). Patterns of human-wildlife conflicts and compensation: Insights from Western Ghats protected areas. *Biological Conservation*, *166*, 175–185. doi:10.1016/j.biocon.2013.06.027

Karanth, K. K., & Kudalkar, S. (2017). History, location, and species matter: Insights for human-wildlife conflict mitigation from India. *Human Dimensions of Wildlife*, *22*(4), 331–346. doi:10.1080/10871209.2017.1334106

Kioko, J., Kiringe, J., & Omondi, P. (2006). Human-elephant conflict outlook in the Tsavo–Amboseli ecosystem. *Pachyderm*, *41*, 53–60.

Kuriyan, R. (2002). Linking local perceptions of elephants and conservation: Samburu Pastoralists in Northern Kenya. *Society & Natural Resources*, *15*(10), 949–957. doi:10.1080/08941920290107675

Lahm, S. (1996). A nationwide survey of crop-raiding by elephants and other species in Gabon. *Pachyderm*, *21*, 69–77.

Leimgruber, P., Azmi, W., Baishya, H., Campos-Arceiz, A., Fernando, P., Jitvijak, W., Williams, C. (2011). Workshop on developing adaptive management for mitigating human-elephant conflict across Asia. *Gajah*, *34*, 63–66.

Leimgruber, P., Gagnon, J. B., Wemmer, C., Kelly, D. S., Songer, M. A., & Selig, E. R. (2003). Fragmentation of Asia's remaining wildlands: Implications for Asian elephant conservation. *Animal Conservation*, *6*(4), 347–359. doi:10.1017/S1367943003003421

Leimgruber, P., Oo, Z. M., Aung, M., Kelly, D. S., Wemmer, C., Senior, B., & Songer, M. (2011). Current status of Asian elephants in Myanmar. *Gajah*, *35*, 76–86.

Leimgruber, P., Senior, B., Aung, M., Songer, M. A., Mueller, T., Wemmer, C., & Ballou, J. D. (2008). Modeling population viability of captive elephants in Myanmar (Burma): Implications for wild populations. *Animal Conservation*, *11*(3), 198–205. doi:10.1111/j.1469-1795.2008.00172.x

Leimgruber, P., & Wemmer, C. (2004). *National elephant symposium and workshop. Report to the USFWS and the Myanmar Forest Department*.

Le Roux, B., & Rouanet, H. (2004). *Geometric data analysis, from correspondence analysis to structured data analysis* (p.180). Dordrecht, The Netherlands: Kluwer Academic Publihsers.

Li, J., Xiaowei, Z., Chuanlin, W., & Wei, L. (2010). Investigation of posttraumatic stress disorder in children after animal-induced injury in China. *Pediatrics*, *126*, e320–e324.

Madhusudan, M. (2003). Living amidst large wildlife: Livestock and crop depredation by large mammals in the interior villages of Bhadra Tiger Reserve, South India. *Environmental Management*, *31*, 466–475.

Maitima, J. M., Mugatha, S. M., Reid, R. S., Gachimbi, L. N., Majule, A., Lyaruu, H., Mugisha, S. (2009). The linkages between land use change, land degradation and biodiversity across East Africa. *African Journal of Environmental Science and Technology*, *3*(10), 310–325. Retrieved from http://www.academicjournals.org/AJEST

Mbora, D. N. M., & McPeek, M. A. (2009). Host density and human activities mediate increased parasite prevalence and richness in primates threatened by habitat loss and fragmentation. *Journal of Animal Ecology*, *78*, 210–218. doi:10.1111/j.1365-2656.2008.01481.x

Mwangi, D. K., Akinyi, M., Maloba, F., Ngotho, M., Kagira, J., Ndeereh, D., & Kivai, S. (2016). Socioeconomic and health implications of human-wildlife interactions in Nthongoni, Eastern Kenya. *African Journal of Wildlife Research*, *46*(2), 87–102. doi:10.3957/056.046.0087

Naughton-Treves, L. (1998). Predicting patterns of crop damage by wildlife around Kibale, Uganda. *Conservation Biology*, *1229*(1), 156–168. Retrieved from http://www.jstor.org/stable/2387471

Newmark, W., Leonard, N., Sariko, H., & Gamassa, D.-G. (1993). Conservation attitudes of local people living adjacent to five protected areas in Tanzania. *Biological Conservation*, *63*(2), 177–183. doi:10.1016/0006-3207(93)90507-W

Nijman, V., & Shepherd, C. R. (2014). Emergence of Mong La on the Myanmar–China border as a global hub for the international trade in ivory and elephant parts. *Biological Conservation*, *179*, 17–22.

Nyamasyo, S. K., & Kihima, B. O. (2014). Changing land use patterns and their impacts on wild ungulates in Kimana Wetland Ecosystem, Kenya. *International Journal of Biodiversity*, *2014*, 1–10. doi:10.1155/2014/486727

Okello, M. M. (2005). NL and use changes and human-wildlife conflicts in the Amboseli Area, Kenya. *Human Dimensions of Wildlife*, *10*(1), 19–28.

Parker, G. E., & Osborn, F. V. (2006). Investigating the potential for chilli *Capsicum spp*. to reduce human-wildlife conflict in Zimbabwe. *Oryx*, *40*(3), 343–346. doi:10.1017/S0030605306000822

Prokop, P., Fančovičová, J., & Kubiatko, M. (2009). Vampires are still alive: Slovakian students' attitudes toward bats. *Anthrozoös*, *22*(1), 19–30.

R Core Team. (2013). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from http://www.r-project.org/

Ripple, W. J., Estes, J. A., Beschta, R. L., Wilmers, C. C., Ritchie, E. G., Hebblewhite, M., Wirsing, A. J. (2014). Status and ecological effects of the world's largest carnivores. *Science*, *343*(6167), 1241484. doi:10.1126/science.1241484

Salerno, J., Borgerhoff Mulder, M., Grote, M. N., Ghiselli, M., & Packer, C. (2016). Household livelihoods and conflict with wildlife in community-based conservation areas across northern Tanzania. *ORYX*, *50*(4), 702–712. doi:10.1017/S0030605315000393

Sampson, C., McEvoy, J., Oo, Z. M., Chit, A. M., Chan, A. N., Tonkyn, D., Leimgruber, P. (2018). New elephant crisis in Asia—Early warning signs from Myanmar. *PLoS One*, *13*(3), e0194113. doi:10.1371/journal.pone.0194113

Santiapillai, C., & Jackson, P. (1990). *The Asian elephant: An action plan for its conservation*. IUCN. Retrieved from https://portals.iucn.org/library/node/6042

SAS Institute Inc. (2017). *JMP®, Version 13*. Cary, NC: Author.

Skogen, K., Mauz, I., & Krange, O. (2009). Cry wolf! Narratives of wolf recovery in France and Norway. *Rural Sociology*, *73*(1), 105–133.

Songer, M., Aung, M., Allendorf, T. D., Calabrese, J. M., & Leimgruber, P. (2016). Drivers of Change in Myanmar's Wild Elephant Distribution. *Tropical Conservation Science*, *9*(4), 1–10. doi: 10.1177/1940082916673749

Sukumar, R. (1989). *The Asian elephant: Ecology and management*. New York, NY: Cambridge University Press.

Sukumar, R. (2003). *The living elephants: Evolutionary Ecology, behavior, and conservation*. New York, NY: Oxford University Press.

Suryawanshi, K. R., Bhatia, S., Bhatnagar, Y. V., Redpath, S., & Mishra, C. (2014). Multiscale factors affecting human attitudes toward snow leopards and wolves. *Conservation Biology*, *28*(6), 1657–1666. doi:10.1111/cobi.12320

Treves, A., & Bruskotter, J. (2014). Tolerance for predatory wildlife. *Science*, *344*, 476–477.

West, P., Igoe, J., & Brockington, D. (2006). Parks and peoples: The social impact of protected areas. *Annual Review of Anthropology*, *35*(1), 251–277. doi:10.1146/annurev.anthro.35.081705.123308