Assessing the Patterns of Human-Wildlife Conflict and Compensation Around Pakke Tiger Reserve, Arunachal Pradesh

Dissertation submitted to Saurashtra University, Rajkot, in partial fulfilment of the Masters of Science Degree in Wildlife Science, June 2019

By

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DECLARATION

I, **Laxmi langlang**, hereby declare that the research work titled "**Assessing the Patterns of Human-Wildlife Conflict and Compensation Around Pakke Tiger Reserve, Arunachal Pradesh"** carried out in partial fulfilment of M.Sc. (Wildlife Science) degree of Saurashtra University, Rajkot is an original piece of work. These investigations were carried out under the supervision of Dr. Abhijit Das, Dr. Gopi G.V. and Dr. Nandini Velho at the Wildlife Institute of India from December 2018 to June 2019. I also declare that this work has not been submitted for any other degree of any university.

Date: 30 June, 2019

Place: Dehradun Laxmi langlang

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

CERTIFICATE

This is to certify that **Ms. Laxmi Langlang** has carried out an original piece of research in partial fulfilment of M.Sc. (Wildlife Science) degree of Saurashtra University, Rajkot. The topic of her dissertation is "**Assessing the Patterns of Human-Wildlife Conflict and Compensation Around Pakke Tiger Reserve, Arunachal Pradesh**". The study was carried out under my supervision from December 2018 to June 2019. I hereby certify that this work has not been submitted for any degree to any university.

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"We've always defined ourselves by the ability to overcome the impossible. And we count these moments. These moments when we dare to aim higher, to break barriers, to reach for the stars, to make the unknown known. We count these moments as our proudest achievements. But we lost all that. Or perhaps we've just forgotten that we are still pioneers. And we've barely begun. And that our greatest accomplishments cannot be behind us, because our destiny lies above us."

~ Cooper, Interstellar

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PROJECT SUMMARY

Of all the types of interactions between humans and wildlife, human-wildlife conflict (hereafter HWC) poses a significant challenge to conservation efforts and species survival. This conflict may be manifested with a range of interactions with more negative actions being killing and injury to wildlife and humans while more neutral actions being internalizing costs of living with wildlife. People living in and around protected areas interact closely with wildlife. The negative interaction may be in the form of crop raiding, livestock depredation, property damage or death and injury to human. Thus, such interactions may result in economic loss to people and may create animosity against conservation through reduced public support and retaliatory killing. Further peoples' perceptions towards HWC may vary by species, especially as large and potentially dangerous animals such as tigers and elephants are seen as a threat to farmers' livelihoods.

In this context, I assessed the patterns of HWC around Pakke Tiger Reserve to identify conflict species and hotspots of conflict. I tried to understand the constraints about compensation in terms of the gap between self-reported conflict and conflict reported to forest department. I also focussed on understanding the perception of people towards commonly found wildlife in the reserve with the help of attitude score.

My study was carried out in 41 villages where I interviewed 327 households around Pakke Tiger Reserve. I used a semi-structured questionnaire and open-ended questions to understand the pattern of conflict, compensation issues, attitude towards different species and mitigation strategies most commonly used. Perception data was also collected.

Crop damage (mostly by wild pigs, macaques and rodents) was reported as the most prevalent type of conflict around PTR followed by livestock depredation (mainly by wild dogs, tigers and leopards). Property damage and human death and injuries were reported to a lesser extent.

Twelve different mitigation strategies were commonly used against crop raiding and livestock depredation. Night patrols and sound were used to keep animals away from fields. Livestock's were mostly grazed in the forest, and hunting of predators was the most common mitigation strategy against livestock depredation.

Apart from snakes which were the most negatively perceived species around the reserve, perception of towards species were more negative for carnivores (tigers, leopards and wild dog)

compared to herbivores (barking deer, sambar). This could be due to the high socio- cultural and economic value of Mithuns that get preyed by large-carnivores.

There was a gap between self-reported conflict incidence and the reporting of the conflict to the forest department. Unsurprisingly, the percentage of people receiving compensation is low and when compensation is received, the disbursed amount was reported to be between 1,000-12,500 INR.

My study highlights human-wildlife interactions and conflict around Pakke Tiger Reserve in Arunachal Pradesh and I find that retaliatory killings especially towards large carnivores that are negatively perceived may be an important conservation intervention required in the long-term.

Keywords

Compensation, human-wildlife conflict, mitigation, Pakke Tiger Reserve, perceptions, retaliation

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INTRODUCTION

Human-wildlife conflict is one of the most pressing issues for species conservation. Many species, especially large-bodied animals, have ranges beyond protected areas which increases the chances of interaction between humans and wildlife and escalates conflict (Karanth et al., 2013a). These negative interactions may be manifested through crop and livestock depredation, property damage, mental and physical costs to humans and wildlife (Barua et al., 2013). This may create animosity against conservation through reduced public support, retaliatory killing or habitat alteration (Madhusudan, 2003).

The baseline tolerance may be low in such areas although successful conservation efforts and species survival depend on tolerance among people (Karanth et al., 2012). Reactive and proactive mitigation strategies are usually employed as conflict mitigation strategies. Reactive mitigation is usually species-specific and impose financial cost and could also lead to retaliation, whereas proactive mitigation strategies (Morzillo & Needham, 2015; Karanth et al., 2017) provides compensation that may increase tolerance and reduce the retaliatory killing of wildlife (Dickman et al., 2013). However, there is a gap between how species are perceived and the most commonly reported conflict species, especially in places that have a low tolerance to wildlife.

Perceptions and attitude about conflict may be shaped by personal experiences, social and cultural norms and beliefs as well as economic aspirations. While a range of animals maybe involved in conflict, the response of people to conflict is likely to be determined by the species involved, especially because large, highly visible and potentially dangerous animals are seen as a threat (Dickman, 2010). For instance, human-elephant conflict reports extend throughout from Africa where there have been reports of crop and structural damage to occasional human injury by African elephants (Hoare, 2015) to Nepal with high reports of property damage by Asian elephants (Pant et al., 2015). Further, the risk level perceived for carnivores may be based on taxonomic identity, physical size or cultural reputation (Miller et al., 2016). Low payments and high transaction cost of getting payments processed (Karanth et al., 2018), especially in remote areas may escalate such conflict.

In this study I propose to examine patterns and correlates of conflict and tolerance towards different conflict-causing species. Specifically, I will look at the most predominant conflict type, the species associated with a particular conflict, mitigation strategies mostly used, their

perception towards different conflict-prone species and compensation trend. I implemented this study around the villages of Pakke Tiger Reserve where anthropogenic pressure and expected low baseline tolerance (compared to other parts of India) are likely to impose a significant cost and risk to both people and wildlife.

Literature review

Interactions between humans and wildlife may take different forms, they may range from positive, neutral to antagonistic. One such negative interaction is that of HWC which can be defined as the impacts of wildlife on humans and their activity, and human-human conflict between two parties with different objectives of pro-wildlife position and those defending other positions (Redpath et al., 2015). Given that 97% of species involved in the conflict are of conservation interest, it is important to characterise the range of interactions, especially negative associations between humans and wildlife (Redpath et al., 2015).

Conflict has direct costs that are manifested as the damage due to crop and livestock loss, injury or death of either humans or wildlife impacts livelihoods. Conflict may also have hidden and indirect costs of diminished psycho-social well-being and food security. Against this background are the high opportunity and transaction cost involved in seeking compensation (Barua et al., 2013).

There are a number of mitigation strategies that are adopted from across the globe (Treves and Karanth, 2003). They range from regulated hunting, selective removal of problem animal to compensation. Global analyses on compensation reveal that the highest compensation is paid for large animals belonging to the family Felidae, Ursidae and Elephantidae. Compensation schemes seem most prevalent in Europe, followed by North America, Asia and Africa (Ravenelle & Nyhus, 2017).

All Indian states have human wildlife conflict related policies except for Nagaland and Manipur. The data of reported conflict in Arunachal Pradesh from the year 2010-2014 showed a significant increase in the number of conflicts reported but the compensation for the same period depicts no compensation paid for year 2010 and 2012. The compensation paid for the crop loss also amounts only 20% of the actual value of crop (Karanth et al., 2018). In India the species involved in conflict and eligible for compensation are listed by state forest department and this differ state-wise. Compensation is in the form of crop and property loss, livestock depredation and human injury and death. The most common forms of conflict occur as crop

loss followed by livestock loss and also human death and injury (Karanth et al., 2013a), which leads to retaliatory killing of the species involved.

Indian protected areas (PAs) support a huge array of globally threatened wildlife that are prone to conflict with people, such as tiger, leopard and elephants (Karanth et al., 2010). The reported conflict for value species like tiger and elephant is higher (Karanth et al., 2013a). However, across species, people are likely to tolerate some species such as Nilgai (*Boselaphus tragocamelus*), Chinkara (*Gazzella bennetti*) and Blackbuck (*Antilope cervicapra*) but are less tolerant of Wild pigs (*Sus scrofa*) and Asian elephants (*Elephas maximus*) (Madhusudan and Karanth, 2002). In north-east India, crop raiding was reported to be the most dominant form of conflict reported in Assam, but the severity and nature of conflict varied across the state as a result of cultural and social economic differences in communities (Wilson et al., 2015). In Arunachal Pradesh, the perceived level of depredation by Dhole is shaped by social and cultural practices, which may in turn exaggerate the assumption of livestock depredation by this species (Lyngdoh et al., 2014).

The patterns and drivers of conflict take different forms. Proximity to reserve was associated with higher conflict and also higher probability of adopting mitigation measures (Karanth & Kudalkar et al., 2017). The history of conflict experienced also governs the change and high use of mitigation measures by people (Karanth & Kudalkar et al., 2017). Often conflict species are drawn to human-dominated landscape for cultivated food plants, making raids seasonal and more frequent during peak cropping season (Gubbi, 2012).

There are several mitigation strategies that maybe used with different levels of efficacy. Fencing, night-watches for animals and physical structures are some of the most commonly used mitigation measures used in different parts of India (Karanth et al., 2013a). Fencing and guarding lowered crop loss in India, whereas other mitigation strategies had little effect. Study conducted in Assam found Fences both chilli and electric as the most effective mitigation against crop depredation followed by spotlights (Davies et al., 2011).

Compensation is another mitigation strategy applied to reduce the economic burden on the affected people and enhance tolerance towards wildlife. But in Rajasthan compensation was ineffective in reducing the hostility of people towards wildlife (Johnson et al., 2018). However, reported conflict and compensation is likely to be an underestimate of the actual conflict given the high transaction costs related to the filing procedure (Karanth et al., 2018).

Importance of the proposed project in the context of current status:

Protected area boundaries experience a disproportionately higher number of HWC incidents, turning them into "conflict hotspots" and imposing significant costs and risks to both people and wildlife. Examining patterns of conflict and associated tolerance is important to devise policies to reduce conflict impacts on people and wildlife, especially in places with a traditional hunting culture where tolerance is expected to be low. Previous studies in this context have focussed on smaller areas and particular species (Lyngdoh et al., 2014). Further conflict studies were mostly focussed in Assam, for instance in Barak valley (by Dutta et al.,2016) and over a larger area in Assam (Wilson et al.,2015). Thus, with the current study I aim to assess human wildlife interaction around an entire tiger reserve (Pakke Tiger Reserve in Arunachal Pradesh) in the north east region and expand the scope to multiple conflict causing species. The objectives of my study are to understand the patterns and perceptions of conflict around Pakke Tiger Reserve (the most common types and species involved in conflict and conflict hotspots). I also evaluated the most commonly used mitigation measures and compensation measures (and the gap between self-reported conflict and conflict reported to the forest department).

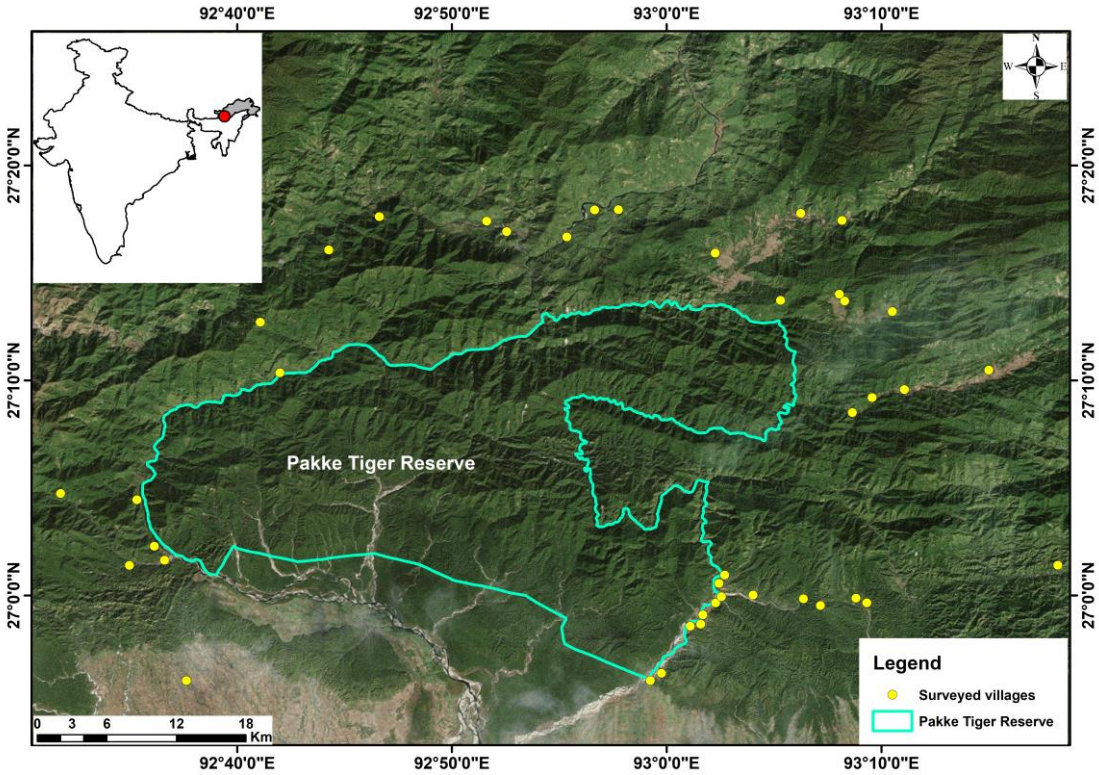
STUDY AREA

Pakke Tiger Reserve (Map 1, area: 861.95 km²; altitudinal range: 100-2000 m ASL, extent: 92°35'-93°09'E and 26°55-27°N) forms part of the Eastern Himalayas Biodiversity Hotspot. The tiger reserve is bound by rivers on three sides, Pakke river in the east, Kameng river in the west and Nameri Tiger reserve to the south., and shares a border with Nameri Tiger Reserve to the south in the state of Assam. The reserve has mostly Assam Valley tropical semi evergreen forest 2B/C1 (Champion & Seth, 1968) and is rugged with valleys in the south and hilly mountainous range in the north. The annual temperature varies from 12 to 36 °C with 2,500 mm of rainfall received annually.

The surrounding area of Pakke Tiger Reserve is manly inhabited by communities such as Nyishi, Puroik, Aka and Miji with different cultural practices and languages. Nyishi forms the largest ethnic group in the eastern part of the reserve and Akas and Mijis mainly occupy the western part of the reserve, whereas Puroiks live in smaller numbers in both regions. They practised animism but many now practise Christianity.

The reserve is surrounded by villages which are highly dependent on forest and agriculture. Families own agricultural land ranging from 1- 15 bigahs. There are two types of agricultural practices, which includes shifting cultivation and settled agriculture. Only rice is grown in agriculture field whereas other vegetables are also grown along with rice in shifting cultivation. Planting mainly starts in July with the onset of south-west monsoon and crops are harvested by the end of December. Rain is the only source of irrigation in shifting cultivation while rice field depends on both natural rainfall and small irrigation drains connected to a natural *nallah* (streams). The community living around the reserve are mainly agriculturists growing paddy, maize, ginger, millet and yam. Plantations are also done in large scale around the reserve that varies with location, rubber plantation on the west and oranges in the east. People in the villages have also started planting turmeric with the help of agriculture and horticulture department. To protect these cops the people, follow various mitigation strategies. For crops such as rice guarding is done both during day and night, whereas for rubber or oranges mitigation is in the form of fencing around the field.

Livestock rearing is also an important livelihood source of people living around the reserve. Mithun (*Bos frontalis)* often considered as gold of Nyishi people is one of the most socio-culturally important and valuable semi-domesticated species found in the area. They are more common in the hilly western and north-eastern part of the reserve, where they are left to graze in the forest throughout the year, with occasional visits by the owner to the forest and the Mithun to its owner's house, mostly for Mithuns to feed on salt. People also rear other cattle – cows, bulls, goats, pigs and poultry. Cattle and goats are left free to graze in the nearby forest while pigs and poultry are stall fed. Many species such as the Asian elephant (*Elephus maximus*),Tiger (*Panthera tigris*), Wild pig (*Sus scrofa)*, Leopard (*Panthera pardus)*, Dhole (*Cuon alpinus)* inhabit the reserve and are likely to cause conflict around the periphery of the reserve.



*Map 1:*Study area map with yellow dots representing sampled villages around Pakke Tiger Reserve.

Methods

DATA COLLECTION

From December 2018 to April 2019, I conducted a total of 327 interviews across 41 villages around PTR, in three different districts (Map. 1, Pakke Kessang, East Kameng and West kameng) of Arunachal Pradesh state. I selected villages that were within a 20 km boundary around PTR to get a representative sample of all the villages. In each village, I first collected information on the number of households and the different areas/parts/colonies in the village. I then allocated my ten interviews proportionate to number of households in each part of the village. In a given area of the village, I started sampling with a random start point after which I selected every fourth to fifth household that I would interview. I sampled an average of 7 households per village. For smaller villages that had less than ten households, I sampled all households in that village. I used a semi-structured questionnaire (with a few open-ended questions) to understand patterns of reported conflict, economic setbacks, attitude towards

different species as well as compensation and mitigation methods. I collected information on various socio-economic characteristics such as: livestock rearing patterns, economic setbacks, agricultural areas (Appendix 1). I also asked open-ended questions about their opinion on which mitigation strategies should be provided by the government. Further to evaluate perception of species, we asked respondents to rank species perceptions on a scale of -2 (highly negative) to +2 (favourable), with 0 being neutral.

A trained researcher assisted me with data collection that we primarily did in *Nyishi* and Hindi, two commonly spoken languages in the area. We were also accompanied by a field assistant and local translator. The data we collected had no personal identifiers of the interviewee and oral consent was taken from both the village head and the individual before starting the interview. I considered the household as the sampling unit and interviewees were restricted to respondents between 18-60 years of age, as people within this age group were likely to be involved in agriculture and/or go into forest without being susceptible to the vagaries of age. Interviews were conducted for one person per household and lasted approximately 45 minutes. To corroborate species identity, I chose to use photographs given that species have different local names.

ANALYSIS

I used Program R (R Core Team 2019), Arc Map (10.5.1) and Microsoft Excel for data analyses. I estimated bootstrapped means and standard errors (based on 10,000 bootstrap iterations because of low sample size) to determine the proportion of type of conflict, different species involved in conflict, the most predominant mitigation strategies and perception towards different conflict prone species. Using Arc Map, I first prepared two heat maps for crop raiding and livestock depredation by summarising data on the frequency of these two types of conflict at the village level. Within these two categories (crop-raiding and livestock depredation) I then considered species/taxa that had more than 40 data points to create heatmaps for these species. The point locations were used to map hotspots by using Kernel Density Estimator (KDE) (Silverman 1988; Brunsdon 1995) which is a method of estimating a probability density function of conflict frequency.

RESULTS

Among the households surveyed most of the respondents were men (66.06%), the average age of the interviewee was 40.11 and majority were not formally educated (37.92%), followed by people who had a basic education of primary level (22.01%). Four major ethnic communities were interviewed during the study with Nyishi (70.64%) forming the predominant tribe of the study area. The households were predominantly agriculturist (34.55%) with an average land holding of 8.27 bigahs (2 acres). The mean income loss occurred due to crop raiding amounts for Rs. 14,725 to 42,000. The compensation received for different conflict type ranged from Rs. 1,000 to 12,5000. I found that 17 wild species are involved in different type of conflicts (Table 1)

Crop raiding is the most common type of conflict around Pakke Tiger Reserve, contributing to 48.31% of the reported conflict. Crop raiding mainly occurs from September to December with losses ranging from average of 14,725 INR to a maximum of 42,000 INR (Table 1).

In terms of livestock depredation, 83.22% of the households reared livestock. Twenty one percent of households owned Mithuns (mean per household:3), an economically important livestock species. Majority of livestock graze within the forest (68.35%). Depredation reportedly occurs during June to August and October to January with losses ranging from an average of 59,475 INR to a maximum of 3,00,000 INR (Table 1).

Table 1: Characteristics of 327 interviewed households around PTR

Characteristics	**Sub-characteristics**	**Household details**
Households sampled		327
Average number of people per household		6.29
Average number of livestock for livestock owning households	Mithun, Cattle, Goat	6.22
	Poultry, Pig	7.11
Compensation (INR)		1,000 to 12,500
Top ranked crop raiding species(with n greater than 40)	Wild pig	25.44%
	Rodent spp.	21.91%

	Macaque spp.	19.79%
Income loss from crop raiding (INR)		Mean:14,725 and maximum:42,000
Top ranked livestock predators(with n greater than 40)	Wild dog	37.85%
	Tiger	33.89%
	Leopard	11.86%
Income loss from predation (INR)		Mean: 59,475 and maximum: 3,00,000

Types of conflicts around Pakke Tiger Reserve

Crop depredation (mean = 0.52 ± SE 0.02, n = 158) was the major type of conflict in the region followed by livestock depredation (mean = 0.49 ± 0.02, n = 146). Property damage (mean =0.04 ± 0.01, n=13) and human death or injury (mean = 0.03 ± 0.01, n = 10) was reportedly much lower in the region (Figure 1).

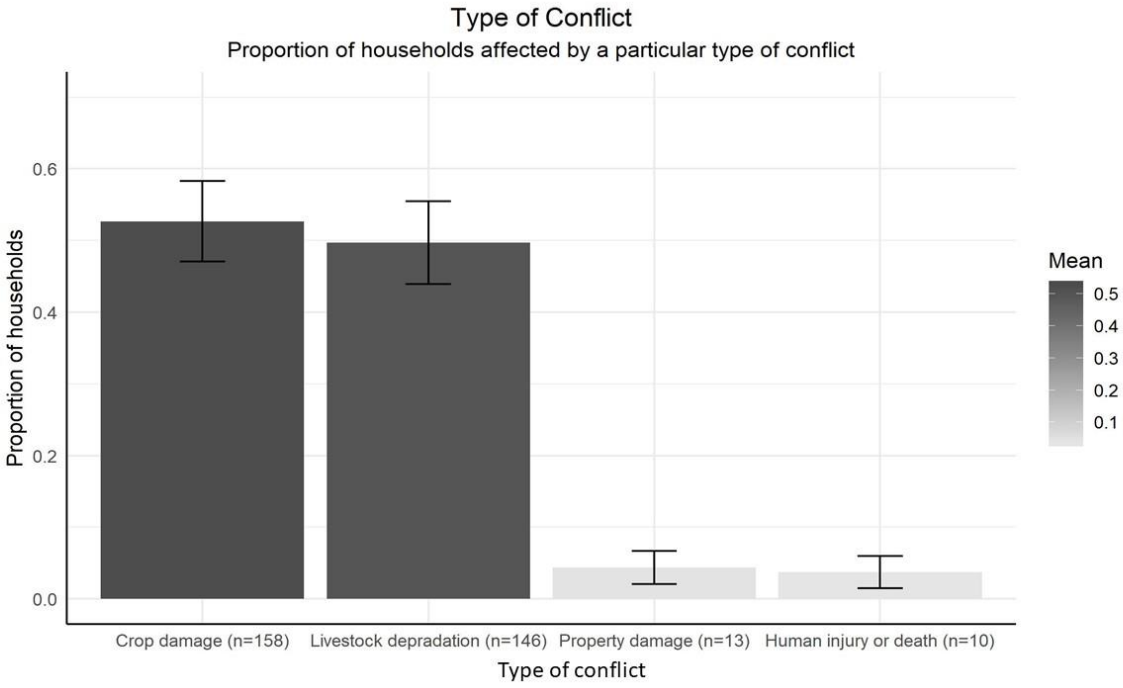


Figure 1: Proportion of households reporting different types of conflict. Here n represents the number of incidents and the bootstrapped mean and standard errors with 10,000 iterations

Eight species were reportedly involved in livestock depredation. Wild Dogs (mean = 0.20 ± 0.02, n = 67), Tigers (mean = 0.18 ± 0.02, n = 60) and Leopards (mean = 0.064 ± 0.01, n =21) were the three most common predators (Figure 2). Nine species were reportedly involved in crop depredation. Wild pigs (Mean = 0.22 ± 0.02, n = 72), Rodent spp. (Mean = 0.19 ± 0.02, n = 62) and Macaques (Mean = 0.17 ± 0.02, n = 56) were the most common crop raiders (Figure 3).

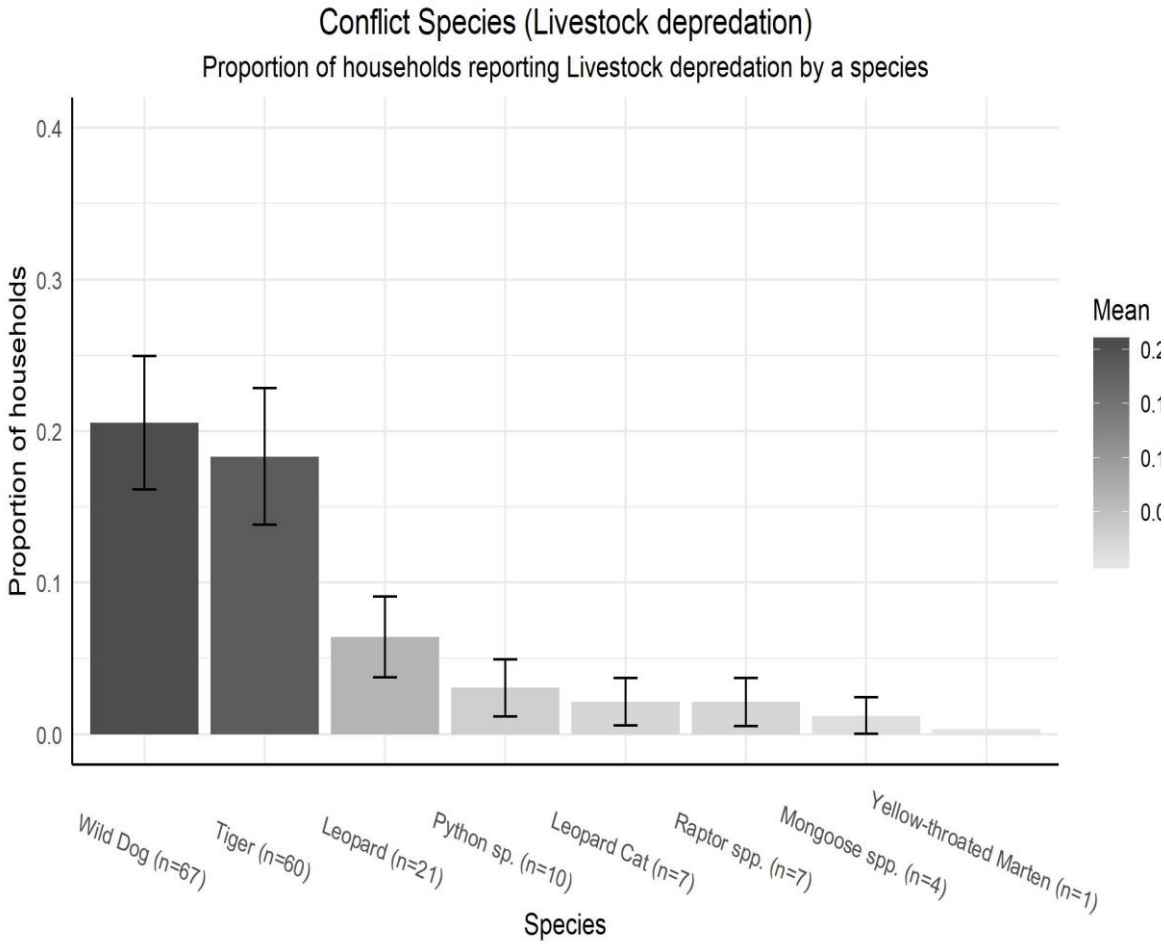


Figure 2: Proportion of households reporting a particular species as an agent of livestock depredation. Here n represents the number of incidents. The means and Standard Errors are bootstrapped with 10,000 iterations.

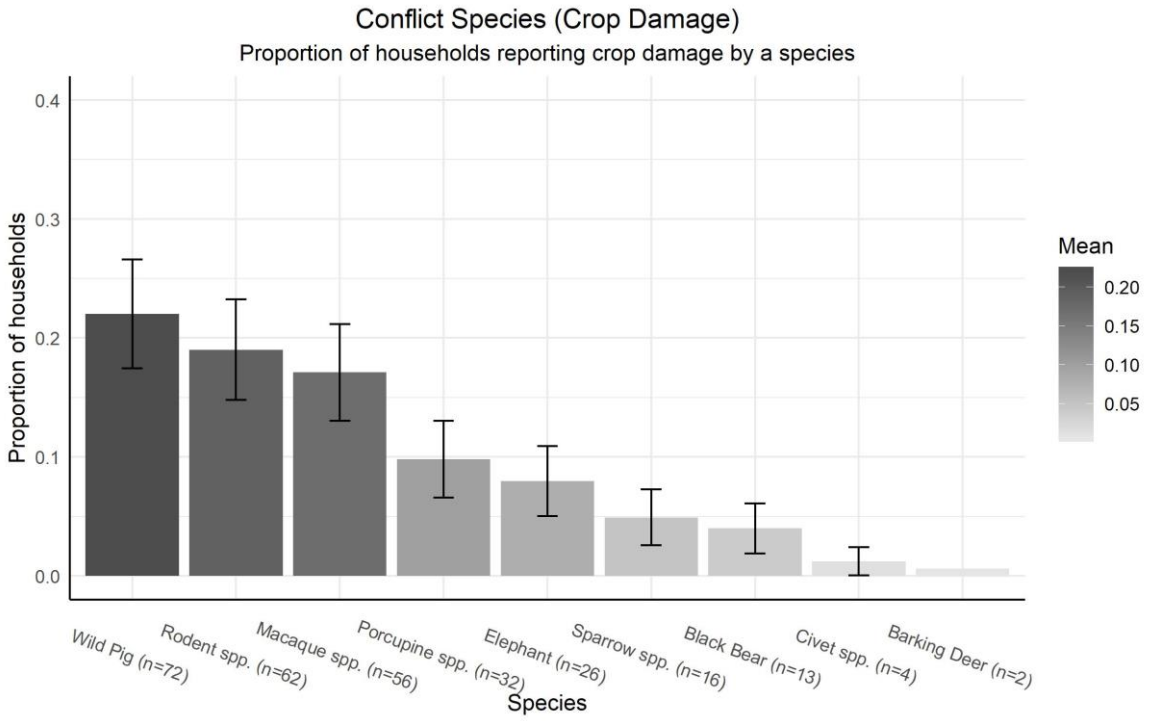
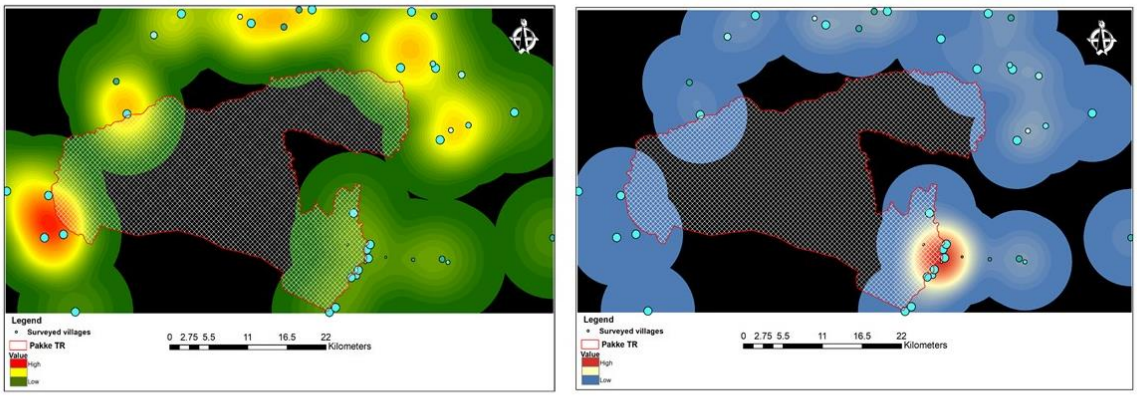
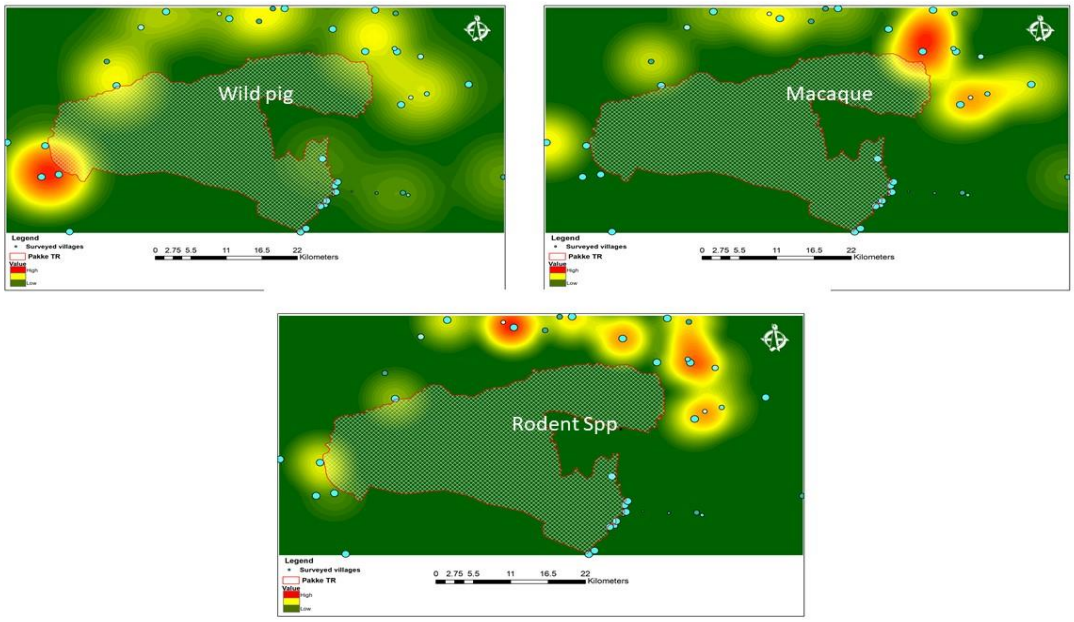


Figure 3: Proportion of households reporting a particular species as an agent of crop depredation. Here n represents the number of incidents. The means and Standard Errors are bootstrapped with 10,000 iterations.

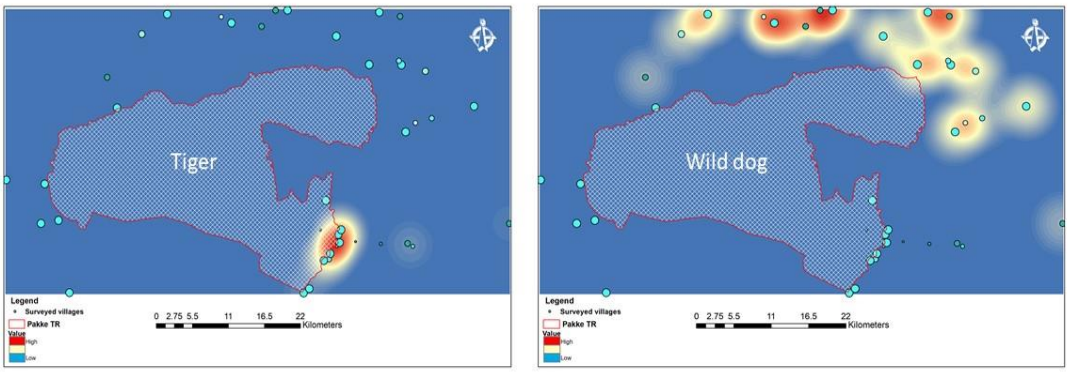
The heat map for crop raiding and livestock depredation shows that the reported frequency of crop raiding is higher around the western side of Pakke (Tippi block in West Kameng district), whereas the reported frequency of livestock depredation is higher on the Eastern side of Pakke (Seijosa block in Pakke Kessang district, Map 2). There was inter-species variation where wild pig raids were reported from the western side of the park, while the northern areas were more likely to have crop-raiding by rodents and macaques and livestock depredation by wild dogs (Map 3). The eastern side of the park was more likely to have livestock depredation by tigers (Map 4).



Map 2: Heat maps of crop and livestock depredation around Pakke Tiger Reserve



Map 3:Heat map of crop raiding species (where n was greater than 40 for each species).



Map 4: Heat map of livestock predators (where n was greater than 40 for each species).

Mitigation strategies

Twelve different mitigation strategies were identified against crop raiding and livestock depredation. Hunting and compensation were two strategies used to deal with crop raiding as well as livestock depredation. Among crop-depredation mitigation strategies night patrols (Mean = 0.49±0.02, n=162), noise and machans were the three most common mitigation strategies to keep the animals away (Figure 4). Hunting was most common among livestock depredation mitigation strategies (Mean = 0.32 ± 0.02). Notably, a very small proportion of people relied on compensation as a mitigation strategy (Mean = 0.03 ± 0.009) (Figure 5). My study revealed a significant gap in conflict experienced and reporting of conflict to the forest department. Forty eight percent of households experienced conflict around the Pakke Tiger Reserve but only 13.14 % applied for compensation and only 5.19% received compensation ranging from 1,000 to 12,500 INR (Table 1).

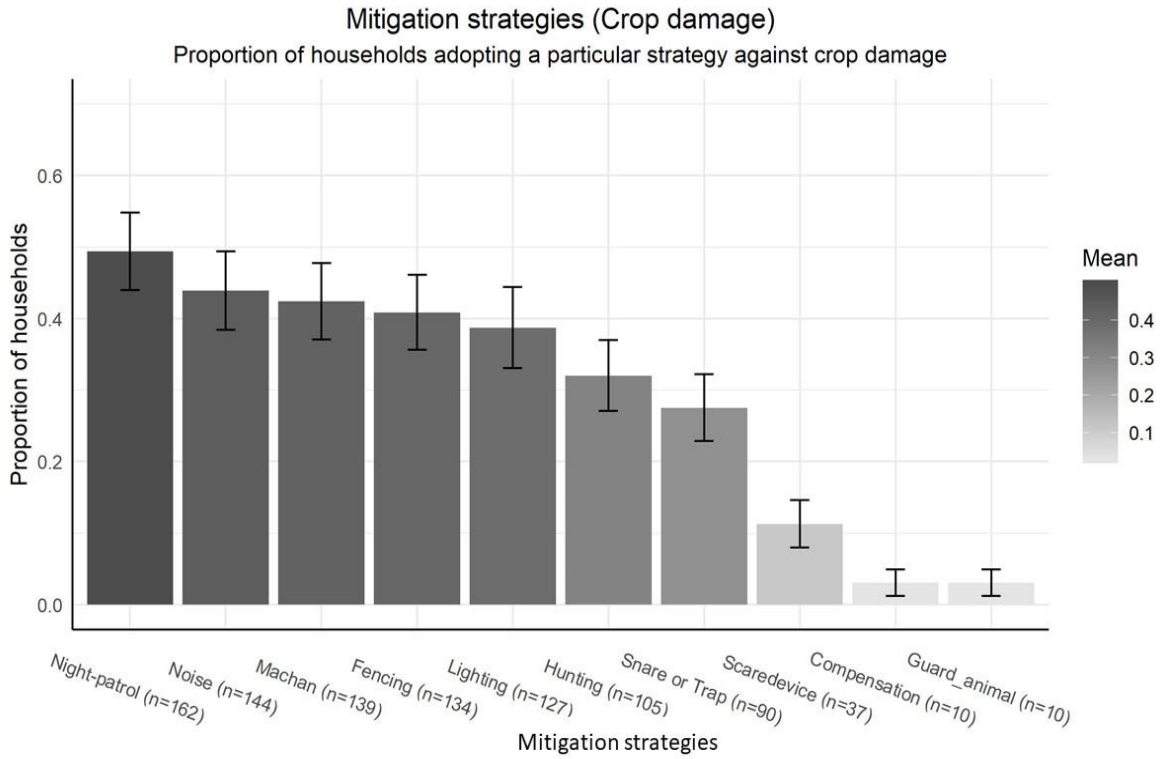


Figure 4: Proportion of households that adopted a particular strategy against crop raiding. Here n represent the number of households using the strategy and mean and standard errors are bootstrapped with 10,000 iterations.

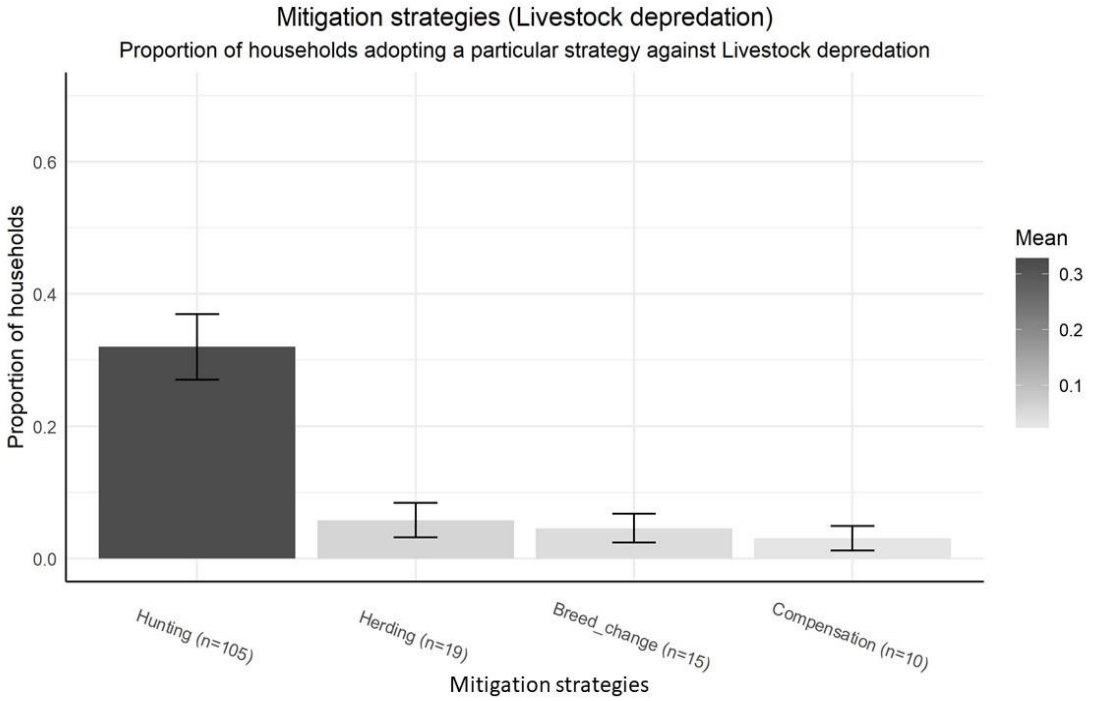


Figure 5: Proportion of households that adopted a particular strategy against livestock depredation. Here n represent the number of households using the strategy and mean and standard errors are bootstrapped with 10,000 iterations.

Perception of species around Pakke Tiger Reserve

Overall 9 species had negative mean scores with snakes, tigers, leopard and wild dog perceived most negatively. Species like sambar, barking deer, porcupines were not perceived as negatively compared to the species mentioned above(Figure 6).

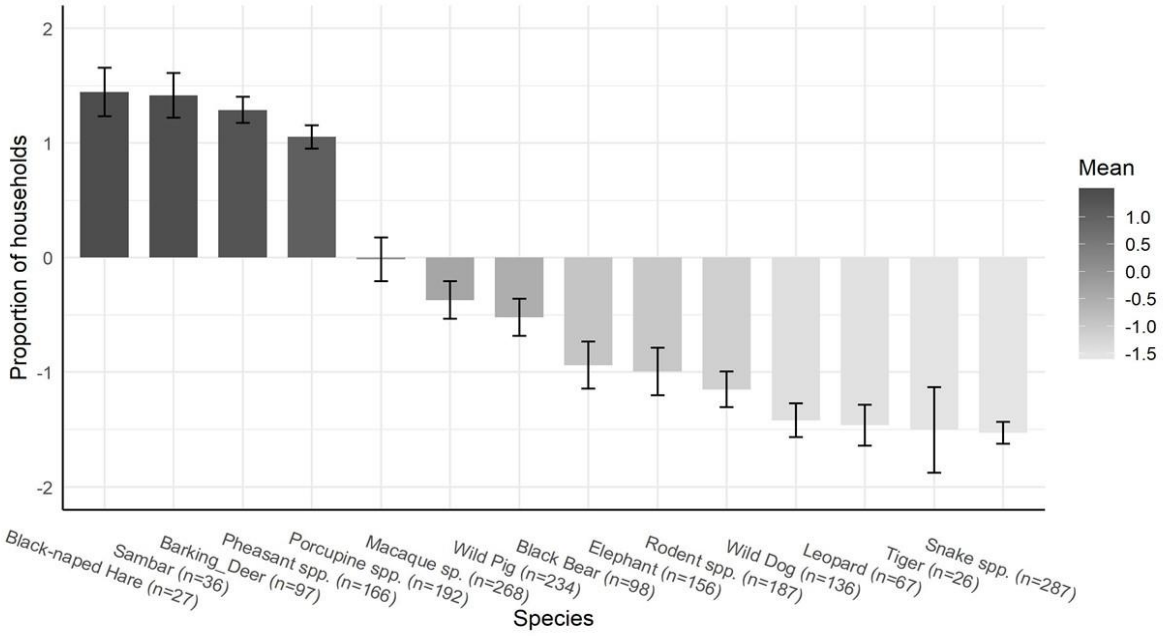


Figure 6: Mean perception score different conflict prone species around the Pakke Tiger Reserve. Here n represents the number of responses for a particular species and the bootstrapped means and standard errors with 10,000 iterations.

Discussion

My study expands on previous studies in two ways. It moves away from a single species and assesses patterns of conflict across multiple species and evaluates mitigation and compensation measures that occur around the entire reserve. Of the four different categories of conflict recorded, crop depredation (48.31%) and livestock depredation (44.64%) are the most predominant type of conflict followed by property damage and human death/injury. These findings is in parallel with the Karanth et al (2012) study in Kanha national park in central India landscape. Wild pig, Macaque spp. and Rodent spp were the most common species that were reportedly involved in crop damage. Elephant although being present in the landscape is not reported as the most common crop raider, which could be because most of the subsistence farmers in the area have stopped cultivating and changed their occupation due to past incidence of crop raiding and dearth of compensation. However, the indirect cost of change in occupation have caused great economic burden on already marginalised poor people. Wild dog, tiger and leopard were reportedly the three major livestock predators that were also most negatively perceived compared with other species (apart from snakes). Mithuns were more likely to be

killed inside the forest or reserve where they graze for a large part of the year. Other studies have found that the probability of depredation is much higher for households which graze their livestock inside the forest or protected area (Karanth et al., 2012; Karanth &Kudalkar 2017). Mithun is an important species that is prized for its high economic as well as cultural value and also acts as capital during emergencies. Against this backdrop, hunting was found to be the most common mitigation strategy against livestock depredation.

Retaliation against species may be shaped by the peoples' perception. A large, highly visible and potentially dangerous animal is likely to be perceived negatively (Dickman, 2010) and retaliation may not be against the actual species involved in conflict.For instance, in Pakke,wild dogsare perceived to be major livestock predators and are killed in retaliation. However ecological studies on wild dogs in the area show that they do not predate much on Mithuns (Lyngdoh et al., 2013). Thus neutral or positive attitudes towards carnivoresmay pertain to other factors such as gender, education and religion (Suryawanshi et al., 2014) and understanding the predictors of conflict and attitudes towards species requires further investigation.

My study found multiple mitigation strategies used to deal with conflict. Night patrolling and sound was the most commonly used methodagainst crop depredation while hunting was the most common strategy against livestock predation. In other parts of India, chilli, electric fences and spotlights were the most effective mitigation strategy against crop depredation (Davies et al., 2011) while physical barriers were mostly used to protect livestock from depredation (Karanth et al., 2012). Compensation from the government was rarely used as a mitigation strategy around Pakke. The limitations of my study are that actual quantification of loss due to conflict could not be estimated given the short-duration of the studyand thus self-reported conflict may be exaggerated. However, there appeared to be a significant gap between the self-reported conflict incidents and reporting to forest department. For instance, 48% of households experienced conflict around Pakke Tiger Reserve but only 13.14 % applied for compensation, of whichonly 5.19% received compensation ranging from 1,000 to 12,500 INR (Table 1). This could also be because transaction costs of reporting a conflict is very high (Karanth et al., 2018), especially in remote states such as Arunachal Pradesh. Further, many households were not aware of the monetary compensation schemes (received from the Forest Department) and programmes supported by civil society such as grain-for-grain that are given in lieu of crop loss. Hence the lack of awareness and subsequent dearth of reporting conflict may not only increase economic burden but also retaliation (Barua et al., 2013). Thus long-

term conservation efforts especially in north-east India where it is difficult to make significant conservation gains, maybe compromised without an understanding of human-wildlife interactions and peoples' perceptions about species.

Appendix1

Questionnaire

A. VISUAL INTERPRETATION
A1. Name of the interviewer
A2. Date (dd/mm/yy)
A3. Time (AM/PM)
A4. Village census code
A5. Village
A6. District
A7. GPS location
A8. House type (bamboo, concrete, semi-concrete)
A9. Roof (tin, tokko, mix (tin+tokko), concrete)
A10.Road type (Metal, Non-metal)
A11.Distance of the school from the village
A12. Distance of the primary health centre from the village
A13. Distance of the community health centre from the village
Introduction, Acclimatization and Questionnaire Background Information
A14. Participation? Y/N
B. BASIC INFORMATION
B1. Age
B2. Tribe
B3. Family Size
B4. Gender
B5. Education
B6. Religion (Donyi Polo/Christian/Hindu/Others(specify)

C. HOUSEHOLD DETAILS
Family Size (Members who eat regularly)
C1. Males (<18/Above 60)
C2. Females (<18/Above 60)
C3. Education (PG/UG/HS(11-12)/Secondary(9-10)/Middle(6-8)/Primary(1-5)/No education
C4. No. of Members
C5. Road connecting to nearest forest office? Y/N
C6. Means of transportation (Public transport/ Private vehicle/ On foot)
C7. Time to reach the FD (Divisional/Range) office
C8. Assets (Y/N)
T.V.
House
Radio
Refrigerator
Mobile phone
Smart Phone with internet
Motor bike
Car
Computer
Sewing machine
Water-Heater
Inverter
LPG connection
Toilet
Toilet with water source
Toilet without water Source

C9. Occupations and Source of Income (Y/N)
Agriculture
Labour (Daily wage)
Livestock rearing
Forest Product
Quarrying
Logging
Firewood
Hunting and bushmeat
Tourism
Weaving
Brewing
Remittances
Government Schemes
Permanent Government Employment
Contractual Government employment
Trade
Shopkeeper
Restaurant
Contract
Salaried in private office
Others (Specify)
Main income source
D. LAND OWNERSHIP
D1. How much land do you own? (Type/Quantity/Local Unit)
D2. What crops have you grown in the last year and how much area does it cover?

D2.1. Crops
1. Rice
2. Rubber
3. Potato
4. Yam
5. Ginger
6. Pineapple
7. Fallow
8. Others
9. Main Crop for income
D2.2. Sell/Home?Mix
D2.3. Area under cultivation (uni A & No. Plantation)
D2.4. Area Lost (Crop raiding/Invertebrates/Factors/Area loss & Unit
D2.5. Months
D3. Economic estimates
Expenditure for growing the main crop in the last year (Plantation, Initial Investment also considered)
D3.1. Main Income Crop
D3.2. Investment: Unit/Rupees
D3.3. If plantation (Annual/Miscellaneous)
D3.4. Yeild (kg): Unit/Rupees
D3.5. Selling price of crop/Kg (Rs)
D.4. Field Location
D.5. Have you changed the type of crop grown in your field in last five years? Y /N
D.6. If yes, what are the reasons for change in crops grown
1. low market price of the crop grown

2.high market price of the current crop
3.Subsidies are not available for the crop grown in past
4. Subsidies available for the current crop in terms of high yielding variety of seeds, fertilisers, loans
5. Labour availability
6. Irrigation is required for the past crops
7. Irrigation is not required for the current crop
8. Crop raiding by wildlife or fear of animal attack
9. Loss of previous land due to flood
10. Others (specify): Crops no longer grown/ Reasons(list in rank order)/New crops/Reasons(list in rank order)

E. How do you feed your livestock? What about in the monsoon?

E1. Livestock	E2. Number	E3. Stall fed	E4.Local Grazed		E5. Park grazed	
			E4.1. Days	E4.2. Hours	E5.1. ays	E5.2. Hours
1. Cattle						
2. Goats						
3. Pigs						
4. Poultry						
5. Mithun						

E6. Did you loose any livestock in the last five year by wildlife?

E7. If yes, How many and which year?

E8. What was the total loss of income due to livestock predation?_____ Rs.

F. Conflict

F1. What are the most common wild animals and birds that you have encountered in and around your village/Field last year and your interaction with them?

Note: Aesthetics, Cultural,

Species	-2	-1	0	+1	+2
Elephant					
Wild pig					
Bear					
Leopard					
Tiger					
Wild dog					
Macaque					
Porcupine Himalayan					
Porcupine G					
Snake					
Pheasants					
Bamboo rats and rodents					
Hare					
Jackal					
Others (specify)					

F2. Of the negatives, what are the three most conflicting species?

F3.What were the human wildlife interaction you experienced in the last year, note: Severity: Which conflict causes more

F3.1.Type	F3.2species	F3.3Months	F3.4Year	F3.5Times			F3.6Report to Govt.? (Which Dept, FD/AD)	F3.7Report t FD for reaso (compensat or rehabitilatio
				1	2-5	>5		

1. Conservation welfare (moral&cultural responsibility towards a species)						
2. Animal welfare (Responsibility towards an individual)						
3. Crop raiding(vertebrates)						
4. Livestock Depredation						
5. Animal attack If yes, deliberate or not						
6. Human Death						
7. If Yes, Deliberate or not						
8. Forestry Damage (Tree plantation)						
9. Crop Damage (Invertebrates)						
10. Property Damage						
11. Snake bite						
12. Human attack (Brey snake)						

F4. What size classes of elephant are involved in the HEC? (1= mixed herd, 2 = solitary male, 3 = solitary = female, 4 = single female with calves)

Conflict type	Size class
1. CR	
2. HI	
3. HD	
4. PD	

F5. If Yes, then details of the incident?

F6. CONSERVATION WELFARE: F6.1. What are the cultural ethos related to these species?

F7 ANIMAL WELFARE: F7.1. Where did you find the species?

F7.2. What do you plan to do with the species?

A) keep in captivity as a pet	
B) Give it to forest department	
C) Sell it to traders	
D) Eat it	
E) Release it back	
F) Others (Specify)	

F8. CROP RAIDING and LIVESTOCK DEPREDATION:

F8.1. Which animal are you more likely to kill?

A) The herbivores which raids crop	

B) Carnivores who predates on livestock?	
C)Both	
D)None of the above	

F9ANIMAL ATTACK: F9.1. Was the attack deliberate? (their perception)

F9.2. Where was the location of the attack?

A) Inside protected area	
B) Inside protected area	
C) Near forest	
D) Inside Village	
E) Others (Specify)	

F9.3. What were you doing when the animal attacked?

F10 .HUMAN DEATH: F10.1Has the animal that was involved in the incident killed other humans previously?

F10.2 If yes, How many?

F10.3 Where was the location of attack?

A) Inside protected area	
B) Near forest	
C) Inside Village	
D) Others (Specify)	

F11. FORESTRY DAMAGE: F11.1Which species was damaged by the animal?

F12.CROP DAMAGE:

F12.1. How Much did you lose due to the damage by invertebrates?

F12.2.Who do you think cause greater loss/damage to crops?

A) Vertebrates	
B) Invertebrates	
C) Same	

F13. PROPERTY DAMAGE:

F13.1. What property was damaged by the animals?

F13.2. When did the incident occur? (Month from the wheel)

A) 4-8 am	
B) 9-12 pm	
C) 1-4 pm	
D) 5-8Pm	
E) 9-12am	
F) 1-4 am	

F14. SNAKE BITE: F14.1. where did the snake bite you?

A) Inside protected area B) Outside protected area C) Near forest d D) Inside Village C) Others (Specify)

14.2 Timing of bite:

G) 4-8 am	
H) 9-12 pm	
I) 1-4 pm	
J) 5-8Pm	
K) 9-12am	
L) 1-4 am	

F14.3 What were you doing when the snake bit you?

F14.4 Did you take any treatment for the bite?

F14.5 If yes, hospital or traditional methods?

F14.6 What did you do with the snake?

A) Killed It	
B) let it go	
C) Others (specify)	

F15. HUMAN ATTACK: F15.1.why do you kill the particular species?

A) Cultural reasons	
B) May attack if not killed	
C) Was involved in conflict	
D) others (Specify)	

Please specify: _____

F16What do you think requires immediate attention out of the above-mentioned interactions?

F17From the above mentioned interaction which interaction causes the maximum economic loss?

F18.Are there any other costs or benefits you feel from having animals?

F19.In case of animal attack and Injury, who do you think are attacked very often?

1. Men	2. Women	3. Children	4. Elderly people

F20. Did FD visit you after the incident? Y/N

F21 FD visit:

1. Within 24 hours	2. Within 1 week	3. Within 1 month	4. >1 month

F22 Has the FD compensated you in cash or other method? Y/N, if others (Specify).

F23. Compensated amount?

1. <1000 Rs	2. <1000-5000 Rs	3. <5000-10000 Rs	4. >10000 Rs

Grain for grain

F24. Why didn't you apply for compensation?

1 Wasn't aware of any compensation schemes	
2 The loss was not significant	
3 don't know how to apply	
4 The FD office is inaccessible	
5 The govt. department are not cooperative (Specify the dept.)	
6 the cost of reporting is more than the compensation	
7 Others (Specify)	

G. Elephant specific

G1. Has the HEC increased or decreased in the last five years?

1. Increased 2. Decreased 3. No change . If yes, why do you think so?

G2. Which mitigation strategy did you use in the last five years?

Measures	Last five years	Type of Interaction	Species	Last year
1. Added or improved fencing				
2. Added or improved night time watching				
3. Added or improved use of guard animals				
4. Added or improved lighting				
5. Added or improved use of loud noise				
6. Added or improved scare devices				
7. Added or improved removal of waste				
8. Added or improved structure				
9. Change crop types				
10. Removal of brush				
11. Change animal breeds or type				

12. Allowed hunters				
13. Stopped hunters				
14. Closer watch				
15. Reduced feeding wild animals				
16. Reduced public land use				
17. Stall feeding animal				
18. Killing the problem animal				
19. Financial compensation				
20. Call forest department for rescue				
21. Machan				
22. Others (specify)				

G3. Which mitigation strategy was mostly used in the last year?

G4. Regarding the problem of these animals in field, house or forest, what would you suggest for solving the problems?

Measures	CR	LP	HI	HD
1. Using preventive methods in the property (use predator proof enclosures during nights, use electric fencing to surround pastures and/ or enclosures, keep heard away from the forests, etc.)				
2. Killing of problem animals				
3. Translocation of problem animal				
4. SMS alert				
5. Faux light				
6. Conflict manager				
7. Do not Know				

8. No solution				
9. Others				

I. Health Index

I1. In the last five years was any member of your family injured by wild animals, and hospitalised?

Yes, once
Yes, more than once (If multiple episodes describe any one of them)
No

I2. Who?

I3. How much did it cost?

Mention 0 in case none under category	Rs
1 Costs at the health centre/hospital (consultation fee/ doctors fees/registration)	
2 Medicine costs (either at hospital or outside prescription)	
3 Laboratory tests	
4 Transport	
5 Food and any other expenses	
6 Wage loss (if any including patient and dependents)	
7 Bribes/informal payments (if any)	
8 Any other	
Total	

J.1 What do you think causes greatest economic loss to you or your family every year?

Flood	

Draught	
Medical cost	
Loss due to wildlife	

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