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An attitude assessment of human-elephant conflict in a critical wildlife corridor within the Terai Arc Landscape, India

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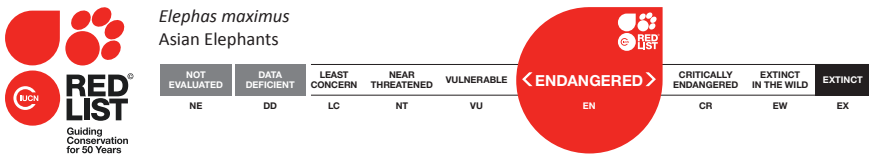
Abstract: This study entails an attitude assessment of the local people living at Mankanthpur Village, one of the bottlenecks in the Bailparao-Kotabagh corridor, Terai West Forest Division, on the issue of elephant conservation, human-(wildlife) elephant conflict, and the measures to mitigate it. Data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

Keywords: Asian Elephant, attitudes, community, crop raiding forest corridor, human-elephant conflict.



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INTRODUCTION

The Terai Arc Landscape (TAL) is defined as the area confined between the river Bagmati in the east and the river Yamuna in the west, all along the Shiwalik Hills in India and Churia Hills in Nepal. It comprises the Himalayan foothills, the Terai floodplains, and Bhabhar tracts. Stretching for over 1500km, TAL straddles two countries, India and Nepal, and includes 14 protected areas (PAs) (WWF India 2007). The TAL includes high density tiger areas and is a priority landscape for the WWF Elephant Action Strategy. TAL in India covers an area of approximately 30,000km^2 across Uttarakhand, Uttar Pradesh and Bihar. The Terai region of Uttarakhand consists of two important national parks of India, namely Rajaji National Park (820km^2) and Corbett National Park (520km^2). Rajaji National Park is situated towards the extreme west, and Corbett forms the heart of the Landscape (Semwal 2005). Key species, like the Asian Elephant *Elephas maximus* and Tiger *Panthera tigris,* are the most endangered species in the landscape. The future of these species lies in the sustainability of these two national parks and connectivity of various corridors in the state of Uttarakhand (Menon 2003; WWF India 2008).

The fertile landscape supports a large human population compared to the Gangetic plains and has a high settlement in search of food and employment (Johnsingh et al. 2004). Unemployment and low productivity has pushed people from the hills to the Terai and Bhabhar. The dependency of local residents on fuel wood, fodder, non-timber forest products (NTFP), and grazing needs, as well as deforestation and unplanned developments are some of the threats to wildlife movement in the landscape (WWF India 2008). On the east of Corbett National Park are the Ramnagar and Terai West Forest divisions. These divisions are important because they serve as the linkage corridors for the movement of wild animals from Corbett Tiger Reserve to far east in other divisions of the Terai Landscape. The Corbett National Park, with an area of 502km^2, is a part of Corbett Tiger Reserve which is 1288m including the Sonanadi Wildlife Sanctuary. The animals, while moving through this corridor, pass by villages in the critical Bailparao-Kotabagh Corridor, resulting in high human-wildlife conflict (Kandpal & Tiwari 2009).

The Asian Elephant occurs in the central and southern Western Ghats, northeastern India, eastern India, northern India, as well as some parts of southern peninsular India. It is included in the Schedule I of the Indian Wildlife (Protection) Act, 1972, and in Appendix I of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). Elephants occur in 16 of 29 states in India (MoEF&CC 2014). In 1992, the Government of India launched Project Elephant, a flagship conservation project that aims to conserve the elephant and its habitat across 10 major landscapes (designated as Project Elephant Ranges), to mitigate elephant-human conflict, and protect the animal from being poached for ivory. The Indian elephant population in 2012 was estimated to be in the range between 27,785 and 31,368 (MoEF&CC 2014). Being a Schedule I species, the Asian Elephant requires immediate protection for its dwindling populations (MoEF&CC 2014). As a high profile and charismatic species, it has important ecological and cultural associations as well. A key conservation problem today remains the exploitation of elephant habitat leading to qualitative degradation and fragmentation throughout its range (MoEF&CC 2014). However, wherever they occur, elephants are known to explore newer areas and extend their range. Several explanations have been suggested (Kangwana 1995). Local overabundance of animals, habitat loss, shortage of food and water resources, or simply a natural instinct are some of the possible causes for elephants to make forays into new areas (Sukumar 1989). Thus, managing such forest corridors in TAL will provide trans-boundary dispersal corridors and migration paths for elephants and many other species, which are crucial for maintaining biological diversity and gene flow.

Despite being endowed with a rich assemblage of wildlife species, TAL faces serious conservation challenges. On the one hand, tiger, elephant, and other species of the region are threatened; on the other hand local communities that directly depend on the region's natural resources are also affected. Conservation objectives in this highly populated zone therefore need to be reinforced by creating opportunities for the local communities, thereby reducing human-elephant conflict while allowing sustainable use of and access to natural resources. It is for this reason that an attitude assessment of the Human Elephant Conflict (HEC) was carried out at Mankanthpur Village, one of the most critical villages in the corridor, as it is flanked by forest on three sides and also acts as a bottleneck in the Terai West Forest Division. The corridor provides passage to a large number of mammals from Corbett National Park to the far east in the landscape. The increasing HEC in the corridor has become one of the main challenges for elephant conservation. Hence the conflict problem is a cause for concern, and understanding the ecological and socio-economic context of the HEC is a prerequisite

to bring about an efficient and long-term management of Asian elephants and their habitats (van Schaik & Rijksen 2002). Therefore, studies on the perception and attitudes of local communities towards wild elephant related problems and conservation in the corridor are helpful for the mitigation of HEC and conservation of wild elephants. The purpose of the study is to learn the perception and attitudes of local communities towards wild elephant related problems and conservation, and to discuss key approaches to the conservation of wild elephants and the mitigation of HEC.

STUDY AREA

This study was conducted in Mankanthpur Village (29°23'30.47''N & 79°7'31.28''E), which is located in the Ramnagar block (Terai West Forest Division) of Nainital District in Uttarakhand. The village falls in the Bailparao-Kotabagh wildlife corridor that connects the western portion of Corbett Tiger Reserve to the east in the Nandhor Valley (Fig. 1). With an average of 130 households, the village shares a border with Ramnagar Forest Division. Urban facilities such as hospitals and post-secondary education (i.e., beyond class 10) are located approximately 6km away. Mankanthpur has a forest-dependent population that practices subsistence agriculture, with some villagers also involved in ecotourism activities as a side profession. The local community utilizes forest biomass such as fuel wood, fodder, and NTFPs, and is moderately homogenous in terms of social group and traditions. Kumauni is the dominant language, although Hindi is also understood and used by all other than the oldest residents.

Men and women follow traditional gender roles found elsewhere in the mountains of Uttarakhand (Pokhriyal 1994). Out migration of men seeking employment elsewhere is common, and women are generally occupied with agricultural and domestic tasks, including care of livestock, children, elders, and the collection of biomass from the nearby forests (Orga 2009). HEC (in the form of crop-raiding, property damage, attack by wild elephants, and fear of attack) is a problem for nearly all families in the village due

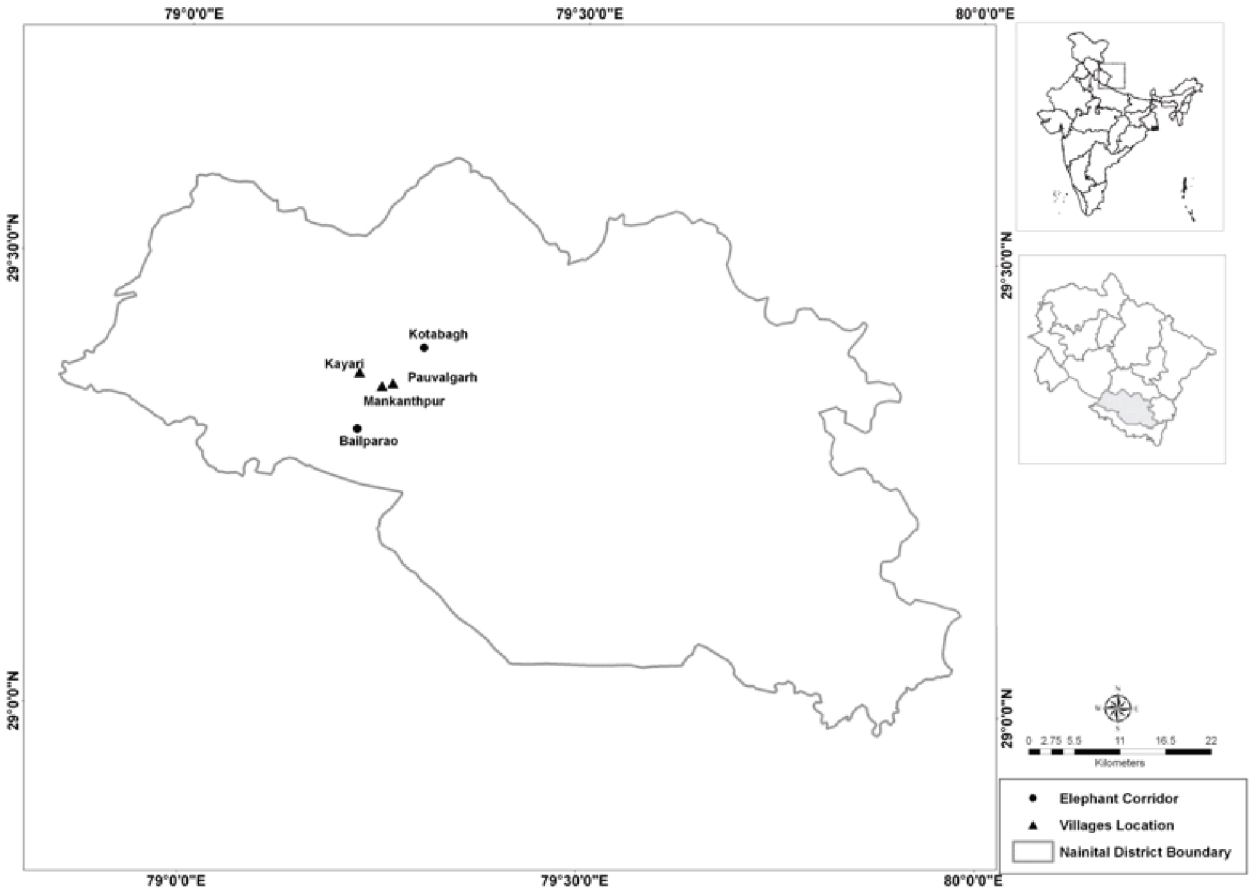

Figure 1. Map of study area.

to the proximity of their agricultural fields to the park border, and the village's location within a traditional elephant migration route. There are about 22 villages in the Bailparao-Kotabagh corridor, and all these villages along the corridor face some form of human-wildlife interaction; Mankanthpur Village is one of these villages (Kandpal & Tiwari 2009).

METHODS

An assessment of HEC in the study area was done due to high elephant incursion into the village. The survey was done in February–April, 2010. The study involved primary data collection in the village through a household survey. For the conflict survey, a door-to-door approach was used with the help of a native-speaking field assistant. The survey was done using a standardized questionnaire, which had open ended and closed questions, and included both quantitative and qualitative questions. Questions that were asked through the questionnaire survey included: frequency and severity of damage by elephants; typese and age of crops damaged; number and sex of elephants involved; attitude of the affected people; the number of damage events or elephant incidents reported by the villagers. Around 120 structured interviews were conducted in the village on an alternating basis, with one adult male or female member from every willing household invited to participate in the survey. Interviews were conducted in Hindi and Kumauni, and later were translated by the native speaking field assistant who assisted with the interviews. The interview was face to face. Valuation based questions were followed up to determine people's perception for different use and non use values related to elephant conservation (Bann 1999). The villagers were made aware of the survey and of the interest in collecting information about crop damage. During the study period the villagers were asked to inform our team about any crop damage incurred in the village, so that we could try to visit the area to inspect the damage and complete the questionnaire. Daily records were maintained regarding the sex of the elephants sighted, type of crop damage by the elephants and age of crops (mature crop or intermediate growth), degree of damage (high, medium, or low), compensation filed, etc. Informants reported that they sometimes did not record an elephant sighting if one or more elephants just "passed through" the village fields without causing damage. To analyze local communities' perception and attitudes towards wild elephant-related problems, we compared interviewees' views including causes of elephant-related problems, measures to mitigate HEC, and attitudes towards conservation. The results were expressed in the form of pie charts and graphs. Based on the study, recommendations were proposed for the same.

RESULTS AND ANALYSES

Mankanthpur Village is typical of communities composed of households who practice a combination of subsistence agriculture and limited cash income generating strategies. The local community utilizes forest biomass such as fuel wood, fodder, and green leaves. Agriculture is the mainstay of the villagers, where more than 85% of the total population is engaged either with agriculture or its allied practices. Among the principal crops grown in the village are rice (*Oryza sativa*), wheat (*Triticum aestivum*), millet (*Pennisetum glaucum)*, barley (*Hordeum vulgare*), pulses, and oil seeds. The ratio of pulses and oil seeds is comparatively low. Wheat occupies the highest percent (30.04%) in the total sown area, followed by rice (29%), and pulses (15.93%). The cultivation of vegetables has been extending and now accounts for 9.16% of the cropped area of the village. According to the data collected, in the months of March and April, the work of threshing, winnowing, and storing for use or selling in the market takes place. Crops such as beans, wheat, gram or Jowar are grown optionally in land holdings. The villagers mostly own the land they cultivate, but the size of these land holdings is very small and uneconomical to cultivate. Villagers generally cultivate their own land; some who are not able to manage on their own give out land for share cropping and tending.

Elephant group size and frequency of crop raids

During the three months of the study period, 98 elephants were recorded near the crop fields in the village, and a total of 62 crop raids occurred from February to April, 2010 (Fig. 2, Image 1). A mean sighting of 1.08 elephants per day was recorded in the study area. Mean elephant group size was 1.58, and mean elephant crop raiding events (events/days) was 0.68. In 62 crop raiding events, a total of 98 elephants was observed. Of these, 52 had tusks (males, 53.06%), 28 were females (28.57%), and 18.37% were single individuals which could not be identified by the villagers as either being male or female.

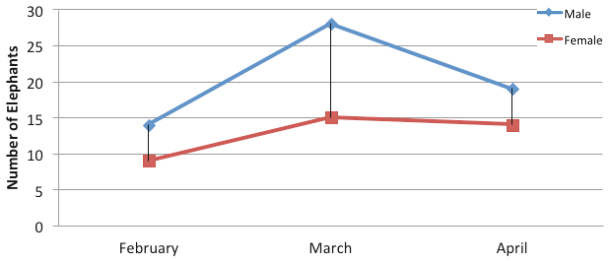

Figure 2. Monthly frequency of elephants encountered in the study area, February–April 2010

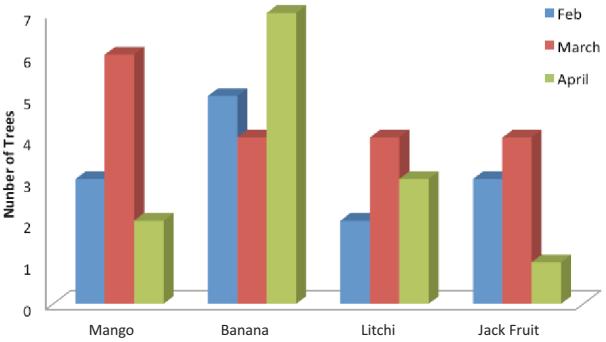

Figure 3. Numbers of mature crop trees damaged by the elephants in the study area, February–April 2010.

Image 1. Crop raid by elephants

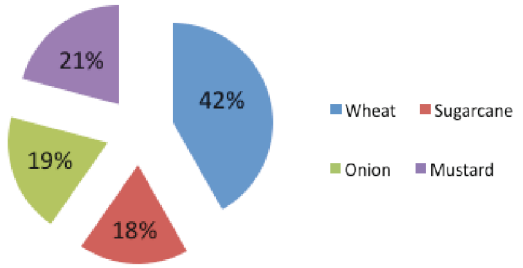

Figure 4. Percentage of damage to different crops from February–April 2010, in the study area

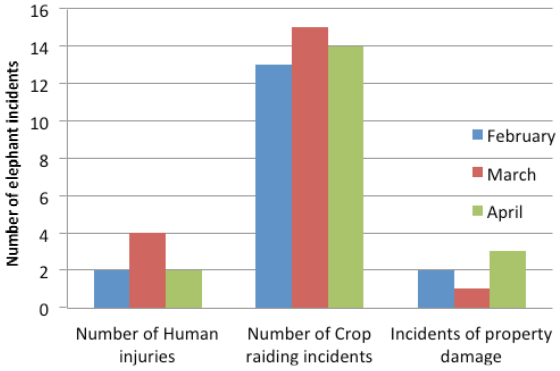

Figure 5. Record of elephant incidents in the study area (February–April 2010)

Crop damage

During the study period elephants reportedly damaged at least 53 'bigha' (3.53ha) of crop land, mainly wheat, and damaged about 36 mature trees across the village: 16 Banana plants *Musa acuminata*, 11 Mango trees *Mangifera indica*, and nine Litchi trees *Litchi chinensis* (Fig. 3). The elephants also smashed Jackfruit trees *Artocarpus heterophyllus*. In the case of wheat damage, the elephants crush the entire plant but generally do not eat the whole plant (Fig. 4). The majority of the landholdings had Onion *Allium cepa* seedlings growing, which were crushed by the elephants as they travelled through the plantations. Wheat is the most widely cultivated food crop in the area, as well as the main subsistence and cash crop, and it suffered a heavy damage. All damage reported was done by elephants. The villagers also complained about lesser damage by rodents and monkeys, however these animals were not perceived as the major crop raiders.

Impact and management measures for HEC

During the course of the survey, eight people were injured by elephants in the village while they were guarding their crops; a few suffered slight fractures, muscle injury, head injury, and minor rubs and sprains. To determine the extent that conflict was a concern among local villagers, people were asked a series of questions about elephants and elephant conflict. Out of 120 households, 48% of respondents felt that the conflict had increased, 10.83% of households felt that the conflict had decreased, and about 15% of households that were not directly affected by the conflict, had 'no problem' (Fig. 5).

Strategies used by farmers to reduce crop raiding

Image 2. Watch huts built in filed to watch elephants

by elephants varied from individual to individual. Individual households watching their fields all night coupled with creating noise through crackers and beating metal objects are the most commonly practiced methods. Watch huts (machaans) are constructed along the farm boundary to guard elephant entry into the field (Image 2). When elephants are spotted, villagers use a combination of loud noises including yelling, firecrackers, hitting metal objects. Bright lights, including flaming torches, are also used. Direct contact with elephants is less common, but sometimes objects are thrown and some villagers move close enough to use whips. These methods reportedly have become less effective overtime, which agrees with the study done by Nyhus et al. in 2000. Farmers occasionally harvest crops before they are fully mature, or plant less valuable crops to avoid the risk of catastrophic damage in the final days before harvest. When asked what methods they thought were necessary to reduce elephant crop raiding, 64% of the respondents replied that guarding their fields and chasing or scaring away elephants using fire, noise, or lights would be the most effective. Twenty percent of the respondents cited structural barriers, including trenches, electric fences, or watchtowers as effective control measures, and the remaining 16% of the respondents cited government assistance and elephant translocations as effective measures.

The severity of the problem is reflected by various measures undertaken at the community level to mitigate HEC in the village. Most people applied one or more measures to cope with HEC. Among them, chasing the elephants away with fire, use of noise and explosives, and regularly guarding the fields were the most widely used measures in all the sectors (Fig. 6).

Effectiveness of existing HEC management measures

"Elephants are always one step ahead of us in this 'arms race' of offenses and defenses. They develop counter measures in no time in response to the techniques that we apply to drive them away" (Manoj Thapa, Bahundangi Village Development Committee, pers. comm. 2006)

Despite the widespread application of measures, i.e., chasing them away with fire, use of noise and explosives, and regularly guarding fields, these were not considered to be effective in mitigating HEC by the people of Mankanthpur village. This perception matches Sukumar (2003) whereby he observed that these techniques are merely effective to drive away inexperienced crops raiders, whereas veteran raiders, usually adult males or some family groups, were difficult to fool. The respondents from Mankanthpur Village however showed clear preference for these measures because they were easy to obtain and use.

Studies have shown that the effectiveness of protection measures such as an electric fence depends not only on fence design and maintenance, but also on the learning capacity and behavioral response of crop-raiding elephants (Sukumar 1989). However, according to the Mankanthpur villagers, traditional measures such as chasing the elephants away with fire and making noise are much more effective than electric fencing.

Perception of Mankanthpur villagers about elephant conservation

In order to prepare and implement long term strategies for wildlife conservation, it is necessary to find out people's attitude towards conservation issues, related conflicts, and linked strategies. Most respondents demonstrated positive thinking in elephant conservation. Fifty-seven percent (n=68) tolerated elephants, while 43.33% (n=52) wanted them eradicated.

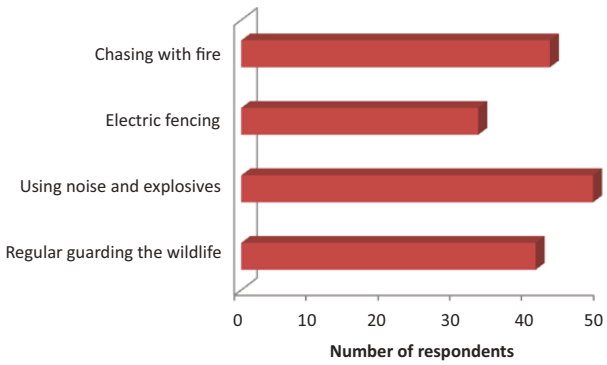

Figure 6. Measures undertaken to mitigate HEC in the study area.

Table 1. Attitudes of local communities towards conservation of wild elephants (n=100)

Attitudes	Reason	Number of interviewees	Percentage (%)
Positive attitude: Support, participate in conservation	Like presence of elephant around them	68	43
	Ecosystem value	8	12
	Endangered	38	9
	Religious	28	41
	Tourism	26	38.23
Negative attitude towards elephant presence	Do not like the elephant presence around them	52	57
Negative attitude among villagers towards elephant due to:			
	Attack on humans	19	19
	Crop raid	69	69
	Property damage	12	12

When asked why they liked elephants, respondents said they felt that elephant sightings bring revenue and jobs through ecotourism (38.23%, n=26), elephants have an ecological value, their presence indicates a healthy ecosystem (11.76%, n=8), they are endangered and their number is decreasing (8.82%, n=12), and, for some respondents, elephants have a religious value in Hindu culture as a symbol of Lord Ganesha (41.17%, n=28) (Table 1) (Images 3,4).

Out of 120 interviewees, 52 respondents did not like elephants. The majority of them (69.16%) attributed this dislike to crop raids by elephants, 12% attributed it to property damage, and 19% said because elephants attack humans they did not like them. Twelve percent (12%) of the respondents want the elephants in community forests, 35% want them in zoos, 43.33% want them in reserve forests, and only 10% of the total respondents want to see them in their present habitat. To examine the tolerance, respondents were asked three hypothetical questions with responses indicating whether they agreed, disagreed, or were indifferent in supporting elephant conservation if their crops were destroyed or their property was damaged. About 52.5% of respondents were not in agreement with supporting elephant conservation if their field was destroyed or property was damaged, 35% agreed that conservation was important, and 12.5% were neutral or indifferent.

Table 2. Attitudes of local communities towards compensation schemesforHuman Elephant Conflict (n=100)

Attitudes	Percentage (%)		
	Agree	Disagree	Don't know
Crop-raiding affects the amount of food consumed in their household	53	28	19
	Not a problem	Sometime	Frequently
Frequency of attack of villagers by wildlife	21	16	45
	Yes		No
Have applied for compensation for crop loss	53		47
Can compensation be an effective way to reduce villagers' suffering due to HEC?	61		39

Perception of effectiveness towards compensation schemes

A total of 62 crop raids occurred from February-April, 2010; complaints were filed for only 29 cases. Out of 120 households, about 47.5% (n=57) were directly affected by HEC, and 40.35% (n=23) complained that they had never received payments after submitting an application for compensation, nor did they receive an explanation. In general the villagers believed that the reason for the delay in resolving complaints was mismanagement within the system, which in turn prevented them from filing for compensation (Table 2). In this village, characteristic landholdings are small with 73.33% of the respondents practicing subsistence farming. Ultimately, none of the respondents whose household had sought a compensation claim expressed satisfaction with the process, and described their experiences in negative terms. Responses were marked by disappointment, regret, and frustration, e.g., as also described in Orga & Badola (2008). In spite of the shortcomings described above, when respondents were asked: ''Do you think that compensation can be an effective way to reduce villagers' suffering due to conflict with wildlife?" 89% of respondents said yes. However, most qualified their response to point out that compensation would only help them if the current scheme was reformed to address the problems they had described in their interviews. The majority of respondents pointed out that receiving the market price for the trampled crop would be a solution towards resolving conflict.

Image 3. Questionnnaire survey

Image 4. Group discussion with villagers

DISCUSSION

The survey results clearly show high levels of HEC in Mankanthpur Village. To ensure the future of elephants in the Bailparao-Kotabagh corridor, it is important to understand the ecological processes that drive HEC, along with the attitude, expectations, and tolerance level of the local people living nearby. The high frequency of crop raids in the study area, if it continues, would create anger towards elephants in the future as it ruins people's livelihoods. This would ultimately undermine support for elephant conservation in the long run. In order to promote broad-based participation in a village like Mankanthpur, and other villages affected by HEC, a compensation mechanism could be made efficient for the groups affected by the crop raids. This would help them realize that human wildlife conflict cannot be totally eliminated and the villagers and conservation community should find a middle way where both villagers and wildlife can co-exist. Conflict can be minimized by building local level capacity (Orga & Badola 2008). At Mankanthpur Village, 4km of electric fence failed because the solar powered electric current was insufficient, the fence had poor maintenance, and the grass that grows below the wires disrupts the supply of current, leading to its low efficiency. Additionally, male elephants used their tusks to destroy the fences, and the fence posts were not sufficiently strong. Frequent breakage points, the challenge of maintaining the entire length of fence, and the cost of upkeep are possible drawbacks to this strategy. A stronger fence with higher current and better maintenance could provide one solution to the elephant problem. Information about safety, maintenance, and operation of existing solar fences must be clearly disseminated.

A proposal by the local residents of enclosing Mankanthpur Village with a 2m tall cemented wall can be trialed provided it is managed well. Trenches are generally not considered to be an effective or cost-efficient strategy because they have a high rate of failure where soil is loose or very wet, and elephants can use their feet to push soft soil into trenches (Sukumar 1989; Santiapillai & Widodo 1993a). According to the respondents, the experience at Mankanthpur Village suggests that trenches, combined with innovative modifications, such as cement barriers where trenches are eroded, can be cost-effective and efficient deterrents. These trenches might reduce the number of available entry points for elephants and enable villagers to concentrate their guarding efforts at fewer locations. As this approach has been experimented down the corridor in a few villages and has helped mitigate elephant intrusions to some extent, the residents of Mankanthpur felt it might work in their village as well.

An effective compensatory mechanism is another way of protecting the critical elephant corridor and reducing the impact of clashes between humans and wildlife (Naughton et al. 1999; Osborn 2004). Community wildlife conservation programmes also have the potential to help mitigate conflict and involve locals in addressing the problem with a wider understanding and thoughtfulness. According to Child (1996), Barnes (1996), and Hulme & Murphee (1999), humans and wildlife have conflicting existences, and to a certain extent monetary incentives can ameliorate these relations or modify behavior. Such incentives include the release of adequate funds by the local NGOs and Forest Departement for the purchase of material

and equipment for scaring away elephants such as searchlights, torches, chilli powder, oil for creating flaming torches, fireworks, etc. Most importantly elephant conservation should be linked to local people's welfare. If the local people are not included in elephant conservation programmes in their areas, they will not care for the survival of the species (Image 5).

As recommended by Santiapillai & Widodo (1993), the establishment of elephant control teams could be helpful and prove to be a strong symbol of the government's support. The WWF-Ramnagar team also believes that joint patrolling by villagers and forest guards could be a way to reduce the conflict and is helping villagers form such groups. Villagers should be made aware of the plantation of buffer crops, as explained by Bell (1984), which are relatively unpalatable to elephants (e.g., timber, tobacco) and could be trialed around food crops in some places. Chillies as a buffer crop may show some promise but only if used in conjunction with other simultaneous defense measures (Osborn & Parker 2002).

Image 5. Asian Elephant *Elephas maximus*

CONCLUSION

Understanding socio-economic status and motivations of the local human community is crucial to the formulation of policies for mitigating human-elephant conflict (Kothari et al. 2002). The survival of elephants is critical from an ecological point of view as elephants play an important role in maintaining the balance in the delicate ecosystem of the TAL (WWF Nepal 2008). For that reason there is a need to prepare long term strategies for conservation of elephants and their habitat. Developing a strong socio-political base that helps formulate a feasible management plan is important for countering conflict problems before they become unmanageable. Hence, it is essential to identify priority elephant conservation areas and work with policy-makers to agree on land use within these landscapes (Fernando et al. 2005). However, a study over one season or a one season based ground survey may not accurately reflect the actual status of conflict. Depending on the cropping patterns or crops available to elephants, the pattern of conflict in a village may change, and so will the attitude and perception of villagers. Therefore, for future studies, improving the information about the type of crops grown or amount of property damaged, and compensation assessment and payment, would improve the quality of information available for analysis of conflict. However there is no universal guideline to reduce HEC. The interventions that reduce the problem in one area or one country may be completely ineffective in another area or situation. Hence, such attitude assessment studies point out that knowledge of public attitudes is useful for developing public awareness programmes, particularly when the public is unaware of the current status and management problems involved in natural resource conservation. As Hill (1998) pointed out, an assessment of the attitudes of local people, particularly towards wild elephants, is an important element in formulating appropriate policies for conserving such large herbivores in the wild. Information gathered from such analyses is useful in developing approaches to avoid unnecessary conflicts, which too often exist between conservationists and people living around protected areas and wildlife corridors in a developing country like India.

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Author Contribution: BJ collected the primary data, did data analysis and produced a project report that was submitted to the WWF-India as her dissertation thesis. DG was her dissertation external guide at the WWF-India, who helped her build this study from scratch; and also helped her in writing of the manuscript and reviewing it from time to time. SKD was the GGS IP University internal advisor for the study conducted. He helped the author with collating the information for the Literature review; and also helped her in framing questionnaire for carrying out the research.